Avian Use Studies for the Crocker Wind Farm Clark County, South Dakota

Year 1 Report

April 13, 2016 – March 28, 2017

Prepared for:

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EXECUTIVE SUMMARY

Crocker Wind Farm, LLC has proposed development of the Crocker Wind Farm (Project) in Clark County, South Dakota. Crocker Wind Farm, LLC contracted Western EcoSystems Technology, Inc. (WEST) to conduct baseline ecological studies at the Project to estimate levels of use by avian species and discuss the potential impacts of wind energy facility construction and operations on wildlife. This document provides results of the Year 1 fixed-point bird use surveys, including eagle and large bird and small bird surveys (as well as incidental observations) conducted from April 13, 2016, to March 28, 2017. Research at the Project was designed to help address the questions posed under Tier 3 of the US Fish and Wildlife Service final *Land-Based Wind Energy Guidelines* and Stage 2 of the *Eagle Conservation Plan Guidance* document. The principal objectives of the study were to: 1) provide site-specific bird resource and use data that would be useful for evaluating potential impacts from the proposed wind energy facility.

The Project is predominately herbaceous cover and hay/pasture (70%), with cultivated crops (16%) and open water (11%) composing most of the remaining land cover. Trees are sparse and are generally found in fence rows, small woodlots, or associated with lakes.

Fixed-point bird use surveys estimated the seasonal, spatial, and temporal use patterns of birds within the Project. Fixed-point surveys were conducted at 20 points located throughout the Project. To increase the likelihood of detecting different-sized birds, each survey was divided into two time periods where the first 20 minutes (min) were used to record all birds (with small birds recorded within a 100-meter (m) survey plot and large birds recorded within an 800-m survey plot), and the remaining 40 min were used to record only large birds (focusing on eagles) within an 800-m survey plot.

A total of 244 surveys were conducted in 15 visits, and 125 unique species were observed (124 during the surveys and one additional species observed incidentally). A total of 9,243 bird observations were recorded within 1,926 separate groups (defined as one or more individuals) during the 20-min fixed-point bird use surveys. Species composition was diverse, with no one species accounting for more than 8.5% of observations. The most abundant identifiable species were red-winged blackbird (8.5% of observations) and common grackle (7.3% of observations). The most abundant identifiable large bird species observed were Canada goose and greater scaup. A total of 78 diurnal raptor observations were recorded within the Project, representing six species.

Passerines were the most abundant bird type observed at the Project, with waterfowl being the second most abundant bird type. Raptor use was relatively low at the Project; mean annual diurnal raptor use was 0.29 raptors/800-m plot/20-min survey, which ranked 34th compared to 46 other studies of wind energy facilities where protocols similar to the present study were implemented and had data for three or four different seasons. Diurnal raptor use during the 20-min surveys was higher during the fall, summer, and spring (0.37, 0.34, and 0.48 birds/plot/20-

min survey, respectively) than during the winter (0.03). Red-tailed hawk accounted for most diurnal raptor use in all seasons. The raptor species with the highest exposure index was the red-tailed hawk, which was ranked 7th of all large bird species with exposure indices at the Project. Low diurnal raptor use was observed throughout the study area.

Eight bald eagle observations were documented during the 244 hours of fixed-point surveys at the Project, with a total of 14 flight minutes observed, 9 of which were documented within 800 m of the observer and below 200 m of height. Bald eagles were infrequently seen and no spatial pattern was discerned; use was documented mostly in spring, with single observations in fall and winter. No golden eagles were observed during the surveys.

Based on species composition of the most common raptor fatalities at other wind energy facilities and species composition of raptors observed at the Project during the surveys, the majority of the fatalities of diurnal raptors will likely consist of red-tailed hawk. The seasonal use data suggests that risk to raptors would be unequal across seasons, with the lower risk in the winter, and relatively higher risk during the remaining seasons.

No federal or state-listed threatened or endangered species were observed. Seventeen sensitive species were recorded during fixed-point bird use surveys, of which seven are listed as species of greatest conservation need in the South Dakota Wildlife Action Plan: bald eagle, American while pelican, chestnut-collared longspur, black tern, marbled godwit, Wilson's phalarope, and willet. Bald eagle is also protected by the Bald and Golden Eagle Protection Act. The remaining species are state rare animals in South Dakota (not state-listed but tracked by the state). Wilson's phalarope was only observed incidentally; each of the 14 remaining species observed incidentally were also observed during the fixed-point surveys.

WEST is currently conducting a second year of avian use surveys at the Project, and the second year report will update the analysis, discussion and conclusions of this Year 1 report.

STUDY PARTICIPANTS

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REPORT REFERENCE

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INTRODUCTION

Crocker Wind Farm, LLC is considering the development of the Crocker Wind Farm (Project) in Clark County, South Dakota. Crocker Wind Farm, LLC contracted Western EcoSystems Technology, Inc. (WEST) to conduct avian use surveys in the Project to estimate levels of use by avian species and discuss the potential impacts of wind energy facility construction and operations on birds. This document provides results of fixed-point bird use surveys, including eagle and large bird and small bird surveys (as well as incidental observations) conducted from April 13, 2016, to March 28, 2017. Research at the Project was designed to help address the questions posed under Tier 3 of the US Fish and Wildlife Service (USFWS) final *Land-Based Wind Energy Guidelines* (USFWS 2012) and Stage 2 of the *Eagle Conservation Plan Guidance* document (USFWS 2013). The following protocols were drafted based upon the most recent methods and recommendations provided by the USFWS and South Dakota Game, Fish, and Parks.

PROJECT AREA

The Project is located in Clark County, South Dakota (Figure 1). The Project falls within the Northern Glaciated Plains Ecoregion, which covers much of the eastern portion of South Dakota (Bryce et al. 1996). The Northern Glaciated Plains are characterized by a flat to gently rolling landscape composed of glacial drift. This ecoregion serves as a transitional zone between tall and shortgrass prairie with high concentrations of temporary and seasonal wetlands that are favorable for duck nesting and migration. The Project is located on a lobe of the Prairie Couteau between the James River to the west and the Big Sioux to the east. Vegetation is dominated by short grass and tall-grass prairies, interspersed with lakes and herbaceous wetlands. Agricultural conversion was primarily from grassland to pasture where soils were rocky or rolling, or corn and soybeans where the land can be tilled. The lands within the Project are characterized by rolling topography with an elevation range from 453.1-584.8 meters (m; 1,486.3–1,918.6 feet [ft]) above sea level. The higher elevations in the couteau run from the north-northwest to south-southeast gently sloping to lower elevations in the west toward the James River valley.

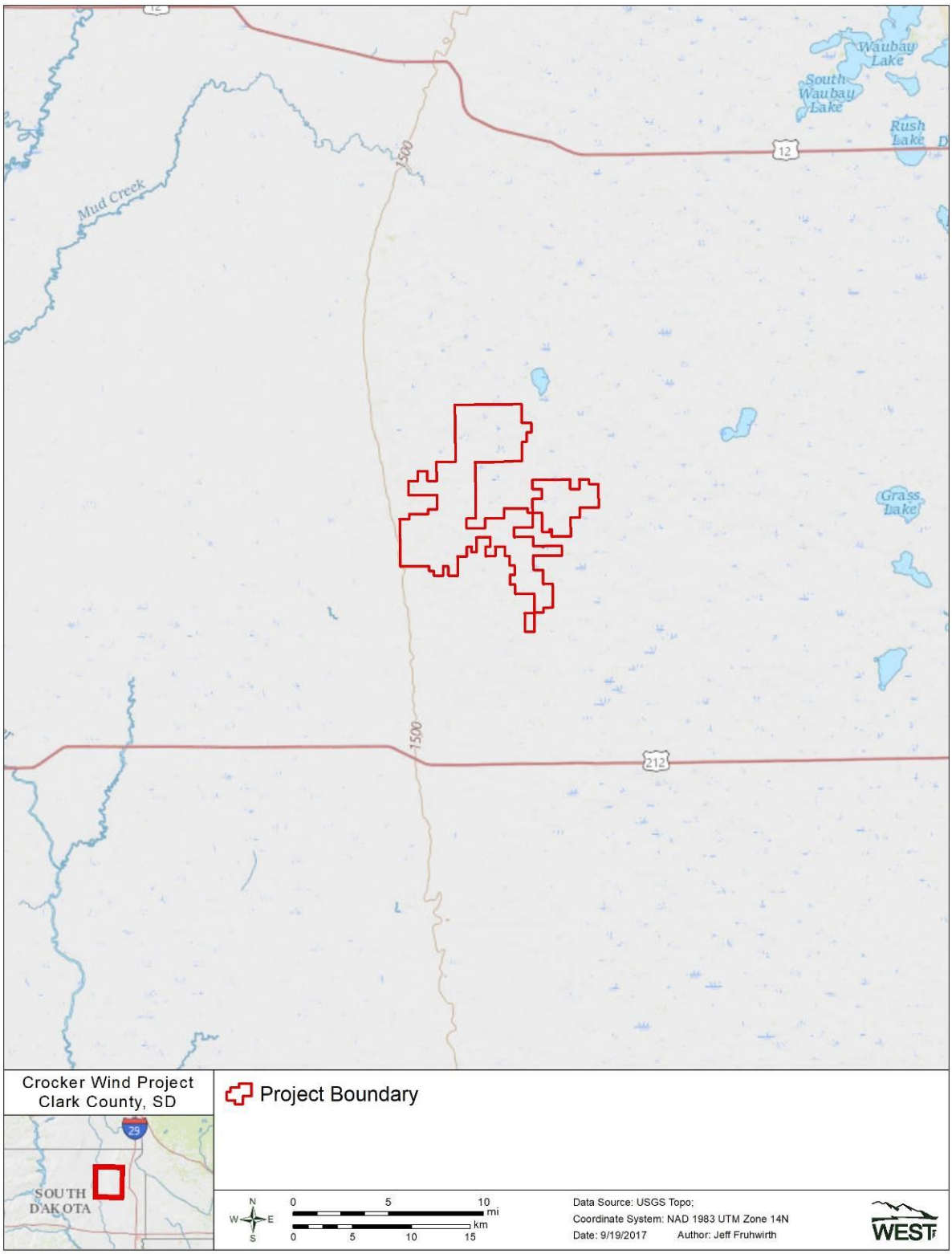

Figure 1. Location of the Crocker Wind Farm, Clark County, South Dakota.

METHODS

Studies at the Project included in this report consisted of the following: 1) fixed-point bird use surveys and 2) incidental wildlife observations.

Fixed-Point Bird Use Surveys

The objective of the fixed-point bird use surveys was to estimate the seasonal and spatial use of the Project by birds, particularly diurnal raptors (defined here as kites, accipiters, buteos, harriers, eagles, falcons, and osprey). Fixed-point bird use surveys (variable circular plots) were conducted using methods described by Reynolds et al. (1980).

Survey Plots

Initially, 16 points were selected in April 2016 within an initial boundary for the Project, to survey representative habitats and topography, while achieving relatively even coverage of the Project; the survey areas covered approximately 30% of the initial Project area per the USFWS *Eagle Conservation Plan Guidance*. After surveys had started at the initial 16 points, the Project boundary expanded to the north and an additional four points were added in late September 2016: Points 17, 18, 19, and 20. The Project boundary was further adjusted towards the end of 2016. As shown on Figure 2, Point 10 is now located outside of the revised Project boundary, along with the majority of the surveyed area associated with Point 7. The data from these points are included in this report along with the data from the points that remain within the modified boundary, since the land cover and topography are similar to other areas within the final Project boundary. While the 20 points surveyed between April 2016 and March 2017 do not cover 30% of the modified Project boundary, it should be noted that a second year of surveys that WEST is currently conducting at the Project added points to cover 30% of the proposed Project area.

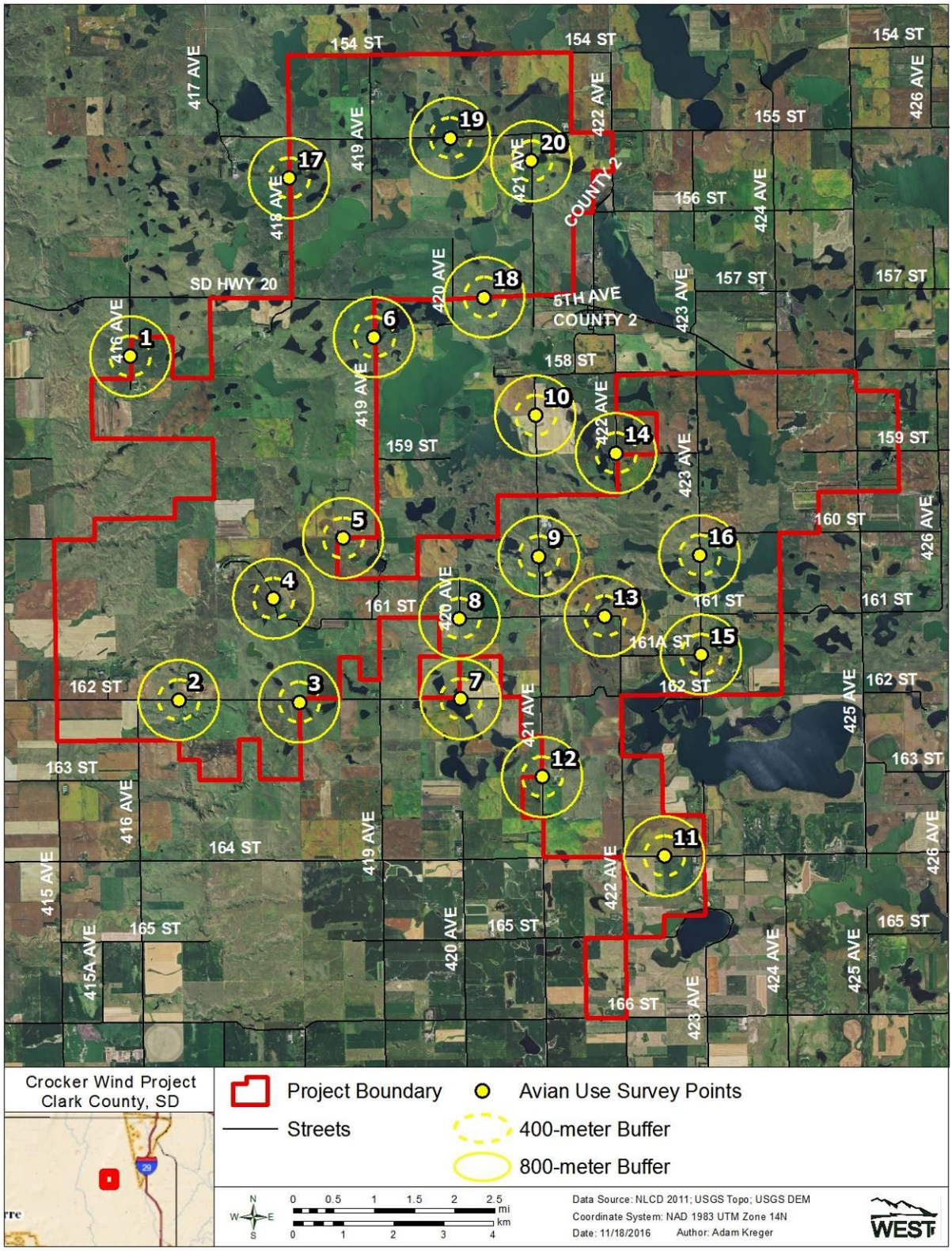

Figure 2. Fixed-points for fixed-point bird use surveys at the Crocker Wind Farm.

Survey Methods

To be consistent with methods employed at other wind energy facilities, surveys were conducted for 20 minutes (min) for large and small birds, and an additional 40 min (60 min total) for large birds only, focusing on eagles. Every bird observed during each survey was recorded, and a unique observation number was assigned to each observation of a group of the same species. Observations of large birds beyond the 800-m radius were recorded, but were not included in statistical analyses. For small birds, observations beyond the 100-m radius were excluded. Large birds included waterbirds, waterfowl, rails and coots, grebes and loons, gulls and terns, shorebirds, diurnal raptors, owls, vultures, upland game birds, doves and pigeons, large corvids (i.e., ravens, magpies, and crows), and goatsuckers. Passerines (excluding large corvids), kingfishers, swifts and hummingbirds, woodpeckers, and most cuckoos were considered small birds.

The date, start and end time of the 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 possible), 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 at first observation were recorded to the nearest 5-m interval. Other information recorded included whether or not the observation was auditory only and the 10-min interval of the 20-min survey in which it was first observed.

For bald eagle (*Haliaeetus leucocephalus*) or golden eagle (*Aquila chrysaetos*) observations, flight height, distance, and behavior data were recorded during each 1-min interval the eagle was within view, per the USFWS *Eagle Conservation Plan Guidance*. Any unusual observations were also noted.

Locations of diurnal raptors, other large birds, and species of concern observed during surveys were recorded on field maps by unique observation number. Flight paths and perch locations were digitized using ArcGIS 10.0. Comments were recorded in the comments section of the data sheet.

Observation Schedule

Sampling intensity was designed to document bird use and behavior by habitat and season within the Project. Surveys were conducted at Points 1-16 from April 12, 2016, to March 30, 2017; and from September 28, 2016, to March 30, 2017 at Points 17-20. Surveys were conducted once month throughout the year except during April, May, and June 2016, when surveys were conducted twice per month. Surveys were conducted during daylight hours and survey periods were varied to approximately cover all daylight hours during a season. To the extent practical, each point was surveyed roughly the same number of times. Some surveys were not conducted due to poor visibility as a result of weather conditions (heavy fog) or site access issues (e.g., muddy roads, unplowed minimum maintenance).

Incidental wildlife observations provide records of wildlife seen outside of the standardized surveys. All diurnal raptors, unusual or unique birds, sensitive species, mammals, reptiles, and amphibians were recorded in a similar fashion to standardized surveys. 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 sensitive species was recorded by Universal Transverse Mercator coordinates using a hand-held Global Positioning System unit.

Statistical Analysis

For analysis purposes, a visit was defined as the required length of time, in days, to survey all of the plots once within the Project. 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, but a single date could not contain surveys from multiple visits. 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 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 being questionable were discussed with the observer and/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® ACCESS or Structured Query Language Server 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

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. In some cases, the tally may represent repeated sightings of the same individual. For example, a sum of 50 observations of northern harrier (*Circus cyaneus*) may be 50 unique birds, or it may be one bird observed on 50 separate visits, or something in between. Species richness by season was calculated by 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 fixed-point bird use surveys.

Bird Use, Percent of Use, and Frequency of Occurrence

For generating standardized fixed-point bird use estimates, large birds detected within the 800-m radius plot at any time were used in the analysis; small birds recorded within a 100-m radius at any time during the first twenty minutes were included in the small bird analysis. The metric used to measure mean bird use was the number of birds/plot/survey. These standardized estimates of mean bird use were used to compare differences between bird types, seasons, survey points, and other studies where similar methods were used. Mean use by season was calculated by 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.

Percent of use was calculated as the proportion of the overall mean use for a particular bird type or species, and the frequency of occurrence was calculated as the percent of surveys in which a particular bird type or species was observed. Frequency of occurrence and percent composition provide relative measures of species use of the proposed wind energy facility. For example, a particular species might have high use estimates for the study area based on just a few observations of large groups. However, the frequency of occurrence would indicate that the species only occurred during a few of the surveys; therefore the species would be less likely to be affected by the wind energy facility.

Bird Flight Height and Behavior

Bird flight heights are important metrics to assess 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. A RSH for potential collision with a turbine blade of 82 to 492 ft above ground level was used for the purposes of the analysis. 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 birds flying within the RSH at any time was calculated using the lowest and highest flight heights recorded.

Bird Exposure Index

The bird exposure index is used as a relative measure of species-specific risk of turbine collision and the species most likely to occur as fatalities at the wind energy facility. A relative index of bird exposure (*R*) was calculated for bird species observed during the surveys using the following formula:

$$R = A \times P_f \times P_t$$

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. The exposure index does not account for other possible collision risk factors, such as foraging or courtship behavior.

Spatial Use

Large bird use data were qualitatively compared to Project area characteristics (e.g., topographic features, water bodies), to identify potential areas of concentrated use by diurnal raptors and other large birds within the Project. This information can be useful in turbine layout design or micro-siting individual turbines to reduce risk to birds.

RESULTS

Fixed-point bird use surveys were conducted within the Project from April 13, 2016, to March 28, 2017. It should be noted that the data from one visit in in the winter season (mid- to late December 2016) is not included in this analysis because site access prevented surveys during a portion of that month, and the datasheets from surveys that were conducted were lost. One-hundred-twenty-five bird species were identified during the wildlife studies at the Project: 109 species during the initial 20-min survey periods (Appendix A1), 15 additional species observed during the remaining 40-min large bird survey period (Appendix A2), and one additional species documented only incidentally (Table 9). Results of the fixed-point bird use surveys and incidental wildlife observations, as well as the specific numbers of unique species for each survey type, are presented below.

Fixed-Point Bird Use Surveys

A total of 244 fixed-point bird use surveys were conducted within the Project during 15 visits (Table 1). Two viewsheds were used when calculating species richness, use, percent composition, percent frequency, and exposure index: 800 m for large birds and 100 m for small birds.

Bird Diversity and Species Richness

One-hundred-twenty-four unique species were observed over the course of all of the fixed-point bird use surveys (Table 1). A mean of 2.95 small bird species/100-m plot/20-min survey and 2.14 large bird species/800-m plot/20-min survey were recorded. Bird diversity (the number of unique species observed) was higher during the spring (89 species), summer (78 species), and fall (61 species) than in winter (24 species). Small bird species richness (mean number of bird species per plot per survey) was highest during the summer (6.05 species/100-m plot/20-min survey) and lowest during the winter (0.51 species/100-m plot/20-min survey; Table 1). Large bird species richness was highest during the spring (3.82 species/800-m plot/20-min survey) and lowest in the winter (0.37 species/800-m plot/20-min survey; Table 1).

Table 1. Summary of species richness and sample size by season and overall during the fixed-point bird use surveys at the Crocker Wind Farm from April 13, 2016 – March 28, 2017.

Season	Number of Visits	# Surveys Conducted	# Unique Species[a]	Species Richness	
				Large Birds[b]	Small Birds[c]
Spring	5	75	89	3.82	3.82
Summer	4	63	78	2.81	6.05
Fall	3	48	61	1.85	1.56
Winter	3	58	24	0.37	0.51
Overall	**15**	**244**	**124**	**2.14**	**2.95**

[a] using all species observed during 60-min survey duration
[b] using 20-min data/800-m radius survey plot for large birds
[c] using 20-min data/100-m radius survey plot for small birds.

A total of 9,243 bird observations were recorded within 1,926 separate groups (defined as one or more individuals) during the 20-min fixed-point bird use surveys (Appendix A1). Species composition was diverse, with no one species accounting for more than 8.5% of observations; the most abundant identifiable species were red-winged blackbird (*Agelaius phoeniceus*; 8.5% of observations) and common grackle (*Quiscalus quiscula*; 7.3% of observations). Among all bird types, passerines were the most abundant (44.5% of observations), followed closely by waterfowl (36.0%). The most commonly recorded identifiable large bird species observed were Canada goose (*Branta canadensis*; 561 observations in 63 groups) and greater scaup (*Aythya marila*; 500 observations in one group). A total of 78 diurnal raptor observations were recorded within the Project during 20-min surveys, representing six species (Appendix A1) and 135 total observations were recorded during the 60-min surveys (Appendix A2), representing eight species (rough-legged hawk [*Buteo lagopus*] and prairie falcon [*Falco mexicanus*] were only documented in the 40-min large bird only portions of the surveys). Red-tailed hawk (*Buteo jamaicensis*) and accounted for the majority of diurnal raptor observations (65.4% during the 20-min surveys; Appendix A1). Eight bald eagles were observed during the 244 hours of surveys conducted at the Project (Appendix A2). No golden eagles were observed during the surveys at the Project.

Bird Use, Percent of Use, and Frequency of Occurrence

Mean bird use, percent of use, and frequency of occurrence were calculated by season for all bird types (Table 2) and species (Appendix B1 shows the 20-min data and Appendix B2 shows the 60-min data). A 100-m viewshed was used for small birds; therefore descriptive statistics for small bird types are not directly comparable to large bird types. Small bird use was highest in the spring and summer (14.96 and 13.90 birds/100-m plot/20-min survey), followed by fall (10.29 birds/100-m plot/20-min survey), and winter (5.25 birds/100-m plot/20-min survey; Table 2). The highest large bird use occurred during the spring (31.97 birds/800-m plot/20-min survey), followed by fall, (18.96 birds/800-m plot/20-min survey), winter (13.73 birds/800-m plot/20-min survey), and summer (9.06 birds/800-m plot/20-min survey; Table 2, Appendix B1).

Passerines

Passerine use was higher during the spring, summer, and fall (14.82, 13.90, and 10.18 birds/100-m plot/20-min survey, respectively) than during the winter (5.25 birds/100-m plot/20-min survey; Table 2). During fall, 79.0% of passerine use was attributable to four species: red-

winged blackbird (5.87 birds/100-m plot/20-min survey), common grackle (2.92 birds/100-m plot/20-min survey), brown-headed cowbird (1.64 birds/100-m plot/20-min survey), and western meadowlark (*Sturnella neglecta;* 1.28 birds/100-m plot/20-min survey; Appendix B1). During summer, European starling (*Sturnus vulgaris*) and common grackle had the highest use among passerines (1.58 and 1.51 birds/100-m plot/20-min survey, respectively). European starling, red-winged blackbird, and Brewer's blackbird (*Euphagus cyanocephalus)* had the highest use during the fall (1.91, 1.68, and 1.39 birds/100-m plot/20-min survey, respectively). During winter, Lapland longspur (*Calcarius lapponicus)*, snow bunting (*Plectrophenax nivalis*), and horned lark (*Eremophila alpestris)* had the highest use among passerine species (1.73, 1.35, and 1.27 birds/100-m plot/20-min survey; Appendix B1). Passerines were observed during more than 90% of surveys during spring and summer, during 73.2% of surveys in fall, and during 42.7% of winter surveys (Table 2).

Loons/Grebes

Pied-billed grebe (*Podilymbus podiceps*) was the only loon/grebe species observed, and use by this species was only observed in fall during the 20-min portion of the surveys (0.06 birds/800-m plot/20-min survey; Table 2, Appendix B1); one observation also was documented in the summer during the latter 40-min potion of the surveys (Appendix A2). Pied-billed grebe accounted for 0.3% of large bird use in fall and was observed during 2.8% of surveys (Table 2).

Waterbirds

Waterbirds were observed in spring, summer, and fall, and use was higher during spring and fall (4.32 and 3.32 birds/800-m plot/20-min survey) than in summer (1.97 birds/800-m plot/20-min survey (Table 2). Most waterbird use in spring (77.8%) was attributable to American white pelican (*Pelecanus erythrorhynchos*; Appendix B1). American white pelican and great egret (*Ardea alba*) accounted for most use in summer, and double-crested cormorant accounted for most waterbird use in fall. Waterbirds accounted for 21.7% of all large bird use in summer, 17.5% of large bird use in fall, and 13.5% of use in spring (Table 2). Waterbirds were observed during 35% of summer surveys, 28.6% of surveys during spring, and 16.8% of fall surveys (Table 2).

Waterfowl

Waterfowl had the highest use during the spring (21.95 birds/800-m plot/20-min survey), followed by winter, (13.37 birds/800-m plot/20-min survey), fall (7.94 birds/800-m plot/20-min survey), and summer (1.86 birds/plot/20-min survey; Table 2). Six species accounted for 91% of waterfowl use in spring: greater scaup (5.00 birds/800-m plot/20-min survey), snow goose (*Chen caerulescens;* 4.12), Canada goose (3.66), mallard (*Anas platyrhynchos*; 3.52), lesser scaup (*Aythya affinis*; 2.09), and blue-winged teal (*Anas discors*; 1.65; Appendix B1). During winter, unidentified ducks accounted for 88.6% of waterfowl use. Canada goose had the highest use among waterfowl species in fall (4.34 birds/800-m plot/20-min survey), and mallard had highest use in summer (0.51 birds/800-m plot/20-min survey; Appendix B1). Waterfowl accounted for nearly all large bird use in winter (97.4%), 68.7% of large bird use in spring, 41.9% of large bird use in fall, and 20.5% of large bird use in summer. Waterfowl were observed

frequently during the spring (72.1% of surveys), than during, summer, fall, and winter (33.2%, 36.5%, and 10.0% of surveys, respectively; Table 2, Appendix B1).

Shorebirds

Shorebird use was higher in spring and fall (2.08 and 3.33 birds/800-m plot/20-min survey, respectively) than in fall (1.26); shorebirds were not observed in winter (Table 2). Shorebirds composed 17.6% of large bird use in fall, 13.9% in summer, and 6.5% of large bird use in spring (Table 2). Shorebirds were observed more frequently during spring and summer (58.9% and 49.4% of surveys, respectively) than during the fall (22.8% of surveys; Table 2).

Gulls/Terns

Gull/tern use was highest in fall (3.52 birds/800-m plot/20-min survey), followed by summer (2.59), spring (2.37), and winter (0.02; Table 2). Gulls/terns accounted for 28.6% of large bird use in summer, 18.6% in fall, 7.4% in spring, and 0.1% of use in winter. Gulls/terns were observed during 23.2% of surveys in spring, 15.6% of summer surveys, 14.9% of fall surveys, and during 1.7% of surveys during winter (Table 2).

Rails/Coots

American coot (*Fulica americana*) was the only rails/coot species observed during the 20-min portion of the surveys, and American coot use was only observed in spring (0.24 birds/800-m plot/20-min survey; Table 2, Appendix B1). Rails/coots accounted for less than 1% of large bird use during spring and were observed during fewer than 2% of surveys (Table 2). One observation of Virginia rail (*Rallus limicola)* was documented in the summer during the 40-min large bird only portion of the surveys (Appendix A2).

Diurnal Raptors

Diurnal raptor use was highest during the summer (0.48 birds/800-m plot/20-min survey) followed by fall and spring (0.37 and 0.34 birds/plot/20-min survey, respectively); diurnal raptor use in winter was low (0.03; Table 2). Red-tailed hawk accounted for most diurnal raptor use in each season (Appendix B1). Red-tailed hawk, American kestrel (*Falco sparverius*) and bald eagle were the only diurnal raptors with use in the winter, and each of these were only seen once or twice during that season (Appendix A2). Diurnal raptors accounted for less than 6% of large bird use each season (Table 2). Diurnal raptors were observed more frequently in spring, summer and fall (26.0%, 36.7%, and 30.3% of surveys, respectively) than in winter (3.3%; Table 2).

Vultures and Owls

Turkey vulture (*Cathartes aura*) was the only vulture species observed, and use by turkey vulture only occurred during the spring (0.01 birds/800-m plot/20-min survey; Table 2; Appendix B1). Turkey vulture composed less than 0.1% of overall large bird use during spring and was observed during 1.2% of surveys (Table 2; Appendix B1). No owls were seen during the 20-min portion of the surveys; one group of two great horned owls was observed during fall during the 40-min large bird only portions of the surveys (Appendix A2).

Upland Game Birds

Upland gamebird use was higher in spring and summer (0.40 and 0.43 birds/800-m plot/20-min survey, respectively) than in fall and winter (0.22 and 0.14, respectively; Table 2). Ring-necked pheasant accounted for most game bird use in spring and summer, while wild turkey accounted for most game bird use in fall and winter. Upland gamebirds accounted for less than 5% of large bird use in each season (Table 2). Gamebirds were observed more frequently in spring and summer (30.5% and 25.3% of surveys, respectively) than in fall or winter (3.8% and 3.5%, respectively; Table 2).

Large Corvids

American crow (*Corvus brachyrhynchos*) was the only large corvid observed (Appendix B1), and use by this species was only observed in spring and winter (0.01 and 0.07 birds/800-m plot/20-min survey, respectively; Table 2, Appendix B1). American crow accounted for less than 1% of overall large bird use during either spring or winter. American crow was observed during less than 4% of surveys during either season (Table 2, Appendix B1).

Goatsuckers

Common nighthawk (*Chordeiles minor*) was the only goatsucker species observed, and use by this species was only observed in summer (0.02 birds/800-m plot/20-min species; Table 2, Appendix B1). Common nighthawk accounted for 0.2% of large bird use in summer and was observed during 1.6% of surveys (Table 2; Appendix B1).

Table 2. Mean bird use (number of birds/plot[a]/20-min survey), percent of total use (%), and frequency of occurrence (%) for each bird type and species by season during the fixed-point bird use surveys at the Crocker Wind Farm from April 13, 2016 – March 28, 2017.

	Mean Use				% of Use				% Frequency			
Type/Species	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
Loons/Grebes	0	0	0.06	0	0	0	0.3	0	0	0	2.8	0
Waterbirds	4.32	1.97	3.32	0	13.5	21.7	17.5	0	28.6	35.0	16.8	0
Waterfowl	21.95	1.86	7.94	13.37	68.7	20.5	41.9	97.4	72.1	33.2	36.5	10.0
Shorebirds	2.08	1.26	3.33	0	6.5	13.9	17.6	0	58.9	49.4	22.8	0
Gulls/Terns	2.37	2.59	3.52	0.02	7.4	28.6	18.6	0.1	23.2	15.6	14.9	1.7
Rails/Coots	0.24	0	0	0	0.7	0	0	0	1.2	0	0	0
Diurnal Raptors	0.34	0.48	0.37	0.03	1.1	5.3	2.0	0.2	26.0	36.7	30.3	3.3
Accipiters	*0.03*	*0.02*	*0.03*	*0*	*<0.1*	*0.2*	*0.1*	*0*	*2.9*	*1.6*	*2.8*	*0*
Buteos	*0.23*	*0.41*	*0.27*	*0.03*	*0.7*	*4.6*	*1.4*	*0.2*	*18.6*	*31.9*	*23.1*	*3.3*
Northern Harrier	*0.04*	*0.05*	*0.03*	*0*	*0.1*	*0.5*	*0.1*	*0*	*3.8*	*4.8*	*2.8*	*0*
Eagles	*0.04*	*0*	*0.02*	*0*	*0.1*	*0*	*<0.1*	*0*	*2.0*	*0*	*1.7*	*0*
Falcons	*0*	*0*	*0.03*	*0*	*0*	*0*	*0.1*	*0*	*0*	*0*	*2.8*	*0*
Vultures	0.01	0	0	0	<0.1	0	0	0	1.2	0	0	0
Upland Game Birds	0.40	0.43	0.22	0.14	1.2	4.7	1.2	1.0	30.5	25.3	3.8	3.5
Doves/Pigeons	0.25	0.46	0.21	0.10	0.8	5.1	1.1	0.7	14.8	27.0	10.4	1.7
Large Corvids	0.01	0	0	0.07	<0.1	0	0	0.5	1.0	0	0	3.5
Goatsuckers	0	0.02	0	0	0	0.2	0	0	0	1.6	0	0
Large Bird Overall	**31.97**	**9.06**	**18.96**	**13.73**	**100**	**100**	**100**	**100**				
Passerines	14.82	13.90	10.18	5.25	99.1	100	99.0	100	93.8	98.4	73.2	42.7
Woodpeckers	0.09	0	0.08	0	0.6	0	0.8	0	7.5	0	6.2	0
Kingfishers	0.01	0	0	0	<0.1	0	0	0	1.2	0	0	0
Unidentified Birds	0.04	0	0.02	0	0.3	0	0.2	0	2.5	0	2.1	0
Small Bird Overall	**14.96**	**13.90**	**10.29**	**5.25**	**100**	**100**	**100**	**100**				

[a] 800-meter (m) radius plot for large birds and 100-m for small birds.

Bird Flight Height and Behavior

Flight height characteristics, based on initial flight height observations and estimated use, were estimated for both bird types and species (Tables 4 and 5). During 20-min fixed-point bird use surveys, 320 groups of large birds were observed flying within the 800-m plot, totaling 1,775 observations. Overall, 16.6% of flying large birds was recorded within the RSH, 48.5% were below the RSH, and 34.9% were flying above the RSH. Among large birds, large corvids (American crow) had the highest percentage of flying birds within the RSH (75.0%) followed by waterbirds (53.4%). One-third (33.3%) of flying diurnal raptors were observed within the RSH, while54.9% were below the RSH and 11.8% were above the RSH. Among diurnal raptor subtypes, buteos had the highest percentage (36.8%) of flying birds recorded within the RSH, followed by accipiters (33.3%), bald eagles (25.0%), and northern harrier (20.0%); no falcons were observed flying within the RSH. Shorebirds, gulls/terns, goatsuckers, and upland game birds were typically observed flying below the RSH, while waterfowl and vultures were typically observed flying above the RSH. The majority of passerines within the 100-m plots (99.0%) were observed below the estimated RSH, while 1.0% were recorded within the RSH; no passerines were observed flying above the RSH (Table 3).

Five large bird species had at least 20 groups observed in flight (Appendix C1). Among these five species, only red-tailed hawk was observed flying within the likely RSH during at least one-third of initial observations (36.7%; Table 4). Two species, northern shoveler (*Anas clypeata*) and California gull (*Larus californicus*), were observed flying within the likely RSH during 100% of observations; however, only one individual of each species was observed. Of all passerine and small bird species, two species had at least one group initially observed flying within the RSH (Appendix C2), and no small bird species were initially observed within the RSH during more than 5% of observations (Table 4).

Table 3. Flight height characteristics by bird type[a] and raptor subtype during 20-minute fixed-point bird use surveys at the Crocker Wind Farm from April 13, 2016 – March 28, 2017.

Bird Type	# Groups Flying	# Obs Flying	Mean Flight Height (m)	% Obs Flying	% within Flight Height Categories		
					0 - 25 m	25 - 150 m[b]	> 150 m
Loons/Grebes	0	0	0	0	0	0	0
Waterbirds	50	174	16.52	29.6	46.6	53.4	0
Waterfowl	107	1,022	28.74	30.8	31.2	11.7	57.0
Shorebirds	43	249	19.30	63.5	76.3	11.6	12.0
Gulls/Terns	41	222	20.37	42.4	85.1	14.9	0
Rails/Coots	0	0	0	0	0	0	0
Diurnal Raptors	48	51	48.10	68.9	54.9	33.3	11.8
Accipiters	*3*	*3*	*11.00*	*100*	*66.7*	*33.3*	*0*
Buteos	*36*	*38*	*35.53*	*65.5*	*55.3*	*36.8*	*7.9*
Northern Harrier	*5*	*5*	*19.00*	*71.4*	*80.0*	*20.0*	*0*
Eagles	*3*	*4*	*300.00*	*80.0*	*0*	*25.0*	*75.0*
Falcons	*1*	*1*	*2.00*	*100*	*100*	*0*	*0*
Vultures	1	1	200.00	100	0	0	100
Upland Game Birds	3	7	3.67	9.7	100	0	0
Doves/Pigeons	24	44	4.83	73.3	100	0	0

Table 3. Flight height characteristics by bird type[a] and raptor subtype during 20-minute fixed-point bird use surveys at the Crocker Wind Farm from April 13, 2016 – March 28, 2017.

Bird Type	# Groups Flying	# Obs Flying	Mean Flight Height (m)	% Obs Flying	% within Flight Height Categories		
					0 - 25 m	25 - 150 m[b]	> 150 m
Large Corvids	2	4	30.00	80.0	25.0	75.0	0
Goatsuckers	1	1	5.00	100	100	0	0
Large Birds Overall	**320**	**1,775**	**25.83**	**35.1**	**48.5**	**16.6**	**34.9**
Passerines	450	1,481	3.66	53.9	99.0	1.0	0
Woodpeckers	9	9	6.33	81.8	100	0	0
Kingfishers	0	0	0	0	0	0	0
Unidentified Birds	1	1	12.00	25.0	100	0	0
Small Birds Overall	**460**	**1,491**	**3.73**	**54.0**	**99.0**	**1.0**	**0**

[a.] 800-meter (m) radius plot for large birds and 100-m radius plot for small birds.
[b.] The likely "rotor-swept height" for potential collision with a turbine blade, or 25 to 150 m (82 to 492 ft) 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 bird species (Appendix C1). Those species that had exposure to the RSH during the initial observation are listed in Table 4, and a complete list of all species is presented in Appendix C1. Based on observations within 100 m, the only small bird species with exposure indices were red-winged blackbird and common grackle, with indices of 0.04 and 0.01, respectively (Table 4). The large bird species with the highest exposure indices were Canada goose and American white pelican (0.23 and 0.22, respectively). Among diurnal raptors, red-tailed hawk had the highest exposure index (0.04; Table 4). The bald eagles documented within the 20-minute surveys had a relative exposure index of < 0.01 (Table 4).

Table 4. Relative exposure index and flight characteristics for bird species[a] during 20-minute fixed-point bird use surveys at the Crocker Farm from April 13, 2016 – March 28, 2017.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within RSH[b] based on Initial obs	Exposure Index	% Within RSH at Anytime
Large Bird Species[c]						
Canada goose	31	2.00	69.4	16.5	0.23	33.5
American white pelican	14	1.09	24.0	83.3	0.22	83.3
mallard	43	1.26	39.8	23.9	0.12	38.7
double-crested cormorant	15	0.78	31.1	47.3	0.11	80.0
unidentified sandpiper	4	0.32	75.9	42.9	0.10	90.5
Franklin's gull	20	1.11	48.7	12.2	0.07	55.4
red-tailed hawk	28	0.19	63.8	36.7	0.04	56.7
ring-billed gull	15	0.20	50.0	40.7	0.04	48.1
snow goose	2	1.04	99.8	2.9	0.03	2.9
American crow	2	0.02	80.0	75.0	0.01	100
unidentified gull	4	0.51	8.6	18.2	<0.01	45.5
Swainson's hawk	6	0.03	85.7	33.3	<0.01	50.0
gadwall	3	0.12	18.8	33.3	<0.01	33.3
northern shoveler	1	0.12	5.7	100	<0.01	100
northern pintail	4	0.03	44.4	50.0	<0.01	50.0
California gull	1	0.01	50.0	100	<0.01	100

Table 4. Relative exposure index and flight characteristics for bird species[a] during 20-minute fixed-point bird use surveys at the Crocker Farm from April 13, 2016 – March 28, 2017.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within RSH[b] based on Initial obs	Exposure Index	% Within RSH at Anytime
Cooper's hawk	3	0.02	100	33.3	<0.01	33.3
great egret	17	0.27	52.4	3.0	<0.01	3.0
great blue heron	3	0.02	50.0	33.3	<0.01	33.3
northern harrier	5	0.03	71.4	20.0	<0.01	20.0
killdeer	36	1.00	70.1	0.5	<0.01	14.2
blue-winged teal	17	0.51	19.0	3.6	<0.01	3.6
unidentified buteo	2	0.01	50.0	50.0	<0.01	50.0
marbled godwit	2	<0.01	66.7	50.0	<0.01	50.0
bald eagle	3	0.01	80.0	25.0	<0.01	25.0
Small Bird Species[c]						
red-winged blackbird	45	2.00	42.3	4.3	0.04	43.9
common grackle	70	1.17	40.2	3.0	0.01	3.0

[a] Only includes species with actual exposure index values; see Appendix C1 for full listing.
[b] The likely "rotor-swept height" for potential collision with a turbine blade, or 25 to 150 m (82 to 492 ft) above ground level.
[c.] 800-m radius plot for large birds and 100-m radius plot for small birds.

Spatial Use

Passerine use, observed within 100 m, was highest at Point 19 (30.0 birds/20-min), and use ranged from 0.67 to 21.9 birds/20-min survey at the other points (Figure 3, Appendix D1). High passerine use at Point 8 was due to one group of 500 snow buntings, and several large groups of other common species, such as red-winged blackbird, American robin (*Turdus migratorius*), and European starling. For all large bird species combined, use was highest at Points 19 and 10 (130 and 66.8 birds/20-min survey, respectively; Figure 3, Appendix D1). No large birds were observed at Points 18 and 20 (for the 20-minute portions of the survey hours that were surveyed September – November 2016 and January – March 2017, and large bird use at other points ranged from 1.08 to 43.6 birds/20-min survey (Appendix D1). The high mean large bird use estimate for Point 19 was largely due to one group of 500 greater scaup and one group of 120 snow geese. At Point 10, relatively high large bird use was attributable to one group of 700 unidentified ducks. Because of these large groups of waterfowl, use by waterfowl was also highest at Points 19 and 10 (110 and 64.4 birds/20-min survey, respectively). Waterfowl use at other points ranged from zero to 34.1 birds/20-min survey. Waterbird use was highest at Point 19 (15.7 birds/20-min survey) and ranged from zero to 5.92 birds/20-min survey at other points. Loon use was only observed at Point 7, while rail/coot use was only observed at Point 6. Shorebirds were observed at all points except Points 18 and 20, with use ranging from 0.15 to 6.14 birds/20-min survey. Diurnal raptors were observed at all points except Points 18 and 20, with use ranging from 0.07 birds/20-min survey at Point 9 to 0.69 at Point 16. Upland gamebird use was highest at Point 15 (1.71 birds/20-min survey), and use ranged from zero to 0.60 birds/20-min survey at other points. Bald eagles were observed at Points 11, 13, and 15, with use ranging from 0.07 to 0.15 birds/20-min survey (Appendix D1). When the 60-min data is examined, bald eagles were observed at five points: 6, 8, 11, 13 and 15 (Appendix D2).

Flight path data includes large bird observations for the entire 60-min survey period. Diurnal raptor flight paths in spring appeared to be concentrated at Points 1, 9, 12, 14, 16, which form a general east-west line through the middle of the Project, as well as at Point 7 in the southwest, just outside of the revised project boundary (Appendix E). In summer, diurnal raptor use was distributed across the Project, with no discernable spatial patterns. Diurnal raptor flight paths in fall and winter were also distributed across the Project with no discernable areas of concentrated activity. The relatively few documented bald eagle flight paths recorded during surveys did not show a spatial pattern (Appendix E).

Waterbird and waterfowl flight paths in spring appeared to be generally distributed throughout the portion of the Project with a full year of data; the lack of flightpaths in the northern portion of the Project in Points 17 – 20 is likely the fact that surveys only occurred during one spring session in March 2017 (Appendix E). In summer, waterbird and waterfowl activity was lower than spring, with some points that had relatively high density of flightpaths in spring showing little to know flightpaths in the summer (Point 1, Point 5); again the lack of flightpaths in the northern four points is due to the fact that no summer surveys were conducted in 2016 at these locations. During fall, the number of waterbird and waterfowl flight paths was relatively higher at Points 10 13 and 6 in the general center of the Project. Few waterfowl and waterbird flight paths were recorded in winter. Overall, no obvious waterbird/waterfowl flyways were observed beyond a general relatively high use in multiple directions across the Project, particularly during spring (Appendix E).

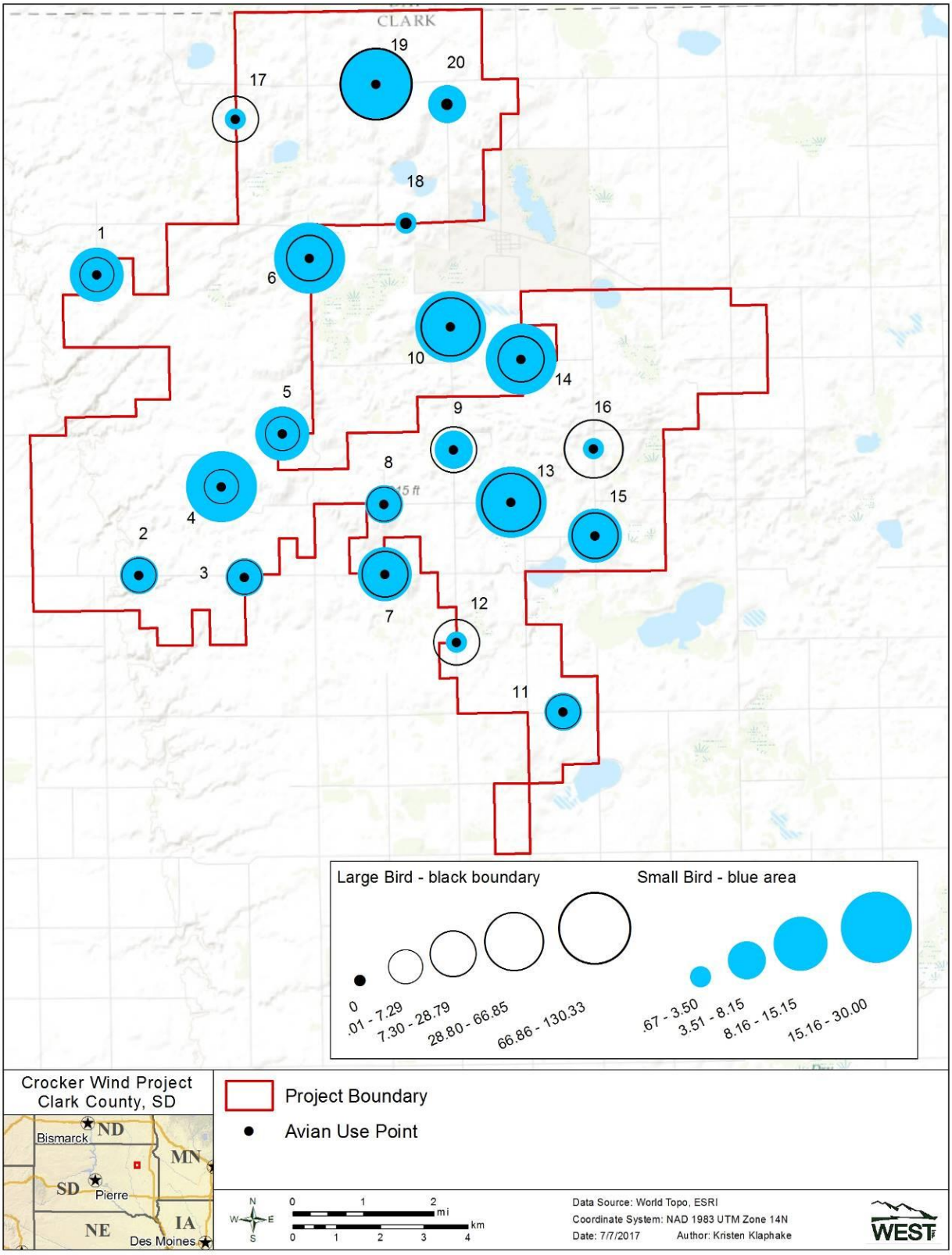

Figure 3. Mean use by point for large birds and small birds at the Crocker Wind Farm during fixed-point bird use surveys from April 13, 2016 to March 28, 2017.

Eagle Minutes

A total of 14 bald eagle flight minutes were documented during 244 large bird use survey observation hours, with the greatest number of minutes documented in spring (13 minutes; Table 5). The majority of eagle minutes in the zone of risk (defined for eagles as within 800 m of the observer and below 200 m in height) were recorded during March 2017 (8 eagle minutes) followed by November 2016 (1 eagle minute) (Table 6). Eagle minutes were documented flying in the zone of risk at three observation points: 6, 8, and 11; additionally, one eagle was documented at Point 13 perched for 59 minutes in October, 2017 and two eagles were documented flying higher than 200 m point 15 in March 2017 (Table 5). Eagle minutes per minute of survey were highest during spring (0.0018) followed by winter (0.0003); no eagle flight minutes were recorded during summer or fall (Table 7).

Table 5. Eagle observations attributable to eagle minutes and eagle minutes by survey point during 60-minute fixed-point large bird surveys conducted in the Crocker Wind Farm from April 13, 2016, to March 28, 2017.

Survey Location	Total Minutes Observed	Minutes Flying In Zone
1	0	0
2	0	0
3	0	0
4	0	0
5	0	0
6	1	1
7	0	0
8	4	4
9	0	0
10	0	0
11	8	4
12	0	0
13	59*	0
14	0	0
15	4	0
17	0	0
18	0	0
19	0	0
20	0	0

* Bald eagle was perched during entire observation

Table 6. Eagle observations attributable to eagle minutes and eagle minutes by month during 60-minute fixed-point large bird surveys conducted in the Crocker Wind Farm from April 13, 2016, to March 28, 2017.

Month/Year	Total Eagle Groups Observed	Total Minutes Observed	Total Minutes Flying in Zone
October, 2016	1	59	0
November, 2016	1	1	1
March, 2017	5	16	8
Total	**8**	**76**	**9**

Table 7. Eagle minutes documented in the zone of risk during 60-minute fixed-point large bird surveys conducted in the Crocker Wind Farm from April 13, 2016, to March 28, 2017.

Season	Eagle Minutes	Survey Effort (hours)	Survey Effort (minutes)	Eagle flight min per min survey
Spring (03/01/16 - 05/31/16)	8	75	4,500	0.0018
Summer (06/01/16 - 08/31/16)	0	63	3,780	0
Fall (09/01/16 - 11/10/16)	0	48	2,880	0
Winter (11/11/16 – 03/16/17)	1	58	3,480	0.0003
Total	**9**	**244**	**14,640**	**0.0006**

Sensitive Species Observations

No federal or state-listed threatened or endangered species were observed during the surveys. Seventeen sensitive species were recorded during fixed-point bird use surveys, and one sensitive species was only observed incidentally (Table 8). Additionally, bald eagles (11 observations), which are protected by the Bald and Golden Eagle Protection Act (BGEPA 1940), were recorded within the Project. This tally may represent repeated observations of the same individual. Seven species listed as species of greatest conservation need in the South Dakota Wildlife Action Plan were recorded: bald eagle, American while pelican, chestnut-collared longspur (*Calcarius ornatus*), black tern (*Chlidonias niger*), marbled godwit (*Limosa fedoa*), Wilson's phalarope (*Phalaropus tricolor*), and willet (*Tringa semipalmata*). Fourteen state rare animals in South Dakota (not state-listed but tracked by the state) were recorded during fixed-point studies (Table 8).

Table 8. Summary of sensitive species observed at the Crocker Wind Farm during fixed-point bird use surveys (FP) and as incidental wildlife observations (Inc.) from April 13, 2016 – March 28, 2017.

			FP		Inc.		Total	
Species	Scientific Name	Status	# of grps	# of obs	# of grps	# of obs	# of grps	# of obs
American white pelican	*Pelecanus erythrorhynchos*	SGCN; S3B,SZN	70	531	0	0	70	531
great egret	*Ardea alba*	S3B,SZN	66	100	0	0	66	100
black tern	*Chlidonias niger*	SGCN; S3B,SZN	5	58	0	0	5	58
bufflehead	*Bucephala albeola*	S1B,S2N	5	47	0	0	5	47
Swainson's hawk	*Buteo swainsoni*	S4B,SZN	12	12	8	11	20	23
great blue heron	*Ardea herodias*	S4B,SZN	11	11	0	0	11	11

Table 8. Summary of sensitive species observed at the Crocker Wind Farm during fixed-point bird use surveys (FP) and as incidental wildlife observations (Inc.) from April 13, 2016 – March 28, 2017.

			FP		Inc.		Total	
Species	**Scientific Name**	**Status**	**# of grps**	**# of obs**	**# of grps**	**# of obs**	**# of grps**	**# of obs**
bald eagle	*Haliaeetus leucocephalus*	BGEPA; SGCN; S1B,S2N	7	8	3	3	10	11
white-faced ibis	*Plegadis chihi*	S2B,SZN	3	11	0	0	3	11
marbled godwit	*Limosa fedoa*	SGCN	5	6	1	4	6	10
chestnut-collared longspur	*Calcarius ornatus*	SGCN	8	8	0	0	8	8
Cooper's hawk	*Accipiter cooperii*	S3B,SZN	3	3	3	4	6	7
Wilson's phalarope	*Phalaropus tricolor*	SGCN	0	0	1	6	1	6
willet	*Tringa semipalmata*	SGCN	2	2	2	2	4	4
California gull	*Larus californicus*	S2B,SZN	2	4	0	0	2	4
prairie falcon	*Falco mexicanus*	S3S4B,S4N	2	2	1	1	3	3
hooded merganser	*Lophodytes cucullatus*	S2B,SZN	2	2	0	0	2	2
black -crowned night-heron	*Nycticorax nycticorax*	S3S4B,SZN	1	1	0	0	1	1
snowy egret	*Egretta thula*	S2B,SZN	1	1	0	0	1	1
Total	**18 species**		**205**	**807**	**19**	**31**	**224**	**838**

EA – Federal Bald and Golden Eagle Protection Act (USFWS 1940)
SGCN – South Dakota species of greatest conservation need, as listed in the South Dakota Wildlife Action Plan (2014)
State Rank Definitions(SDGFP 2016):
S1 Critically imperiled because of extreme rarity (5 or fewer occurrences or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extinction.
S2 Imperiled because of rarity (6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extinction throughout its range.
S3 Either very rare and local throughout its range, or found locally (even abundantly at some of its locations)in a restricted range,or vulnerable to extinction throughout its range because of other factors; in the range of 21 of 100 occurrences.
S4 Apparently secure, though it may be quite rare in parts of its range, especially at the periphery. Cause for long term concern.
S#B = Breeding Season
S#N = Non-breeding Season
SZ = No definable occurrences for conservation purposes, usually assigned to migrants

Incidental Observations

Fifteen unique bird species were observed incidentally at the Project, totaling 83 bird observations within 63 separate groups during the study (Table 9). Wilson's phalarope was only observed incidentally. Each of the remaining bird species were also observed during the fixed-point studies.

Table 9. Incidental wildlife observed while conducting all surveys at the Crocker Wind Farm from April 13, 2016 – March 28, 2017.

Species	Scientific Name	# grps	# obs
red-tailed hawk	*Buteo jamaicensis*	33	37
Swainson's hawk	*Buteo swainsoni*	8	11
American kestrel	*Falco sparverius*	3	6
Wilson's phalarope	*Phalaropus tricolor*	1	6
Cooper's hawk	*Accipiter cooperii*	3	4
marbled godwit	*Limosa fedoa*	1	4
bald eagle	*Haliaeetus leucocephalus*	3	3
ring-necked pheasant	*Phasianus colchicus*	2	3
willet	*Tringa semipalmata*	2	2
great horned owl	*Bubo virginianus*	1	1
northern harrier	*Circus cyaneus*	1	1
prairie falcon	*Falco mexicanus*	1	1
rough-legged hawk	*Buteo lagopus*	1	1
short-eared owl	*Asio flammeus*	1	1
turkey vulture	*Cathartes aura*	1	1
unidentified eagle		1	1
Total	**15 Species**	**63**	**83**

DISCUSSION

The bird species observed in the Project during the study are typical to those commonly found in the pastures, grasslands and pothole lakes that typify the Prairie Pothole region of the upper Great Plains.

Seasonal patterns of bird use were observed for small birds and large birds. Small bird use was highest in the spring followed by summer and species diversity for small birds was highest in summer, indicating that passerine species typically found in pastureland areas such as brown-headed cowbird (*Molothrus ater*), barn swallow (*Hirundo rustica*), western meadowlark, and red-winged blackbird as well as grassland-specialists such as chestnut-collared longspurs and grasshopper sparrows (*Ammodramus savannarum*) likely breed in the Project. Diurnal raptor use was generally consistent from spring to fall; winter diurnal raptor use was low and only red-tailed hawks, bald eagles and American kestrel were observed. Due to the grazed pastureland and herbaceous landscape within and surrounding the Project, features such as wooded areas (beyond tree lots and fence rows) that provide significant nesting habitat for raptors were generally not present. Sustained higher use by red-tailed hawk and the presence of juveniles suggest red-tailed hawks breed in the area. Waterfowl use and diversity was highest in spring, with moderate use and diversity in fall. Waterfowl use in winter was higher than fall; however, this was due to one very large group of unidentified ducks observed on November 11, 2016; these were likely late migrants rather than overwintering individuals. Waterfowl were not observed at the Project from early December 2016 through mid-March 2017. The pothole lakes and ponds provide nesting habitat for waterfowl, and species whose seasonal use data and/or documentation of juveniles suggests the potential of breeding pairs include blue-winged teal (*Anas discors*), gadwall *(Anas strepera*), mallard, and wood duck (*Aix sponsa*).

Both small and large birds showed a pattern of higher use observed at individual survey points. Small bird use was highest at Point 19 largely due to one large flock of red-winged blackbirds and one large flock of Brewer's blackbirds; however, Point 19 was only surveyed six times, from late September 2016 to March 2017. Among the 16 points surveyed for the entire year, small bird use was more evenly distributed. Among large birds, the highest use also occurred at Point 19, attributable one large flock of 500 greater scaup and several large groups (i.e., more than 20 individuals) of other waterfowl and waterbird species. Among the 16 points surveyed for the entire year, large bird use was highest at Point 10 due to one group of 700 unidentified ducks.

Bird Types of Potential Concern

Three bird types are of concern in the region and were observed with some regularity during the current study: passerines, raptors, and waterfowl. Passerines were the most abundant bird type observed at the Project, followed closely by waterfowl. Diurnal raptors had relatively low use. Passerines, waterfowl, and diurnal raptors are discussed in more detail below.

Passerines

Passerines, excluding large corvids, account for 59.3% (4,788 of 8,069 total fatalities) of the fatalities reported from 212 studies at North American wind energy facilities (see Appendix F for a list of facilities and references). Among these studies, 167 passerine species were identified, yet 96 species had 10 or fewer fatalities found. Over a third (36.2%) of passerine fatalities were attributed to just four species: horned lark (*Eremophila alpestris*; 794 of 4,788 passerine fatalities [16.6%]), red-eyed vireo (*Vireo olivaceus*; 425 fatalities [8.9%]), golden-crowned kinglet (*Regulus satrapa*; 269 fatalities [5.6%]), and western meadowlark (246 fatalities [5.1%]; see Appendix F for a list of facilities and references).

Given the relative diversity of passerine species documented at the Project, it is likely that the Project would result in direct impacts to passerines, likely spread out in relatively low numbers across multiple passerine species. The results of this study further indicate that risk to passerines may be higher in the spring and summer, and fatalities would likely include species common to both agricultural and grassland landscapes.

Waterfowl

As noted in the Results section, the distribution of use across the Project, particularly large bird use, is largely driven by waterfowl. Points 19 and 10 each have nearby potholes, which may explain some of the higher waterfowl use at these points compared to some of the other points. Point 10 is located outside of the revised project boundary.

Historically, waterfowl do not seem especially vulnerable to turbine collisions. In an analysis of 116 studies of bird mortality at over 70 facilities, waterfowl made up 2.7% of 4,975 fatalities found (Erickson et al. 2014). In a database of 213 publicly available fatality studies, 207 waterfowl fatalities out of 8,069 total fatalities (2.6%) were documented (see Appendix F for a list of facilities and references). However, during a recent spring migration fatality monitoring study at two wind energy facilities located along the border between North Dakota and South

Dakota located in similar habitat to the Project, 61.0% of carcasses found were waterfowl species; mallard accounted for the majority of waterfowl carcasses found (Graff et al. 2016).

Given the data collected during the survey and the Project's location in the Prairie Pothole region, it appears that the Project will have higher use by waterfowl in spring, followed by summer; risk to these species may be higher during these seasons. As stated above, various studies show differing risk of direct impacts to waterfowl species, and it is possible that post-construction studies at the Project may show that waterfowl comprise a higher percentage of mortalities than at other locations in the Midwest in more agricultural settings. However, even in the Graff 2016 study which documented waterfowl as the primary avian fatality in spring migration, the rates (0.79 waterfowl per megawatt [MW] per spring) do not appear to approach levels that would affect populations (overall 48.4 million breeding ducks, 13.5 million migrating mallards in 2016, as documented in the USFWS' Waterfowl Population Status report).

Diurnal Raptors

Diurnal raptor use, while generally low, was higher from spring through fall, with relatively low use in winter. Use was low across the Project, with Point 16 having the relatively highest use. Given the data collected during the use surveys to date, it is likely that the Project will have relatively low risk to raptors overall, with risk generally confined to relatively common species such as the red-tailed hawk

Use Comparison

Diurnal raptors occur in most areas with the potential for wind energy development (National Research Council [NRC] 2007). Annual mean diurnal raptor use at the Project (0.29 raptors/800-m plot/20-min survey) was compared with 34 other 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 raptors/800-m plot/20-min survey. A relative ranking of annual mean raptor use was developed based on the results from these wind energy facilities as low (0 – 0.5 raptors/plot/20-min survey), low to moderate (0.5 – 1.0 raptors/plot/20-min survey), moderate (1.0 – 2.0 raptors/plot/20-min survey), high (2.0 – 3.0 raptors/plot/20-min survey), and very high (more than 3.0 raptors/plot/20-min survey). Under this ranking, annual mean diurnal raptor use at the Project is considered to be comparatively low compared to the other facilities with raptor use data.

Exposure Index Analysis

Exposure index analysis, which considers relative probability of exposure based on abundance, proportion of observations flying, and proportion of flight height of each species within the RSH, may provide some insight into which species would fly most often within RSH and potentially be the most likely turbine casualties. This index does not, however, take into consideration behavior (e.g., foraging, courtship), flight speed, size of the bird, the ability to detect and avoid turbines, and other factors that may vary among species and influence likelihood of turbine collision. For these reasons, the exposure index is only a relative index of collision risk among species. At the Project, the diurnal raptor species with the highest relative exposure index was red-tailed hawk, which was influenced by the relatively high number of observations within RSH

by this species. Based on the relative abundance of red-tailed hawk throughout the year, and a higher exposure index than other raptor species during the studies at the Project, there is higher potential for red-tailed hawk fatalities compared to other raptor species.

Species of Concern

Seven species listed as species of greatest conservation need in the South Dakota Wildlife Action Plan were recorded during the 2016/2017 fixed-point surveys within the Project: bald eagle, American white pelican, chestnut-collared longspur, black tern, marbled godwit, Wilson's phalarope, and willet (Table 5). The bald eagle is also legally protected under BGEPA (1940), while the others are further protected under the Migratory Bird Treaty Act (MBTA 1918). The remainder of this section discusses these sensitive species that were observed during surveys.

Bald Eagle

Eleven bald eagle observations were recorded (8 during surveys and 3 incidentally), with most observations in the spring, followed by single observations in winter and fall, and none during the summer. The Project occurs within the nesting, migration, and winter range of the bald eagle. In South Dakota, bald eagles typically nest along large rivers and reservoirs that provide foraging habitat and trees in the adjacent uplands which provides nesting structure (SDGFD 2005). As documented in 2016 and 2017 aerial nest surveys, there are no bald eagle nests within the Project; the nearest documented are approximately 3.2 miles north of the Project (WEST 2017). However, bald eagles may occur in the area during migration and during the winter. Bald eagles were seldom observed throughout the study; therefore, no consistent pattern of use across the Project could be determined, beyond relative low use.

American White Pelican

A total of 531 American white pelicans were observed in the Project, 82% of which were observed during spring. Of the 213 studies at North American wind energy facilities reviewed by WEST (see Appendix F for a list of facilities and references), a total of two American white pelican fatalities were reported, both of which were found in the Midwest. Therefore this species appears to be at relatively low risk to collisions from wind turbines.

Chestnut-collared Longspur

Eight chestnut-collared longspurs were observed during the 2016/2017 study. Two chestnut-collared longspur fatalities were reported in the 213 studies at North American wind energy facilities reviewed by WEST (see Appendix F for a list of facilities and references), neither of which were found in the Midwest. All chestnut-collared longspur observations occurred between late May and early July. Given that passerines generally fly well below the RSH, collision risk to this species is anticipated to be low.

Black Tern

Fifty-eight black terns were observed in five groups during the 2016/2017 study. One black tern fatality has been documented in the North American wind energy fatality studies reviewed by WEST, and this fatality occurred in the Midwest. All black terns were observed during one

survey at Point 7 in late May. Given the infrequency of black tern observations at the Projects and the low record of fatalities at other wind projects, collision risk to black tern is anticipated to be low.

Marbled Godwit

Ten marbled godwits were observed in spring during the 2016/2017 study. No marbled godwit fatalities have been documented in the North American wind energy fatality studies reviewed by WEST. The timing of observations suggest that marbled godwit migrates through the area. Based on the relatively low, transient use of the Project, collision risk to marbled godwits is anticipated to be low.

Wilson's phalarope

One group of six Wilson's phalarope was observed incidentally during late May. No Wilson's phalarope fatalities have been documented in the North American wind energy fatality studies reviewed by WEST. Based on the low number of observations and the fact the species does not appear to be at high risk of collision to with wind turbines in general, collision risk to Wilson's phalarope is anticipated to be low.

Willet

Four willets were observed in late May and early June. No willet fatalities have been documented in the North American wind energy fatality studies reviewed by WEST. Given the low use of the Project and the fact the species does not appear to be at high risk of collision to with wind turbines in general, risk to willet is anticipated to be low.

CONCLUSIONS

Raptor use at the Project was generally lower than use levels recorded at other wind energy facilities, based on research conducted at facilities throughout the US. Diurnal raptor fatality rates at the Project are expected to be within the range of fatality rates observed at other facilities where raptor use levels are lower. The seasonal use data suggests that risk to raptors would be unequal across seasons, with the lower risk in the winter, and relatively higher risk during the remaining seasons; the species most apparent at risk is the relatively common red-tailed hawk.

Passerines were the most abundant bird type observed at the Project, with waterfowl being the second most abundant bird type. The results of this study indicate that risk to passerines may be higher in the spring and summer, and fatalities would likely include species common to both agricultural and grassland landscapes. Given the relative high waterfowl use at the Project, it is possible that that waterfowl may comprise a higher percentage of avian mortalities at this Project compared to other wind projects in the Midwest in more agricultural settings; risk to this group is likely to be relatively higher in the spring and summer, and lowest in the winter. Given the results of other publicly available post-construction mortality surveys at other wind project in the US, including project in the Prairie Pothole region, it is anticipated that passerine and

waterfowl fatalities would likely consist of multiple species, but with relatively low numbers of fatalities per species that would not approach levels that would affect populations.

No federal or state-listed threatened or endangered species were observed during the surveys; seven species listed as species of greatest conservation need were documented. These species include waterbird, waterfowl, tern and shorebird species that would be expected to utilize the potholes located within and adjacent to the Project; one grassland-associated species of greatest conservation need was also documented.

This study also was designed to document use by eagles, following the Eagle Conservation Plan Guidance survey recommendations. During the 244 hours of observation during the year of surveys, eight bald eagles were observed flying for a total of 14 minutes, nine minutes of which were documented within 800 m of the observer and below 200 m in height. Bald eagles were infrequently seen and no spatial pattern was discerned; use was documented mostly in spring, with single observations in fall and winter. Bald eagle use and therefore risk at this Project appears to be relatively low. No golden eagles were documented during this survey.

WEST is currently conducting a second year of avian use surveys at the Project, and the second year report will update the analysis, discussion and conclusions of this Year 1 report.

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Appendix A. All Bird Types and Species Observed at the Crocker Wind Farm during Fixed-Point Bird Use Surveys from April 13, 2016 to March 28, 2017

Appendix A1. Summary of individuals and group observations by bird type and species for 20-minute fixed-point bird use surveys at the Crocker Wind Farm[a] from April 13, 2016 to March 28, 2017.

		Spring		Summer		Fall		Winter		Total	
Type/Species	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Loons/Grebes		**0**	**0**	**0**	**0**	**1**	**2**	**0**	**0**	**1**	**2**
pied-billed grebe	*Podilymbus podiceps*	0	0	0	0	1	2	0	0	1	2
Waterbirds		**46**	**340**	**46**	**123**	**20**	**132**	**0**	**0**	**112**	**595**
American bittern	*Botaurus lentiginosus*	0	0	1	7	0	0	0	0	1	7
American white pelican	*Pelecanus erythrorhynchos*	20	266	13	46	3	14	0	0	36	326
double-crested cormorant	*Phalacrocorax auritus*	11	55	12	31	6	97	0	0	29	183
glossy ibis	*Plegadis falcinellus*	1	1	0	0	0	0	0	0	1	1
great blue heron	*Ardea herodias*	1	1	2	2	3	3	0	0	6	6
great egret	*Ardea alba*	11	14	18	37	7	13	0	0	36	64
sandhill crane	*Grus canadensis*	2	3	0	0	0	0	0	0	2	3
white-faced ibis	*Plegadis chihi*	0	0	0	0	1	5	0	0	1	5
Waterfowl		**171**	**1,963**	**45**	**118**	**33**	**449**	**15**	**802**	**264**	**3,332**
blue-winged teal	*Anas discors*	28	123	15	24	0	0	0	0	43	147
bufflehead	*Bucephala albeola*	3	24	0	0	0	0	1	20	4	44
Canada goose	*Branta canadensis*	41	264	5	23	14	245	3	29	63	561
canvasback	*Aythya valisineria*	2	10	0	0	0	0	1	5	3	15
common goldeneye	*Bucephala clangula*	1	30	0	0	0	0	1	5	2	35
gadwall	*Anas strepera*	6	18	3	14	0	0	0	0	9	32
greater scaup	*Aythya marila*	1	500	0	0	0	0	0	0	1	500
green-winged teal	*Anas crecca*	3	5	0	0	0	0	0	0	3	5
hooded merganser	*Lophodytes cucullatus*	1	1	0	0	0	0	0	0	1	1
lesser scaup	*Aythya affinis*	5	197	0	0	1	8	0	0	6	205
mallard	*Anas platyrhynchos*	57	298	14	32	8	54	4	13	83	397
northern pintail	*Anas acuta*	5	8	1	1	0	0	0	0	6	9
northern shoveler	*Anas clypeata*	5	28	0	0	0	0	1	7	6	35
red-breasted merganser	*Mergus serrator*	1	2	0	0	0	0	0	0	1	2
redhead	*Aythya americana*	1	2	0	0	0	0	0	0	1	2
ring-necked duck	*Aythya collaris*	7	36	1	3	2	70	0	0	10	109
ruddy duck	*Oxyura jamaicensis*	1	2	0	0	0	0	0	0	1	2
snow goose	*Chen caerulescens*	2	412	1	1	0	0	0	0	3	413
tundra swan	*Cygnus columbianus*	0	0	0	0	0	0	1	12	1	12
unidentified duck		1	3	1	5	6	63	3	711	11	782
wood duck	*Aix sponsa*	0	0	4	15	2	9	0	0	6	24

Appendix A1. Summary of individuals and group observations by bird type and species for 20-minute fixed-point bird use surveys at the Crocker Wind Farm[a] from April 13, 2016 to March 28, 2017.

		Spring		Summer		Fall		Winter		Total	
Type/Species	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Shorebirds		**57**	**164**	**46**	**80**	**15**	**148**	**0**	**0**	**118**	**392**
greater yellowlegs	*Tringa melanoleuca*	0	0	0	0	1	8	0	0	1	8
killdeer	*Charadrius vociferus*	45	118	33	40	10	103	0	0	88	261
lesser yellowlegs	*Tringa flavipes*	1	1	0	0	0	0	0	0	1	1
marbled godwit	*Limosa fedoa*	3	3	0	0	0	0	0	0	3	3
unidentified sandpiper		1	20	1	27	3	36	0	0	5	83
upland sandpiper	*Bartramia longicauda*	7	22	11	12	0	0	0	0	18	34
Wilson's snipe	*Gallinago delicata*	0	0	1	1	1	1	0	0	2	2
Gulls/Terns		**31**	**192**	**14**	**166**	**18**	**166**	**1**	**1**	**64**	**525**
California gull	*Larus californicus*	2	4	0	0	0	0	0	0	2	4
Forster's tern	*Sterna forsteri*	1	34	0	0	0	0	0	0	1	34
Franklin's gull	*Leucophaeus pipixcan*	13	119	6	107	9	78	0	0	28	304
ring-billed gull	*Larus delawarensis*	14	33	5	5	5	16	1	1	25	55
unidentified gull		1	2	3	54	4	72	0	0	8	128
Rails/Coots		**3**	**19**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**19**
American coot	*Fulica americana*	3	19	0	0	0	0	0	0	3	19
Diurnal Raptors		**28**	**30**	**29**	**30**	**16**	**16**	**2**	**2**	**75**	**78**
Accipiters		*1*	*1*	*1*	*1*	*1*	*1*	*0*	*0*	*3*	*3*
Cooper's hawk	*Accipiter cooperii*	1	1	1	1	1	1	0	0	3	3
Buteos		*21*	*22*	*25*	*26*	*12*	*12*	*2*	*2*	*60*	*62*
red-tailed hawk	*Buteo jamaicensis*	17	18	19	20	11	11	2	2	49	51
Swainson's hawk	*Buteo swainsoni*	2	2	5	5	0	0	0	0	7	7
unidentified buteo	*Buteo spp*	2	2	1	1	1	1	0	0	4	4
Northern Harrier		*3*	*3*	*3*	*3*	*1*	*1*	*0*	*0*	*7*	*7*
northern harrier	*Circus cyaneus*	3	3	3	3	1	1	0	0	7	7
Eagles		*3*	*4*	*0*	*0*	*1*	*1*	*0*	*0*	*4*	*5*
bald eagle	*Haliaeetus leucocephalus*	3	4	0	0	1	1	0	0	4	5
Falcons		*0*	*0*	*0*	*0*	*1*	*1*	*0*	*0*	*1*	*1*
American kestrel	*Falco sparverius*	0	0	0	0	1	1	0	0	1	1
Vultures		**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**
turkey vulture	*Cathartes aura*	1	1	0	0	0	0	0	0	1	1
Upland Game Birds		**20**	**24**	**23**	**27**	**2**	**13**	**2**	**8**	**47**	**72**
ring-necked pheasant	*Phasianus colchicus*	19	23	22	26	1	1	1	1	43	51
sharp-tailed grouse	*Tympanuchus phasianellus*	0	0	1	1	0	0	0	0	1	1
wild turkey	*Meleagris gallopavo*	1	1	0	0	1	12	1	7	3	20

Appendix A1. Summary of individuals and group observations by bird type and species for 20-minute fixed-point bird use surveys at the Crocker Wind Farm[a] from April 13, 2016 to March 28, 2017.

		Spring		Summer		Fall		Winter		Total	
Type/Species	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Doves/Pigeons		**9**	**15**	**22**	**29**	**5**	**10**	**2**	**6**	**38**	**60**
mourning dove	*Zenaida macroura*	9	15	22	29	4	6	0	0	35	50
rock pigeon	*Columba livia*	0	0	0	0	1	4	2	6	3	10
Large Corvids		**1**	**1**	**0**	**0**	**0**	**0**	**2**	**4**	**3**	**5**
American crow	*Corvus brachyrhynchos*	1	1	0	0	0	0	2	4	3	5
Passerines		**377**	**1,797**	**652**	**1,436**	**103**	**559**	**44**	**318**	**1,176**	**4,110**
American goldfinch	*Spinus tristis*	1	1	29	33	16	21	0	0	46	55
American robin	*Turdus migratorius*	14	18	15	19	0	0	0	0	29	37
American tree sparrow	*Spizella arborea*	1	6	0	0	2	8	1	2	4	16
bank swallow	*Riparia riparia*	1	1	2	3	0	0	0	0	3	4
barn swallow	*Hirundo rustica*	19	35	22	67	7	17	0	0	48	119
blue jay	*Cyanocitta cristata*	0	0	0	0	2	4	0	0	2	4
bobolink	*Dolichonyx oryzivorus*	13	25	18	22	0	0	0	0	31	47
Brewer's blackbird	*Euphagus cyanocephalus*	0	0	0	0	1	50	0	0	1	50
brown-headed cowbird	*Molothrus ater*	39	247	31	63	1	40	0	0	71	350
brown thrasher	*Toxostoma rufum*	1	1	3	3	0	0	0	0	4	4
chestnut-collared longspur	*Calcarius ornatus*	1	1	3	3	0	0	0	0	4	4
chipping sparrow	*Spizella passerina*	2	4	2	2	1	2	0	0	5	8
clay-colored sparrow	*Spizella pallida*	2	2	16	16	0	0	0	0	18	18
cliff swallow	*Petrochelidon pyrrhonota*	1	1	10	92	1	20	0	0	12	113
common grackle	*Quiscalus quiscula*	42	305	79	357	5	13	0	0	126	675
common yellowthroat	*Geothlypis trichas*	1	1	16	16	1	1	0	0	18	18
dark-eyed junco	*Junco hyemalis*	0	0	0	0	2	5	1	1	3	6
dickcissel	*Spiza americana*	0	0	10	10	0	0	0	0	10	10
eastern bluebird	*Sialia sialis*	5	9	1	1	0	0	0	0	6	10
eastern kingbird	*Tyrannus tyrannus*	8	11	42	51	4	8	0	0	54	70
eastern wood-pewee	*Contopus virens*	0	0	1	1	0	0	0	0	1	1
European starling	*Sturnus vulgaris*	5	12	2	101	4	69	2	40	13	222
field sparrow	*Spizella pusilla*	0	0	1	1	0	0	0	0	1	1
grasshopper sparrow	*Ammodramus savannarum*	1	1	27	27	0	0	0	0	28	28
Harris' sparrow	*Zonotrichia querula*	1	1	0	0	0	0	0	0	1	1
horned lark	*Eremophila alpestris*	7	7	8	8	2	51	8	76	25	142
house sparrow	*Passer domesticus*	2	3	2	4	2	8	3	9	9	24
house wren	*Troglodytes aedon*	0	0	1	1	0	0	0	0	1	1
Lapland longspur	*Calcarius lapponicus*	2	180	0	0	1	10	5	104	8	294
marsh wren	*Cistothorus palustris*	0	0	9	36	1	1	0	0	10	37

Appendix A1. Summary of individuals and group observations by bird type and species for 20-minute fixed-point bird use surveys at the Crocker Wind Farm[a] from April 13, 2016 to March 28, 2017.

		Spring		Summer		Fall		Winter		Total	
Type/Species	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
northern rough-winged swallow	*Stelgidopteryx serripennis*	3	3	1	1	0	0	0	0	4	4
northern shrike	*Lanius excubitor*	0	0	0	0	1	1	2	2	3	3
orchard oriole	*Icterus spurius*	1	1	16	19	0	0	0	0	17	20
purple martin	*Progne subis*	0	0	0	0	1	6	0	0	1	6
red-eyed vireo	*Vireo olivaceus*	0	0	1	1	0	0	0	0	1	1
red-winged blackbird	*Agelaius phoeniceus*	59	500	59	189	2	101	0	0	120	790
Savannah sparrow	*Passerculus sandwichensis*	6	6	17	19	3	7	0	0	26	32
sedge wren	*Cistothorus platensis*	0	0	4	4	0	0	0	0	4	4
snow bunting	*Plectrophenax nivalis*	5	11	0	0	0	0	19	79	24	90
song sparrow	*Melospiza melodia*	15	15	25	25	1	5	0	0	41	45
swamp sparrow	*Melospiza georgiana*	0	0	1	1	0	0	0	0	1	1
tree swallow	*Tachycineta bicolor*	10	30	9	15	6	35	0	0	25	80
unidentified blackbird		0	0	0	0	3	35	0	0	3	35
unidentified bluebird		1	1	1	1	0	0	0	0	2	2
unidentified flycatcher		0	0	2	3	0	0	0	0	2	3
unidentified passerine		0	0	0	0	0	0	2	2	2	2
unidentified sparrow		0	0	13	18	6	11	1	3	20	32
unidentified swallow		3	120	4	9	1	1	0	0	8	130
vesper sparrow	*Pooecetes gramineus*	7	8	22	22	6	6	0	0	35	36
warbling vireo	*Vireo gilvus*	0	0	1	1	0	0	0	0	1	1
western kingbird	*Tyrannus verticalis*	2	5	23	31	0	0	0	0	25	36
western meadowlark	*Sturnella neglecta*	73	164	82	89	16	18	0	0	171	271
willow flycatcher	*Empidonax traillii*	0	0	2	3	0	0	0	0	2	3
yellow-headed blackbird	*Xanthocephalus xanthocephalus*	21	58	6	31	0	0	0	0	27	89
yellow-rumped warbler	*Setophaga coronata*	0	0	0	0	4	5	0	0	4	5
yellow warbler	*Setophaga petechia*	2	3	13	17	0	0	0	0	15	20
Goatsuckers		**0**	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**1**	**1**
common nighthawk	*Chordeiles minor*	0	0	1	1	0	0	0	0	1	1
Woodpeckers		**7**	**7**	**0**	**0**	**4**	**4**	**0**	**0**	**11**	**11**
downy woodpecker	*Picoides pubescens*	0	0	0	0	1	1	0	0	1	1
hairy woodpecker	*Picoides villosus*	1	1	0	0	0	0	0	0	1	1
northern flicker	*Colaptes auratus*	6	6	0	0	3	3	0	0	9	9
Kingfishers		**2**	**2**	**1**	**1**	**0**	**0**	**0**	**0**	**3**	**3**
belted kingfisher	*Megaceryle alcyon*	2	2	1	1	0	0	0	0	3	3

Appendix A1. Summary of individuals and group observations by bird type and species for 20-minute fixed-point bird use surveys at the Crocker Wind Farm[a] from April 13, 2016 to March 28, 2017.

		Spring		Summer		Fall		Winter		Total	
Type/Species	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Unidentified Birds		**4**	**4**	**4**	**32**	**1**	**1**	**0**	**0**	**9**	**37**
unidentified bird (small)		4	4	0	0	1	1	0	0	5	5
unidentified large bird		0	0	4	32	0	0	0	0	4	32
Overall		**757**	**4,559**	**883**	**2,043**	**218**	**1,500**	**68**	**1,141**	**1,926**	**9,243**

[a] Regardless of distance from observer.

Appendix A2. Summary of individuals and group observations by bird type and species for 60-minute fixed-point bird use surveys at the Crocker Wind Farm[a] from April 13, 2016 to March 28, 2017.

		Spring		Summer		Fall		Winter		Total	
Type/Species	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**#obs**
Loons/Grebes		**0**	**0**	**1**	**1**	**1**	**2**	**0**	**0**	**2**	**3**
pied-billed grebe	*Podilymbus podiceps*	0	0	1	1	1	2	0	0	2	3
Waterbirds		**95**	**598**	**89**	**199**	**30**	**147**	**0**	**0**	**214**	**944**
American bittern	*Botaurus lentiginosus*	0	0	1	7	0	0	0	0	1	7
American white pelican	*Pelecanus erythrorhynchos*	40	437	27	80	3	14	0	0	70	531
black-crowned night-heron	*Nycticorax nycticorax*	0	0	1	1	0	0	0	0	1	1
cattle egret	*Bubulcus ibis*	1	3	0	0	0	0	0	0	1	3
double-crested cormorant	*Phalacrocorax auritus*	22	114	24	50	10	102	0	0	56	266
glossy ibis	*Plegadis falcinellus*	2	10	0	0	0	0	0	0	2	10
great blue heron	*Ardea herodias*	3	3	3	3	5	5	0	0	11	11
great egret	*Ardea alba*	25	28	32	57	9	15	0	0	66	100
sandhill crane	*Grus canadensis*	2	3	0	0	0	0	0	0	2	3
snowy egret	*Egretta thula*	0	0	1	1	0	0	0	0	1	1
white-faced ibis	*Plegadis chihi*	0	0	0	0	3	11	0	0	3	11
Waterfowl		**288**	**2,939**	**84**	**213**	**58**	**1,168**	**19**	**901**	**449**	**5,221**
blue-winged teal	*Anas discors*	33	133	20	34	0	0	0	0	53	167
bufflehead	*Bucephala albeola*	4	27	0	0	0	0	1	20	5	47
Canada goose	*Branta canadensis*	76	503	5	23	25	859	5	53	111	1,438
canvasback	*Aythya valisineria*	2	10	0	0	1	1	1	5	4	16
common goldeneye	*Bucephala clangula*	1	30	0	0	0	0	1	5	2	35
gadwall	*Anas strepera*	9	46	8	24	1	5	0	0	18	75
greater scaup	*Aythya marila*	1	500	0	0	0	0	0	0	1	500
greater white-fronted goose	*Anser albifrons*	1	60	0	0	0	0	0	0	1	60
green-winged teal	*Anas crecca*	3	5	0	0	0	0	0	0	3	5
hooded merganser	*Lophodytes cucullatus*	2	2	0	0	0	0	0	0	2	2
lesser scaup	*Aythya affinis*	7	218	0	0	1	8	0	0	8	226
mallard	*Anas platyrhynchos*	103	441	27	61	9	55	5	68	144	625
northern pintail	*Anas acuta*	10	18	1	1	1	2	0	0	12	21
northern shoveler	*Anas clypeata*	9	35	4	9	1	3	1	7	15	54
red-breasted merganser	*Mergus serrator*	2	3	1	2	0	0	0	0	3	5
redhead	*Aythya americana*	2	4	0	0	0	0	0	0	2	4
ring-necked duck	*Aythya collaris*	11	52	1	3	2	70	0	0	14	125
ruddy duck	*Oxyura jamaicensis*	2	37	0	0	0	0	0	0	2	37
snow goose	*Chen caerulescens*	5	654	2	2	0	0	0	0	7	656
tundra swan	*Cygnus columbianus*	0	0	0	0	0	0	1	12	1	12
unidentified duck		3	9	9	30	14	150	4	731	30	920

Appendix A2. Summary of individuals and group observations by bird type and species for 60-minute fixed-point bird use surveys at the Crocker Wind Farm[a] from April 13, 2016 to March 28, 2017.

		Spring		Summer		Fall		Winter		Total	
Type/Species	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**#obs**
unidentified goose		1	150	0	0	0	0	0	0	1	150
wood duck	*Aix sponsa*	1	2	6	24	3	15	0	0	10	41
Shorebirds		**78**	**200**	**60**	**135**	**17**	**151**	**0**	**0**	**155**	**486**
American avocet	*Recurvirostra americana*	1	2	0	0	0	0	0	0	1	2
American golden-plover	*Pluvialis dominica*	1	11	0	0	0	0	0	0	1	11
greater yellowlegs	*Tringa melanoleuca*	2	4	0	0	3	11	0	0	5	15
killdeer	*Charadrius vociferus*	54	128	33	40	10	103	0	0	97	271
lesser yellowlegs	*Tringa flavipes*	2	2	0	0	0	0	0	0	2	2
marbled godwit	*Limosa fedoa*	5	6	0	0	0	0	0	0	5	6
unidentified sandpiper	*NA*	2	21	4	68	3	36	0	0	9	125
upland sandpiper	*Bartramia longicauda*	11	26	18	22	0	0	0	0	29	48
white-rumped sandpiper	*Calidris fuscicollis*	0	0	1	1	0	0	0	0	1	1
willet	*Tringa semipalmata*	0	0	2	2	0	0	0	0	2	2
Wilson's snipe	*Gallinago delicata*	0	0	2	2	1	1	0	0	3	3
Gulls/Terns		**81**	**397**	**25**	**226**	**33**	**223**	**1**	**1**	**140**	**847**
black tern	*Chlidonias niger*	5	58	0	0	0	0	0	0	5	58
Bonaparte's gull	*Chroicocephalus philadelphia*	0	0	0	0	1	3	0	0	1	3
California gull	*Larus californicus*	2	4	0	0	0	0	0	0	2	4
Forster's tern	*Sterna forsteri*	1	34	0	0	0	0	0	0	1	34
Franklin's gull	*Leucophaeus pipixcan*	23	173	9	157	17	122	0	0	49	452
ring-billed gull	*Larus delawarensis*	46	105	13	15	9	24	1	1	69	145
unidentified gull	*NA*	4	23	3	54	6	74	0	0	13	151
Rails/Coots		**3**	**19**	**1**	**1**	**0**	**0**	**0**	**0**	**4**	**20**
American coot	*Fulica americana*	3	19	0	0	0	0	0	0	3	19
Virginia rail	*Rallus limicola*	0	0	1	1	0	0	0	0	1	1
Diurnal Raptors		**54**	**59**	**40**	**41**	**30**	**30**	**5**	**5**	**129**	**135**
Accipiters		*1*	*1*	*1*	*1*	*1*	*1*	*0*	*0*	*3*	*3*
Cooper's hawk	*Accipiter cooperii*	1	1	1	1	1	1	0	0	3	3
Buteos		*37*	*40*	*34*	*35*	*21*	*21*	*3*	*3*	*95*	*99*
red-tailed hawk	*Buteo jamaicensis*	28	31	25	26	20	20	2	2	75	79
rough-legged hawk	*Buteo lagopus*	1	1	0	0	0	0	0	0	1	1
Swainson's hawk	*Buteo swainsoni*	5	5	7	7	0	0	0	0	12	12
unidentified buteo	*Buteo spp*	3	3	2	2	1	1	1	1	7	7
Northern Harrier		*10*	*11*	*4*	*4*	*4*	*4*	*0*	*0*	*18*	*19*
northern harrier	*Circus cyaneus*	10	11	4	4	4	4	0	0	18	19

Appendix A2. Summary of individuals and group observations by bird type and species for 60-minute fixed-point bird use surveys at the Crocker Wind Farm[a] from April 13, 2016 to March 28, 2017.

		Spring		Summer		Fall		Winter		Total	
Type/Species	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**#obs**
Eagles		*5*	*6*	*0*	*0*	*1*	*1*	*1*	*1*	*7*	*8*
bald eagle	*Haliaeetus leucocephalus*	5	6	0	0	1	1	1	1	7	8
Falcons		*0*	*0*	*1*	*1*	*3*	*3*	*1*	*1*	*5*	*5*
American kestrel	*Falco sparverius*	0	0	1	1	1	1	1	1	3	3
prairie falcon	*Falco mexicanus*	0	0	0	0	2	2	0	0	2	2
Other Raptors		*1*	*1*	*0*	*0*	*0*	*0*	*0*	*0*	*1*	*1*
unidentified raptor		1	1	0	0	0	0	0	0	1	1
Owls		**0**	**0**	**0**	**0**	**1**	**2**	**0**	**0**	**1**	**2**
great horned owl	*Bubo virginianus*	0	0	0	0	1	2	0	0	1	2
Vultures		**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**
turkey vulture	*Cathartes aura*	1	1	0	0	0	0	0	0	1	1
Upland Game Birds		**25**	**29**	**32**	**36**	**3**	**14**	**6**	**16**	**66**	**95**
ring-necked pheasant	*Phasianus colchicus*	24	28	31	35	2	2	3	4	60	69
sharp-tailed grouse	*Tympanuchus phasianellus*	0	0	1	1	0	0	1	1	2	2
wild turkey	*Meleagris gallopavo*	1	1	0	0	1	12	2	11	4	24
Doves/Pigeons		**10**	**17**	**22**	**29**	**6**	**11**	**2**	**6**	**40**	**63**
mourning dove	*Zenaida macroura*	10	17	22	29	4	6	0	0	36	52
rock pigeon	*Columba livia*	0	0	0	0	2	5	2	6	4	11
Large Corvids		**4**	**4**	**1**	**1**	**0**	**0**	**4**	**7**	**9**	**12**
American crow	*Corvus brachyrhynchos*	4	4	1	1	0	0	4	7	9	12
Goatsuckers		**0**	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**1**	**1**
common nighthawk	*Chordeiles minor*	0	0	1	1	0	0	0	0	1	1
Overall		**639**	**4,263**	**356**	**883**	**179**	**1,748**	**37**	**936**	**1,211**	**7,830**

[a] Regardless of distance from observer.

Appendix B. Mean Use, Percent of Use, and Frequency of Occurrence for Large and Small Birds Observed during Fixed-Point Bird Use Surveys at the Crocker Wind Farm from April 13, 2016 to March 28, 2017

Appendix B1. Mean bird use (number of birds/20-min survey), percent of total use (%), and frequency of occurrence (%) for each bird type and species by season during the fixed-point bird use surveys at the Crocker Wind Farm from April 13, 2016 to March 28, 2017.

	Mean Use				% of Use				% Frequency			
Type/Species	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
Loons/Grebes	**0**	**0**	**0.06**	**0**	**0**	**0**	**0.3**	**0**	**0**	**0**	**2.8**	**0**
pied-billed grebe	0	0	0.06	0	0	0	0.3	0	0	0	2.8	0
Waterbirds	**4.32**	**1.97**	**3.32**	**0**	**13.5**	**21.7**	**17.5**	**0**	**28.6**	**35.0**	**16.8**	**0**
American bittern	0	0.11	0	0	0	1.2	0	0	0	1.6	0	0
American white pelican	3.36	0.73	0.29	0	10.5	8.1	1.5	0	16.6	17.5	4.2	0
double-crested cormorant	0.65	0.50	2.51	0	2.0	5.6	13.3	0	11.4	14.4	8.2	0
glossy ibis	0.01	0	0	0	<0.1	0	0	0	1.2	0	0	0
great blue heron	0.01	0.03	0.07	0	<0.1	0.4	0.3	0	1.2	3.2	6.5	0
great egret	0.26	0.59	0.31	0	0.8	6.5	1.6	0	9.1	17.6	8.6	0
sandhill crane	0.03	0	0	0	<0.1	0	0	0	1.0	0	0	0
white-faced ibis	0	0	0.14	0	0	0	0.7	0	0	0	2.8	0
Waterfowl	**21.95**	**1.86**	**7.94**	**13.37**	**68.7**	**20.5**	**41.9**	**97.4**	**72.1**	**33.2**	**36.5**	**10.0**
blue-winged teal	1.65	0.38	0	0	5.2	4.2	0	0	29.8	15.9	0	0
bufflehead	0.24	0	0	0.33	0.8	0	0	2.4	3.2	0	0	1.7
Canada goose	3.66	0.36	4.34	0.48	11.5	4.0	22.9	3.5	39.8	4.7	15.7	3.3
canvasback	0.10	0	0	0.08	0.3	0	0	0.6	2.0	0	0	1.7
common goldeneye	0.30	0	0	0.08	0.9	0	0	0.6	1.0	0	0	1.7
gadwall	0.26	0.22	0	0	0.8	2.4	0	0	8.9	4.7	0	0
greater scaup	5.00	0	0	0	15.6	0	0	0	1.0	0	0	0
green-winged teal	0.06	0	0	0	0.2	0	0	0	2.5	0	0	0
hooded merganser	0.01	0	0	0	<0.1	0	0	0	1.2	0	0	0
lesser scaup	2.09	0	0.13	0	6.5	0	0.7	0	5.8	0	1.7	0
mallard	3.52	0.51	0.94	0.22	11.0	5.6	5.0	1.6	43.4	14.3	15.6	6.7
northern pintail	0.10	0.02	0	0	0.3	0.2	0	0	5.0	1.6	0	0
northern shoveler	0.34	0	0	0.12	1.1	0	0	0.8	6.0	0	0	1.7
red-breasted merganser	0.02	0	0	0	<0.1	0	0	0	1.2	0	0	0
redhead	0.02	0	0	0	<0.1	0	0	0	1.0	0	0	0
ring-necked duck	0.39	0.05	1.17	0	1.2	0.5	6.2	0	5.8	1.6	1.7	0
ruddy duck	0.02	0	0	0	<0.1	0	0	0	1.0	0	0	0
snow goose	4.12	0.02	0	0	12.9	0.2	0	0	2.0	1.6	0	0
tundra swan	0	0	0	0.20	0	0	0	1.5	0	0	0	1.7
unidentified duck	0.04	0.08	1.15	11.85	0.1	0.9	6.1	86.3	1.2	1.6	12.4	5.0
wood duck	0	0.24	0.19	0	0	2.7	1.0	0	0	4.8	4.9	0

Appendix B1. Mean bird use (number of birds/20-min survey), percent of total use (%), and frequency of occurrence (%) for each bird type and species by season during the fixed-point bird use surveys at the Crocker Wind Farm from April 13, 2016 to March 28, 2017.

	Mean Use				% of Use				% Frequency			
Type/Species	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
Shorebirds	**2.08**	**1.26**	**3.33**	**0**	**6.5**	**13.9**	**17.6**	**0**	**58.9**	**49.4**	**22.8**	**0**
greater yellowlegs	0	0	0.13	0	0	0	0.7	0	0	0	1.7	0
killdeer	1.46	0.63	2.42	0	4.6	7.0	12.8	0	50.7	39.7	19.0	0
lesser yellowlegs	0.01	0	0	0	<0.1	0	0	0	1.2	0	0	0
marbled godwit	0.04	0	0	0	0.1	0	0	0	3.8	0	0	0
unidentified sandpiper	0.25	0.42	0.76	0	0.8	4.7	4.0	0	1.2	1.6	6.9	0
upland sandpiper	0.32	0.19	0	0	1.0	2.1	0	0	13.6	17.6	0	0
Wilson's snipe	0	0.02	0.02	0	0	0.2	0.1	0	0	1.6	2.1	0
Gulls/Terns	**2.37**	**2.59**	**3.52**	**0.02**	**7.4**	**28.6**	**18.6**	**0.1**	**23.2**	**15.6**	**14.9**	**1.7**
California gull	0.05	0	0	0	0.2	0	0	0	2.5	0	0	0
Forster's tern	0.42	0	0	0	1.3	0	0	0	1.2	0	0	0
Franklin's gull	1.49	1.67	1.62	0	4.7	18.4	8.6	0	12.5	7.8	10.4	0
ring-billed gull	0.39	0.08	0.41	0.02	1.2	0.9	2.1	0.1	13.5	7.8	8.6	1.7
unidentified gull	0.02	0.84	1.49	0	<0.1	9.3	7.8	0	1.0	4.7	3.8	0
Rails/Coots	**0.24**	**0**	**0**	**0**	**0.7**	**0**	**0**	**0**	**1.2**	**0**	**0**	**0**
American coot	0.24	0	0	0	0.7	0	0	0	1.2	0	0	0
Diurnal Raptors	**0.34**	**0.48**	**0.37**	**0.03**	**1.1**	**5.3**	**2.0**	**0.2**	**26.0**	**36.7**	**30.3**	**3.3**
Accipiters	*0.03*	*0.02*	*0.03*	*0*	*<0.1*	*0.2*	*0.1*	*0*	*2.9*	*1.6*	*2.8*	*0*
Cooper's hawk	0.03	0.02	0.03	0	<0.1	0.2	0.1	0	2.9	1.6	2.8	0
Buteos	*0.23*	*0.41*	*0.27*	*0.03*	*0.7*	*4.6*	*1.4*	*0.2*	*18.6*	*31.9*	*23.1*	*3.3*
red-tailed hawk	0.18	0.32	0.26	0.03	0.6	3.5	1.3	0.2	17.4	25.3	21.4	3.3
Swainson's hawk	0.02	0.08	0	0	<0.1	0.9	0	0	1.2	6.5	0	0
unidentified buteo	0.02	0.02	0.02	0	<0.1	0.2	<0.1	0	1.2	1.7	1.7	0
Northern Harrier	*0.04*	*0.05*	*0.03*	*0*	*0.1*	*0.5*	*0.1*	*0*	*3.8*	*4.8*	*2.8*	*0*
northern harrier	0.04	0.05	0.03	0	0.1	0.5	0.1	0	3.8	4.8	2.8	0
Eagles	*0.04*	*0*	*0.02*	*0*	*0.1*	*0*	*<0.1*	*0*	*2.0*	*0*	*1.7*	*0*
bald eagle	0.04	0	0.02	0	0.1	0	<0.1	0	2.0	0	1.7	0
Falcons	*0*	*0*	*0.03*	*0*	*0*	*0*	*0.1*	*0*	*0*	*0*	*2.8*	*0*
American kestrel	0	0	0.03	0	0	0	0.1	0	0	0	2.8	0
Vultures	**0.01**	**0**	**0**	**0**	**<0.1**	**0**	**0**	**0**	**1.2**	**0**	**0**	**0**
turkey vulture	0.01	0	0	0	<0.1	0	0	0	1.2	0	0	0
Upland Game Birds	**0.40**	**0.43**	**0.22**	**0.14**	**1.2**	**4.7**	**1.2**	**1.0**	**30.5**	**25.3**	**3.8**	**3.5**
ring-necked pheasant	0.38	0.41	0.02	0.02	1.2	4.5	0.1	0.1	30.5	25.3	2.1	1.8
sharp-tailed grouse	0	0.02	0	0	0	0.2	0	0	0	1.6	0	0
wild turkey	0.01	0	0.20	0.12	<0.1	0	1.1	0.9	1.2	0	1.7	1.8

Appendix B1. Mean bird use (number of birds/20-min survey), percent of total use (%), and frequency of occurrence (%) for each bird type and species by season during the fixed-point bird use surveys at the Crocker Wind Farm from April 13, 2016 to March 28, 2017.

	Mean Use				% of Use				% Frequency			
Type/Species	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
Doves/Pigeons	**0.25**	**0.46**	**0.21**	**0.10**	**0.8**	**5.1**	**1.1**	**0.7**	**14.8**	**27.0**	**10.4**	**1.7**
mourning dove	0.25	0.46	0.12	0	0.8	5.1	0.7	0	14.8	27.0	8.3	0
rock pigeon	0	0	0.08	0.10	0	0	0.4	0.7	0	0	2.1	1.7
Large Corvids	**0.01**	**0**	**0**	**0.07**	**<0.1**	**0**	**0**	**0.5**	**1.0**	**0**	**0**	**3.5**
American crow	0.01	0	0	0.07	<0.1	0	0	0.5	1.0	0	0	3.5
Goatsuckers	**0**	**0.02**	**0**	**0**	**0**	**0.2**	**0**	**0**	**0**	**1.6**	**0**	**0**
common nighthawk	0	0.02	0	0	0	0.2	0	0	0	1.6	0	0
Overall Large Birds	**31.97**	**9.06**	**18.96**	**13.73**	**100**	**100**	**100**	**100**				
Passerines	**14.82**	**13.90**	**10.18**	**5.25**	**99.1**	**100**	**99.0**	**100**	**93.8**	**98.4**	**73.2**	**42.7**
American goldfinch	0.01	0.50	0.42	0	<0.1	3.6	4.1	0	1.2	29.9	24.6	0
American robin	0.19	0.27	0	0	1.3	1.9	0	0	15.2	17.6	0	0
American tree sparrow	0.06	0	0.13	0.03	0.4	0	1.3	0.6	1.0	0	1.7	1.7
bank swallow	0	0.05	0	0	0	0.3	0	0	0	3.1	0	0
barn swallow	0.36	1.06	0.35	0	2.4	7.6	3.4	0	18.2	30.1	12.5	0
blue jay	0	0	0.05	0	0	0	0.5	0	0	0	1.7	0
bobolink	0.12	0.19	0	0	0.8	1.4	0	0	10.0	14.3	0	0
Brewer's blackbird	0	0	1.39	0	0	0	13.5	0	0	0	2.8	0
brown-headed cowbird	1.64	0.96	0	0	11.0	6.9	0	0	40.9	32.0	0	0
brown thrasher	0.01	0.03	0	0	<0.1	0.2	0	0	1.2	3.3	0	0
chestnut-collared longspur	0	0.05	0	0	0	0.4	0	0	0	4.9	0	0
chipping sparrow	0.05	0.03	0.03	0	0.3	0.2	0.3	0	2.5	3.1	1.7	0
clay-colored sparrow	0.04	0.24	0	0	0.3	1.7	0	0	4.1	20.7	0	0
cliff swallow	0.01	1.13	0	0	<0.1	8.1	0	0	1.2	12.6	0	0
common grackle	2.92	1.51	0.26	0	19.5	10.8	2.6	0	38.7	48.2	11.0	0
common yellowthroat	0.01	0.17	0.02	0	<0.1	1.3	0.2	0	1.2	15.8	2.1	0
dark-eyed junco	0	0	0.08	0.02	0	0	0.8	0.3	0	0	3.3	1.7
dickcissel	0	0.16	0	0	0	1.2	0	0	0	13.1	0	0
eastern bluebird	0.17	0.02	0	0	1.1	0.1	0	0	7.0	1.6	0	0
eastern kingbird	0.12	0.78	0.17	0	0.8	5.6	1.6	0	9.1	43.0	2.1	0
eastern wood-pewee	0	0.02	0	0	0	0.1	0	0	0	1.6	0	0
European starling	0.16	1.58	1.91	0.67	1.1	11.4	18.6	12.7	6.6	3.1	7.6	3.3
field sparrow	0	0.02	0	0	0	0.1	0	0	0	1.6	0	0
grasshopper sparrow	0.03	0.43	0	0	0.2	3.1	0	0	2.9	34.9	0	0
Harris' sparrow	0.01	0	0	0	<0.1	0	0	0	1.2	0	0	0
horned lark	0.08	0.13	0.85	1.27	0.6	0.9	8.3	24.1	7.0	12.8	3.3	10.0

Appendix B1. Mean bird use (number of birds/20-min survey), percent of total use (%), and frequency of occurrence (%) for each bird type and species by season during the fixed-point bird use surveys at the Crocker Wind Farm from April 13, 2016 to March 28, 2017.

	Mean Use				% of Use				% Frequency			
Type/Species	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
house sparrow	0.04	0.06	0.13	0.12	0.3	0.4	1.3	2.2	2.5	3.1	1.7	3.3
house wren	0	0.02	0	0	0	0.1	0	0	0	1.6	0	0
Lapland longspur	0	0	0.17	1.73	0	0	1.6	33.0	0	0	1.7	3.3
marsh wren	0	0.14	0.02	0	0	1.0	0.2	0	0	4.8	2.1	0
northern rough-winged swallow	0.04	0.02	0	0	0.3	0.1	0	0	3.8	1.6	0	0
northern shrike	0	0	0.02	0.02	0	0	0.2	0.3	0	0	1.7	1.8
orchard oriole	0.01	0.29	0	0	<0.1	2.1	0	0	1.2	17.5	0	0
purple martin	0	0	0.12	0	0	0	1.2	0	0	0	2.1	0
red-eyed vireo	0	0.02	0	0	0	0.1	0	0	0	1.6	0	0
red-winged blackbird	5.87	0.78	1.68	0	39.2	5.6	16.4	0	53.9	25.5	3.3	0
Savannah sparrow	0.10	0.30	0.14	0	0.7	2.2	1.4	0	9.8	20.7	3.8	0
sedge wren	0	0.06	0	0	0	0.4	0	0	0	6.2	0	0
snow bunting	0.11	0	0	1.35	0.7	0	0	25.7	4.0	0	0	24.3
song sparrow	0.24	0.29	0.14	0	1.6	2.1	1.4	0	18.6	17.7	2.8	0
tree swallow	0.41	0.19	0.58	0	2.7	1.4	5.7	0	12.9	11.0	8.3	0
unidentified blackbird	0	0	0.68	0	0	0	6.6	0	0	0	6.5	0
unidentified bluebird	0.03	0	0	0	0.2	0	0	0	2.9	0	0	0
unidentified flycatcher	0	0.05	0	0	0	0.3	0	0	0	3.1	0	0
unidentified sparrow	0	0.27	0.25	0.05	0	1.9	2.4	1.0	0	19.2	12.1	1.7
unidentified swallow	0	0.05	0.02	0	0	0.3	0.2	0	0	3.2	2.1	0
vesper sparrow	0.16	0.32	0.10	0	1.1	2.3	1.0	0	10.7	28.4	5.0	0
warbling vireo	0	0.02	0	0	0	0.1	0	0	0	1.7	0	0
western kingbird	0.14	0.50	0	0	1.0	3.6	0	0	2.9	20.7	0	0
western meadowlark	1.28	0.84	0.31	0	8.6	6.1	3.0	0	60.4	52.5	17.9	0
willow flycatcher	0	0.05	0	0	0	0.3	0	0	0	3.2	0	0
yellow-headed blackbird	0.35	0.09	0	0	2.3	0.7	0	0	15.4	1.6	0	0
yellow-rumped warbler	0	0	0.14	0	0	0	1.4	0	0	0	2.8	0
yellow warbler	0.04	0.25	0	0	0.3	1.8	0	0	2.5	12.8	0	0
Woodpeckers	**0.09**	**0**	**0.08**	**0**	**0.6**	**0**	**0.8**	**0**	**7.5**	**0**	**6.2**	**0**
downy woodpecker	0	0	0.02	0	0	0	0.2	0	0	0	2.1	0
hairy woodpecker	0.01	0	0	0	<0.1	0	0	0	1.2	0	0	0
northern flicker	0.08	0	0.06	0	0.5	0	0.6	0	6.2	0	4.2	0
Kingfishers	**0.01**	**0**	**0**	**0**	**<0.1**	**0**	**0**	**0**	**1.2**	**0**	**0**	**0**
belted kingfisher	0.01	0	0	0	<0.1	0	0	0	1.2	0	0	0

Appendix B1. Mean bird use (number of birds/20-min survey), percent of total use (%), and frequency of occurrence (%) for each bird type and species by season during the fixed-point bird use surveys at the Crocker Wind Farm from April 13, 2016 to March 28, 2017.

	Mean Use				% of Use				% Frequency			
Type/Species	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
Unidentified Birds	**0.04**	**0**	**0.02**	**0**	**0.3**	**0**	**0.2**	**0**	**2.5**	**0**	**2.1**	**0**
unidentified bird (small)	0.04	0	0.02	0	0.3	0	0.2	0	2.5	0	2.1	0
Overall Small Birds	**14.96**	**13.90**	**10.29**	**5.25**	**100**	**100**	**100**	**100**				

Appendix B2. Mean bird use (number of birds/60-min survey), percent of total use (%), and frequency of occurrence (%) for each bird type and species by season during the fixed-point bird use surveys at the Crocker Wind Farm from April 13, 2016 to March 28, 2017.

	Mean Use				% of Use				% Frequency			
Type/Species	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
Loons/Grebes	**0**	**0.02**	**0.06**	**0**	**0**	**0.1**	**0.2**	**0**	**0**	**1.6**	**2.8**	**0**
pied-billed grebe	0	0.02	0.06	0	0	0.1	0.2	0	0	1.6	2.8	0
Waterbirds	**7.28**	**3.18**	**3.71**	**0**	**14.7**	**22.8**	**10.9**	**0**	**39.1**	**49.3**	**26.5**	**0**
American bittern	0	0.11	0	0	0	0.8	0	0	0	1.6	0	0
American white pelican	5.24	1.27	0.29	0	10.6	9.1	0.9	0	27.6	25.4	4.2	0
black-crowned night-heron	0	0.02	0	0	0	0.1	0	0	0	1.6	0	0
cattle egret	0.04	0	0	0	<0.1	0	0	0	1.2	0	0	0
double-crested cormorant	1.33	0.81	2.65	0	2.7	5.8	7.8	0	16.4	24.0	13.1	0
glossy ibis	0.12	0	0	0	0.3	0	0	0	2.5	0	0	0
great blue heron	0.04	0.05	0.11	0	<0.1	0.3	0.3	0	3.8	3.2	8.6	0
great egret	0.47	0.91	0.36	0	1.0	6.5	1.0	0	18.6	28.8	13.5	0
sandhill crane	0.03	0	0	0	<0.1	0	0	0	1.0	0	0	0
snowy egret	0	0.02	0	0	0	0.1	0	0	0	1.6	0	0
white-faced ibis	0	0	0.31	0	0	0	0.9	0	0	0	5.6	0
Waterfowl	**33.3**	**3.37**	**20.95**	**15.02**	**67.1**	**24.2**	**61.6**	**96.1**	**75.4**	**41.2**	**44.2**	**11.7**
blue-winged teal	1.77	0.54	0	0	3.6	3.8	0	0	33.6	17.6	0	0
bufflehead	0.28	0	0	0.33	0.6	0	0	2.1	4.5	0	0	1.7
Canada goose	6.45	0.36	14.92	0.88	13.0	2.6	43.9	5.7	44.6	4.7	19.9	5.0
canvasback	0.10	0	0.03	0.08	0.2	0	<0.1	0.5	2.0	0	2.8	1.7
common goldeneye	0.30	0	0	0.08	0.6	0	0	0.5	1.0	0	0	1.7
gadwall	0.61	0.38	0.10	0	1.2	2.7	0.3	0	10.1	9.5	2.1	0
greater scaup	5.00	0	0	0	10.1	0	0	0	1.0	0	0	0
greater white-fronted goose	0.60	0	0	0	1.2	0	0	0	1.0	0	0	0
green-winged teal	0.06	0	0	0	0.1	0	0	0	2.5	0	0	0
hooded merganser	0.02	0	0	0	<0.1	0	0	0	2.5	0	0	0
lesser scaup	2.35	0	0.13	0	4.7	0	0.4	0	8.2	0	1.7	0
mallard	5.34	0.97	0.97	1.13	10.7	7.0	2.9	7.3	53.4	22.4	18.3	8.3
northern pintail	0.26	0.02	0.03	0	0.5	0.1	<0.1	0	11.6	1.6	1.7	0
northern shoveler	0.43	0.15	0.06	0.12	0.9	1.1	0.2	0.7	9.8	6.4	2.1	1.7
red-breasted merganser	0.04	0.03	0	0	<0.1	0.2	0	0	2.5	1.6	0	0
redhead	0.04	0	0	0	<0.1	0	0	0	2.2	0	0	0
ring-necked duck	0.59	0.05	1.17	0	1.2	0.3	3.4	0	8.2	1.6	1.7	0
ruddy duck	0.46	0	0	0	0.9	0	0	0	2.2	0	0	0
snow goose	6.54	0.03	0	0	13.2	0.2	0	0	5.0	3.1	0	0
tundra swan	0	0	0	0.20	0	0	0	1.3	0	0	0	1.7

Appendix B2. Mean bird use (number of birds/60-min survey), percent of total use (%), and frequency of occurrence (%) for each bird type and species by season during the fixed-point bird use surveys at the Crocker Wind Farm from April 13, 2016 to March 28, 2017.

	Mean Use				% of Use				% Frequency			
Type/Species	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
unidentified duck	0.16	0.47	3.22	12.18	0.3	3.4	9.5	78.0	4.1	11.0	24.4	5.0
unidentified goose	1.88	0	0	0	3.8	0	0	0	1.2	0	0	0
wood duck	0.02	0.38	0.32	0	<0.1	2.8	0.9	0	1.2	7.9	6.9	0
Shorebirds	**2.58**	**2.13**	**3.40**	**0**	**5.2**	**15.3**	**10.0**	**0**	**63.9**	**50.9**	**22.8**	**0**
American avocet	0.02	0	0	0	<0.1	0	0	0	1.2	0	0	0
American golden-plover	0.14	0	0	0	0.3	0	0	0	1.2	0	0	0
greater yellowlegs	0.05	0	0.21	0	0.1	0	0.6	0	1.2	0	4.4	0
killdeer	1.58	0.63	2.42	0	3.2	4.5	7.1	0	54.5	39.7	19.0	0
lesser yellowlegs	0.04	0	0	0	<0.1	0	0	0	4.1	0	0	0
marbled godwit	0.08	0	0	0	0.2	0	0	0	6.2	0	0	0
unidentified sandpiper	0.28	1.06	0.76	0	0.6	7.6	2.2	0	4.1	4.7	6.9	0
upland sandpiper	0.39	0.35	0	0	0.8	2.5	0	0	17.3	24.0	0	0
white-rumped sandpiper	0	0.02	0	0	0	0.1	0	0	0	1.6	0	0
willet	0	0.03	0	0	0	0.2	0	0	0	3.1	0	0
Wilson's snipe	0	0.03	0.02	0	0	0.2	<0.1	0	0	3.1	2.1	0
Gulls/Terns	**4.76**	**3.54**	**4.72**	**0.02**	**9.6**	**25.3**	**13.9**	**0.1**	**43.0**	**23.8**	**19.3**	**1.7**
black tern	0.72	0	0	0	1.5	0	0	0	1.2	0	0	0
Bonaparte's gull	0	0	0.06	0	0	0	0.2	0	0	0	2.1	0
California gull	0.05	0	0	0	0.1	0	0	0	2.5	0	0	0
Forster's tern	0.42	0	0	0	0.9	0	0	0	1.2	0	0	0
Franklin's gull	2.16	2.45	2.56	0	4.4	17.6	7.5	0	18.8	10.9	13.2	0
ring-billed gull	1.12	0.24	0.56	0.02	2.3	1.7	1.7	0.1	30.8	12.8	10.3	1.7
unidentified gull	0.28	0.84	1.53	0	0.6	6.0	4.5	0	3.5	4.7	3.8	0
Rails/Coots	**0.24**	**0.02**	**0**	**0**	**0.5**	**0.1**	**0**	**0**	**1.2**	**1.6**	**0**	**0**
American coot	0.24	0	0	0	0.5	0	0	0	1.2	0	0	0
Virginia rail	0	0.02	0	0	0	0.1	0	0	0	1.6	0	0
Diurnal Raptors	**0.70**	**0.65**	**0.66**	**0.08**	**1.4**	**4.6**	**1.9**	**0.5**	**39.4**	**42.9**	**40.8**	**8.4**
Accipiters	*0.03*	*0.02*	*0.03*	*0*	*<0.1*	*0.1*	*<0.1*	*0*	*2.9*	*1.6*	*2.8*	*0*
Cooper's hawk	0.03	0.02	0.03	0	<0.1	0.1	<0.1	0	2.9	1.6	2.8	0
Buteos	*0.43*	*0.55*	*0.46*	*0.05*	*0.9*	*4.0*	*1.3*	*0.3*	*28.2*	*38.1*	*33.6*	*5.0*
red-tailed hawk	0.30	0.41	0.44	0.03	0.6	2.9	1.3	0.2	21.9	30.0	31.9	3.3
rough-legged hawk	0.01	0	0	0	<0.1	0	0	0	1.0	0	0	0
Swainson's hawk	0.06	0.11	0	0	0.1	0.8	0	0	3.8	8.0	0	0
unidentified buteo	0.05	0.03	0.02	0.02	0.1	0.2	<0.1	0.1	4.1	3.2	1.7	1.7
Northern Harrier	*0.15*	*0.06*	*0.09*	*0*	*0.3*	*0.5*	*0.3*	*0*	*9.1*	*4.8*	*8.9*	*0*

Appendix B2. Mean bird use (number of birds/60-min survey), percent of total use (%), and frequency of occurrence (%) for each bird type and species by season during the fixed-point bird use surveys at the Crocker Wind Farm from April 13, 2016 to March 28, 2017.

	Mean Use				% of Use				% Frequency			
Type/Species	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
northern harrier	0.15	0.06	0.09	0	0.3	0.5	0.3	0	9.1	4.8	8.9	0
Eagles	*0.06*	*0*	*0.02*	*0.02*	*0.1*	*0*	*<0.1*	*0.1*	*3.0*	*0*	*1.7*	*1.7*
bald eagle	0.06	0	0.02	0.02	0.1	0	<0.1	0.1	3.0	0	1.7	1.7
Falcons	*0*	*0.02*	*0.07*	*0.02*	*0*	*0.1*	*0.2*	*0.1*	*0*	*1.6*	*4.9*	*1.8*
American kestrel	0	0.02	0.03	0.02	0	0.1	<0.1	0.1	0	1.6	2.8	1.8
prairie falcon	0	0	0.04	0	0	0	0.1	0	0	0	2.1	0
Other Raptors	*0.03*	*0*	*0*	*0*	*<0.1*	*0*	*0*	*0*	*2.9*	*0*	*0*	*0*
unidentified raptor	0.03	0	0	0	<0.1	0	0	0	2.9	0	0	0
Owls	**0**	**0**	**0.04**	**0**	**0**	**0**	**0.1**	**0**	**0**	**0**	**2.1**	**0**
great horned owl	0	0	0.04	0	0	0	0.1	0	0	0	2.1	0
Vultures	**0.01**	**0**	**0**	**0**	**<0.1**	**0**	**0**	**0**	**1.2**	**0**	**0**	**0**
turkey vulture	0.01	0	0	0	<0.1	0	0	0	1.2	0	0	0
Upland Game Birds	**0.46**	**0.57**	**0.24**	**0.28**	**0.9**	**4.1**	**0.7**	**1.8**	**36.8**	**33.4**	**5.4**	**8.8**
ring-necked pheasant	0.45	0.56	0.04	0.07	0.9	4.0	0.1	0.4	36.8	33.4	3.8	5.3
sharp-tailed grouse	0	0.02	0	0.02	0	0.1	0	0.1	0	1.6	0	1.8
wild turkey	0.01	0	0.20	0.19	<0.1	0	0.6	1.2	1.2	0	1.7	1.8
Doves/Pigeons	**0.28**	**0.46**	**0.23**	**0.10**	**0.6**	**3.3**	**0.7**	**0.6**	**16.1**	**27.0**	**10.4**	**1.7**
mourning dove	0.28	0.46	0.12	0	0.6	3.3	0.4	0	16.1	27.0	8.3	0
rock pigeon	0	0	0.10	0.10	0	0	0.3	0.6	0	0	4.2	1.7
Large Corvids	**0.04**	**0.02**	**0**	**0.12**	**<0.1**	**0.1**	**0**	**0.8**	**4.5**	**1.7**	**0**	**6.9**
American crow	0.04	0.02	0	0.12	<0.1	0.1	0	0.8	4.5	1.7	0	6.9
Goatsuckers	**0**	**0.02**	**0**	**0**	**0**	**0.1**	**0**	**0**	**0**	**1.6**	**0**	**0**
common nighthawk	0	0.02	0	0	0	0.1	0	0	0	1.6	0	0
Overall	**49.66**	**13.96**	**34.00**	**15.62**	**100**	**100**	**100**	**100**				

Appendix C. Species Exposure Indices for Large and Small Birds during Fixed-Point Bird Use Surveys at the Crocker Wind Farm from April 13, 2016 to March 28, 2017

Appendix C1. Relative exposure index and flight characteristics for each large bird species during the 20-minute fixed-point bird use surveys at the Crocker Wind Farm from April 13, 2016 to March 28, 2016.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within RSH based on initial obs	Exposure Index	% Within RSH at anytime
Canada goose	31	2.00	69.4	16.5	0.23	33.5
American white pelican	14	1.09	24.0	83.3	0.22	83.3
mallard	43	1.26	39.8	23.9	0.12	38.7
double-crested cormorant	15	0.78	31.1	47.3	0.11	80.0
unidentified sandpiper	4	0.32	75.9	42.9	0.10	90.5
Franklin's gull	20	1.11	48.7	12.2	0.07	55.4
red-tailed hawk	28	0.19	63.8	36.7	0.04	56.7
ring-billed gull	15	0.20	50.0	40.7	0.04	48.1
snow goose	2	1.04	99.8	2.9	0.03	2.9
American crow	2	0.02	80.0	75.0	0.01	100
unidentified gull	4	0.51	8.6	18.2	<0.01	45.5
Swainson's hawk	6	0.03	85.7	33.3	<0.01	50.0
gadwall	3	0.12	18.8	33.3	<0.01	33.3
northern shoveler	1	0.12	5.7	100	<0.01	100
northern pintail	4	0.03	44.4	50.0	<0.01	50.0
California gull	1	0.01	50.0	100	<0.01	100
Cooper's hawk	3	0.02	100	33.3	<0.01	33.3
great egret	17	0.27	52.4	3.0	<0.01	3.0
great blue heron	3	0.02	50.0	33.3	<0.01	33.3
northern harrier	5	0.03	71.4	20.0	<0.01	20.0
killdeer	36	1.00	70.1	0.5	<0.01	14.2
blue-winged teal	17	0.51	19.0	3.6	<0.01	3.6
unidentified buteo	2	0.01	50.0	50.0	<0.01	50.0
marbled godwit	2	<0.01	66.7	50.0	<0.01	50.0
bald eagle	3	0.01	80.0	25.0	<0.01	25.0
unidentified duck	4	3.82	1.7	0	0	84.6
greater scaup	0	1.26	0	0	0	0
lesser scaup	0	0.55	0	0	0	0
ring-necked duck	1	0.34	11.0	0	0	0
ring-necked pheasant	3	0.21	13.7	0	0	0
mourning dove	22	0.20	72.0	0	0	0
bufflehead	0	0.16	0	0	0	0
upland sandpiper	1	0.13	2.9	0	0	0
Forster's tern	1	0.11	100	0	0	0
common goldeneye	0	0.10	0	0	0	0

Appendix C1. Relative exposure index and flight characteristics for each large bird species during the 20-minute fixed-point bird use surveys at the Crocker Wind Farm from April 13, 2016 to March 28, 2016.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within RSH based on initial obs	Exposure Index	% Within RSH at anytime
wood duck	0	0.10	0	0	0	0
wild turkey	0	0.08	0	0	0	0
tundra swan	0	0.06	0	0	0	0
American coot	0	0.06	0	0	0	0
canvasback	0	0.05	0	0	0	0
rock pigeon	2	0.05	80.0	0	0	50.0
American bittern	0	0.03	0	0	0	0
white-faced ibis	1	0.03	100	0	0	0
greater yellowlegs	0	0.03	0	0	0	0
green-winged teal	1	0.02	40.0	0	0	100
pied-billed grebe	0	0.01	0	0	0	0
Wilson's snipe	0	<0.01	0	0	0	0
sandhill crane	0	<0.01	0	0	0	0
red-breasted merganser	0	<0.01	0	0	0	0
American kestrel	1	<0.01	100	0	0	0
ruddy duck	0	<0.01	0	0	0	0
redhead	0	<0.01	0	0	0	0
sharp-tailed grouse	0	<0.01	0	0	0	0
common nighthawk	1	<0.01	100	0	0	100
turkey vulture	1	<0.01	100	0	0	0
lesser yellowlegs	0	<0.01	0	0	0	0
hooded merganser	0	<0.01	0	0	0	0
glossy ibis	0	<0.01	0	0	0	0

RSH: The likely “rotor swept heights” for potential collision with a turbine blade, or 25-150 m (82-492 ft) above ground level (AGL).

Appendix C2. Relative exposure index and flight characteristics for each small bird species during the 20-minute fixed-point bird use surveys at the Crocker Wind Farm from April 13, 2016 to March 28, 2017.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within RSH based on initial obs	Exposure Index	% Within RSH at anytime
red-winged blackbird	45	2.00	42.3	4.3	0.04	43.9
common grackle	70	1.17	40.2	3.0	0.01	3.0
European starling	5	1.01	74.0	0	0	0
brown-headed cowbird	35	0.65	51.8	0	0	2.3
horned lark	7	0.60	76.8	0	0	0
western meadowlark	28	0.60	31.6	0	0	16.0
Lapland longspur	3	0.55	89.5	0	0	0
snow bunting	10	0.44	77.5	0	0	26.1
barn swallow	40	0.43	91.7	0	0	22.2
cliff swallow	9	0.29	17.8	0	0	0
Brewer's blackbird	1	0.27	100	0	0	0
tree swallow	19	0.26	87.1	0	0	32.8
eastern kingbird	22	0.26	50.8	0	0	0
American goldfinch	24	0.21	63.5	0	0	0
song sparrow	3	0.16	19.4	0	0	0
western kingbird	16	0.16	63.9	0	0	0
vesper sparrow	6	0.14	20.6	0	0	0
unidentified blackbird	3	0.13	100	0	0	42.9
unidentified sparrow	16	0.13	87.1	0	0	0
Savannah sparrow	3	0.13	23.3	0	0	0
American robin	6	0.12	20.0	0	0	0
grasshopper sparrow	1	0.11	3.6	0	0	0
yellow-headed blackbird	8	0.11	40.0	0	0	0
house sparrow	3	0.09	40.9	0	0	0
bobolink	15	0.08	77.3	0	0	0
orchard oriole	10	0.08	63.2	0	0	0
yellow warbler	4	0.07	31.6	0	0	0
clay-colored sparrow	5	0.07	29.4	0	0	0
American tree sparrow	1	0.05	37.5	0	0	0
common yellowthroat	1	0.05	7.7	0	0	0
eastern bluebird	3	0.05	75.0	0	0	0
dickcissel	2	0.04	20.0	0	0	0
marsh wren	0	0.04	0	0	0	0
northern flicker	7	0.03	77.8	0	0	14.3
yellow-rumped warbler	3	0.03	80.0	0	0	0
chipping sparrow	0	0.03	0	0	0	0

Appendix C2. Relative exposure index and flight characteristics for each small bird species during the 20-minute fixed-point bird use surveys at the Crocker Wind Farm from April 13, 2016 to March 28, 2017.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within RSH based on initial obs	Exposure Index	% Within RSH at anytime
purple martin	1	0.02	100	0	0	0
dark-eyed junco	3	0.02	100	0	0	0
unidentified swallow	3	0.02	100	0	0	0
sedge wren	0	0.02	0	0	0	0
unidentified bird (small)	1	0.01	25.0	0	0	0
northern rough-winged swallow	4	0.01	100	0	0	0
chestnut-collared longspur	2	0.01	66.7	0	0	0
willow flycatcher	2	0.01	100	0	0	0
unidentified flycatcher	0	0.01	0	0	0	0
bank swallow	2	0.01	100	0	0	0
brown thrasher	2	0.01	66.7	0	0	0
blue jay	0	<0.01	0	0	0	0
northern shrike	0	<0.01	0	0	0	0
unidentified bluebird	1	<0.01	100	0	0	0
warbling vireo	1	<0.01	100	0	0	0
downy woodpecker	1	<0.01	100	0	0	0
red-eyed vireo	0	<0.01	0	0	0	0
house wren	0	<0.01	0	0	0	0
field sparrow	1	<0.01	100	0	0	0
eastern wood-pewee	1	<0.01	100	0	0	0
Harris' sparrow	0	<0.01	0	0	0	0
hairy woodpecker	1	<0.01	100	0	0	0
belted kingfisher	0	<0.01	0	0	0	0

RSH: The likely “rotor swept heights” for potential collision with a turbine blade, or 25-150 m (82-492 ft) above ground level (AGL).

Appendix C3. Relative exposure index and flight characteristics for each large bird species during the 60-minute fixed-point bird use surveys at the Crocker Wind Farm from April 13, 2016 to March 28, 2016.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within RSH based on initial obs	Exposure Index	% Within RSH at anytime
Canada goose	71	4.88	65.7	48.7	1.56	63.8
mallard	90	2.12	49.4	38.6	0.40	53.5
American white pelican	35	1.70	29.1	72.5	0.36	82.6
double-crested cormorant	37	1.06	45.7	56.4	0.27	73.5
Franklin's gull	39	1.66	63.9	24.9	0.26	62.3
greater white-fronted goose	1	0.15	100	100	0.15	100
gadwall	10	0.27	56.0	71.4	0.11	71.4
unidentified sandpiper	7	0.49	56.0	38.6	0.10	81.4
unidentified gull	9	0.58	22.5	64.7	0.08	73.5
red-tailed hawk	45	0.28	66.7	39.6	0.07	60.4
black tern	5	0.18	100	37.9	0.07	100
ring-billed gull	45	0.46	61.8	23.5	0.07	33.3
American golden-plover	1	0.03	100	100	0.03	100
snow goose	5	1.66	99.7	1.8	0.03	5.2
glossy ibis	1	0.03	90.0	100	0.03	100
American crow	7	0.05	83.3	60.0	0.03	70.0
great egret	37	0.42	59.8	6.9	0.02	12.1
Swainson's hawk	11	0.04	91.7	36.4	0.01	45.5
northern pintail	7	0.08	33.3	42.9	0.01	71.4
northern shoveler	5	0.19	11.1	50.0	0.01	66.7
marbled godwit	4	0.02	83.3	60.0	<0.01	60.0
bald eagle	6	0.02	87.5	42.9	<0.01	42.9
unidentified buteo	3	0.03	42.9	66.7	<0.01	66.7
great blue heron	6	0.04	54.5	33.3	<0.01	33.3
northern harrier	13	0.07	68.4	15.4	<0.01	15.4
blue-winged teal	23	0.58	24.0	5.0	<0.01	5.0
California gull	1	0.01	50.0	100	<0.01	100
redhead	1	0.01	50.0	100	<0.01	100
Cooper's hawk	3	0.02	100	33.3	<0.01	33.3
upland sandpiper	4	0.19	14.6	14.3	<0.01	14.3
killdeer	44	1.03	70.8	0.5	<0.01	14.1
ring-necked duck	4	0.39	16.0	5.0	<0.01	5.0
unidentified duck	10	4.46	5.5	0	0	39.2
greater scaup	0	1.26	0	0	0	0
lesser scaup	0	0.62	0	0	0	0
unidentified goose	1	0.47	100	0	0	0

Appendix C3. Relative exposure index and flight characteristics for each large bird species during the 60-minute fixed-point bird use surveys at the Crocker Wind Farm from April 13, 2016 to March 28, 2016.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within RSH based on initial obs	Exposure Index	% Within RSH at anytime
ring-necked pheasant	4	0.28	11.6	0	0	0
mourning dove	23	0.21	73.1	0	0	0
bufflehead	0	0.17	0	0	0	0
wood duck	0	0.17	0	0	0	0
ruddy duck	0	0.12	0	0	0	0
Forster's tern	1	0.11	100	0	0	0
common goldeneye	0	0.10	0	0	0	0
wild turkey	0	0.10	0	0	0	0
tundra swan	0	0.06	0	0	0	0
American coot	0	0.06	0	0	0	0
white-faced ibis	3	0.06	100	0	0	9.1
canvasback	1	0.06	6.2	0	0	100
greater yellowlegs	1	0.05	13.3	0	0	0
rock pigeon	3	0.05	81.8	0	0	44.4
American bittern	0	0.03	0	0	0	0
red-breasted merganser	0	0.02	0	0	0	0
green-winged teal	1	0.02	40.0	0	0	100
pied-billed grebe	0	0.01	0	0	0	0
American kestrel	2	0.01	66.7	0	0	0
Bonaparte's gull	1	0.01	100	0	0	0
Wilson's snipe	0	0.01	0	0	0	0
lesser yellowlegs	0	0.01	0	0	0	0
cattle egret	1	<0.01	100	0	0	0
sharp-tailed grouse	1	<0.01	50.0	0	0	0
prairie falcon	2	<0.01	100	0	0	100
great horned owl	1	<0.01	100	0	0	0
willet	2	<0.01	100	0	0	0
sandhill crane	0	<0.01	0	0	0	0
unidentified raptor	0	<0.01	0	0	0	0
hooded merganser	1	<0.01	50.0	0	0	0
American avocet	0	<0.01	0	0	0	0
white-rumped sandpiper	1	<0.01	100	0	0	0
Virginia rail	0	<0.01	0	0	0	0
snowy egret	1	<0.01	100	0	0	0
common nighthawk	1	<0.01	100	0	0	100
black-crowned night-heron	1	<0.01	100	0	0	0

Appendix C3. Relative exposure index and flight characteristics for each large bird species during the 60-minute fixed-point bird use surveys at the Crocker Wind Farm from April 13, 2016 to March 28, 2016.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within RSH based on initial obs	Exposure Index	% Within RSH at anytime
turkey vulture	1	<0.01	100	0	0	0
rough-legged hawk	1	<0.01	100	0	0	0

RSH: The likely “rotor swept heights” for potential collision with a turbine blade, or 25-150 m (82-492 ft) above ground level (AGL).

Appendix D. Mean Use by Point for All Birds, Major Bird Types, and Diurnal Raptor Subtypes during Fixed-Point Bird Use Surveys at the Crocker Wind Farm from April 13, 2016 to March 28, 2017

Appendix D1. Mean use (number of birds/20-minute survey) by point for all birds[a], major bird types, and diurnal raptor subtypes observed at the Crocker Wind Farm during fixed-point bird use surveys from April 13, 2016 to March 28, 2017.

	Survey Point									
Bird Type	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Loons/Grebes	0	0	0	0	0	0	0.15	0	0	0
Waterbirds	0	3.21	0	2.21	2.67	3.79	2.23	3.69	0.71	0.62
Waterfowl	3.33	0	2.53	0.43	1.47	15.86	8.31	0.08	13.43	64.38
Shorebirds	2	0.21	0.73	2.29	0.33	1.07	3.31	0.15	5.21	0.38
Gulls/Terns	0	2.71	0	1.29	0	6.21	1.62	1.23	0.79	1.31
Rails/Coots	0	0	0	0	0	1.36	0	0	0	0
Diurnal Raptors	**0.53**	**0.21**	**0.40**	**0.21**	**0.40**	**0.21**	**0.15**	**0.54**	**0.07**	**0.08**
Accipiters	*0*	*0*	*0*	*0*	*0.07*	*0*	*0*	*0*	*0*	*0*
Buteos	*0.53*	*0.14*	*0.27*	*0.21*	*0.27*	*0.21*	*0.15*	*0.54*	*0.07*	*0*
Northern Harrier	*0*	*0.07*	*0.13*	*0*	*0.07*	*0*	*0*	*0*	*0*	*0.08*
Eagles	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Falcons	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Vultures	0	0.07	0	0	0	0	0	0	0	0
Upland Game Birds	0.07	0.21	0.07	0.21	0.60	0.07	0.15	0.08	0.14	0.08
Doves/Pigeons	0.47	0.64	0.13	0	0	0.21	0.15	0.54	0.07	0
Large Corvids	0	0	0	0.07	0	0	0	0	0.07	0
Goatsuckers	0	0	0	0	0	0	0	0	0	0
All Large Birds	**6.40**	**7.29**	**3.87**	**6.71**	**5.47**	**28.79**	**16.08**	**6.31**	**20.50**	**66.85**
Passerines	9.93	5.50	8.00	19.07	10.60	17.07	15.00	8.15	5.36	17.62
Woodpeckers	0.07	0	0.07	0.21	0	0	0.08	0	0	0
Kingfishers	0	0	0	0	0	0	0.08	0	0	0
Unidentified Birds	0	0	0	0	0	0.14	0	0	0	0.08
All Small Birds	**10.00**	**5.50**	**8.07**	**19.29**	**10.60**	**17.21**	**15.15**	**8.15**	**5.36**	**17.69**

[a] 800-meter (m) radius plot for large birds, 100-m radius plot for small birds.

Appendix D1 (*continued*). Mean use (number of birds/20-minute survey) by point for all birds[a], major bird types, and diurnal raptor subtypes observed at the Crocker Wind Farm during fixed-point bird use surveys from April 13, 2016 to March 28, 2017.

	Survey Point									
Bird Type	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Loons/Grebes	0	0	0	0	0	0	0	0	0	0
Waterbirds	0	0.23	2.50	3.86	4.29	5.92	0	0	15.67	0
Waterfowl	0.31	14.46	34.07	5.36	8.50	15.62	20.33	0	110.33	0
Shorebirds	0.15	0.46	6.14	3.71	0.86	0.69	0.33	0	0.67	0
Gulls/Terns	0	0.31	0.07	3.00	0.57	18.46	0	0	3.50	0
Rails/Coots	0	0	0	0	0	0	0	0	0	0
Diurnal Raptors	**0.38**	**0.31**	**0.21**	**0.29**	**0.50**	**0.69**	**0.17**	**0**	**0.17**	**0**
Accipiters	*0*	*0*	*0*	*0*	*0.14*	*0*	*0*	*0*	*0*	*0*
Buteos	*0.15*	*0.31*	*0.14*	*0.29*	*0.21*	*0.69*	*0*	*0*	*0*	*0*
Northern Harrier	*0.08*	*0*	*0*	*0*	*0*	*0*	*0.17*	*0*	*0*	*0*
Eagles	*0.15*	*0*	*0.07*	*0*	*0.14*	*0*	*0*	*0*	*0*	*0*
Falcons	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0.17*	*0*
Vultures	0	0	0	0	0	0	0	0	0	0
Upland Game Birds	0.15	0.15	0.43	0.50	1.71	0.54	0	0	0	0
Doves/Pigeons	0.08	0.15	0.21	1.07	0.50	0.08	0	0	0	0
Large Corvids	0	0	0	0	0.21	0	0	0	0	0
Goatsuckers	0	0	0	0.07	0	0	0	0	0	0
All Large Birds	**1.08**	**16.08**	**43.64**	**17.86**	**17.14**	**42.00**	**20.83**	**0**	**130.33**	**0**
Passerines	6.69	3.00	21.86	19.57	10.79	3.23	3.50	0.67	30.00	5.40
Woodpeckers	0.23	0	0.14	0	0	0	0	0	0	0
Kingfishers	0	0	0	0	0	0	0	0	0	0
Unidentified Birds	0	0.08	0	0	0	0	0	0	0	0
All Small Birds	**6.92**	**3.08**	**22.00**	**19.57**	**10.79**	**3.23**	**3.50**	**0.67**	**30.00**	**5.40**

[a] 800-meter (m) radius plot for large birds, 100-m radius plot for small birds.

Appendix D2. Mean use (number of birds/60-minute survey) by point for all birds[a], major bird types, and diurnal raptor subtypes observed at the Crocker Wind Farm during fixed-point bird use surveys from April 13, 2016 to March 28, 2017.

	Survey Point									
Bird Type	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Loons/Grebes	0	0	0	0	0	0	0.15	0	0	0
Waterbirds	0.73	3.21	0.13	2.36	6.73	7.21	2.85	9.38	1.00	2.00
Waterfowl	5.93	0	6.80	4.93	3.53	22.21	24.23	0.15	18.07	70.46
Shorebirds	2.20	0.21	1.00	2.43	0.40	2.29	3.46	0.15	7.71	0.46
Gulls/Terns	1.27	3.86	0	1.43	3.20	7.29	8.31	2.85	3.57	2.92
Rails/Coots	0	0	0	0	0	1.36	0	0	0	0
Diurnal Raptors	**0.67**	**0.43**	**0.67**	**0.43**	**0.53**	**0.36**	**0.38**	**1.15**	**0.29**	**0.23**
Accipiters	*0*	*0*	*0*	*0*	*0.07*	*0*	*0*	*0*	*0*	*0*
Buteos	*0.67*	*0.21*	*0.47*	*0.43*	*0.40*	*0.21*	*0.31*	*0.92*	*0.29*	*0*
Northern Harrier	*0*	*0.21*	*0.20*	*0*	*0.07*	*0*	*0*	*0.08*	*0*	*0.23*
Eagles	*0*	*0*	*0*	*0*	*0*	*0.07*	*0*	*0.15*	*0*	*0*
Falcons	*0*	*0*	*0*	*0*	*0*	*0*	*0.08*	*0*	*0*	*0*
Other Raptors	*0*	*0*	*0*	*0*	*0*	*0.07*	*0*	*0*	*0*	*0*
Owls	0	0	0	0	0	0	0.15	0	0	0
Vultures	0	0.07	0	0	0	0	0	0	0	0
Upland Game Birds	0.13	0.21	0.07	0.29	0.67	0.07	0.15	0.15	0.43	0.15
Doves/Pigeons	0.47	0.64	0.13	0	0	0.21	0.15	0.54	0.21	0
Large Corvids	0	0.14	0.07	0.07	0	0	0.15	0	0.07	0.08
Goatsuckers	0	0	0	0	0	0	0	0	0	0
All Large Birds	**11.40**	**8.79**	**8.87**	**11.93**	**15.07**	**41.00**	**40.00**	**14.38**	**31.36**	**76.31**

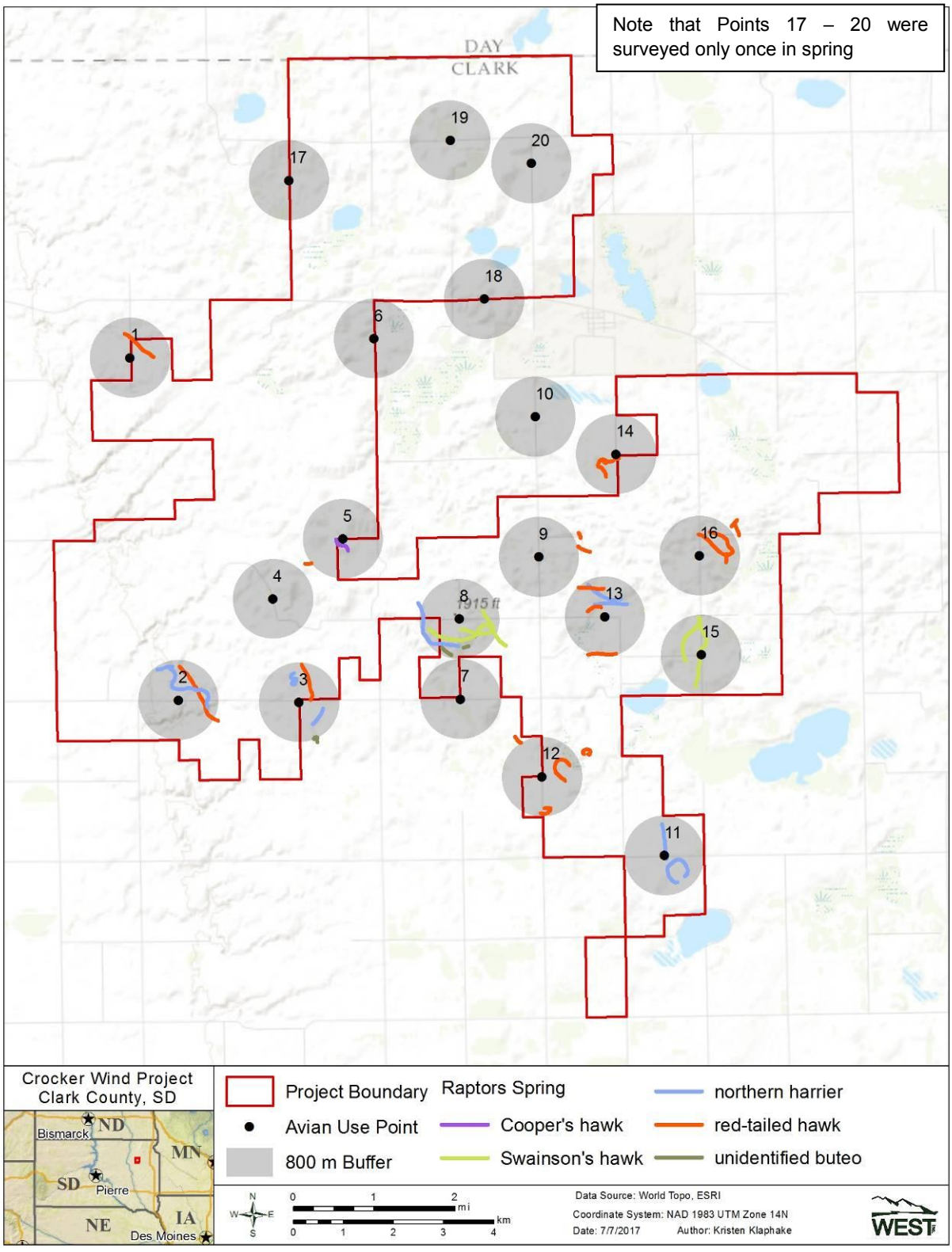
[a.] 800-meter (m) radius plot for large birds, 100-m radius plot for small birds.

Appendix D2 (*continued*). Mean use (number of birds/60-minute survey) by point for all birds[a], major bird types, and diurnal raptor subtypes observed at the Crocker Wind Farm during fixed-point bird use surveys from April 13, 2016 to March 28, 2017.

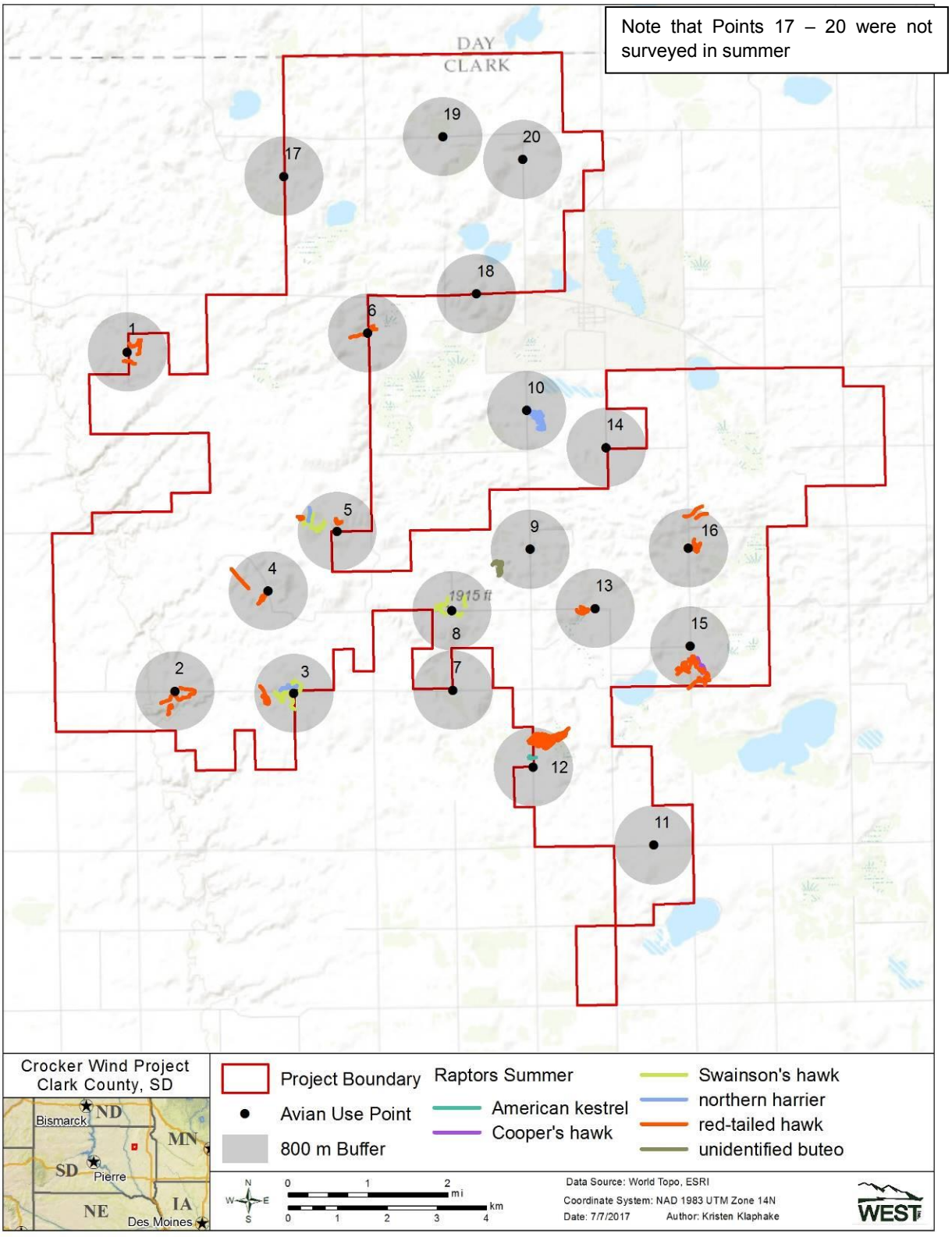
	Survey Point									
Bird Type	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Loons/Grebes	0	0	0.07	0	0	0	0	0	0	0
Waterbirds	1.08	0.23	3.64	4.71	7.36	6.54	0.17	0	16.17	0
Waterfowl	8.00	57.00	36.5	15.14	24.50	21.31	20.83	0	130.67	0
Shorebirds	0.46	0.54	6.29	4.43	0.93	1.54	0.33	0	0.67	0
Gulls/Terns	0.23	0.62	0.14	3.43	1.43	19.15	0.50	0	4.00	0
Rails/Coots	0	0	0.07	0	0	0	0	0	0	0
Diurnal Raptors	**0.46**	**0.54**	**0.64**	**0.36**	**0.79**	**1.00**	**0.33**	**0**	**0.50**	**0**
Accipiters	*0*	*0*	*0*	*0*	*0.14*	*0*	*0*	*0*	*0*	*0*
Buteos	*0.15*	*0.46*	*0.36*	*0.29*	*0.50*	*0.77*	*0.17*	*0*	*0.33*	*0*
Northern Harrier	*0.15*	*0*	*0.21*	*0.07*	*0*	*0.08*	*0.17*	*0*	*0*	*0*
Eagles	*0.15*	*0*	*0.07*	*0*	*0.14*	*0*	*0*	*0*	*0*	*0*
Falcons	*0*	*0.08*	*0*	*0*	*0*	*0.15*	*0*	*0*	*0.17*	*0*
Other Raptors	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Owls	0	0	0	0	0	0	0	0	0	0
Vultures	0	0	0	0	0	0	0	0	0	0
Upland Game Birds	0.31	0.23	0.50	0.57	2.14	0.62	0	0.17	0.17	0
Doves/Pigeons	0.08	0.15	0.21	1.07	0.57	0.08	0	0	0	0
Large Corvids	0	0	0	0	0.21	0	0	0	0	0.20
Goatsuckers	0	0	0	0.07	0	0	0	0	0	0
All Large Birds	**10.62**	**59.31**	**48.07**	**29.79**	**37.93**	**50.23**	**22.17**	**0.17**	**152.17**	**0.20**

[a] 800-meter (m) radius plot for large birds, 100-m radius plot for small birds.

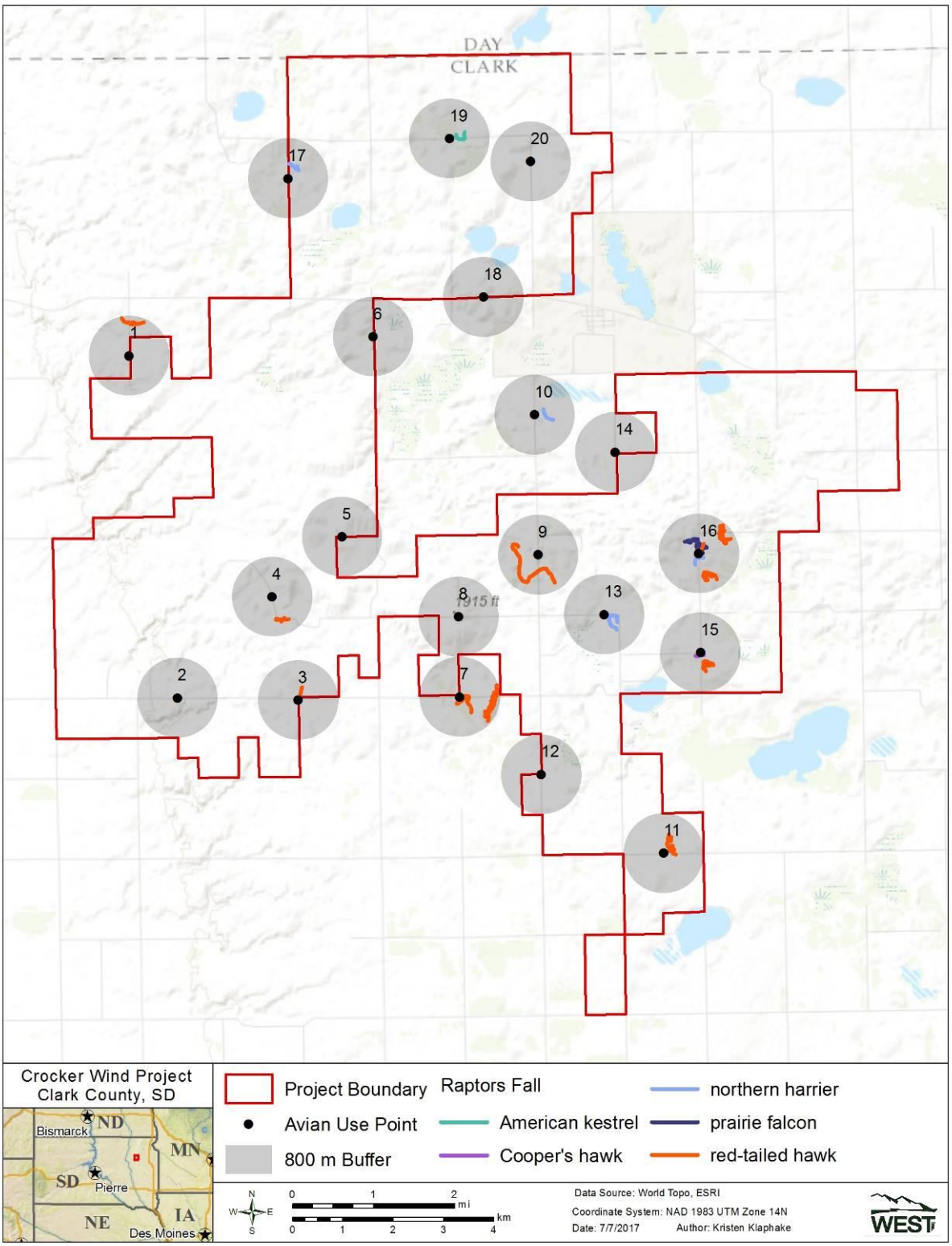
Appendix E. Large Bird Flight Paths Recorded during Fixed-Point Bird Use Surveys at the Crocker Wind Farm from April 13, 2016 to March 28, 2017



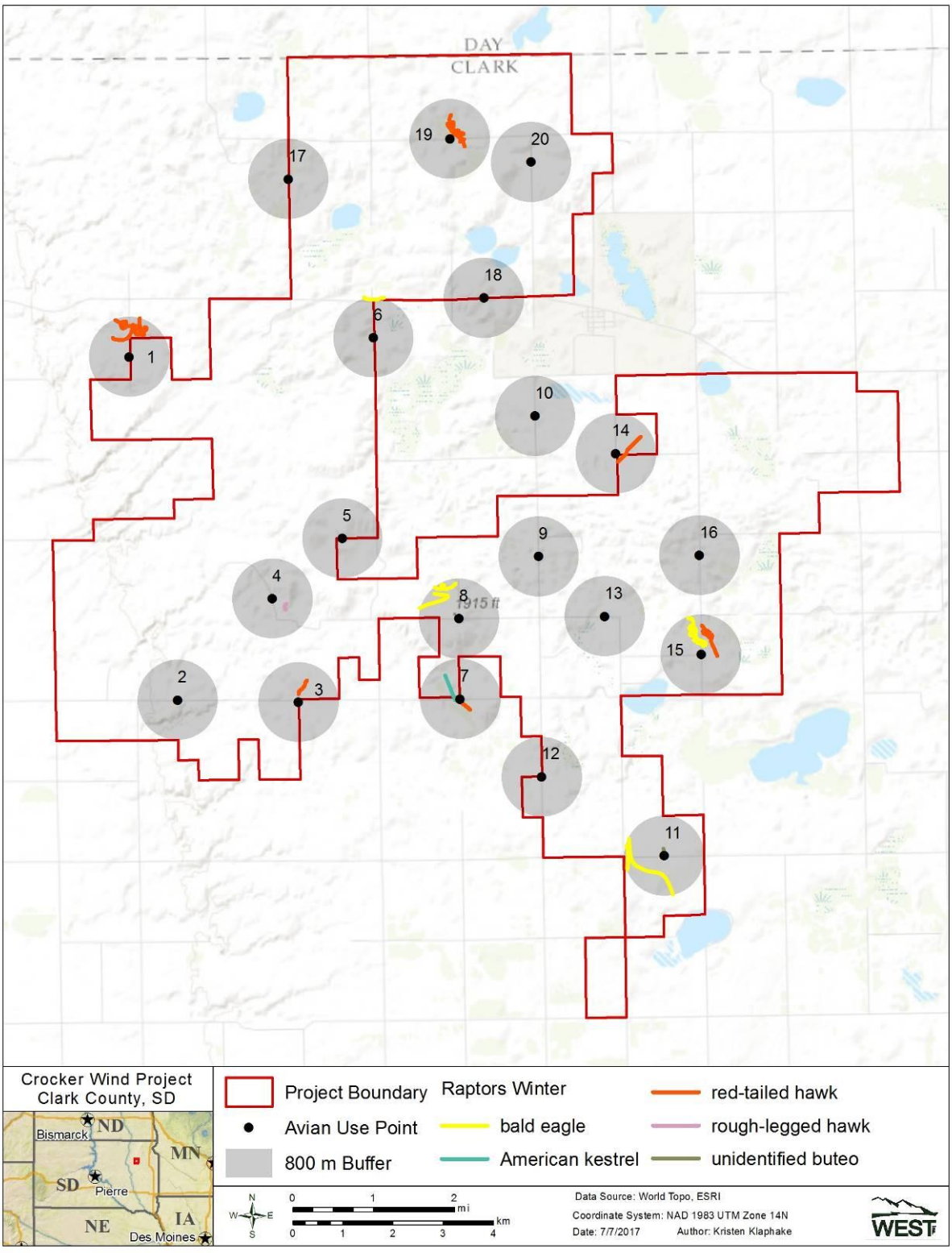
Appendix E. Diurnal raptor flight paths recorded at the Crocker Wind Farm during spring fixed-point bird use surveys from April 13, 2016 to March 28, 2017.



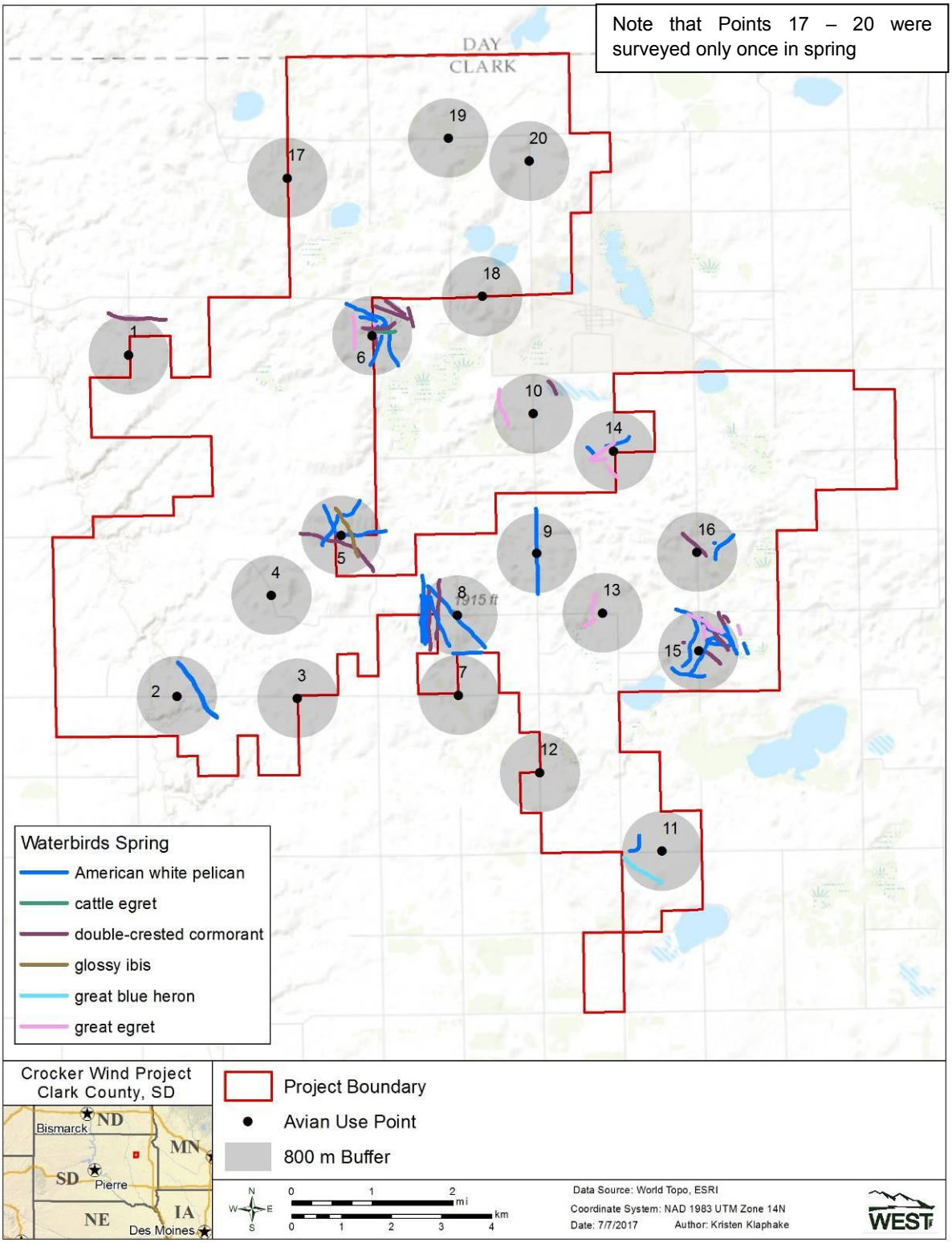
Appendix E (continued). Diurnal raptor flight paths recorded at the Crocker Wind Farm during summer fixed-point bird use surveys from April 13, 2016 to March 28, 2017.



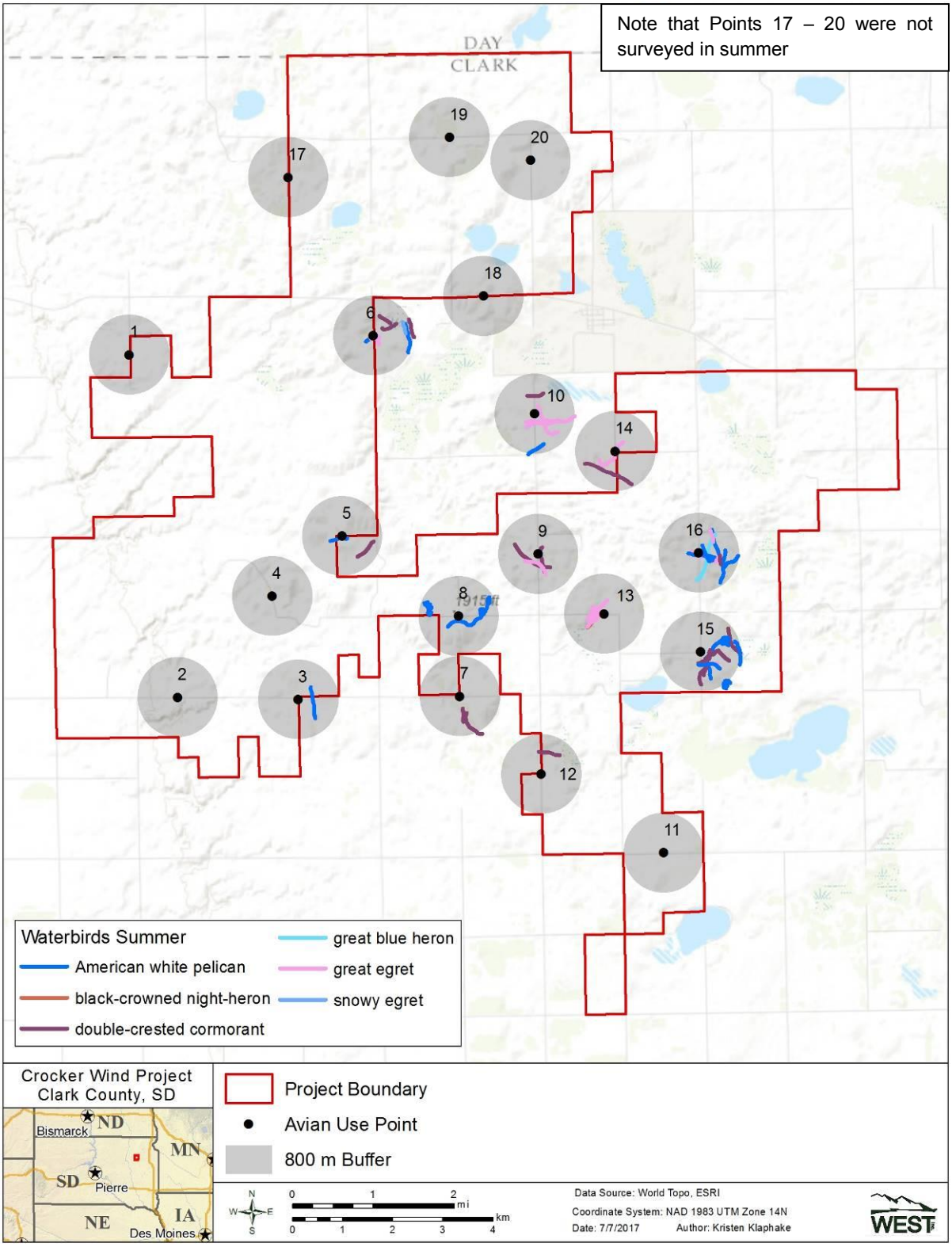
Appendix E (continued). Diurnal raptor flight paths recorded at the Crocker Wind Farm during **fall fixed-point bird use surveys from April 13, 2016 to March 28, 2017.**



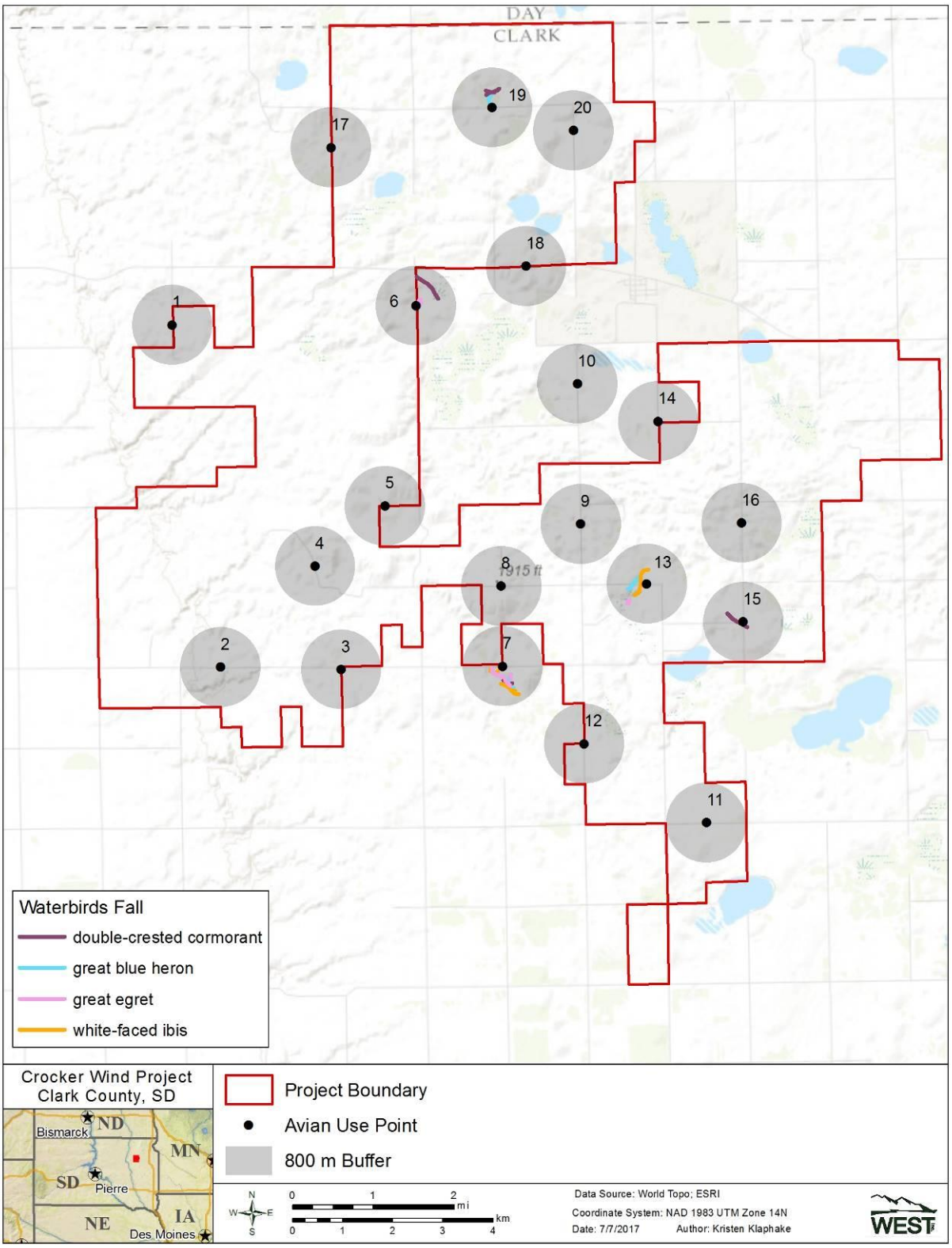
Appendix E (continued). Diurnal raptor flight paths recorded at the Crocker Wind Farm during winter fixed-point bird use surveys from April 13, 2016 to March 28, 2017.



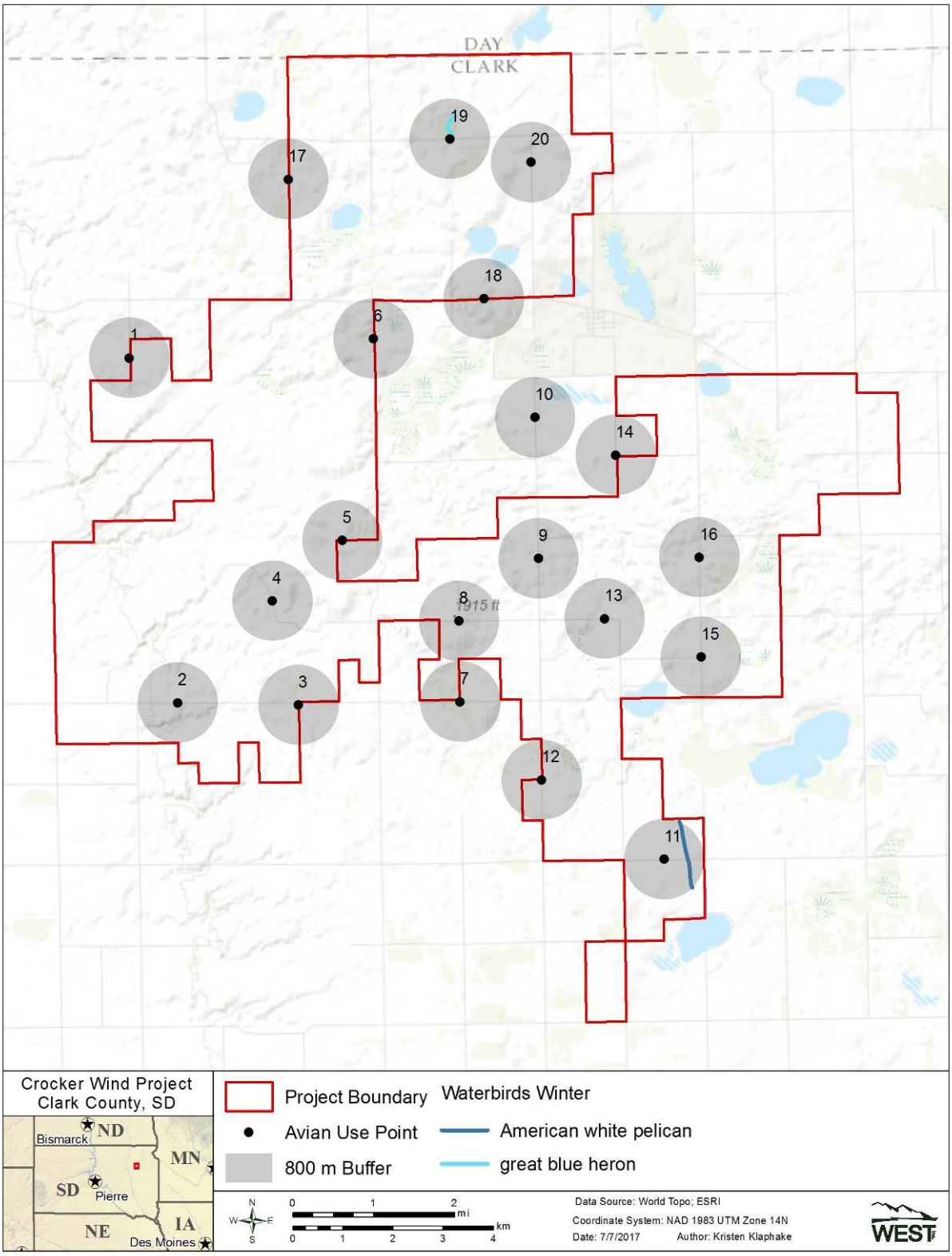
Appendix E (continued). Waterbird flight paths recorded at the Crocker Wind Farm during spring fixed-point bird use surveys from April 13, 2016 to March 28, 2017.



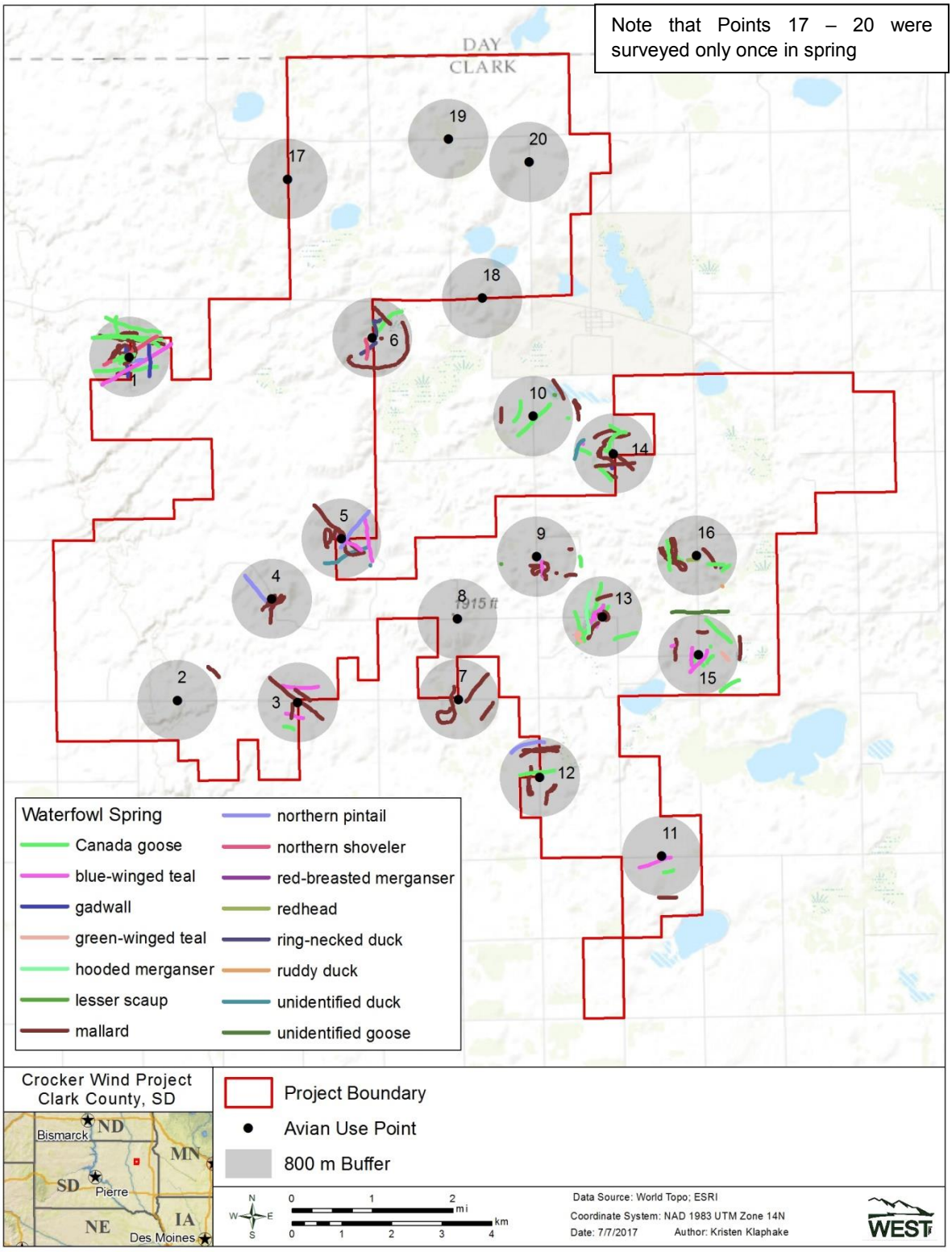
Appendix E (continued). Waterbird flight paths recorded at the Crocker Wind Farm during summer fixed-point bird use surveys from April 13, 2016 to March 28, 2017.



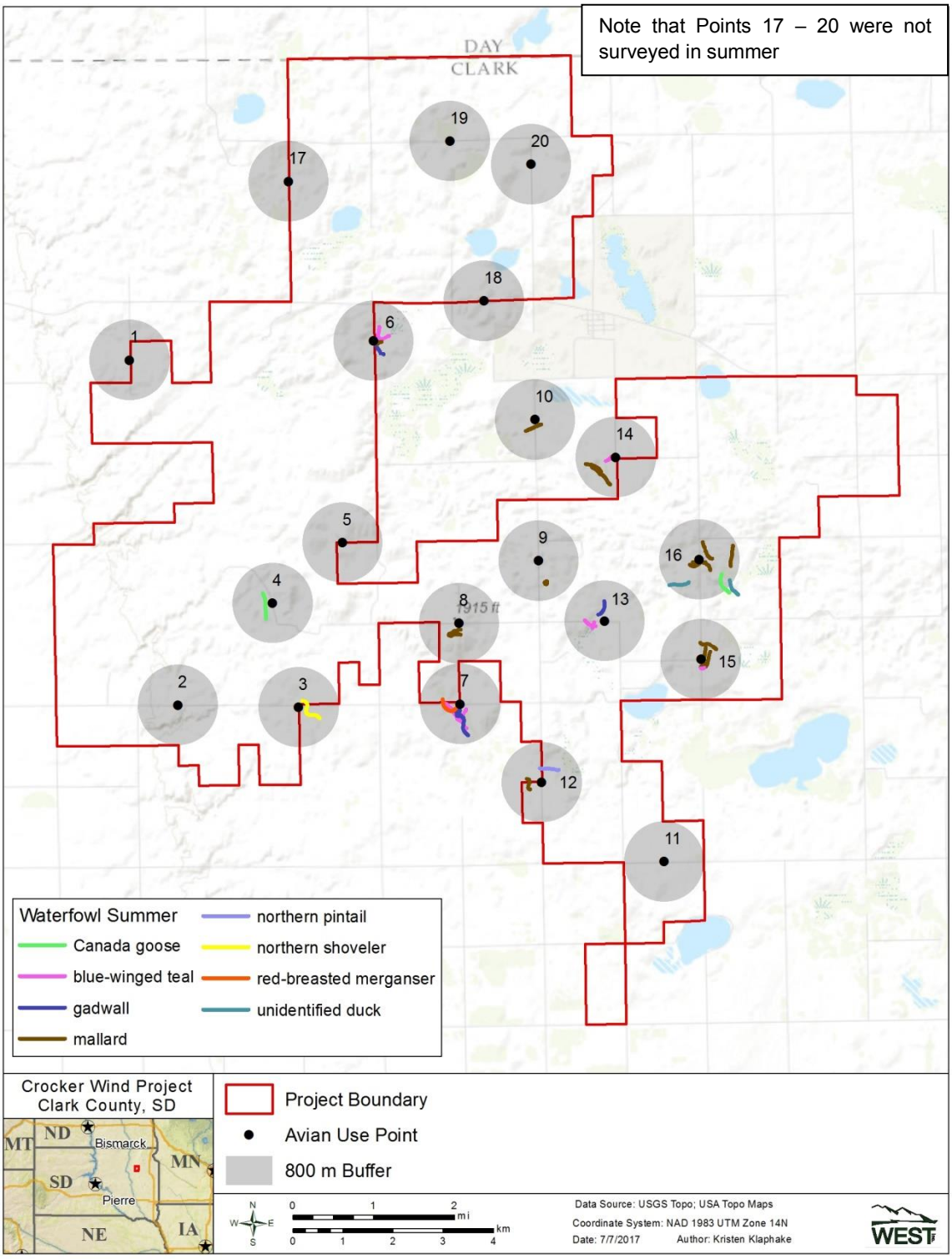
Appendix E (continued). Waterbird flight paths recorded at the Crocker Wind Farm during fall fixed-point bird use surveys from April 13, 2016 to March 28, 2017.



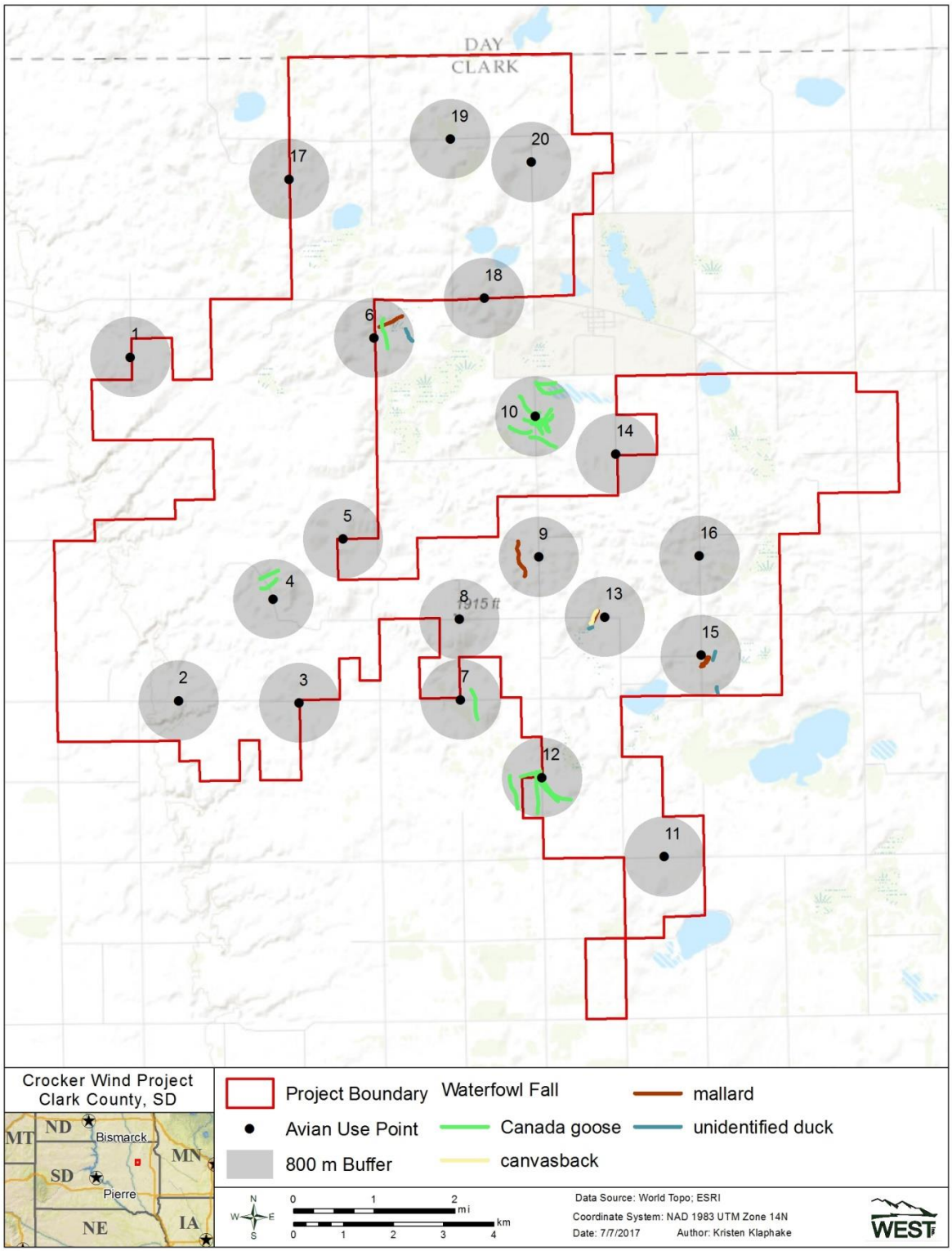
Appendix E (continued). Waterbird flight paths recorded at the Crocker Wind Farm during winter fixed-point bird use surveys from April 13, 2016 to March 28, 2017.



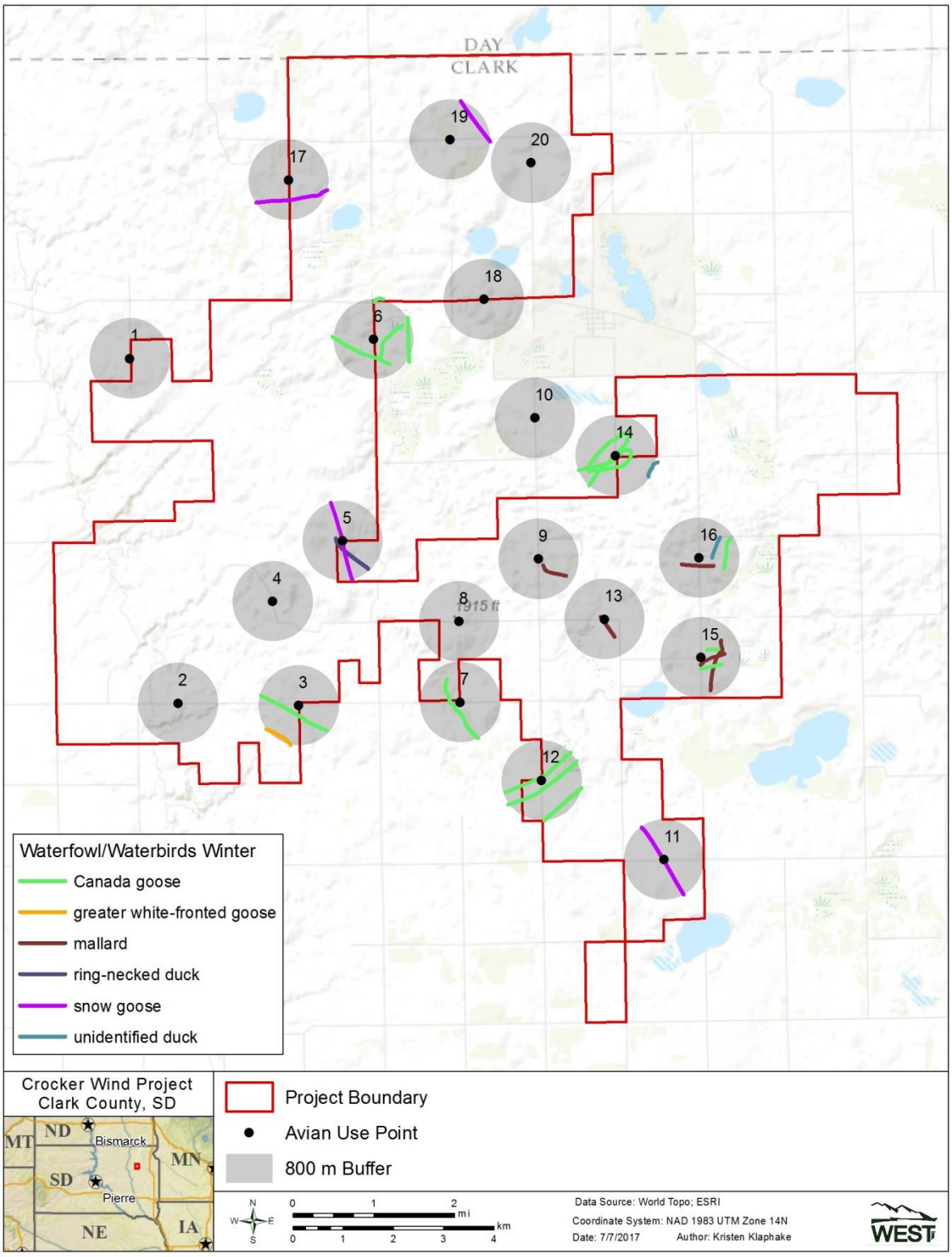
Appendix E (continued). Waterfowl flight paths recorded at the Crocker Wind Farm during spring fixed-point bird use surveys from April 13, 2016 to March 28, 2017.



Appendix E (continued). Waterfowl flight paths recorded at the Crocker Wind Farm during summer fixed-point bird use surveys from April 13, 2016 to March 28, 2017.

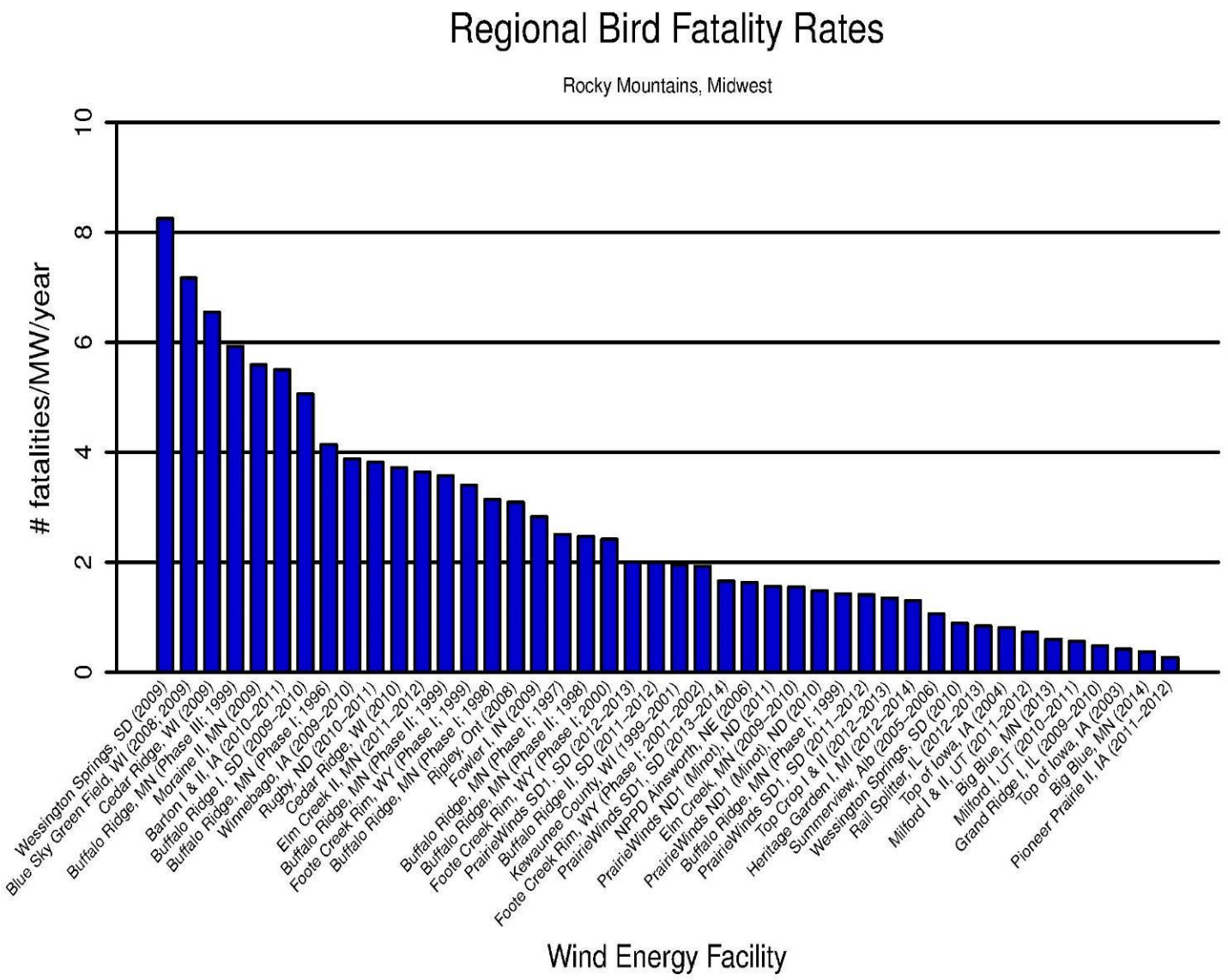


Appendix E (continued). Waterfowl flight paths recorded at the Crocker Wind Farm during fall fixed-point bird use surveys from April 13, 2016 to March 28, 2017.



Appendix E (continued). Waterfowl flight paths recorded at the Crocker Wind Farm during winter fixed-point bird use surveys from April 13, 2016 to March 28, 2017.

Appendix F. North American Fatality Summary Tables



Appendix F1. Fatality rates for all birds (number of birds per megawatt per year) reported in publicly-available studies at wind energy facilities in the Rocky Mountains and Midwest regions of North America.

Appendix F1. Wind energy facilities in North America with publicly-available and comparable fatality data for all bird species, by geographic region.

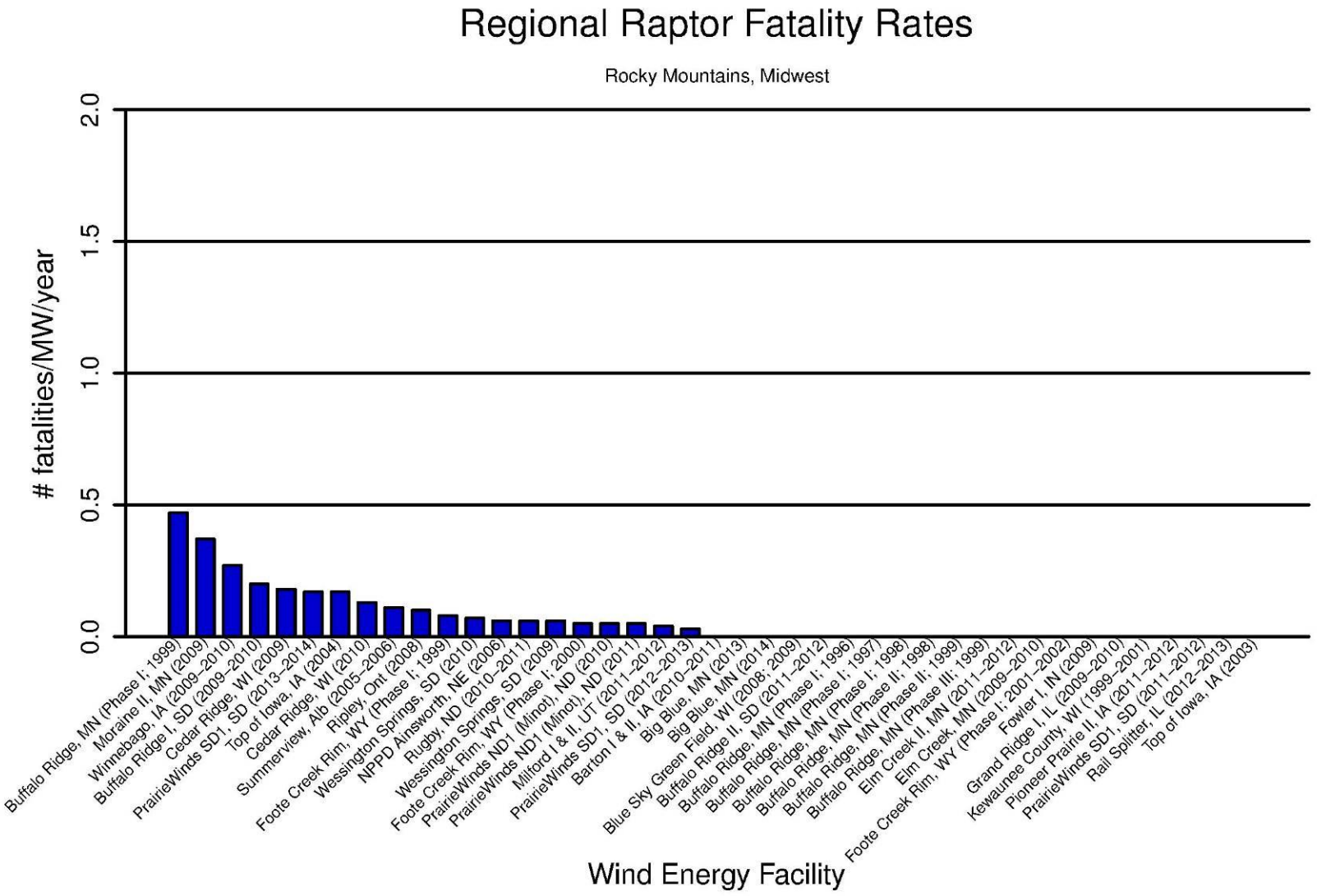
Wind Energy Facility	Fatality Estimate[A]	No. of Turbines	Total MW
Midwest			
Wessington Springs, SD (2009)	8.25	34	51
Blue Sky Green Field, WI (2008; 2009)	7.17	88	145
Cedar Ridge, WI (2009)	6.55	41	67.6
Buffalo Ridge, MN (Phase III; 1999)	5.93	138	103.5
Moraine II, MN (2009)	5.59	33	49.5
Barton I & II, IA (2010-2011)	5.50	80	160
Buffalo Ridge I, SD (2009-2010)	5.06	24	50.4
Buffalo Ridge, MN (Phase I; 1996)	4.14	73	25
Winnebago, IA (2009-2010)	3.88	10	20
Rugby, ND (2010-2011)	3.82	71	149
Cedar Ridge, WI (2010)	3.72	41	68
Elm Creek II, MN (2011-2012)	3.64	62	148.8
Buffalo Ridge, MN (Phase II; 1999)	3.57	143	107.25
Buffalo Ridge, MN (Phase I; 1998)	3.14	73	25
Ripley, Ont (2008)	3.09	38	76
Fowler I, IN (2009)	2.83	162	301
Buffalo Ridge, MN (Phase I; 1997)	2.51	73	25
Buffalo Ridge, MN (Phase II; 1998)	2.47	143	107.25
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 (2012-2013)	1.35	68 (phase I) 132 (phase (II)	300 (102 (phase I) 198 (phase II))
Heritage Garden I, MI (2012-2014)	1.30	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
Rocky Mountains			
Foote Creek Rim, WY (Phase I; 1999)	3.40	69	41.4
Foote Creek Rim, WY (Phase I; 2000)	2.42	69	41.4
Foote Creek Rim, WY (Phase I; 2001-2002)	1.93	69	41.4
Summerview, Alb (2005-2006)	1.06	39	70.2
Milford I & II, UT (2011-2012)	0.73	107	160.5 (58.5 I, 102 II)
Milford I, UT (2010-2011)	0.56	58	145

A=number of bird fatalities/MW/year

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:

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



Appendix F2. Fatality rates for raptors (number of raptors per megawatt per year) reported in publically-available studies at wind energy facilities in western/eastern North America.

Appendix F2. Wind energy facilities in North America with publicly-available and comparable use and fatality data for raptors, by geographic region.

Wind Energy Facility	Use Estimate[A]	Raptor Fatality Estimate[B]	No. of Turbines	Total MW
Crocker, ND	**0.288**			
	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
	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 I, 102 II)
Foote Creek Rim, WY (Phase I; 2001-2002)	0.554	0	69	41.4

A=number of raptors/plot/20min survey
B=number of fatalities/MW/year

Appendix F2 (*continued*). Wind energy facilities in North America with publicly-available and comparable use and fatality data for raptors.

Data from the following sources:

Project Name	Use reference	Fatality reference	Project Name	Use reference	Fatality reference
Barton I & II, IA (2010-2011)	NA	Derby et al. 2011a	Grand Ridge I, IL (2009-2010)	Derby et al. 2009	Derby et al. 2010g
Big Blue, MN (2013)	NA	Fagen Engineering 2014	Kewaunee County, WI (1999-2001)	NA	Howe et al. 2002
Big Blue, MN (2014)	NA	Fagen Engineering 2015	Milford I & II, UT (2011-2012)	NA	Stantec 2012
Blue Sky Green Field, WI (2008; 2009)	NA	Gruver et al. 2009	Moraine II, MN (2009)	NA	Derby et al. 2010d
Buffalo Ridge I, SD (2009-2010)	NA	Derby et al. 2010b	NPPD Ainsworth, NE (2006)	NA	Derby et al. 2007
Buffalo Ridge II, SD (2011-2012)	NA	Derby et al. 2012a	Pioneer Prairie II, IA (2011-2012)	NA	Chodachek et al. 2012
Buffalo Ridge, MN (Phase I; 1996)	NA	Johnson et al. 2000a	PrairieWinds ND1 (Minot), ND (2010)	NA	Derby et al. 2011c
Buffalo Ridge, MN (Phase I; 1997)	NA	Johnson et al. 2000a	PrairieWinds ND1 (Minot), ND (2011)	NA	Derby et al. 2012c
Buffalo Ridge, MN (Phase I; 1998)	NA	Johnson et al. 2000a	PrairieWinds SD1, SD (2011-2012)	NA	Derby et al. 2012d
Buffalo Ridge, MN (Phase I; 1999)	NA	Johnson et al. 2000a	PrairieWinds SD1, SD (2012-2013)	NA	Derby et al. 2013
Buffalo Ridge, MN (Phase II; 1998)	NA	Johnson et al. 2000a	PrairieWinds SD1, SD (2013-2014)	NA	Derby et al. 2014
Buffalo Ridge, MN (Phase II; 1999)	NA	Johnson et al. 2000a	Rail Splitter, IL (2012-2013)	NA	Good et al. 2013b
Buffalo Ridge, MN (Phase III; 1999)	NA	Johnson et al. 2000a	Ripley, Ont (2008)	NA	Jacques Whitford 2009
Cedar Ridge, WI (2009)	NA	Arnett et al. 2010	Rugby, ND (2010-2011)	NA	Derby et al. 2011b
Cedar Ridge, WI (2010)	NA	BHE Environmental 2010	Summerview, Alb (2005-2006)	NA	Brown and Hamilton 2006b
Elm Creek II, MN (2011-2012)	NA	Derby et al. 2012b	Top of Iowa, IA (2003)	NA	Jain 2005
Elm Creek, MN (2009-2010)	NA	Derby et al. 2010c	Top of Iowa, IA (2004)	NA	Jain 2005
Foote Creek Rim, WY (Phase I; 1999)	Johnson et al. 2000b	Young et al. 2003a	Wessington Springs, SD (2009)	Derby et al. 2008	Derby et al. 2010f
Foote Creek Rim, WY (Phase I; 2000)	Johnson et al. 2000b	Young et al. 2003a, 2003b	Wessington Springs, SD (2010)	Derby et al. 2008	Derby et al. 2011d
Foote Creek Rim, WY (Phase I; 2001-2002)	Johnson et al. 2000b	Young et al. 2003a, 2003b	Winnebago, IA (2009-2010)	NA	Derby et al. 2010e
Fowler I, IN (2009)	NA	Johnson et al. 2010a			

Appendix F3. Publicly-available and comparable fatality estimates and habitat types from North American wind-energy facilities.

Wind Energy Facility	Bird Fatalities (birds/MW/year)	Raptor Fatalities (raptors/MW/year)	Bat Fatalities (bats/MW/year)	Predominant Habitat Type	Citation
Barton I & II, IA (2010-2011)	5.5	0	1.85	agriculture	Derby et al. 2011a
Big Blue, MN (2013)	0.6	0	2.04	agriculture	Fagen Engineering 2014
Big Blue, MN (2014)	0.37	0	1.43	agriculture	Fagen Engineering 2015
Blue Sky Green Field, WI (2008; 2009)	7.17	0	24.57	agriculture	Gruver et al. 2009
Buffalo Ridge I, SD (2009-2010)	5.06	0.2	0.16	agriculture/grassland	Derby et al. 2010b
Buffalo Ridge II, SD (2011-2012)	1.99	0	2.81	agriculture, grassland	Derby et al. 2012a
Buffalo Ridge, MN (Phase I; 1996)	4.14	0	NA	agriculture	Johnson et al. 2000a
Buffalo Ridge, MN (Phase I; 1997)	2.51	0	NA	agriculture	Johnson et al. 2000a
Buffalo Ridge, MN (Phase I; 1998)	3.14	0	NA	agriculture	Johnson et al. 2000a
Buffalo Ridge, MN (Phase I; 1999)	1.43	0.47	0.74	agriculture	Johnson et al. 2000a
Buffalo Ridge, MN (Phase II; 1998)	2.47	0	2.16	agriculture	Johnson et al. 2000a
Buffalo Ridge, MN (Phase II; 1999)	3.57	0	2.59	agriculture	Johnson et al. 2000a
Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)	NA	NA	4.35	agriculture	Johnson et al. 2004
Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)	NA	NA	1.64	agriculture	Johnson et al. 2004
Buffalo Ridge, MN (Phase III; 1999)	5.93	0	2.72	agriculture	Johnson et al. 2000a
Buffalo Ridge, MN (Phase III; 2001/Lake Benton II)	NA	NA	3.71	agriculture	Johnson et al. 2004
Buffalo Ridge, MN (Phase III; 2002/Lake Benton II)	NA	NA	1.81	agriculture	Johnson et al. 2004
Cedar Ridge, WI (2009)	6.55	0.18	30.61	agriculture	BHE Environmental 2010
Cedar Ridge, WI (2010)	3.72	0.13	24.12	agriculture	BHE Environmental 2011

Appendix F3. Publicly-available and comparable fatality estimates and habitat types from North American wind-energy facilities.

Wind Energy Facility	Bird Fatalities (birds/MW/year)	Raptor Fatalities (raptors/MW/year)	Bat Fatalities (bats/MW/year)	Predominant Habitat Type	Citation
Crescent Ridge, IL (2005-2006)	NA	NA	3.27	agriculture	Kerlinger et al. 2007
Crystal Lake II, IA (2009)	NA	NA	7.42	agriculture	Derby et al. 2010a
Elm Creek II, MN (2011-2012)	3.64	0	2.81	agriculture, grassland	Derby et al. 2012b
Elm Creek, MN (2009-2010)	1.55	0	1.49	agriculture	Derby et al. 2010c
Foote Creek Rim, WY (Phase I; 1999)	3.4	0.08	3.97	grassland	Young et al. 2003a
Foote Creek Rim, WY (Phase I; 2000)	2.42	0.05	1.05	grassland	Young et al. 2003a
Foote Creek Rim, WY (Phase I; 2001-2002)	1.93	0	1.57	grassland	Young et al. 2003a
Forward Energy Center, WI (2008-2010)	NA	NA	18.17	agriculture	Grodsky and Drake 2011
Fowler I, II, III, IN (2010)	NA	NA	18.96	agriculture	Good et al. 2011
Fowler I, II, III, IN (2011)	NA	NA	20.19	agriculture	Good et al. 2012
Fowler I, II, III, IN (2012)	NA	NA	2.96	agriculture	Good et al. 2013c
Fowler I, IN (2009)	2.83	0	8.09	agriculture	Johnson et al. 2010a
Fowler III, IN (2009)	NA	NA	1.84	agriculture	Johnson et al. 2010b
Grand Ridge I, IL (2009-2010)	0.48	0	2.1	agriculture	Derby et al. 2010g
Harrow, Ont (2010)	NA	NA	11.13	agriculture	Natural Resource Solutions Inc. (NRSI) 2011
Heritage Garden I, MI (2012-2014)	1.3	NA	5.9	agriculture	Kerlinger et al. 2014
Judith Gap, MT (2006-2007)	NA	NA	8.93	agriculture/grassland	TRC 2008
Judith Gap, MT (2009)	NA	NA	3.2	agriculture/grassland	Poulton and Erickson 2010
Kewaunee County, WI (1999-2001)	1.95	0	6.45	agriculture	Howe et al. 2002
Milford I & II, UT (2011-2012)	0.73	0.04	1.67	desert shrub	Stantec 2012
Milford I, UT (2010-2011)	0.56	NA	2.05	desert shrub	Stantec 2011
Moraine II, MN (2009)	5.59	0.37	2.42	agriculture/grassland	Derby et al. 2010d

Appendix F3. Publicly-available and comparable fatality estimates and habitat types from North American wind-energy facilities.

Wind Energy Facility	Bird Fatalities (birds/MW/year)	Raptor Fatalities (raptors/MW/year)	Bat Fatalities (bats/MW/year)	Predominant Habitat Type	Citation
NPPD Ainsworth, NE (2006)	1.63	0.06	1.16	agriculture/grassland	Derby et al. 2007
Pioneer Prairie II, IA (2011-2012)	0.27	0	4.43	agriculture, grassland	Chodachek et al. 2012
Pioneer Prairie II, IA (2013)	NA	NA	3.83	agriculture	Chodachek et al. 2014
PrairieWinds ND1 (Minot), ND (2010)	1.48	0.05	2.13	agriculture	Derby et al. 2011c
PrairieWinds ND1 (Minot), ND (2011)	1.56	0.05	1.39	agriculture, grassland	Derby et al. 2012c
PrairieWinds SD1, SD (2011-2012)	1.41	0	1.23	grassland	Derby et al. 2012d
PrairieWinds SD1, SD (2012-2013)	2.01	0.03	1.05	grassland	Derby et al. 2013
PrairieWinds SD1, SD (2013-2014)	1.66	0.17	0.52	grassland	Derby et al. 2014
Rail Splitter, IL (2012-2013)	0.84	0	11.21	agriculture	Good et al. 2013b
Ripley, Ont (2008)	3.09	0.1	4.67	agriculture	Jacques Whitford 2009
Rugby, ND (2010-2011)	3.82	0.06	1.6	agriculture	Derby et al. 2011b
Summerview, Alb (2005-2006)	1.06	0.11	10.27	agriculture	Brown and Hamilton 2006b
Summerview, Alb (2006; 2007)	NA	NA	11.42	agriculture/grassland	Baerwald 2008
Top Crop I & II (2012-2013)	1.35	NA	12.55	agriculture	Good et al. 2013a
Top of Iowa, IA (2003)	0.42	0	7.16	agriculture	Jain 2005
Top of Iowa, IA (2004)	0.81	0.17	10.27	agriculture	Jain 2005
Wessington Springs, SD (2009)	8.25	0.06	1.48	grassland	Derby et al. 2010f
Wessington Springs, SD (2010)	0.89	0.07	0.41	grassland	Derby et al. 2011d
Winnebago, IA (2009-2010)	3.88	0.27	4.54	agriculture/grassland	Derby et al. 2010e

Appendix F4. Summary of all publicly-available post-construction monitoring studies, with project characteristics and select study methodologies.

Wind Energy Facility	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Barton I & II, IA (2010-2011)	80	160	100	26	200 m x 200 m	1 year	weekly (spring, fall; migratory turbines), monthly (summer, winter; non-migratory turbines)
Big Blue, MN (2013)	18	36	78 or 90 (according to Gamesa website)	18	200m diameter	NA	weekly, monthly (Nov and Dec)
Big Blue, MN (2014)	18	36	78 or 90 (according to Gamesa website)	18	200m diameter	NA	weekly, monthly (Nov and Dec)
Blue Sky Green Field, WI (2008; 2009)	88	145	80	30	160 m x 160 m	fall, spring	daily(10 turbines), weekly (20 turbines)
Buffalo Ridge, MN (1994-1995)	73	25	37	73	100 x 100m	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)
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

Appendix F4. Summary of all publicly-available post-construction monitoring studies, with project characteristics and select study methodologies.

Wind Energy Facility	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
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	100 x 100m	1 year	weekly (spring, summer, fall), monthly (winter)
Castle River, Alb (2001-2002)	60	39.6	50	60	50-m radius	2 years	weekly, bi-weekly
Castle River, Alb (2001-2002)	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
Cedar Ridge, WI (2010)	41	68	80	20	160 m x 160 m	1 year	Five turbines were surveyed daily, 15 turbines surveyed every 4 days in rotating groups each day. All 20 surveyed every three days during late fall
Crescent Ridge, IL (2005-2006)	33	49.5	80	33	70-m radius	1 year	weekly (fall, spring)
Crystal Lake II, IA (2009)	80	200	80	15	100 m x 100 m	spring, summer, fall	3 times per week for 26 weeks
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 x 200m (2 random migration search areas 100 x 100m)	1 year	20 searched every 28 days, 10 turbines every 7 days during migration)

Appendix F4. Summary of all publicly-available post-construction monitoring studies, with project characteristics and select study methodologies.

Wind Energy Facility	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
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
Fowler I, II, III, IN (2010)	355	600	Vestas = 80, Clipper = 80, GE = 80	136	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	176	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 (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
Grand Ridge I, IL (2009-2010)	66	99	80	30	160 m x 160 m	1 year	weekly, monthly
Harrow, Ont (2010)	24	39.6	NA	12	50-m radius from turbine base	4 months	twice-weekly

Appendix F4. Summary of all publicly-available post-construction monitoring studies, with project characteristics and select study methodologies.

Wind Energy Facility	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Heritage Garden I, MI (2012-2014)	14	28	90	14	120x120 m except one plot that was 280x280 m	1 years	weekly (spring, summer, and fall) and bi-weekly (winter)
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)
Lakefield Wind, MN (2012)	137	205.5	80	26	100 m x 100 m	7.5 months	3 times per week
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	35m radius	5 months	weekly, twice weekly
Milford I & II, UT (2011-2012)	107	160.5 (58.5 I, 102 II)	80	43	120x120	NA	every 10.5 days
Milford I, UT (2010-2011)	58	145	80	24	120x120	NA	weekly
Moraine II, MN (2009)	33	49.5	82.5	30	200 m x 200 m	1 year	weekly (migratory), monthly (non-migratory)
NPPD Ainsworth, NE (2006)	36	20.5	70	36	220 m x 220 m	spring, summer, fall	bi-monthly
Pioneer Prairie II, IA (2011-2012)	62	102.3	80	63	80 x 80m	1 year	weekly (spring and fall), every two weeks (summer), monthly (winter)
Pioneer Prairie II, IA (2013)	62	102.3	80	62	80x80 m (5 turbines), road and pad within 100 m of turbine (57 turbines)	NA	weekly

Appendix F4. Summary of all publicly-available post-construction monitoring studies, with project characteristics and select study methodologies.

Wind Energy Facility	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Pioneer Trail, IL (2012-2013)	94	150.5	NA	50	80x80m	fall, spring	weekly
Prairie Rose, MN (2014)	119	200	80	10	100x100m	6 months	weekly
PrairieWinds SD1, SD (2012-2013)	108	162	80	50	200 x 200m	1 year	bi-weekly
PrairieWinds SD1, SD (2013-2014)	108	162	80	45	200 x 200m	1 year	twice monthly (spring, summer, fall), monthly (winter)
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 x 100m	3 season	twice monthly
PrairieWinds SD1, SD (2011-2012)	108	162	80	50	200 x 200m	1 year	twice monthly (spring, summer, fall), monthly (winter)
Rail Splitter, IL (2012-2013)	67	100.5	80	34	60 m radius	1 year	weekly (spring, summer, and fall) and bi-weekly (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.
Rugby, ND (2010-2011)	71	149	78	32	200 m x 200 m	1 year	weekly (spring, fall; migratory turbines), monthly (non-migratory turbines)
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)
Top Crop I & II (2012-2013)	132	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

Appendix F4. Summary of all publicly-available post-construction monitoring studies, with project characteristics and select study methodologies.

Wind Energy Facility	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Top of Iowa, IA (2004)	89	80	71.6	26	76 m x 76 m	spring, summer, fall	once every 2 to 3 days
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)
Winnebago, IA (2009-2010)	10	20	78	10	200 m x 200 m	1 year	weekly (migratory), monthly (non-migratory)

Appendix F4 (*continued*). Summary of all publicly-available post-construction monitoring studies, with project characteristics and select study methodologies.

Wind Energy Facility	Reference	Wind Energy Facility	Reference
Barton I & II, IA (2010-2011)	Derby et al. 2011a	Fowler III, IN (2009)	Johnson et al. 2010b
Big Blue, MN (2013)	Fagen Engineering 2014	Grand Ridge I, IL (2009-2010)	Derby et al. 2010g
Big Blue, MN (2014)	Fagen Engineering 2015	Harrow, Ont (2010)	Natural Resource Solutions 2011
Blue Sky Green Field, WI (2008; 2009)	Gruver et al. 2009	Heritage Garden I, MI (2012-2014)	Kerlinger et al. 2014
Buffalo Ridge, MN (1994-1995)	Osborn et al. 1996, 2000	Judith Gap, MT (2006-2007)	TRC 2008
Buffalo Ridge, MN (Phase I; 1996)	Johnson et al. 2000a	Judith Gap, MT (2009)	Poulton and Erickson 2010
Buffalo Ridge, MN (Phase I; 1997)	Johnson et al. 2000a	Kewaunee County, WI (1999-2001)	Howe et al. 2002
Buffalo Ridge, MN (Phase I; 1998)	Johnson et al. 2000a	Lakefield Wind, MN (2012)	MPUC 2012
Buffalo Ridge, MN (Phase I; 1999)	Johnson et al. 2000a	McBride, Alb (2004)	Brown and Hamilton 2004
Buffalo Ridge, MN (Phase II; 1998)	Johnson et al. 2000a	Melancthon, Ont (Phase I; 2007)	Stantec Ltd. 2008
Buffalo Ridge, MN (Phase II; 1999)	Johnson et al. 2000a	Milford I & II, UT (2011-2012)	Stantec 2012
Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)	Johnson et al. 2004	Milford I, UT (2010-2011)	Stantec 2011
Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)	Johnson et al. 2004	Moraine II, MN (2009)	Derby et al. 2010d
Buffalo Ridge, MN (Phase III; 1999)	Johnson et al. 2000a	NPPD Ainsworth, NE (2006)	Derby et al. 2007
Buffalo Ridge, MN (Phase III; 2001/Lake Benton II)	Johnson et al. 2004	Pioneer Prairie II, IA (2011-2012)	Chodachek et al. 2012
Buffalo Ridge, MN (Phase III; 2002/Lake Benton II)	Johnson et al. 2004	Pioneer Prairie II, IA (2013)	Chodachek et al. 2014
Buffalo Ridge I, SD (2009-2010)	Derby et al. 2010b	Pioneer Trail, IL (2012-2013)	ARCADIS 2013
Buffalo Ridge II, SD (2011-2012)	Derby et al. 2012a	Prairie Rose, MN (2014)	Chodachek et al. 2015
Castle River, Alb (2001-2002)	Brown and Hamilton 2006a	PrairieWinds SD1, SD (2012-2013)	Derby et al. 2013
Castle River, Alb (2001-2002)	Brown and Hamilton 2006a	PrairieWinds SD1, SD (2013-2014)	Derby et al. 2014
Cedar Ridge, WI (2009)	BHE Environmental 2010	PrairieWinds ND1 (Minot), ND (2010)	Derby et al. 2011c
Cedar Ridge, WI (2010)	BHE Environmental 2011	PrairieWinds ND1 (Minot), ND (2011)	Derby et al. 2012c
Crescent Ridge, IL (2005-2006)	Kerlinger et al. 2007	PrairieWinds SD1, SD (2011-2012)	Derby et al. 2012d
Crystal Lake II, IA (2009)	Derby et al. 2010a	Rail Splitter, IL (2012-2013)	Good et al. 2013b
Elm Creek, MN (2009-2010)	Derby et al. 2010c	Ripley, Ont (2008)	Jacques Whitford 2009
Elm Creek II, MN (2011-2012)	Derby et al. 2012b	Ripley, Ont (2008-2009)	Golder Associates 2010
Erie Shores, Ont (2006)	James 2008	Rugby, ND (2010-2011)	Derby et al. 2011b
Foote Creek Rim, WY (Phase I; 1999)	Young et al. 2003a	Summerview, Alb (2005-2006)	Brown and Hamilton 2006b
Foote Creek Rim, WY (Phase I; 2000)	Young et al. 2003a	Summerview, Alb (2006; 2007)	Baerwald 2008
Foote Creek Rim, WY (Phase I; 2001-2002)	Young et al. 2003a	Top Crop I & II (2012-2013)	Good et al. 2013a
Forward Energy Center, WI (2008-2010)	Grodsky and Drake 2011	Top of Iowa, IA (2003)	Jain 2005
Fowler I, IN (2009)	Johnson et al. 2010a	Top of Iowa, IA (2004)	Jain 2005
Fowler I, II, III, IN (2010)	Good et al. 2011	Wessington Springs, SD (2009)	Derby et al. 2010f
Fowler I, II, III, IN (2011)	Good et al. 2012	Wessington Springs, SD (2010)	Derby et al. 2011d
Fowler I, II, III, IN (2012)	Good et al. 2013c	Winnebago, IA (2009-2010)	Derby et al. 2010e