Appendix E
Triple H Wind Project Avian Use Surveys

Avian Use Surveys for the Triple H Wind Project Hughes and Hyde Counties, South Dakota

Final Report

April 2016 – March 2017

Prepared for:

Triple H Wind Project, LLC

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EXECUTIVE SUMMARY

Triple H Wind Project, LLC (THWP) has proposed a wind energy facility in Hughes and Hyde Counties, South Dakota referred to as the Triple H Wind Project (Project). THWP contracted Western EcoSystems Technology, Inc. (WEST) to conduct baseline wildlife surveys to estimate the potential impacts of Project construction and operations on wildlife. This document provides the results of fixed-point avian use surveys conducted at the Project from April 2016 through March 2017. The surveys were conducted following the tiered process outlined in the US Fish and Wildlife Service (USFWS) Land-Based Wind Energy Guidelines and the USFWS Eagle Conservation Plan Guidance (ECPG).

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; 2) provide information that could be used for project planning and design of the facility to minimize impacts to birds; and 3) collect data on eagle use in the area following the ECPG. This survey effort was designed to supplement additional baseline wildlife surveys conducted at the Project in 2016/2017 including a raptor nest survey, prairie grouse lek surveys, acoustic monitoring for bats, and a habitat characterization study, the results of which are included in separate reports.

Year-round avian use surveys were conducted at 24 points established throughout the Project from April 18, 2016 to March 28, 2017. Surveys at each point were conducted approximately monthly for a period of 60 minutes (min), with all bird species recorded during the first 20 min, and then only large birds recorded during the remaining 40 min of the survey period. A total of 238 60-min fixed-point surveys were completed and 59 unique bird species were identified. Regardless of bird size, five species composed 63.5% of all observations: red-winged blackbird, sandhill crane, snow goose, horned lark, and Canada goose. All other species accounted for less than 3% of the observations, individually. The most abundant large bird species observed were sandhill crane (3,970 individuals in 20 groups) and snow goose (3,875 individuals in six groups).

Diurnal raptor use was highest during the spring (0.34 birds/plot/60-min survey) and lowest during the winter (0.09). Six diurnal raptor species were identified with the most common being northern harrier (21 observations) and red-tailed hawk (17 observations). A total of four eagles (all bald eagles) were recorded during surveys, with an additional two bald eagles and four golden eagles observed incidentally during the study. The raptor species with the highest exposure index was the red-tailed hawk (0.02), which was ranked sixth of all species. Diurnal raptor use was recorded at all but three of the 24 points with the highest use recorded at point 10, primarily due to higher use by *Buteo* species and northern harriers at this point.

Mean annual diurnal raptor use was 0.12 raptors/plot/20-min survey, which ranked 44th 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. While overall risk to raptors is low, based on species composition of the most common raptor fatalities at other

western 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 hawks. It is expected that risk to raptors would be unequal across seasons, with the lowest risk in the winter and highest risk during the spring. Raptor fatality rates are expected to be comparable to other wind energy facilities in South Dakota and the Midwest region.

A total of 15 sensitive species were observed within the Project during surveys or incidentally during the study. No state and/or federally-listed species were observed. Sensitive species recorded during the study included 12 species designated as either a state species of greatest conservation need and/or federal bird of conservation concern. Three rare species that are tracked by the South Dakota Natural Heritage Program were observed during surveys or incidentally within the Project.

STUDY PARTICIPANTS

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REPORT REFERENCE

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INTRODUCTION

In 2016, Triple H Wind Project, LLC contracted Western EcoSystems Technology, Inc. (WEST) to conduct surveys and monitor wildlife resources in the Triple H Wind Project (Project) to estimate the impacts of wind energy facility construction and operations on wildlife. This document provides results of fixed-point avian use surveys conducted at the Project from April 18, 2016 through March 28, 2017. This survey effort supplements additional baseline survey work conducted at the Project in 2016/2017 including a raptor nest survey, prairie grouse lek surveys, acoustic monitoring for bats, and a habitat characterization study. Baseline wildlife studies at the Project were designed to address the questions posed under Tier 3 of the US Fish and Wildlife Service (USFWS) *Final Land-based Wind Energy Guidelines* (WEG; USFWS 2012) and Tier 2 of the USFWS *Eagle Conservation Plan Guidance* (ECPG; USFWS 2013).

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; 2) provide information that could be used for project planning and design of the facility to minimize impacts to birds; and 3) collect data on eagle use in the area following the ECPG (USFWS 2013).

STUDY AREA

The proposed 39,091-acre (ac; 15,820-hectare [ha]) Project is located in Hughes and Hyde Counties, South Dakota, northeast of the Missouri River (Figure 1). The Project is located within the Northwestern Glaciated Plains Level III Ecoregion, a transitional region between the generally more level, moister, more agricultural Northern Glaciated Plains to the east and the generally more irregular, dryer, Northwestern Great Plains to the west and southwest (US Environmental Protection Agency 2015). This ecoregion is characterized by significant surface irregularity and high concentrations of seasonal and semi-permanent wetlands (prairie potholes). The topography within the Project consists of rolling hills, with elevations ranging from 558 to 642 meters (m; 1,830 to 2,106 feet [ft]) above sea level. Land ownership in and around the Project is primarily private.

The majority of the lands within the Project support agriculture, either as cultivated crops, hay, or pasture lands. Approximately 91% of the project consists of cultivated crops (22,692 ac [9,183 ha; 58.1%] and grassland/herbaceous plants (12,984 ac [5,254 ha; 33.0%]; Figure 2, Table 1) based on US Geological Survey (USGS) National Land Cover Dataset (NLCD; USGS NLCD 2011; Homer et al. 2015) and WEST habitat mapping data (Heath 2016b). The Project contains approximately 2,517 ac (1,018 ha; 6.4%) of lakes, wetlands, and stock ponds (Table 1). The remainder of the Project is composed of developed areas (1.8%) and trees (0.7%) (Figure 2, Table 1).

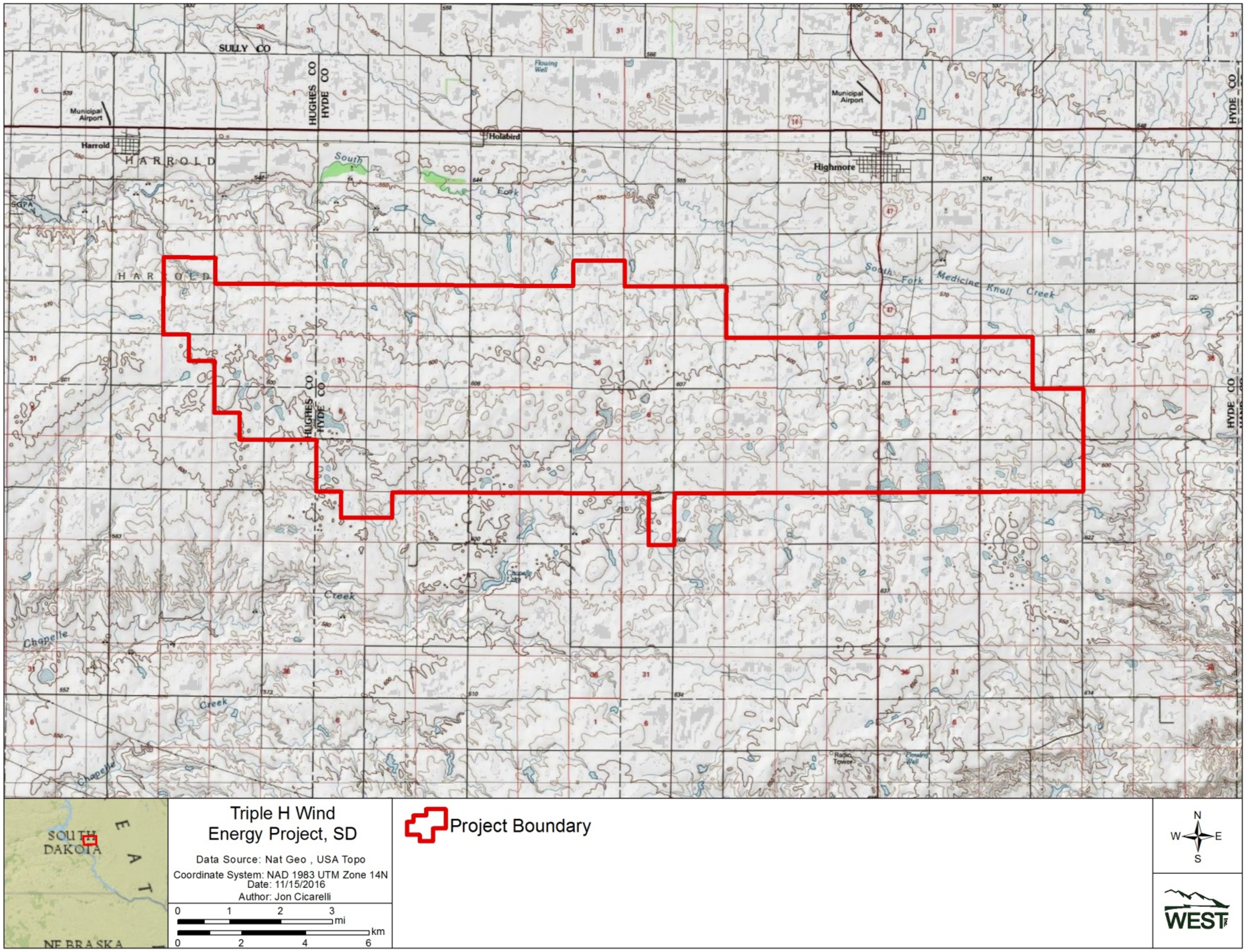

Figure 1. Overview of the Triple H Wind Project, Hughes and Hyde Counties, South Dakota.

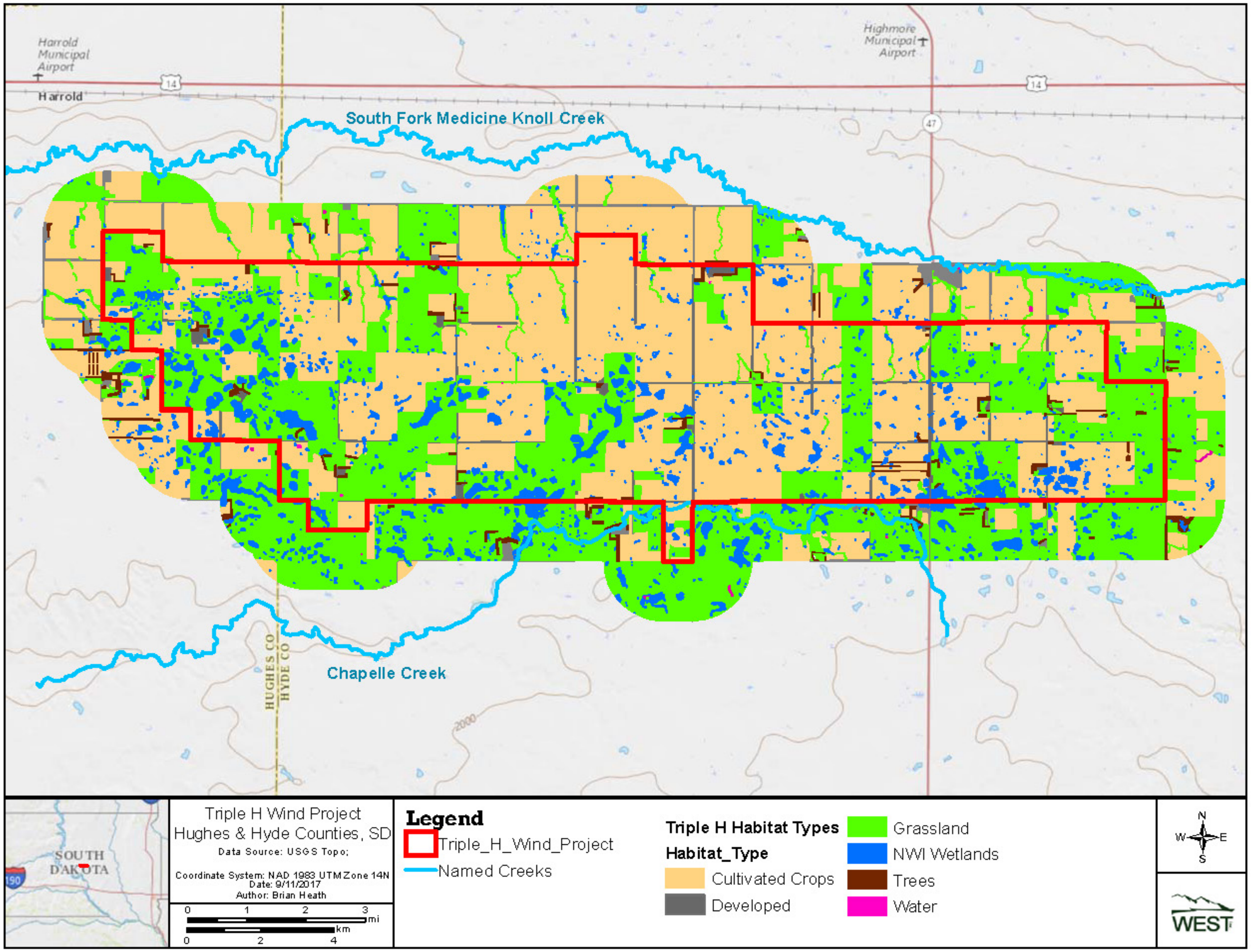

Figure 2. The land cover types and coverage within the Triple H Wind Project, Hughes and Hyde Counties, South Dakota (USGS NLCD 2011; Homer et al. 2015 and WEST habitat mapping Heath 2016b).

Table 1. Land cover types, coverages, and composition within the Triple H Wind Project.

Land Cover	Acres	% Composition
Croplands	22,692.1	58.1
Grasslands/Herbaceous/Hay/Pasture	12,894.3	33.0
NWI Wetlands/ Water	2,517.0	6.4
Developed	715.1	1.8
Trees	273.1	0.7
Total	**39,091.5***	**100**

Data from the US Geological Survey (USGS) National Land Cover Dataset (NLCD; USGS NLCD 2011, Homer et al. 2015) and Heath (2016b).
* Total acreage calculated based on digitizing of cover types during desktop analysis and is approximate.

METHODS

Fixed-Point Avian Use Surveys

Avian point count surveys are the most widely used methodology for pre-construction avian use characterization and risk analysis (e.g., USFWS "Tier 3" studies [USFWS 2012]), because of their effectiveness and efficiency for characterizing the use of selected sites by a broad spectrum of diurnally-active birds (Ralph et al. 1993, Strickland et al. 2011). The objective of the fixed-point avian use surveys was to estimate the seasonal and spatial use of the study area by birds, particularly diurnal raptors (defined here as kites, accipiters, buteos, harriers, eagles, falcons, and osprey) and other large bird species. Fixed-point avian use surveys (variable circular plots) were conducted using methods described by Reynolds et al. (1980). Survey methodologies were generally comparable to those used at other wind energy sites in South Dakota, and were consistent with methods and survey efforts recommended in the WEG and ECPG (USFWS 2012, 2013).

Survey Plots

Twenty-four points were established throughout the Project with each survey plot consisting of an 800-m (2,625-ft) radius circle centered on the point (Figure 3). Plots were selected to survey representative habitats and topography of the Project, while meeting ECPG spatial sampling recommendations. The ECPG recommends at least 30% survey coverage of areas within one kilometer (km; 1.6 miles [mi]) of turbine locations (USFWS 2013). Because turbine locations were unknown at the start of surveys, plots were selected such that survey viewsheds covered approximately 30% of the entire 39,069-ac Project area.

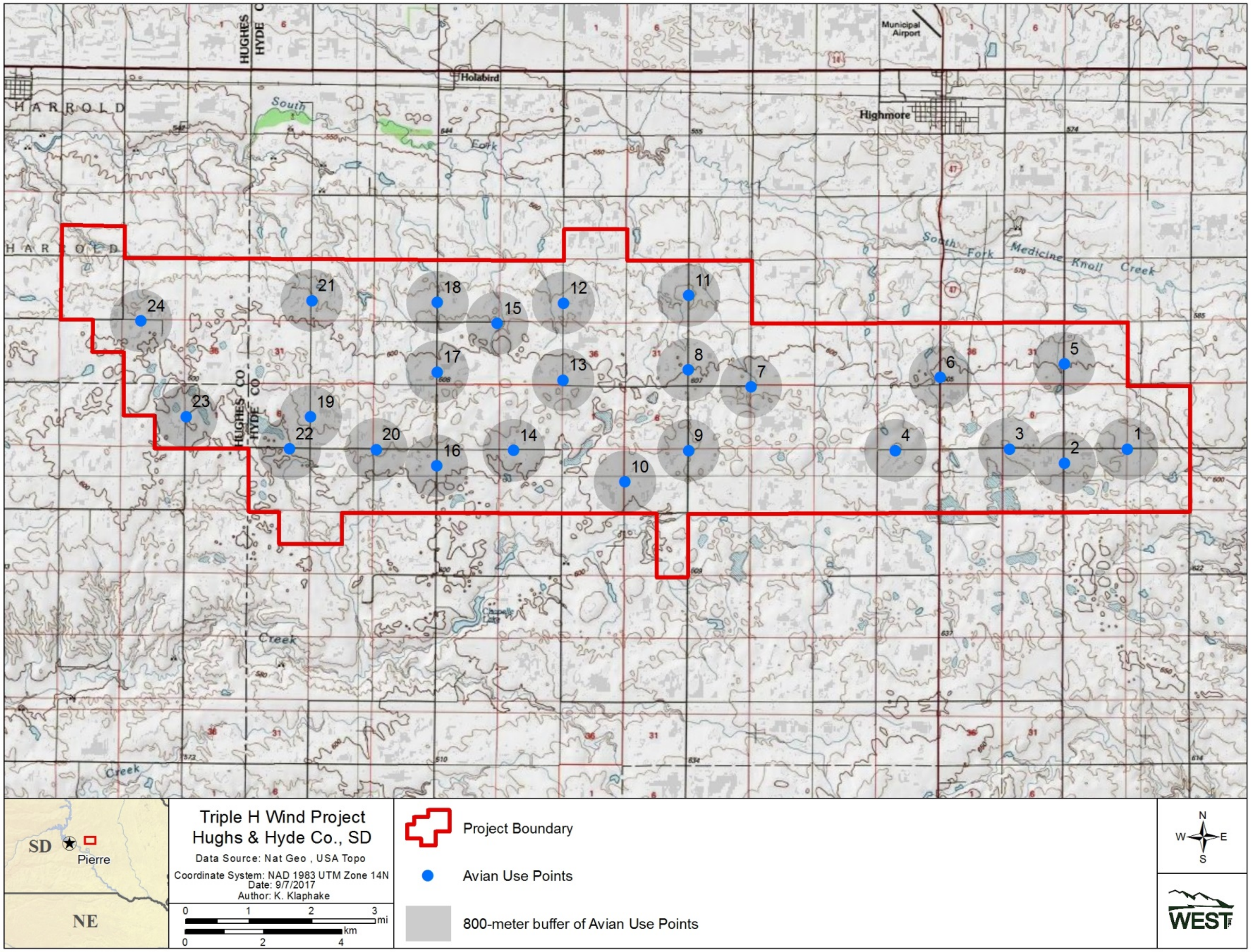

Figure 3. Locations of avian use survey points at the Triple H Wind Project, Hughes and Hyde Counties, South Dakota.

Survey Methods

Points were surveyed for 60 minutes (min) each, with all species of birds recorded during the first 20-min of the survey period, and then only large birds recorded for the remaining 40-min. The initial 20-min surveys allowed for comparison of small and large bird use, including diurnal raptor use, with the majority of wind projects in the region, while the 60-min eagle surveys are consistent with the ECPG and were used to obtain a stronger dataset with which to evaluate large bird use and potential risk, particularly for eagles. Large birds observed within an 800-m plot and small birds within a 100-m plot were used for quantitative analysis and other comparative metrics. Small birds were defined as cuckoos, hummingbirds, swifts, woodpeckers, and passerines. Large birds were defined as waterbirds, waterfowl, shorebirds, diurnal raptors (i.e., kites, accipiters, buteos, eagles, falcons, northern harrier [*Circus cyaneus*], and osprey [*Pandion haliaetus*]), vultures, upland game birds, doves and pigeons, large corvids (e.g., magpies, crows, and ravens), large cuckoos, and goatsuckers.

The date, start and end time of the survey period, and weather information (e.g., temperature, wind speed and direction, and cloud cover) were recorded for each survey. Every bird group (each group may be as small as just one individual) observed during a survey was recorded and identified by a unique observation number. Information collected for each observation included: 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). 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 (16-ft) interval. Other information collected included whether or not the observation was auditory only, as well as the 10-min interval of the survey during which the detection first occurred. Additionally, for all eagle observations, data were collected following ECPG methodology, including minute by minute data collected throughout the duration of each eagle observation (USFWS 2013).

Locations of diurnal raptors, other large birds, and species of concern observed during surveys were recorded on field maps by unique observation numbers. Flight paths and perch locations were digitized using ArcGIS 10.4. 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 study area. Surveys were conducted approximately once per month from April 18, 2016 through March 28, 2017, with seasons defined as follows: spring (March 1 to May 14), summer (May 15 to August 14), fall (August 15 to November 14), and winter (November 15 to February 28). Surveys were carried out 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; however, harsh weather and road conditions in winter and spring prevented surveys at some points during those seasons.

Incidental Observations

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.

Quality Assurance and Quality Control

Quality assurance and quality control (QA/QC) measures were implemented at all stages of the study, including in the field, during data entry and analysis, and report writing. Following field surveys, observers were responsible for inspecting data forms for completeness, accuracy, and legibility. Potentially erroneous data were identified using a series of database queries. Irregular codes or data suspected as questionable were discussed with the observer 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 database was developed to store, organize, and retrieve survey data. Data were keyed into the electronic database using a pre-defined protocol to facilitate subsequent QA/QC and data analysis. All data forms and electronic data files were retained for reference.

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 study area. Visits were assigned according to the following criteria: 1) a single visit had to be completed in a single season, and 2) a visit could be spread across multiple dates, 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.

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 individuals of northern harrier 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 avian use surveys.

Avian Use, Percent of Use, and Frequency of Occurrence

For generating standardized fixed-point avian use estimates, large birds detected within the 800-m radius plot during the full 60-min survey were used in the analysis, while small birds recorded within a 100-m radius plot during the initial 20-min survey were used in the analysis. The metric used to measure mean bird use was the number of birds per plot per survey (60-min survey for large birds and 20-min survey for small birds). 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.

While surveys for large birds at the Project were conducted over a 60-min survey period, for comparison to studies at other wind energy facilities that historically collected data during 20-min surveys, a separate use estimate for diurnal raptors was also calculated by using only those diurnal raptor observations recorded during the first 20-min of each survey.

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 25 to 150 m (82 to 492 ft) above ground level (AGL) 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:

$$R = A*P_f*P_t$$

Where A equals mean relative use for species *i* (large bird observations within 800 m of the observer or 100 m for small birds) averaged across all surveys, P_f equals the proportion of all observations of species *i* where activity was recorded as flying (an index to the approximate percentage of time species *i* spends flying during the daylight period), and P_t equals the proportion of all initial flight height observations of species *i* within the likely RSH. The exposure index does not account for other possible collision risk factors, such as foraging or courtship behavior.

Spatial Use

Large bird flight paths were qualitatively compared to study area characteristics (e.g., topographic features). The objective of mapping observed large bird locations and flight paths was to identify areas of concentrated use and/or consistent flight patterns by eagles, other diurnal raptors, waterbirds, waterfowl, and shorebirds. This information can be useful in turbine layout design or micro-siting individual turbines to reduce risk to birds.

RESULTS

Fixed-point avian use surveys were conducted within the Project from April 18, 2016 through March 28, 2017, during which time 238 surveys were completed (Table 2). The majority of survey points (15 of 24 total points) were visited 11 or 12 times, while the remaining nine points were visited only seven or eight times due to weather-related issues (e.g., flooded roads, snow and ice, drifted minimum maintenance roads, etc.) during the winter and spring. Two separate viewsheds and survey periods were used when calculating species richness, use, percent composition, percent frequency, and exposure index for large and small birds: an 800-m plot and 60-min survey period for large birds and a 100-m plot and 20-min survey period for small birds.

Bird Diversity and Species Richness

Fifty-nine unique species were observed over the course of all fixed-point avian use surveys (Table 2). A mean of 1.21 large bird species/800-m plot/60-min survey and 1.64 small bird species/100-m plot/20-min survey was recorded. Bird diversity (the number of unique species observed) was highest during the summer (41 species), followed by spring (39), fall (26), and winter (10). Large bird species richness (mean number of species per plot per survey) was higher during the summer (2.18 species/plot/survey) and spring (1.98) compared to the fall (0.81) and winter (0.17). Small bird species richness was similarly higher during the summer (3.43 species/plot/survey) and spring (2.03) than during the fall (0.79) and winter (0.55; Table 2).

Table 2. Summary of species richness (species/plot[a]/survey[b]), and sample size by season and overall during the fixed-point bird avian surveys at the Triple H Wind Project from April 18, 2016 to March 28, 2017.

Season	Number of Visits	# Surveys Conducted	# Unique Species	Species Richness	
				Large Birds	Small Birds
Spring	3	47	39	1.98	2.03
Summer	3	72	41	2.18	3.43
Fall	3	71	26	0.81	0.79
Winter	3	48	10	0.17	0.55
Overall	**12**	**238**	**59**	**1.21**	**1.64**

[a] 800-meter (m) radius for large birds and 100-m radius for small birds.
[b] 20-minute (min) survey period of small birds and 60-min survey period for large birds.

During the full 60-min survey period, a total of 25,849 birds were observed within 1,008 separate groups (defined as one or more individuals; Appendix A). Regardless of bird size, five species (8.5% of all species) composed 63.5% of all observations: red-winged blackbird (*Agelaius phoeniceus*), sandhill crane (*Grus canadensis*), snow goose (*Chen caerulescens*), horned lark (*Eremophila alpestris*), and Canada goose (*Branta Canadensis*). All other species accounted for less than 3% of the observations, individually. The most abundant large bird species observed were sandhill crane (3,970 individuals in 20 groups) and snow goose (3,875 individuals in six groups). A total of 61 diurnal raptors were recorded within the Project, representing six identified species (Appendix A).

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 3) and species (Appendix B). The highest overall large bird use occurred during the spring (120.50 birds/800-m plot/60-min survey), followed by fall (57.52), summer (4.28), and winter (0.57). Alternatively, small bird use was considerably higher in the winter (103.27 birds/100-m plot/20-min survey), compared to spring (56.25), summer (9.25), and fall (8.96; Table 3).

Waterbirds

Waterbird use was substantially higher in the fall (55.15 birds/plot/60-min survey) than in spring (0.01) and summer (0.03); no waterbirds were observed during winter surveys (Table 3). Higher use in fall was attributed almost entirely to several large groups of sandhill cranes (Appendix A). Waterbirds accounted for 95.9% of overall large bird use during fall, but less than 1% of the overall large bird use during other seasons. Waterbirds were observed during 13.9% of fall surveys, 2.8% of summer surveys, and only 1.4% of spring surveys (Table 3).

Waterfowl

Waterfowl had much higher use during the spring (102.62 birds/plot/60-min survey), compared to summer (0.83), fall (0.97), and winter (0.24; Table 3). High waterfowl use during the spring was largely due to several large groups of snow goose and Canada goose, which together accounted for 84.2% of the overall large bird use in spring (Appendices A and B1). Waterfowl composed 85.2% of the overall large bird use in spring and 42.6% in winter, but only 19.5% in summer and 1.7% in fall. Waterfowl were observed more frequently during the spring (32.8% of surveys) and summer (26.4%) compared to the fall (2.8%) and winter (4.4%; Table 3).

Shorebirds

Shorebirds had higher use during the spring (1.38 birds/plot/60-min survey) and summer (1.04), compared to fall (0.10); no shorebird use was recorded during winter (Table 3). Shorebirds composed 24.4% of overall large bird use during the summer, but less than 2% of the large bird use during other seasons. Shorebirds were observed during nearly half of spring and summer surveys (43.1% and 48.6%), but during only 4.3% of fall surveys (Table 3).

Gulls/Terns

Use by gulls/terns was observed only during spring (7.00 birds/plot/60-min survey) and fall (0.06; Table 3). The much higher use in spring was attributed entirely to several large groups of Franklin's gulls (*Leucophaeus pipixcan*; Appendix A). Gulls/terns composed 5.8% of overall large bird use in spring, but only 0.1% in fall, and were observed during 5.6% of spring surveys and 1.4% of fall surveys (Table 3).

Diurnal Raptors

Diurnal raptor use was highest during the spring (0.34 birds/plot/60-min survey), followed by summer (0.25), fall (0.24), and winter (0.09; Table 3). Higher use during the spring was primarily due to higher use of the area by northern harrier (0.12 birds/plot/60-min survey) and red-tailed hawk (*Buteo jamaicensis*; 0.10; Appendix B). These two species also had the highest use of any diurnal raptor during both summer and fall, while bald eagle (*Haliaeetus leucocephalus*) had the highest use in winter (0.04 birds/plot/60-min survey; Appendix B). The only other diurnal raptor species observed during surveys were Swainson's hawk (*Buteo swainsoni*), American kestrel (*Falco sparverius*), and merlin (*Falco columbarius*), each with use estimates of less than 0.04 birds/plot/60-min survey in any give season (Appendix B). Diurnal raptors accounted for 14.8% of overall large bird use in winter and 5.8% in summer, but less than 1% of large bird use in spring and fall. Diurnal raptors were observed during 25.3% of spring surveys, 20.8% of spring surveys, 24.1% of fall surveys, and 8.5% of winter surveys (Table 3).

While large bird surveys at the Project were conducted over a 60-min survey period, for comparison to studies at other wind energy facilities that historically collected data during 20-min surveys, a separate use estimate for diurnal raptors was also calculated based on only the first 20 min of the survey. Based on this separate analysis, the annual mean diurnal raptor use at the Project was 0.12 raptors/plot/20-min survey.

Upland Game Birds

Upland game bird use was higher in the summer (0.76 birds/plot/60-min survey) and spring (0.57) than during fall (0.36) and winter (0.22; Table 3). The upland game bird species with the highest use was ring-necked pheasant (*Phasianus colchicus*) which comprised between 93% and 100% of upland game bird use in any given season (Appendix B1). Only two other upland game bird species were recorded during surveys: greater prairie-chicken (*Tympanuchus cupido*) and gray partridge (*Perdix perdix*). Use by greater prairie-chicken was observed only during the spring (0.04 birds/plot/60-min survey) and use by gray partridge was observed only during the fall (0.01; Appendix B). Upland game birds composed 38.7% of overall large bird use during the winter and 17.9% during the summer, but less than 1% of large bird use during spring and fall. Upland game birds were observed during 30.0% of spring surveys, 41.7% of summer surveys, 12.7% of fall surveys, and 1.9% of winter surveys (Table 3).

Large Corvids

American crow (*Corvus brachyrhyncos*) was the only large corvid species observed, and use by this species was higher during the spring (8.39 birds/plot/60-min survey) than during fall (0.11) and winter (0.02); no large corvid use was observed in summer (Table 3; Appendix B). American crows accounted for 7.0% of overall large bird use in spring and 3.9% in winter, but only 0.2% in fall. This species was observed during 6.9% of spring surveys, 2.8% of fall surveys, and 2.2% of winter surveys (Table 3; Appendix B).

Passerines

Passerine use during the initial 20-min surveys (within a 100-m radius plot) was highest during the spring (42.04 birds/plot/20-min survey), followed by summer (9.25), fall (8.60), and winter (4.75; Table 3). Horned lark had the highest use by any one passerine species during the spring (25.08 birds/plot/20-min survey) and winter (2.55; Appendix B2), while western meadowlark (*Sturnella neglecta*) had the highest use in summer and snow bunting (*Plectrophenax nivalis*) had the highest use in fall (Appendix B2). Passerines were observed during 81.1% of spring surveys, 93.1% of summer surveys, 49.5% of fall surveys, and 33.0% of winter surveys (Table 3). Passerines accounted for over 95% of overall small bird use during summer and fall, but only 74.7% in spring and 4.6% in winter (Table 3). This lower percentage of use in spring and winter was attributed to several large groups of unidentified small birds observed in spring (601 individuals in eight groups) and winter (5,271 individuals in 14 groups; Appendix A), which comprised 25.3% of overall small bird use in spring and 95.4% in winter (Table 3).

Table 3. Mean bird use (number of birds/plot[a]/survey[b]), percent of use (%), and frequency of occurrence (%) for each bird type and species by season during the fixed-point avian use surveys at the Triple H Wind Project from April 18, 2016 to March 28, 2017.

	Mean Use				% of Use				% Frequency			
Type/Species	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
Waterbirds	0.01	0.03	55.15	0	<0.1	0.6	95.9	0	1.4	2.8	13.9	0
Waterfowl	102.62	0.83	0.97	0.24	85.2	19.5	1.7	42.6	32.8	26.4	2.8	4.4
Shorebirds	1.38	1.04	0.10	0	1.1	24.4	0.2	0	43.1	48.6	4.3	0
Gulls/Terns	7	0	0.06	0	5.8	0	0.1	0	5.6	0	1.4	0
Diurnal Raptors	0.34	0.25	0.24	0.09	0.3	5.8	0.4	14.8	25.3	20.8	24.1	8.5
Buteos	*0.14*	*0.08*	*0.07*	*0.02*	*0.1*	*1.9*	*0.1*	*3.2*	*11.1*	*6.9*	*7.2*	*1.9*
Northern Harrier	*0.12*	*0.10*	*0.08*	*0*	*<0.1*	*2.3*	*0.1*	*0*	*11.9*	*8.3*	*8.5*	*0*
Eagles	*0.04*	*0*	*0*	*0.04*	*<0.1*	*0*	*0*	*7.7*	*4.4*	*0*	*0*	*4.4*
Falcons	*0*	*0.01*	*0.01*	*0.02*	*0*	*0.3*	*<0.1*	*3.9*	*0*	*1.4*	*1.4*	*2.2*
Other Raptors	*0.04*	*0.06*	*0.07*	*0*	*<0.1*	*1.3*	*0.1*	*0*	*4.2*	*5.6*	*7.0*	*0*
Upland Game Birds	0.57	0.76	0.36	0.22	0.5	17.9	0.6	38.7	30.0	41.7	12.7	1.9
Doves/Pigeons	0.18	1.36	0.52	0	0.1	31.8	0.9	0	11.1	43.1	14.4	0
Large Corvids	8.39	0	0.11	0.02	7.0	0	0.2	3.9	6.9	0	2.8	2.2
Large Birds Overall	**120.50**	**4.28**	**57.52**	**0.57**	**100**	**100**	**100**	**100**				
Passerines	42.04	9.25	8.60	4.75	74.7	100	96.0	4.6	81.1	93.1	49.5	33.0
Unidentified Birds	14.21	0	0.36	98.53	25.3	0	4.0	95.4	18.6	0	16.7	20.4
Small Birds Overall	**56.25**	**9.25**	**8.96**	**103.27**	**100**	**100**	**100**	**100**				

[a.] 800-meter (m) radius plot for large birds and 100-m for small birds.
[b] 60-minute (min) survey period for large birds and 20-min survey period for small birds.

Bird Flight Height and Behavior

Flight height characteristics, based on initial flight height observations and estimated use, were calculated for both bird types and species (Tables 4 and 5). During 60-min fixed-point avian use surveys, 216 groups of large birds, totaling 9,631 individuals, were observed flying within the 800-m plots. Overall, 16.8% of flying large birds were recorded within the RSH for turbine blades of 25 to 150 m (82 – 492 ft) AGL, 13.4% were below the RSH, and the majority of birds (69.8%) were flying above the RSH. The majority (70.0%) of flying diurnal raptors were observed below the RSH, while 18.0% were within the RSH and 12.0% were above the RSH. Approximately half (48.1%) of shorebirds were recorded within the RSH, with the remaining 51.9% observed below the RSH. The majority of waterbirds and waterfowl were recorded above the RSH (75.1% and 77.1%, respectively). All upland gamebirds and dove/pigeons (100%) and most large corvids (99.1%) were observed below the RSH. The majority (97.0%) of passerines recorded during 20-min surveys within the 100-m plots were observed below the estimated RSH, with only 3.0% recorded within the RSH and none observed flying above the RSH (Table 4).

Nine large bird species had at least 10 groups observed flying (Appendix C), and of these, the only species observed flying within the likely RSH during at least 50% of initial observations was red-tailed hawk (50.0%) and unidentified duck (50.0%; Table 5). Of all passerines and other small birds observed, seven species had at least 10 groups observed flying (Appendix C), and of these, only brown-headed cowbird (*Molothrus ater*) and horned lark were recorded flying within the RSH (27.9% and less than 0.1%, respectively; Table 5).

Table 4. Flight height characteristics by bird type[a] and raptor subtype during fixed-point avian use surveys[b] at the Triple H Wind Project from April 18, 2016 to 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[c]	> 150 m
Waterbirds	22	3,954	291.41	99.5	<0.1	24.8	75.1
Waterfowl	72	4,737	40.58	98.8	10.5	12.5	77.1
Shorebirds	28	79	11.75	51.6	51.9	48.1	0
Gulls/Terns	5	508	68.80	100	81.3	0	18.7
Diurnal Raptors	47	50	48.81	83.3	70.0	18.0	12.0
Buteos	14	16	65.57	72.7	37.5	43.8	18.8
Northern Harrier	20	21	4.90	100	100	0	0
Eagles	3	3	38.00	75.0	66.7	33.3	0
Falcons	2	2	3.5.00	66.7	100	0	0
Other Raptors	8	8	144.62	80.0	50.0	12.5	37.5
Upland Game Birds	7	32	2.00	25.8	100	0	0
Doves/Pigeons	29	59	4.21	41.3	100	0	0
Large Corvids	6	212	13.83	99.5	99.1	0.9	0
Large Birds Overall	**216**	**9,631**	**57.96**	**96.6**	**13.4**	**16.8**	**69.8**
Passerines	217	2,577	4.74	73.0	97.0	3.0	0
Unidentified Small Birds	19	5,866	4.53	99.5	100	0	0
Small Birds Overall	**236**	**8,443**	**4.72**	**89.6**	**99.1**	**0.9**	**0**

a. 800-meter (m) radius plot for large birds and 100-m for small birds.
b 60-minute (min) survey period for large birds and 20-min survey period for small birds.
c. The likely "rotor-swept height" for potential collision with a turbine blade, or 25 to 150 m (82 to 492 feet) above ground level.

Bird Exposure Index

A relative exposure index based on initial flight height observations and relative abundance (defined as the use estimate) was calculated for each bird species. Those species that had exposure to the RSH are listed in Table 5, and a complete list of all species is presented in Appendix C. Sandhill crane had an exposure index far higher than any other species (3.43), followed by Canada goose (1.54) and snow goose (1.02; Table 5). All other species had an exposure index of 0.10 or less. The only diurnal raptor species with exposure indices greater than zero were red-tailed hawk (0.02), bald eagle (less than 0.01), and Swainson's hawk (less than 0.01). Based on observations within 100 m, the small bird species with the highest exposure index was brown-headed cowbird, with an index of 0.19 (Table 5).

Table 5. Relative exposure index and flight characteristics for bird species[a] during fixed-point avian use surveys[b] at the Triple H Wind Project from April 18, 2016 to March 28, 2017.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within RSH[c] based on Initial obs	Exposure Index	% Within RSH at Anytime
Large Bird Species[d]						
sandhill crane	18	13.90	99.5	24.8	3.43	26.7
Canada goose	13	3.53	97.0	45.0	1.54	45.0
snow goose	6	17.64	100	5.8	1.02	5.8
unidentified shorebird	1	0.10	100	100	0.10	100
unidentified duck	11	0.07	100	50.0	0.04	62.5
red-tailed hawk	10	0.06	70.6	50.0	0.02	66.7
blue-winged teal	9	0.08	83.3	30.0	0.02	30.0
American crow	6	1.76	99.5	0.9	0.02	0.9
northern pintail	13	0.07	84.0	23.8	0.01	33.3
mallard	16	0.16	62.7	9.4	<0.01	34.4
marbled godwit	7	0.05	60.0	22.2	<0.01	22.2
bald eagle	3	0.02	75.0	33.3	<0.01	33.3
unidentified hawk	7	0.04	77.8	14.3	<0.01	14.3
great blue heron	3	0.01	100	33.3	<0.01	33.3
Swainson's hawk	4	0.01	100	25.0	<0.01	25.0
greater yellowlegs	2	<0.01	100	50.0	<0.01	50.0
Small Bird Species[d]						
brown-headed cowbird	40	0.86	80.5	27.9	0.19	27.9
yellow-headed blackbird	2	0.06	100	57.9	0.04	57.9
bank swallow	2	0.02	100	62.5	0.02	62.5
horned lark	24	5.99	92.4	<0.1	<0.01	<0.1

[a.] 800-meter (m) radius plot for large birds and 100-m for small birds
[b] 60-minute (min) survey period for large birds and 20-min survey period for small birds.
[c.] RSH: the likely rotor-swept heights for potential collision with a turbine blade or 25 to 150 m (82 to 492 feet) above ground level.
[d] Only includes species with actual exposure index values. For a complete list of all species refer to Appendix C.

Spatial Use

For all large bird species combined, use was highest at points 15 and 2 (353.86 and 264.08 birds/60-min survey; Figure 4a, Appendix D). Large bird use at other points ranged from 0.43 to 105.92 birds/60-min survey. The high mean use estimate for Point 15 was largely due to high waterbird (primarily sandhill crane) use at this point (349.43 birds/60-min survey), while high use at Point 2 was attributed to waterfowl (primarily snow goose; Appendix D). Waterbird use at other points ranged from zero to 66.43 birds/60-min survey, while waterfowl use at other points ranged from zero to 50.33. Waterbird use was recorded at only 10 of the 24 observation points, while waterfowl were recorded at all but one point (Appendix D). Use by gull/terns ranged from zero to 25.00 birds/60-min survey, with use recorded at only four of the 24 points. Diurnal raptor use was more consistent across observation points, ranging from zero to 0.88 birds/60-min survey; Figure 4b, Appendix D). The highest raptor use occurred at points 10 and 15, with zero raptor use recorded at points 11, 20, and 21 (Figure 4b). Eagle use was recorded at only four points (1, 16, 18, and 24) with use values ranging from 0.08 to 0.09 birds/60-min survey (Appendix D). Upland game bird use was recorded at all but three points with use ranging from 0.08 to 2.91 birds/60-min survey, while use by doves/pigeons was observed at all but five points and ranged from 0.09 to 2.09 birds/60-min survey (Appendix D). Large corvid use was recorded at only four points and ranged from 0.14 to 16.75 birds/60-min survey. Small bird use, focused within 100 m, was highest at points 6 and 3 (447.33 and 111.00 birds/20-min survey) and ranged from 2.42 to 72.27 birds/20-min survey at other points (Figure 4c). The high mean use at Point 6 was primarily attributed to unidentified small birds, while high use at Point 3 was largely due to passerine use (Appendix D).

Flight paths of waterbirds, waterfowl, shorebirds, and diurnal raptor subtypes were digitized and mapped (Figures 5a-c). No obvious flyways or concentration areas were observed for any species. The available data do not indicate that any portions of the study area warrant being excluded from development due to relatively high bird use.

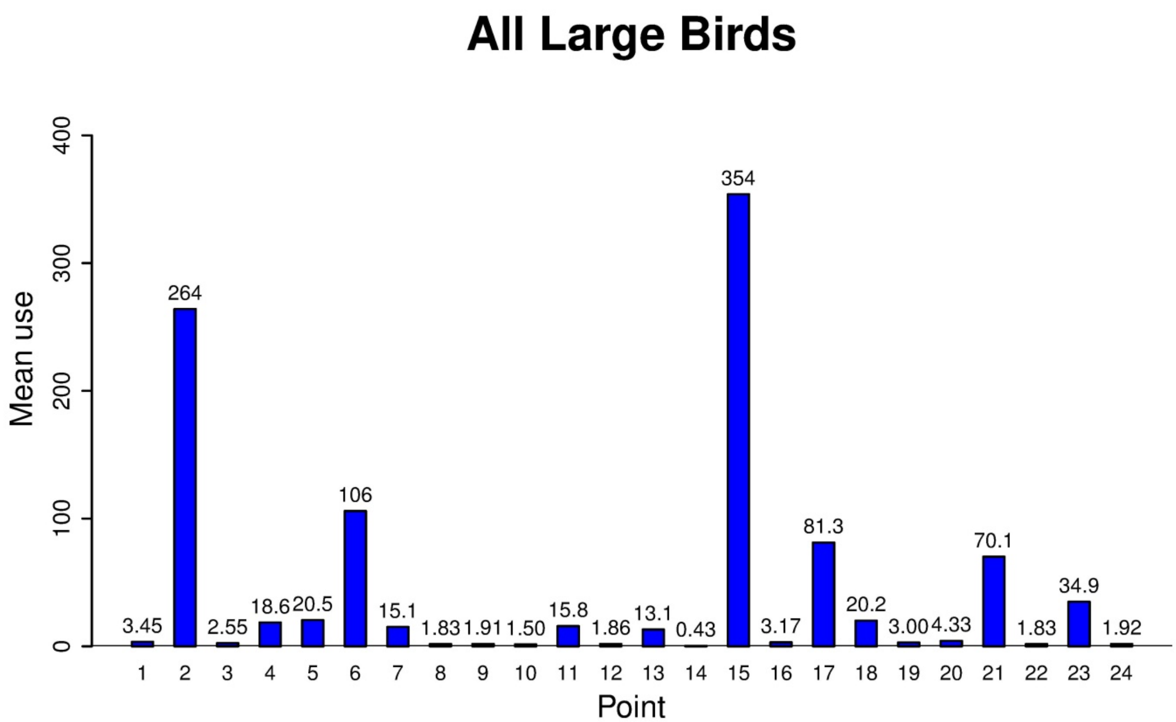

Figure 4a. Relative large bird use (birds/800-meter plot/60-minute survey) by observation point during avian use surveys at the Triple H Wind Project from April 18, 2016 to March 28, 2017.

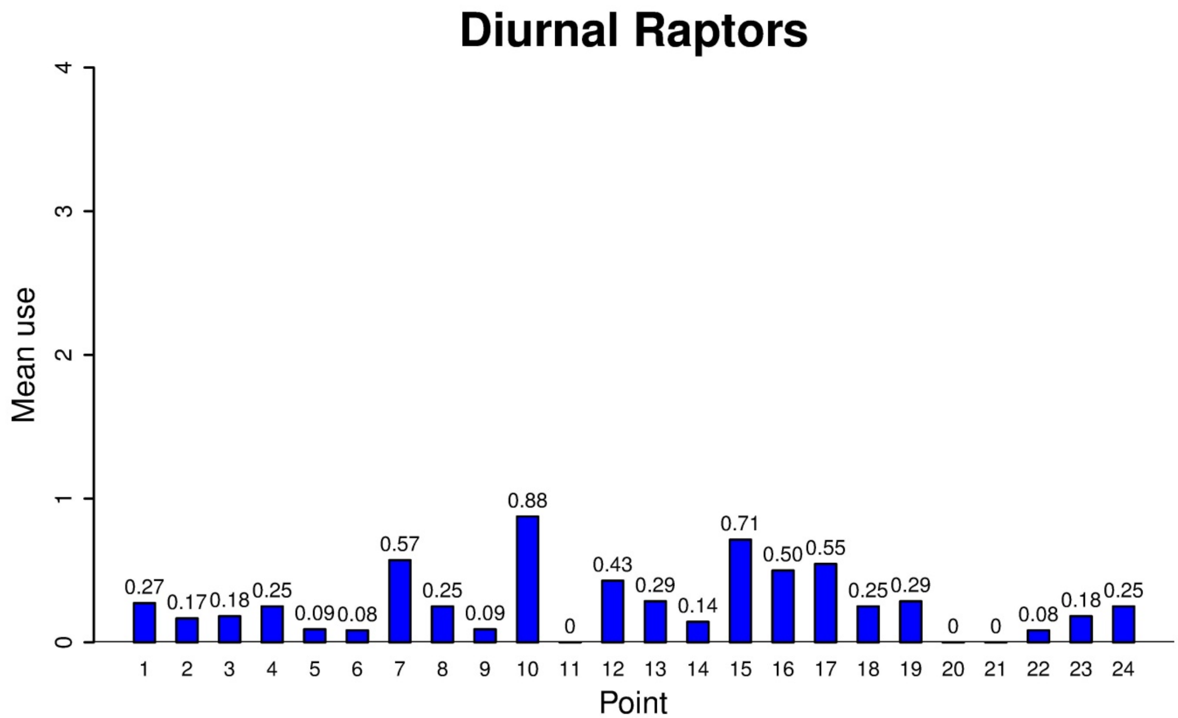

Figure 4b. Relative diurnal raptor use (raptors/800-meter plot/60-minute survey) by observation point during avian use surveys at the Triple H Wind Project from April 18, 2016 to March 28, 2017.

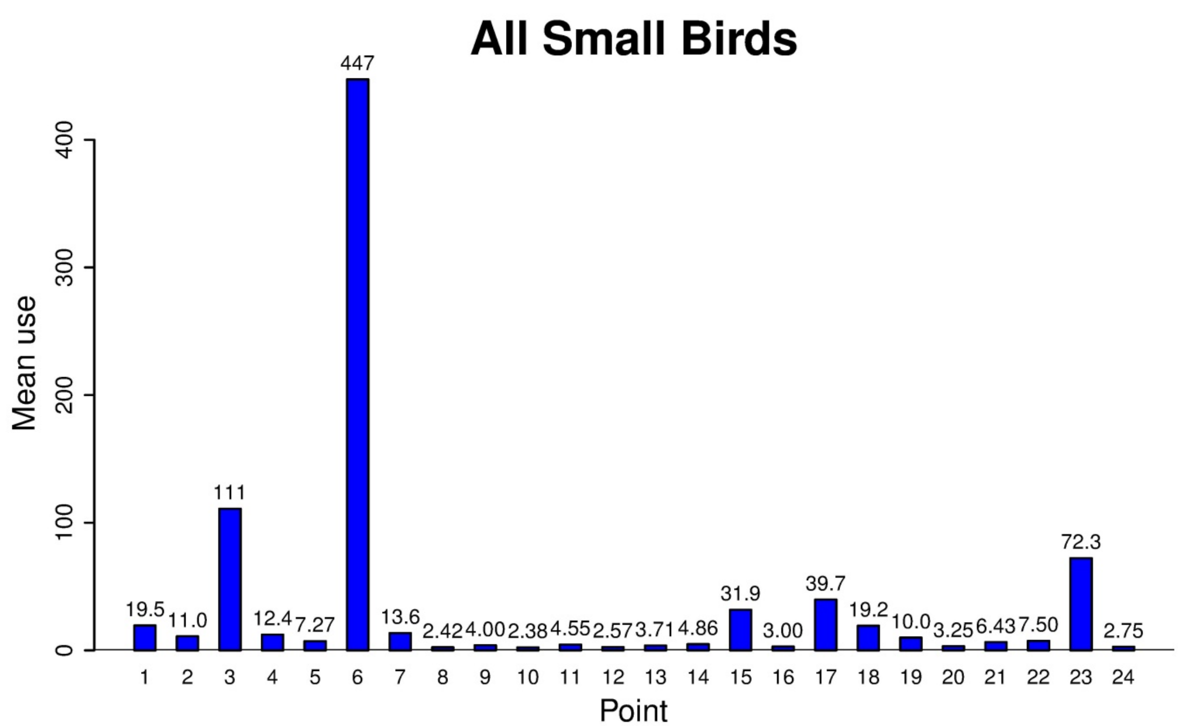

Figure 4c. Relative small bird use (birds/100-meter plot/20-minute survey) by observation point during avian use surveys at the Triple H Wind Project from April 18, 2016 to March 28, 2017.

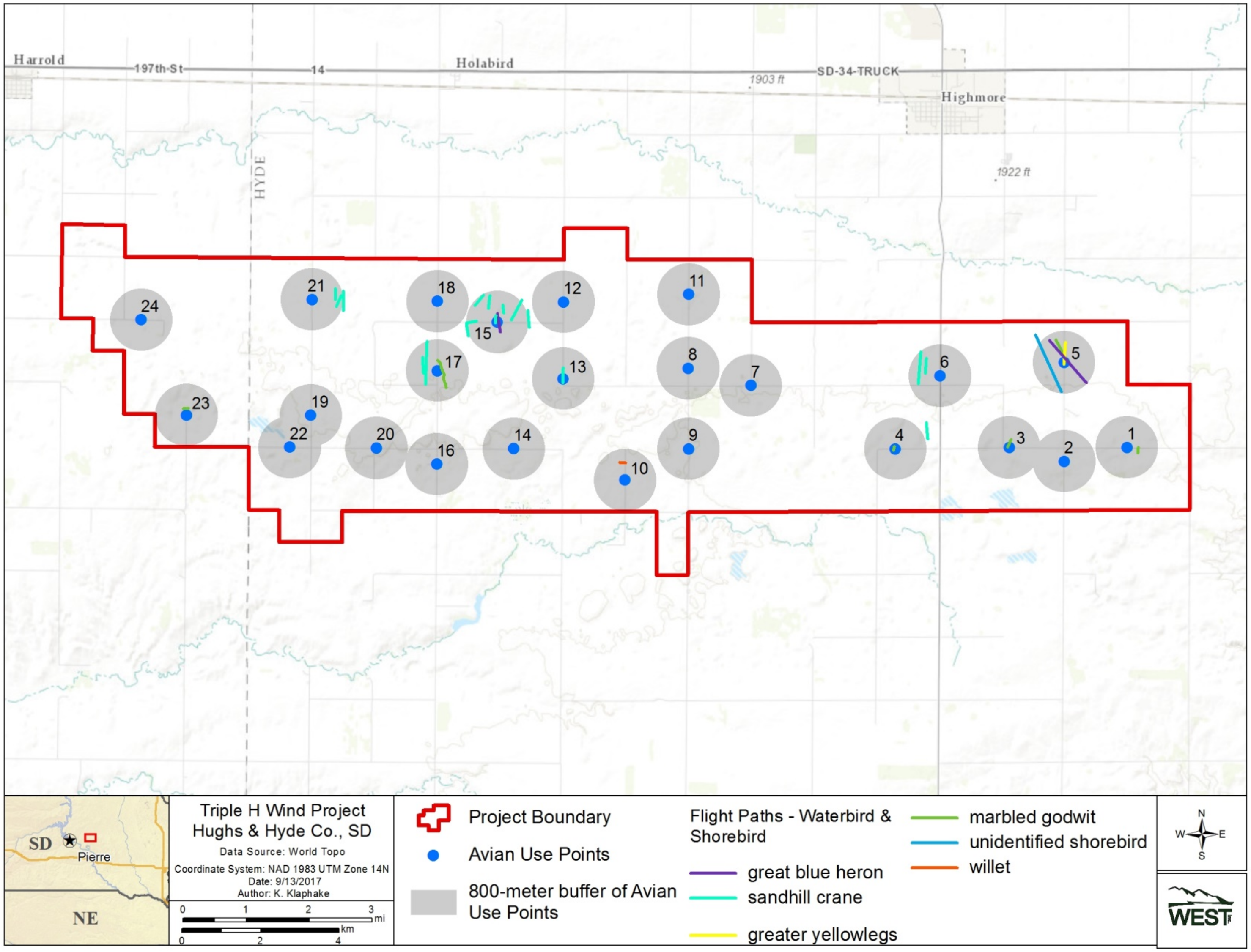

Figure 5a. Flight paths for waterbirds and shorebirds observed during avian use surveys at the Triple H Wind Project from April 18, 2016 to March 28, 2017.

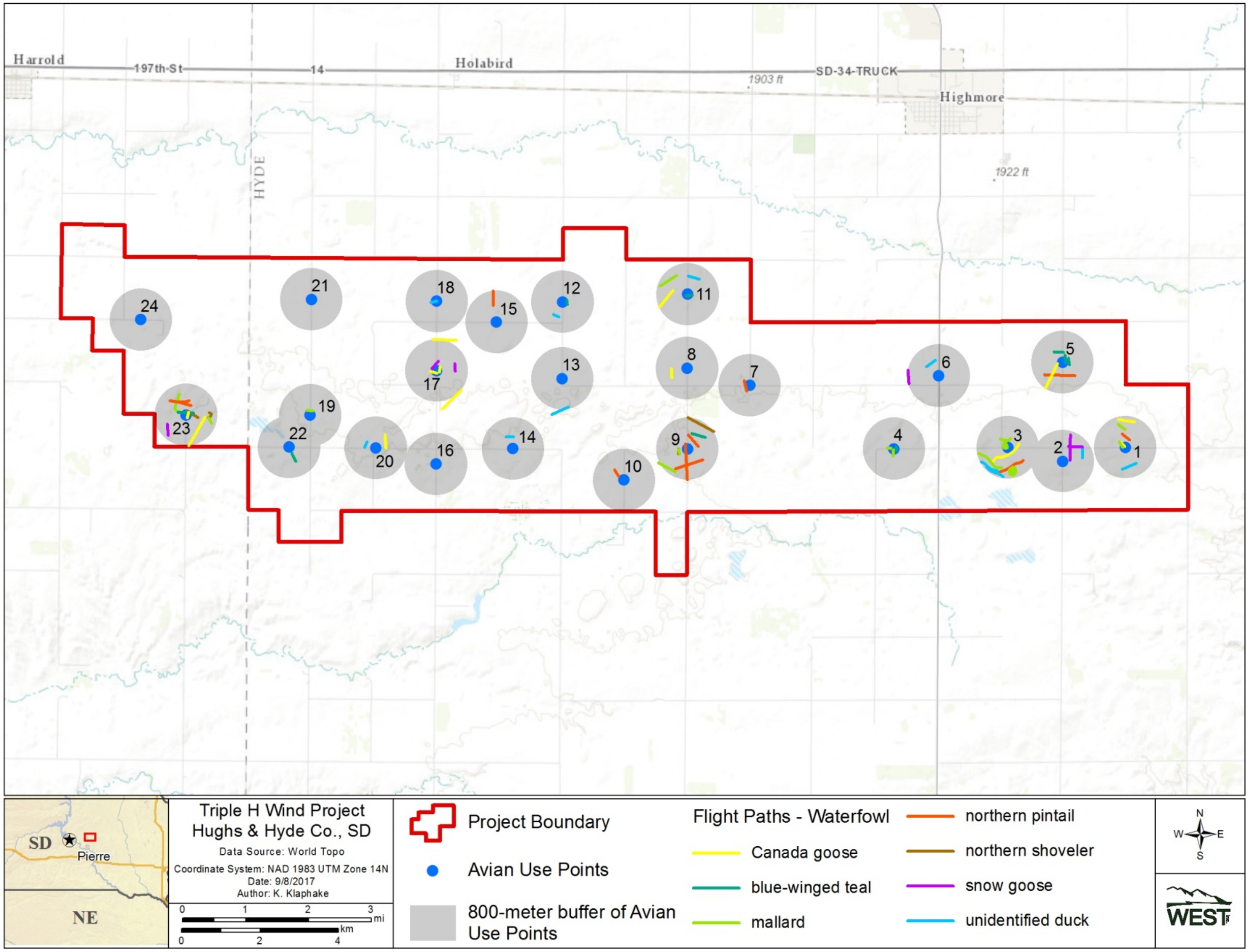

Figure 5b. Flight paths for waterfowl observed during avian use surveys at the Triple H Wind Project from April 18, 2016 to March 28, 2017.

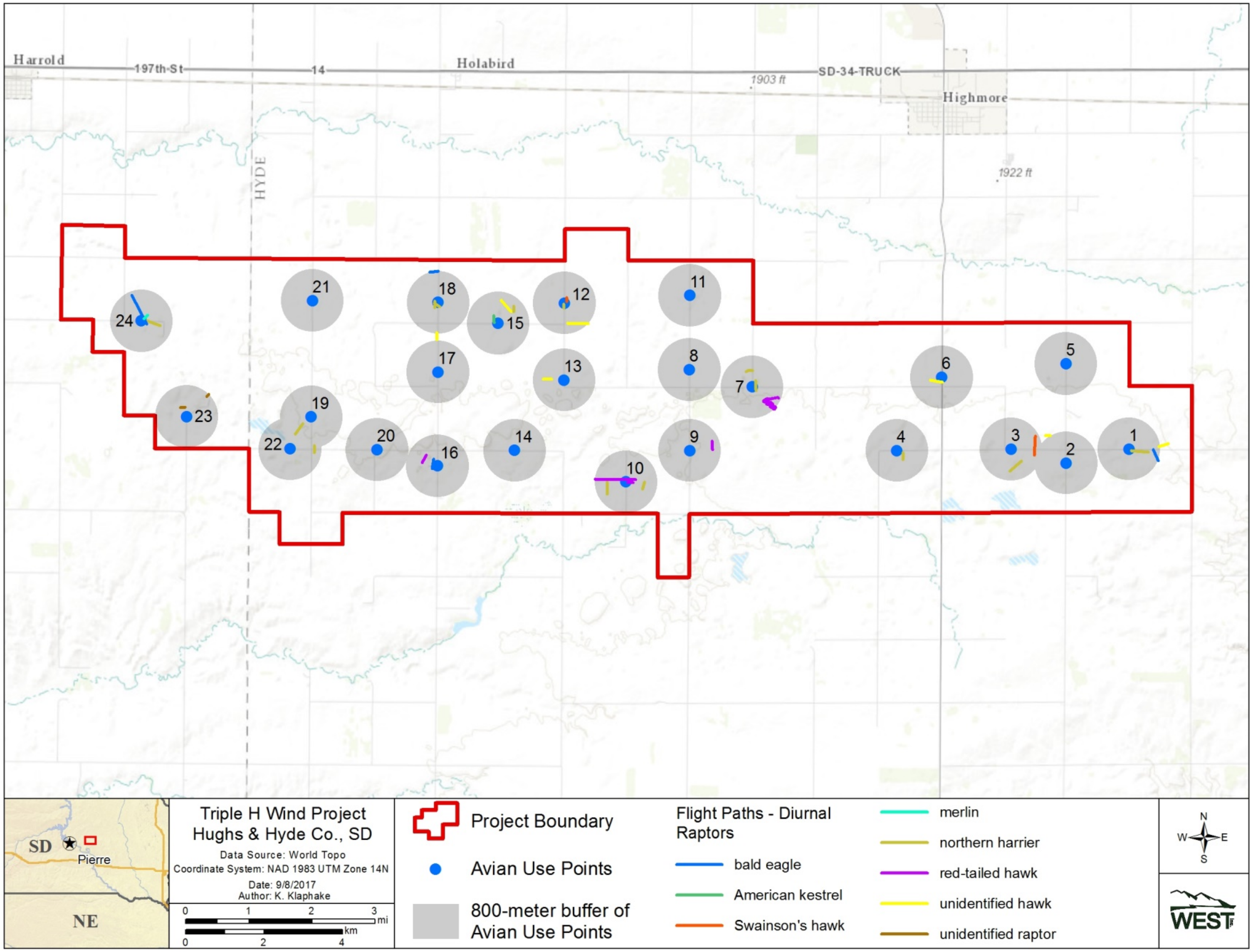

Figure 5c. Flight paths for diurnal raptors observed during avian use surveys at the Triple H Wind Project from April 18, 2016 to March 28, 2017.

Eagle Observations

The total eagle use survey effort was 237 hours, during which time four bald eagles (two adults and two immature birds) were observed within the 800-m survey radius around each point count location. Two of the observations occurred in spring and two in winter (Appendix A). These four bald eagle observations resulted in a total of four eagle minutes, with two eagle minutes recorded during spring and two in winter (Table 6). An eagle minute is defined as one minute of flight at or below 200 m AGL within 800 m of the observation point. The four eagle observations were recorded from four separate observation points: 1, 16, 18, and 24 (Figure 5c). Two additional bald eagles were recorded incidentally during the study (both during winter) and four golden eagles (*Aquila chrysaetos*) were also observed incidentally (two in spring and two in winter; see Incidental Observations section below).

Table 6. Eagle minutes[a] by season for bald eagles (BAEA) observed during avian use surveys at the Triple H Wind Project from April 18, 2016 to March 28, 2017.

Parameter	Spring	Summer	Fall	Winter	Total
Survey Hours	47	71	71	48	237
BAEA Observations	2	0	0	2	4
BAEA Observations ≤800m and ≤ 200m AGL	2	0	0	2	4
Eagle Minutes ≤800m and ≤ 200m AGL	2	0	0	2	4

[a] Eagle minutes are defined as the total number of minutes eagles were observed flying within the 800-meter (0.5-mile) radius plot and at or below 200 meters (656 feet) above ground level (AGL).

Incidental Observations

Nine bird species, totaling 23 individuals, were observed incidentally during avian use surveys at the Project (Table 7). Three species, Cooper's hawk (*Accipiter cooperii*; two individuals), golden eagle (four individuals), and sharp-tailed grouse (*Tympanuchus phasianellus*; two individuals) were only seen incidentally at the Project (i.e., were not observed during standardized avian use surveys).

Table 7. Incidental wildlife observed while conducting surveys at the Triple H Wind Project from April 18, 2016 to March 28, 2017.

Species	Scientific Name	# grps	# obs
American kestrel	*Falco sparverius*	4	4
bald eagle	*Haliaeetus leucocephalus*	2	2
Cooper's hawk	*Accipiter cooperii*	2	2
golden eagle	*Aquila chrysaetos*	4	4
northern harrier	*Circus cyaneus*	1	1
red-tailed hawk	*Buteo jamaicensis*	1	1
Swainson's hawk	*Buteo swainsoni*	1	1
unidentified raptor		2	2
greater prairie-chicken	*Tympanuchus cupido*	2	4
sharp-tailed grouse	*Tympanuchus phasianellus*	1	2
Total	**9 species**	**20**	**23**

Sensitive Species Observations

Fifteen sensitive species (all birds) were recorded during surveys or incidentally during the year-long study (Table 8). This is a tally that in some cases may represent repeated observations of the same individual. No state and/or federally-listed species were observed during the study. Of the 15 species recorded during surveys or incidentally within the Project 12 species were designated as a state species of greatest conservation need (SGCN; SDGFP 2014a) and/or federal birds of conservation concern (BCC) in the Prairie Potholes Bird Conservation Region (11; USFWS 2008; Table 8). Three rare species that are tracked by the South Dakota Natural Heritage Program were observed during surveys or incidentally within the Project (SDGFP 2017; Table 8). Both the bald and golden eagle are provided further protection under the Federal Bald and Golden Eagle Protection Act (BGEPA 1940).

Table 8. Summary of sensitive species observed at the Triple H Wind Project during avian use surveys (AU) and as incidental wildlife observations (Inc.) from April 18, 2016 to March 28, 2017.

			AU		Inc.		Total	
Species	**Scientific Name**	**Status**	**# of grps**	**# of obs**	**# of grps**	**# of obs**	**# of grps**	**# of obs**
bald eagle	*Haliaeetus leucocephalus*	SGCN	4	4	2	2	6	6
black tern	*Chlidonias niger*	BCC, SGCN	1	4	0	0	1	4
chestnut-collared longspur	*Calcarius ornatus*	BCC, SGCN	10	17	0	0	10	17
Cooper's hawk	*Accipiter cooperii*	RA-S3B,SZN	0	0	2	2	2	2
dickcissel	*Spiza Americana*	BCC	3	6	0	0	3	6
golden eagle	*Aquila chrysaetos*	BCC, RA-S3S4B,S3N	0	0	4	4	4	4
grasshopper sparrow	*Ammodramus savannarum*	BCC	7	8	0	0	7	8
great blue heron	*Ardea herodias*	RA-S4B,SZN	3	3	0	0	3	3
greater prairie-chicken	*Tympanuchus cupido*	SGCN	2	3	2	4	4	7
lark bunting	*Calamospiza melanocorys*	SGCN	8	15	0	0	8	15
marbled godwit	*Limosa fedoa*	BCC, SGCN	13	15	0	0	13	15
merlin	*Falco columbarius*	RA-S3B,S3N	1	1	0	0	1	1
Swainson's hawk	*Buteo swainsoni*	BCC, RA-S4B,SZN	4	4	1	1	5	5
upland sandpiper	*Bartramia longicauda*	BCC	24	30	0	0	24	30
willet	*Tringa semipalmata*	SGCN	3	3	0	0	3	3
Total	**15 species**		**83**	**113**	**11**	**13**	**94**	**126**

BCC = USFWS Birds of Conservation Concern in Prairie Potholes Bird Conservation Region (BCR 11; USFWS 2008); SGCN = state species of greatest conservation need (SDGFP 2014b); RA-S#B, S#N = state breeding and non-breeding ranks of rare animals tracked by South Dakota Natural Heritage Program (SDGFP 2017).

DISCUSSION

The WEG (USFWS 2012) and ECPG (USFWS 2013) both use a tiered approach to assess the impacts of wind energy development on species and their habitats. The 2016-2017 avian use surveys conducted at the Project and reported on herein were designed to address Tier 3 of the WEG and Tier 2 of the ECPG, providing site-specific data on avian use at the Project, and supplementing other baseline wildlife surveys at the Project. These studies provide additional data that, when combined with available literature reviewed in previous tiers, allows for assessing risk of potential significant adverse impacts to species of concern; identifying measures to mitigate significant adverse impacts, if necessary; and/or identifying a need for more field studies, if necessary. While the avian use surveys included small bird species observed during the initial 20-min of the survey period and all large birds observed during the full 60-min survey period, this report and impact assessment focuses on a smaller group of species, namely eagles and other diurnal raptors, as well as water dependent species (i.e., waterbirds and waterfowl).

Potential Impacts

Wind energy facilities can directly or indirectly impact wildlife resources. Direct impacts include fatalities from construction and operation of the wind energy facility and the loss of habitat where infrastructure is placed. Indirect impacts include the displacement of wildlife, either temporarily or permanently, during construction or the operational period of a wind energy facility and rendering habitat unsuitable through fragmentation of the landscape.

Mortality or injury due to collisions with turbines or other infrastructure is the most probable direct impact to birds from wind energy facilities. Collisions may occur with resident birds foraging and flying within the Project, or with migrant birds seasonally moving through the area. Project construction could affect birds through loss of habitat or fatalities from construction equipment. Impacts from decommissioning of the facility are anticipated to be similar to construction in terms of noise, disturbance, and equipment used. Potential mortality from construction equipment is expected to be relatively low, as equipment used in wind energy facility construction generally moves at slow rates or is stationary for long periods (e.g., cranes). The highest risk of direct mortality to birds during construction is most likely the potential destruction of nests of ground- and shrub-nesting species during initial site clearing.

Post-construction fatality monitoring reports from the Midwest region of North America show a wide variation in levels of bird mortality, ranging from 0.27 to 8.25 birds/MW/year (Figure 6; Appendix E1). This same wide variation in mortality was noted for studies specific to South Dakota wind farms, as bird mortality at the Wessington Springs facility ranged between 8.25 and 0.89 bird fatalities/MW/year in 2009 (Derby 2010f) and 2010 (Derby et al. 2011d), respectively. Other studies in South Dakota report between 1.41 and 5.06 birds/MW/year (Appendix E1).

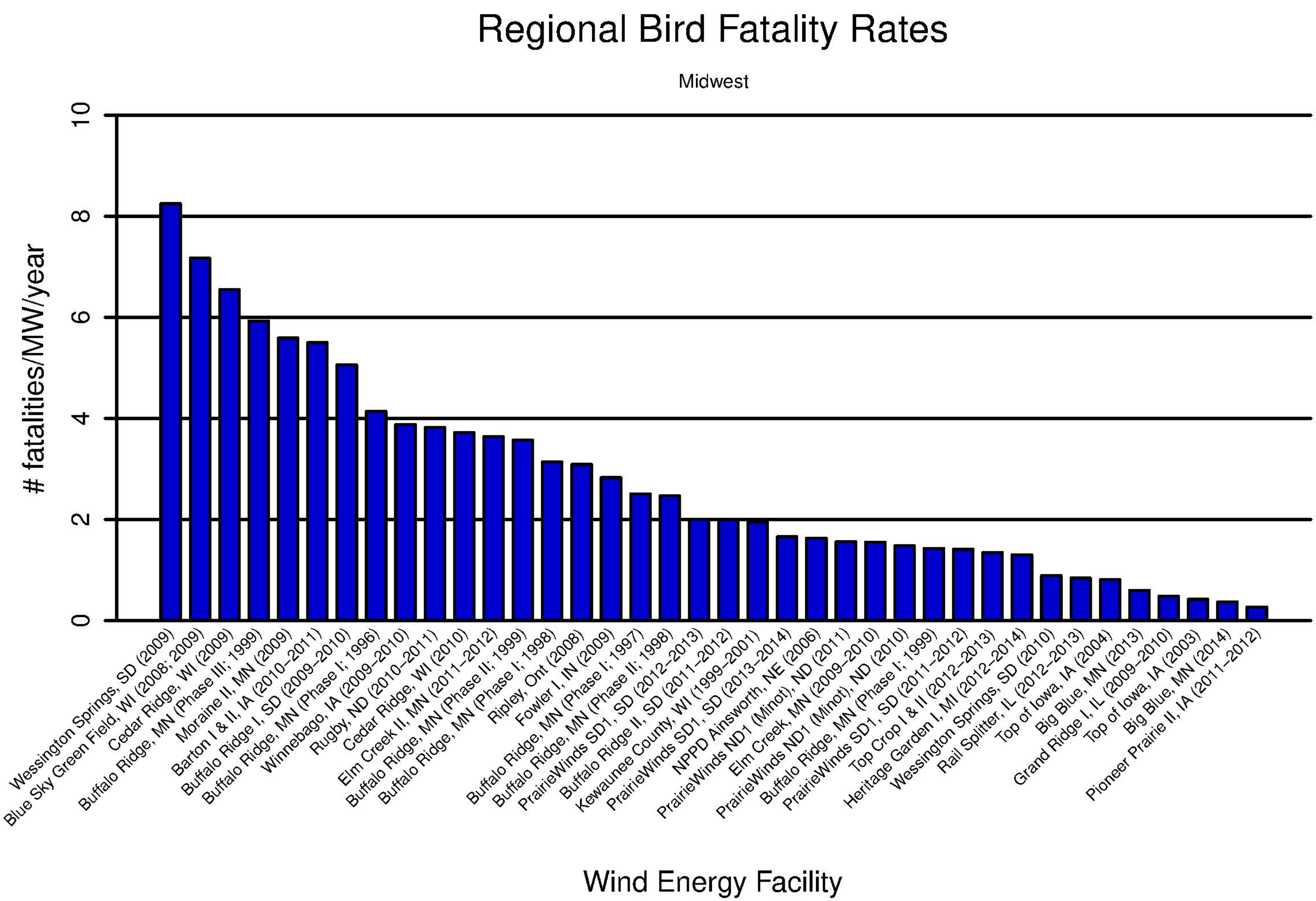

Figure 6. Fatality rates for all birds (number of birds per megawatt [MW] per year) from publicly available wind energy facilities in the Midwest region of North America.

Figure 7 (*continued*). Fatality rates for all birds (number of birds per megawatt per year) reported in publicly available studies at wind energy facilities in the Midwest region of North America.

Data from the following sources:

Wind Energy Facility	Reference	Wind Energy Facility	Reference	Wind Energy Facility	Reference
Wessington Springs, SD (2009)	Derby et al. 2010f	Buffalo Ridge, MN (Phase I, 1998)	Johnson et al. 2000b	Buffalo Ridge, MN (Phase 1; 1998)	Johnson et al. 2000b
Blue Sky Green Field, WI (2008; 2009)	Gruver et al. 2009	Ripley, Ont (2008)	Jacques Whitford 2009	Prairie Winds SD1, SD (2011-2012)	Derby et al. 2012d
Cedar Ridge, WI (2009)	BHE Environmental 2010	Fowler I, IN (2009)	Johnson et al. 2010	Top Crop I & II (2012-2013)	Good et al. 2013a
Buffalo Ridge, MN (Phase III; 1998)	Johnson et al. 2000b	Buffalo Ridge, MN (Phase I; 1997)	Johnson et al. 2000b	Heritage Garden I, MI (2012-2014)	Kerlinger et al. 2014
Moraine II, MN (2009)	Derby et al. 2010d	Buffalo Ridge, MN (Phase II; 1998)	Johnson et al. 2000b	Wessington Springs, SD (2010)	Derby et al. 2011d
Barton I & II, IA (2010-2011)	Derby et al. 2011a	Prairie Winds SD1, SD (2012-2013)	Derby et al. 2013a	Rail Splitter, IL (2012-2013)	Good et al. 2013b
Buffalo Ridge I, SD (2009-2010)	Derby et al. 2010b	Buffalo Ridge II, SD (2011-2012)	Derby et al. 2012a	Top of Iowa, IA (2004)	Jain 2005
Buffalo Ridge, MN (Phase I; 1996)	Johnson et al. 2000b	Kewaunee County, WI (1999-2001)	Howe et al. 2002	Big Blue, MN (2013)	Fagen Engineering 2014
Winnebago, IA (2009-2010)	Derby et al. 2010e	Prairie Winds SD1, SD (2013-2014)	Derby et al. 2014	Grand Ridge I, IL (2009-2010)	Derby et al. 2010g
Rugby, ND (2010-2011)	Derby et al. 2011b	NPPD Ainsworth, NE (2006)	Derby et al. 2007	Top of Iowa, IA (2003)	Jain 2005
Cedar Ridge, WI (2010)	BHE Environmental 2011	Prairie Winds ND1 (Minot), ND (2011)	Derby et al. 2012c	Big Blue, MN (2014)	Fagen Engineering 2015
Elm Creek II, MN (2011-2012)	Derby et al. 2012b	Elm Creek, MN (2009-2010)	Derby et al. 2010c	Pioneer PrairieII, IA (2011-2012)	Chodachek et al. 2012
Buffalo Ridge, MN (Phase II, 1999)	Johnson et al. 2000b	Prairie Winds ND1 (Minot), ND (2010)	Derby et al. 2011c		

In addition to direct effects through collision mortality, wind energy development indirectly affects wildlife resources, causing a loss of habitat where infrastructure is placed and loss of habitat through behavioral avoidance and perhaps habitat fragmentation. Loss of habitat from installation of wind energy facility infrastructure (i.e., turbines, access roads, maintenance buildings, substations and overhead transmission lines) can be long-term or temporary; however, long-term infrastructure generally occupies only 5% to 10% of the entire development area (BLM 2005). Estimates of temporary construction impacts range from 0.2 to 1.0 hectares (0.5 to 2.5 acres) per turbine (Strickland and Johnson 2006, Denholm et al. 2009).

Behavioral displacement (avoidance) may lead to decreased habitat suitability for local populations (e.g., Stevens et al. 2013, Shaffer and Buhl 2015). Birds displaced by wind energy development may move to lower quality habitat with fewer disturbances, with an overall effect of reducing breeding success. Behavioral avoidance may render much larger areas unsuitable or less suitable for some species of wildlife, depending on how far each species is displaced from wind energy facilities. Indirect effects also include habitat fragmentation (e.g., more habitat edges due to roads and smaller areas of contiguous habitat) which could provide more generalized habitats and resistance-free travel lanes for predators and competitors in, for example, large grasslands and forests. This may impact the survivorship and reproductive ability of birds in the vicinity of the wind energy facility. Some studies suggest displacement effects associated with wind energy may have a greater impact than collision mortality (Gill et al. 1996, Pearce-Higgins 2012). The greatest concern for indirect impact of wind energy facilities on wildlife resources is where these facilities have been constructed in native vegetation communities, such as grasslands or shrub steppe that provide comparatively rare, high-quality habitat for some bird species and species of concern (USFWS 2012).

Relative to the Project, approximately 58% of the area is cultivated croplands and several areas with herbaceous vegetation area hayed. Siting facilities on agricultural land or other disturbed land cover types within the Project will reduce the potential for fragmentation and displacement.

Bird Types of Concern

The majority of bird species commonly observed during this study are not of conservation concern. For example, waterfowl was the most abundant large bird type recorded, accounting for 48.1% of overall large bird observations; however, approximately 95% of all waterfowl observations were of snow goose and Canada goose. These two species were primarily observed in very large groups flying above the RSH during spring. Both are abundant species in the Central flyway (USFWS 2016). The second most common large bird type recorded during surveys was waterbird which composed nearly 40% of large bird observations; however, the majority of waterbird use was attributed to just 20 groups of sandhill cranes totaling 3,970 individuals observed during fall migration.

Although the avian use surveys reported herein were conducted for all bird species observed, the discussion focuses on a waterbirds, waterfowl, and diurnal raptors including eagles. Upland game birds, including greater prairie-chicken were recorded at the Project in very low numbers (with the exception of the non-native ring-necked pheasant), and are not addressed here. For more information on surveys conducted at the Project specifically for greater prairie-chicken, refer to the prairie grouse lek survey report (Heath 2016a).

Waterbirds

Waterbirds, including sandhill cranes, do not appear to be particularly susceptible to collision with wind turbines. Waterbirds made up 0.2% of all bird fatalities (n = 4,975) in an analysis of 116 standardized monitoring studies conducted at over 70 wind energy facilities throughout the US and Canada (Erickson et al. 2014a). According to the National Research Council (NRC, 2007) cumulative effects report, waterbirds comprised about 1% of documented fatalities at 14 wind energy facilities. Among publicly available reports reviewed by WEST, waterbirds accounted for 0.2% of fatalities recorded during 172 studies at facilities across North America (14 of 6,511 total fatalities; see Appendix F for a list of facilities and references). The tally in WEST's database excludes three sandhill crane fatalities documented in non-standardized resources (Smallwood and Karas 2009; Navarrete and Griffis-Kyle 2013, as cited in Gerber et al. 2014; Navarrete and Griffis-Kyle 2014; Stehn 2011). Only three sandhill crane fatalities at wind energy facilities are known: one fatality at an older-generation facility at Altamont Pass in California (Smallwood and Karas 2009), and two fatalities from a facility in west Texas (Navarrete and Griffis-Kyle 2013, as cited in Gerber et al. 2014; Stehn 2011), documented as part of a wintering crane displacement study conducted by graduate student L. Navarrete of Texas Tech University. The study in Texas also noted sandhill cranes using areas within three m (10 ft) of turbines (N. Gates, USFWS, pers. comm.).

Sandhill cranes composed 99.9% of waterbird observations recorded during the study. This included total of 3,970 individual cranes, observed in 20 separate groups (all during fall). The majority (about 75%) of these observations were recorded flying above the RSH, indicating these individuals were migrating over the Project, rather than using habitats within the Project. Sandhill cranes composed 96% of overall large bird use recorded during the fall; despite being observed during only 12.5% of fall surveys. Despite their abundance, potential impacts to sandhill cranes are estimated to be low based on all available data regarding crane and wind energy facility interactions in North America; however, the risk of collision cannot be entirely ruled out.

Waterfowl

Based on available evidence, 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. 2014a). In a database of 172 publicly available fatality studies, 184 waterfowl fatalities out of 6,511 total fatalities (2.9%) were documented, (see Appendix E for a list of facilities and references). Mallard (*Anas platyrhynchos*) was the most frequently found species (93 casualties).

Approximately 95% of waterfowl observations at the Project were of two species: snow goose (3,875 individuals in six groups) and Canada goose (778 individuals in 16 groups). Both species were primarily observed in fall flying above the RSH. Despite their abundance in the Central

Flyway, these two species do not appear to be susceptible to collision with turbines and adverse impacts from the Project are not anticipated.

Diurnal Raptors

Use Comparison

Diurnal raptors occur in most areas with the potential for wind energy development (NRC 2007). Annual mean diurnal raptor use at the Project (0.12 raptors/plot/20-min survey) was compared with 46 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/plot/20-min survey (Figure 7). 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), moderate (1.0 – 2.0), high (2.0 – 3.0), and very high (more than 3.0). Under this ranking, annual mean diurnal raptor use at the Project is considered to be low, ranking 44th compared to the 46 other wind energy facilities (Figure 7).

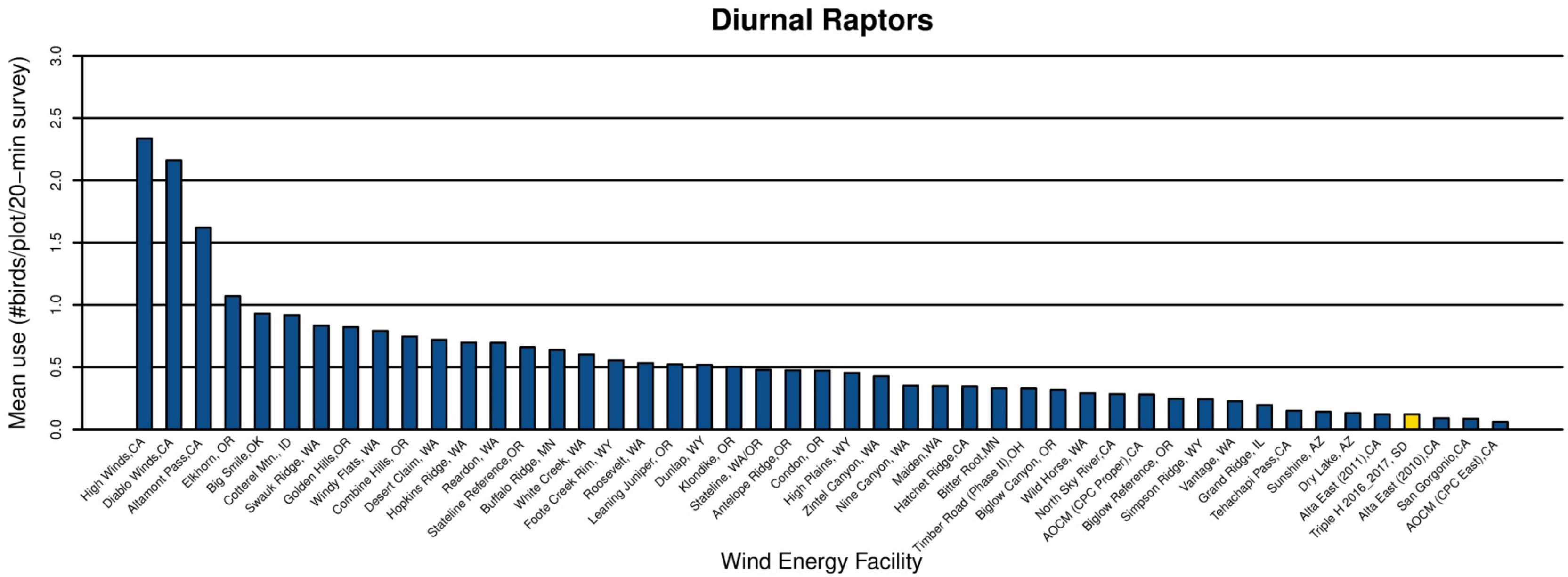

Figure 7. Comparison of annual diurnal raptor use during fixed-point avian use surveys at the Triple H Wind Project from April 18, 2016 to March 28, 2017, and annual diurnal raptor use recorded other North American wind energy facilities.

Data from the following sources:

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

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 (0.02), which was influenced by the relatively high use estimates by this species. Bald eagle and Swainson's hawk, each with an exposure index of less than 0.1, ranked lower, primarily due to the lower use estimates by these species or a relatively lower proportion of flight heights observed in the RSH. Based on the relative abundance of red-tailed hawk throughout the year and a higher exposure index than other raptor species during the surveys at the Project, there is higher potential for red-tailed hawk fatalities compared to other raptor species.

Fatality Studies

Johnson and Stephens (2011) summarized mortality data recorded at wind energy facilities in western North America, which included facilities in Alberta, Canada, as well as the states of North and South Dakota, Nebraska, Kansas, Oklahoma, Texas, Montana, Wyoming, Colorado, New Mexico, Idaho, Utah, Arizona, Nevada, Washington, Oregon, and California. Raw fatality counts were available at 21 facilities, while estimates of fatality rates were available at only 18 of these facilities. Eighteen facilities reported raptor fatality rates, which ranged from zero to 1.79 raptor fatalities per MW per year (mean: 0.19, median: 0.09 fatalities/MW/year; Johnson and Stephens 2011). The raptor fatality rates at two facilities were high relative to the remaining 16 facilities: Diablo Winds (1.79 raptor fatalities/MW/year) and SMUD (0.53 raptor fatalities/MW/year) facilities, both located in California. Estimates of raptor fatality rates at the remaining 16 facilities ranged from zero to 0.15 raptor fatalities/MW/year, with a mean of 0.07 fatalities/MW/year (median: 0.09 fatalities/MW/year).

Across North America, a total of 495 diurnal raptors representing 16 species are documented as wind turbine fatalities in 172 studies with publicly available fatality data (see Appendix E for a list of facilities and references), although not all facilities found diurnal raptor fatalities. Buteos were found most often as fatalities (258 fatalities; 52.1% of raptor fatalities), followed by falcons (174; 35.2%). About 77% of all Buteo fatalities were red-tailed hawk (199 fatalities), and about 91% of falcon fatalities were American kestrel (159 fatalities). Combined, these two species accounted for about 72% of all diurnal raptor fatalities documented in North America. Each remaining species accounted for 25 or fewer fatalities and accounted for 5.1% or less of the total fatalities individually.

A comparison of raptor fatality rates in the Midwest region of North America, which includes wind energy facilities in South Dakota, is illustrated in Figure 8, and a complete list of all publicly available and comparable raptor fatality rates from Midwestern projects can be found in

Appendix E2. Diurnal raptor fatality rates at Midwestern facilities has ranged from zero to 0.47 raptor/MW/year, with just over half (20 of 36 facilities) having an estimated raptor fatality rate of zero (Figure 8, Appendix E2). At facilities in South Dakota, diurnal raptor fatality rates have been lower, ranging from zero to 0.20 raptors/MW/year (Figure 8, Appendix E2).

Within the Midwest region of North America, a total of 64 diurnal raptors representing nine species have been documented as wind turbine fatalities in 59 studies with publicly available fatality data (Table 9; see Appendix E2 for a list of facilities and references), although not all facilities found diurnal raptor fatalities. Buteo fatalities were reported most often (49 fatalities; 77% of raptor fatalities), followed by accipiters and falcons (six each; 9% each; Table 9). About 90% of all Buteo fatalities were red-tailed hawk (44 fatalities). During avian use survey at the Project, northern harrier was the most common raptor species recorded; however, this species has rarely been found as a fatality (no documented fatality in the Midwest; Table 9) despite its abundance in the region. Red-tailed hawk was the next most common raptor recorded during surveys and is the most likely species to be found as a fatality at the Project, should raptor fatalities occur.

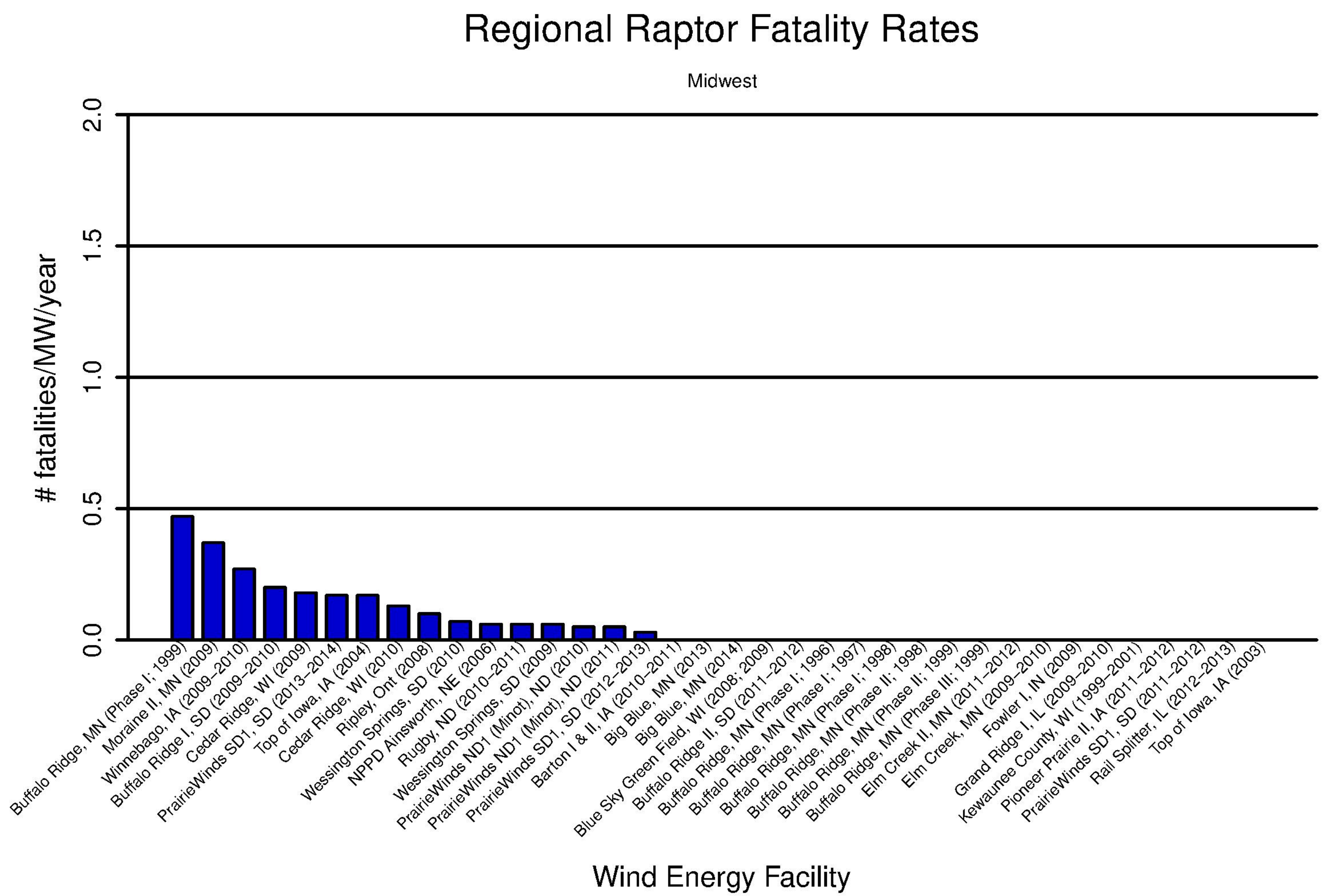

Figure 8. Fatality rates for diurnal raptors (number of raptors per MW per year) from publicly available wind energy facilities in the Midwest region of North America.

Figure 8 (*continued*). Fatality rates for diurnal raptors (number of raptors per MW per year) from publicly available wind energy facilities in the Midwest region of North America.

Data from the following sources:

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

Table 9 Raptor fatalities, by species, recorded at new-generation wind energy facilities in the Midwest region of North America.

Species	Scientific Name	Number of Raptor Fatalities*	Percent Composition of Raptor Fatalities
red-tailed hawk	*Buteo jamaicensis*	44	68.8
American kestrel	*Falco sparverius*	5	7.8
sharp-shinned hawk	*Accipiter striatus*	4	6.3
rough-legged hawk	*Buteo lagopus*	3	4.7
Cooper's hawk	*Accipiter cooperii*	2	3.1
Ferruginous hawk	*Buteo regalis*	1	1.6
Golden eagle	*Aquila chrysaetos*	1	1.6
merlin	*Falco columbarius*	1	1.6
Swainson's hawk	*Buteo swainsoni*	1	1.6
Unidentified accipter	*Accipter spp.*	1	1.6
unidentified raptor		1	1.6
Total		**64**	**100**

* Number of raptor fatalities are unadjusted, raw counts.

Use versus Fatality Rates

Comparable pre-construction raptor use and post-construction raptor mortality data are available for several studies at new-generation wind energy facilities, resulting in 34 pairs of raptor use with fatality data (see Appendix E2). Of these, 16 pairings were from studies at facilities classified as having relatively low raptor use (less than 0.5 raptors/plot/20-min survey), 13 were classified as having low to moderate raptor use (between 0.5 and 1.0), and five were classified as having moderate or high raptor use (greater than 1.0). Due to the relatively low sample size and other biological factors that can influence raptor fatality rates as discussed above, it is not known if the relationship between raptor use and fatality rates is a simple linear relationship. Additionally, mortality estimation for wind resource areas with moderate to high raptor use is subject to greater uncertainty due to a lack of available data, as few wind resource areas have had moderate or high pre-construction raptor use estimates. Furthermore, variation in species composition is likely to influence overall raptor mortality; however, data are not available at this time to perform species-specific regression analyses.

WEST used the available data to assess risk to raptors by examining the mean and range of mortality for wind energy facilities considered to have low raptor use. The proposed Project is classified as having low raptor use, and raptor fatality rates for this project may occur within the range of other wind energy facilities that also have low raptor use (i.e., a mean of 0.05 and a range of zero to 0.09 raptors/MW/year).

Eagles

Documenting the temporal and spatial use of the Project, using methodology consistent with the ECPG, was a primary goal of the avian use survey effort. Over the course of 237 hours of survey, a total of only four eagles, all bald eagles, were observed. An additional two bald eagles and four golden eagles were recorded incidentally during the study. All bald and golden eagle observations occurred in the winter and spring, suggesting very little to no use of the Project by breeding eagles. This is supported by the results of eagle nest surveys conducted at the Project in 2016 during which no eagle nests were located within the Project and the surrounding 10-mile (16.1-km) buffer (Heath 2016c).

Eagle mortalities at wind energy facilities in the contiguous US (excluding the Altamont Pass Wind Resource Area in California) were summarized from public domain data by Pagel et al. (2013). Thirty-two wind energy facilities have experienced eagle fatalities (85 total fatalities – six bald eagles and 79 golden eagles [Pagel et al. 2013]). Three of the six bald eagle fatalities discussed by Pagel et al. (2013) were found in the Midwest (Iowa) and two were found in the Rocky Mountains (Wyoming). Two additional bald eagle fatalities have been found at wind energy facilities in Ontario (Allison 2012). Of the 212 North American studies at wind energy facilities (see Appendix E for a list of facilities and references), 24 golden eagle fatalities have been documented. Of those 24, 17 were found in California, five were found in the Pacific Northwest, and one eagle was found in both the Rocky Mountains and Midwest.

Given the low use of the site by bald and golden eagles and the relatively few bald eagle fatalities documented at wind energy facilities, impacts to eagles at the Project is estimated to be low; however, risk of collision cannot be entirely ruled out. For a thorough discussion of the potential effects of wind energy development on eagles, please see the Eagle Conservation Plan Guidance (USFWS 2013).

CONCLUSIONS AND RECOMMENDATIONS

Tier 3 studies are used to address questions regarding impacts that could not be sufficiently addressed using available literature (i.e., during Tier 1 and 2 desktop analyses). These studies provide additional data that, when combined with available literature reviewed in previous tiers, allow for a better-informed assessment of the risk of significant adverse impacts to species of concern at the project area. The 2016-2017 avian use surveys conducted at the Project supplement additional wildlife studies completed at the Project including eagle/raptor nest surveys, prairie grouse lek surveys, habitat characterization study, and acoustic monitoring for bats (Heath 2016b, 2016a, 2016c, Heath et al. 2017).

Currently, few published studies are available from the Midwest that correlate raptor use and mortality rates. 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. Only four bald eagles were observed during avian use surveys, with an additional two bald eagles and four golden eagles observed incidentally during the study. Diurnal raptor fatality rates are expected to be within the range of fatality rates observed at other facilities where raptor use levels are lower. To date, no relationships have been observed between overall use by other bird types and fatality rates of those bird types at wind energy facilities. However, the flight characteristics, breeding, and foraging habits of some species may result in increased exposure for these species at the Project. To date, overall fatality rates for birds (including nocturnal migrants) at wind energy facilities have been consistently low in the Midwest region of North America. Overall bird fatality estimates at 38 wind energy facilities in this region have ranged from 0.27 to 8.25 fatalities/MW/year and diurnal raptor fatality rates have ranged from zero to

0.47 raptors/MW/year. Continued research conducted at facilities in South Dakota and the Midwest will help further our understanding of the impacts of wind energy facilities on bird species in this region.

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Appendix A. All Bird Types and Species Observed at the Triple H Wind Project during Fixed-Point Avian Use Surveys, April 18, 2016 – March 28, 2017

Appendix A. Summary of the number of observations and groups recorded by species and bird type for fixed-point avian use surveys at the Triple H Wind Project[a], April 18, 2016 – March 28, 2017.

		Spring		Summer		Fall		Winter		Total	
Type / Species	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Waterbirds		**1**	**1**	**2**	**2**	**21**	**3,971**	**0**	**0**	**24**	**3,974**
double-crested cormorant	*Phalacrocorax auritus*	0	0	1	1	0	0	0	0	1	1
great blue heron	*Ardea herodias*	1	1	1	1	1	1	0	0	3	3
sandhill crane	*Grus canadensis*	0	0	0	0	20	3,970	0	0	20	3,970
Waterfowl		**54**	**4,652**	**29**	**60**	**2**	**70**	**3**	**11**	**88**	**4,793**
American wigeon	*Anas americana*	0	0	1	4	0	0	0	0	1	4
blue-winged teal	*Anas discors*	2	5	9	19	0	0	0	0	11	24
Canada goose	*Branta canadensis*	11	745	1	2	1	20	3	11	16	778
mallard	*Anas platyrhynchos*	15	32	7	19	0	0	0	0	22	51
northern pintail	*Anas acuta*	13	21	3	4	0	0	0	0	16	25
northern shoveler	*Anas clypeata*	3	9	2	3	0	0	0	0	5	12
snow goose	*Chen caerulescens*	5	3,825	0	0	1	50	0	0	6	3,875
unidentified duck		5	15	6	9	0	0	0	0	11	24
Shorebirds		**28**	**71**	**59**	**75**	**3**	**7**	**0**	**0**	**90**	**153**
greater yellowlegs	*Tringa melanoleuca*	2	2	0	0	0	0	0	0	2	2
killdeer	*Charadrius vociferus*	19	28	25	33	3	7	0	0	47	68
marbled godwit	*Limosa fedoa*	6	6	7	9	0	0	0	0	13	15
unidentified shorebird	*NA*	1	35	0	0	0	0	0	0	1	35
upland sandpiper	*Bartramia longicauda*	0	0	24	30	0	0	0	0	24	30
willet	*Tringa semipalmata*	0	0	3	3	0	0	0	0	3	3
Gulls/Terns		**4**	**504**	**0**	**0**	**1**	**4**	**0**	**0**	**5**	**508**
black tern	*Chlidonias niger*	0	0	0	0	1	4	0	0	1	4
Franklin's gull	*Leucophaeus pipixcan*	4	504	0	0	0	0	0	0	4	504
Diurnal Raptors		**21**	**22**	**16**	**18**	**17**	**17**	**4**	**4**	**58**	**61**
Buteos		*9*	*10*	*5*	*6*	*5*	*5*	*1*	*1*	*20*	*22*
red-tailed hawk	*Buteo jamaicensis*	6	7	4	5	4	4	1	1	15	17
Swainson's hawk	*Buteo swainsoni*	2	2	1	1	1	1	0	0	4	4
unidentified buteo	*Buteo spp*	1	1	0	0	0	0	0	0	1	1
Northern Harrier		*8*	*8*	*6*	*7*	*6*	*6*	*0*	*0*	*20*	*21*
northern harrier	*Circus cyaneus*	8	8	6	7	6	6	0	0	20	21
Eagles		*2*	*2*	*0*	*0*	*0*	*0*	*2*	*2*	*4*	*4*
bald eagle	*Haliaeetus leucocephalus*	2	2	0	0	0	0	2	2	4	4
Falcons		*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*4*	*4*
American kestrel	*Falco sparverius*	1	1	0	0	1	1	1	1	3	3
merlin	*Falco columbarius*	0	0	1	1	0	0	0	0	1	1

Appendix A. Summary of the number of observations and groups recorded by species and bird type for fixed-point avian use surveys at the Triple H Wind Project[a], April 18, 2016 – March 28, 2017.

Type / Species	Scientific Name	Spring # grps	Spring # obs	Summer # grps	Summer # obs	Fall # grps	Fall # obs	Winter # grps	Winter # obs	Total # grps	Total # obs
Other Raptors		*1*	*1*	*4*	*4*	*5*	*5*	*0*	*0*	*10*	*10*
unidentified hawk		1	1	3	3	5	5	0	0	9	9
unidentified raptor		0	0	1	1	0	0	0	0	1	1
Upland Game Birds		**25**	**31**	**46**	**55**	**12**	**26**	**1**	**12**	**84**	**124**
gray partridge	*Perdix perdix*	0	0	0	0	1	1	0	0	1	1
greater prairie-chicken	*Tympanuchus cupido*	2	3	0	0	0	0	0	0	2	3
ring-necked pheasant	*Phasianus colchicus*	23	28	46	55	11	25	1	12	81	120
Doves/Pigeons		**6**	**9**	**46**	**98**	**15**	**36**	**0**	**0**	**67**	**143**
mourning dove	*Zenaida macroura*	5	7	46	98	12	17	0	0	63	122
rock pigeon	*Columba livia*	1	2	0	0	3	19	0	0	4	21
Large Corvids		**4**	**204**	**0**	**0**	**2**	**8**	**1**	**1**	**7**	**213**
American crow	*Corvus brachyrhynchos*	4	204	0	0	2	8	1	1	7	213
Passerines		**149**	**2,276**	**316**	**736**	**63**	**6,622**	**19**	**238**	**547**	**9,872**
American goldfinch	*Spinus tristis*	0	0	3	6	0	0	0	0	3	6
American robin	*Turdus migratorius*	7	21	6	7	1	10	0	0	14	38
American tree sparrow	*Spizella arborea*	2	9	0	0	0	0	0	0	2	9
bank swallow	*Riparia riparia*	1	5	1	3	0	0	0	0	2	8
barn swallow	*Hirundo rustica*	0	0	19	43	6	40	0	0	25	83
bobolink	*Dolichonyx oryzivorus*	0	0	16	27	0	0	0	0	16	27
Brewer's blackbird	*Euphagus cyanocephalus*	2	15	0	0	0	0	0	0	2	15
brown-headed cowbird	*Molothrus ater*	11	116	57	192	2	3	0	0	70	311
brown thrasher	*Toxostoma rufum*	0	0	2	2	0	0	0	0	2	2
chestnut-collared longspur	*Calcarius ornatus*	7	8	3	9	0	0	0	0	10	17
common grackle	*Quiscalus quiscula*	7	11	41	80	4	15	0	0	52	106
dark-eyed junco	*Junco hyemalis*	1	1	0	0	0	0	0	0	1	1
dickcissel	*Spiza americana*	0	0	3	6	0	0	0	0	3	6
eastern kingbird	*Tyrannus tyrannus*	0	0	15	22	0	0	0	0	15	22
European starling	*Sturnus vulgaris*	4	8	0	0	2	155	0	0	6	163
grasshopper sparrow	*Ammodramus savannarum*	0	0	6	7	1	1	0	0	7	8
horned lark	*Eremophila alpestris*	26	1,135	8	18	5	9	14	122	53	1,284
house sparrow	*Passer domesticus*	0	0	2	23	0	0	2	53	4	76
lark bunting	*Calamospiza melanocorys*	0	0	8	15	0	0	0	0	8	15
northern rough-winged swallow	*Stelgidopteryx serripennis*	0	0	3	5	0	0	0	0	3	5
orchard oriole	*Icterus spurius*	0	0	1	1	0	0	0	0	1	1

Appendix A. Summary of the number of observations and groups recorded by species and bird type for fixed-point avian use surveys at the Triple H Wind Project[a], April 18, 2016 – March 28, 2017.

		Spring		Summer		Fall		Winter		Total	
Type / Species	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
red-winged blackbird	*Agelaius phoeniceus*	27	456	33	54	2	6,000	0	0	62	6,510
Savannah sparrow	*Passerculus sandwichensis*	4	5	0	0	0	0	0	0	4	5
Say's phoebe	*Sayornis saya*	1	1	0	0	0	0	0	0	1	1
snow bunting	*Plectrophenax nivalis*	1	400	0	0	1	200	2	61	4	661
song sparrow	*Melospiza melodia*	5	6	1	2	4	109	0	0	10	117
tree swallow	*Tachycineta bicolor*	1	1	2	4	0	0	0	0	3	5
unidentified passerine		0	0	3	23	2	4	0	0	5	27
unidentified sparrow		0	0	4	7	0	0	0	0	4	7
western kingbird	*Tyrannus verticalis*	0	0	6	14	0	0	0	0	6	14
western meadowlark	*Sturnella neglecta*	41	70	71	154	33	76	1	2	146	302
yellow-headed blackbird	*Xanthocephalus xanthocephalus*	1	8	2	12	0	0	0	0	3	20
Unidentified Birds		**8**	**601**	**0**	**0**	**16**	**136**	**14**	**5,271**	**38**	**6,008**
unidentified small bird		8	601	0	0	16	136	14	5,271	38	6,008
Overall		**300**	**8,371**	**514**	**1,044**	**152**	**10,897**	**42**	**5,537**	**1,008**	**25,849**

[a] Regardless of distance from observer.

Appendix B. Mean Use, Percent of Use, and Frequency of Occurrence for Large Birds and Small Birds Observed during Fixed-Point Surveys at the Triple H Wind Project, April 18, 2016 – March 28, 2017

Appendix B1. Mean bird use (number of birds/plot[a]/60-min survey), percent of use (%), and frequency of occurrence (%) for each large bird type and species by season during the fixed-point avian use surveys at the Triple H Wind Project from April 18, 2016 – March 28, 2017.

	Mean Use				% of Use				% Frequency			
Type/Species	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
Waterbirds	**0.01**	**0.03**	**55.15**	**0**	**<0.1**	**0.6**	**95.9**	**0**	**1.4**	**2.8**	**13.9**	**0**
double-crested cormorant	0	0.01	0	0	0	0.3	0	0	0	1.4	0	0
great blue heron	0.01	0.01	0.01	0	<0.1	0.3	<0.1	0	1.4	1.4	1.4	0
sandhill crane	0	0	55.14	0	0	0	95.9	0	0	0	12.5	0
Waterfowl	**102.62**	**0.83**	**0.97**	**0.24**	**85.2**	**19.5**	**1.7**	**42.6**	**32.8**	**26.4**	**2.8**	**4.4**
American wigeon	0	0.06	0	0	0	1.3	0	0	0	1.4	0	0
blue-winged teal	0.07	0.26	0	0	<0.1	6.2	0	0	2.8	11.1	0	0
Canada goose	16.48	0.03	0.28	0.24	13.7	0.6	0.5	42.6	14.4	1.4	1.4	4.4
mallard	0.44	0.26	0	0	0.4	6.2	0	0	12.5	8.3	0	0
northern pintail	0.29	0.06	0	0	0.2	1.3	0	0	13.9	4.2	0	0
northern shoveler	0.12	0.04	0	0	0.1	1.0	0	0	2.8	2.8	0	0
snow goose	85.00	0	0.69	0	70.5	0	1.2	0	6.7	0	1.4	0
unidentified duck	0.21	0.12	0	0	0.2	2.9	0	0	5.6	8.3	0	0
Shorebirds	**1.38**	**1.04**	**0.10**	**0**	**1.1**	**24.4**	**0.2**	**0**	**43.1**	**48.6**	**4.3**	**0**
greater yellowlegs	0.03	0	0	0	<0.1	0	0	0	1.4	0	0	0
killdeer	0.78	0.46	0.10	0	0.6	10.7	0.2	0	40.3	30.6	4.3	0
marbled godwit	0.08	0.12	0	0	<0.1	2.9	0	0	6.9	9.7	0	0
unidentified shorebird	0.49	0	0	0	0.4	0	0	0	1.4	0	0	0
upland sandpiper	0	0.42	0	0	0	9.7	0	0	0	26.4	0	0
willet	0	0.04	0	0	0	1.0	0	0	0	4.2	0	0
Gulls/Terns	**7.00**	**0**	**0.06**	**0**	**5.8**	**0**	**0.1**	**0**	**5.6**	**0**	**1.4**	**0**
black tern	0	0	0.06	0	0	0	0.1	0	0	0	1.4	0
Franklin's gull	7.00	0	0	0	5.8	0	0	0	5.6	0	0	0
Diurnal Raptors	**0.34**	**0.25**	**0.24**	**0.09**	**0.3**	**5.8**	**0.4**	**14.8**	**25.3**	**20.8**	**24.1**	**8.5**
Buteos	*0.14*	*0.08*	*0.07*	*0.02*	*0.1*	*1.9*	*0.1*	*3.2*	*11.1*	*6.9*	*7.2*	*1.9*
red-tailed hawk	0.10	0.07	0.06	0.02	<0.1	1.6	<0.1	3.2	6.9	5.6	5.7	1.9
Swainson's hawk	0.03	0.01	0.01	0	<0.1	0.3	<0.1	0	2.8	1.4	1.4	0
unidentified buteo	0.01	0	0	0	<0.1	0	0	0	1.4	0	0	0
Northern Harrier	*0.12*	*0.10*	*0.08*	*0*	*<0.1*	*2.3*	*0.1*	*0*	*11.9*	*8.3*	*8.5*	*0*
northern harrier	0.12	0.10	0.08	0	<0.1	2.3	0.1	0	11.9	8.3	8.5	0
Eagles	*0.04*	*0*	*0*	*0.04*	*<0.1*	*0*	*0*	*7.7*	*4.4*	*0*	*0*	*4.4*
bald eagle	0.04	0	0	0.04	<0.1	0	0	7.7	4.4	0	0	4.4

Appendix B1. Mean bird use (number of birds/plot[a]/60-min survey), percent of use (%), and frequency of occurrence (%) for each large bird type and species by season during the fixed-point avian use surveys at the Triple H Wind Project from April 18, 2016 – March 28, 2017.

	Mean Use				% of Use				% Frequency			
Type/Species	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
Falcons	*0*	*0.01*	*0.01*	*0.02*	*0*	*0.3*	*<0.1*	*3.9*	*0*	*1.4*	*1.4*	*2.2*
American kestrel	0	0	0.01	0.02	0	0	<0.1	3.9	0	0	1.4	2.2
merlin	0	0.01	0	0	0	0.3	0	0	0	1.4	0	0
Other Raptors	*0.04*	*0.06*	*0.07*	*0*	*<0.1*	*1.3*	*0.1*	*0*	*4.2*	*5.6*	*7.0*	*0*
unidentified hawk	0.04	0.04	0.07	0	<0.1	1.0	0.1	0	4.2	4.2	7.0	0
unidentified raptor	0	0.01	0	0	0	0.3	0	0	0	1.4	0	0
Upland Game Birds	**0.57**	**0.76**	**0.36**	**0.22**	**0.5**	**17.9**	**0.6**	**38.7**	**30.0**	**41.7**	**12.7**	**1.9**
gray partridge	0	0	0.01	0	0	0	<0.1	0	0	0	1.4	0
greater prairie-chicken	0.04	0	0	0	<0.1	0	0	0	2.8	0	0	0
ring-necked pheasant	0.53	0.76	0.35	0.22	0.4	17.9	0.6	38.7	30.0	41.7	12.7	1.9
Doves/Pigeons	**0.18**	**1.36**	**0.52**	**0**	**0.1**	**31.8**	**0.9**	**0**	**11.1**	**43.1**	**14.4**	**0**
mourning dove	0.10	1.36	0.25	0	<0.1	31.8	0.4	0	6.9	43.1	13.0	0
rock pigeon	0.08	0	0.27	0	<0.1	0	0.5	0	4.2	0	4.3	0
Large Corvids	**8.39**	**0**	**0.11**	**0.02**	**7.0**	**0**	**0.2**	**3.9**	**6.9**	**0**	**2.8**	**2.2**
American crow	8.39	0	0.11	0.02	7.0	0	0.2	3.9	6.9	0	2.8	2.2
Overall	**120.50**	**4.28**	**57.52**	**0.57**	**100**	**100**	**100**	**100**				

[a] 800-meter (m) radius plot for large birds

Appendix B2. Mean bird use (number of birds/plot[a]/20-min survey), percent of use (%), and frequency of occurrence (%) for each small bird type and species by season during the fixed-point avian use surveys at the Triple H Wind Project from April 18, 2016 – March 28, 2017.

	Mean Use				% of Use				% Frequency			
Type / Species	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
Passerines	**42.04**	**9.25**	**8.60**	**4.75**	**74.7**	**100**	**96.0**	**4.6**	**81.1**	**93.1**	**49.5**	**33.0**
American goldfinch	0	0.08	0	0	0	0.9	0	0	0	4.2	0	0
American robin	0.76	0.10	0.14	0	1.4	1.1	1.5	0	9.7	8.3	1.4	0
American tree sparrow	0.38	0	0	0	0.7	0	0	0	8.3	0	0	0
bank swallow	0.07	0.04	0	0	0.1	0.5	0	0	1.4	1.4	0	0
barn swallow	0	0.60	0.54	0	0	6.5	6	0	0	25.0	5.8	0
bobolink	0	0.32	0	0	0	3.5	0	0	0	15.3	0	0
Brewer's blackbird	0.21	0	0	0	0.4	0	0	0	2.8	0	0	0
brown-headed cowbird	1.61	2.06	0.04	0	2.9	22.2	0.5	0	11.1	58.3	2.8	0
brown thrasher	0	0.03	0	0	0	0.3	0	0	0	2.8	0	0
chestnut-collared longspur	0.11	0.12	0	0	0.2	1.4	0	0	4.2	4.2	0	0
common grackle	0.16	1.03	0.22	0	0.3	11.1	2.4	0	10.6	33.3	5.7	0
dark-eyed junco	0.01	0	0	0	<0.1	0	0	0	1.4	0	0	0
dickcissel	0	0.08	0	0	0	0.9	0	0	0	4.2	0	0
eastern kingbird	0	0.31	0	0	0	3.3	0	0	0	19.4	0	0
European starling	0.26	0	2.16	0	0.5	0	24.1	0	9.2	0	2.8	0
grasshopper sparrow	0	0.08	0.01	0	0	0.9	0.2	0	0	6.9	1.4	0
horned lark	25.08	0.25	0.13	2.55	44.6	2.7	1.4	2.5	32.8	11.1	7.1	24.8
house sparrow	0	0.32	0	0.98	0	3.5	0	1.0	0	2.8	0	3.7
lark bunting	0	0.17	0	0	0	1.8	0	0	0	8.3	0	0
northern rough-winged swallow	0	0.07	0	0	0	0.8	0	0	0	4.2	0	0
orchard oriole	0	0.01	0	0	0	0.2	0	0	0	1.4	0	0
red-winged blackbird	2.67	0.69	0	0	4.7	7.5	0	0	22.2	34.7	0	0
Savannah sparrow	0.07	0	0	0	0.1	0	0	0	5.6	0	0	0
Say's phoebe	0.01	0	0	0	<0.1	0	0	0	1.4	0	0	0
snow bunting	8.89	0	2.78	1.17	15.8	0	31.0	1.1	2.2	0	1.4	4.1
song sparrow	0.08	0.03	1.51	0	0.1	0.3	16.9	0	6.9	1.4	4.2	0
tree swallow	0.01	0.06	0	0	<0.1	0.6	0	0	1.4	2.8	0	0
unidentified passerine	0	0.22	0.03	0	0	2.4	0.3	0	0	2.8	1.4	0
unidentified sparrow	0	0.10	0	0	0	1.1	0	0	0	5.6	0	0
western kingbird	0	0.19	0	0	0	2.1	0	0	0	8.3	0	0
western meadowlark	1.54	2.14	1.05	0.04	2.7	23.1	11.7	<0.1	52.2	75.0	28.2	2.2
yellow-headed blackbird	0.11	0.15	0	0	0.2	1.7	0	0	1.4	1.4	0	0

Appendix B2. Mean bird use (number of birds/plot[a]/20-min survey), percent of use (%), and frequency of occurrence (%) for each small bird type and species by season during the fixed-point avian use surveys at the Triple H Wind Project from April 18, 2016 – March 28, 2017.

	Mean Use				% of Use				% Frequency			
Type / Species	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
Unidentified Birds	**14.21**	**0**	**0.36**	**98.53**	**25.3**	**0**	**4.0**	**95.4**	**18.6**	**0**	**16.7**	**20.4**
unidentified small bird	14.21	0	0.36	98.53	25.3	0	4.0	95.4	18.6	0	16.7	20.4
Overall	**56.25**	**9.25**	**8.96**	**103.27**	**100**	**100**	**100**	**100**				

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

Appendix C. Species Exposure Indices for Large Birds and Small Birds during Fixed-Point Surveys at the Triple H Wind Project, April 18 2016 – to March 28, 2017

Appendix C1. Relative exposure index and flight characteristics by large bird species during the 60-minute fixed-point avian use surveys at the Triple H Wind Project from April 18, 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
sandhill crane	18	13.90	99.5	24.8	3.43	26.7
Canada goose	13	3.53	97.0	45.0	1.54	45.0
snow goose	6	17.64	100	5.8	1.02	5.8
unidentified shorebird	1	0.10	100	100	0.10	100
unidentified duck	11	0.07	100	50.0	0.04	62.5
red-tailed hawk	10	0.06	70.6	50.0	0.02	66.7
blue-winged teal	9	0.08	83.3	30.0	0.02	30.0
American crow	6	1.76	99.5	0.9	0.02	0.9
northern pintail	13	0.07	84.0	23.8	0.01	33.3
mallard	16	0.16	62.7	9.4	<0.01	34.4
marbled godwit	7	0.05	60.0	22.2	<0.01	22.2
bald eagle	3	0.02	75.0	33.3	<0.01	33.3
unidentified hawk	7	0.04	77.8	14.3	<0.01	14.3
great blue heron	3	0.01	100	33.3	<0.01	33.3
Swainson's hawk	4	0.01	100	25.0	<0.01	25.0
greater yellowlegs	2	<0.01	100	50.0	<0.01	50.0
Franklin's gull	4	1.44	100	0	0	0
ring-necked pheasant	6	0.45	25.8	0	0	0
mourning dove	28	0.43	37.7	0	0	0
killdeer	16	0.30	41.2	0	0	0
upland sandpiper	1	0.11	13.3	0	0	0
rock pigeon	1	0.09	61.9	0	0	0
northern harrier	20	0.07	100	0	0	4.8
northern shoveler	4	0.04	83.3	0	0	0
black tern	1	0.01	100	0	0	0
American wigeon	0	0.01	0	0	0	0
willet	1	0.01	33.3	0	0	0
American kestrel	1	0.01	50.0	0	0	0
greater prairie-chicken	0	<0.01	0	0	0	0
unidentified raptor	1	<0.01	100	0	0	0
merlin	1	<0.01	100	0	0	0
gray partridge	1	<0.01	100	0	0	0
double-crested cormorant	1	<0.01	100	0	0	0
unidentified buteo	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 small birds during the 20-minute fixed-point avian use surveys at the Triple H Wind Project from April 18, 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
brown-headed cowbird	40	0.86	80.5	27.9	0.19	27.9
yellow-headed blackbird	2	0.06	100	57.9	0.04	57.9
bank swallow	2	0.02	100	62.5	0.02	62.5
horned lark	24	5.99	92.4	<0.1	<0.01	<0.1
unidentified bird (small)	19	31.62	99.5	0	0	0
snow bunting	4	2.87	100	0	0	0
western meadowlark	19	1.13	15.7	0	0	0
red-winged blackbird	27	0.72	78.1	0	0	45.0
European starling	1	0.60	0.60	0	0	0
song sparrow	0	0.41	0	0	0	0
house sparrow	0	0.37	0	0	0	0
common grackle	39	0.35	86.0	0	0	0
barn swallow	21	0.29	62.5	0	0	0
American robin	6	0.22	71.1	0	0	0
bobolink	5	0.08	47.8	0	0	0
American tree sparrow	1	0.08	66.7	0	0	0
eastern kingbird	5	0.08	36.4	0	0	0
unidentified passerine	3	0.06	100	0	0	0
chestnut-collared longspur	4	0.05	47.1	0	0	0
western kingbird	2	0.05	28.6	0	0	0
Brewer's blackbird	1	0.04	93.3	0	0	0
lark bunting	1	0.04	8.3	0	0	0
unidentified sparrow	1	0.02	14.3	0	0	0
grasshopper sparrow	0	0.02	0	0	0	0
dickcissel	0	0.02	0	0	0	0
American goldfinch	3	0.02	100	0	0	0
northern rough-winged swallow	3	0.02	100	0	0	0
tree swallow	1	0.02	60.0	0	0	0
Savannah sparrow	1	0.01	40.0	0	0	0
brown thrasher	1	<0.01	50.0	0	0	0
orchard oriole	0	<0.01	0	0	0	0
Say's phoebe	0	<0.01	0	0	0	0
dark-eyed junco	0	<0.01	0	0	0	0
brown-headed cowbird	40	0.86	80.5	27.9	0.19	27.9

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 Surveys at the Triple H Wind Project, April 18, 2016 – March 28, 2017

Appendix D. Mean use (number of birds/plot[a]/ survey[b]) by observation point for all birds, major bird types, and diurnal raptor subtypes observed at the Triple H Wind Project during fixed-point avian use surveys from April 18, 2016 – March 28, 2017.

	Observation Point											
Bird Type	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Waterbirds	0	0.83	0	15.00	14.73	29.17	0	0	0	0	0.91	0
Waterfowl	1.55	259.25	1.45	1.25	1.00.	50.33	0.29	1.00	1.45	0.12	14.45	0.71
Shorebirds	0.82	0.83	0.18	0.62	3.82	0.92	0.14	0.50	0.18	0.25	0.18	0.29
Gulls/Terns	0	2	0	0	0	25.00	12.14	0	0	0	0	0
Diurnal Raptors	0.27	0.17	0.18	0.25	0.09	0.08	0.57	0.25	0.09	0.88	0	0.43
Buteos	0	0	0.09	0	0.09	0	0.29	0.17	0.09	0.38	0	0.14
Northern Harrier	0.09	0.08	0.09	0.25	0	0	0.29	0.08	0	0.50	0	0.14
Eagles	0.09	0	0	0	0	0	0	0	0	0	0	0
Falcons	0	0	0	0	0	0	0	0	0	0	0	0
Other Raptors	0.09	0.08	0	0	0	0.08	0	0	0	0	0	0.14
Upland Game Birds	0.27	0.25	0.27	1.00	0.82	0.17	0.57	0.08	0.09	0.25	0	0.29
Doves/Pigeons	0.55	0.75	0.45	0.50	0.09	0.25	1.00	0	0.09	0	0.27	0
Large Corvids	0	0	0	0	0	0	0.43	0	0	0	0	0.14
All Large Birds	**3.45**	**264.08**	**2.55**	**18.62**	**20.55**	**105.92**	**15.14**	**1.83**	**1.91**	**1.50**	**15.82**	**1.86**
Passerines	19.36	10.75	92.64	9.62	5.64	4.33	13.43	2.17	3.00	2.25	4.55	2.57
Unidentified Small Birds	0.09	0.25	18.36	2.75	1.64	443.00	0.14	0.25	1.00	0.12	0	0
All Small Birds	**19.45**	**11.00**	**111.00**	**12.38**	**7.27**	**447.33**	**13.57**	**2.42**	**4.00**	**2.38**	**4.55**	**2.57**

[a.] 800-meter (m) radius plot for large birds, 100-m for small birds.
[b] 60-minute (min) survey period for large birds, 20-min survey period for small birds.

Appendix D (*continued*). Mean use (number of birds/plot[a]/ survey[b]) by observation point for all birds, major bird types, and diurnal raptor subtypes observed at the Triple H Wind Project during fixed-point avian use surveys from April 18, 2016 – March 28, 2017.

	Observation Point											
Bird Type	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
Waterbirds	11.43	0	349.43	0	30.00	0	0	0	66.43	0	0.09	0
Waterfowl	0.43	0.14	0.43	0.33	48.27	0.17	1.71	3.83	0.43	0.25	20.09	0
Shorebirds	0.29	0.14	0.86	0.67	1.09	0.50	0.43	0.17	0.71	0.08	0.91	0.25
Gulls/Terns	0	0	0.57	0	0	0	0	0	0	0	8.64	0
Diurnal Raptors	0.29	0.14	0.71	0.50	0.55	0.25	0.29	0	0	0.08	0.18	0.25
Buteos	0.14	0	0.14	0.42	0.36	0	0	0	0	0	0	0
Northern Harrier	0	0.14	0.14	0	0	0.17	0.29	0	0	0.08	0	0.08
Eagles	0	0	0	0.08	0	0.08	0	0	0	0	0	0.08
Falcons	0	0	0.14	0	0.09	0	0	0	0	0	0	0.08
Other Raptors	0.14	0	0.29	0	0.09	0	0	0	0	0	0.18	0
Upland Game Birds	0.43	0	0.57	0	0.45	1.67	0.57	0.17	1.00	0.67	2.91	0.08
Doves/Pigeons	0.29	0	1.29	1.00	0.91	0.83	0	0.17	1.57	0.75	2.09	1.33
Large Corvids	0	0	0	0.67	0	16.75	0	0	0	0	0	0
All Large Birds	**13.14**	**0.43**	**353.86**	**3.17**	**81.27**	**20.17**	**3.00**	**4.33**	**70.14**	**1.83**	**34.91**	**1.92**
Passerines	3.71	4.43	31.43	3.00	39.73	16.42	9.71	3.25	6.43	7.42	47.09	2.75
Unidentified Small Birds	0	0.43	0.43	0	0	2.83	0.29	0	0	0.08	25.18	0
All Small Bird	**3.71**	**4.86**	**31.86**	**3.00**	**39.73**	**19.25**	**10.00**	**3.25**	**6.43**	**7.50**	**72.27**	**2.75**

[a.] 800-meter (m) radius plot for large birds, 100-m for small birds.
[b] 60-minute (min) survey period for large birds, 20-min survey period for small birds.

Appendix E. North American Fatality Summary Tables

Appendix E1. 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)	5.5	80	160
Buffalo Ridge I, SD (2009-2010)	5.06	24	50.4
Buffalo Ridge, MN (Phase I; 1996)	4.14	73	25
Winnebago, IA (2009-2010)	3.88	10	20
Rugby, ND (2010-2011)	3.82	71	149
Cedar Ridge, WI (2010)	3.72	41	68
Elm Creek II, MN (2011-2012)	3.64	62	148.8
Buffalo Ridge, MN (Phase II; 1999)	3.57	143	107.25
Buffalo Ridge, MN (Phase I; 1998)	3.14	73	25
Ripley, Ont (2008)	3.09	38	76
Fowler I, IN (2009)	2.83	162	301
Buffalo Ridge, MN (Phase I; 1997)	2.51	73	25
Buffalo Ridge, MN (Phase II; 1998)	2.47	143	107.25
PrairieWinds SD1, SD (2012-2013)	2.01	108	162
Buffalo Ridge II, SD (2011-2012)	1.99	105	210
Kewaunee County, WI (1999-2001)	1.95	31	20.46
PrairieWinds SD1, SD (2013-2014)	1.66	108	162
NPPD Ainsworth, NE (2006)	1.63	36	20.5
PrairieWinds ND1 (Minot), ND (2011)	1.56	80	115.5
Elm Creek, MN (2009-2010)	1.55	67	100
PrairieWinds ND1 (Minot), ND (2010)	1.48	80	115.5
Buffalo Ridge, MN (Phase I; 1999)	1.43	73	25
PrairieWinds SD1, SD (2011-2012)	1.41	108	162
Top Crop I & II (2012-2013)	1.35	68 (phase I) 132 (phase (II)	102 (phase I) 198 (phase II)
Heritage Garden I, MI (2012-2014)	1.3	14	28
Wessington Springs, SD (2010)	0.89	34	51
Rail Splitter, IL (2012-2013)	0.84	67	100.5
Top of Iowa, IA (2004)	0.81	89	80
Big Blue, MN (2013)	0.6	18	36
Grand Ridge I, IL (2009-2010)	0.48	66	99
Top of Iowa, IA (2003)	0.42	89	80
Big Blue, MN (2014)	0.37	18	36
Pioneer Prairie II, IA (2011-2012)	0.27	62	102.3
	Rocky Mountains		
Foote Creek Rim, WY (Phase I; 1999)	3.4	69	41.4
Foote Creek Rim, WY (Phase I; 2000)	2.42	69	41.4
Foote Creek Rim, WY (Phase I; 2001-2002)	1.93	69	41.4
Summerview, Alb (2005-2006)	1.06	39	70.2
Milford I & II, UT (2011-2012)	0.73	107	160.5 (58.5 I, 102 II)

Appendix E1. 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
Pacific Northwest			
Windy Flats, WA (2010-2011)	8.45	114	262.2
Leaning Juniper, OR (2006-2008)	6.66	67	100.5
Linden Ranch, WA (2010-2011)	6.65	25	50
Biglow Canyon, OR (Phase II; 2009-2010)	5.53	65	150
White Creek, WA (2007-2011)	4.05	89	204.7
Tuolumne (Windy Point I), WA (2009-2010)	3.2	62	136.6
Stateline, OR/WA (2001-2002)	3.17	454	299
Klondike II, OR (2005-2006)	3.14	50	75
Klondike III (Phase I), OR (2007-2009)	3.02	125	223.6
Hopkins Ridge, WA (2008)	2.99	87	156.6
Harvest Wind, WA (2010-2012)	2.94	43	98.9
Nine Canyon, WA (2002-2003)	2.76	37	48.1
Biglow Canyon, OR (Phase II; 2010-2011)	2.68	65	150
Stateline, OR/WA (2003)	2.68	454	299
Klondike IIIa (Phase II), OR (2008-2010)	2.61	51	76.5
Combine Hills, OR (Phase I; 2004-2005)	2.56	41	41
Big Horn, WA (2006-2007)	2.54	133	199.5
Biglow Canyon, OR (Phase I; 2009)	2.47	76	125.4
Combine Hills, OR (2011)	2.33	104	104
Biglow Canyon, OR (Phase III; 2010-2011)	2.28	76	174.8
Hay Canyon, OR (2009-2010)	2.21	48	100.8
Elkhorn, OR (2010)	1.95	61	101
Pebble Springs, OR (2009-2010)	1.93	47	98.7
Biglow Canyon, OR (Phase I; 2008)	1.76	76	125.4
Wild Horse, WA (2007)	1.55	127	229
Goodnoe, WA (2009-2010)	1.4	47	94
Vantage, WA (2010-2011)	1.27	60	90
Hopkins Ridge, WA (2006)	1.23	83	150
Stateline, OR/WA (2006)	1.23	454	299
Kittitas Valley, WA (2011-2012)	1.06	48	100.8
Klondike, OR (2002-2003)	0.95	16	24
Vansycle, OR (1999)	0.95	38	24.9
Palouse Wind, WA (2012-2013)	0.72	58	104.4
Elkhorn, OR (2008)	0.64	61	101
Marengo I, WA (2009-2010)	0.27	78	140.4
Marengo II, WA (2009-2010)	0.16	39	70.2
Biglow Canyon, OR (Phase I; 2009)	2.47	76	125.4
Combine Hills, OR (2011)	2.33	104	104
Biglow Canyon, OR (Phase III; 2010-2011)	2.28	76	174.8
Hay Canyon, OR (2009-2010)	2.21	48	100.8
Elkhorn, OR (2010)	1.95	61	101
Pebble Springs, OR (2009-2010)	1.93	47	98.7
Biglow Canyon, OR (Phase I; 2008)	1.76	76	125.4
Wild Horse, WA (2007)	1.55	127	229
Goodnoe, WA (2009-2010)	1.4	47	94
Vantage, WA (2010-2011)	1.27	60	90
Hopkins Ridge, WA (2006)	1.23	83	150
Stateline, OR/WA (2006)	1.23	454	299
Kittitas Valley, WA (2011-2012)	1.06	48	100.8
Klondike, OR (2002-2003)	0.95	16	24
Vansycle, OR (1999)	0.95	38	24.9

Appendix E1. 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
Palouse Wind, WA (2012-2013)	0.72	58	104.4
Elkhorn, OR (2008)	0.64	61	101
Marengo I, WA (2009-2010)	0.27	78	140.4
Marengo II, WA (2009-2010)	0.16	39	70.2
California			
Pine Tree, CA (2009-2010, 2011)	17.44	90	135
Montezuma I, CA (2012)	8.91	16	36.8
Alta I-V, CA (2013-2014)	7.8	290	720 (150 GE, 570 vestas)
Alta I, CA (2011-2012)	7.07	100	150
Shiloh I, CA (2006-2009)	6.96	100	150
Montezuma I, CA (2011)	5.19	16	36.8
Dillon, CA (2008-2009)	4.71	45	45
Diablo Winds, CA (2005-2007)	4.29	31	20.46
Shiloh III, CA (2012-2013)	3.3	50	102.5
Shiloh II, CA (2010-2011)	2.8	75	150
Shiloh II, CA (2009-2010)	1.9	75	150
Mustang Hills, CA (2012-2013)	1.66	50	150
Alta II-V, CA (2011-2012)	1.66	190	570
High Winds, CA (2003-2004)	1.62	90	162
Solano III, CA (2012-2013)	1.6	55	128
Pinyon Pines I & II, CA (2013-2014)	1.18	100	NA
High Winds, CA (2004-2005)	1.1	90	162
Montezuma II, CA (2012-2013)	1.08	34	78.2
Alta VIII, CA (2012-2013)	0.66	50	150
Alite, CA (2009-2010)	0.55	8	24
Pine Tree, CA (2009-2010, 2011)	17.44	90	135
Montezuma I, CA (2012)	8.91	16	36.8
Alta I-V, CA (2013-2014)	7.8	290	720 (150 GE, 570 Vestas)
Alta I, CA (2011-2012)	7.07	100	150
Shiloh I, CA (2006-2009)	6.96	100	150
Montezuma I, CA (2011)	5.19	16	36.8
Alta VIII, CA (2012-2013)	0.66	50	150
Alite, CA (2009-2010)	0.55	8	24
Southwest			
Dry Lake I, AZ (2009-2010)	2.02	30	63
Dry Lake II, AZ (2011-2012)	1.57	31	65
Southern Plains			
Buffalo Gap I, TX (2006)	1.32	67	134
Barton Chapel, TX (2009-2010)	1.15	60	120
Buffalo Gap II, TX (2007-2008)	0.15	155	233
Big Smile, OK (2012-2013)	0.09	66	132
Red Hills, OK (2012-2013)	0.08	82	123
Southeast			
Buffalo Mountain, TN (2000-2003)	11.02	3	1.98
Buffalo Mountain, TN (2005)	1.1	18	28.98
Northeast			
Stetson Mountain I, ME (2013)	6.95	38	57
Criterion, MD (2011)	6.4	28	70
Mount Storm, WV (2011)	4.24	132	264

Appendix E1. 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
Pinnacle, WV (2012)	3.99	23	55.2
Mount Storm, WV (2009)	3.85	132	264
Record Hill, ME (2012)	3.7	22	50.6
Criterion, MD (2013)	3.49	28	70
Lempster, NH (2009)	3.38	12	24
Stetson Mountain II, ME (2012)	3.37	17	25.5
Rollins, ME (2012)	2.9	40	60
Casselman, PA (2009)	2.88	23	34.5
Mountaineer, WV (2003)	2.69	44	66
Stetson Mountain I, ME (2009)	2.68	38	57
Noble Ellenburg, NY (2009)	2.66	54	80
Lempster, NH (2010)	2.64	12	24
Mount Storm, WV (2010)	2.6	132	264
Maple Ridge, NY (2007)	2.34	195	321.75
Noble Bliss, NY (2009)	2.28	67	100
Criterion, MD (2012)	2.14	28	70
Maple Ridge, NY (2007-2008)	2.07	195	321.75
Record Hill, ME (2014)	1.84	22	50.6
Noble Altona, NY (2010)	1.84	65	97.5
High Sheldon, NY (2010)	1.76	75	112.5
Mars Hill, ME (2008)	1.76	28	42
Noble Wethersfield, NY (2010)	1.7	84	126
Mars Hill, ME (2007)	1.67	28	42
Noble Chateaugay, NY (2010)	1.66	71	106.5
Noble Clinton, NY (2008)	1.59	67	100
High Sheldon, NY (2011)	1.57	75	112.5
Casselman, PA (2008)	1.51	23	34.5
Beech Ridge, WV (2013)	1.48	67	100.5
Munnsville, NY (2008)	1.48	23	34.5
Stetson Mountain II, ME (2010)	1.42	17	25.5
Cohocton/Dutch Hill, NY (2009)	1.39	50	125
Cohocton/Dutch Hills, NY (2010)	1.32	50	125
Noble Bliss, NY (2008)	1.3	67	100
Beech Ridge, WV (2012)	1.19	67	100.5
Stetson Mountain I, ME (2011)	1.18	38	57
Noble Clinton, NY (2009)	1.11	67	100
Locust Ridge, PA (Phase II; 2009)	0.84	51	102
Noble Ellenburg, NY (2008)	0.83	54	80
Locust Ridge, PA (Phase II; 2010)	0.76	51	102

A=number of bird fatalities/MW/year

Appendix E1 (*continued*). Wind energy facilities in North America with publicly-available and comparable fatality data for all bird species.

Data from the following sources:

Wind Energy Facility	Fatality Estimate	Wind Energy Facility	Fatality Estimate
Alite, CA (2009-2010)	Chatfield et al. 2010b	Locust Ridge, PA (Phase II; 2009)	Arnett et al. 2011
Alta I, CA (2011-2012)	Chatfield et al. 2012	Locust Ridge, PA (Phase II; 2010)	Arnett et al. 2011
Alta II-V, CA (2011-2012)	Chatfield et al. 2014	Maple Ridge, NY (2007)	Jain et al. 2009a
Alta I-V, CA (2013-2014)	Chatfield et al. 2012	Maple Ridge, NY (2007-2008)	Jain et al. 2009d
Alta VIII, CA (2012-2013)	Chatfield and Bay 2014	Marengo I, WA (2009-2010)	URS Corporation 2010b
Barton Chapel, TX (2009-2010)	WEST 2011	Marengo II, WA (2009-2010)	URS Corporation 2010c
Barton I & II, IA (2010-2011)	Derby et al. 2011a	Mars Hill, ME (2007)	Stantec 2008
Beech Ridge, WV (2012)	Tidhar et al. 2013	Mars Hill, ME (2008)	Stantec 2009a
Beech Ridge, WV (2013)	Young et al. 2014b	Milford I & II, UT (2011-2012)	Stantec 2012
Big Blue, MN (2013)	Fagen Engineering 2014	Milford I, UT (2010-2011)	Stantec 2011b
Big Blue, MN (2014)	Fagen Engineering 2015	Montezuma I, CA (2011)	ICF International 2012
Big Horn, WA (2006-2007)	Kronner et al. 2008	Montezuma I, CA (2012)	ICF International 2013
Big Smile, OK (2012-2013)	Derby et al. 2013b	Montezuma II, CA (2012-2013)	Harvey & Associates 2013
Biglow Canyon, OR (Phase I; 2008)	Jeffrey et al. 2009a	Moraine II, MN (2009)	Derby et al. 2010d
Biglow Canyon, OR (Phase I; 2009)	Enk et al. 2010	Mount Storm, WV (2009)	Young et al. 2009a, 2010b
Biglow Canyon, OR (Phase II; 2009-2010)	Enk et al. 2011a	Mount Storm, WV (2010)	Young et al. 2010a, 2011b
Biglow Canyon, OR (Phase II; 2010-2011)	Enk et al. 2012b	Mount Storm, WV (2011)	Young et al. 2011a, 2012b
Biglow Canyon, OR (Phase III; 2010-2011)	Enk et al. 2012a	Mountaineer, WV (2003)	Kerns and Kerlinger 2004
Blue Sky Green Field, WI (2008; 2009)	Gruver et al. 2009	Munnsville, NY (2008)	Stantec 2009b
Buffalo Gap I, TX (2006)	Tierney 2007	Mustang Hills, CA (2012-2013)	Chatfield and Bay 2014
Buffalo Gap II, TX (2007-2008)	Tierney 2009	Nine Canyon, WA (2002-2003)	Erickson et al. 2003c
Buffalo Mountain, TN (2000-2003)	Nicholson et al. 2005	Noble Altona, NY (2010)	Jain et al. 2011b
Buffalo Mountain, TN (2005)	Fiedler et al. 2007	Noble Bliss, NY (2008)	Jain et al. 2009e
Buffalo Ridge I, SD (2009-2010)	Derby et al. 2010b	Noble Bliss, NY (2009)	Jain et al. 2010a
Buffalo Ridge II, SD (2011-2012)	Derby et al. 2012a	Noble Chateaugay, NY (2010)	Jain et al. 2011c
Buffalo Ridge, MN (Phase I; 1996)	Johnson et al. 2000b	Noble Clinton, NY (2008)	Jain et al. 2009c
Buffalo Ridge, MN (Phase I; 1997)	Johnson et al. 2000b	Noble Clinton, NY (2009)	Jain et al. 2010b
Buffalo Ridge, MN (Phase I; 1998)	Johnson et al. 2000b	Noble Ellenburg, NY (2008)	Jain et al. 2009b
Buffalo Ridge, MN (Phase I; 1999)	Johnson et al. 2000b	Noble Ellenburg, NY (2009)	Jain et al. 2010c
Buffalo Ridge, MN (Phase II; 1998)	Johnson et al. 2000b	Noble Wethersfield, NY (2010)	Jain et al. 2011a
Buffalo Ridge, MN (Phase II; 1999)	Johnson et al. 2000b	NPPD Ainsworth, NE (2006)	Derby et al. 2007
Buffalo Ridge, MN (Phase III; 1999)	Johnson et al. 2000b	Palouse Wind, WA (2012-2013)	Stantec 2013a
Casselman, PA (2008)	Arnett et al. 2009	Pebble Springs, OR (2009-2010)	Gritski and Kronner 2010b
Casselman, PA (2009)	Arnett et al. 2010	Pine Tree, CA (2009-2010, 2011)	BioResource Consultants 2012
Cedar Ridge, WI (2009)	BHE Environmental 2010	Pinnacle, WV (2012)	Hein et al. 2013
Cedar Ridge, WI (2010)	BHE Environmental 2011	Pinyon Pines I & II, CA (2013-2014)	Chatfield and Russo 2014
Cohocton/Dutch Hill, NY (2009)	Stantec 2010	Pioneer Prairie II, IA (2011-2012)	Chodachek et al. 2012
Cohocton/Dutch Hills, NY (2010)	Stantec 2011a	PrairieWinds ND1 (Minot), ND (2010)	Derby et al. 2011c
Combine Hills, OR (2011)	Young et al. 2006a	PrairieWinds ND1 (Minot), ND (2011)	Derby et al. 2012c
Combine Hills, OR (Phase I; 2004-2005)	Enz et al. 2012	PrairieWinds SD1, SD (2011-2012)	Derby et al. 2012d
Criterion, MD (2011)	Young et al. 2012a	PrairieWinds SD1, SD (2012-2013)	Derby et al. 2013a
Criterion, MD (2012)	Young et al. 2013	PrairieWinds SD1, SD (2013-2014)	Derby et al. 2014
Criterion, MD (2013)	Young et al. 2014a	Rail Splitter, IL (2012-2013)	Good et al. 2013b
Diablo Winds, CA (2005-2007)	WEST 2006, 2008	Record Hill, ME (2012)	Stantec 2013b
Dillon, CA (2008-2009)	Chatfield et al. 2009	Record Hill, ME (2014)	Stantec 2015
Dry Lake I, AZ (2009-2010)	Thompson et al. 2011	Red Hills, OK (2012-2013)	Derby et al. 2013c
Dry Lake II, AZ (2011-2012)	Thompson and Bay 2012	Ripley, Ont (2008)	Jacques Whitford 2009
Elkhorn, OR (2008)	Jeffrey et al. 2009b	Rollins, ME (2012)	Stantec 2013c
Elkhorn, OR (2010)	Enk et al. 2011b	Rugby, ND (2010-2011)	Derby et al. 2011b
Elm Creek II, MN (2011-2012)	Derby et al. 2010c	Shiloh I, CA (2006-2009)	Kerlinger et al. 2009
Elm Creek, MN (2009-2010)	Derby et al. 2012b	Shiloh II, CA (2009-2010)	Kerlinger et al. 2010
Foote Creek Rim, WY (Phase I; 1999)	Young et al. 2003c	Shiloh II, CA (2010-2011)	Kerlinger et al. 2013a
Foote Creek Rim, WY (Phase I; 2000)	Young et al. 2003c	Shiloh III, CA (2012-2013)	Kerlinger et al. 2013b
Foote Creek Rim, WY (Phase I; 2001-2002)	Young et al. 2003c	Solano III, CA (2012-2013)	AECOM 2013
Fowler I, IN (2009)	Johnson et al. 2010	Stateline, OR/WA (2001-2002)	Erickson et al. 2004
Goodnoe, WA (2009-2010)	URS Corporation 2010a	Stateline, OR/WA (2003)	Erickson et al. 2004
Grand Ridge I, IL (2009-2010)	Derby et al. 2010g	Stateline, OR/WA (2006)	Erickson et al. 2007
Harvest Wind, WA (2010-2012)	Downes and Gritski 2012a	Stetson Mountain I, ME (2009)	Stantec 2009c
Hay Canyon, OR (2009-2010)	Gritski and Kronner 2010a	Stetson Mountain I, ME (2011)	Normandeau Associates 2011
Heritage Garden I, MI (2012-2014)	Kerlinger et al. 2014	Stetson Mountain I, ME (2013)	Stantec 2014
High Sheldon, NY (2010)	Tidhar et al. 2012a	Stetson Mountain II, ME (2010)	Normandeau Associates 2010
High Sheldon, NY (2011)	Tidhar et al. 2012b	Stetson Mountain II, ME (2012)	Stantec 2013d
High Winds, CA (2003-2004)	Kerlinger et al. 2006	Summerview, Alb (2005-2006)	Brown and Hamilton 2006
High Winds, CA (2004-2005)	Kerlinger et al. 2006	Top Crop I & II (2012-2013)	Good et al. 2013a
Hopkins Ridge, WA (2006)	Young et al. 2007a	Top of Iowa, IA (2003)	Jain 2005
Hopkins Ridge, WA (2008)	Young et al. 2009b	Top of Iowa, IA (2004)	Jain 2005

Appendix E1 (*continued*). Wind energy facilities in North America with publicly-available and comparable fatality data for all bird species.

Data from the following sources:

Wind Energy Facility	Fatality Estimate	Wind Energy Facility	Fatality Estimate
Kewaunee County, WI (1999-2001)	Howe et al. 2002	Tuolumne (Windy Point I), WA (2009-2010)	Enz and Bay 2010
Kittitas Valley, WA (2011-2012)	Stantec 2012	Vansycle, OR (1999)	Erickson et al. 2000
Klondike II, OR (2005-2006)	NWC and WEST 2007	Vantage, WA (2010-2011)	Ventus 2012
Klondike III (Phase I), OR (2007-2009)	Gritski et al. 2010	Wessington Springs, SD (2009)	Derby et al. 2010f
Klondike IIIa (Phase II), OR (2008-2010)	Gritski et al. 2011	Wessington Springs, SD (2010)	Derby et al. 2011d
Klondike, OR (2002-2003)	Johnson et al. 2003	White Creek, WA (2007-2011)	Downes and Gritski 2012b
Leaning Juniper, OR (2006-2008)	Gritski et al. 2008	Wild Horse, WA (2007)	Erickson et al. 2008
Lempster, NH (2009)	Tidhar et al. 2010	Windy Flats, WA (2010-2011)	Enz et al. 2011
Lempster, NH (2010)	Tidhar et al. 2011	Winnebago, IA (2009-2010)	Derby et al. 2010e
Linden Ranch, WA (2010-2011)	Enz and Bay 2011		

Appendix E2. 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
Triple H, SD (2016-2017)	**0.12**			
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
Pacific Northwest				
White Creek, WA (2007-2011)	NA	0.47	89	204.7
Tuolumne (Windy Point I), WA (2009-2010)	0.77	0.29	62	136.6
Vantage, WA (2010-2011)	NA	0.29	60	90
Linden Ranch, WA (2010-2011)	NA	0.27	25	50

Appendix E2. 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
Harvest Wind, WA (2010-2012)	NA	0.23	43	98.9
Goodnoe, WA (2009-2010)	NA	0.17	47	94
Leaning Juniper, OR (2006-2008)	0.522	0.16	67	100.5
Klondike III (Phase I), OR (2007-2009)	NA	0.15	125	223.6
Hopkins Ridge, WA (2006)	0.698	0.14	83	150
Biglow Canyon, OR (Phase II; 2009-2010)	0.318	0.14	65	150
Big Horn, WA (2006-2007)	0.511	0.11	133	199.5
Stateline, OR/WA (2006)	0.478	0.11	454	299
Kittitas Valley, WA (2011-2012)	NA	0.09	48	100.8
Wild Horse, WA (2007)	0.291	0.09	127	229
Stateline, OR/WA (2001-2002)	0.478	0.09	454	299
Stateline, OR/WA (2003)	0.478	0.09	454	299
Elkhorn, OR (2010)	1.07	0.08	61	101
Hopkins Ridge, WA (2008)	0.698	0.07	87	156.6
Elkhorn, OR (2008)	1.07	0.06	61	101
Klondike II, OR (2005-2006)	0.504	0.06	50	75
Klondike IIIa (Phase II), OR (2008-2010)	NA	0.06	51	76.5
Combine Hills, OR (2011)	0.746	0.05	104	104
Biglow Canyon, OR (Phase III; 2010-2011)	0.318	0.05	76	174.8
Marengo II, WA (2009-2010)	NA	0.05	39	70.2
Windy Flats, WA (2010-2011)	NA	0.04	114	262.2
Pebble Springs, OR (2009-2010)	NA	0.04	47	98.7
Biglow Canyon, OR (Phase I; 2008)	0.318	0.03	76	125.4
Biglow Canyon, OR (Phase II; 2010-2011)	0.318	0.03	65	150
Nine Canyon, WA (2002-2003)	0.35	0.03	37	48.1
Hay Canyon, OR (2009-2010)	NA	0	48	100.8
Biglow Canyon, OR (Phase I; 2009)	0.318	0	76	125.4
Marengo I, WA (2009-2010)	NA	0	78	140.4
Klondike, OR (2002-2003)	0.504	0	16	24
Vansycle, OR (1999)	0.66	0	38	24.9
Combine Hills, OR (Phase I; 2004-2005)	0.746	0	41	41
California				
Montezuma I, CA (2011)	NA	1.06	16	36.8
Solano III, CA (2012-2013)	NA	0.95	55	128
Montezuma I, CA (2012)	NA	0.79	16	36.8
High Winds, CA (2003-2004)	2.337	0.5	90	162
Montezuma II, CA (2012-2013)	NA	0.46	34	78.2
Shiloh II, CA (2010-2011)	NA	0.44	75	150
Shiloh I, CA (2006-2009)	NA	0.42	100	150
Diablo Winds, CA (2005-2007)	2.161	0.4	31	20.46
High Winds, CA (2004-2005)	2.337	0.28	90	162
Alta I, CA (2011-2012)	0.19	0.27	100	150
Alite, CA (2009-2010)	NA	0.12	8	24
Shiloh II, CA (2009-2010)	NA	0.11	75	150
Mustang Hills, CA (2012-2013)	NA	0.08	50	150
Alta I-V, CA (2013-2014)	NA	0.08	290	720 (150 GE, 570 vestas)
Alta II-V, CA (2011-2012)	0.04	0.05	190	570
Alta VIII, CA (2012-2013)	NA	0.02	50	150
Dillon, CA (2008-2009)	NA	0	45	45

Appendix E2. 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
Southwest				
Dry Lake I, AZ (2009-2010)	0.13	0	30	63
Dry Lake II, AZ (2011-2012)	NA	0	31	65
Southern Plains				
Barton Chapel, TX (2009-2010)	NA	0.25	60	120
Buffalo Gap I, TX (2006)	NA	0.1	67	134
Red Hills, OK (2012-2013)	NA	0.04	82	123
Big Smile, OK (2012-2013)	NA	0	66	132
Buffalo Gap II, TX (2007-2008)	NA	0	155	233
Southeast				
Buffalo Mountain, TN (2000-2003)	NA	0	3	1.98
Buffalo Mountain, TN (2005)	NA	0	18	28.98
Northeast				
Munnsville, NY (2008)	NA	0.59	23	34.5
Noble Ellenburg, NY (2009)	NA	0.25	54	80
Noble Clinton, NY (2009)	NA	0.16	67	100
Noble Wethersfield, NY (2010)	NA	0.13	84	126
Noble Bliss, NY (2009)	NA	0.12	67	100
Noble Ellenburg, NY (2008)	NA	0.11	54	80
Noble Bliss, NY (2008)	NA	0.1	67	100
Noble Clinton, NY (2008)	NA	0.1	67	100
Mount Storm, WV (2010)	NA	0.1	132	264
Noble Chateaugay, NY (2010)	NA	0.08	71	106.5
Cohocton/Dutch Hills, NY (2010)	NA	0.08	50	125
Mountaineer, WV (2003)	NA	0.07	44	66
High Sheldon, NY (2010)	NA	0.06	75	112.5
Mount Storm, WV (2011)	NA	0.03	132	264
Maple Ridge, NY (2007-2008)	NA	0.03	195	321.75
Criterion, MD (2011)	NA	0.02	28	70
Beech Ridge, WV (2012)	NA	0.01	67	100.5
Beech Ridge, WV (2013)	NA	0.01	67	100.5
Locust Ridge, PA (Phase II; 2009)	NA	0	51	102
Locust Ridge, PA (Phase II; 2010)	NA	0	51	102
High Sheldon, NY (2011)	NA	0	75	112.5
Cohocton/Dutch Hill, NY (2009)	NA	0	50	125
Lempster, NH (2009)	NA	0	12	24
Lempster, NH (2010)	NA	0	12	24
Stetson Mountain II, ME (2010)	NA	0	17	25.5
Stetson Mountain II, ME (2012)	NA	0	17	25.5
Mount Storm, WV (2009)	NA	0	132	264
Casselman, PA (2009)	NA	0	23	34.5
Casselman, PA (2008)	NA	0	23	34.5
Mars Hill, ME (2007)	NA	0	28	42
Mars Hill, ME (2008)	NA	0	28	42
Pinnacle, WV (2012)	NA	0	23	55.2
Stetson Mountain I, ME (2011)	NA	0	38	57
Stetson Mountain I, ME (2009)	NA	0	38	57
Stetson Mountain I, ME (2013)	NA	0	38	57
Noble Altona, NY (2010)	NA	0	65	97.5
Munnsville, NY (2008)	NA	0.59	23	34.5
Noble Ellenburg, NY (2009)	NA	0.25	54	80

Appendix E2. 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
Noble Clinton, NY (2009)	NA	0.16	67	100
Noble Wethersfield, NY (2010)	NA	0.13	84	126
Noble Bliss, NY (2009)	NA	0.12	67	100
Noble Ellenburg, NY (2008)	NA	0.11	54	80
Noble Bliss, NY (2008)	NA	0.1	67	100
Noble Clinton, NY (2008)	NA	0.1	67	100
Mount Storm, WV (2010)	NA	0.1	132	264
Noble Chateaugay, NY (2010)	NA	0.08	71	106.5
Cohocton/Dutch Hills, NY (2010)	NA	0.08	50	125
Mountaineer, WV (2003)	NA	0.07	44	66
High Sheldon, NY (2010)	NA	0.06	75	112.5
Mount Storm, WV (2011)	NA	0.03	132	264
Maple Ridge, NY (2007-2008)	NA	0.03	195	321.75
Criterion, MD (2011)	NA	0.02	28	70
Beech Ridge, WV (2012)	NA	0.01	67	100.5
Beech Ridge, WV (2013)	NA	0.01	67	100.5
Locust Ridge, PA (Phase II; 2009)	NA	0	51	102
Locust Ridge, PA (Phase II; 2010)	NA	0	51	102
High Sheldon, NY (2011)	NA	0	75	112.5
Cohocton/Dutch Hill, NY (2009)	NA	0	50	125
Lempster, NH (2009)	NA	0	12	24
Lempster, NH (2010)	NA	0	12	24
Stetson Mountain II, ME (2010)	NA	0	17	25.5
Stetson Mountain II, ME (2012)	NA	0	17	25.5
Mount Storm, WV (2009)	NA	0	132	264
Casselman, PA (2009)	NA	0	23	34.5
Casselman, PA (2008)	NA	0	23	34.5
Mars Hill, ME (2007)	NA	0	28	42
Mars Hill, ME (2008)	NA	0	28	42
Pinnacle, WV (2012)	NA	0	23	55.2
Stetson Mountain I, ME (2011)	NA	0	38	57
Stetson Mountain I, ME (2009)	NA	0	38	57
Stetson Mountain I, ME (2013)	NA	0	38	57
Noble Altona, NY (2010)	NA	0	65	97.5

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

Appendix E2 (continued). Wind energy facilities in North America with publicly-available and comparable use and raptors.

Data from the following sources:

Project Name	Use Estimate	Fatality Estimate	Project Name	Use Estimate
Montezuma I, CA (2011)		ICF International 2012	Beech Ridge, WV (2012)	
Solano III, CA (2012-2013)		AECOM 2013	Beech Ridge, WV (2013)	
Montezuma I, CA (2012)		ICF International 2013	Locust Ridge, PA (Phase II; 2009)	
High Winds, CA (2003-2004)	Kerlinger et al. 2005	Kerlinger et al. 2006	Locust Ridge, PA (Phase II; 2010)	
Montezuma II, CA (2012-2013)		Harvey & Associates 2013	High Sheldon, NY (2011)	
Shiloh II, CA (2010-2011)		Kerlinger et al. 2013a	Cohocton/Dutch Hill, NY (2009)	
Shiloh I, CA (2006-2009)		Kerlinger et al. 2009	Lempster, NH (2009)	
Diablo Winds, CA (2005-2007)	WEST 2006	WEST 2006, 2008	Lempster, NH (2010)	
High Winds, CA (2004-2005)		Kerlinger et al. 2006	Stetson Mountain II, ME (2010)	
Alta I, CA (2011-2012)	Erickson et al. 2009	Chatfield et al. 2012	Stetson Mountain II, ME (2012)	
Alite, CA (2009-2010)		Chatfield et al. 2010b	Mount Storm, WV (2009)	
Shiloh II, CA (2009-2010)		Kerlinger et al. 2010	Casselman, PA (2009)	
Mustang Hills, CA (2012-2013)		Chatfield and Bay 2014	Casselman, PA (2008)	
Alta I-V, CA (2013-2014)		Chatfield et al. 2014	Mars Hill, ME (2007)	
Alta II-V, CA (2011-2012)	Erickson et al. 2009	Chatfield et al. 2012	Mars Hill, ME (2008)	
Alta VIII, CA (2012-2013)		Chatfield and Bay 2014	Pinnacle, WV (2012)	
Dillon, CA (2008-2009)		Chatfield et al. 2009	Stetson Mountain I, ME (2011)	
Buffalo Ridge, MN (Phase I; 1999)		Johnson et al. 2000b	Stetson Mountain I, ME (2009)	
Moraine II, MN (2009)		Derby et al. 2010d	Stetson Mountain I, ME (2013)	
Winnebago, IA (2009-2010)		Derby et al. 2010e	Noble Altona, NY (2010)	
Buffalo Ridge I, SD (2009-2010)		Derby et al. 2010b	White Creek, WA (2007-2011)	
Cedar Ridge, WI (2009)		BHE Environmental 2010	Tuolumne (Windy Point I), WA (2009-2010)	Johnson et al. 2006
PrairieWinds SD1, SD (2013-2014)		Derby et al. 2014	Vantage, WA (2010-2011)	
Top of Iowa, IA (2004)		Jain 2005	Linden Ranch, WA (2010-2011)	
Cedar Ridge, WI (2010)		BHE Environmental 2011	Harvest Wind, WA (2010-2012)	
Ripley, Ont (2008)		Jacques Whitford 2009	Goodnoe, WA (2009-2010)	
Wessington Springs, SD (2010)	Derby et al. 2008	Derby et al. 2011d	Leaning Juniper, OR (2006-2008)	Kronner et al. 2005
Rugby, ND (2010-2011)		Derby et al. 2011b	Klondike III (Phase I), OR (2007-2009)	
NPPD Ainsworth, NE (2006)		Derby et al. 2007	Hopkins Ridge, WA (2006)	Young et al. 2003a
Wessington Springs, SD (2009)	Derby et al. 2008	Derby et al. 2010f	Biglow Canyon, OR (Phase II; 2009-2010)	WEST 2005c
PrairieWinds ND1 (Minot), ND (2011)		Derby et al. 2012c	Big Horn, WA (2006-2007)	Johnson and Erickson 2004
PrairieWinds ND1 (Minot), ND (2010)		Derby et al. 2011c	Stateline, OR/WA (2006)	Erickson et al. 2003a
PrairieWinds SD1, SD (2012-2013)		Derby et al. 2013a	Kittitas Valley, WA (2011-2012)	
Elm Creek, MN (2009-2010)		Derby et al. 2010c	Wild Horse, WA (2007)	Erickson et al. 2003d
Rail Splitter, IL (2012-2013)		Good et al. 2013b	Stateline, OR/WA (2001-2002)	Erickson et al. 2003a
Pioneer Prairie II, IA (2011-2012)		Chodachek et al. 2012	Stateline, OR/WA (2003)	Erickson et al. 2003a
Buffalo Ridge, MN (Phase III; 1999)		Johnson et al. 2000b	Elkhorn, OR (2010)	WEST 2005a
Buffalo Ridge, MN (Phase II; 1998)		Johnson et al. 2000b	Hopkins Ridge, WA (2008)	Young et al. 2003a
Buffalo Ridge, MN (Phase II; 1999)		Johnson et al. 2000b	Elkhorn, OR (2008)	WEST 2005a
Blue Sky Green Field, WI (2008; 2009)		Gruver et al. 2009	Klondike II, OR (2005-2006)	Johnson et al. 2002a
Elm Creek II, MN (2011-2012)		Derby et al. 2012b	Klondike IIIa (Phase II), OR (2008-2010)	
Barton I & II, IA (2010-2011)		Derby et al. 2011a	Combine Hills, OR (2011)	Young et al. 2003d
PrairieWinds SD1, SD (2011-2012)		Derby et al. 2012d	Biglow Canyon, OR (Phase III; 2010-2011)	WEST 2005c
Kewaunee County, WI (1999-2001)		Howe et al. 2002	Marengo II, WA (2009-2010)	
Buffalo Ridge II, SD (2011-2012)		Derby et al. 2012a	Windy Flats, WA (2010-2011)	

Appendix E2 (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 Estimate	Fatality Estimate	Project Name	Use Estimate	Fatality Estimate
Buffalo Ridge, MN (Phase I; 1996)		Johnson et al. 2000b	Pebble Springs, OR (2009-2010)		Gritski and Kronner 2010b
Buffalo Ridge, MN (Phase I; 1997)		Johnson et al. 2000b	Biglow Canyon, OR (Phase I; 2008)	WEST 2005c	Jeffrey et al. 2009a
Buffalo Ridge, MN (Phase I; 1998)		Johnson et al. 2000b	Biglow Canyon, OR (Phase II; 2010-2011)	WEST 2005c	Enk et al. 2011a
Fowler I, IN (2009)		Johnson et al. 2010	Nine Canyon, WA (2002-2003)	Erickson et al. 2001b	Erickson et al. 2003c
Big Blue, MN (2013)		Fagen Engineering 2014	Hay Canyon, OR (2009-2010)		Gritski and Kronner 2010a
Big Blue, MN (2014)		Fagen Engineering 2015	Biglow Canyon, OR (Phase I; 2009)	WEST 2005c	Enk et al. 2010
Top of Iowa, IA (2003)		Jain 2005	Marengo I, WA (2009-2010)		URS Corporation 2010b
Grand Ridge I, IL (2009-2010)	Derby et al. 2009	Derby et al. 2010g	Klondike, OR (2002-2003)	Johnson et al. 2002a	Johnson et al. 2003
Munnsville, NY (2008)		Stantec 2009b	Vansycle, OR (1999)	WCIA and WEST 1997	Erickson et al. 2000
Noble Ellenburg, NY (2009)		Jain et al. 2010c	Combine Hills, OR (Phase I; 2004-2005)	Young et al. 2003d	Young et al. 2006a
Noble Clinton, NY (2009)		Jain et al. 2010b	Summerview, Alb (2005-2006)		Brown and Hamilton 2006
Noble Wethersfield, NY (2010)		Jain et al. 2011a	Foote Creek Rim, WY (Phase I; 1999)	Johnson et al. 2000c	Young et al. 2003c
Noble Bliss, NY (2009)		Jain et al. 2010a	Foote Creek Rim, WY (Phase I; 2000)	Johnson et al. 2000c	Young et al. 2003c, 2003e
Noble Ellenburg, NY (2008)		Jain et al. 2009b	Milford I & II, UT (2011-2012)		Stantec 2012
Noble Bliss, NY (2008)		Jain et al. 2009e	Foote Creek Rim, WY (Phase I; 2001-2002)		Derby et al. 2012b
Noble Clinton, NY (2008)		Jain et al. 2009c	Buffalo Mountain, TN (2000-2003)		Nicholson et al. 2005
Mount Storm, WV (2010)		Young et al. 2010a, 2011b	Buffalo Mountain, TN (2005)		Fiedler et al. 2007
Noble Chateaugay, NY (2010)		Jain et al. 2011c	Barton Chapel, TX (2009-2010)		WEST 2011
Cohocton/Dutch Hills, NY (2010)		Stantec 2011a	Buffalo Gap I, TX (2006)		Tierney 2007
Mountaineer, WV (2003)		Kerns and Kerlinger 2004	Red Hills, OK (2012-2013)		Derby et al. 2013c
High Sheldon, NY (2010)		Tidhar et al. 2012a	Big Smile, OK (2012-2013)	Derby et al. 2010a	Derby et al. 2013b
Mount Storm, WV (2011)		Young et al. 2010a, 2011b	Buffalo Gap II, TX (2007-2008)		Tierney 2009
Maple Ridge, NY (2007-2008)		Jain et al. 2009d	Dry Lake I, AZ (2009-2010)	Thompson et al. 2011	Thompson et al. 2011
Criterion, MD (2011)		Young et al. 2012a	Dry Lake II, AZ (2011-2012)		Thompson and Bay 2012