Appendix D. Bird and Bat Conservation Strategy for the North Bend Wind Farm

Draft Bird and Bat Conservation Strategy
North Bend Wind Project
Hyde and Hughes Counties, South Dakota

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1.0 INTRODUCTION

1.1 Background and Purpose

Although wind energy facilities utilize a renewable-energy resource, potential impacts to birds and bats may result from their construction and operation. Interactions with wind turbines and the associated infrastructure such as energy transmission, distribution, and substations have been found to result in fatalities or indirect effects, including displacement and habitat loss. To address these concerns, North Bend Wind Project, LLC (North Bend), contracted Western EcoSystems Technology, Inc. (WEST) to develop this site-specific Bird and Bat Conservation Strategy (BBCS) for the North Bend Wind Project (Project) in Hyde and Hughes counties, South Dakota. This BBCS outlines various processes North Bend has employed and/or will employ to: 1) comply with all state and federal avian and bat conservation and protection laws and regulations applicable to the Project; 2) ensure effects to avian and bat resources are identified, quantified, and analyzed; and 3) avoid, minimize, and mitigate potential effects consistent with the US Fish and Wildlife Service (USFWS) *Land-based Wind Energy Guidelines* (WEG; USFWS 2012).

Federal laws and regulations protect most birds found in and around the Project area, including the Migratory Bird Treaty Act of 1918 (MBTA), the Bald and Golden Eagle Protection Act of 1940 (BGEPA), and the federal Endangered Species Act of 1973 (ESA). The purpose of the BBCS is to meet the intent of these regulations and guidelines by reducing and managing the risk to avian and bat species. This BBCS has been voluntarily prepared as a good faith effort by North Bend to proactively address potential impacts to birds and bats resulting from the construction and operation of the Project.

1.2 Objectives

North Bend developed this BBCS to meet the following objectives:

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

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

2.0 SITE AND PROJECT DESCRIPTION

The Project area is in Hughes and Hyde counties, South Dakota, approximately 6 kilometers (km; 4 miles [mi]) south of Harrold, South Dakota. This area is within the intersection of the Northwestern Great Plains Level III Ecoregions (US Environmental Protection Agency [USEPA] 2013) and the Bird Conservation Region (BCR 11; Prairie Potholes [US North American Bird Conservation Initiative 2021]; Figure 2.1). The Northwestern Glaciated Plains ecoregion has broad surface irregularity and dense concentrations of wetlands. In contrast, this area along the Southern Missouri Coteau exhibits a topography of gentle, rolling hills rather than steep hummocks, with fewer areas of high wetland density, and more stream erosion (USEPA 2013) much of which has been converted to cultivated crops. The river breaks landform is also common near riparian areas and consists of uplands with broken terraces that descend to the Missouri River and its major tributaries.

The topography within the Project area consists of rolling hills, with elevations ranging from 548.5–653.8 meters (m; 1,800.0–2,145.0 feet [ft]) above mean sea level (US Geological Survey [USGS] 2021). Land ownership within the Project area is primarily private, with a few scattered State Resource Management Areas (USGS Protected Areas Database of the US 2019) one of which fall within the Project area (Figure 2.2). Named creeks in the Project area are Chapelle Creek and South Chapelle Creek (Figure 2.2; USGS 2019). Wetlands are dispersed throughout the Project area, but most are in the northeastern portion of the Project area (Figure 2.2; USFWS National Wetlands Inventory [NWI] 2021). Most wetlands are herbaceous wetlands, followed by open water (i.e., freshwater pond, and lakes; Table 2.1).

Land cover types were digitized using ArcGIS (version 10.4) within the current Project area. Using US Department of Agriculture (USDA) National Agriculture Imagery Program (NAIP [USDA 2019]) aerial imagery in combination with 2011 South Dakota Land Cover Patterns (National Land Cover Database (NLCD; 2016), USDA National Agricultural Statistics Service (NASS) National Cropland Layer (USDA NASS 2018) cropland classification, and field inspections, all lands within the current Project area were digitized and assigned one of eight cover types (Table 2.1). NWI data were used to represent water for the purpose of mapping within the current Project area. Water features visible on the aerial imagery, but not located in the NWI data tables, were digitized as "Wetland/Water" on the map (Figure 2.2).

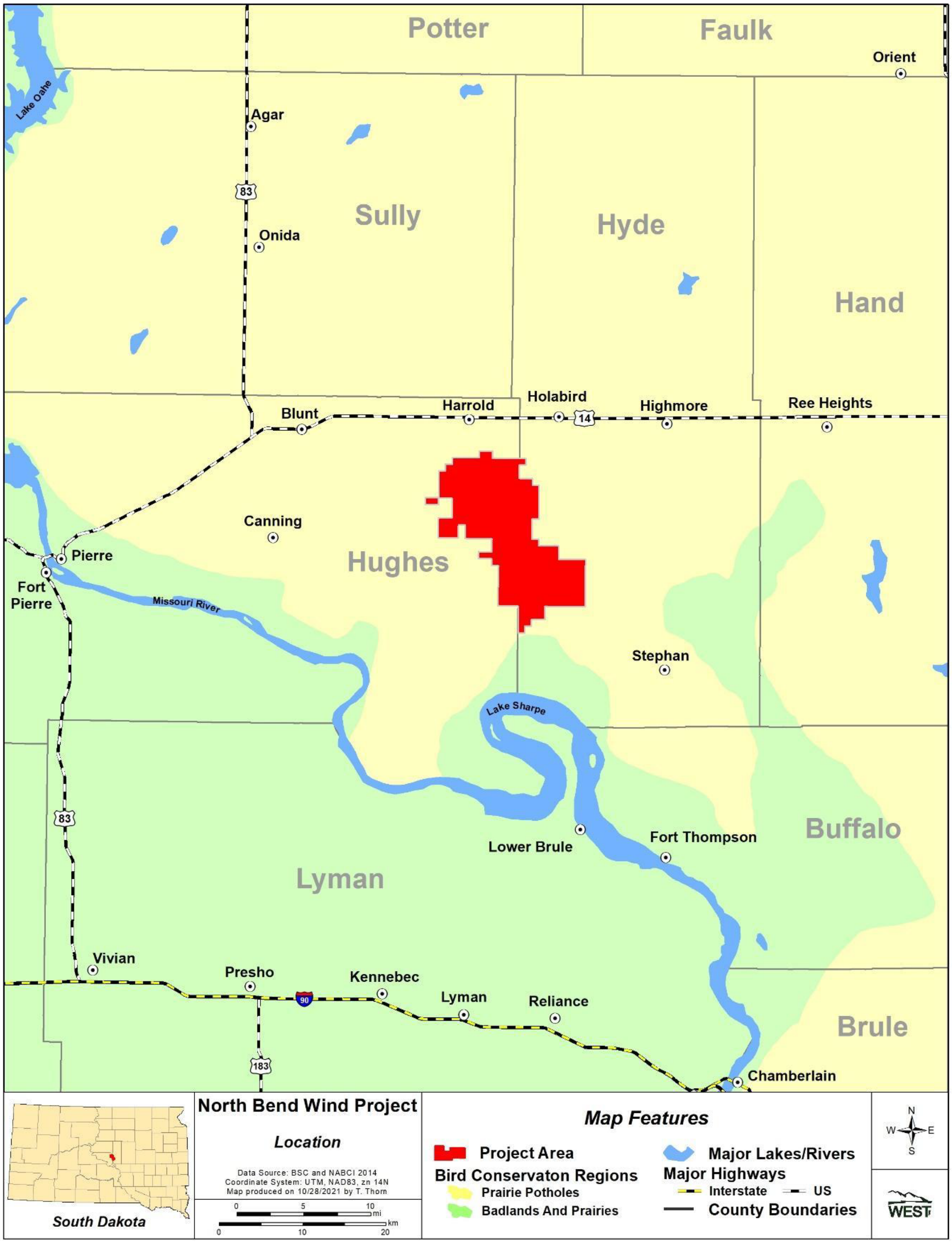

Figure 2.1. Project overview of the North Bend Wind Project in Hyde and Hughes counties, South Dakota. Shaded regions indicate Bird Conservation Regions 11 (Prairie Potholes) and 17 (Badlands and Prairies).

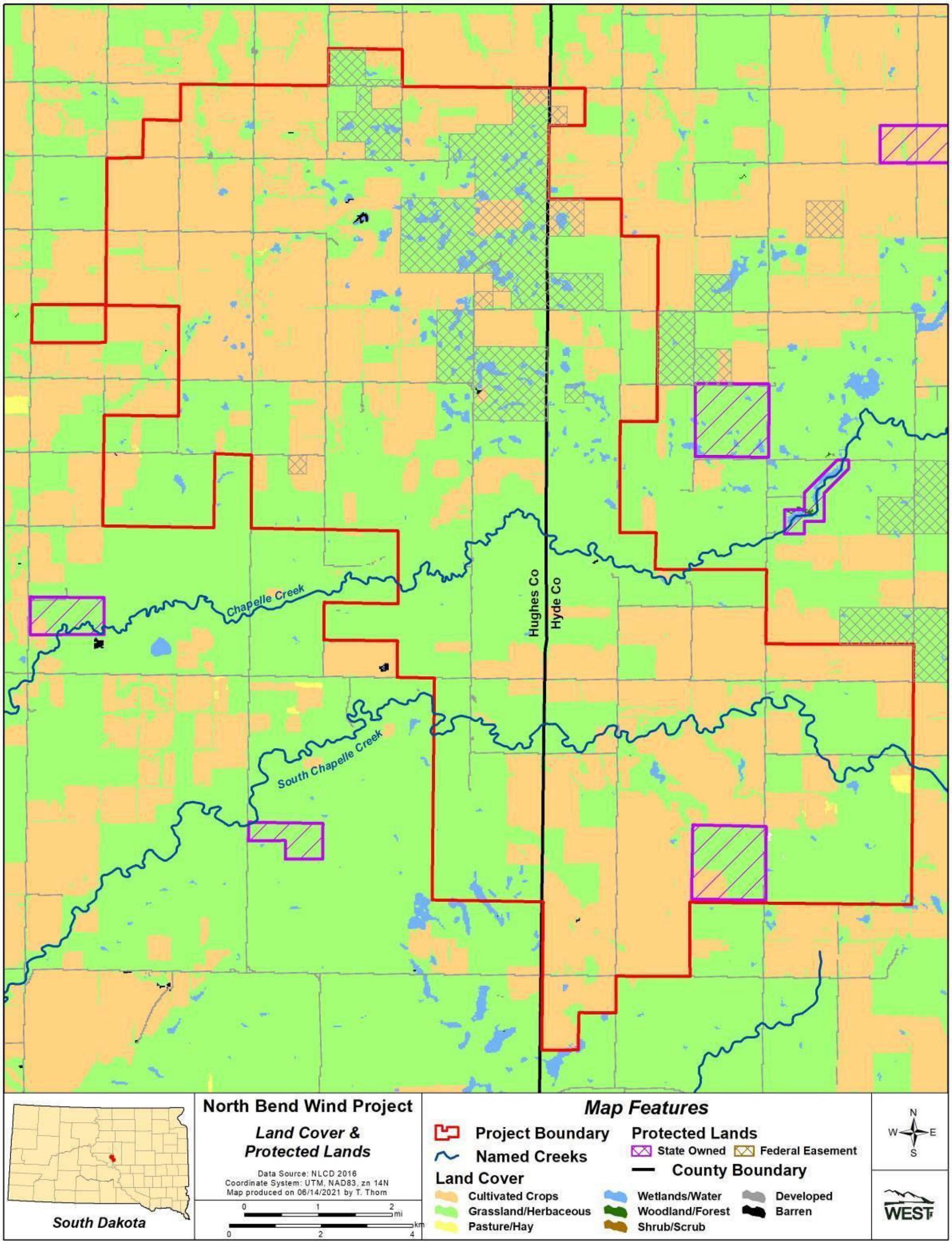

Figure 2.2. Digitized land cover within the current North Bend Wind Project in Hyde and Hughes counties, South Dakota.

Table 2.1. Land cover, coverage, and percent (%) composition within the North Bend Wind Project, Hughes and Hyde counties, South Dakota.

Land Cover	Coverage (Hectares)	% Composition
Herbaceous	9,846.3	51.9
Cultivated crops	8,334.6	43.9
Developed	389.7	2.1
Herbaceous wetlands	347.7	1.8
Open water	29.1	0.2
Hay/Pasture	22.9	0.1
Barren land	6.6	<0.1
Shrub/Scrub	1.8	<0.1
Total	**18,978.7**	**100**

Source: National Land Cover Database (2016).

The dominant land cover type within the current Project area is herbaceous, representing 51.9% of the land cover (9,846.3 ha [24,330.7 ac]) followed by cultivated crops (43.9%; 8,334.6 ha [20,595.2 ac]; Table 2.1, Figure 2.2). Additional land cover types included developed (2.1%; 389.7 ha [963.0 ac]), followed by herbaceous wetlands (1.8%; 347.7 ha [859.1 ac]). All remaining land cover types in the Project area were less than 0.5% collectively (Table 2.1).

3.0 REGULATORY REQUIREMENTS RELEVANT TO THIS BIRD AND BAT CONSERVATION STRATEGY

3.1 Federal Endangered Species Act

Species at risk of extinction are protected under the federal ESA, as amended (16 US Code [USC] 1531 *et seq*. [1973]). The purpose of the ESA is to protect threatened and endangered species and to provide a means to conserve their habitats. Take under the ESA is defined as "…to harass, harm, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct." (ESA Section 3(19), 16 USC 1532(19) [1973]). Harm is defined as an act which injures or kills a wildlife species, including significant habitat modification or degradation; whereas harass is defined as an intentional or negligent act or omission which creates the likelihood of injury by annoying the animal to the extent it significantly disrupts normal behavior patterns, such as breeding, feeding, or sheltering. The ESA authorizes the USFWS to issue permits for "incidental take" of some wildlife species, which is take resulting from an otherwise lawful activity.

3.2 Migratory Bird Treaty Act

The MBTA integrates and implements four international treaties that provide for the protection of migratory birds. The MBTA prohibits the "…taking, killing, possession, transportation, import and export of migratory birds, their eggs, parts, and nests, except when specifically authorized by the Department of the Interior." (16 USC 703 [1918]). The word "take" is defined by regulation as "to pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to pursue, hunt, shoot, wound, kill, trap, capture, or collect." (50 Code of Federal Regulations [CFR] 10.12 [1973]). The USFWS maintains a list of all species protected by the MBTA at 50 CFR 10.13 (1973). This list includes over 1,000 species of migratory birds, including eagles and other raptors, waterfowl, shorebirds, seabirds, wading birds, and passerines.

On October 4, 2021, the Department of the Interior's (USDOI) USFWS published the final rule (86 Federal Register [FR] 54642) in the FR to revoke the January 7, 2021 (86 FR 1134), Solicitor's Office Opinion M-37050 (M-Opinion), which codified the Solicitor's Office memorandum opinion release in December 22, 2017 (see USDOI 2017). The M-Opinion determined that the legal scope of the MBTA applies only to intentional take of migratory birds and concluded that the incidental take of birds resulting from an otherwise lawful activity is not prohibited. The recent ruling (October 4, 2021) to revoke the M-Opinion will become effective December 3, 2021. The result of this rule will return implementation of the MBTA, prohibiting incidental take and applying enforcement discretion, to previous agency practices prior to the 2017 M-Opinion. This is consistent with the Department of Energy commitments under Executive Order 13186 (2001).

3.3 Bald and Golden Eagle Protection Act

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

In September 2009, the USFWS promulgated a final rule on two new permit regulations that specifically authorize under the BGEPA the non-purposeful (i.e., incidental) take of eagles and eagle nests in certain situations (50 CFR 22.26 [2009] and 22.27 [2009]). Revisions to the final rule were issued on December 16, 2016 (81 FR 91494). The permits authorize limited take of bald and golden eagles; authorizing individuals, companies, government agencies and other organizations to disturb or otherwise take eagles in the course of conducting lawful activities. To facilitate issuance of Eagle Take Permits (ETPs) for wind energy facilities, the USFWS finalized the *Eagle Conservation Plan Guidance - Module 1 - Land-based Wind Energy Version 2* (ECPG; USFWS 2013). If eagles are identified as a potential risk at a project site, developers are encouraged to follow the ECPG. The ECPG describes specific actions that are recommended to achieve compliance with the regulatory requirements in the BGEPA for an ETP, as described in 50 CFR 22.26 (2009) and 22.27 (2009). The ECPG provides a national framework for assessing and mitigating risk specific to eagles through development of Eagle Conservation Plans and issuance of programmatic ETPs for eagles at wind facilities.

3.4 South Dakota Game, Fish, and Parks Siting Guidelines for Wind Power in South Dakota

The *Siting Guidelines for Wind Power Projects in South Dakota* address activities and concerns associated with siting and permitting wind turbines in South Dakota. The guidelines highlight the Missouri Coteau in central South Dakota, where the Project area is located, and the Coteau des Prairies in eastern South Dakota, as areas identified as potential sites for wind development in

South Dakota. These guidelines also contain contact information for state agencies, wildlife experts and universities, interest groups, and local resource management agencies (South Dakota Game, Fish and Parks [SDGFP] 2009).

4.0 AGENCY CONSULTATION

The WEG strongly encourages energy developers to coordinate with agencies to obtain information on bird, bat, or other wildlife issues within a project area and vicinity. Agencies can help developers identify potential biological resource issues early in the development process. Bird and bat baseline studies were designed in accordance with the WEG.

5.0 AVIAN AND BAT RESOURCES: TIERS 1–3

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

5.1 Tiers 1 and 2 – Preliminary Site Evaluation and Characterization

As described in the WEG, Tiers 1 and 2 provide a framework for evaluating potential issues that may need to be addressed before further actions can be taken relative to the development or operations of the Project. The objective of the Tier 1 study is to assist the developer in further identifying a potential wind energy site. Tier 1 studies provide a preliminary desktop evaluation or screening of public data from federal, state, and tribal entities, and offer early guidance about the sensitivity of the site in regards to flora and fauna. The objective of Tier 2 studies is to determine potential effects of the proposed project on any federal- and state-listed sensitive species. Tier 2 studies typically include a more substantive review of existing information, including publicly available data on land use and land cover, topography, wetland data, wildlife, habitat, and sensitive plant distribution, a reconnaissance-level site visit (to confirm presence of habitat types), and contacting the agencies involved.

5.1.1 Site Characterization Study

In 2016, a Site Characterization Study was conducted by WEST to address the recommendations of a Tier 2 study described in the WEG (Appendix A). This study described potentially sensitive habitats and other protected lands and associated wildlife. Three identified protected lands were all contained outside of the Project area. A review of federally protected species identified nine species that could potentially occur within the Project and included 1 mammal (northern long-eared bat [*Myotis septentrionalis*];

NLEB), 7 birds (Table 5.1), and 1 fish (pallid sturgeon [*Scaphirhynchus albus*]). Although occurrence of these species is generally unknown, these species are likely not to occur often due to limited habitat, landscape features, and no to scarce previous observations from publicly available data.

Table 5.1. Bird species listed as state or federally threatened, endangered, or protected by the Bald and Golden Eagle Protection Act with the potential to occur at the North Bend Wind Project, Hyde and Hughes counties, South Dakota.

Common Name	Scientific Name	Status
bald eagle	*Haliaeetus leucocephalus*	BGEPA
golden eagle	*Aquila chrysaetos*	BGEPA
least tern[1]	*Sterna antillarum*	DL, SE
piping plover	*Charadrius melodus*	FT, ST
whooping crane	*Grus americana*	FE, SE
rufa red knot	*Calidris canutus rufa*	FT
Sprague's pipit	*Anthus spragueii*	FC

BGEPA = Bald and Golden Eagle Protection Act (1940), FE = Federally endangered (US Fish and Wildlife Service [USFWS] 2021d), FT = Federally threatened (USFWS 2021d), FC = Federal candidate (USFWS 2021d), DL = Delisted (USFWS 2021c, 2021d), SE = State endangered (South Dakota Game, Fish and Parks [SDGFP] 2016), ST = State threatened (SDGFP 2016).

[1] Delisted as of February 12, 2021 (USFWS 2021c, 2021d).

Additionally, a Habitat Characterization Study (HCS) was conducted by WEST in 2016, which focused on land cover within the Project area (Appendix B). The HCS quantified habitat types into five general habitat categories in the Project area, which included areas in Hughes and Hyde counties, South Dakota. The review comprised 2014 USDA NAIP aerial imagery in combination with 2011 South Dakota Land Cover Patterns (NLCD 2011), 2015 USDA National Agricultural Statistics Service cropland classification data, and field inspections. USFWS NWI (2016) data were used to represent water features within the study area. Water features visible on aerial imagery, but not in the NWI database, were digitized as "water" habitat.

Additional desktop reviews were conducted by WEST prior to Tier 3 studies and during the drafting of this BBCS to address insufficient information and changes made to the Project boundary over the development of the Project. Table 5.1 provides a list of species protected under the state's endangered species law, federal ESA and BGEPA potentially occurring in Hyde and Hughes counties. In addition, USFWS Birds of Conservation Concern (BCC; USFWS 2021a) with the potential to occur in Hyde and Hughes county are listed in Table 5.2. A list of bat species with the potential to occur in Hyde and Hughes counties, including the federally threatened NLEB, (SDGFP 2016, USFWS 2021d), is presented in Table 5.3.

Table 5.2. US Fish and Wildlife Service Birds of Conservation Concern potentially occurring at the North Bend Wind Project, Hyde and Hughes counties, South Dakota.

Common Name	Scientific Name
American golden-plover	*Pluvialis dominica*
black tern[1]	*Chlidonias niger*
black-billed cuckoo	*Coccyzus erythropthalmus*
bobolink[1]	*Dolichonyx oryzivorus*
chestnut-collared longspur[1]	*Calcarius ornatus*
Franklin's gull[1]	*Leucophaeus pipixcan*
golden eagle[1]	*Aquila chrysaetos*

Table 5.2. US Fish and Wildlife Service Birds of Conservation Concern potentially occurring at the North Bend Wind Project, Hyde and Hughes counties, South Dakota.

Common Name	Scientific Name
grasshopper sparrow[1]	*Ammodramus savannarum*
greater prairie-chicken[1]	*Tympanuchus cupido*
Hudsonian godwit	*Limosa haemastica*
lesser yellowlegs	*Tringa flavipes*
marbled godwit[1]	*Limosa fedoa*
northern harrier[1]	*Circus hudsonius*
red-headed woodpecker[1]	*Melanerpes erythrocephalus*
semipalmated sandpiper	*Calidris pusilla*
willet[1]	*Tringa semipalmata*

[1] Observed during site-specific avian studies

Table 5.3. Bat species potentially occurring at the North Bend Wind Project, Hyde and Hughes counties, South Dakota[1].

Common Name	Scientific Name
big brown bat	*Eptesicus fuscus*
little brown bat	*Myotis lucifugus*
long-legged bat	*Myotis volans*
northern long-eared bat	*Myotis septentrionalis*[2]
Townsend's big-eared bat	*Corynorhinus townsendii*
western small-footed bat	*Myotis ciliolabrum*
eastern red bat	*Lasiurus borealis*
hoary bat	*Lasiurus cinereus*
silver-haired bat	*Lasionycteris noctivagans*
evening bat	*Nycticeius humeralis*

Source:

[1.] Listed in the South Dakota Bat Management Plan (South Dakota Bat Working Group 2004)

[2] Federally listed species (US Fish and Wildlife Service 2021d)

5.1.2 Whooping Crane Stopover Habitat Assessment

From the most recent telemetry data available (2009 through 2018) and confirmed whooping (*Grus americana*) crane sightings managed by USFWS (to include data from spring 2021), there have been two detections of whooping crane within the Project area (Pearse et al. 2020, USFWS 2021b; Figure 5.1). The first was in 1997 of four adult birds visually identified along the northwestern portion of the Project. The second was of an individual radio-tagged bird in 2011 in the northeastern portion of the Project area.

A desktop review and analysis of potential whooping crane stopover habitat within and adjacent to the Project was conducted in 2018 using The Watershed Institute model (TWI 2012; Figure 5.2; Appendix C) and updated in 2021 using the Niemuth model (Niemuth et al. 2018; Appendix N). The federally endangered whooping crane migrates through South Dakota to breeding grounds in Canada and wintering grounds in Texas along the Gulf of Mexico (Canadian Wildlife Service [CWS] and USFWS 2007). The entire Project area is contained within the 50th percentile of all sightings along the migration corridor (Niemuth et al. 2018, Pearse et al. 2018).

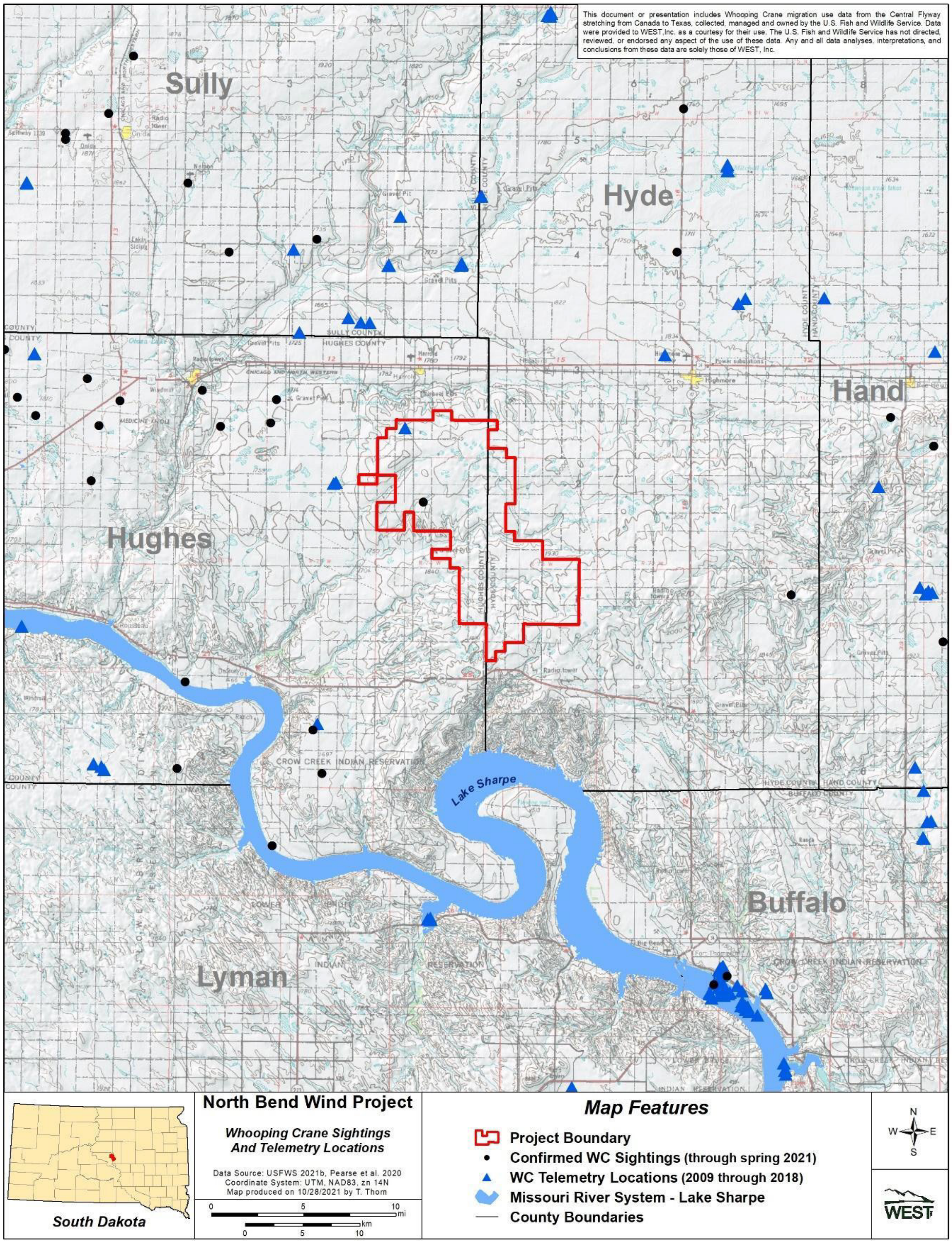

Figure 5.1. Whooping crane sighting (circles; US Fish and Wildlife Service 2021b) and telemetry locations (triangles; Pearse et al. 2020) in and within the vicinity of the North Bend Wind Project, Hyde and Hughes counties, South Dakota.

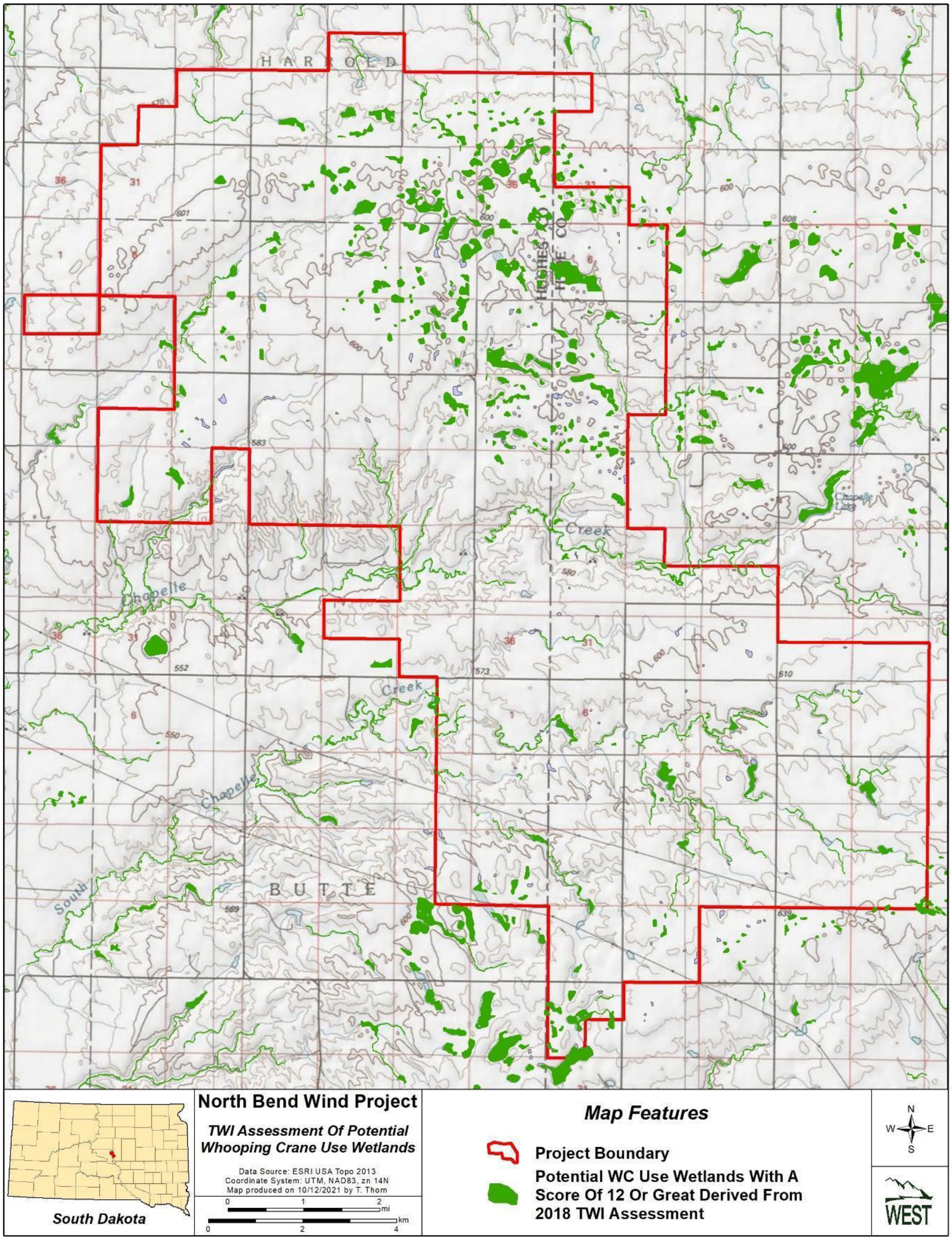

Figure 5.2. Map of wetlands scored using the The Watershed Institute (TWI) method in 2018 for the current North Bend Wind Project, Hyde and Hughes counties, South Dakota.

Potential stopover habitat for whooping cranes was initially evaluated using a model developed by The Watershed Institute (TWI 2012). The TWI habitat assessment model is a quantitative and easily replicated desktop approach to evaluating the quantity, quality, and locations of potential whooping crane stopover habitat in an area. The model is based on available data for water regime, water depth, visibility obstructions, wetland size, disturbance, and proximity to feeding areas, which are all factors shown to affect how whooping cranes choose stopover habitat. The initial goal of the TWI model was to provide electric utilities with a tool for making power line-marking decisions, but the USFWS stated in a personal communication (D. Mulhern, USFWS [retired], November 19, 2012) that the model should also be applicable to wind power development areas for the identification of potential whooping crane stopover habitat. The desktop evaluation of potential whooping crane stopover habitat using the TWI model included the current Project area and immediately adjacent lands (Figure 5.2). High-scoring features (12+; considered suitable stopover habitat by TWI analysis) throughout the Project area are depicted in Figure 5.2. High-scoring features occur both within the Project area and in the immediately adjacent landscape.

Since the initial review of potentially suitable migratory stopover habitat in 2018, USFWS has recommended the use of new models and available information, including a landscape-scale approach to whooping crane use areas (Pearse Model; Pearse et al. 2015), a predicted whooping crane use model (Niemuth Model; Niemuth et al. 2018), and an evaluation of NWI wetlands within the five highest use deciles (deciles 6 – 10), as described in Niemuth et al. (2018) and recommended by Western Area Power Administration (WAPA; January 5, 2023.)

Using a grid-based approach, the Pearse Model used telemetry data from 58 whooping cranes over five years. The grid was created using 20-square-km (7-square-mi) grid cells across the extent of stopover sites used by whooping cranes. By using the telemetry data, stopover sites were assessed for each grid cell and later categories into four groups: unoccupied, low intensity, core intensity, and extended-core intensity. These categories were based on the density of stopover sites and the time whooping crane spent in that area. This model extends across the entire migration corridor and provides general trend information. Overlaying the USGS site use intensity data with the current Project indicates that the Project is located in an area with three unoccupied grid cells and one low-intensity use grid cell that spans approximately half the Project area (Figure 5.3).

The Niemuth Model was developed using 13 variables to identify whooping crane probability of use across the landscape in North and South Dakota, such as habitat attributes, survey effort, and distance from the center of the migration corridor. To aid in conservation planning, the Niemuth model then divided the probability dataset into 10 equal-area bins, or deciles, with the lowest probability use areas in the lower bins, and the higher probability use areas in the higher bins (Niemuth et al. 2018)[1]. This model was then validated by analyzing the frequency of use against the probability of use based on location data from 46 radio-tagged individuals. The performance of the Niemuth model from whooping crane sightings was adequately validated by

[1] Niemuth et al. (2018) decile data is displayed in reverse order from the published paper. As displayed in Figure 5.5, deciles 5 – 10 are the deciles with the highest probability of use by whooping cranes based on the model

the telemetry data, where the highest three deciles of probability of use (based on habitat) contained 89% of documented whooping cranes. In the Project area, the relative probability of whooping crane use ranged from 0.009 to 0.257 on a probability scale of 0–1.0 (Figure 5.4; see also Appendix N). These values fall within the highest five deciles of probability of use (Niemuth et al. 2018).

In general, potential stopover habitat within the Project area has no to low intensity use within the migration corridor, since nearly half the Project area contains unoccupied grid cells (Pearse et al. 2015; Figure 5.3) and the highest relative probability of use is only 0.257 out of 1.0 (Niemuth et al. 2018; Figure 5.4). However, much of the Project area falls within the highest use deciles (Niemuth et al. 2018; Figure 5.5). Additionally, there have been two whooping cranes documented within the Project area either by telemetry or from sightings (Figure 5.1). To satisfy the conservation requirements of the Programmatic Environmental Impact Statement and Biological Assessment for the Upper Great Plains, the Project will provide conservation funds for the 1,310.8 ac of wetlands within 0.5 mi of proposed turbine locations since they all fall within the five highest whooping crane use deciles (Niemuth et al. 2018; Figure 5.5).

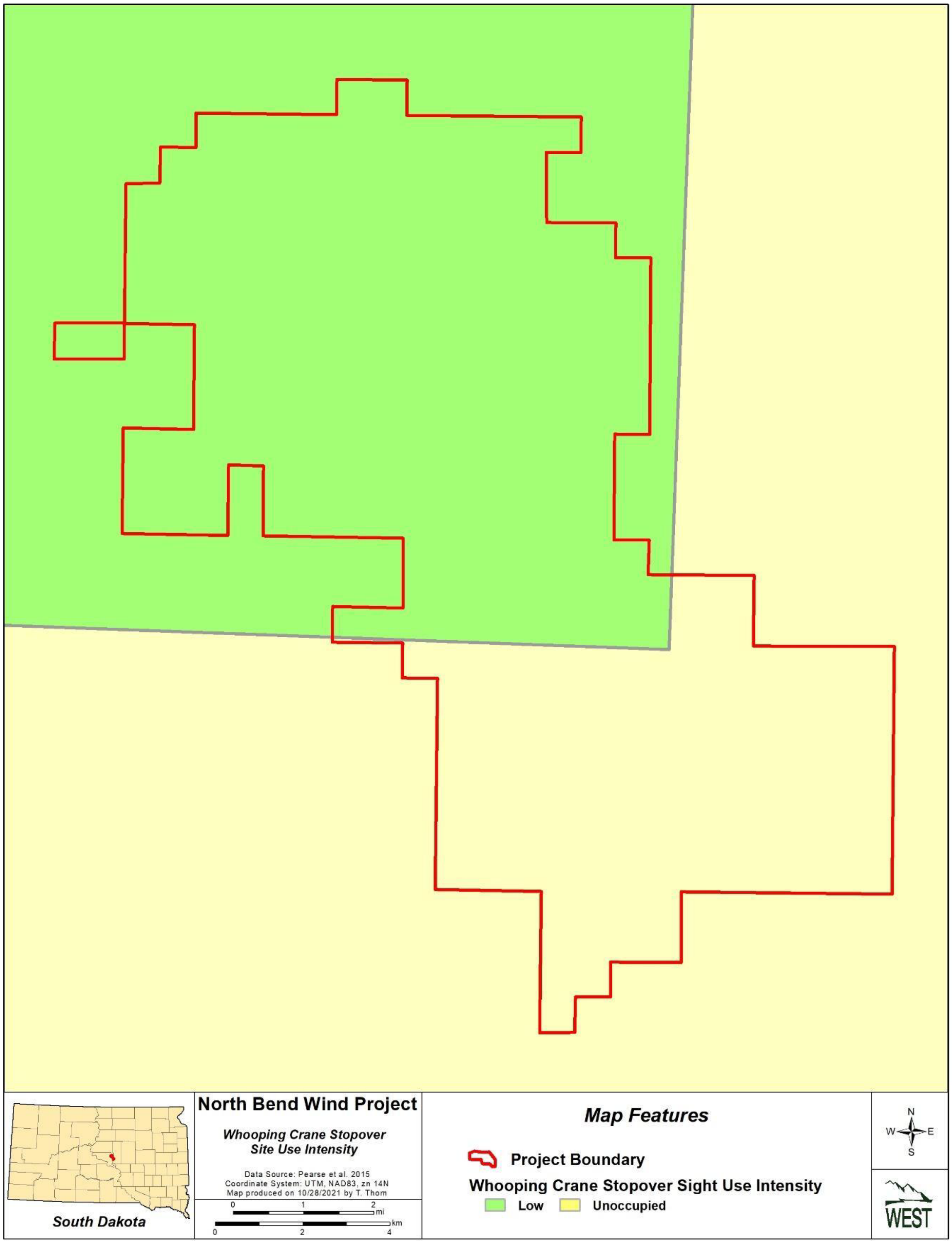

Figure 5.3. Pearse et al. (2015) whooping crane stopover sight use intensity map of the North Bend Wind Project, Hyde and Hughes counties, South Dakota.

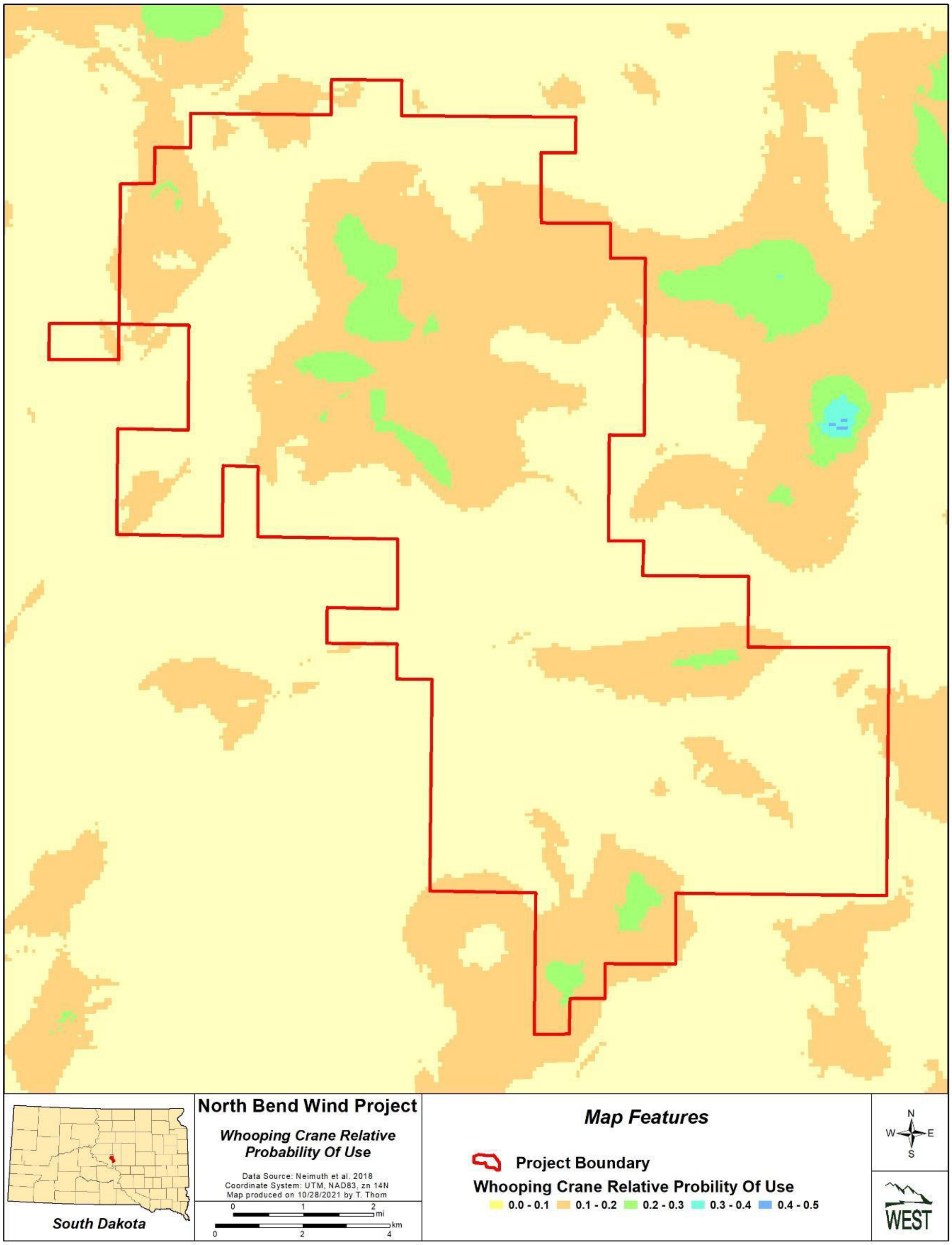

Figure 5.4. Niemuth et al. (2018) relative probability of whooping crane use map, North Bend Wind Project, Hyde and Hughes counties, South Dakota. Probability of use above 0.5 is not visible at this scale.

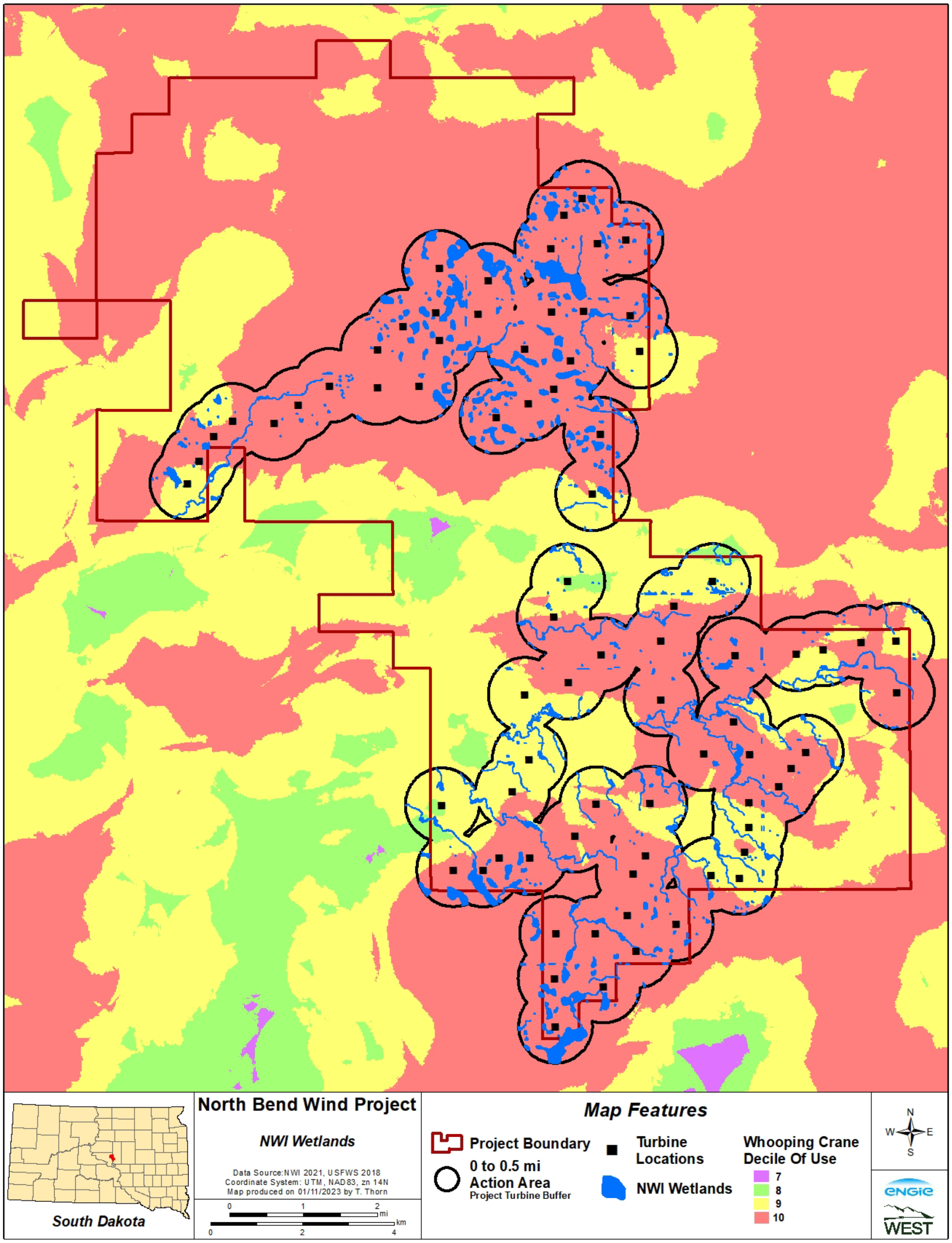

Figure 5.5. Niemuth et al. (2018) whooping crane use by deciles, North Bend Wind Project, Hyde and Hughes counties, South Dakota. National Wetland Inventory (USFWS 2021) data displayed within 0.5 miles of proposed turbine locations.

5.1.3 Northern Long-eared Bat Habitat Assessment

The NLEB is listed as a federally threatened species (USFWS 2015, 2021d), but will be reclassified on March 31, 2023 as federally endangered (https://public-inspection.federalregister.gov/2023-01656.pdf). The range of the NLEB is across all of South Dakota, including Hughes and Hyde counties. A desktop assessment of the presence of potentially suitable habitat for the NLEB was conducted across the Project area in 2017 (Appendix D) and updated in 2020 using the *2020 Range-wide Indiana Bat Survey Guidelines* (USFWS 2020a; Figure 5.6 ; Appendix N). Suitable habitat for NLEB consists of forested areas where bats might roost, forage, and commute between roosting and foraging sites. NLEB primarily forage or travel in forest habitat and are typically constrained to forest features (Boyles et al. 2009). Therefore, habitat suitability was evaluated based primarily on the presence of forested areas that NLEB might use for roosting and foraging.

WEST conducted a desktop assessment of potentially suitable NLEB habitat by reviewing the 2016 NLCD within a 4.0-km (2.5-mi) buffer of the Project area, and delineating potential suitable habitat types (e.g., deciduous forest, evergreen forest, mixed forest, and woody wetlands) using ArcGIS (version 10.4). The habitat delineations were then cross-checked and edited based on the most recent publicly available aerial imagery from the USDA NAIP (2019) for the Project area. The overall habitat layer was edited to remove areas cleared of trees and to refine habitat boundaries. Narrow commuting corridors not captured by the NLCD were also added, based on the aerial imagery.

Once the desktop assessment was completed, a habitat analysis was conducted to assess connectivity of suitable foraging habitats (i.e., woodlots, forested riparian corridors, and natural vegetation communities adjacent to these habitats), roosting habitats, and commuting habitats (i.e., shelterbelts/tree-lines, wooded hedgerows) as suggested in the *Indiana Bat Section 7 and Section 10 Guidance for Wind Energy Projects* (USFWS 2011). The guidance suggests assessing the potential presence of Indiana bats (*Myotis sodalis*) and NLEB within a project based on availability of travel/commuting corridors within the project's boundary, and connectivity to foraging or roosting habitat within a 4.0-km buffer of the project. The minimum size for suitable foraging/roosting habitat is not well understood, but lower estimates are approximately 8 ha (20 ac; Broders et al. 2006). A minimum patch size of 4 ha (10 ac) was assigned to potential roosting habitat. Trees up to 305 m (1,000 ft) from the next nearest suitable roost tree, woodlot, or wooded fencerow were considered suitable habitat (USFWS 2011). The 305-m distance is based on observations of NLEB behavior indicating isolated trees might only be suitable as habitat when the trees are less than 305 m from other forested/wooded habitats (USFWS 2020a). Based on this informed guidance, it is reasonable to conclude NLEB are unlikely to occur within the Project area beyond patches separated by more than 305 m from the nearest connected suitable habitat (USFWS 2011, 2020a; Figure 5.6).

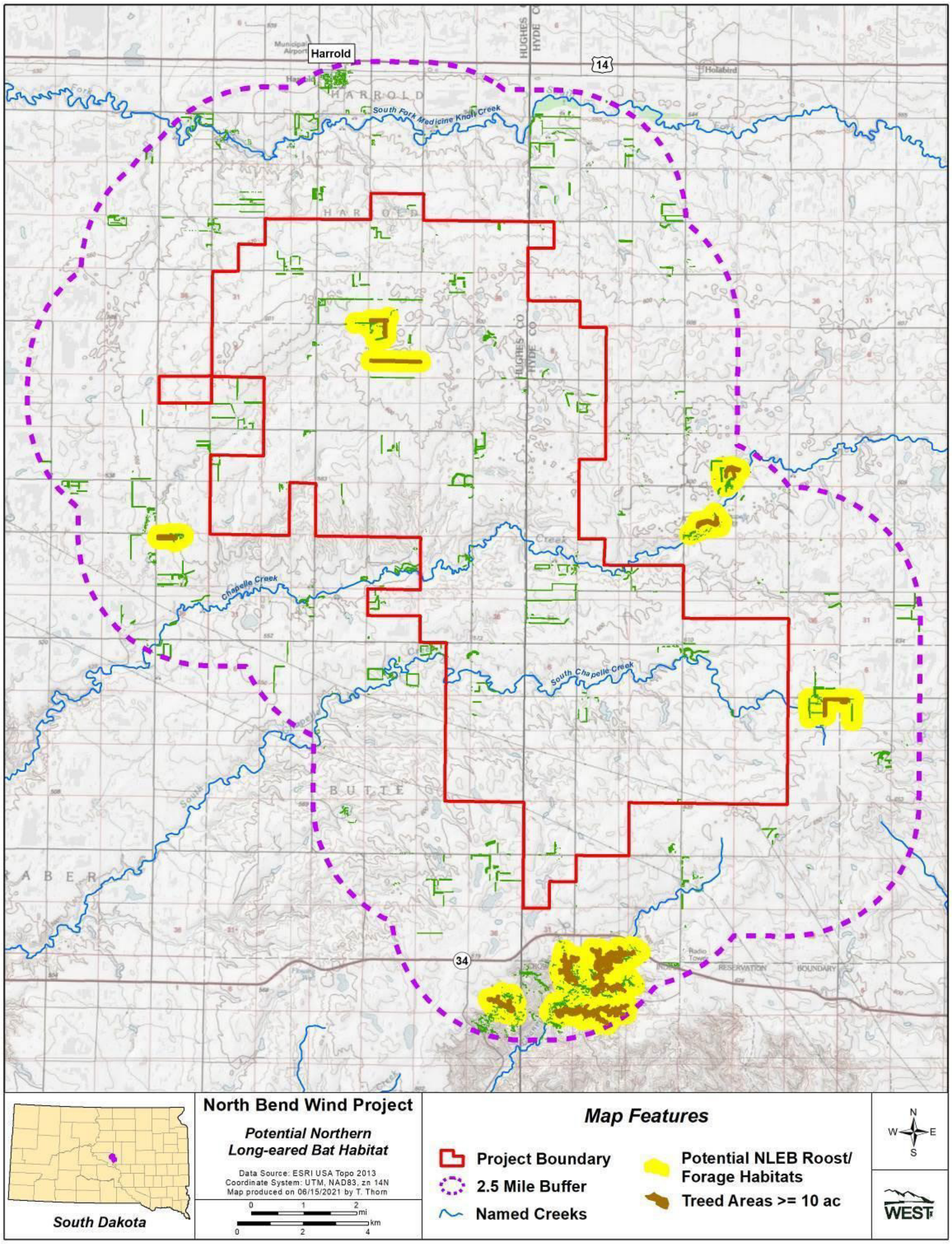

Figure 5.6. Northern long-eared bat habitat assessment of the North Bend Wind Project and 4.0-kilometer (2.5-mile) buffer, Hughes and Hyde counties, South Dakota.

Forested patches were sorted by size into the following groups: less than 4 ha (small forest patches), 4 – 20 ha (10 – 50 ac; potential NLEB roost/foraging habitat), and greater than 20 ha (large potential roost/foraging habitat). All polygons representing forested habitats were buffered by 152 m (500 ft) and dissolved to group any habitat patches within 305 m of each other. This buffer, representing all forested habitats within 305 m of each other, was then purged of small, isolated patches by selecting only those connected habitats containing forested patches at least 4 ha in size. This selection of habitat patches was then buffered by 305 m to represent the potential foraging area for NLEB, resulting in eight patches covering 1,734.4 ha (4,285.7 total ac) within the Project area and 4.0-km buffer (Figure 5.6). Within the Project, potentially suitable NLEB habitat was limited to two patches that covered 277.6 ha (686.0 ac).

5.2 Tier 3 – Baseline Avian and Bat Studies

Tier 3 pre-construction studies have been ongoing within the Project area since 2016 and will continue into 2022. These studies have included eagle and avian use surveys, raptor nest surveys, prairie grouse lek surveys, and bat acoustic surveys. Details and summaries of the methods and results are provided in the sections below.

5.2.1 Eagle and Avian Use Surveys

Fixed-point avian use surveys are the most widely used methodology for pre-construction avian use characterization and turbine siting considerations (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 Project area by birds over the 4-year period when surveys were conducted. Project boundaries changed over time, and therefore altered avian use survey locations. Unless otherwise noted, surveys were conducted once a month for 70 minutes (min) each. Small bird species (e.g., passerines and woodpeckers) were recorded during the first 10 min of the survey period, and then only large bird species were recorded for the next 60 min. The initial 10-min surveys allowed for comparison of small bird use with the majority of wind projects in the region. The 60-min surveys encompassing large birds (e.g., waterfowl, raptors, vultures) were consistent with the ECPG and were used to obtain a stronger dataset with which to evaluate large bird use, particularly for eagles.

Survey plots were selected to survey representative habitats and topography of the Project area while meeting ECPG spatial sampling recommendations. The ECPG recommended at least 30% coverage of areas within 1.0 km (0.6 mi) of turbine locations or within the minimum convex polygon (MCP) of the complete turbine array (USFWS 2013) should be surveyed. As location of turbines were unknown at the time of sampling, survey coverage attempted to include 30% coverage of the Project area at the time. Based on the final turbine layout, survey coverage covered 28.1% of the proposed MCP. Large birds observed within an 800-m (2,625-ft) plot and small birds observations within a 100-m (328-ft) plot were used for quantitative analysis and other comparative metrics. During surveys, observation locations of raptors, other large birds, and species of concern (SOC) were recorded on field maps by unique observation numbers. Flight paths and perch locations were digitized using ArcGIS 10.4. Additionally, for all eagle observations, data were collected following ECPG methodology (USFWS 2013).

A number of protected avian or SOC have the potential to occur within South Dakota. This includes bald and golden eagles (two federally listed species), and four additional state-listed species (SDGFP 2014). Recently, the USFWS has updated the BCC for each BCR (USFWS 2021a). There are 34 BCC species and eight Tier 2a South Dakota bird species of greatest conservation need (SGCN; SDGFP 2014) with the potential to be present within the Project area.

The Project area has shifted numerous times during development due to various logistic constraints. As such, avian use information from 2016 to 2019 (see Appendix E) is synthesized with additional survey efforts from 2019 to 2021 (Appendix N) to provide a high-level overview of the methods and results as limited sampling points overlap the most recent and constricted Project area.

5.2.1.1 Fixed-point Survey Efforts (2016 – 2017)

The following provides a summary of the avian use survey effort conducted April 18, 2016 – March 28, 2017, within the current Project area (Figure 5.7). During this effort, surveys were conducted for 60 min at each survey point location with all birds recorded for the first 20 min, and only large birds recorded for the following 40 min. While this methodology differs from later surveys, results from these previous efforts can provide general information on species composition and diversity within the current Project area. Sixty hours of surveys were completed at five point-count locations. This effort resulted in 41 unique bird species observed during surveys with horned lark (*Eremophila alpestris*; 387 observations, 9 groups), Canada goose (*Branta canadensis*; 201, 5), and Franklin's gull (*Leucophaeus pipixcan*; 95, 1), being the most commonly observed species. Northern harrier (*Circus hudsonius*; 4, 4), bald eagle (1) and merlin (*Falco columbarius*; 1) were the only raptors identified to species during surveys. No golden eagles were documented during survey efforts. No federally or state-listed species were observed during the surveys.

5.2.1.2 Fixed-point Survey Efforts (2018 – 2019)

The following provides a summary of avian use survey effort conducted January 23, 2018 – January 14, 2019, within the current Project area (Figure 5.7). There were 27 survey locations resulting in 324 fixed-point surveys completed. This effort resulted in 60 unique large bird species being observed. The most commonly recorded large bird species were snow goose (*Anser caerulescens*; 19,515 observations, 19 groups), Canada goose (6,007, 31), and greater white-fronted goose (*Anser albifrons*; 4,870, 14). Nine diurnal raptor species were documented during surveys, with northern harrier (17, 17) the most frequently recorded species. For small birds, western meadowlark (*Sturnella neglecta*; 197, 102) was the most commonly observed species, followed by red-winged blackbird (*Agelaius phoeniceus*; 91, 25), and brown-headed cowbird (*Molothrus ater*; 90, 31). Six golden eagle observations and four bald eagle observations were documented during survey efforts. No federally or state-listed species were observed while conducting surveys.

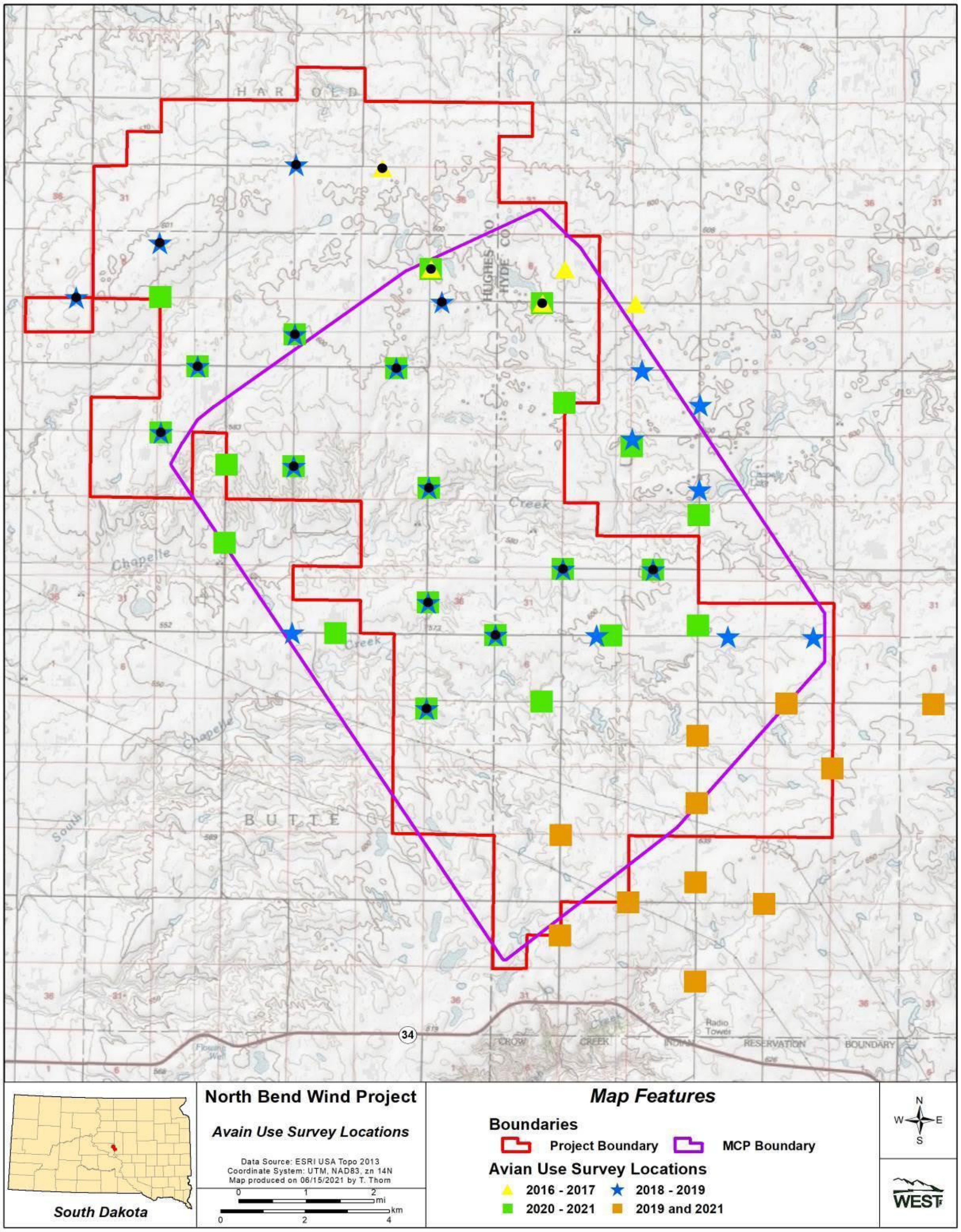

Figure 5.7. Location of fixed-point avian use survey stations completed in from 2016 – 2021 throughout the North Bend Wind Project boundary located in Hughes and Hyde counties, South Dakota. The minimum convex polygon (MCP) boundary (purple outline) encapsulates the final proposed turbine layout.

5.2.1.3 Fixed-point Survey Efforts (2019 – 2020)

Surveys were conducted from April 5, 2019 – March 31, 2020, at 19 survey points (Figure 5.7). There were 212 fixed-point surveys completed for both large and small bird. Sixty unique species were recorded during surveys, including 38 unique large birds and 22 unique small birds. The most observed large bird species were sandhill crane (*Antigone canadensis*; 2,950 observations, 15 groups), Canada goose (674, 26), and mallard (*Anas platyrhynchos*; 175, 45). The most observed raptors identified within the Project area were red-tailed hawk (*Buteo jamaicensis*; 48, 30), followed by northern harrier (16, 15). Red-winged blackbird (714, 84), brown-headed cowbird (274, 58), and western meadowlark (251, 145) were the most recorded small bird species. One bald eagle was observed during fixed-point surveys. No other eagle or federal- or state-listed species was observed while conducting surveys within the Project area during the 2019 – 2020 survey year. There were four species identified as both BCC and SGCN recorded, including marbled godwit (*Limosa fedoa*; 22 observations), black tern (*Chlidonias niger;* 16), greater prairie-chicken (*Tympanuchus cupido*; 1), and chestnut-collared longspur (*Calcarius ornatus*; 11). Five additional species identified are categorized as BCC species, including Franklin's gull (65 observations), northern harrier (27), bobolink (*Dolichonyx oryzivorus*; 73), grasshopper sparrow (*Ammodramus savannarum*; 36), and red-headed woodpecker (*Melanerpes erythrocephalus;* 2). Lark bunting (*Calamospiza melanocorys*), a SCCN, was also recorded (45 observations).

5.2.1.4 Fixed-point Survey Efforts (2020 – 2021)

Surveys were conducted from April 6, 2020 – March 13, 2021, at 23 survey points (Figure 5.7). There were 276 fixed-point surveys completed for both large and small birds. Sixty-nine unique species were recorded during surveys, including 37 unique large birds and 32 unique small birds. For large birds, the most commonly observed species recorded included Canada goose (589 observations, 27 groups), snow goose (428, 6), and sandhill crane (94, 5). Five diurnal raptor species were identified within the Project area, with northern harrier (31, 31) and red-tailed hawk (25, 25) being the most commonly observed. For small birds, red-winged blackbird (211 observations, 39 groups), western meadowlark (192, 192), horned lark (177, 38), and brown-headed cowbird (101, 22) were the most commonly observed species. No eagles or federal- or state-listed species were observed while conducting surveys within the Project area during this effort. There were three species identified as both BCC and SGCN, including marbled godwit (1 observation), black tern (5), and chestnut-collared longspur (26). Five species were BCC, including Franklin's gull (9 observations), northern harrier (31), bobolink (4), grasshopper sparrow (56), and red-headed woodpecker (4).

5.2.1.5 Fixed-point Survey Efforts (2020 – 2021)

An additional 11 points were surveyed in the southern portion of the Project area (Figure 5.7 ; orange squares) in 2019 for a brief time, but surveys at these points were later stopped due to anticipated Project development. In early 2021, it was determined there could be potential development in this area again. These 11 survey locations were again surveyed, starting February 25, 2021, and this summary includes data collected through September 2021. There were 88 fixed-point surveys completed for both large and small bird. Fifty-one unique species were recorded during surveys, including 31 unique large birds and 20 unique small birds. The most commonly observed large bird species were Franklin's gull (153 observations, 3 groups), Canada goose (137, 7), and American white pelican (*Pelecanus erythrorhynchos*; 69, 2). The most commonly observed raptors identified within the Project area were red-tailed hawk (23 observations, 23 groups), followed by northern harrier (9, 9) and Swainson's hawk (*Buteo swainsoni*; 8, 8). Western meadowlark (80, 78), red-winged blackbird (75, 12), and brown-headed cowbird (64, 26) were the most frequently recorded small bird species. No eagles or federal- or state-listed species were observed while conducting surveys within the Project area during this effort. There were two species identified as both BCC and SGCN, marbled godwit (11 observations) and chestnut-collared longspur (24). Four additional species are categorized as BCC species, including Franklin's gull (153 observations), northern harrier (9), bobolink (4), and grasshopper sparrow (25).

5.2.1.6 Fixed-point Survey Efforts Summarized

Since the beginning of development (i.e., 2016), there were 47 unique fixed-point survey locations for eagles and other avian species within the Project area, resulting in approximately 960 hours of survey effort. A total of six bald and four golden eagle observations have been detected during this effort. No eagle has been detected within the Project area since 2019. Table 5.4 summaries the number of sensitive species (i.e., protected by BGEPA, BCC, and SGCN) observations reported since the 2016–2021 survey efforts (see Section 5.2.1.3).

Table 5.4. Summary of protected and sensitive species observed at the North Bend Wind Project during avian use surveys from April 18, 2016, through September 30, 2021.

Species	Scientific Name	Status[1]	Observations
bald eagle[2]	*Haliaeetus leucocephalus*	SGCN; BGEPA	6
golden eagle[2]	*Aquila chrysaetos*	BCC, SGCN, BGEPA	4
marbled godwit	*Limosa fedoa*	BCC, SGCN	34
black tern	*Chlidonias niger*	BCC, SGCN	21
greater prairie-chicken	*Tympanuchus cupido*	BCC, SGCN	6
chestnut-collared longspur	*Calcarius ornatus*	BCC, SGCN	61
Franklin's gull	*Leucophaeus pipixcan*	BCC	227
northern harrier	*Circus hudsonius*	BCC	67
bobolink	*Dolichonyx oryzivorus*	BCC	81
grasshopper sparrow	*Ammodramus savannarum*	BCC	117
red-headed woodpecker	*Melanerpes erythrocephalus*	BCC	6
lark bunting	*Calamospiza melanocorys*	SGCN	45

[1] SGCN = Species of Greatest Conservation Need (SDGFP 2016); BGEPA = USFWS Bald and Golden Eagle Protection Act (1940) BCC = USFWS Birds of Conservation Concern in Prairie Potholes Bird Conservation Region (BCR 11; USFWS 2021a).

[2] Combined efforts from April 2016 through October 2021.

5.2.2 Raptor Nest Surveys

Raptor nest surveys were conducted in the spring of 2016 (Appendix G), 2018 (Appendix H), 2019, and 2020 (Appendix N). The objectives of the nest surveys were to gather information on eagle nest locations and information on other raptor species nesting in the area, all of which may be subject to disturbance or displacement effects from wind facility construction and operation. Surveys were conducted within the Project area and a 1.0-mi (1.6-km) buffer for all raptors. Due to various guidance from USFWS over the past several years, additional eagle nest survey efforts have included various buffers from 10.0 mi (16.1 km; USFWS 2013), 4.0 mi (6.4 km; USFWS 2020b) and 2.0 mi (3.2 km; USFWS 2020c). For the purposes of this section, the current 2.0-mi buffer was used to summarize the results of these efforts. Prior to the surveys, topographic and aerial maps were evaluated to determine where raptor and eagle nesting habitat is likely to occur (e.g., riparian habitat along creeks, open lakes with large trees) so these areas could be targeted during the aerial surveys. A biologist conducted the surveys in a helicopter operated by a pilot experienced in conducting low-altitude wildlife surveys. Surveys were generally conducted on days with good visibility and no precipitation. The locations of all raptor nests and survey paths were recorded using a hand-held onboard Global Positioning System (GPS) receiver.

For all raptor and eagle nest structures detected, the biologist recorded nest location coordinates with the GPS receiver, species present (if any), condition of the nest, presence of eggs or young (if present and visible), and the substrate of the nest (e.g., tree, power pole, rock outcrop). The status of each nest was determined as either: Occupied – an adult in incubating position, eggs, nestlings or fledglings, a newly constructed or refurbished stick nest and/or the presence of one or more adults on or immediately adjacent to the nest structure(s); or Unoccupied – a nest with no evidence of recent use, or attendance by adult raptors. Efforts were made to minimize disturbance to nesting raptors, livestock, or occupied dwellings to the greatest extent possible. Photographs were taken of possible eagle nests.

5.2.2.1 2016 Surveys

Aerial surveys were conducted from March 28 – April 1, 2016, to search for eagle and raptor nests. During the 2016 aerial survey, three raptor nests were documented within the Project area (Table 5.5, Figure 5.8). Two nests were occupied by red-tailed hawks, while one nest was inactive. No eagle or potential eagle nests were located within the Project area and 2.0-mi buffer.

Table 5.5. Location of raptor nest sites observed during 2016 surveys located in the current North Bend Wind Project and surrounding 2.0-mile (3.2-kilometer) buffer, Hughes and Hyde counties, South Dakota.

Nest ID	Northing	Easting	Species[1]	2016 Status
1	442383	4922347	RTHA	Occupied
2	444594	4919242	UNRA	Unoccupied
16	444423	4925361	RTHA	Occupied

[1] RTHA = red-tailed hawk, UNRA = unknown raptor.

ID = Identification.

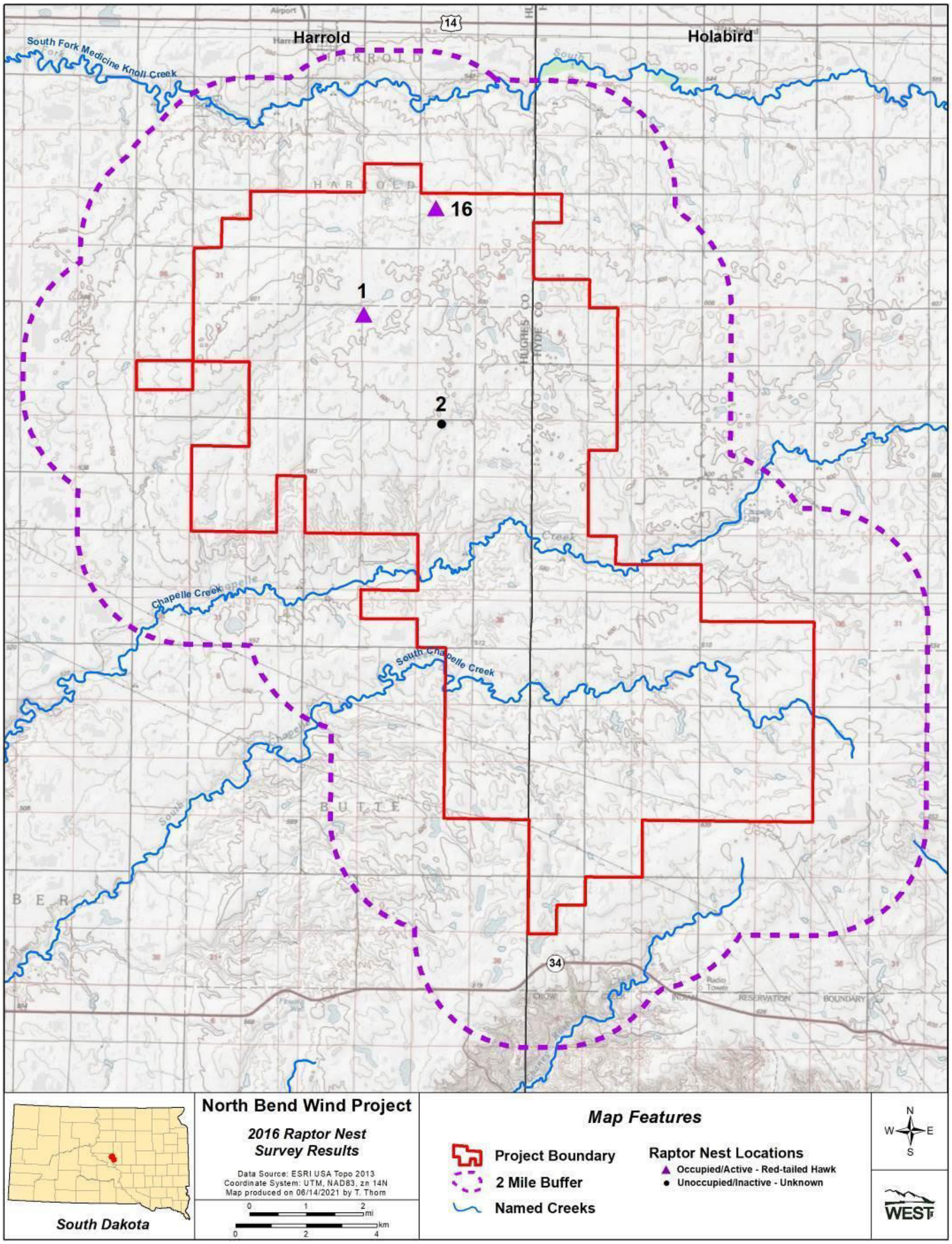

Figure 5.8. Location of raptor nests identified during surveys in 2016 for the North Bend Wind Project and 2.0 miles (3.2-kilometer) buffer in Hughes and Hyde counties, South Dakota.

5.2.2.2 2018 Surveys

An aerial survey for raptor nests was completed for the Project from March 9 – 14, 2018, with follow-up ground surveys conducted in conjunction with other work in May 2018. During these surveys, 15 raptor nests were identified (Figure 5.9). All three of the previously documented nests from 2016 were re-visited; one was confirmed occupied with a great-horned owl (*Bubo virginianus*) nest and two could not be relocated. No potential eagle nests were identified within the Project area or 2.0-mi buffer. Nine of the 15 nests were classified as unoccupied nests of unknown raptor species. The remaining occupied nests included four great-horned owl nests, one Swainson's hawk nest, and one red-tailed hawk nest (Table 5.6).

Table 5.6. Location of raptor nest sites surveyed and/or observed during 2018 surveys located in the current North Bend Wind Project and surrounding 3.2-kilometer (2.0-mile) buffer, Hughes and Hyde counties, South Dakota.

Nest ID	Northing	Easting	Species[1]	2018 Status
1	442383	4922347	GHOW	Occupied
2	444594	4919242	DNL	n/a
17[2]	444423	4925361	DNL	n/a
19	447561	4925661	UNRA	Unoccupied
30	448709	4915493	GHOW	Occupied
46	451315	4923410	UNRA	Unoccupied
47	450147	4927430	UNRA	Unoccupied
48	450012	4916820	UNRA	Unoccupied
53	452476	4916512	UNRA	Unoccupied
58	445523	4914147	UNRA	Unoccupied
59	435866	4923410	UNRA	Unoccupied
60	437402	4918910	UNRA	Unoccupied
61	438491	4919700	GHOW	Occupied
62	443789	4915766	UNRA	Unoccupied
63	446691	4925852	GHOW	Occupied
69	448861	4910473	RTHA	Occupied
70	443433	4906458	SWHA	Occupied

[1.] DNL = did not locate, GHOW = great horned owl, UNRA = unknown raptor, RTHA = red-tailed hawk, SWHA = Swainson's hawk.

[2] Originally labeled Nest ID 16 in 2016 survey efforts.

ID = Identification; n/a = denotes nest no longer available (e.g., due to being in a new No Fly Zone or falling out of a tree due to winds).

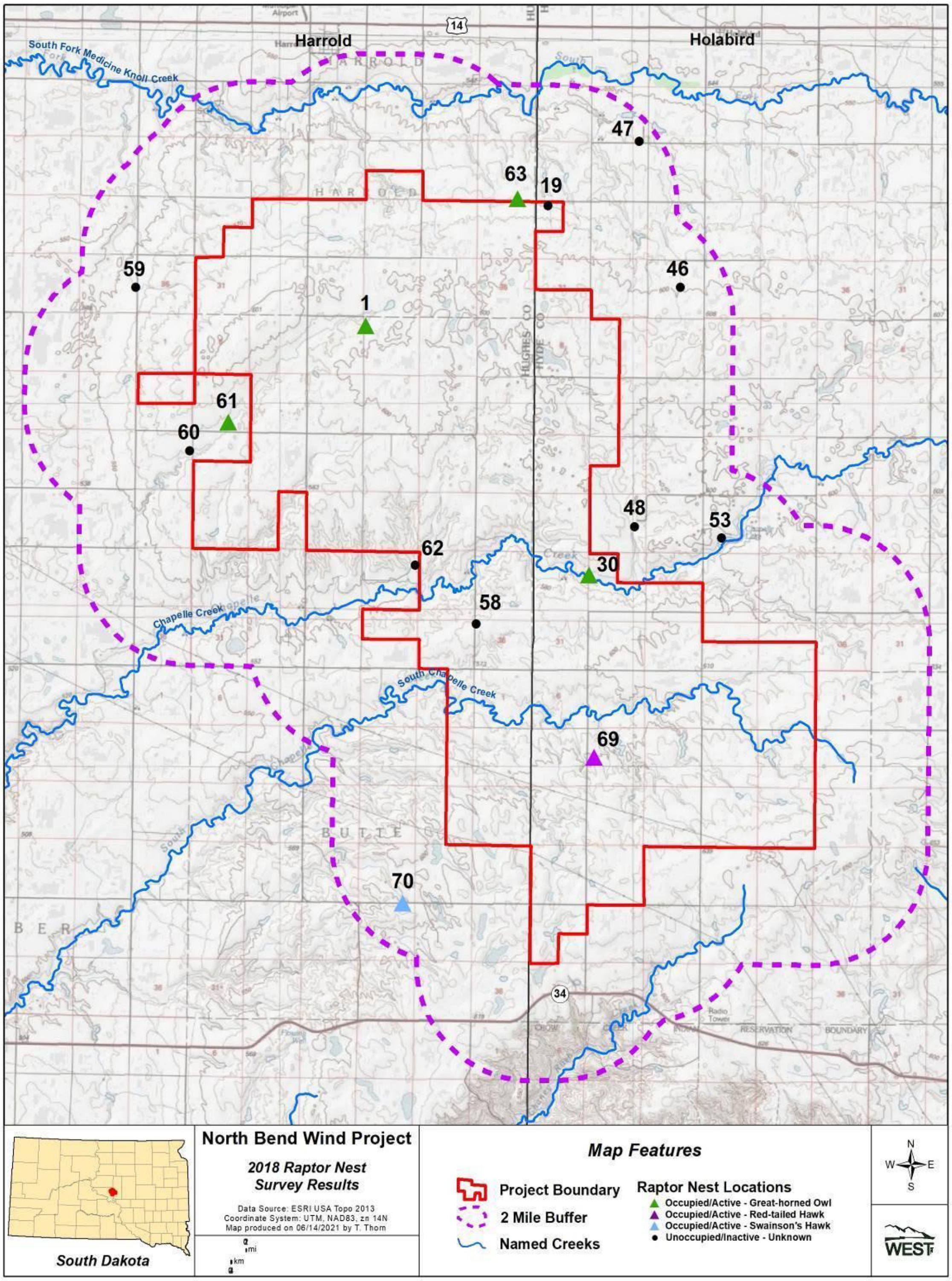

Figure 5.9. Location of raptor nests identified during surveys in 2018 for the North Bend Wind Project and 2.0-mile (3.2-kilometer buffer in Hughes and Hyde counties, South Dakota.

5.2.2.3 2019 Surveys

Two aerial nest surveys for the Project were conducted on March 26 and April 16 – 17, 2019. Eighteen nests were documented during surveys (Figure 5.9) and seven previously identified nests were either not present or were excluded from surveys due to access considerations (Figure 5.9; No Fly Areas; no permission). Eleven nests were determined to be occupied, with adults in the nest, adults perched in the same tree, or with eggs in the nest. Seven nests were considered unoccupied as no activity was recorded during either survey in accordance with the ECPG (Figure 5.10 , Table 5.7). Of occupied nests, five were occupied by great horned owl, one by ferruginous hawk (*Buteo regalis*), three by red-tailed hawk, and two by unidentified raptors (eggs were present in the nest or adults were not identified; Table 5.7). No eagle or potential eagle nests were identified within the Project area or 2.0-mi buffer.

Table 5.7. Location of raptor nest sites surveyed and/or observed during 2019 surveys located in the current North Bend Wind Project and surrounding 3.2-kilometer (2.0-mile) buffer, Hughes and Hyde counties, South Dakota.

Nest ID	Northing	Easting	Species	2019 Status
2	444594	4919242	DNL	n/a
17	444423	4925361	DNL	n/a
19	444179	4925747	DNL	n/a
30	448709	4915493	UNRA	Occupied
46	451315	4923410	UNRA	Unoccupied
47	450147	4927430	GHOW	Occupied
48	450012	4916820	DNL	n/a
56	459961	4913766	DNL	n/a
58	445523	4914147	UNRA	Unoccupied
59	435866	4923410	DNL	n/a
60	437402	4918910	UNRA	Unoccupied
61	438491	4919700	GHOW	Occupied
62	443789	4915766	RTHA	Occupied
63	446691	4925852	DNL	n/a
70	443433	4906458	UNRA	Unoccupied
73	437079	4918884	UNRA	Unoccupied
75	447665	4925512	RTHA	Occupied
86	447117	4911890	RTHA	Occupied
87	442263	4909846	FEHA	Occupied
89	440967	4914462	GHOW	Occupied
90	439921	4917768	UNRA	Occupied
91	439620	4917741	GHOW	Occupied
92	456143	4916029	GHOW	Occupied
94	437892	4926281	UNRA	Unoccupied
95	435635	4920750	UNRA	Unoccupied

[1] DNL = did not locate, UNRA = unknown raptor, GHOW = great horned owl, RTHA = red-tailed hawk, FEHA = ferruginous hawk.

ID = Identification, n/a = denotes nest no longer available (e.g., due to being in a new No Fly Zone or falling out of a tree due to winds).

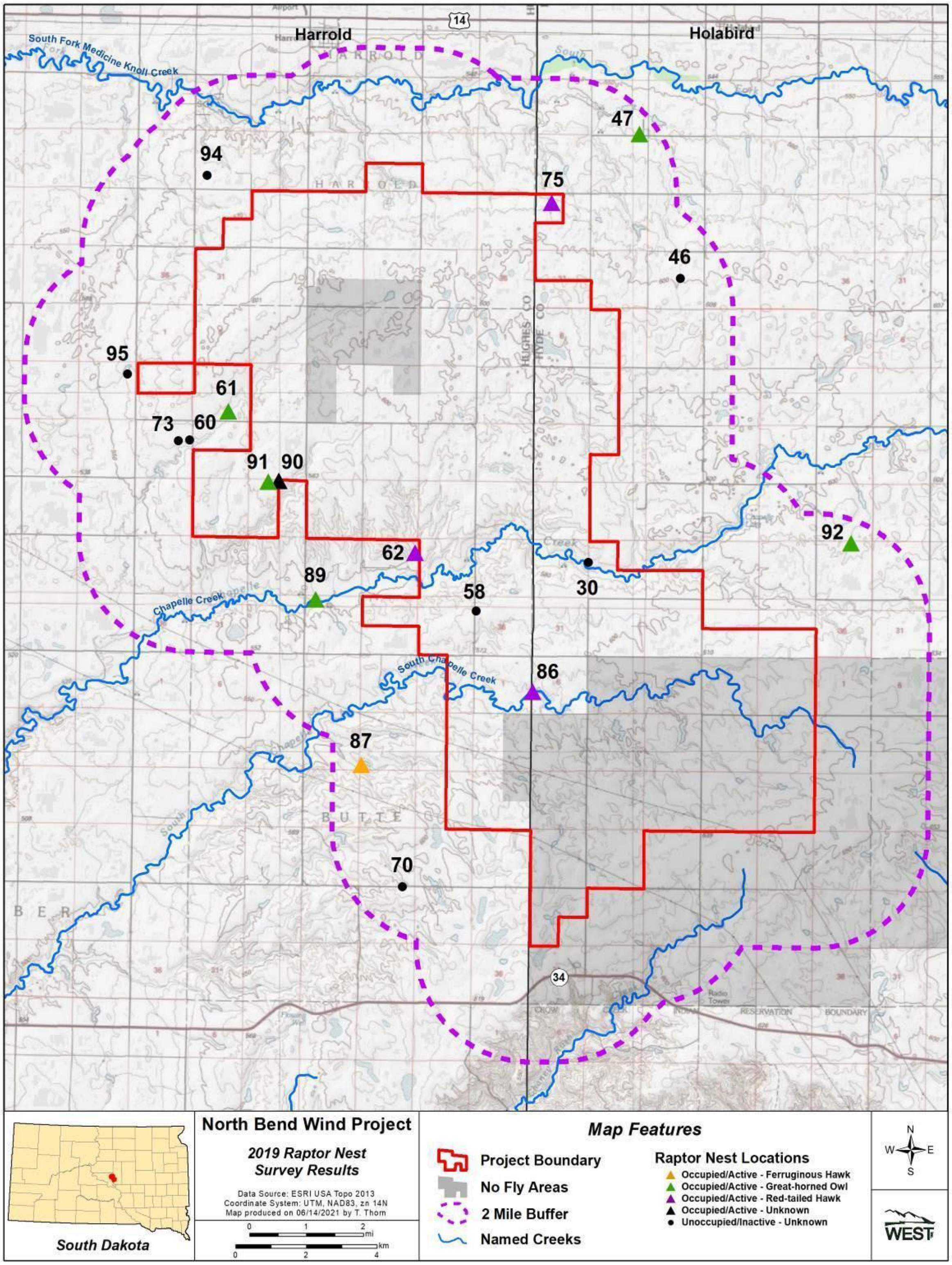

Figure 5.10. Location of raptor nests identified during surveys in 2019 for the North Bend Wind Project and 2.0-mile (3.2-kilometer) buffer in Hughes and Hyde counties, South Dakota. Shaded "No Fly Areas" include areas not surveyed in 2019.

5.2.2.4 2020 Surveys

Three nest surveys for the Project area were conducted on March 2 – 3, March 12 and 20, and April 20, 2020. Thirty-five nests were documented during surveys. Nineteen nests were previously identified within the Project and the associated 2.0-mi buffer, and four previously identified nests were either not present or were excluded from surveys due to access considerations (no permission). Of the 35 observed nests, seven were occupied by red-tailed hawks, five by great horned owls, and one by ferruginous hawks. One occupied nest could not be identified to species (i.e., unknown raptor). Of special interest, two nest locations were used by two different species (Table 5.8, Figure 5.11). Nest 62 and Nest 90 were first occupied by great horned owls and then by red-tailed hawks. A final nest (Nest 108) was a raptor stick nest with a Canada goose occupying the nest. The remaining nests were considered unoccupied as no activity was recorded during either survey in accordance with the ECPG (Figure 5.11). No eagle or potential eagle nests were identified within the Project area or the 2.0-mi buffer. Table 5.8 presents a cumulative summary of survey results in 2016, 2018, 2019, and 2020 for occupied nests within the Project area and 2.0-mi buffer.

Table 5.8. Yearly summary of all potential raptor nests[1] surveyed and/or observed during survey efforts for the North Bend Wind Project, Hughes and Hyde counties, South Dakota[2].

Nest ID	Northing	Easting	2016 Status	2018 Status	2019 Status	2020 Status
1	442383	4922347	RTHA	GHOW	n/a[3]	n/a
2	444594	4919242	UNRA	DNL	DNL	n/a
16[4]	444423	4925361	RTHA	DNL	DNL	n/a
19	447561	4925661		UNRA	DNL	
30	448709	4915493		GHOW	UNRA	RTHA
46	451315	4923410		UNRA	UNRA	UNRA
47	450147	4927430		UNRA	GHOW	
48	450012	4916820		UNRA	DNL	
53	452476	4916512		UNRA		RTHA
54	452741	4916572				GHOW
56	459961	4913766		UNRA	DNL	
58	445523	4914147		UNRA	UNRA	UNRA
59	435866	4923410		UNRA	DNL	n/a
60	437402	4918910		UNRA	UNRA	UNRA
61	438491	4919700		GHOW	GHOW	UNRA
62	443789	4915766		UNRA	DNL	GHOW
62	443789	4915766			RTHA	RTHA
63	446691	4925852		GHOW	DNL	
69	448861	4910473		RTHA	n/a	
70	443433	4906458		SWHA	UNRA	
73	437079	4918884			UNRA	UNRA
75	447665	4925512			RTHA	GHOW
86	447117	4911890			RTHA	RTHA
87	442263	4909846			FEHA	DNL
89	440967	4914462			GHOW	GHOW
90	439921	4917768			UNRA	GHOW
90	439921	4917768			UNRA	RTHA
91	439620	4917741			GHOW	UNRA
92	456143	4916029			GHOW	RTHA

Table 5.8. Yearly summary of all potential raptor nests[1] surveyed and/or observed during survey efforts for the North Bend Wind Project, Hughes and Hyde counties, South Dakota[2].

Nest ID	Northing	Easting	2016 Status	2018 Status	2019 Status	2020 Status
94	437892	4926281			UNRA	UNRA
95	435635	4920750			UNRA	UNRA
100	452654	4916585				UNRA
101	450680	4917677				GHOW
102	437420	4918824				UNRA
103	440497	4921656				RTHA
104	440905	4910925				UNRA
106	447119	4920622				GHOW
107	444593	4919229				UNRA
108[5]	452741	4916580				CAGO
109	443810	4915783				UNRA
110	448289	4920613				UNRA
111	447491	4926950				UNRA
113	450014	4916821				RTHA
114	441881	4911305				UNRA
115	443356	4906471				FEHA
116	454972	4914450				UNRA

[1] UNRA = unknown raptor, GHOW = great horned owl, RTHA = red-tailed hawk, SWHA = Swainson's hawk, FEHA = ferruginous hawk, CAGO = Canada goose.

[2] Occupied nest sites in a given year are denoted by species code of the individuals that nested there.

[3] n/a denotes nests no longer available (e.g., due to being in a new No Fly Zone or falling out of a tree due to winds)

[4] Nest 16 was changed to Nest 17 for 2018, 2019, and 2020.

[5] Raptor stick nest identified with a nesting Canada goose.

ID = identification

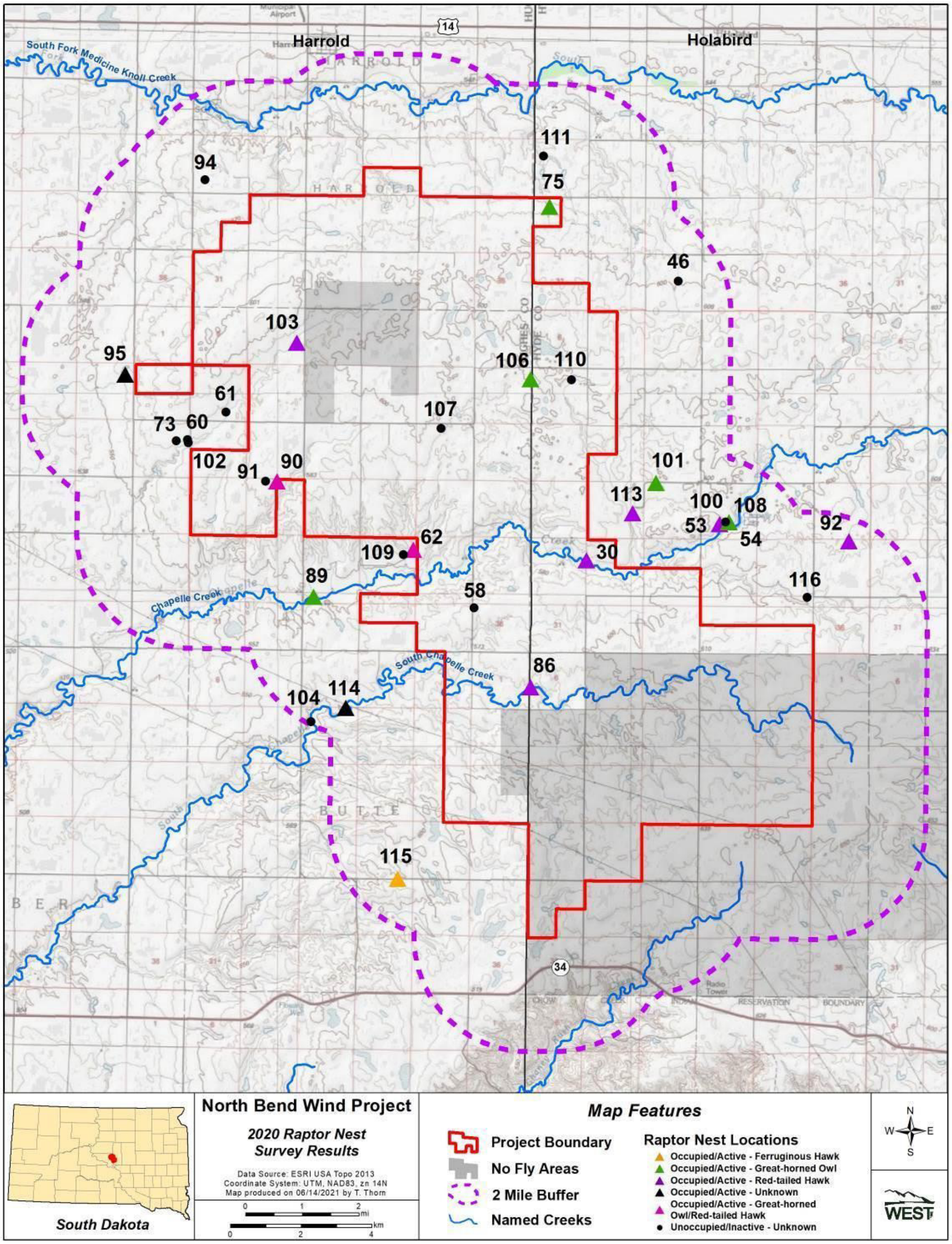

Figure 5.11. Location of raptor nests identified during surveys in 2020 for the North Bend Wind Project and 2.0-mile (3.2-kilometer) buffer in Hughes and Hyde counties, South Dakota. Shaded "No Fly Area" included areas not surveyed in 2020.

5.2.3 Prairie Grouse Lek Surveys

The Project area occurs within the occupied range of the greater prairie-chicken and sharp-tailed grouse (*Tympanuchus phasianellus*; combined as "prairie grouse"). Greater prairie-chicken is listed as a SGCN in South Dakota, but both species are considered upland game birds and are hunted in South Dakota (SDGFP 2014). WEST conducted surveys to document prairie grouse leks during the breeding season within the Project area. The objective of the prairie grouse lek surveys was to identify potential leks and determine status of each lek to help inform Project development decisions. These surveys were conducted in 2016 (Appendix I), 2018 (Appendix J), 2019, and 2020 (Appendix N), and followed Project changes as described above in "Eagle and Avian Use Surveys" for the respective years (Figure 5.7).

Surveys were conducted three times each survey year from late March to the end of the first week of May (with the exception of 2019 surveys) and included the respective Project areas and a 1.0-mi buffer. Surveys began approximately 30 min prior to sunrise until 90–120 min after sunrise. To the extent possible, all surveys were conducted on relatively calm mornings (winds less than 24–32 km per hour [kph; 15–20 mi per hour (mph)]) and on days with no precipitation. Surveys were conducted to document the presence and the number of male and female birds attending leks. Because both sharp-tailed grouse and greater prairie-chicken are found within the area, the identification of species observed during the surveys was recorded, when possible. Information collected during all surveys included date, time, temperature, cloud cover, precipitation, and observer(s).

The SDGFP defines a lek as "a traditional display area where two or more male sage-grouse have attended in two or more of the previous five years" (Connelly et al. 2003). "Active leks" are locations where two or more birds were observed or heard in courtship behavior during more than one survey period. "Potential leks" are locations where birds were observed or heard engaging in courtship behavior during only one survey period, where birds were observed in more than one survey period but not in courtship behavior, or where the number of birds could not be confirmed (e.g., heard at least one bird). If no birds were seen or heard in any of the three surveys, the lek was classified as inactive for the season. Results include a cumulative summary of all survey efforts across years as it relates to the current Project area and a 1.0-mi buffer (Figure 5.12).

5.2.3.1 Aerial Surveys

Aerial surveys were conducted in 2016 and 2018 with a Cessna 172. Surveys included north/south transects across the Project area and 1.0-mi buffer spaced approximately 0.25 mi (0.40 km) apart at an altitude of approximately 100–150 ft (30-45 m) above ground level. An onboard GPS unit was used to keep the plane on transect, document lek locations, and record daily flight paths. Observers recorded the number of birds on the lek and whether the lek was occupied by greater prairie-chicken or sharp-tailed grouse. The following characteristics were used to distinguish between these species from the air: a square-tail shape and dark, blocky body for greater prairie-chicken, versus a pointed-tail shape with white under tail coverts and lighter body color for sharp-tailed grouse.

5.2.3.2 Ground Surveys

Ground visits were conducted in 2019 and 2020 by traveling publicly accessible roads (or roads where permission was previously obtained) throughout the Project area and a 1.0-mi buffer (Appendix N) During ground visits, the following information was recorded and included lek identification, location, species, type of detection (auditory or visual), number of males (if possible), and number of females (if possible). If a new lek was identified during this effort, it was documented with the same information and identified using a new unique lek identification number.

Sixteen prairie grouse leks were identified during a combination of aerial surveys and ground lek visits during the 2016, 2018, 2019, and 2020 breeding seasons within the Project area and 1.0-mi buffer (Figure 5.12). One lek location was active in 2016, 14 in 2018, six in 2019, and eight in 2020 (Table 5.9). Of these active and potential leks, all were greater prairie-chicken leks (Table 5.9).

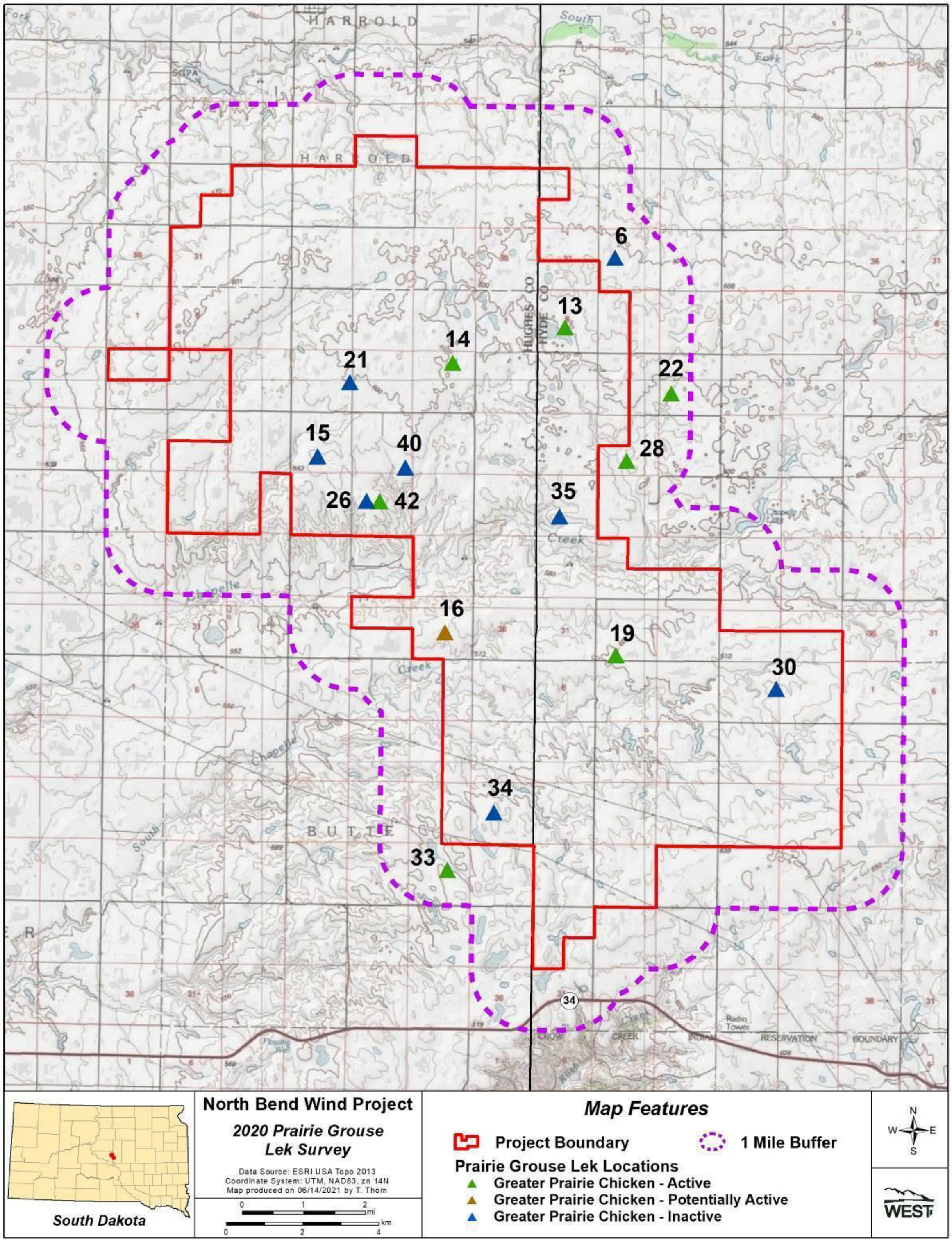

Figure 5.12. Location and 2020 status of potential prairie grouse leks identified in the 2016, 2018, 2019, and 2020 breeding seasons during surveys within the North Bend Wind Project and 1.6-kilometer (1.0-mile) buffer from, Hughes and Hyde counties, South Dakota.

Table 5.9. Location and maximum number of prairie grouse observed at potential leks during surveys for the current North Bend Wind Project and 1.6-kilometer (1.0-mile) buffer, Hughes and Hyde counties, South Dakota.

Lek ID	Species	2016 Status	2018 Status	2019 Status	2020 Status	Grouse Numbers (2020)
6	GRPC	Active	Inactive	Inactive	Inactive	0
13	GRPC	n/a	Active	Active	Active	5
14	GRPC	n/a	Active	Active	Active-auditory only	At least 3
15	GRPC	n/a	Active	Inactive	Inactive	0
16	GRPC	n/a	Active	Active-auditory only	Potentially active	At least 1
19	GRPC	n/a	Active	Active	Active	4
21	GRPC	n/a	Active	Inactive	Inactive	0
22	GRPC	n/a	Active	Inactive	Active-auditory only	At least 2
26	GRPC	n/a	Active	Inactive	Inactive	0
28	GRPC	n/a	Active	Inactive	Active	5
30	GRPC	n/a	Active	Inactive	Inactive	0
33	GRPC	n/a	Active	Active	Active-auditory only	Unknown
34	GRPC	n/a	Active	Inactive	Inactive	0
35	GRPC	n/a	Active	Inactive	Inactive	0
40	GRPC	n/a	Active	Inactive	Inactive	0
42	GRPC	n/a	n/a	Active	Active-auditory only	At least 3

ID = identification; GRPC = greater prairie-chicken; n/a = not surveyed.

5.2.4 Bat Acoustic Surveys

WEST conducted acoustic monitoring studies to estimate levels of bat activity within the Project area from May 26 – October 21, 2016, and April 25 – October 25, 2018, at three locations, including two in cropland to be representative of proposed turbine locations,] and one bat feature; Figure 5.13; Appendices K and L). The bat feature included proximity with water features, trees, hedge rows, and other bat-associated habitats. AnaBat™ SD2 ultrasonic bat detectors (Titley Scientific, Columbia, Missouri), placed 1.5 m (5.0 ft) above the ground to minimize insect noise, were used during the study. Studies of bat activity followed the recommendations of the WEG and Kunz et al. (2007a), detectors were programmed to turn on approximately 30 min before sunset and turn off approximately 30 min after sunrise each night. The study was divided into two primary seasons (summer and fall). WEST defined the fall migration period (FMP; July 30 – October 14) as a standard for comparison with activity from other wind energy facilities. During the FMP, bats begin moving toward wintering areas, and many species of bats initiate reproductive behaviors (Cryan 2008). This period of increased landscape-scale movement and reproductive behavior is often associated with increased levels of bat fatalities at operational wind energy facilities (WEST 2019).

For each survey location, bat passes were sorted into two groups based on the call's minimum frequency. High-frequency (HF) bats, such as eastern red bats (*Lasiurus borealis*) and *Myotis* species (such as NLEB]) have minimum frequencies greater than 30 kilohertz (kHz). Low-frequency (LF) bats, such as big brown bats (*Eptesicus fuscus*), silver-haired bats (*Lasionycteris noctivagans*), and hoary bats (*Lasiurus cinereus*), typically emit echolocation calls with minimum frequencies below 30 kHz.

Summarized results of these efforts included three general trends. First, overall bat activity varied by season, with lower activity recorded in the summer and higher activity in the fall. Second, at all stations and frequencies, bat passes peaked during the first half of September. Finally, the bat feature recorded more bat passes/detector night than in the cropland, as was expected. However, there was little variation in the overall activity between seasons between the detectors in croplands.

There was some variation between years in the composition of HF and LF activity. In 2016, there were more HF bat passes recorded, while in 2018 more LF bat passes were recorded (Table5.10). Generally, there was less activity recorded in 2018 than in 2016.

Table 5.10. Results of bat activity surveys conducted at stations within the North Bend Wind Project area, Hughes and Hyde counties, South Dakota, from May 26 – October 21, 2016, and April 25 – October 25, 2018. Passes are separated by call frequency: high frequency (HF) and low frequency (LF).

Year	Station	Type	# of HF Bat Passes	# of LF Bat Passes	Total Bat Passes	Detector-Nights	Bat Passes/Night[1]
2016	West	cropland	49	53	102	61	1.67 ± 0.44
	East	bat feature	128	95	223	95	2.35 ± 0.37
Total			**177**	**148**	**325**	**156**	**-**
2018	West	cropland	5	12	17	151	0.11 ± 0.04
	East	bat feature	54	79	133	127	1.05 ± 0.20
Total			**59**	**91**	**150**	**278**	**-**

[1]± bootstrapped standard error.

---Total not given due to differences in how stations were selected and their objectives.

Use of bat activity to predict post-construction mortality is difficult to relate and lacks any direct relationship based on pre-construction survey efforts (Hein, et al. 2013, Solick et al. 2020). Furthermore, there is some evidence that activity increases from pre-construction to post-construction (Richardson et al, 2021). Acoustic surveys can provide some level of species composition including the presence of HF bats within the Project area and possible presence of listed species such as NLEB. Additional analysis of HF calls collected during the 2016 and 2018 surveys were completed following USFWS guidance (USFWS 2019a, 2022). All calls were initially vetted through Kaleidoscope Pro 5.4.7 using the Bats of North America classifier 5.4.0 for 2016 data and Kaleidoscope Pro 5.1.6 using the Bats of North America classifier 4.2.0. A total of 11 HF calls were flagged by the software, and manual review of those calls by a bat expert determined that none were NLEB (Appendix P).

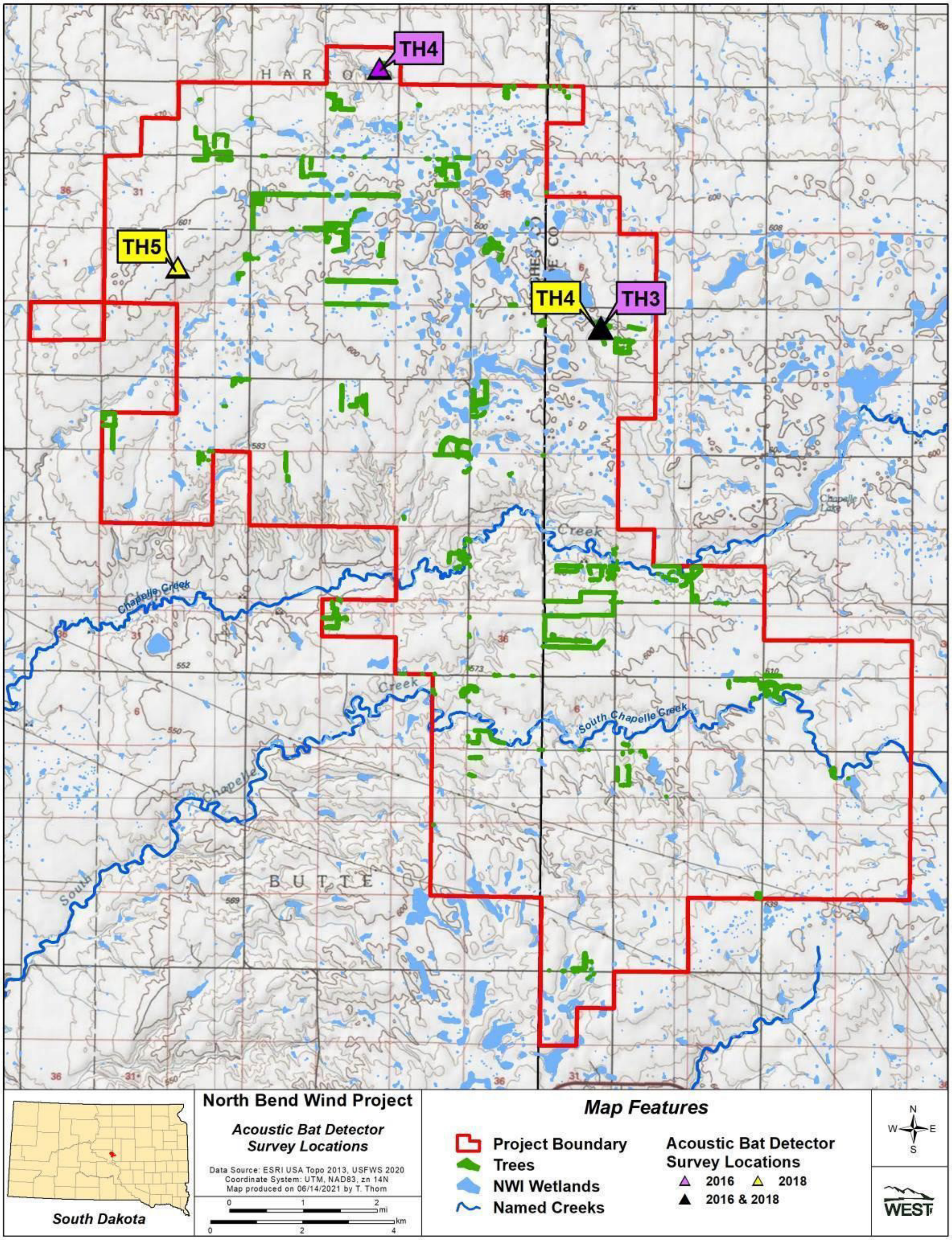

Figure 5.13. Location of AnaBat detectors deployed during 2016 and 2018 within the North Bend Wind Project boundary in Hughes and Hyde counties, South Dakota.

6.0 ASSESSMENT OF RISKS TO BIRDS AND BATS

Potential impacts to species from wind energy development includes collisions during construction and operation, as well as other impacts such as habitat loss/fragmentation and disturbance/displacement of individuals from converted habitats and areas near project infrastructure. The data from site-specific and regional pre-construction avian and bat surveys, as well as publicly available information from other wind energy projects, were used to provide an assessment of risk to birds and bats at the Project. Bird risk associated with other sources of mortality (e.g., power line electrocutions/or collisions, vehicle collisions) was also assessed by reviewing literature of other sources of bird mortality.

6.1 Mortality Risk Assessment

6.1.1 Birds

Project construction can result in the direct mortality of birds and other wildlife. Incidental impacts from construction activities could include the destruction of nests, eggs, or young, as well as collisions with vehicles and construction equipment. Collision with various man-made structures can be a significant source of bird mortality (Table 6.1). On a nationwide scale, wind turbines are estimated to be responsible for 0.01% to 0.02% of all avian mortalities due to human structures (Table 6.1; Erickson et al. 2001, 2002b, 2005).

Table 6.1. Estimated annual avian mortality from anthropogenic causes in the United States.

Mortality Source	Estimated Annual Mortality	Reference
Depredation by domestic cats	1.4 – 3.7 billion	Loss et al. 2013
Collisions with buildings	98 – 980 million	Klem 1990
Collisions with power lines	Tens of thousands to 174 million	US Fish and Wildlife Service (USFWS) 2002, Avian and Powerline Line Interaction Committee 2006
Automobiles	60 – 80 million	Erickson et al. 2005
Pesticides	67 million	Pimentel et al. 1991
Communication towers	6.8 million	Longcore et al. 2012
Oil pits	500,000 – 1 million	USFWS 2009
Wind turbines	368,000 – 573,000	Smallwood 2013, Erickson et al. 2014
Aircraft	4,722	Dolbeer et al. 2009

The number of avian mortalities at wind energy facilities is generally low when compared to the total number of birds observed at these sites (Erickson et al. 2002b). Although avian collision mortality can occur during both the breeding and migration seasons, patterns in avian mortality at tall towers, buildings, wind turbines, and other man-made structures suggest that the majority of mortalities occur during the spring and fall migration periods (National Research Council [NRC] 2007). Limited data from existing wind facilities suggest that migratory species represent roughly half of documented mortalities, while resident species represent the other half (NRC 2007).

6.1.1.1 Raptors

Raptors occur in most areas with the potential for wind energy development (NRC 2007) and raptor use within the Project area was assessed using fixed-point avian use surveys. The Project area and survey methodology have shifted numerous times during development (Figure 6.1) due to various logistic constraints and changes in Project area. However, observations collected from all years of field effort (2016-2017, 2018-2019, 2019-2020, 2020-2021, and ongoing 2021-2022 field effort) are included in this report to provide general information on raptor use.

No federal or state endangered non-eagle raptor species were seen within the Project during any field effort. One BCC, the northern harrier, was observed within the Project and was the most commonly observed raptor species during spring, summer, and fall for all years except for the 2019-2020 and ongoing 2021-2022 field effort.

Potential impacts to bald and golden eagles are of particular concern for wind projects in the US. Both species are protected by the BGEPA and MBTA. From January 2016 through September 2021, 12 total eagle observations (six of bald eagles and six of golden eagles) were recorded during 900 hours of survey effort (following the ECPG) within 800 m from observation point and below 200 m above ground level. Although levels of bald and golden eagle use were relatively low within the Project area, there is the potential for collision risk to both bald and golden eagles at the Project. Siting turbines away from known raptor nest locations and abrupt topographic features, as well as away from areas of identified concentrated use or prey sources, may help to minimize potential impacts to raptors including eagles. There are no known eagle nests within two mi of the Project.

Twenty-five studies from wind energy facilities in South Dakota, North Dakota, and Minnesota have publicly available raptor mortality data. Among these, diurnal raptor fatalities ranged from zero fatalities per megawatt (MW) per year to 0.47 fatality/MW/year (Figure 6.2). Based on the general proximity of these facilities to the Project, diurnal raptor fatalities at the Project may be within this range; however, other factors, such as comparisons of abundance or use in relation to other facilities, habitat, or species compositions, may help further inform potential risk.

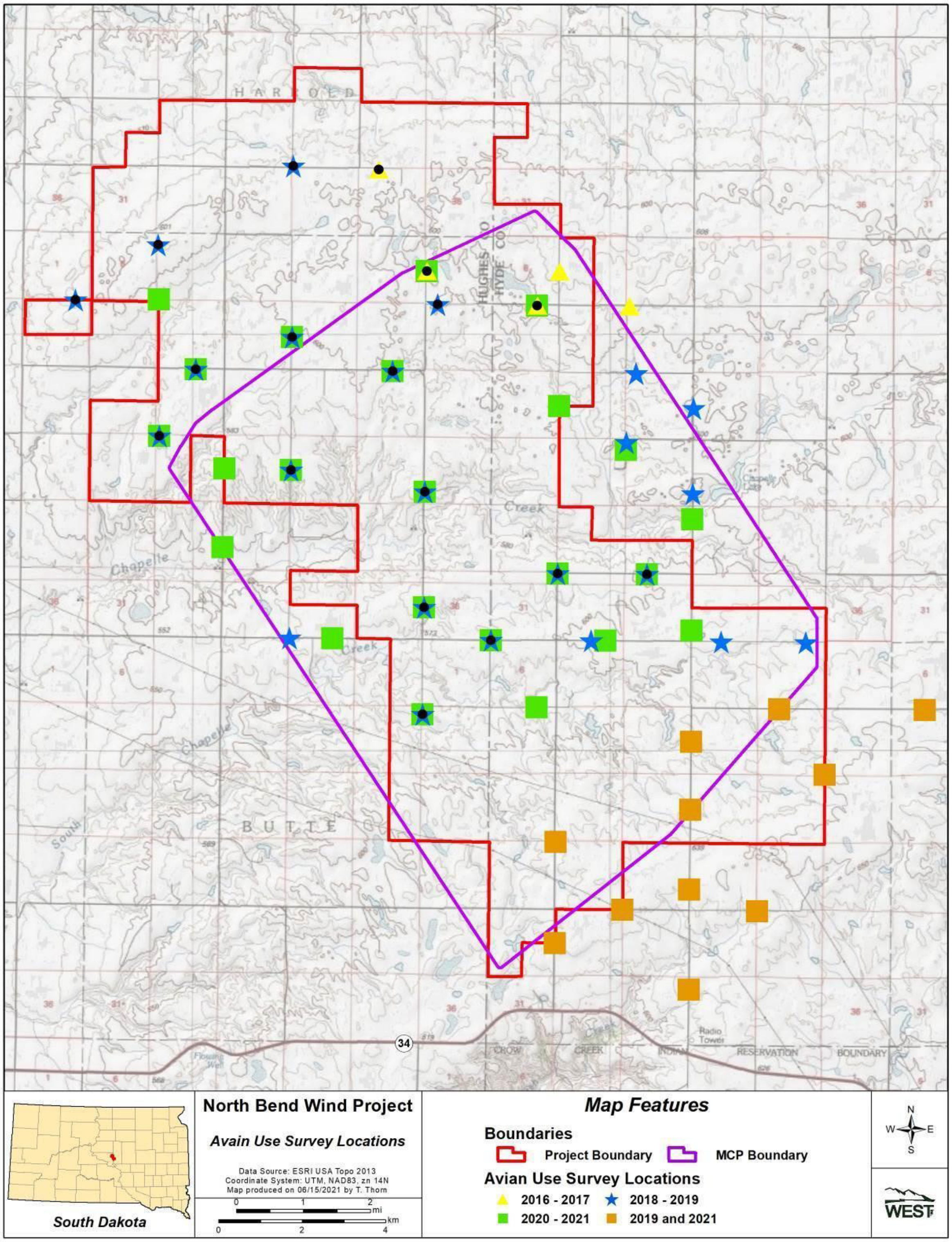

Figure 6.1. Location of fixed-point avian use survey stations completed in from 2016-2021 throughout the North Bend Wind Project boundary located in Hughes and Hyde counties, South Dakota. The Minimum Convex Polygon Boundary (purple outline) encapsulates the final proposed turbine layout.

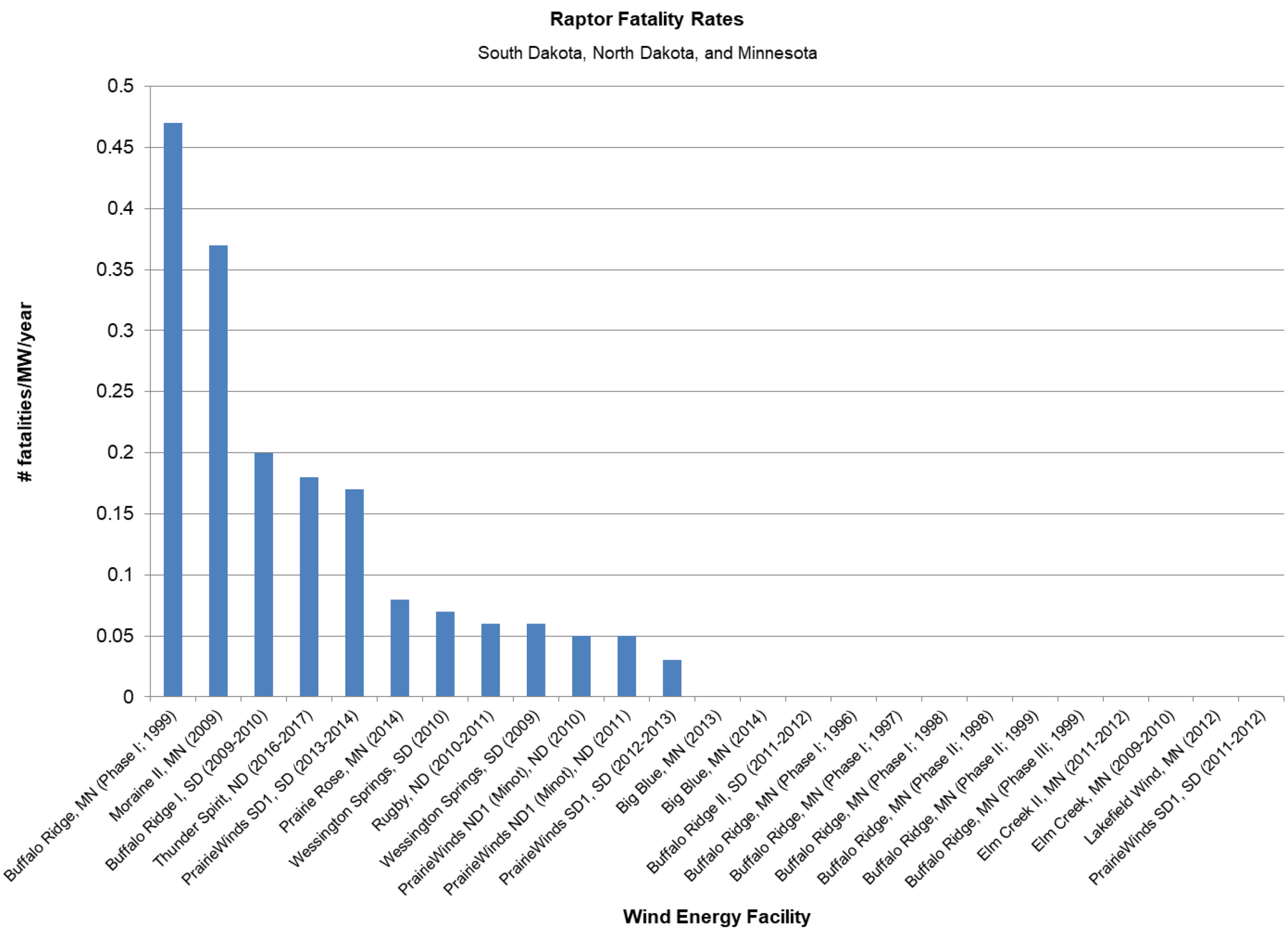

Figure 6.2. Fatality rates for diurnal raptors (number of raptors per megawatt [MW] per year) from publicly available studies at wind energy facilities in South Dakota, North Dakota, and Minnesota.

Figure 6.2 (*continued*). Fatality rates for bats (number of bats per megawatt [MW] per year) from publicly available studies at wind energy facilities in South Dakota, North Dakota, and Minnesota.

Data from the following sources:

Wind Energy Facility	Fatality Reference
Buffalo Ridge, MN (Phase I; 1999)	Johnson et al. 2000a
Moraine II, MN (2009)	Derby et al. 2010e
Buffalo Ridge I, SD (2009-2010)	Derby et al. 2010c
Thunder Spirit, ND (2016-2017)	Derby et al. 2018
PrairieWinds SD1, SD (2013-2014)	Derby et al. 2014
Prairie Rose, MN (2014)	Chodachek et al. 2015
Wessington Springs, SD (2010)	Derby et al. 2011a
Rugby, ND (2010-2011)	Derby et al. 2011b
Wessington Springs, SD (2009)	Derby et al. 2010b
PrairieWinds ND1 (Minot), ND (2010)	Derby et al. 2011c
PrairieWinds ND1 (Minot), ND (2011)	Derby et al. 2012d
PrairieWinds SD1, SD (2012-2013)	Derby et al. 2013
Big Blue, MN (2013)	Fagen Engineering 2014
Big Blue, MN (2014)	Fagen Engineering 2015
Buffalo Ridge II, SD (2011-2012)	Derby et al. 2012a
Buffalo Ridge, MN (Phase I; 1996)	Johnson et al. 2000a
Buffalo Ridge, MN (Phase I; 1997)	Johnson et al. 2000a
Buffalo Ridge, MN (Phase I; 1998)	Johnson et al. 2000a
Buffalo Ridge, MN (Phase II; 1998)	Johnson et al. 2000a
Buffalo Ridge, MN (Phase II; 1999)	Johnson et al. 2000a
Buffalo Ridge, MN (Phase III; 1999)	Johnson et al. 2000a
Elm Creek II, MN (2011-2012)	Derby et al. 2012b
Elm Creek, MN (2009-2010)	Derby et al. 2010d
Lakefield Wind, MN (2012)	Minnesota Public Utilities Commission 2012
Prairie Winds SD1, SD (2011-2012)	Derby et al. 2012c

6.1.1.2 Non-raptor Species

Several birds of conservation concern (BCC) species and species of greatest conservation need (SGCN) were observed throughout the years that avian use fixed-point surveys were conducted. Two BCC passerine species, bobolink and grasshopper sparrow, and one BCC gull species, Franklin's gull, were observed in the Project area during the 2019-2020, 2020-2021, and ongoing field efforts. Chestnut-collared longspur and marbled godwit, species that are both a BCC and SGCN, were also observed in avian use fixed-points during those time frames. Red-headed woodpecker, a BCC species, and lark bunting, a SGCN, were observed only during the 2019-2020 field effort. The results of this study show that risk of collisions with wind turbines for passerines would most likely be greatest in the spring and summer, as mean use and the percent of total use were highest in those seasons. Given the presence of non-raptorial birds throughout the Project, risk of collisions with wind turbines will likely be uniform throughout most of the Project area (Appendix E).

6.1.2 Bats

Bat fatalities have been discovered at most wind energy facilities monitored in North America, with estimated mortality rates ranging from 0.10 (Tierney 2007) to 39.70 bats/MW/year (Fiedler et al. 2007 2007). In 2012, an estimated 600,000 bats died as a result of interactions with wind turbines in the US (Hayes 2013). Bat mortality at wind farms is largely due to collisions with moving turbine blades (Grodsky et al. 2011 2011, Rollins et al. 2012), but the underlying reasons for why bats come near turbines are still largely unknown (Cryan and Barclay 2009). While it is generally expected that pre-construction bat activity is positively correlated to post-construction bat mortalities (Kunz et al. 2007a), to date, this relationship has not been found to be significantly correlated (Hein et al. 2013, Solick et al. 2020). Therefore, the current approach to assessing the risk to bats requires a qualitative analysis of activity levels, spatial and temporal relationships, species composition, and comparison to regional fatality patterns.

Overall, bat activity rates at the Project were low to moderate, with the majority of bat passes consisting of HF bats during the 2016 study (177 calls), and LF bats during the 2018 study (91 calls) with no NLEB calls detected. Given that hoary bats, eastern red bats, and silver-haired bats are among the most commonly found bat fatalities at many facilities (Arnett et al. 2008, Arnett and Baerwald 2013), it is expected these three species would likely be the most common fatalities at the Project.

Most bat fatality studies at wind energy facilities in the US have shown a peak in fatality in August and September, generally lower mortality earlier in the summer, and very low mortality during the spring (Johnson 2005, Arnett et al. 2008). At the Project, peak activity occurred from late July to early August in 2018, and early September in 2016. These results suggest bat fatalities at the Project may be highest during the late summer to early fall, consistent with fall bat migration.

Among facilities with publicly available data in South Dakota, North Dakota, and Minnesota, bat fatalities have ranged between 0.16 and 19.87 fatalities/MW/year (Figure 6.3). The closest operating wind energy facility to the Project with public post-construction fatality data is the PrairieWinds SD1, located approximately 80 km (50 mi) southeast of the Project. Bat casualty rates at PrairieWinds SD1 have ranged from 0.52–1.23 bats/MW/year (Derby et al. 2012c, 2013, 2014). It is likely the Project will have similar fatality rates as the PrairieWinds SD1 wind energy facility; however, PrairieWinds SD1 is composed of more herbaceous grassland habitat (64%) and less cropland 33% habitats whereas the Project is primarily composed of less grassland (52%) and more cropland (44%) habitats. Some studies indicate facilities in agricultural settings in the Midwest can produce higher levels of bat fatalities (Jain 2005, Baerwald 2008, Gruver et al. 2009); therefore, fatalities at the Project may be more similar to other wind energy facilities in the Midwest. Mean bat activity at the Project during the FMP (9.08 ± 3.23 in 2016 and 0.39 ± 0.06 in 2018 for representative sites) was within the range of values reported for publicly available Midwest studies (median 6.97 bat passes per detector-night; Appendices K and L). Therefore, it is expected that bat mortality at the Project would be low to moderate and follow similar patterns as those observed at other facilities in the Midwest.

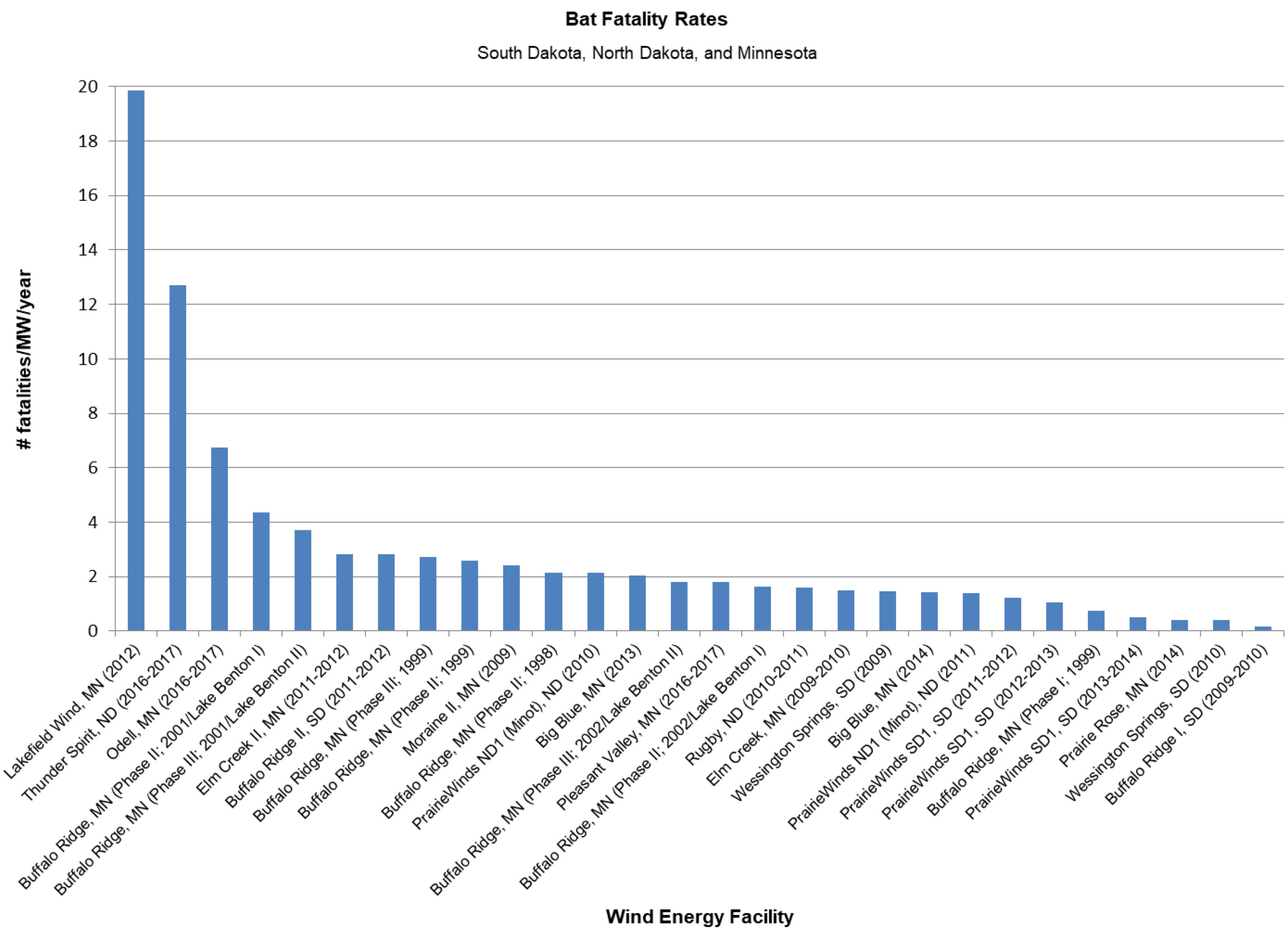

Figure 6.3. Fatality rates for bats (number of bats per megawatt [MW] per year) from publicly available studies at wind energy facilities in South Dakota, North Dakota, and Minnesota.

Figure 6.3 (*continued*). Fatality rates for bats (number of bats per megawatt [MW] per year) from publicly available studies at wind energy facilities in South Dakota, North Dakota, and Minnesota.

Data from the following sources:

Wind Energy Facility	Fatality Reference
Lakefield Wind, MN (2012)	Minnesota Public Utilities Commission 2012
Thunder Spirit, ND (2016-2017)	Derby et al. 2018
Odell, MN (2016-2017)	Chodachek and Gustafson 2018
Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)	Johnson et al. 2004
Buffalo Ridge, MN (Phase III; 2001/Lake Benton II)	Johnson et al. 2004
Elm Creek II, MN (2011-2012)	Derby et al. 2012b
Buffalo Ridge II, SD (2011-2012)	Derby et al. 2012a
Buffalo Ridge, MN (Phase III; 1999)	Johnson et al. 2000a
Buffalo Ridge, MN (Phase II; 1999)	Johnson et al. 2000a
Moraine II, MN (2009)	Derby et al. 2010e
Buffalo Ridge, MN (Phase II; 1998)	Johnson et al. 2000a
PrairieWinds ND1 (Minot), ND (2010)	Derby et al. 2011c
Big Blue, MN (2013)	Fagen Engineering 2014
Buffalo Ridge, MN (Phase III; 2002/Lake Benton II)	Johnson et al. 2004
Pleasant Valley, MN (2016-2017)	Tetra Tech 2017
Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)	Johnson et al. 2004
Rugby, ND (2010-2011)	Derby et al. 2011b
Elm Creek, MN (2009-2010)	Derby et al. 2010d
Wessington Springs, SD (2009)	Derby et al. 2010b
Big Blue, MN (2014)	Fagen Engineering 2015
PrairieWinds ND1 (Minot), ND (2011)	Derby et al. 2012d
PrairieWinds SD1, SD (2011-2012)	Derby et al. 2012c
PrairieWinds SD1, SD (2012-2013)	Derby et al. 2013
Buffalo Ridge, MN (Phase I; 1999)	Johnson et al. 2000a
PrairieWinds SD1, SD (2013-2014)	Derby et al. 2014
Prairie Rose, MN (2014)	Chodachek et al. 2015
Wessington Springs, SD (2010)	Derby et al. 2011a
Buffalo Ridge I, SD (2009-2010)	Derby et al. 2010c

6.2 Disturbance/Displacement

6.2.1 Birds

In addition to removing habitat, wind turbines may displace wildlife from an area due to the creation of edge habitat, the introduction of vertical structures, and disturbances directly associated with turbine operation (e.g., noise and shadow flicker; NRC 2007, USFWS 2012). Impacts are concentrated near turbine locations and along access roads, although available data indicate avoidance of wind turbines by primarily grassland birds generally extends 75 to 800 m (245 to 2,625 ft) from a turbine, depending on the environment and the bird species affected (Strickland 2004; Shaffer and Buhl 2016). The magnitude of these impacts is expected to be minimal, as the Project will result in a relatively small amount of habitat loss and disruption relative to the surrounding landscape. Impacts are expected to consist primarily of shifts in species distribution within the Project area similar to existing trends in species distribution resulting from other ongoing anthropogenic effects, such as grassland conversion to cropland and wetland drainage (USFWS 2012). Pearse et al. (2021) described a "Zone of Influence" (potential avoidance) extending out to five km (3.1 mi) from existing wind turbines based on an analysis of telemetry locations from whooping crane along their migration corridor. Similar to grassland birds, potential impacts to whooping cranes is expected to be minimal as potential stopover habitat (i.e., wetlands) can be found in the surrounding area (Appendix C; Section 5.1.2).

A review of the literature by Dooling (2002) on how well birds can hear in noisy (windy) conditions suggests that birds cannot hear the noise from wind turbine blades as well as humans can. In practical terms, a human with normal hearing can probably hear a wind turbine blade from twice as far away as can the average bird. Although Dooling's study was intended to explore potential avoidance measures for birds, the author found that birds habituate to acoustic disturbances and that blade noise becomes inaudible to some bird species at 25 m (82 ft) from the turbine, suggesting that impacts from noise may be minimal at these distances.

Raptors nesting closer to turbines have the potential to be disturbed due to construction or operation of the facility. Birds displaced from wind energy facilities might move to lower quality habitat with fewer disturbances, with an overall effect of reducing breeding success. Most studies on raptor displacement at wind energy facilities, however, indicate effects to be negligible (Howell and Noone 1992; Johnson et al. 2000a; Madders and Whitfield 2006). Given the low density of raptor nests documented within the current Project boundary and surrounding area during four years of nest surveys, limited displacement of nesting raptors is anticipated for the Project.

Wind energy facility construction appears to cause small-scale local displacement of grassland passerines (Leddy et al. 1999, Johnson et al. 2000a, Shaffer and Buhl 2016). Construction also reduces habitat effectiveness because of the presence of access roads and large gravel pads surrounding turbines (Leddy 1996, Johnson et al. 2000a). Leddy et al. (1999) surveyed bird densities in Conservation Reserve Program grasslands at the Buffalo Ridge wind energy facility in Minnesota and found mean densities of 10 grassland bird species were four times higher at areas located 180 m (591 ft) from turbines than they were at grasslands nearer turbines. Similarly, Shaffer and Buhl (2016) demonstrated reduced breeding density by seven of nine breeding grassland birds and the attraction of one species (killdeer [*Charadrius vociferus*]), likely attributed to increased nesting habitat from road and pad construction, and has recommended assessing displacement out to 300 m (984.3 ft) for grassland species (Shaffer et al. 2019). Johnson et al. (2000a) found reduced use of habitat by seven of 22 grassland-breeding birds following construction of the Buffalo Ridge wind energy facility. Results from the Stateline wind energy facility in Oregon and Washington (Erickson et al. 2004) and the Combine Hills wind energy facility in Oregon (Young et al. 2006) suggest a relatively small impact of wind energy facilities on grassland-nesting passerines. Transect surveys conducted prior to and after construction of the wind energy facilities found that grassland passerine use was significantly reduced within approximately 50 m (164 ft) of turbine strings, but areas further away from turbine strings did not have reduced bird use. The majority (51.9%) of the Project area consists of herbaceous (e.g., grassland) cover while 43.9% of the Project area consists of cultivated crops. While turbines have been sited to avoid and minimize impacts to grasslands to the extent possible given other limiting factors by moving turbines out of grasslands or to the periphery of those grasslands, some displacement may still occur for avian grassland species.

6.2.2 Bats

Limited information is available regarding the disturbance or displacement of bats at wind energy facilities (Kunz et al. 2007b). Any bats roosting in the Project area may be temporarily disturbed by human activities, although roosting habitat is limited within the Project area and activities would largely occur away from water resources and human structures that could attract bats. Bat habitat for resident bats within the Project area is limited to a few forested patches, small groves of trees, fencerows near homesteads, and wetland areas. Outbuildings and other anthropogenic structures may be used as roosting habitat by some species, and cultivated crops may provide marginal foraging habitat for bat species adapted to using that habitat. Due to the lack of any known maternity roosts near the Project (nearest in the Black Hills, South Dakota [Abernethy et al. 2019]), and avoidance of siting turbines near larger (≥ 10 ac) tracts of trees, displacement impacts to bats at the Project are expected to be minimal.

6.3 Potential Risk to Endangered, Threatened, and Sensitive Species

The USFWS Information for Planning and Consultation (IPaC) tool (USFWS 2021d) and SDGFP county distribution list (SDGFP 2016) identified the potential for several federally and state-listed species to occur within Hyde and Hughes counties, South Dakota (Section 5.1.1, Tables 5.1, 5.2, 5.3). In addition, the USFWS IPaC identified several BCC species that may potentially occur in the Project (Section 5.1.1, Table 5.2). Some of these BCC species, as well as other BCC species, were identified during site-specific avian use studies (Section 5.2.1, Table 5.4). The potential impacts to these species are described below. Federally listed species are also addressed in the Project's biological assessment.

6.3.1 Northern Long-eared Bat and Other Sensitive Bat Species

The Project area is not located near any large, known bat colonies (Appendix A), caves, rocky outcrops, or other features that are likely to attract large numbers of bats. In addition, the Project area does not contain topographic features that may funnel migrating bats (e.g., long draws or treed riparian corridors). Roosting habitat within the Project is limited to a few forested patches (Appendix D; Section 5.1.3), trees near homesteads, and various barns and outbuildings. Although the Project provides limited roosting opportunities for bats, North Bend has avoided areas identified as potential roosting habitats for siting turbines pursuant to USFWS recommendations, thus minimizing impacts to sensitive bat species. Additionally, curtailment below 5.0 m/s during the fall season (August 15 – October 15) shall be implemented to further reduce potential impacts to the species as required under the PEIS and PBA.

6.3.2 Bald and Golden Eagle

There are no known eagle concentration areas (see Section 5.2) within the Project area or immediate vicinity of the Project. Eagle observations recorded during baseline studies conducted in the Project area suggest eagle use is relatively low (Appendix E). Based on the results of avian use surveys, the Project does not appear to contain areas of concentrated eagle foraging opportunities (e.g., carcass pits, prairie dog colonies, large lakes). Additionally, there are no known prairie dog (*Cynomys* spp.) colonies within the Project area. The rolling hills comprising the Project area are not expected to create conditions suitable for strong updrafts of wind and would not be expected to greatly influence the potential collision risk to eagles. Additionally, there has been no detection of an occupied eagle nest within 2.0 mi of the Project area (Appendices G and H). Based on relatively low eagle use and the lack of nesting eagles in the Project area and surrounding vicinity, impacts to eagles are estimated to be low.

6.3.3 Piping Plover

No piping plovers (*Sternula antillarum*; a state- listed threatened [ST] species and federally listed threatened [FT] species; USFWS 1985]) were detected in the Project area during avian use surveys or incidentally (Appendix E); however, the species is known to breed along the Missouri River system (SDGFP 2016). Due to the lack of observations and the Project's location outside of the species' breeding locations in South Dakota, impacts to piping plover are estimated to be low.

6.3.4 Rufa Red Knot

No rufa red knots (*Calidris canutus rufa*; FT [USFWS 2014]) were detected in the Project area during avian use surveys or incidentally (Appendix E); however, the species may potentially migrate over the Project area (USFWS 2019b). Limited stopover habitat for the species (e.g., wetlands) exists within the Project. Due to the lack of detections, limited suitable stopover habitat, and the Project's location outside of the species' breeding and winter ranges, impacts to rufa red knot are estimated to be low.

6.3.5 Whooping Crane

The Project area is contained completely within the 50th percentile whooping crane migration corridor and occasional sightings are expected. However, no whooping cranes (state-listed endangered species [SDGFP 2016] and federal-listed endangered species [USFWS 1967]) were detected in the Project area during avian use surveys or incidentally; however potentially suitable whooping crane stopover habitat does occur in the Project and surrounding landscape (Section 5.1.2), and the species is known to occur in Hyde and Hughes counties (SDGFP 2016) based on one observation from 1997 (Appendix C). The widespread availability of suitable stopover habitat indicates that if whooping cranes are displaced by development of the Project, the birds are likely to find similar or better habitat nearby. Due to the lack of concentrated whooping crane stopover habitat within the Project relative to the surrounding landscape, impacts to whooping crane are estimated to be low. Implementation of biomonitoring and curtailment (Appendix M) has been successful at the adjacent Triple H Wind Project (Appendix O).

6.3.6 Black Tern

Twenty-one black tern (BCC [USFWS 2021a] and South Dakota SGCN [SDGFP 2014]) observations were detected in the Project area incidentally or during avian use surveys (Section 5.2.1.6). Although the Project area lies within the breeding range of the species, impacts to black tern are estimated to be low due to the limited amount of suitable habitat (e.g., marshes, ponds, lakes, flooded fields, and wetlands) in the Project area.

6.3.7 Greater Prairie-chicken

Six greater prairie-chicken (BCC [USFWS 2021a] and South Dakota SGCN [SDGFP 2014]) observations were detected in the Project area during avian use surveys (Section 5.2.1.6). Additionally, a total of 16 leks have been identified as active since 2016 (Section 5.2.3). However, in the last survey (2020), only eight of these leks remained active with at least two males in attendance for two or more years in the past five years. As greater prairie-chicken is a grassland bird, avoidance of grasslands will help reduce potential impacts to the species. As the Project is within a landscape that includes grasslands and not all turbines (or infrastructure) could avoid grasslands, turbines are expected to be sited within one mile of active leks, potential local impacts to this species.

6.3.8 Chestnut-collared Longspur

Sixty-one chestnut-collared longspur (BCC [USFWS 2021a] and SGCN [SDGFP 2014]) observations were detected in the Project area during avian use surveys (Section 5.2.1.6). The Project area lies within the breeding range of the species (Bleho et al. 2020). Due to the number of detections in the Project area and the amount of potentially suitable breeding (e.g., short-grass prairie) and foraging (e.g., agricultural land) habitat, impacts to chestnut-collared longspur are estimated to be low to moderate.

6.3.9 Franklin’s Gull

Franklin’s gull (BCC [USFWS 2021a]) was the most common sensitive status species recorded within the Project area, totaling 227 observations (Section 5.2.1.6). The Project lies within the species’ breeding range (USFWS 2021d). Due to the number of observations and suitable breeding habitat (e.g., wetlands) in the Project area, impacts to Franklin’s gull are estimated to be low to moderate.

6.3.10 Northern Harrier

Sixty-seven northern harrier (BCC [USFWS 2021a]) observations were detected in the Project area during avian use surveys (Section 5.2.1.6). The Project area contains foraging and nesting habitat (e.g., grasslands) that the species uses with some regularity. Due to the number of detections and potentially suitable foraging habitat, impacts to this species are estimated to be low to moderate.

6.3.11 Bobolink

Eighty-one bobolink (BCC [USFWS 2021a]) observations were detected in the Project area during avian use surveys or incidentally (Section 5.2.1.6); and, the Project lies within the species’ breeding range (USFWS 2021d). Due to the few detections (see Section 5.2) and limited suitable breeding habitat (e.g., damp meadows and dense prairies), impacts to bobolinks are estimated to be low.

6.3.12 Grasshopper Sparrow

Grasshopper sparrow (BCC [USFWS 2021a]) was the second most often observed species in the Project area during avian use surveys with 117 detections (Section 5.2.1.6). The Project area lies within the breeding range of the species. Due to the number of detections in the Project area and the amount of potentially suitable habitat (e.g., grasslands, prairies, hayfields, agricultural fields), impacts to grasshopper sparrow are estimated to be low to moderate.

6.3.13 Red-headed Woodpecker

Six red-headed woodpecker (BCC [USFWS 2021a]) observations were detected in the Project area during avian use surveys (Section 5.2.1.6); however, the Project lies within the species' breeding range (USFWS 2021d). Due to the lack of detections and limited suitable breeding habitat (e.g., isolated tree groves and shelterbelts, orchards, shade trees), impacts to red-headed woodpecker are estimated to be low.

6.3.14 Marbled Godwit

Thirty-four marbled godwit (BCC [USFWS 2021] and SGCN [SDGFP 2014]) observations were detected in the Project area during avian surveys (Section 5.2.1.6). Although the Project area lies within the breeding range of the species (USFWS 2021d), impacts to marbled godwit are estimated to be low to moderate due to the presence of potentially suitable habitat (e.g., native prairie with nearby wetlands) in the Project area.

6.3.15 Lark Bunting

Forty-five lark bunting (BCC [USFWS 2021a]) observations were detected in the Project area during avian surveys (Section 5.2.1.6). Although the Project area lies within the breeding range of the species (USFWS 2021d), impacts to lark bunting are estimated to be low to moderate due to the presence of potentially suitable habitats (e.g., native prairies, hay/pasture).

7.0 AVOIDANCE AND MINIMIZATION MEASURES

Information gathered during Tier 1, 2, and 3 studies will be used during the Project design and turbine and infrastructure siting process to reduce potential impacts to birds and bats and their habitats. The following conservation measures will be implemented during the design, construction, and operational phases of the Project. These conservation measures represent North Bend's willingness to ensure the least harm to avian and bat species.

7.1 Conservation Measures Implemented During Site Selection and Project Design

Based on the initial Tier 1-3 studies, North Bend determined the Project area to be the preferred location for a wind energy project based upon the following reasons related to potential avian and bat impacts:

- The Project area does not contain known federally threatened or endangered species or designated critical habitat with exception of one whooping crane observation in 1997.
- Eagle and raptor use of the Project area was considered relatively low for the region.

North Bend made efforts during initial site selection and during Project design to locate and select wind turbines, meteorological (met) towers, and other appurtenances such that bird and bat collisions are minimized. Project design and siting measures to avoid or minimize risk to avian and bat species included the following:

- Avoidance of eagle nests by at least two miles.
- Northern long-eared bat summer roosting and foraging habitats were avoided.
- Use the existing road network to reduce the need for road construction.
- Coordinate with the Federal Aviation Administration to minimize the number of wind turbines and met towers that require lighting.
- Keep lighting at substations and other operations and maintenance facilities at a minimum required for safety and security needs (e.g., directional, hooded and/or shielded, low-intensity, low-sodium lights equipped with motion sensors). Extinguish all internal turbine nacelle and tower lighting when unoccupied.
- Maximize power generation per turbine to reduce the number of turbines needed to achieve maximum energy production, to the extent commercially reasonable.
- Larger wetland complexes and any associated wetland easements were avoided to the extent practical.

7.2 Conservation Measures to be Implemented during Construction

Construction of the Project is expected to begin in 2022 and occur over a period of approximately 16 months, which will be the heaviest use of the site during the life of the Project. The following conservation measures will be implemented to avoid or minimize risk to avian and bat species during construction:

- Vehicle speeds will be limited to 25 mph (40 kph; DeVault et al. 2014). Construction vehicles will be restricted to pre-designated access routes. Following Project construction, roads not needed for site operations will be restored to native vegetation.
- To the extent feasible, the area required for Project construction and operation will be minimized. North Bend will develop a restoration plan for restoring all areas of temporary disturbance to their previous condition, including the use of native species when seeding or planting during restoration. The restoration plan will ensure:
    - All areas disturbed temporarily by Project construction will be restored, including temporary disturbance areas around structure construction sites, laydown/staging areas, and temporary access roads.
    - Topsoil salvage will be included in all grading activities, to the extent feasible.
    - Performance criteria, habitat replacement specifications, and tentative timeframes for restoration of the site, in addition to provisions for a monitoring program to assess the success of the restoration efforts will be included.
- Appropriate natural fiber erosion control methods will be used during construction to eliminate or minimize runoff in highly sensitive areas, and to avoid impacts to hydrology.

- North Bend will develop and implement a noxious weed control plan in accordance with the land lease agreements.
- North Bend will provide training resources to all construction and site personnel on identification of sensitive species and their habitats to minimize and/or avoid disturbance.
- No construction activities will occur within 2.0 mi of a prairie grouse lek (as defined on February 17, 2017; per the SDGFP) from March 1 – June 30. If a 2.0-mi avoidance buffer cannot be maintained, then no construction activities will occur within the first two hours after sunrise.
- Gravel will be placed at least 1.5 m (5.0 ft) around each turbine foundation that could discourage small mammals and reptiles from burrowing under or near turbine bases.
- Sensitive resources (e.g., nests) identified during pre-construction activities will be flagged and all site personnel notified of their presence and necessary setbacks.
- No unleashed dogs (*Canis familiaris*) will be allowed on the Project site during construction.
- All trash will be covered in containers and work sites will be cleared daily of any garbage and debris related to food.
- All permanent met towers will be un-guyed.
- All power lines will be constructed in accordance with the most current Avian Power Lines Interaction Committee (APLIC) Guidelines (APLIC 2012) to protect birds from electrocution and collision.
- A mitigation offset for potentially impacted whooping crane stopover habitat (1,310.8 ac) will be implemented by a third party in accordance to direction from the WAPA and USFWS prior to an interconnect.

7.3 Conservation Measures to be Implemented during Operations

- Low speed limits (e.g., less than 25 mph) will be enforced on all roads within the Project.
- Other than maintenance vehicles, which will park at the entrance of turbines for maintenance purposes, parts and equipment that may be used as cover for prey will not be stored at the base of wind turbines while a turbine is operational and spinning.
- Fire hazards from vehicles and human activities will be reduced (e.g., use of spark arrestors on power equipment, avoiding driving vehicles off roads, allowing smoking in designated areas only).
- North Bend will develop and implement a noxious weed control plan in accordance with the land lease agreements.
- Pest and weed control measures will be implemented as specified by county, state, and federal requirements.

- One year of post-construction monitoring will be conducted following the draft protocol in Section 8.1). With support from SDGFP, North Bend is also working cooperatively with SDGFP on a Tier 5 project to assess grassland bird displacement within a fragmented grassland landscape.
- Curtailment of turbine operation between August 15 and October 15 at wind speed below 5.0 m/s.
- North Bend will develop and implement a site-specific worker training plan throughout the operational life of the Project to inform workers of the biological resources present on site. This training will include whooping crane identification and turbine curtailment procedures to shut down turbines in the event a whooping crane is observed within 2.0 mi of a turbine (Appendix M). All employees and contractors working in the field will be required to participate in the plan prior to working on site.
- A carcass removal program will be implemented to minimize potential attractants for carrion-feeding raptors.
- All of North Bend's employees and contractors working on site will receive worker awareness training for identifying and responding to encounters with sensitive biological resources, including avian and bat species. The training will:
  - Be conducted by North Bend or their designee.
  - Include instructions for all employees, contractors, and site visitors to avoid harassing or disturbing wildlife.
  - Include instruction on identification and values of plant and wildlife species and significant natural plant community habitats, the issue of micro-trash and its effects, fire protection measures, , and hazardous material spill and containment measures.
  - Provide information to contractors and employees on the Project detailing information on potential state and federal special-status animal and plant species that might be discovered on the Project site.
  - Employees will be informed that they are not authorized to approach, handle, or otherwise move any eagles that might be encountered during construction, whether alive, injured, or deceased. Operations personnel will be instructed to report any finding of an injured or deceased eagle to the USFWS within 24 hours of positive identification of the eagle by a qualified biologist.

8.0 POST-CONSTRUCTION MONITORING: TIER 4

Based on preliminary analysis of data from Triple H Year 1 post-construction monitoring, fatalities are relatively low as compared to other projects in the Midwest and upper Great Plains at an estimated rate of 0.56 bird fatalities/megawatt (MW) and 0.53 bats/MW. These results were generated using GenEst (Dalthorp et al. 2018) as a fatality estimator and 2,662 standardized carcass searches with associate bias trials. No federally or state listed species were detected. No raptor were detected. Two species of greatest conservation need were detected during standard carcass searches including upland sandpiper (4) and grasshopper sparrow (1). Thirteen total bats were detected including eastern red bat (6), hoary bat (5), and silver-haired bat (2). It is expected, due to proximity, that North Bend will have similar results to the adjacent Triple H wind project.

8.1 Tier 4a – Avian and Bat Fatality Monitoring

North Bend will complete one year of Tier 4a avian and bat fatality monitoring efforts that are consistent with recommendations for operations monitoring included in the WEG, the PEIS, and are consistent with monitoring programs that have been conducted at wind projects in the Midwest and upper Great Plains. This post-construction study shall consist of three primary survey components: 1) standardized carcass searches, 2) searcher efficiency (SEEF) trials to estimate the probability a carcass was found by technicians during a standardized search, and 3) carcass persistence trials (CPT) to estimate the average length of time a carcass remained in the search area for possible detection. In addition, a search area adjustment will be estimated to account for carcasses that fell outside of search areas. Surveys will use a combination of square plots, roads and pads, and eagle/large bird scans. The survey was designed to achieve a g-value of 0.205 for northern long-eared bats using the USGS's Evidence of Absence (EoA) estimator (Huso et al. 2015) based on guidance from WAPA (pers. comm. January 5, 2023), as described below.

8.1.1 Survey Design – Carcass Searches

<u>8.1.1.1 Square Plots</u>

During the early spring months (approximately May 1 – May 15), when vegetation is short or sparse, all of the proposed turbines (71) will be searched with 160-m (525-ft) square plots until such time visibility is reduced to preclude effective searcher efficiency. Search frequency shall be approximately every three days. Starting October 1 through October 31, all proposed turbines will be searched with square plots once every two weeks. Starting March 1 through March 31, all proposed turbines will be searched with square plots once every two weeks. Searches will be done by walking a grid pattern within the search plot using a 10-m (33-ft) spacing between transects.

<u>8.1.1.2 Roads and Pads</u>

During late winter and early spring, (approximately April 1 - May 1), all turbines will be searched once every two weeks via road and pads out to 100 m (328 ft) from the turbine base. Starting May 16 (or once vegetation reduces visibility), through September 30, all 71 turbines will be searched via road and pads approximately every three days. Searches will be done by a biologist walking the road and pad within 100 m of the turbine while scanning for carcasses.

<u>8.1.1.3 Eagle/Large Bird Scans</u>

During late winter and early spring (approximately April 1 – May 15) and late fall (September 16 – October 31), eagle/large bird scans will be conducted at each turbine once every two weeks. During the winter months (November 1 – February 28), eagle/large bird scans will be conducted at each turbine once per month. Using binoculars, a biologist will scan the ground that is visible around each turbine, in each cardinal direction (north, east, south, west) up to 200 m (656 ft) out from the turbine.

8.1.2 Bias Trials

8.1.2.1 Searcher Efficiency Trials

The objective of SEEF trials is to collect data to estimate the probability observers detected bird and bat carcasses. This effort accounts for biases associated with changes in conditions such as vegetation, topography, weather (e.g., rain and/or cloud cover, muddy plots), and searcher variability that could have affected SEEF. Estimates of SEEF shall be used to adjust the total number of carcasses found to account for those missed by technicians.

SEEF trials will begin at the start of carcass searches and will be conducted in the same search areas throughout the study period. Approximately eight SEEF trials will be stratified by the type and size of carcasses (large bird, small bird, or bat), by search area (road and pad or full), and season (spring, summer, or fall) totaling approximately 144 individual SEEF trials. A bias trial administrator will place SEEF carcasses in search areas to keep technicians unaware of when and where the SEEF trial carcasses (SEEF carcasses) will be placed. Bird carcasses used for the trials can include non-native/non-protected or commercially available species, including rock pigeon (*Columba livia*) for large birds, two-week old quail (*Coturnix* spp.) for small birds. Brown-colored house mice (*Mus musculus*) can be used as surrogates for bats.

8.1.2.2 Carcass Persistence Trials

The objective of CPT is to collect data to estimate the average probability a bird or bat carcass remains available to be found during the search interval. The data collected will be used to adjust for the potential bias of carcasses removed during carcass searches. CPT will be conducted throughout the spring, summer, and fall, to incorporate the effects of varying weather, climatic conditions, and scavenger rates. Possible means of carcass removal include predators, scavengers, insects, or agricultural practices (e.g., being plowed into a field). Estimates of bird and bat carcass persistence will be used to adjust the total number of carcasses found as compared to those removed from the search area.

An estimated 30 CPT carcasses (10 large birds, 10 small birds, and 10 mice) will be used at each search type for CPT (road and pad plots and full plots). CPT carcasses will be monitored over a 30-day period according to the following schedule: every day for the first four days, then on day seven, 10, 14, 20, and 30. The condition of carcasses will be recorded each time the CPT carcasses were checked.

8.1.3 Statistical Analysis

8.1.3.1 Fatality Rate Estimation

Carcasses included in fatality rate estimates will include those found within the search areas (square plots or road and pad) and have an estimated time of death within the study period. Fatality estimates will be calculated for all categories (all birds, large birds, small birds, and bats) by season using GenEst (a generalized estimator of fatality; Dalthorp et al. 2018, Simonis et al. 2018). To obtain an overall estimate of fatality, each carcass included in the analysis will be adjusted for SEEF, carcass persistence, a detection reduction factor (also referred to as "*k*"; see below), and a search area adjustment. Estimates and confidence intervals (CI) will be calculated using a parametric bootstrap (Dalthorp et al. 2018) for each individual category listed above, assuming more than five fatalities were detected for the respective category (e.g., all birds, bats). Because fatalities of northern long-eared bats are considered rare events, the USGS's Evidence of Absence (EoA) estimator (Huso et al. 2015) was used to predict take of northern long-eared bats and to quantify uncertainty around those take predictions. As noted above, the survey methodology achieved an estimated overall g-value of 0.205.

8.1.3.2 Searcher Efficiency Estimation

Data collected during SEEF trials will be used to estimate the probability bird and bat carcasses detected by technicians. Estimates of SEEF will be used to adjust carcass counts for detection bias. Estimates will be obtained for each size class separately using a logit regression model (Dalthorp et al. 2018). Model selection will be done using an information theoretic approach known as AICc or corrected Akaike Information Criteria (Burnham and Anderson 2002). The best model will be selected as the most parsimonious model within two AICc units of the model with the lowest AICc value.

8.1.3.3 Carcass Persistence Estimation

Data collected during CPT will be used to estimate the amount of time in days that carcasses remained available to be located by the searcher. Estimates of carcass persistence will be used to adjust carcass counts for removal bias. The persistence of a carcass will be modeled using an interval-censored survival regression for each size class using exponential, log-logistic, lognormal, and Weibull distributions (Kalbfleisch and Prentice 2002, Dalthorp et al. 2018). Covariates (explanatory variables of interest) will be fitted to each of the parameters of the distributions. The best model will be selected as the most parsimonious model within two AICc units of the model with the lowest AICc value.

8.1.3.4 Detection Reduction Factor

The change in SEEF between successive searches will be defined by a parameter called the *detection reduction factor* (*k*) that ranges from zero to one. When *k* is zero it implies that a carcass is missed on the first search and that carcass would never be found. A *k* of one implied SEEF remains constant no matter how many times a carcass is missed. The detection reduction factor is a required parameter for GenEst; however, data will not collected to estimate *k*. A value for *k* of 0.67 has been estimated for bats (Huso et al. 2017) and this value will be assumed in this study for birds and bats.

8.1.3.5 Search Area Adjustment Estimate

The search area adjustment accounts for unsearched areas beneath turbines and is calculated as a probability that ranged from zero to one. For example, an area adjustment of 0.75 means that an estimated 75% of carcasses will fall within the search area. Unsearched areas can be attributed to obstacles such as ground cover (e.g., tall crops) or terrain, or areas where carcasses fall outside the search area (e.g., a carcass landed 120 m [394 ft] away from the turbine on a plot searched out to 100 m from the turbine base). The area adjustment will be estimated as the product of the unsearched area around each turbine and a carcass-density distribution. The carcass-density distribution predicts the likelihood a carcass falls a given distance from the turbine base. Separate area adjustments will be estimated for large birds, small birds, and bats.

A number of analysis methods exist to calculate the search area adjustment. The method used will be determined by the number of carcasses found during surveys. The proportion of area searched will be calculated in a geographic information system as the amount of area searched divided by the total area searched at each 1-m (3-ft) annulus around the turbine. The area adjustment will be estimated by combining the carcass-density distribution with the proportion of area searched for each 1-m annulus across the search area and summarizing across the distances.

In addition to implementing the previously described fatality monitoring protocol, the Project has committed to long-term monitoring for injured or deceased bird and bats. During operations, all injured MBTA-covered species, raptors, waterfowl, waterbirds, federally or state-listed bird species, and federally listed bats will be promptly delivered to the appropriate rehabilitation center or other approved facility as specified in state and federal permits; or as directed by necessary law enforcement personnel. All injured non-protected bird and bat species will be humanely euthanized on site.

Carcasses of federally listed species or eagle carcasses, if discovered, will be flagged, covered, and left in place. The USFWS will be notified within 24 hours of the discovery, and any handling of the carcass will be at the USFWS' direction/authorization. For non-federally listed species and non-eagle carcasses, North Bend may, at their option, either leave the carcasses in place or properly collect and dispose of the carcasses, depending on the selected practice at the Project, as determined by the Project's legal counsel. Should "leave in place" be the practice at the Project, then the person making the discovery will complete the Wildlife Incident Report form and file the form in the facility's files. Should it be Project practice to collect and dispose of non-listed and non-eagle carcass discoveries, the appropriate wildlife salvage and collection permits will be obtained from the SDGFP and USFWS prior to any collection of the carcasses. Upon completing the Wildlife Incident Report, the person will collect and dispose of the carcass in accordance with the applicable permit(s) and complete any reporting required by the applicable permit(s).

8.2 Tier 4b – Assessing Impacts to Habitat

Tier 3 studies have identified grassland habitats and species of habitat fragmentation concern (e.g., generally grassland bird species) within the Project that have the potential to be displaced based on previous research (Shaffer and Buhl 2016). Shaffer et al. (2019) provides an approach to quantify impacted grasslands for mitigation offsets. North Bend has followed guidance from both the USFWS and SDGFP to avoid grasslands to the extent possible and/or to site turbines to the periphery of grasslands as a minimization measure. However, based on the approach provided by Shaffer et al. (2019) and applying wildlife agency recommended avoidance and minimization measures, there could still be substantial voluntary grassland offsets requested. The current offset mitigation analysis (Shaffer et al. 2019), quantifies the proportion of grassland area that intersects a specified buffer around turbines, regardless of the habitat where that turbine is placed. With the support of SDGFP (support letter dated July 12, 2021), an alternative approach has been proposed to include a Tier 5 research effort, described in Section 9.

9.0 RESEARCH: TIER 5

In addition to Tiers 1-4 described above, the WEG discuss *Tier 5 Other Post-Construction Studies*. In general, the studies identified in Tier 5 are research related and "will not be necessary for most wind energy projects". However, considering the concern about potentially impacted grasslands and with the support of SDGFD (support letter provided on July 16, 2021), North Bend elected to proceed with a Tier 5 study to evaluate grassland breeding bird displacement along habitat edges that will incorporate results of post-construction monitoring (Section 8.1). This effort is designed using a robust before-after-control-impact design with a minimum of one year pre-construction data and two years of post-construction data. The objective of this study is to evaluate the effect of implementing avoidance and minimization measures on breeding grassland bird displacement.

10.0 ADAPTIVE MANAGEMENT

In the WEG, the USFWS defines adaptive management as "an iterative decision process that promotes flexible decision-making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood. Comprehensively applying the tiered approach embodies the adaptive management process" (USFWS 2012). The WEG further notes that adaptive management at a wind facility is unlikely to be needed if it is sited in accordance with the tiered approach. Nevertheless, North Bend recognizes the value of applying this approach to its Project activities that include some uncertainty with respect to wildlife impacts. As such, North Bend will incorporate an adaptive approach for the conservation of wildlife potentially impacted by the Project.

Section 5.0 of this BBCS describes the tiered approach used to study pre-construction wildlife conditions and predict Project impacts. Based on Project siting and the results of pre-construction wildlife studies, no significant adverse impacts are anticipated from the Project and mortality is expected to fall within the overall range of other projects in the Midwest and Mountain Prairie USFWS Regions (Section 6.0). More specifically, Project impacts are expected to be similar to those at Triple H (Section 8.1). Since the results of post-construction monitoring at Triple H did not show higher than anticipated impacts and in fact impacts were lower than most wind projects in the upper Great Plains and Midwest, adaptive management responses are not anticipated at this time. Thresholds for considering an adaptive response will follow those for Triple H and may include:

- Mortality of an eagle or a species listed as state or federally endangered/threatened; or
- Significant levels of mortality of unlisted species of birds or bats. Significance will be determined by qualified biologists and will be based on the latest information available,

including the most recent data on species' population sizes and trends. For example, even relatively high levels of mortality of the most common species may not be significant. Conversely, lower levels of mortalities of less common species may be of more concern, particularly if these species appear to be at risk (e.g., USFWS BCC).

If impacts are determined to be higher than anticipated, an assessment of why this is occurring will be conducted to aid in developing appropriate mitigation actions. If causation of effects is unknown, further monitoring efforts may be implemented to help understand effects. Some of the adaptive management options that could be considered, depending on the results of the post-construction mortality monitoring, and taking into account economic feasibility[2], include:

- Additional on-site studies (e.g., more intensive area use studies, prey base studies);
- Addition or modification of anti-perching, anti-nesting, or electrocution protection devices on "problem" Project facilities;
- Prey-base management through habitat alteration; and
- Experimentation with visual and/or auditory bird flight diverters.

If mitigation measures are put into place, additional monitoring to determine the effectiveness of the mitigation measures may be conducted, and, depending on the results, further remedial measures may or may not be warranted.

11.0 CONCLUSIONS

This BBCS was written to provide guidance for avoiding, minimizing, and monitoring potential effects to avian and bat species at the Project. The measures described in this document are intended to help protect and reduce effects to avian and bat species during the construction phase of the Project, as well as to monitor potential effects to avian and bat species following implementation of the Project. Further, it is anticipated that this BBCS will facilitate adaptive management at the Project based on information gathered during all phases of the Project and based on Tier 4 efforts at the Project.

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[2] Once the Project is operational there is a fixed amount of capital expenditure and the only available source of funding is from operational budgets, which must be within the economic parameters of the Project.

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12.2 Acts, Rules, and Regulations

16 United States Code (USC) § 668. 1940. Title 16 - Conservation; Chapter 5a - Protection and Conservation of Wildlife; Subchapter II - Protection of Bald and Golden Eagles; Section (§) 668 - Bald and Golden Eagles. 16 USC 668. [June 8, 1940, Chapter (Ch.) 278, Section (§) 2, 54 Statute (Stat.) 251; Public Law (PL) 87-884, October 24, 1962, 76 Stat. 1246; PL 92–535, §2, October 23, 1972, 86 Stat. 1065; PL 95-616, §9, November 8, 1979, 92 Stat. 3114.]. Available online: https://www.gpo.gov/fdsys/pkg/USCODE-2010-title16/pdf/USCODE-2010-title16-chap5A-subchapII.pdf

16 United States Code (USC) § 668c. 1940. Title 16 - Conservation; Chapter 5a - Protection and Conservation of Wildlife; Subchapter II - Protection of Bald and Golden Eagles; Section (§) 668c - Definitions. 16 USC 668c. [June 8, 1940, Chapter (Ch.) 278, Section (§) 4, 54 Statute (Stat.) 251; Public Law (PL) 92-535, § 4, October 23, 1972, 86 Stat. 1065.]. Available online: https://www.gpo.gov/fdsys/pkg/USCODE-2010-title16/pdf/USCODE-2010-title16-chap5A-subchapII.pdf

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Appendix A. Triple H Wind Project –Site Characterization Study - Report

Site Characterization Study of the Triple H Wind Resource Area
Hughes and Hyde Counties, South Dakota

Prepared for:

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Western EcoSystems Technology, Inc.

March 9, 2016

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This document or presentation includes Whooping Crane migration use data from the Central Flyway stretching from Canada to Texas, collected, managed and owned by the U.S. Fish and Wildlife Service. Data were provided to Western Ecosystems Technology, Inc. as a courtesy for their use. The U.S. Fish and Wildlife Service has not directed, reviewed, or endorsed any aspect of the use of these data. Any and all data analyses, interpretations, and conclusions from these data are solely those of Western Ecosystems Technology, Inc.

EXECUTIVE SUMMARY

The Triple H Wind Resource Area (THWRA or Project) is approximately 39,069 acres (ac; 15,811 hectares [ha]) located in the Northwestern Glaciated Plains Level III Ecoregion of Hughes and Hyde Counties, South Dakota. Land ownership in and around the THWRA is primarily private. Dominant land cover types are grassland and crop. The most abundant cover types within the THWRA are herbaceous lands followed by croplands: corn, sunflower, and spring wheat. Wetlands, individual trees, isolated tree stands, and deciduous tree lines are scattered throughout the THWRA.

Grasslands scattered throughout the THWRA may provide stopover habitat for migrant or individual birds. Harvested grain crops, such as corn and sunflower (observed during the 2016 site visit), could serve as feeding areas for migrating water birds, waterfowl, and other birds. The intermittent and perennial streams and emergent wetlands provide important stopover habitat for migrating water birds, waterfowl, and shorebirds, and may be attractive to raptors that hunt birds concentrated at waterbodies. These types of habitats are found throughout the region and, therefore, their presence in the THWRA are unlikely to disproportionally concentrate bird use compared to the surrounding areas.

There are two State Trust Lands within the boundary of the THWRA, and there are 3 protected areas within 10 miles of the THWRA with the potential to attract wildlife to the general region. The closest area likely to attract wildlife is Hyde County Waterfowl Production Area that is adjacent to the southern edge of the project boundary.

Wildlife species associated with grasslands and tilled agricultural landscapes are expected to be the most common species at the THWRA. Data from the two closest US Geological Survey (USGS) Breeding Bird Survey (BBS) routes from 2011 to 2014 include 86 bird species, with brown-headed cowbird, western meadowlark, common grackle, dickcissel, red-winged blackbird, mourning dove, and cliff swallow being the most commonly recorded species. A great horned owl nest and a total of 11 avian species and one mammal species, were recorded during the February 26, 2016 site visit, .with snow goose and horned lark being the most commonly observed species.

Seven federally-listed endangered, threatened, or candidate species have the potential to occur within the counties containing the THWRA based on geographic ranges: northern long-eared bat, whooping crane, red knot, piping plover, interior least tern, Sprague’s pipit, and pallid sturgeon. Occurrence of any of these species within the actual THWRA is unknown, but unlikely.

The following diurnal raptor and vulture species may occur in the THWRA: bald eagle, broad-winged hawk, Cooper’s hawk, ferruginous hawk, golden eagle, northern goshawk, northern harrier, osprey, red-tailed hawk, rough-legged hawk, sharp-shinned hawk, and Swainson’s hawk, three of which were documented during the winter 2016 site visit: golden eagle, northern harrier, and great horned owl. Non-breeding golden eagles are known to occur in the vicinity of the THWRA; bald eagles may occur year-round in the Project area. Nocturnal owl species that could be found in the Project area include the long-eared owl, short-eared owl, great horned owl, eastern screech owl, northern saw-whet owl, and burrowing owl.

One occupied great horned owl nest was recorded during the winter 2016 site. Potential raptor nesting areas were also documented in the winter 2016 site visit. Suitable raptor nesting habitat is present in the form of living and dead trees, buildings, and utility poles. Grassland areas could provide nesting habitat for ground-nesting raptors. Two prairie dog colonies were observed on the southern and eastern boundaries of the Project during the site visit. Prairie dog towns have the potential to concentrate raptor use. Other potential raptor prey species such as rodents, shrews, cottontails, and other birds are also present within the THWRA. Wetlands also serve to concentrate prey resources during most times of the year, but especially during migration and winter. With raptor roost sites (e.g., trees and power poles) and food available, it is likely that some raptors will use the THWRA for foraging.

Six of the eight bat species, based on range maps, that potentially occur in or around the THWRA have been documented as fatalities at wind energy facilities: big brown bat, eastern red bat, hoary bat, little brown bat, northern long-eared bat (federally-threatened and a State SGCN), and silver-haired bat. The other two bat species, the Townsend's big-eared bat (a State SGCN) and the western small-footed myotis, are unlikely to occur within the THWRA. Some suitable roosting and foraging bat habitat was found in the THWRA during the February 2016 site visit. Development and operation of the THWRA would likely result in fatalities of some bats with peak fatalities likely occurring during the fall season; however, fatalities should be within the average range of bat mortalities found at wind farms throughout the Midwest and South Dakota.

Information about sensitive species presence and locations may be requested from South Dakota Department of Game, Fish, and Parks (SDDGFP) and the US Fish and Wildlife Service (USFWS); however, a search of the USFWS iPaC database has been conducted and is included in the report.

INTRODUCTION

Knowledge of biological resource issues early in the development phase of wind energy facilities helps the industry identify, avoid, and minimize future impacts potentially resulting from project construction and operations. This report describes biological resources present within the proposed Triple H Wind Resource Area (THWRA or Project) and evaluates these general characteristics relative to potential or known impacts on the resources from the proposed Project. This Site Characterization Study (SCS) is intended to meet the requirements of a Tier 2 Site Characterization of the Land-based Wind Energy Guidelines (USFWS 2012a) by describing biological issues and potential risks that development may pose to species of concern or their habitats.

STUDY AREA

The THWRA located in Hughes and Hyde Counties, approximately 2 miles (mi; 3.2 kilometers [km]) south of the city of Holabird, South Dakota (Figure 1). The THWRA 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. This ecoregion is characterized by significant surface irregularity and high concentrations of seasonal and semi-permanent wetlands (prairie potholes). Land use is transitional between the intensive dryland farming to the east and the predominance of cattle ranching and farming to the west (Bryce et al. 1996). Mean temperatures in the area range between 14 – 60 Fahrenheit degrees (°F) (-10 and 16 Celsius degrees [°C]) and annual precipitation ranges from 9.8 to 21.6 inches (in) (250 to 550 mm; Bryce et al. 1996). The topography within the THWRA consists of rolling hills, with elevations ranging from 558 to 642 meters (m; 1,830 to 2,106 feet [ft]) above sea level (ASL; Figures 2 and 3; US Geological Survey [USGS] Digital Elevation Model [DEM] 2013). Land ownership in and around the THWRA is primarily private.

The primary land use/cover within the THWRA is herbaceous lands followed by cultivated crops, especially corn (*Zea mays*), sunflower (*Helianthus sp.*), and spring wheat (*Triticum aestivum*). All other land use/cover types represent a small percentage of the total area (Figure 4; US Geological Survey [USGS] National Land Cover Data [NLCD] 2011). Native plant communities are present within the THWRA, but non-native grasses are the most abundant grass type. The THWRA also contains open water areas, farmsteads, tree rows, wooded areas along streams, wind breaks, and wooded patches behind residences. Wetlands, especially freshwater emergent wetlands, are dispersed throughout the (Figure 5; USFWS NWI 2015, US Geological Service [USGS] National Hydrography Dataset [NHD] 2015). Appendix A includes representative photographs of the THWRA.

METHODS

Biological resources within the THWRA were evaluated through a reconnaissance-level site visit and a desktop search of publicly available data. Several sources of data were used to identify biological resources within the Project area, including published literature, field guides, prior assessments of the area, agency reports, data available from the US Fish and Wildlife Service (USFWS), the South Dakota Game, Fish, and Parks Department (SDDGFP), the USFWS National Wetlands Inventory (NWI), and public data sets. Information about sensitive species presence and locations was found online using the SDGFPD's list of Rare Animals and Plants (SDDGFP 2009, 2016a), the SDGFP's list of Threatened, Endangered, and Candidate Species (SDDGFPD 2015), and the USFWS Information, Planning, and Conservation (IPaC) System (USFWS 2016a, Appendix B).

The reconnaissance-level site visit conducted as part of this evaluation entailed an examination of the site from accessible public roads on February 26, 2016. Biological features and potential wildlife habitat, including plant communities, creeks, wetlands, topographic features, potential raptor nesting habitat, and potential raptor prey populations were evaluated during this visit. All wildlife species observed during the site visit were recorded (see Observed Wildlife section below), and photos were taken of the THWRA (Appendix A).

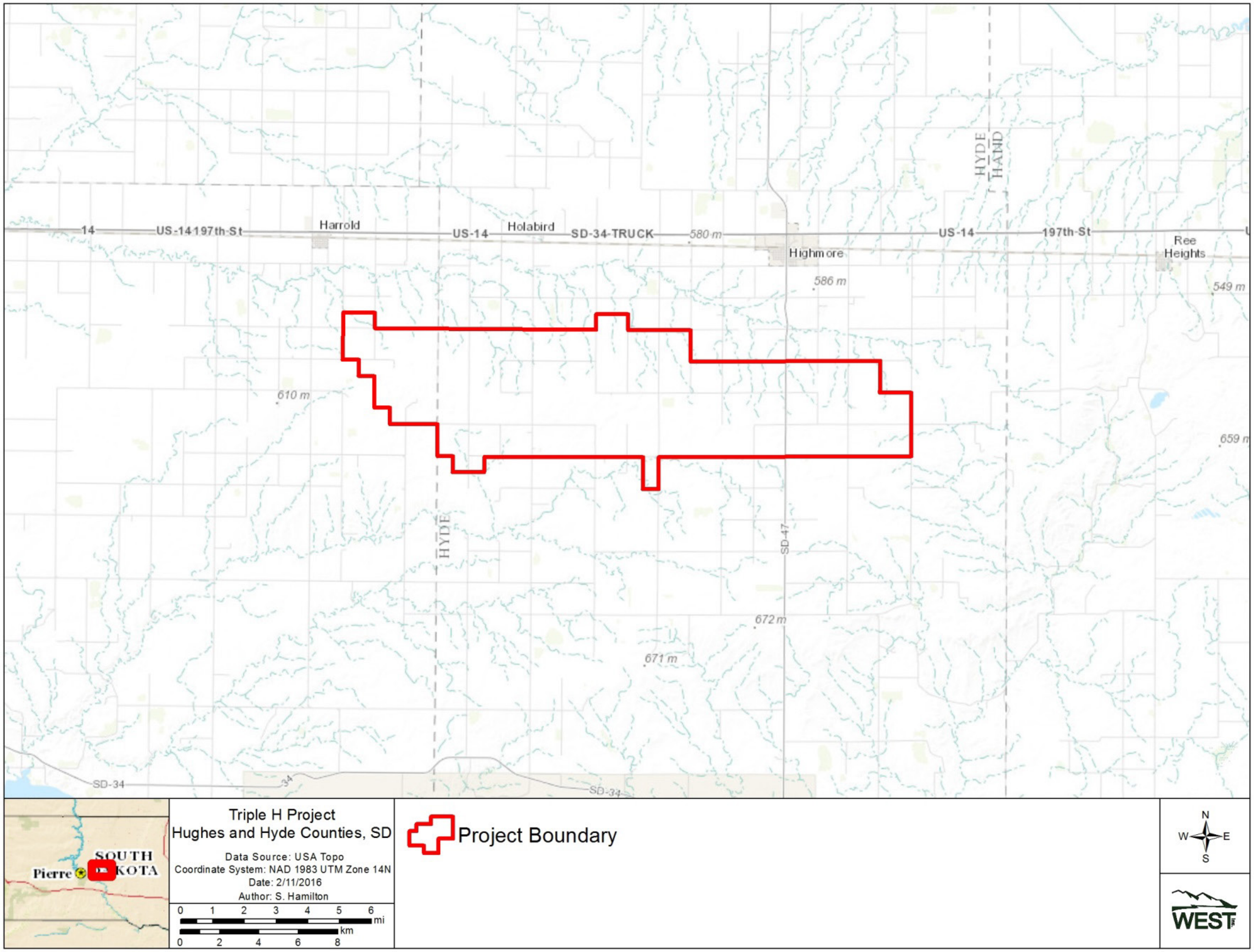

Figure 1. General location of the Triple H Wind Resource Area in Hughes and Hyde Counties, South Dakota.

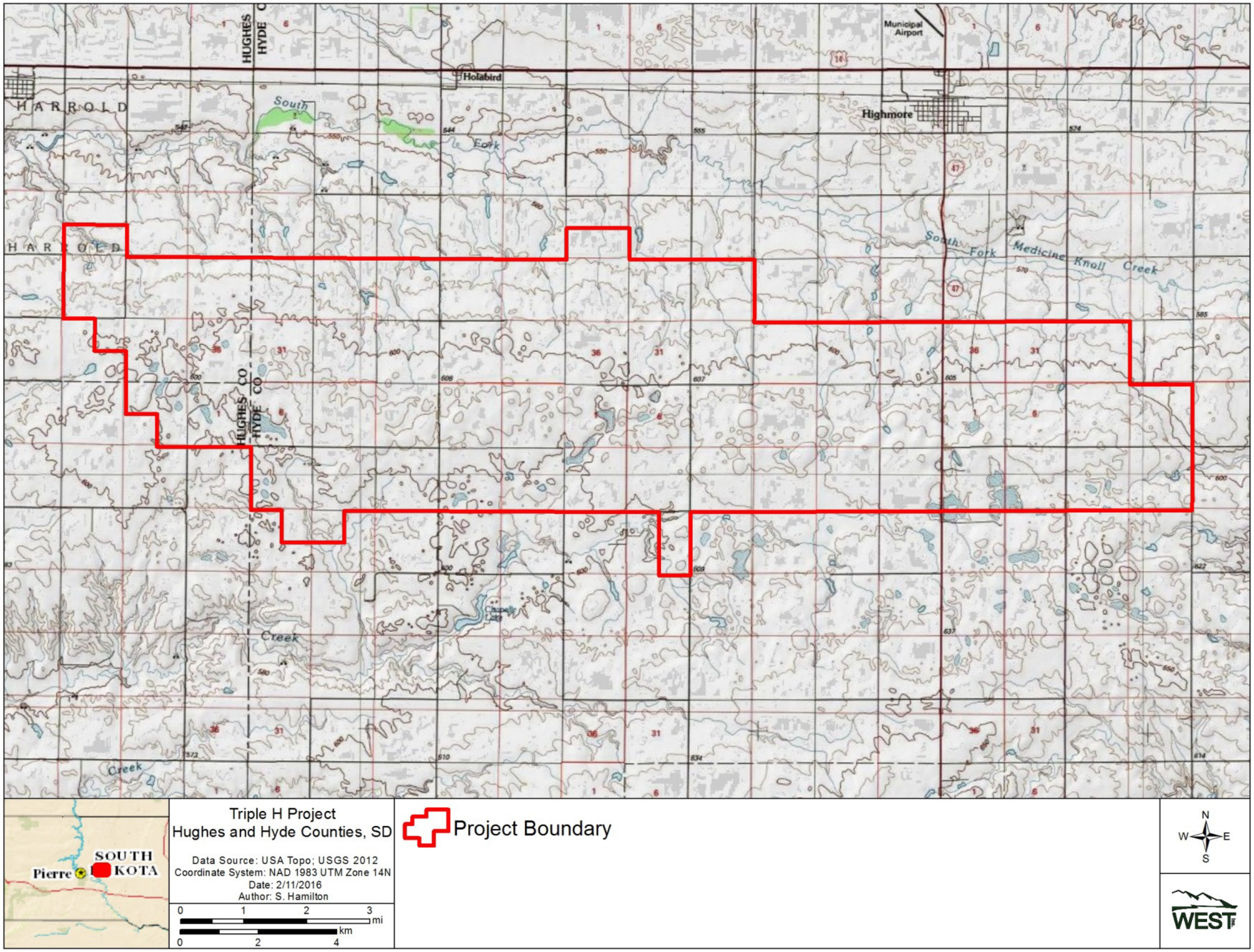

Figure 2. Topography of the Triple H Wind Resource Area in Hughes and Hyde Counties, South Dakota.

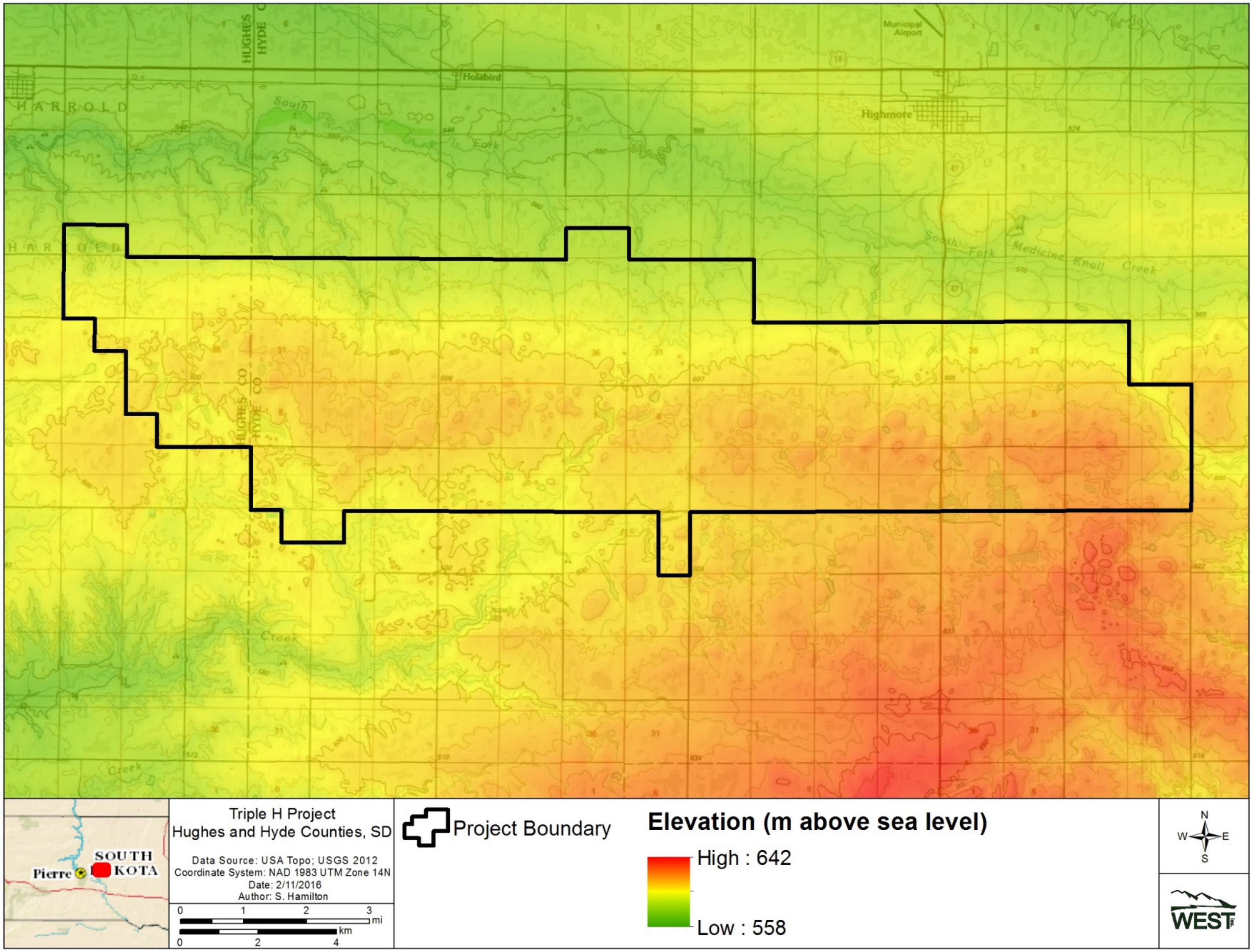

Figure 3. Elevation in the Triple H Wind Resource Area in Hughes and Hyde Counties, South Dakota.

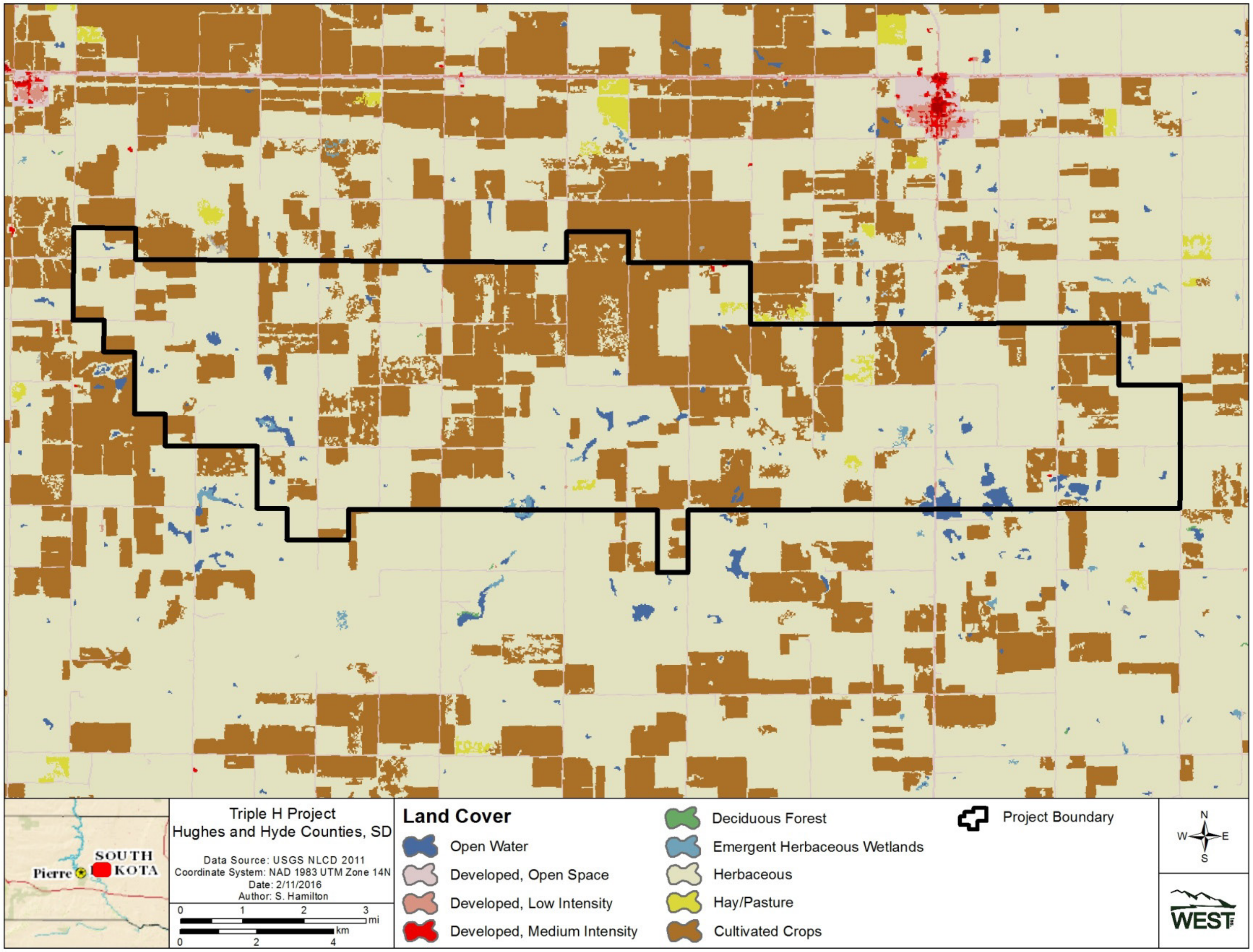

Figure 4. Land cover/use within the Triple H Wind Resource Area in Hughes and Hyde Counties, South Dakota.

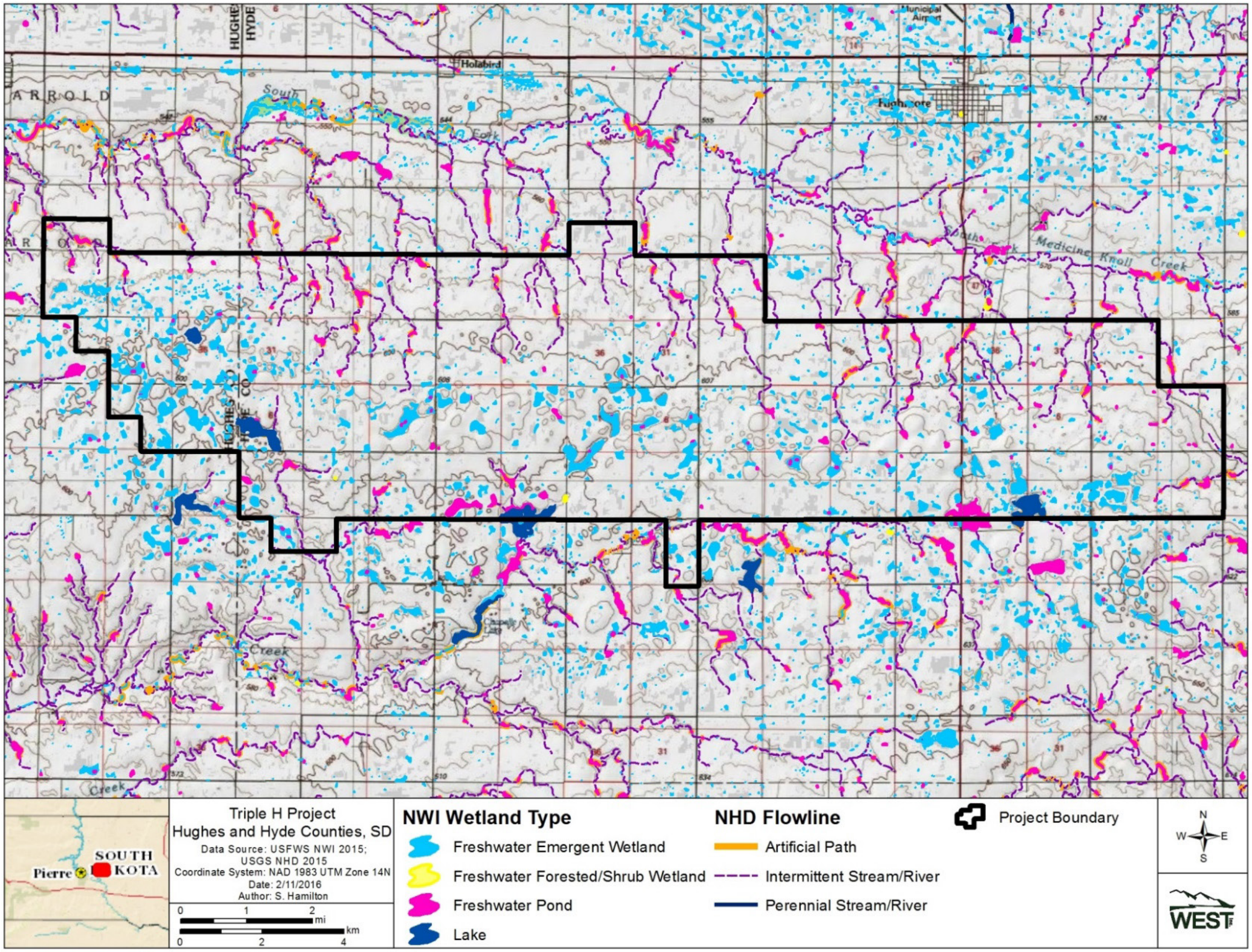

Figure 5. National Wetland Inventory (NWI) and National Hydrography Dataset (NHD) rivers, streams, and wetlands within the Triple H Wind Resource Area in Hughes and Hyde Counties, South Dakota..

RESULTS

Land Cover

Approximately 62.3% of the THWRA is covered by herbaceous lands, followed by cultivated crops (33.4%); all other land cover/use types represent less than 5% of the total Project area (Table 1, Figure 4; USGS NLCD 2011). Although the “herbaceous” category does not differentiate between planted and native grass, the site visit indicated that herbaceous areas and hay/pasture areas included both native and introduced plant species such as Kentucky bluegrass (*Poa pratensis*), smooth brome (*Bromus inermis*), and blue grama (*Bouteloua gracilis*).

Table 1. Land cover/use (acres and percent composition) present within the Triple H Wind Resource Area (THWRA). Source: USGS NLCD 2011.

Land Cover/Use	Acreage within the THWRA	% Composition within the THWRA
Herbaceous	24,327.7	62.3
Cultivated Crops	13,040.5	33.4
Developed, Open Space	900.7	2.3
Open Water	565.5	1.4
Hay/Pasture	126.2	0.3
Emergent Herbaceous Wetlands	74.2	0.2
Developed, Low Intensity	20.2	<0.1
Developed, Medium Intensity	8.9	<0.1
Deciduous Forest	2.2	<0.1
Total	**39,066.1**	**100**

Wetlands and Riparian Areas

Broad-scale information about wetlands and riparian areas is based on USFWS NWI (2015), USGS NHD (2015) data (Table 2, Figure 5), topographic data (USGS DEM 2013), and aerial imagery (Figure 6; USDA 2014). Land cover/use data (Table 1, Figure 4, USGS NLCD 2011) are not a good representation of wetlands because they are not fine-scale enough to show the small wetland areas indicated in the USFWS NWI (2015) dataset. Therefore, there is a large discrepancy in the acreage of emergent wetlands reported in the NLCD and NWI datasets (74.2 ac and 1,979.8 ac, respectively). Although the NWI dataset likely overestimates the acreage of wetlands currently present within the Project area, it better represents the actual wetland cover at the THWRA as evidenced during the site visit on February 26, 2016.

According to NWI data, 1,115 features make up about 2,684 acres of wetlands and open water within the THWRA. Freshwater emergent wetlands are the dominant wetland type, making up about 73.8% of all NWI recorded wetlands in the THWRA (Table 2; USFWS NWI 2015). Freshwater ponds (13.8%), lakes (12.3%), and freshwater forested/shrub wetlands (0.1%) are the only other wetland feature types present within the THWRA.

Table 2. Wetland types and acreage within the Triple H Wind Resource Area (THWRA). Source: USFWS NWI 2015.

Wetland Type	Wetland Acreage within the THWRA	% Composition of Wetlands within the THWRA
Freshwater Emergent Wetland	1,979.8	73.8
Freshwater Pond	370.1	13.8
Lake	331.2	12.3
Freshwater Forested/Shrub Wetland	2.7	0.1
Total	**2,683.8**	**100**

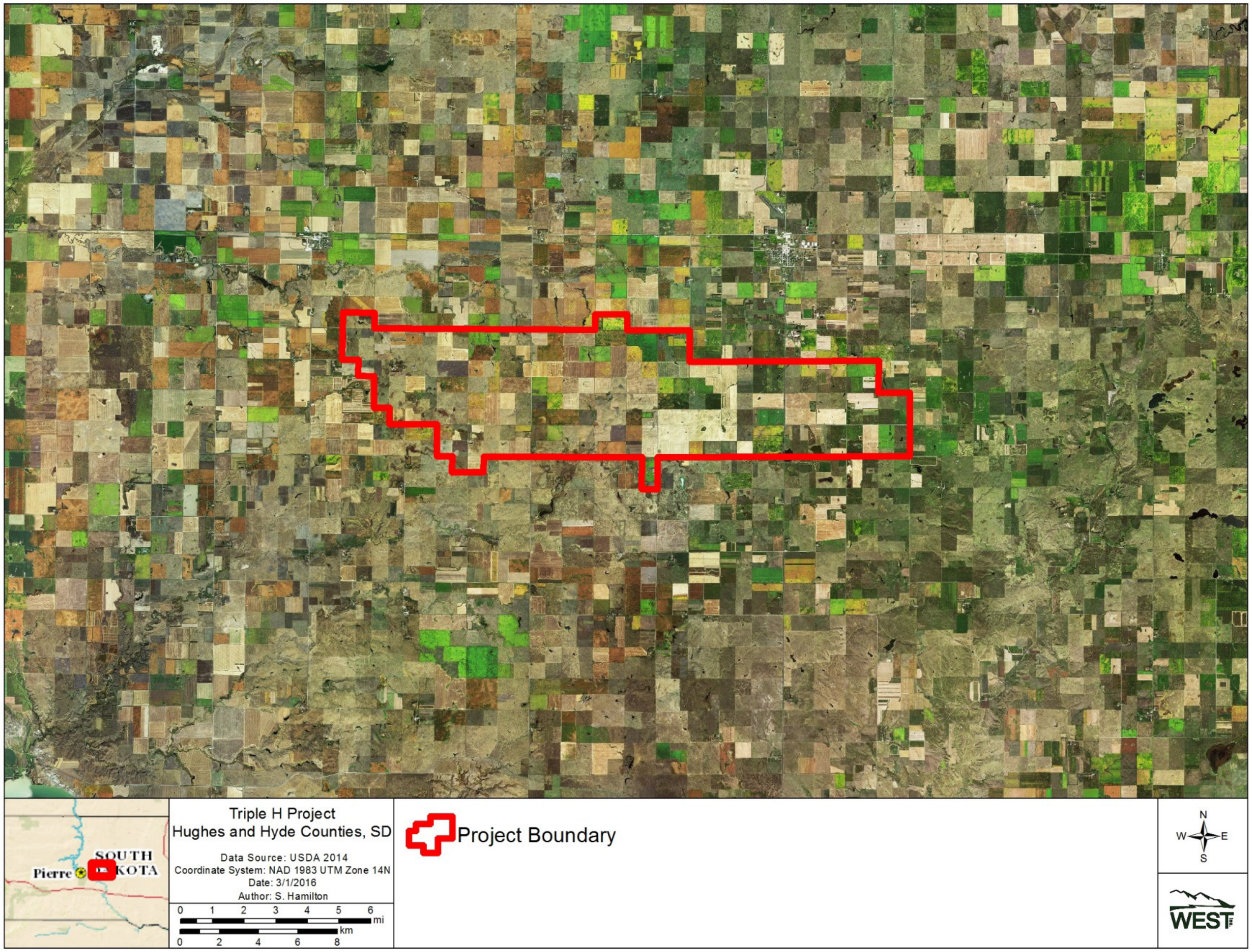

Figure 6. Aerial imagery of the Triple H Wind Resource Area, Hughes and Hyde Counties, South Dakota.

Sensitive Habitats

State and federal agencies and organizations frequently purchase easements to conserve important habitats for migratory birds and other sensitive species. There are two State Trust Lands within the boundary of the THWRA, and two other protected areas within 10 mi (16 km) of the THWRA, with the potential to attract wildlife to the general region. Huron Wetland Management District - Waterfowl Production Area, adjacent to the southern edge of the Project boundary, is the closest protected area (Table 3).

Table 3. Protected Areas within 10 miles of the Triple H Wind Resource Area. Sources: Landscape Assessment Tool 2016, TNC 2016, Google Earth 2016.

Protected Area	Governing Agency/ Organization	Approximate Distance from Project Area (mi)	Direction from Project Area
Huron Wetland Management District - Waterfowl Production Area	USFWS	0	S
Crow Creek Reservation	Crow Creek Tribe	9.6	S
Hand County Waterfowl Production Area 36	USFWS	9.9	SE

Some acreage within the Project area might be under contract with the U.S. Department of Agriculture – Farm Service Agency (USDA-FSA) and be managed in agreement under the US Conservation Reserve Program (CRP). Although some restrictions may apply to the properties under this program, which could affect construction or operational procedures, CRP lands do not exclude wind development. The Hughes County FSA office may be contacted to verify the US CRP (2004) information, in order to adjust Project activities if necessary, by avoiding installation of wind turbines on CRP lands within the THWRA to the extent possible, or by siting turbines along the edges of CRP lands so that associated development (access roads, facilities) can be built on non-CRP lands.

The presence of wind turbines may alter landscape structure so that animal habitat use patterns are altered, possibly displacing some wildlife, including species of concern, through the indirect effects of habitat fragmentation and degradation. The greatest concern with displacement impacts are for wind energy facilities placed on native grasslands, which may be present in some locations throughout the THWRA (Table 1; NLCD 2011). Because the THWRA contains some native grasslands, it is possible that some grassland-dependent species may be displaced. As the project becomes more defined in terms of layout and proposed ground disturbance, further investigation into sensitive species and habitats may be warranted.

Development of the Project facilities, infrastructure, roads, and transmission lines could result in temporary impacts to the plant community itself as well as permanent loss of some vegetation into its developed land use. Installation of buried and overhead electrical collector systems and concrete pads for turbine foundations will primarily only have temporary surface impacts as the majority of the disturbed area will undergo restoration and revegetation rather than remaining permanently converted.

Wildlife

When exploring prospective sites for a wind energy facility, knowledge of wildlife and other biological resources helps the developer identify and avoid potential environmental problems early in the development process. The purpose of this section is to characterize wildlife resources within the proposed THWRA to determine if additional biological resource surveys are warranted, as well as to identify the timing of recommended future studies. Wildlife species associated with grasslands and cultivated croplands are expected to be the most common species at the THWRA. The federal Endangered Species Act (ESA) mandates protection of species listed as federally threatened or endangered and their associated habitats (ESA 1973).

Observed Wildlife

Wildlife species and habitats likely to occur in the THWRA were examined through a search of existing data and the site visit. Available data used to identify wildlife resources within the THWRA included published literature, field guides, and public data sets, as well as the SDGFP and USFWS websites. Western EcoSystems Technology, Inc. (WEST) biologist conducted a site visit on February 26, 2016 to evaluate habitat, potential for bird migratory pathways, and to look for raptor nests, prey populations, and other biological resources, recording all wildlife species and habitat characteristics observed during the site visit.

A total of 11 avian species and a great horned owl nest were recorded during the site visit conducted in 2016 (Table 4), with snow goose and horned lark being the most common avian species observed. Numerous photographs were also taken of the THWRA (Appendix A).

Table 4. Wildlife species observed at the Triple H Wind Resource Area and vicinity during the February 26, 2016 site visit .

Common Name	Scientific Name
Passerines	
horned lark	*Eremophila alpestris*
mourning dove	*Zenaida macroura*
red-winged blackbird	*Agelaius phoeniceus*
unknown sparrow	N/A
Raptors	
golden eagle	*Aquila chrysaetos*
great horned owl	*Bubo virginianus*
northern harrier	*Circus cyaneus*
unknown raptor	N/A
Upland Game Birds	
ring-necked pheasant	*Phasianus colchicus*
Water Birds	
snow goose	*Chen caerulescens*
unknown duck	N/A
Mammals	
black-tailed prairie dog	*Cynomys ludovicianus*

Federally-Listed Species

Six wildlife species listed as federally threatened (T) or endangered (E) under the ESA (ESA 1973) have been verified to occur or have the potential to occur in Hughes and Hyde Counties

(USFWS 2016b). This includes four federally listed avian species, one federally listed bat species, and one federally listed fish species (Table 5; USFWS 2016b). These six species are described in more detail below. One candidate (C) species possibly occurs as a migrant in Hyde County. Candidate species are not federally protected under the ESA, but some candidate birds are federally protected under the MBTA. However, since candidate species may become protected under the ESA within the life of the proposed project, they are addressed in this section (see Sprague's pipit).

Table 5. Wildlife species listed as federally endangered (E), threatened (T), and candidate species by the US Fish and Wildlife Service (USFWS) with the potential to occur in the Triple H Wind Resource Area. Sources: Jennings et. al 2005; USFWS 2016b.

Common Name	Scientific Name	Federal Status	Likelihood of Occurrence in THWRA
Mammals			
northern long-eared bat	*Myotis septentrionalis*	T	Possible
Birds			
whooping crane[1]	*Grus americana*	E	Possible
red knot	*Calidris canutus rufa*	T	Unlikely
interior least tern[1]	*Sterna antillarum*	E	Possible
piping plover[1]	*Charadrius melodus*	T	Possible
Sprague's pipit	*Anthus spragueii*	C	Unlikely
Fish			
pallid sturgeon	*Scaphirhynchus albus*	E	No occurrence

[1] Also listed as State threatened or endangered (SDDGFP 2015)

Northern Long-eared Bat

The northern long-eared bat (NLEB, *Myotis septentrionalis*) is found in the United States, from Maine to North Carolina on the Atlantic Coast, westward to eastern Oklahoma and north through part of South and North Dakota (USFWS 2016c). This species hibernates in caves and abandoned mines during winter. During the summer, individuals may roost alone or in small colonies beneath exfoliating bark, or in cavities or crevices of both live and dead trees (BCI 2015).

South Dakota contains 21 known northern long-eared bat hibernacula, all within the Black Hills, in western South Dakota, nine of which are abandoned mines (USFWS 2015d). Northern long-eared bats, including some pregnant females, have been captured during the summer along the Missouri River in South Dakota (Swier 2006, Kiesow and Kiesow 2010). Acoustic data recorded by bat monitoring stations operated by the South Dakota Department of Game, Fish, and Parks (SDDGFP) also detected the northern long-eared bat sporadically throughout the State (across 16 counties) in 2011 and 2012 (USFWS 2015d).

The USFWS recently determined that all operating wind facilities greater than 150 mi (241.4 km) from a cave with documented white-nose syndrome (WNS) would be exempt under rule 4d, and as currently understood, the Project falls within the 4d rule area for NLEB (greater than 150 mi from a cave with documented white nose syndrome; USFWS 2016k). The THWRA is located within the estimated range for the species (USFWS 2016c) and, as evidenced during to the site visit, suitable habitat features in the form of tall trees, abandoned buildings, riparian areas, and caves are present throughout the proposed THWRA. Although WNS (caused by the fungus

Pseudogymnoascus destructans) is the primary threat to northern long-eared bat populations (USFWS 2016c), there is additional concern about the impacts of wind facilities on bat species.

Due to its location, the presence of limited suitable habitat, and recorded occurrences of NLEB in the general vicinity of the Project, it is possible that this species occurs in the Project area during migration and/or summer (see Bats section).

Whooping Crane

The whooping crane (*Grus americana*) is a Federal and State endangered migratory species that prefers stopovers in croplands interspersed with palustrine wetlands (USFWS 2016e). The only self-sustaining wild population, with an estimated 308 whooping cranes (including 39 juveniles and 112 adult pairs) as of the winter of 2014-2015 (USFWS 2016e, USFWS 2016f), over-winters in the Texas Gulf Coast at the Aransas National Wildlife Refuge. The cranes then migrate north through Oklahoma, Kansas, Nebraska, and the Dakotas to breed in the Northwest Territories of Canada (USFWS 2016g). Each spring and fall, 95% of whooping crane sightings occur within a 180-mile (289-km) wide migration corridor along this route (Stehn 1998). The THWRA is within the 75 and 80% migration corridor (Figure 7; Stehn and Wassenich 2007).

Whooping cranes occasionally migrate with sandhill cranes (*Grus canadensis*), so stop-over sites used by sandhill cranes may be used to identify potential whooping crane stop-over areas (Canadian Wildlife Service [CWS] and USFWS 2007). The THWRA provides potentially suitable habitat for both sandhill and whooping crane species as it is primarily composed of herbaceous cover and cropland (62.3% and 33.4%, respectively), with interspersed streams and areas of open water (1.4% of the Project Area; Table 1). Although no whooping crane sightings have been documented within the THWRA, there have been eight confirmed sightings between 1991 and 2011 within 10 miles (16 km) of the current Project boundary (Cooperative Whooping Crane Tracking Project [CWCTP] 2014). In the spring of 2010, during monitoring for cranes conducted at the Titan I wind facility in Hand County, South Dakota, approximately 6 mi (9.25 km) northeast of the Project boundary, a group of five whooping cranes spent three days approximately 2 mi (3.22 km) from the project. The closest they ever were on the ground from a turbine was 1.2 mi (2 km; Stehn 2011).

Whooping cranes generally migrate at 1,000-5,000 ft (305-1,524 m), altitudes well above turbine height (Stehn and Wassenich 2007); thus, for the most part, whooping cranes are unlikely to collide with turbines. However, whooping cranes ascend and descend during landing, or in inclement weather, they may fly at lower altitudes, sometimes within rotor swept areas. Because whooping cranes are so rare, it is very difficult to predict the probability of whooping cranes colliding with proposed turbines. Generally, risk is considered low due to low population numbers and the little amount of time they spend flying during migration within the rotor swept heights. Due to its location, the habitat features observed during the site visit surrounded by agricultural and grassland cover types and freshwater emergent wetlands, and the documented whooping crane sightings in the general area, it is likely that this species occurs within the THWRA, but not to a greater degree than the surrounding areas with similar habitat.

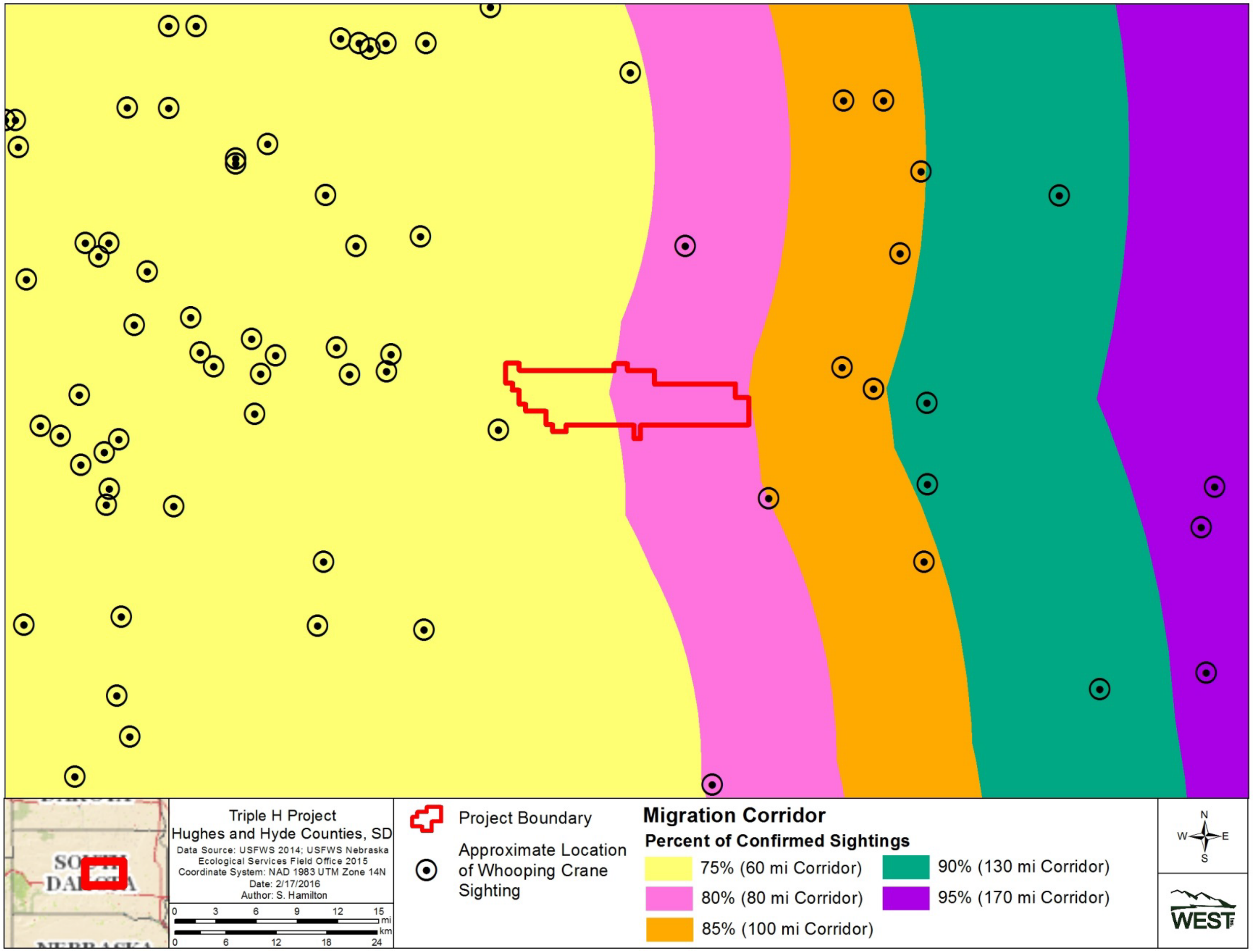

Figure 7. Location of the Triple H Wind Resource Area, Hughes and Hyde Counties, South Dakota, in relation to the whooping crane migration corridor and whooping crane observations.

Red Knot

The rufa red knot (*Calidris canutus rufa*) is a federally-listed threatened shorebird species that breeds in the tundra of the central Canadian Arctic and winters in Tierra del Fuego at the southern tip of South America (USFWS 2013b). Outside of its breeding grounds, it uses marine habitats such as estuaries and bays (USFWS 2015b). The red knot is a potential but infrequent migrant through the THWRA during spring and fall, however, potential of occurrence within the Project area is considered unlikely given the lack of confirmed observations in the region (eBird 2016) and lack of suitable stopover habitat within the THWRA.

Interior Least Tern

The Federally and State endangered least tern (*Sterna antillarum*), interior population, breeds along barren areas near water such as riverine inter-channel sandbars, salt marshes, or salt flats (NatureServe 2016a). These birds prefer open habitat, and tend to avoid thick vegetation and narrow beaches. Favorable nesting habitat includes sand and gravel bars within a wide unobstructed river channel or open flats along shorelines of lakes and reservoirs, away from disturbed areas and near plentiful sources of small fish, although they will forage up to 12 km (7.5. mi) from their nests (USFWS 2015c, NatureServe 2016). Ideal foraging areas include shallow water regions of lakes, ponds, and rivers (USFWS 2013a, NatureServe 2016a).

Least terns may occur anywhere in Hughes and Hyde Counties, South Dakota during migration or breeding along the Missouri River. Although no suitable nesting habitat was identified within the THWRA during the site visit conducted in February 2016, there is evidence of breeding activity of interior least terns within 13 mi (21 km) of the Project area (USFWS 2013a, 2015c). There is some potential for interior least terns to occur in the Project area when they migrate.

Piping Plover

The piping plover (*Charadrius melodus*) is a Federally and State threatened migratory shorebird that nests and forages along shorelines of small lakes, large beaches, river islands, or industrial pond shorelines. Wide beaches with sparse vegetation are preferred nesting habitat, while wintering habitat includes ocean beaches (NatureServe 2016b). The piping plover Northern Great Plains Distinct Population Segment (DPS) occupies sand and gravel bars and beaches along major rivers and around lakes, reservoirs, ponds, and alkali wetlands. In South Dakota, the species has been documented in Hughes County (SDDGFP 2015), one of the counties intersected by the THWRA.

Critical Habitat is designated along the Missouri River/Oahe Reservoir in Hughes County (USFWS 2002); this is the closest critical habitat to the THWRA (within about 20 mi [33 km] to the west of the Project boundary). There is very little information available about historic levels of breeding piping plovers prior to the 1980's. The 1988 Recovery Plan (USFWS 1988) documents historic breeding along the Missouri River and in alkaline wetlands in South Dakota. Although Oahe Reservoir supported approximately 19% of all Missouri River piping plovers from 1994 through 2004 (Aron 2005), recent surveys of off-river sites have found few birds nesting in alkaline wetlands throughout the State (USFWS 2009).

Inland nesting piping plovers are infrequently seen at suitable migration stopover points, indicating that they may fly non-stop to their Gulf of Mexico wintering areas (Johnson et al. 1997). Reports of piping plovers during migration are not common for the State, but do occur east and west of the THWRA (eBird.org 2016). Piping plovers are not known to breed within the THWRA, but they do breed in the vicinity of the Project along the Missouri River (Aron 2005). The February 2016 site visit indicated that emergent wetlands within the Project may provide limited suitable piping plover habitat during low water years (Table 2). Although unlikely, the potential for occurrence of breeding piping plovers exists based on suitable habitat present within and around the THWRA. Outside of the breeding period, this species may migrate over the Project area.

Sprague's Pipit

The Sprague pipit (*Anthus spragueii*), a federal candidate species, is a declining ground nesting songbird that breeds and winters in open, contiguous grasslands that lack shrubs or trees. Breeding territories are established for both nesting and foraging, and are likely influenced by the size of grassland patches and the amount of grassland in the landscape (Jones 2010). Therefore, Sprague's pipit is an area sensitive species that is highly vulnerable to grassland degradation and fragmentation. Sprague's pipits may not be as tightly tied to native prairie in winter or migration as they are during the breeding season (Igl and Ballard 1999). The breeding range of Sprague's pipit in South Dakota is generally north of the THWRA; however the species may migrate through any portion of South Dakota using native and non-native habitats such as weedy fields, pastures, and grazed grasslands as stopover sites, and native, medium to intermediate height prairie with low visual obstruction as breeding territories (Davis 2004, USFWS 2014a).

Verified or potential occurrence of this species has been reported for Hyde County (USFWS 2016h, eBird 2016). The proposed Project might cause grassland habitat loss, alteration, and fragmentation, with negative effects on habitat suitability for Sprague's pipits. While large blocks of native prairie in the THWRA are limited and use of the Project area by breeding Sprague's pipits is unlikely, use of the Project area by migrant birds is possible.

Pallid Sturgeon

The pallid sturgeon (*Scaphirhynchus albus*) is a Federally and State endangered fish species adapted to sandy areas with fine substrates, floodplains, backwaters, chutes, sloughs, islands, sandbars, and main channel waters within large river ecosystems (USFWS 2014b). Major threats to this species are habitat alteration caused by channelization and dam construction, leading to the replacement of estuarine and flooded areas by permanent lakes and alteration of water flow and temperature. Although potential/verified occurrence of the pallid sturgeon has been reported for all counties that are contiguous with the Missouri River, including Hughes County, its geographic range falls outside the THWRA (USFWS 2013b). The pallid sturgeon can be found in the Missouri River, approximately 13.5 mi (21.7 km) southwest of the Project. Therefore, the pallid sturgeon will not be affected by the development and operations of the THWRA.

South Dakota State-Listed Species

Eight species ranked by the state of South Dakota as threatened or endangered are listed as occurring in Hughes and Hyde Counties (SDDGFP 2015), including three federally-listed avian species (whooping crane, interior least tern, and piping plover) and one federally-listed fish species (pallid sturgeon), discussed in the Federally-Listed Species section above. Of the remaining four species, two are mammals (swift fox [*Vulpes velox*] and northern river otter [*Lontra Canadensis*]), one is a fish (sicklefin chub [*Macrhybopsis meeki*]), and one is a reptile (false map turtle (*Graptemys pseudogeographica*; Table 6).

Table 6. State of South Dakota threatened (T) or endangered (E) species with documented occurrence in Hughes and Hyde Counties. Sources: SDDGF 2015, USGS 2016.

Common Name	Scientific Name	State Status	Likelihood of Occurrence within the THWRA
Mammals			
Northern river otter	*Lontra canadensis*	T	Possible
swift fox	*Vulpes velox*	T	Unlikely
Birds			
whooping crane[1]	*Grus americana*	E	Possible
interior least tern[1]	*Sterna antillarum*	E	Possible
piping plover[1]	*Charadrius melodus*	T	Possible
Fish			
pallid sturgeon[1]	*Scaphirhynchus albus*	E	No occurrence
sicklefin chub	*Macrhybopsis meeki*	T	Unlikely
Reptile			
false map turtle	*Graptemys pseudogeographica*	T	Possible

[1] Also a Federally listed species described in the Federally-listed Species section

Northern River Otter

The northern river otter (*Lontra canadensis*) can be found in various aquatic environments such as marshes, rivers, streams, and lakes. They require abundant riparian vegetation and prey, good water quality, limited disturbance, and year-round access to open water (SDDGFP 2016b).

Water development, fluctuating water levels in reservoirs, shoreline development, pesticide residue runoff and other contamination of wetlands, accumulation of toxic substances in otter prey, and alteration of riparian vegetation resulting in habitat loss and degradation, are considered major threats to the northern river otter (SDDGFP 2012). Waterbodies within the THWRA may provide marginal habitat for northern river otters. Whenever possible, project siting and development of the THWRA along waterbodies should consider minimization of ground disturbance and construction activity impacts by using already disturbed areas for placement of poles, avoiding removal of riparian vegetation, and avoiding construction of access roads adjacent to wetland and riparian habitats. With appropriate siting of infrastructure, any key features for otters can be avoided and negative effects can be minimized.

Swift Fox

The swift fox (*Vulpes velox*) relies on open, rolling mixed-grass and short grass prairies with little or no shrubs. They also inhabit areas of mixed agricultural use, but population densities are lower in these areas. Prairie dog towns are a preferred habitat of swift fox, as they use burrows made by other mammals or dig their own burrows in sandy soils on high ground (NatureServe 2016c). Major threats to this species include loss of suitable native short and mixed-grass prairie due to conversion to agricultural and development. Herbaceous and agricultural areas within the THWRA, as well as prairie dog towns identified during the site visit, might provide suitable habitat for the swift fox. If swift foxes are present in prairie dog colonies immediately adjacent to the proposed Project area, direct impacts could include increased habitat loss and fragmentation from the disturbance of prairie dog colonies or complexes. Additional prairie dog town surveys are recommended within the proposed project area and, if found, they should be avoided to the extent possible to minimize disturbance to foxes and other species (i.e. raptors). Surveys for foxes may be required if the priaire dog complexes cannot be avoided by construction. However, based on a compilation of recent records and areas with established populations (Stratman 2015) and because the THWRA falls slightly outside of the species distribution (USGS 2016), it is unlikely that this species will occur in the THWRA.

Sicklefin Chub

The sicklefin chub (*Macrhybopsis meeki*), adapted to gravel and sand runs of large rivers with low to moderate gradients, such as the Missouri River, has experienced population declines as the result of habitat alteration caused by channelization, water diversion, and dam construction (NatureServe 2016d). No large rivers run through the THWRA, and the Missouri River is located 13.5 mi (21.7 km) south of the Project; therefore, it is unlikely that the sicklefin chub will occur in the THWRA and no direct impacts are anticipated.

False Map Turtle

The false map turtle (*Graptemys pseudogeographica*) occupies large rivers and associated oxbows, lakes, ponds, reservoirs, sloughs, and wetland. This species needs areas with abundant vegetation and soft substrates, and sites that are protected from shore predators for basking (Bandas and Higgins 2004). The greatest threats to survival are destruction of nesting habitat and nests by camping tourists, agricultural practices, and pollution. In South Dakota, numbers are decreasing due to several possible factors, including water pollution, river channelization, impoundments, reduction of suitable nesting sites, and unlawful shooting (NatureServe 2016e). Although the wetlands and streams within the THWRA represent potential habitat for the false map turtle, impacts can be minimized by proper siting of infrastructure and avoiding wetlands and waterbodies to the extent possible; therefore it is unlikely that the false map turtle will be negatively impacted as a result of the Project activities.

Sensitive and Special-Status Plant Species

Two federally Threatened plant species, the Leedy's roseroot (*Rhodiola integrifolia leedyi*) and the western prairie fringed orchid (*Platanthera praeclara*), are known to occur in South Dakota, neither of which has been documented in Hughes or Hyde Counties (USFWS 2016i, j). There are no State Threatened or Endangered plant species in South Dakota (SDGFPD 2015), and no State Rare Plant species occur within the THWRA based on documented occurrences (SDDGFP 2009).

Species of Greatest Conservation Need (SGCN)

In addition to the Federally and State-listed species noted above, there are several species identified as Species of Greatest Conservation Need (SGCN) by the SDDGFP's Wildlife Action

Plan (SDDGFP 2014) that have the potential to occur in the THWRA. Only bird and bat SGCN are presented in Table 7, as these are the two groups most likely to be impacted by a wind facility.

One bat SGCN, the northern long-eared bat (NLEB, *Myotis septentrionalis*), has the potential to occur in the THWRA (Table 7), while nineteen bird SGCN have the potential to occur in the THWRA. Most of these avian species are also protected under the Migratory Bird Treaty Act (MBTA 1918), the federal Bald and Golden Eagle Protection Act (BGEPA 1940), or listed as Birds of Conservation Concern (BCC; Appendix C; USFWS 2008).

Table 7. Birds and bats listed as South Dakota Species of Greatest Conservation Need with the potential to occur in the Triple H Wind Resource Area, based on distribution range maps. Federally and State-listed bird and bat species are included. Source: Jennings et al. 2005; USGS GAP 2016.

Common Name	Scientific Name	Spring	Summer	Fall	Winter
Bats					
northern long-eared bat[2]	*Myotis septentrionalis*		X		
Birds					
American white pelican	*Pelecanus erythrorhynchos*		X		
Baird's sparrow	*Ammodramus bairdii*	X		X	
bald eagle	*Haliaeetus leucocephalus*	X	X	X	X
black tern[1]	*Chlidonias niger*		X		
burrowing owl	*Athene cunicularia*		X		
chestnut-collared longspur[1]	*Calcarius ornatus*		X		
ferruginous hawk	*Buteo regalis*	X	X	X	X
greater prairie-chicken	*Tympanuchus cupido*	X	X	X	X
interior least tern[2]	*Sterna antillarum athalassos*		X		
lark bunting	*Calamospiza melanocorys*		X		
LeConte's sparrow	*Ammodramus leconteii*	X		X	
marbled godwit[1]	*Limosa fedoa*	X		X	
northern goshawk	*Accipiter gentilis*				X
osprey	*Pandion haliaetus*	X		X	
piping plover[2]	*Charadrius melodus*		X		
Sprague's pipit	*Anthus spragueii*	X	X	X	
whooping crane[2]	*Grus americana*	X		X	
willet	*Catoptrophorus semipalmatus*		X		
Wilson's phalarope	*Phalaropus tricolor*		X		

[1]Observed during BBS surveys in two closest routes (Pardieck et al. 2015)
[2]Also a Federal and/or State listed species described in the Federally-listed or State-listed Species section

Raptors

A desktop assessment of potential raptor roosting habitat, prey base, and species distributions was used to determine which raptor species have the potential to occur within the THWRA (Table 8). Three raptor species (golden eagle, northern harrier, and great-horned owl) were observed during the February 2016 field visit.

Bald Eagle

The bald eagle (*Haliaeetus leucocephalus*), a species protected under the Bald and Golden Eagle Protection Act (BGEPA 1940), occurs in South Dakota as a resident (BirdLife International and NatureServe 2014), utilizing suitable areas year-round, with verified and potential occurrences reported for Hughes and Hyde Counties (eBirds 2016, NatureServe 2016f). Preferred nesting, foraging, and roosting bald eagle habitats include large, mature trees near water with abundant fish and waterfowl prey, especially in areas with little disturbance. Preferred perch sites include tall trees and snags located near nesting and foraging areas that provide good vantage points, while nests and foraging activities are usually associated with permanent water bodies (Buehler 2000, All About Birds 2016). There are multiple lakes and rivers within and/or adjacent to the Project that provide suitable nesting and wintering habitat for bald eagles. Furthermore, the Project is approximately 13.5 mi (21.7 km) northeast of the Missouri River, which serves as a migration corridor and provides suitable nesting and wintering habitat for bald eagles. Sightings of bald eagles are common along the Missouri River, near Oahe Reservoir (eBird 2016).

According to this desktop analysis, bald eagle use and/or nesting within the vicinity of the Project are likely. Surveys would be necessary to define actual eagle use, inform siting, and estimate potential impacts to bald eagles.

Table 8. Raptor species with the potential to occur in the Triple H Wind Resource Area, based on range maps. Federally and State-listed bird species are included. Source: Jennings et al. 2005.

Common Name	Scientific Name	Spring	Summer	Fall	Winter
Vultures					
turkey vulture	*Cathartes aura*		X		
Osprey, Eagles, Kites, and Hawks					
bald eagle	*Haliaeetus leucocephalus*	X	X	X	X
broad-winged hawk	*Buteo platypterus*	X		X	
Cooper's hawk	*Accipter cooperii*				X
ferruginous hawk[1]	*Buteo regalis*	X	X	X	X
golden eagle*	*Aquila chrysaetos*				X
northern goshawk[1]	*Accipiter gentilis*				X
northern harrier*	*Circus cyaneus*		X		
osprey[1]	*Pandion haliaetus*	X		X	
red-tailed hawk	*Buteo jamaicensis*	X	X	X	X
tough-legged hawk	*Buteo lagopus*				X
sharp-shinned hawk	*Accipter striatus*				X
Swainson's hawk[2]	*Buteo swainsoni*		X		
Falcons					
American kestrel	*Falco sparverius*	X	X	X	X
merlin	*Falco columbarius*				X
peregrine falcon	*Falco peregrinus*	X		X	
prairie falcon	*Falco mexicanus*				X
Owls					
burrowing owl[1]	*Athene cunicularia*		X		
Eastern screech-owl	*Megascops asio*	X	X	X	X
great horned owl*	*Bubo virginianus*	X	X	X	X
long-eared owl	*Asio otus*		X		
Northern saw-whet owl	*Aegolius acadicus*				X
short-eared owl	*Asio flammeus*	X	X	X	X

*Observed during February 2016 site visit to THWRA
[1]SGCN birds
[2]Observed during BBS surveys in two closest routes (Pardieck et al. 2015)

Golden Eagle

The golden eagle (*Aquila chrysaetos*), a federally protected species under the BGEPA (1940), usually hunts on the rimrock terrain of open grassland areas and nest on cliffs near open foraging areas such as grasslands or shrublands (Kochert et al. 2002). Observations of golden eagles have been reported in South Dakota during spring, fall, and winter (eBird 2016), with the majority of sightings in the vicinity of the Project area reported during the winter season (National Audubon Society [Audubon] 2010). During the site visit, suitable foraging and roosting habitat for this raptor species, such as tall trees within open grasslands, was found in the THWRA. Additionally, one golden eagle was observed perched in a tree between a crop field and a grassland during the site visit to THWRA.

Potential impacts for this species resulting from project development and operation include loss or disturbance of nesting, roosting, and foraging habitat, loss of nests, and collision with turbines and/or transmission lines. There have been documented golden eagle fatalities at wind energy facilities in the United States (Erickson et al. 2001), and the USFWS has expressed increasing concern regarding the potential effects of wind energy development on golden eagle populations (Pagel et al. 2010). Results from this desktop analysis and site visit indicate a golden eagle use within the THWRA. Similar to bald eagles, field surveys would be required to determine actual use levels and inform potential impact assessments further.

<u>Other Raptor Species with Potential to Occur in the Area</u>

Sixteen diurnal raptors, one vulture, and six owls have the potential to occur as residents and/or migrant species in the THWRA at some point during the year. One of these diurnal raptors, the northern harrier, was observed during the site visit conducted in February 2016 (Table 4).

Of the 16 diurnal raptors with potential to occur in the THWRA, five species are likely to nest within or around the Project area (Jennings et al. 2005): Ferruginous hawk (*Buteo regalis*), northern harrier (*Circus cyaneus*), red-tailed hawk (*Buteo jamaicensis*), Swainson's hawk (*Buteo swainsoni*), and American kestrel (*Falco sparverius*). Turkey vultures (*Cathartes aura*) are also summer residents (Jennings et al. 2005; Table 8). Broad-winged hawk (*Buteo platypterus*), osprey (*Pandion haliaetus*), and peregrine falcon (*Falco peregrinus*) are possible migrants through the THWRA. In addition to the species listed above, raptor species that may occur within the THWRA outside of the breeding season (migration, winter, or post-breeding dispersal) include: bald eagle, Cooper's hawk (*Accipter cooperii*), golden eagle, northern goshawk (*Accipiter gentilis*), rough-legged hawk (*Buteo lagopus*), sharp-shinned hawk (*Accipter striatus*), merlin (*Falco columbarius*), and prairie falcon (*Falco mexicanus*). Several of these raptor species are considered Species of Greatest Conservation Need (SPGN) by the state of South Dakota (Tables 7 and 8).

Of the eight owl species potentially occurring in the Project area, five have the potential to nest within the THWRA or vicinity (Jennings et al. 2005): burrowing owl (*Athene cunicularia*), eastern screech-owl (*Megascops asio*), great horned owl (*Bubo virginianus*), long-eared owl (*Asio otus*), and short-eared owl (*Asio flammeus*). One great horned owl was observed sitting on a nest approximately three miles south of the project boundary during the February 2016 site visit. The northern saw-whet owl (*Aegolius acadicus*) is a possible winter resident (Jennings et al. 2005).

Potential for Raptor Migration in the Area

Several factors influence the migratory pathways of raptors, the most significant of which is geography. Two geographical features often used by raptors during migration are ridgelines and shorelines of large bodies of water (Liguori 2005). The up drafts formed as the wind hits the ridges and thermals created over land (but not water) make for energy-efficient travel for raptors over long distances (Liguori 2005). It is for this reason that raptors often follow corridors or pathways (e.g., along prominent ridges with defined edges) during migration. Topography in the THWRA is relatively flat to gently rolling hills (Figures 2 and 3). None of the features of the THWRA are likely to concentrate raptors; however, the THWRA is located within the Central Flyway avian migratory corridor used by raptors, and wetlands and water impoundments may provide some stopover and/or foraging habitat for raptors that migrate through the area.

Potential Raptor Nesting Habitat

Within the THWRA, trees and woodland areas occur around wetlands, streams, and houses, providing potential nesting opportunities for some raptor species. Raptors may also nest on man-made structures, such as power poles associated with power lines and structures associated with transmission lines, both of which are present in the Project area. Ground-nesting raptors, such as burrowing owls and northern harriers, may nest in the grassland areas located throughout the THWRA. One great horned owl was observed sitting on a nest located approximately 3.5 mi (5 km) south of the Project boundary during the February 2016 site visit.

Areas of Potentially High Prey Density within the Triple H Wind Resource Area

Studies at some wind energy facilities indicate that individual raptor species appear to differ from one another in their susceptibility to collision (National Research Council [NRC] 2007). Results from the Altamont Pass Wind Energy Facility (APWRA) suggest that mortality for some species is not necessarily related to abundance, possibly implying that the variance in susceptibility may be in part due to behavioral differences between species (Orloff and Flannery 1992). Orloff and Flannery (1992, 1996) suggested that high golden eagle mortality at the APWRA was in part due to the apparently high densities of California ground squirrels (*Spermophilus beecheyi*) in the area (Thelander and Smallwood 2007). Continued research at APWRA revealed that the degree of aggregation of Botta's pocket gopher (*Thomomys bottae*) burrows around the turbines was positively correlated to red-tailed hawk fatality rates (Smallwood et al. 2001, Thelander and Smallwood 2007, Thelander et al. 2003).

Rodents and lagomorphs are the prey species most likely to occur within the THWRA as these types of prey are associated with grassland and prairie habitats. Prairie dog towns, as well as other areas of colonial small mammals (e.g., ground squirrels), are known to attract foraging raptors. Prairie dog colonies are important foraging grounds for several raptor species likely to occur at the site, including red-tailed hawk, northern harrier, and Swainson's hawk. Hunting raptors may be concentrated year-round in the vicinity of prairie dog towns. Black-tailed prairie dogs (*Cynomys ludovicianus*) and eastern cottontails (*Sylvilagus floridanus)* as well as other prey species have the potential to occur within the THWRA based on USGS GAP range maps (USGS GAP 2016).

Black-tailed prairie dog towns provide hunting opportunities for eagles and may increase the risk for raptors. Some raptors are susceptible to collision with wind turbines, especially while hunting (Hoover and Morrison 2005). Prairie dog colonies are important foraging grounds for several raptor species likely to occur at the THWRA, including golden eagle, ferruginous hawk, red-tailed hawk, northern harrier, and Swainson's hawk. Foraging raptors may be concentrated in the vicinity of prairie dog towns year-round. Two prairie dog colonies were observed on the southern and eastern boundaries of the THWRA during the February 2016 site visit; one colony was located on the Huron Wetland Management District – Waterfowl Production Area, and the other was located on private property. Additionally, not all areas identified as potential habitat were visible from existing, passable public roads. Placing setbacks from all prairie dog colonies may help reduce the risk of collision for raptors and eagles. It is generally recommended that active prairie dog colonies be avoided to the maximum extent possible when siting wind energy facilities.

In addition to lagomorphs and large colonial rodents, smaller rodent (e.g., mice, rats), bird, and shrew species associated with grassland/pasture or agricultural areas likely occur in the area. Ponds, wetlands, and flooded areas may concentrate waterfowl, waterbirds, and shorebirds in wet years when water is abundant. If flooded depressions are used by large concentrations of these species, then they may serve as an attractant to some foraging raptors, especially those that often feed on waterfowl and/or shorebirds (e.g., bald eagle, golden eagle, peregrine falcon, and prairie falcon). Because these water systems are heavily dependent on rainfall patterns, their ability to support concentration of prey species and foraging raptors will likely vary significantly from year to year.

It should also be noted that prey densities can fluctuate dramatically based on habitat and climatic factors, and are likely to change over time. With raptor roost sites (e.g., trees and power poles) and food available, it is likely that some raptors will use the THWRA for foraging.

Bird Migration

Most species of birds are protected by the Migratory Bird Treaty Act (MBTA 1918). Nocturnal migrating passerines are assumed to move in broad fronts across inland landscapes rather than along specific topographical features (Gauthreaux et al. 2003, NRC 2007). Large numbers of passerines have collided with lighted communication towers and buildings when foggy conditions and spring or fall migration coincide. Birds appear to become confused by the lights during foggy or low ceiling conditions and fly in circles around lighted structures until they become exhausted or collide with the structure (Erickson et al. 2001). Most collisions at communication towers are attributed to the guy wires on these structures, which wind turbines do not have.

Many species of songbirds migrate at night and may collide with tall man-made structures, though no large mortality events have been documented at wind energy facilities in North America on the same scale as those mortality events observed at communication towers (National Wind Coordinating Collaborative [NWCC] 2004).

The THWRA is located within the Central Flyway and it is likely that birds including passerines, raptors, and waterfowl migrate through the proposed Project area. Wetlands and grasslands found within the THWRA may provide stopover habitat for migrants or individuals during post-breeding dispersal. The combination of wetlands and grasslands found in the THWRA may be attractive to a broader suite of birds than when only one of these land cover types occurs. Additionally, corn fields, one of the harvested crops present within the THWRA, typically serve as feeding areas for migrating and wintering waterfowl. However, concentrated bird use within the Project area is unlikely as the habitats within the THWRA are similarly distributed throughout the immediate surrounding areas.

The Hyde County Waterfowl Production Area, located adjacent to the southern edge of the project boundary (Table 3), has the potential to attract waterfowl to the general area, which may result in increased risk of collision with turbines. Cultivated crop lands may provide food in the form of wasted grains for migrating birds, such as sandhill cranes and geese. Emergent wetlands and small ponds are also utilized for foraging and reproduction by resident bird species which have been observed on Breeding Bird Survey Routes (see Breeding Bird Section) near the THWRA. It's possible that large numbers of waterfowl may concentrate around the local waterbodies; therefore, locating turbines as far from lakes as possible will reduce the potential for collisions and will also minimize the risk of disturbing lakes and their complexes. Overall impacts are expected to be similar to other projects in the Midwest.

Breeding Birds

Displacement of grassland nesting birds is often one of the primary concerns wildlife agencies express regarding the placement of wind facilities in and near grassland areas. Recent research has focused on the potential displacement of grassland passerines at wind energy facilities, and some uncertainty currently exists over the effects of wind energy facilities on the breeding success of these birds. In Minnesota, researchers found that breeding passerine density on CRP grasslands was reduced in the immediate vicinity of turbines (Leddy et al. 1999), but changes in density at broader scales were not detected (Johnson et al. 2000). Piorkowski (2006) conducted a displacement study at a wind energy facility in Oklahoma where, of the grassland species present in the proposed wind resource area, only the western meadowlark showed significantly lower densities near turbines. Piorkowski (2006) suggested that habitat characteristics were more important to determining passerine breeding densities than the presence of wind turbines. Shaffer and Buhl (2015) documented some avoidance by some grassland nesting species out to 300 m (985 ft) at wind energy facilities in North and South Dakota. The proposed THWRA contains a grassland/herbaceous cover, with the potential to support grassland sensitive species that may be negatively affected by development. Species potentially affected include several grassland obligate species and area sensitive species such as the burrowing owl, McCown's longspur (*Calcaneus mccownii*), and Baird's sparrow (*Ammodramus bairdii*; Ribic et al. 2009).

Important Bird Areas

Passerines are the most abundant bird group in most terrestrial ecosystems and are the most often reported fatalities at wind energy facilities (NRC 2007). The National Audubon Society (Audubon) has identified Important Bird Areas (IBAs) that provide essential habitat for one or more bird species (Audubon 2015). The IBAs include sites for breeding, wintering, and/or migrating birds, and can range from only a few acres to thousands of acres in size. The closest IBA to the Project area is the Fort Pierre National Grassland located 22.1 mi (35.6 km) southwest of the Project boundary. Other IBAs within 35 mi (56 km) of the THWRA include: Pierre Missouri River Bottomlands, Stone Lake Outwash Area, and Wolsey Crane Stopover Area (Audubon 2015).

USFWS Birds of Conservation Concern

The USFWS lists 27 Birds of Conservation Concern (BCC) species within the Prairie Potholes Bird Conservation Region 11 (BCR 11; Appendix C; USFWS 2008). These species are protected under the Migratory Bird Treaty Act (MBTA 1918), but do not receive any greater protection than other migratory birds unless they are also listed by the USFWS under the ESA (1973) or BGEPA (1940). However, these species have been identified as vulnerable to population declines in the BCR by the USFWS (2008).

The potential exists for some of these species to breed within suitable habitats in the THWRA, including the American bittern (*Botaurus lentiginosus*), least bittern (*Ixobrychus exilis*), Swainson's hawk, upland sandpiper (*Bartramia longicauda*), marbled godwit (*Limosa fedoa*), black tern (*Chlidonias niger*), black-billed cuckoo (*Coccyzus erythropthalmus*), short-eared owl, red-headed woodpecker (*Melanerpes erythrocephalus*), Sprague's pipit (*Anthus spragueii*), grasshopper sparrow (*Ammodramus savannarum*), chestnut-collared longspur (*Calcarius ornatus*), and dickcissel (*Spiza Americana*; Jennings et al. 2005). Although not recently recorded along nearby routes during BBS, there is potential for breeding bald eagles within the Project area (see Bald Eagle Section). The remaining BCC raptor, the peregrine falcon, is not likely to breed in the THWRA (Jennings et al. 2005). The remaining BCC species (Appendix C) are a mix of shorebirds, marsh birds, waterfowl, and passerines.

USGS Breeding Bird Survey

The two nearest USGS Breeding Bird Survey (BBS) Routes to the THWRA are the Crow Creek Route to the southeast and the Fort Thompson Route to the south (Figure 8; USGS 2014). Each BBS route is about 24.5 mi (39.4 km) long, and all birds seen or heard are tallied for a 3-minute period at survey points located every half-mile (0.8 km) along the route (USGS 1998).

From 2011 to 2014, 86 bird species have been recorded along the two BBS Routes (Pardieck et al. 2015). No currently designated Federal or State endangered or threatened species has been recorded. In 2011, 2,242 individual birds of 80 species were observed along the two routes surveyed (1,146 individuals of 65 species in Crow Creek and 1,096 birds of 53 species in Fort Thompson; Pardieck et al. 2015). The most abundant species observed were the brown-headed cowbird (*Molothrus ater*; 290 individuals), western meadowlark (*Sturnella neglecta*; 244 individuals), common grackle (*Quiscalus quiscula;* 196 individuals), dickcissel (*Spiza americana*; 174 individuals), red-winged blackbird (*Agelaius phoeniceus*; 156 individuals), mourning dove (*Zenaida macroura*; 134 individuals), and cliff swallow (*Hirundo rustica*; 108 individuals).

Ten BCC (USFWS 2008) species have been observed along the Crow Creek and/or Fort Thompson route (American bittern, black tern, chestnut-collared longspur, dickcissel, grasshopper sparrow, marbled godwit, red-headed woodpecker, Swainson's hawk, upland sandpiper; Appendix C).

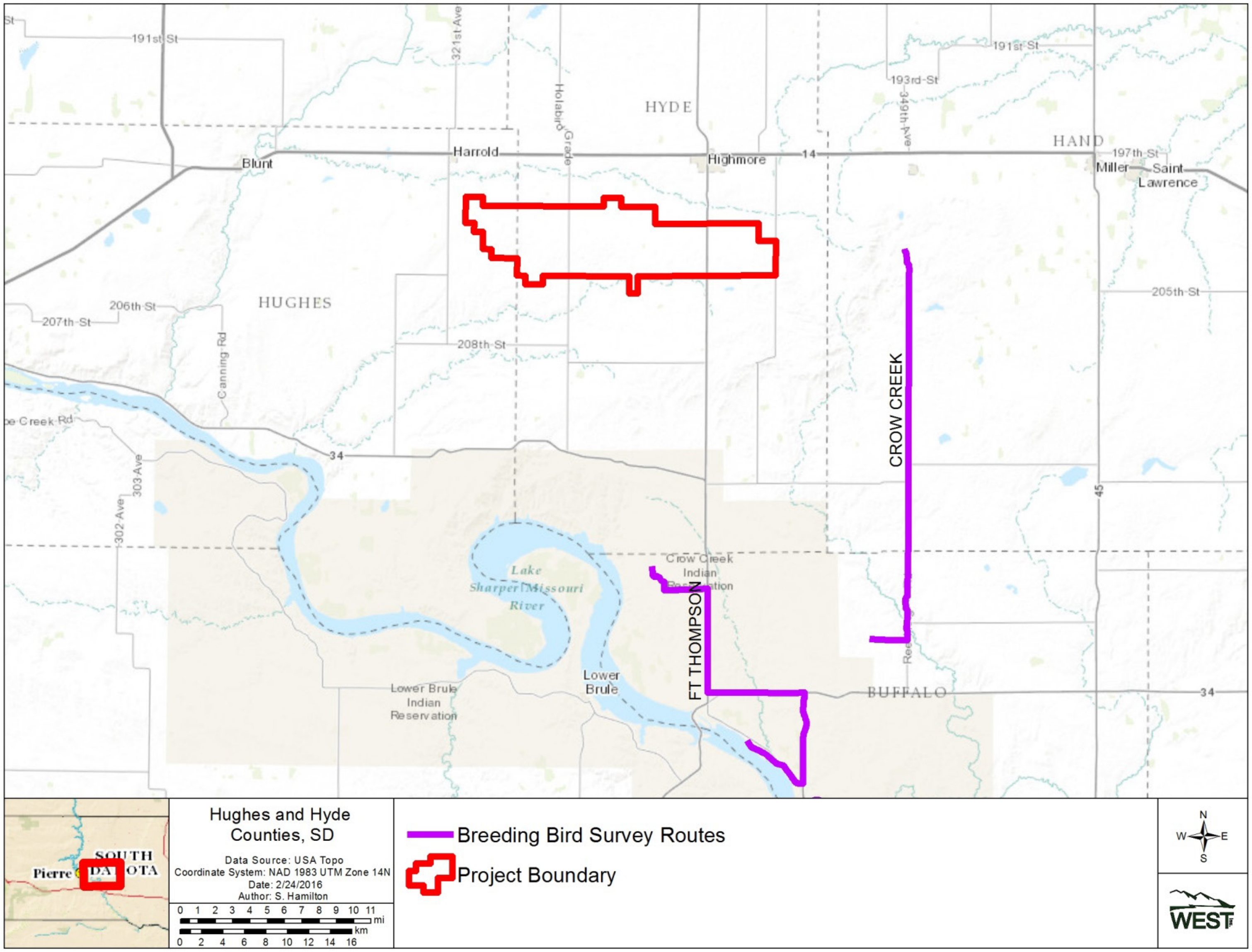

Figure 8. Nearest US Geological Survey Breeding Bird Survey routes to the Triple H Wind Resource Area (USGS 2014).

Bats

Based on range maps (BCI 2015; USGS GAP 2016), eight bat species are possible residents and/or migrants in the THWRA (Table 9). Two of the eight species in Table 9 are included due to range (BCI 2015), but are unlikely to occur in the THWRA based on habitat restrictions: the Townsend's big-eared bat (*Corynorhinus townsendii*) and the western small-footed myotis (*Myotis ciliolabrum*). The six remaining species that have potential to occur in the THWRA based on range maps (Table 9) have been documented as fatalities at wind energy facilities: big brown bat (*Eptesicus fuscus*), eastern red bat (*Lasiurus borealis*), hoary bat (*Lasiurus cinereus*), little brown bat (*Myotis lucifugus*), northern long-eared bat (*Myotis septentrionalis*), and silver-haired bat (*Lasionycteris noctivagans*; Table 9 and 10).

Table 9. Bat species with the potential to occur in the Triple H Wind Resource Area based on range maps (BCI 2015).

Species	Scientific Name	Habitat	Likelihood of Occurrence
big brown bat[1]	*Eptesicus fuscus*	Common in most habitats; abundant in deciduous forests and suburban areas with agriculture; maternity colonies beneath bark, or in tree cavities, buildings, barns, or bridges.	Probable
eastern red bat[1]	*Lasiurus borealis*	Abundant tree bat; roosts in trees; solitary, prefers forested environments	Probable
hoary bat[1]	*Lasiurus cinereus*	Usually not found in human-made structures; roosts in trees along forest borders; very wide-spread.	Probable
little brown myotis[1]	*Myotis lucifugus*	Found in a wide variety of habitats. Especially associated with humans, often using buildings, attics, and other man-made structures for nursery colonies. Roost in tree cavities and crevices, and forage over meadows, farmland, and cliff faces.	Probable
northern long-eared bat[1,2,3]	*Myotis septentrionalis*	Found roosting beneath exfoliating bark and in tree cavities. Hibernates in caves and underground mines.	Possible
silver-haired bat[1]	*Lasionycteris noctivagans*	Common bat in forested areas, particularly old growth forests; maternity colonies in tree cavities or hollows; hibernates beneath exfoliating bark, in wood piles, and in cliff faces.	Probable
Townsend's big-eared bat[2]	*Corynorhinus townsendii*	Commonly found in arid desert scrub and pine forests; maternity colonies in mines, caves, and buildings; hibernates in caves and abandoned mines.	Unlikely
western small-footed myotis	*Myotis ciliolabrum*	Hibernates in caves or mines. Rears young in cliff-face crevices, erosion cavities, and beneath rocks on the ground.	Unlikely

[1] Known wind energy facility fatality (Derby et al. 2010, Derby et al. 2012, DeWitt 2011, Fiedler et al. 2007, Hale and Karsten 2010, Johnson et al. 2000, 2004, Krenz et al. 2000, Miller 2008, Osborn et al. 1996, 2000, Piorkowski et al. 2010, Thompson 2011)

[2] Species of Greatest Conservation Need (SGCN; Aron 2005)

[3] Federally-listed Species (USFWS 2016)

Of the eight potentially occurring species listed in Table 9, two species of bats are considered Species of Greatest Conservation Need (SGCN) in South Dakota: Townsend's big-eared bat and northern long-eared bat (Table 7). While no known Townsend's big-eared bat fatalities at wind energy facilities have occurred, there are known northern long-eared bat wind facility fatalities (Table 10). The northern long-eared bat is also federally listed as threatened under the Endangered Species Act (ESA) by the USFWS (Table 5).

Table 10. Summary of public cumulative bat fatalities (by species) from wind energy facilities in North America.

Common Name	Scientific Name	# Fatalities[1]	% Composition
hoary bat[2]	*Lasiurus cinereus*	5,486	36.22
eastern red bat[2]	*Lasiurus borealis*	3,711	24.5
silver-haired bat[2]	*Lasionycteris noctivagans*	2,592	17.11
little brown bat	*Myotis lucifugus*	1,141	7.53
tri-colored bat[2]	*Perimyotis subflavus*	644	4.25
big brown bat[2]	*Eptesicus fuscus*	581	3.84
Mexican free-tailed bat[2]	*Tadarida brasiliensis*	515	3.4
unidentified bat	*N/A*	330	2.18
northern long-eared bat	*Myotis septentrionalis*	46	0.3
unidentified Myotis	*N/A*	39	0.26
Seminole bat	*Lasiurus seminolus*	14	0.09
western red bat	*Lasiurus blossevillii*	13	0.09
Indiana bat	*Myotis sodalis*	7	0.05
evening bat[2]	*Nycticeius humeralis*	7	0.05
big free-tailed bat	*Nyctinomops macrotis*	6	0.04
western yellow bat	*Lasiurus xanthinus*	3	0.02
unidentified free-tailed bat	*N/A*	3	0.02
eastern small-footed bat	*Myotis leibii*	2	0.01
pocketed free-tailed bat	*Nyctinomops femorosaccus*	2	0.01
unidentified Lasiurus bat	*Lasiurus spp.*	2	0.01
canyon bat	*Parastrellus hesperus*	1	0.01
cave Myotis[2]	*Myotis velifer*	1	0.01
long-legged bat	*Myotis volans*	1	0.01
Total	**19**	**15,147**	**100**

[1] These are raw data and are not corrected for searcher efficiency or scavenging.
[2] Potential resident or migrant in the WPWRA (BCI 2015).
Cumulative fatalities and species from data compiled by Western EcoSystems Technology, Inc. (WEST) from publicly available fatality documents (listed in Appendix D).
Additional notes on bat species and numbers:
Indiana bat fatalities in this table are also reported by USFWS (2010, 2011a). Three additional Indiana bat fatalities have been reported in USFWS Press releases (2011b, 2012b, 2012c), but are not included in this summary of bats found as fatalities.
One long-eared bat (*Myotis evotis*) was an incidental fatality recorded at Tehachapi, California (Anderson et al. 2004), but was not part of a formal search and is not included above.
An additional 677 bat fatalities (evening bat, eastern red bat, hoary bat, tricolored bat, Mexican free-tailed bat, and unidentified bat) have been found in Texas (Hale and Karsten 2010), but the number of fatalities by species is not reported.
Canyon bat formerly known as western pipistrelle (*Pipistrellus hesperus*; BCI 2015), and tricolored bat formerly known as eastern pipistrelle (*Pipistrellus subflavus*; BCI 2015).

The field visit conducted in February 2016 revealed some potential natural roosts in the form of mature tree stands with exfoliating bark near drainages (Appendix A). The larger cottonwood trees near streams may provide roosting habitat for several species which generally prefer to roost under the bark or in the foliage of larger trees. Numerous human-built barns, sheds, and other structures may provide suitable day, night, maternity, and bachelor roosts for bats during the summer or during migratory stop-overs. Several structures were located in close proximity to, or surrounded by, tree stands, providing alternate roosts for a bat colony. Although limited, several derelict man-made structures were also located near suitable drinking water sources in the form of still drainages, standing pooled water and flooded areas, and farm ponds. Stock tanks, found throughout the THWRA, also have potential to concentrate bats as they are usually reliable water sources year-round regardless of precipitation.

Bats generally forage over water and other open spaces, such as agricultural fields, grasslands, streams, and wetlands (Lee and McCracken 2002, Downs and Sanderson 2010). Because the THWRA is largely comprised of agricultural fields and grasslands, potential foraging habitat is present throughout the Project area. Insects often concentrate over wet areas associated with wetlands and streams, which may in turn concentrate foraging bats. Wooded areas adjacent to streams, open water areas, tree lines, and riparian areas provide areas of suitable foraging habitat for bats within the THWRA. Bat use is likely to be greatest in areas around ponds and wetlands when these areas have some available water, as bats would likely concentrate around these features to forage and drink. No bat hibernacula are known to occur in the area.

Bat casualties have been reported from most wind energy facilities where post-construction fatality data are publicly available. Reported estimates of bat mortality at wind energy facilities have ranged from 0.01 – 47.5 fatalities per turbine per year (0.9 – 43.2 bats per megawatt [MW] per year) in the US, with an average of 3.4 per turbine or 4.6 per MW (NWCC 2004). A majority of the bat casualties at wind energy facilities to date are migratory species that conduct long migrations between summer roosts and winter areas. The species most commonly found as fatalities at wind energy facilities include hoary bat, silver-haired bat (*Lasionycteris noctivagans*), and eastern red bat (*Lasiurus borealis*; Johnson 2005) (Table 10). To date, the highest numbers of bat fatalities found at wind energy facilities have occurred in eastern North America on ridge tops dominated by deciduous forest (NWCC 2004). However, Gruver et al. (2009), Barclay et al. (2007), and Jain (2005) recently reported relatively high fatality rates from facilities in Wisconsin, Canada, and Iowa that were located in grassland and agricultural habitats. Unlike the eastern U.S. wind energy facilities that reported higher bat fatality rates, the Wisconsin, Alberta and Iowa facilities are in open grasslands and crop fields. Based on data from other wind energy facilities in North America (Table 10), the most likely species to be impacted are the hoary bat and eastern red bat, with other migratory species also having some potential for impacts, although likely at lower levels.

Several studies have shown that bat fatalities peak in late summer and early fall, coinciding with the migration of many species (Johnson 2005; Kunz et al. 2007a; Arnett et al. 2008). A smaller spike in bat fatalities occurs during spring migration for some species at some facilities (Arnett et al. 2008). Operation of the proposed THWRA will likely result in some bat mortality. While the magnitude of these fatalities and the degree to which bat species will be affected is difficult to determine, they should be within the average range of bat mortalities found throughout the Midwest and South Dakota based on general vegetation and landscape characteristics. Within the THWRA, the fall migration season will likely have the highest wind turbine-caused fatalities caused by collisions with moving turbine blades (Grodsky et al. 2011; Rollins et al. 2012) and barotrauma (Baerwald 2008).

Summary

Six species protected under the federal ESA (1973) have potential to occur within the counties containing the THWRA (SDDGFP 2015, USFWS 2016b; Appendix B): northern long-eared bat, piping plover, whooping crane, red knot, interior least tern, and pallid sturgeon. Of these, the whooping crane, piping plover, interior least tern, and red knot may possibly migrate through the area. The northern long-eared bat also has the potential to be a summer resident within the THWRA and occur during migration. The pallid sturgeon is unlikely to occur in the THWRA, as well as the Sprague's pipit, a Candidate species. No critical habitat for these species occurs within the THWRA. Year-round bald eagle use is possible within the THWRA, while golden eagles are likely to use the Project area during the winter, as evidenced during the site visit. Bald and golden eagles receive special protections under the BGEPA (1940). No State or Federally-listed plant species are known to occur within the counties intersected by the THWRA.

Sixteen diurnal raptor species have the potential to occur as residents, migrants, or rare visitors in the THWRA. Six owl species and one vulture species may also occur in the area. There is some potential habitat for nesting raptors within the THWRA and surrounding areas, mainly in the form of trees, utility poles, and old barns. Open grassland habitat for ground-nesting species, such as northern harriers and burrowing owls, is present throughout the THWRA.

Topography in the THWRA is relatively flat to gently rolling hills that would generally not be expected to concentrate or funnel raptors during migration. Prairie dog towns and emergent wetlands with concentrated prey species could attract migrating and wintering raptors, including eagles, into the area. Wetlands may provide important stopover habitat for migrating water birds (including the federally-listed whooping crane), waterfowl, shorebirds, passerines, and raptors. The THWRA project area is within the delineated whooping crane migration corridor and historical records of whooping cranes have occurred near the Project area.

Eight bat species have the potential to occur within the THWRA at some time during the year based on range maps, but two of these species are unlikely to occur based on habitat within the THWRA. Bat roosting habitat within the THWRA is present as isolated tree stands and human structures throughout the THWRA. Tree lines, wooded streams, agricultural fields, pastureland, and wetlands likely provide foraging habitat for bats throughout the THWRA, while pooled water, flooded areas, drainage ditches, stock tanks, and farm ponds provide drinking areas that may concentrate bat activity. Overall, bat impacts are likely to be within the average range of bat mortalities found throughout the region based on general vegetation and landscape characteristics of the THWRA.

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Appendix A. Photographs of the Triple H Wind Resource Area from the Site Visit on February 26, 2016. Additional photographs are available upon request.


Photo 1. Untilled grassland with stock tank in the foreground. Grassland may be grazed.


Photo 2. Untilled grassland with wetland. Wetland is a potential attractant for migratory birds.

Photo 3. Hay pasture with tree rows in the background.

Photo 4. Harvested sunflower field within the THWRA. Harvested grain fields could serve as feeding areas for migrating water birds, waterfowl, and other birds.

Photo 5. Harvested corn field within the THWRA. Harvested grain fields could serve as feeding areas for migrating water birds, waterfowl, and other birds.

Photo 6. Trees in draw provide potential raptor nesting habitat and bat foraging and roosting habitat.

Photo 7. Black-tailed prairie dog colony found on the southern boundary of the THWRA, in the Huron Wetland Management District – Waterfowl Production Area. Prairie dog colonies provide hunting opportunities for eagles and raptors, and thereby, may attract eagles and raptors to the area. This may increase the risk of raptor and wind turbine collision.

Photo 8. Exfoliating bark on trees, such as this one, provide roosting habitat for bats.

Appendix B. US Fish and Wildlife Service iPaC online review

Appendix C. Bird Species of Conservation Concern (USFWS BCC) within the Prairie Potholes Bird Conservation Region

Appendix C. US Fish and Wildlife Service (USFWS) Birds Conservation Concern (BCC) within the Bird Conservation Region (BCR) 11 (Prairie Potholes) and their presence/absence in the vicinity of the Triple H Winds Resource Area (Pardieck et al. 2014, USFWS 2008).

Species	Recorded from 2011 to 2014 on Crow Creek Breeding Bird Survey Route?	Recorded in 2011 and 2013 on Fort Thompson Breeding Bird Survey Route?
Horned Grebe	No	No
American Bittern	Yes	No
Least Bittern	No	No
Bald Eagle	No	No
Swainson's Hawk	Yes	No
Peregrine Falcon	No	No
Yellow Rail	No	No
Mountain Plover	No	No
Solitary Sandpiper	No	No
Upland Sandpiper	Yes	Yes
Long-billed Curlew	No	No
Hudsonian Godwit	No	No
Marbled Godwit	Yes	Yes
Buff-breasted Sandpiper	No	No
Short-billed Dowitcher	No	No
Black Tern	Yes	No
Black-billed Cuckoo	No	No
Short-eared Owl	No	No
Red-headed Woodpecker	No	Yes
Sprague's Pipit	No	No
Grasshopper Sparrow	Yes	Yes
Baird's Sparrow	No	No
Nelson's Sharp-tailed Sparrow	No	No
McCown's Longspur	No	No
Smith's Longspur	No	No
Chestnut-collared Longspur	Yes	Yes
Dickcissel	Yes	Yes

Appendix D. Summary of Publicly-Available Studies from North American Wind Energy Facilities that have Reported Bat Fatalities

Appendix D. Summary of publicly-available studies from North American wind energy facilities that report bat fatality data.

Data from the following sources:

Project, Location	Reference	Project, Location	Reference
Alite, CA (09-10)	Chatfield et al. 2010	Klondike IIIa (Phase II), OR (08-10)	Gritski et al. 2011
Alta Wind I, CA (11-12)	Chatfield et al. 2012	Leaning Juniper, OR (06-08)	Gritski et al. 2008
Alta Wind II-V, CA (11-12)	Chatfield et al. 2012	Lempster, NH (09)	Tidhar et al. 2010
Barton I & II, IA (10-11)	Derby et al. 2011a	Lempster, NH (10)	Tidhar et al. 2011
Barton Chapel, TX (09-10)	WEST 2011	Linden Ranch, WA (10-11)	Enz and Bay 2011
Beech Ridge, WV (12)	Tidhar et al. 2013b	Locust Ridge, PA (Phase II; 09)	Arnett et al. 2011
Big Horn, WA (06-07)	Kronner et al. 2008	Locust Ridge, PA (Phase II; 10)	Arnett et al. 2011
Big Smile, OK (12-13)	Derby et al. 2013b	Madison, NY (01-02)	Kerlinger 2002b
Biglow Canyon, OR (Phase I; 08)	Jeffrey et al. 2009a	Maple Ridge, NY (06)	Jain et al. 2007
Biglow Canyon, OR (Phase I; 09)	Enk et al. 2010	Maple Ridge, NY (07)	Jain et al. 2009a
Biglow Canyon, OR (Phase II; 09-10)	Enk et al. 2011a	Maple Ridge, NY (07-08)	Jain et al. 2009d
Biglow Canyon, OR (Phase II; 10-11)	Enk et al. 2012b	Maple Ridge, NY (12)	Tidhar et al. 2013a
Biglow Canyon, OR (Phase III; 10-11)	Enk et al. 2012a	Marengo I, WA (09-10)	URS Corporation 2010b
Blue Sky Green Field, WI (08; 09)	Gruver et al. 2009	Marengo II, WA (09-10)	URS Corporation 2010c
Buena Vista, CA (08-09)	Insignia Environmental 2009	Mars Hill, ME (07)	Stantec 2008
Buffalo Gap I, TX (06)	Tierney 2007	Mars Hill, ME (08)	Stantec 2009a
Buffalo Gap II, TX (07-08)	Tierney 2009	McBride, Alb (04)	Brown and Hamilton 2004
Buffalo Mountain, TN (00-03)	Nicholson et al. 2005	Melancthon, Ont (Phase I; 07)	Stantec Ltd. 2008
Buffalo Mountain, TN (05)	Fiedler et al. 2007	Meyersdale, PA (04)	Arnett et al. 2005
Buffalo Ridge, MN (94-95)	Osborn et al. 1996, 2000	Moraine II, MN (09)	Derby et al. 2010d
Buffalo Ridge, MN (00)	Krenz and McMillan 2000	Mount Storm, WV (Fall 08)	Young et al. 2009b
Buffalo Ridge, MN (Phase I; 96)	Johnson et al. 2000	Mount Storm, WV (09)	Young et al. 2009a, 2010b
Buffalo Ridge, MN (Phase I; 97)	Johnson et al. 2000	Mount Storm, WV (10)	Young et al. 2010a, 2011b
Buffalo Ridge, MN (Phase I; 98)	Johnson et al. 2000	Mount Storm, WV (11)	Young et al. 2011a, 2012b
Buffalo Ridge, MN (Phase I; 99)	Johnson et al. 2000	Mountaineer, WV (03)	Kerns and Kerlinger 2004
Buffalo Ridge, MN (Phase II; 98)	Johnson et al. 2000	Mountaineer, WV (04)	Arnett et al. 2005
Buffalo Ridge, MN (Phase II; 99)	Johnson et al. 2000	Munnsville, NY (08)	Stantec 2009b
Buffalo Ridge, MN (Phase II; 01/Lake Benton I)	Johnson et al. 2004	Nine Canyon, WA (02-03)	Erickson et al. 2003
Buffalo Ridge, MN (Phase II; 02/Lake Benton I)	Johnson et al. 2004	Noble Altona, NY (10)	Jain et al. 2011b
Buffalo Ridge, MN (Phase III; 99)	Johnson et al. 2000	Noble Bliss, NY (08)	Jain et al.2009e
Buffalo Ridge, MN (Phase III; 01/Lake Benton II)	Johnson et al. 2004	Noble Bliss, NY (09)	Jain et al. 2010a
Buffalo Ridge, MN (Phase III; 02/Lake Benton II)	Johnson et al. 2004	Noble Bliss/Wethersfield, NY (11)	Kerlinger et al. 2011

Appendix D. Summary of publicly-available studies from North American wind energy facilities that report bat fatality data.

Data from the following sources:

Project, Location	Reference	Project, Location	Reference
Buffalo Ridge I, SD (09-10)	Derby et al. 2010b	Noble Chateaugay, NY (10)	Jain et al. 2011c
Buffalo Ridge II, SD (11-12)	Derby et al. 2012a	Noble Clinton, NY (08)	Jain et al. 2009c
Casselman, PA (08)	Arnett et al. 2009	Noble Clinton, NY (09)	Jain et al. 2010b
Casselman, PA (09)	Arnett et al. 2010	Noble Ellenburg, NY (08)	Jain et al. 2009b
Castle River, Alb. (01)	Brown and Hamilton 2006a	Noble Ellenburg, NY (09)	Jain et al. 2010c
Castle River, Alb. (02)	Brown and Hamilton 2006a	Noble Wethersfield, NY (10)	Jain et al. 2011a
Cedar Ridge, WI (09)	BHE Environmental 2010	NPPD Ainsworth, NE (06)	Derby et al. 2007
Cedar Ridge, WI (10)	BHE Environmental 2011	Oklahoma Wind Energy Center, OK (04; 05)	Piorkowski and O'Connell 2010
Cohocton/Dutch Hill, NY (09)	Stantec 2010	Pebble Springs, OR (09-10)	Gritski and Kronner 2010b
Cohocton/Dutch Hills, NY (10)	Stantec 2011	PGC site 6-3 (07)	Capouillez and Librandi-Mumma 2008, Librandi-Mumma and Capouillez 2011
Combine Hills, OR (Phase I; 04-05)	Young et al. 2006	Pine Tree, CA (09-10)	BioResource Consultants 2010
Combine Hills, OR (11)	Enz et al. 2012	Pioneer Prairie I, IA (Phase II; 11-12)	Chodachek et al. 2012
Condon, OR	Fishman Ecological Services 2003	PrairieWinds ND1 (Minot), ND (10)	Derby et al. 2011c
Crescent Ridge, IL (05-06)	Kerlinger et al. 2007	PrairieWinds ND1 (Minot), ND (11)	Derby et al. 2012c
Criterion, MD (11)	Young et al. 2012a	PrairieWinds SD1 (Crow Lake), SD (11-12)	Derby et al. 2012d
Criterion, MD (12)	Young et al. 2013	PrairieWinds SD1 (Crow Lake), SD (12-13)	Derby et al. 2013a
Crystal Lake II, IA (09)	Derby et al. 2010a	Prince Wind Farm, Ont (06)	Natural Resource Solutions 2008
Diablo Winds, CA (05-07)	WEST 2006, 2008	Prince Wind Farm, Ont (07)	Natural Resource Solutions 2009
Dillon, CA (08-09)	Chatfield et al. 2009	Prince Wind Farm, Ont (08)	Natural Resource Solutions 2009
Dry Lake I, AZ (09-10)	Thompson et al. 2011	Red Canyon, TX (06-07)	Miller 2008
Dry Lake II, AZ (11-12)	Thompson and Bay 2012	Red Hills, OK (12-13)	Derby et al. 2013c
Elkhorn, OR (08)	Jeffrey et a. 2009b	Ripley, Ont (08)	Jacques Whitford 2009
Elkhorn, OR (10)	Enk et al. 2011b	Ripley, Ont (08-09)	Golder Associates 2010
Elm Creek, MN (09-10)	Derby et al. 2010c	Rugby, ND (10-11)	Derby et al. 2011b
Elm Creek II, MN (11-12)	Derby et al. 2012b	Searsburg, VT (97)	Kerlinger 2002a
Foote Creek Rim, WY (Phase I; 99)	Young et al. 2003	Shiloh I, CA (06-09)	Kerlinger et al. 2009
Foote Creek Rim, WY (Phase I; 00)	Young et al. 2003	Shiloh II, CA (09-10)	Kerlinger et al. 2010a
Foote Creek Rim, WY (Phase I; 01-02)	Young et al. 2003	SMUD Solano, CA (04-05)	Erickson and Sharp 2005
Forward Energy Center, WI (08-10)	Grodsky and Drake 2011	Stateline, OR/WA (01-02)	Erickson et al. 2004
Fowler I, IN (09)	Johnson et al. 2010a	Stateline, OR/WA (03)	Erickson et al. 2004
Fowler III, IN (09)	Johnson et al. 2010b	Stateline, OR/WA (06)	Erickson et al. 2007
Fowler I, II, III, IN (10)	Good et al. 2011	Steel Winds I, NY (07)	Grehan 2008

Appendix D. Summary of publicly-available studies from North American wind energy facilities that report bat fatality data.

Data from the following sources:

Project, Location	Reference	Project, Location	Reference
Fowler I, II, III, IN (11)	Good et al. 2012	Stetson Mountain I, ME (09)	Stantec 2009c
Fowler I, II, III, IN (12)	Good et al. 2013	Stetson Mountain I, ME (11)	Normandeau Associates 2011
Goodnoe, WA (09-10)	URS Corporation 2010a	Stetson Mountain II, ME (10)	Normandeau Associates 2010
Grand Ridge I, IL (09-10)	Derby et al. 2010g	Summerview, Alb (05-06)	Brown and Hamilton 2006b
Harrow, Ont (10)	Natural Resource Solutions 2011	Summerview, Alb (06; 07)	Baerwald 2008
Harvest Wind, WA (10-12)	Downes and Gritski 2012a	Top of Iowa, IA (03)	Jain 2005
Hay Canyon, OR (09-10)	Gritski and Kronner 2010a	Top of Iowa, IA (04)	Jain 2005
High Sheldon, NY (10)	Tidhar et al. 2012a	Tuolumne (Windy Point I), WA (09-10)	Enz and Bay 2010
High Sheldon, NY (11)	Tidhar et al. 2012b	Vansycle, OR (99)	Erickson et al. 2000
High Winds, CA (03-04)	Kerlinger et al. 2006	Vantage, WA (10-11)	Ventus Environmental Solutions 2012
High Winds, CA (04-05)	Kerlinger et al. 2006	Wessington Springs, SD (09)	Derby et al. 2010f
Hopkins Ridge, WA (06)	Young et al. 2007	Wessington Springs, SD (10)	Derby et al. 2011d
Hopkins Ridge, WA (08)	Young et al. 2009c	White Creek, WA (07-11)	Downes and Gritski 2012b
Jersey Atlantic, NJ (08)	NJAS 2008a, 2008b, 2009	Wild Horse, WA (07)	Erickson et al. 2008
Judith Gap, MT (06-07)	TRC 2008	Windy Flats, WA (10-11)	Enz et al. 2011
Judith Gap, MT (09)	Poulton and Erickson 2010	Winnebago, IA (09-10)	Derby et al. 2010e
Kewaunee County, WI (99-01)	Howe et al. 2002	Wolfe Island, Ont (May-June 09)	Stantec Ltd. 2010a
Kibby, ME (11)	Stantec 2012	Wolfe Island, Ont (July-December 09)	Stantec Ltd. 2010b
Kittitas Valley, WA (11-12)	Stantec Consulting 2012	Wolfe Island, Ont (January-June 10)	Stantec Ltd. 2011a
Klondike, OR (02-03)	Johnson et al. 2003	Wolfe Island, Ont (July-December 10)	Stantec Ltd. 2011b
Klondike II, OR (05-06)	NWC and WEST 2007	Wolfe Island, Ont (January-June 11)	Stantec Ltd. 2011c
Klondike III (Phase I), OR (07-09)	Gritski et al. 2010	Wolfe Island, Ont (July-December 11)	Stantec Ltd. 2012

Two Indiana bat fatalities are reported by USFWS (2010, 2011c), among other reports. Three additional Indiana bat fatalities have been reported (2011a, 2012b, 2012c), but are not included in this list of public reports. One incidental long-eared bat (*Myotis evotis*) was recorded at Tehachapi, California (Anderson et al. 2004), but is not included in this list of public reports. Additional bat fatalities (evening bat, eastern red bat, hoary bat, tricolored bat, Mexican free-tailed bat, and unidentified bat) have been found in Texas (Hale and Karsten 2010), but the number of fatalities by species is not reported.

Appendix B. Triple H Wind Project Habitat Characterization – Technical Memo

ENVIRONMENTAL & STATISTICAL CONSULTANTS
415 West 17th Street, Suite 200, Cheyenne, Wyoming 82001
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October 6, 2016

Christina White
Triple H Wind Project, LLC
3760 State St., Suite 200
Santa Barbara, CA 93105

RE: Triple H Wind Project Habitat Characterization

Dear Ms. White,

Vegetation types (or Habitat) were delineated using ArcGIS, ArcMap 10.3 within the Triple H Wind Project (THWP) and a one mile buffer (Buffer). Using 2014 USDA NAIP aerial imagery in combination with 2011 South Dakota Land Cover Patterns, and 2015 USDA NASS cropland classification, all land within the two areas was digitized and assigned one of five habitat types (excluding National Wetland Inventory [NWI] wetlands; Table 1). NWI data was used to represent water within the two study areas. Those water features visible on the aerial imagery but not in the NWI data were digitized as “water” habitat.

The THWP, as described, contained slightly more than 39,271 acres and the one mile buffer contained approximately 31,858 acres. Croplands and grasslands were the dominant land cover types in the THWP accounting for 58% and 33% of the project area (Table 1). In descending order, the following habitat types made up the remaining area of the THWP: NWI wetlands, developed (roads, urban, residential, etc), trees, and water. Grasslands and croplands were again the dominant land cover within the Buffer area accounting for 46% and 45% of the area. Habitat types other than grassland and croplands in the Buffer in descending order included: NWI wetlands, developed, trees, and water (Table 1). The percentage of croplands was greater in the THWP than within the Buffer; whereas, grassland habitat was more prevalent within the Buffer.

Croplands were distributed primarily in the central portion of the THWP and grassland habitat was generally located in areas where NWI wetlands were more numerous (Figure 1). Grassland habitat consisted of herbaceous vegetation that appeared to be either cropped for hay production or grazed by livestock.

Let me know if you have any questions or need further details.

Sincerely,

Brian Heath
Project Manager

Table 1. Digitized Land Cover within the Triple H Wind Project and 1 Mile Buffer.

	THWP		Buffer	
Habitat Type	**Acres**	**%**	**Acres**	**%**
Cropland	22,796.8	58.0%	14,462.6	45.4%
Grassland	12,953.2	33.0%	14,643.9	46.0%
Developed	718.3	1.8%	719	2.3%
Trees	274.3	0.7%	386.2	1.2%
NWI Wetland[a]	2,524.2	6.4%	1,621.8	5.1%
Water	4.3	0.0%	24.4	0.1%
Total	39,271.1	100.0%	31,857.9	100.0%

[a] USFWS National Wetland Inventory

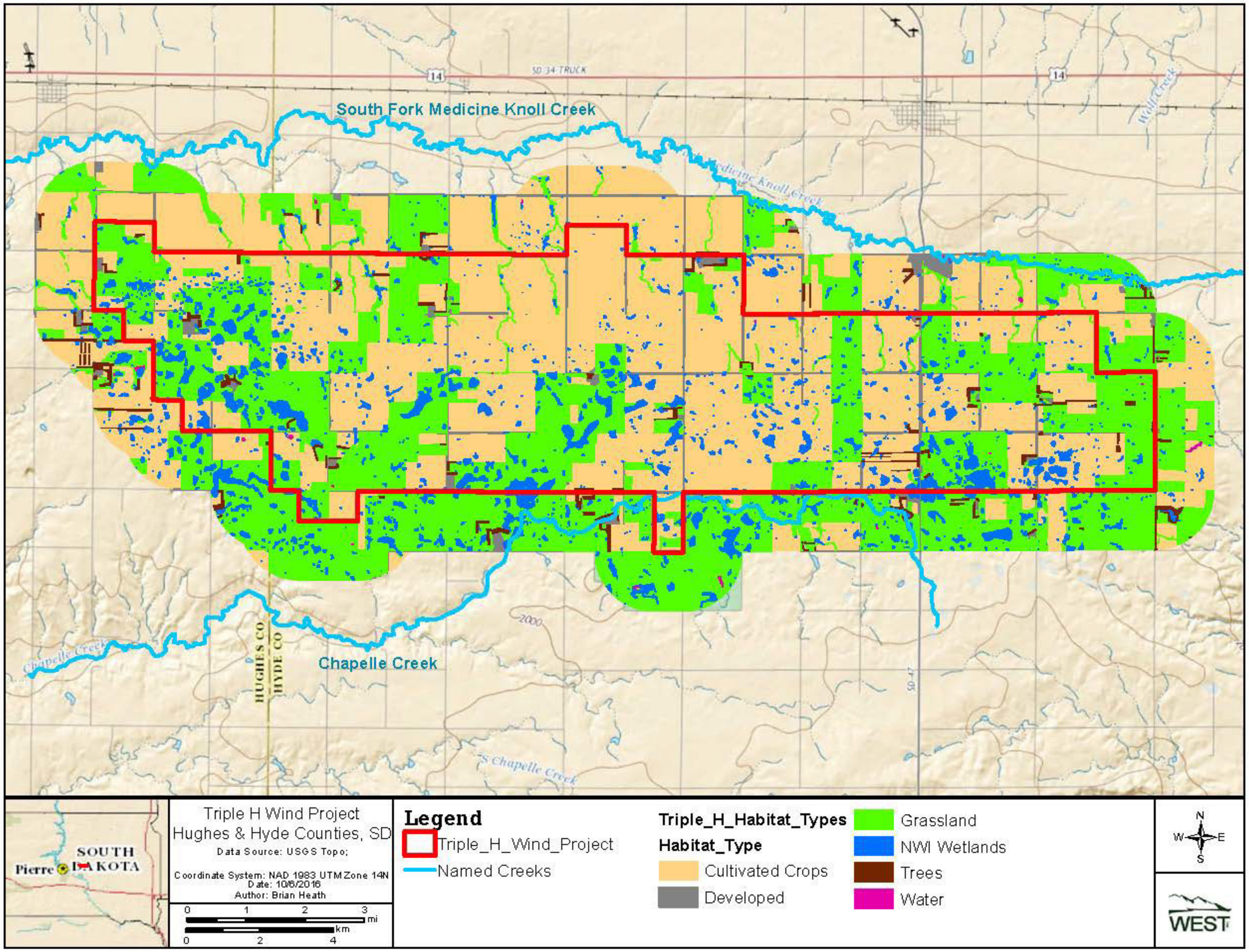

Figure 1. Digitized Land cover within the Triple H Wind Project and 1 mile buffer.

Appendix C. Whooping Crane Stopover Habitat Assessment for the Triple H Wind Project, Hughes and Hyde Counties, South Dakota

Whooping Crane Stopover Habitat Assessment
For the Triple H Wind Project
Hughes and Hyde Counties, SD

Prepared for:

Triple H Wind Project, LLC

3760 State Street, Suite 200
Santa Barbara, California 93105

Prepared by:

Victoria Poulton & Brian Heath

Western EcoSystems Technology, Inc.
415 West 17th Street, Suite 200
Cheyenne, Wyoming 82001

September 1, 2017

Pre-Decisional Document - Privileged and Confidential - Not For Distribution

INTRODUCTION

Triple H Wind Project, LLC is proposing construction of the Triple H Wind Project (THWP) in Hughes and Hyde Counties, SD (Figure 1). Whooping cranes migrate through the U.S. along an approximately 200-mile wide corridor between breeding grounds in Canada and wintering grounds in Texas along the Gulf of Mexico (Canadian Wildlife Service [CWS] and U.S. Fish and Wildlife Service [USFWS] 2007). The THWP is located in the distance bands where 75-85% of observations have occurred, based on confirmed sightings (CWCTP 2014; Figure 1). Potential stop-over habitat for whooping cranes was evaluated using a model developed by The Watershed Institute, Inc. (TWI 2012). The TWI habitat assessment model is a quantitative and easily-replicated desktop approach to evaluating the quantity, quality, and locations of potential whooping crane stopover habitat in a given area. It is based on available data on water regime, water depth, visibility obstructions, wetland size, disturbance, and proximity to feeding areas, which are all factors that have been shown to affect how whooping cranes choose stopover habitat. The initial goal of the TWI model was to provide electric utilities with a tool for making power line-marking decisions, but the USFWS stated in a personal communication (D. Mulhern, USFWS [retired], November 19, 2012) that it should be applicable to wind power development areas for the identification of potential whooping crane stop-over habitat as well. This report describes results of the desktop evaluation of potential whooping crane stopover habitat using the TWI model for the THWP project area plus a 10-mile buffer.

TWI WHOOPING CRANE HABITAT ASSESSMENT

The TWI model is based on National Wetlands Inventory (NWI) wetlands data (USFWS 2016). It should be noted that wetland features identified in the NWI dataset may not all meet criteria defined by the U.S. Army Corps of Engineers for jurisdictional wetlands, and not all surface water features are represented in the NWI Version 1 dataset. Some additional surface water features were added to the set of features evaluated; these features were available from site-specific land cover mapping. NWI features were selected that intersected a 10-mile buffer of the THWP. Wetland features were then screened for unsuitability based on size, construction, and proximity to human disturbance and visual obstructions. U.S. National Agriculture Imagery Program (NAIP) aerial imagery from 2016 was used to evaluate the presence of human development and visual obstructions such as wooded areas. Spatial datasets for roads, highways, railroads, bridges, and electric transmission lines were available from South Dakota GIS (2017) or were digitized from available topographic and aerial imagery.

Screening and scoring of wetlands occurred in a step-wise fashion. Wetlands were first screened based on wetland type; wetlands described as forested, scrub-shrub, or excavated were removed from the dataset. The second screening step removed wetlands with calculated acreage of 0.25 acre or less. The third screening step was to designate buffers around human developments/sources of disturbance and screen the wetlands or portions of wetlands within those disturbance buffers. Table 1 lists human disturbance types included and the disturbance buffers used (based on the TWI model).

Table 1. Disturbance types and buffer distances used to screen wetlands, based on TWI 2012.

Disturbance Type	Disturbance Buffer (m)*	Comments
Paved Roads	400	Non-State Trunk Road Inventory (NSTRI)
Gravel Roads	200	Non-State Trunk Road Inventory (NSTRI)
Dwellings and Developments	200	South Dakota GIS; only occupied structures were selected
Railroads	400	Spatial data not publicly available. Digitized from USGS 1:24,000 topographic map.
Power Lines	200	Spatial data not publicly available. Digitized from USGS 1:24,000 topographic map.
Bridges	400	Spatial data not publicly available. Digitized from NAIP 2016 aerial imagery.

* Width of the buffer applied to each side of a linear feature, or radius applied to a point feature

Following the TWI model, wetlands were assigned scores based on five attributes that contribute to high-quality stop-over habitat for whooping cranes, including water regime, distance to crop fields for feeding, wetland size, whether the wetland is natural or man-made, and if the wetland is part of a wetland mosaic (Table 2). The scores for the five attributes were summed. Resulting scores were compared to the scores calculated by TWI for Quivira National Wildlife Refuge (NWR), which is a traditional stop-over site for whooping cranes in Kansas. Based on the average score for Quivira wetlands, scores of 12 or higher were considered by TWI to be potentially suitable habitat.

Aside from a few traditional stop-over sites such as Quivira NWR and Cheyenne Bottoms in Kansas, whooping crane stop-over sites are highly variable from year to year. If a wetland feature is scored by the TWI as potentially suitable (12 or higher), that does not necessarily mean that a whooping crane will ever visit that site; however, if a whooping crane is migrating through the area and conditions (stormy or foggy weather, inclement winds, sunset) cause the bird to look for a place to stop, it is more likely to choose a feature that possesses the characteristics scored highly by the TWI model, compared to lower scoring features.

Table 2. Wetland scoring system used by the TWI model (TWI 2012).

Score Type	Attributes	Score Value
Water Regime	Permanent (H)[1]	5
	Intermittently Exposed (G)[1]	4
	Semi-Permanent (F)[1]	3
	Seasonally Flooded (C)[1]	2
	Intermittently/Temporarily Flooded (J/A)[1]	1
Distance to Food	Within/adjacent to cropland[2]	5
	<0.5 km from cropland[2]	4
	0.51 – 1.0 km from cropland[2]	3
	1.1 – 1.5 km from cropland[2]	2
	>1.5 km from cropland[2]	1
Wetland Size	>7 acres	5
	5 - 6.9 acres	4
	3 – 4.9 acres	3
	1 – 2.9 acres	2
	<1 acre	1
Natural Wetland	Natural[3]	2
	Created[3]	0
Wetland Mosaic	Yes[4]	3
	No[4]	0

[1] – Codes in parenthesis are codes from the Wetlands and Deepwater Habitats Classification system (Cowardin et al. 1979) used by the NWI system

[2] – Cropland areas from National Land Cover Database (NLCD; USGS 2014) and include the “cultivated crops” category.

[3] – Based on NWI wetland codes indicating the wetland was diked or impounded.

[4] – A wetland was considered part of a mosaic if it was within ¼ mile of four or more other wetlands and with no visual obstructions such as wooded areas or buildings between the wetlands. Visual obstructions were assessed based on NAIP (2016) aerial imagery.

RESULTS

For the THWP and 10-mile buffer combined, 14,100 NWI features initially were identified. An additional 23 water bodies were digitized and added to the dataset, based on desktop or field assessments, for a total of 14,123 features going into the model. For these added features that did not have attributes provided by the NWI dataset, the highest score possible was assumed to be conservative for the regime and wetland type scores. Due to the high number of features retained by the model, an additional 1,065 linear, potentially incised and/or wooded features (intermittent and unknown perennial streambed features) were removed from the dataset, resulting in 10,403 remaining scored features[1]. Of the 10,403 scored features, 4,867 had a score of 12 or higher.

[1] This step is not part of the TWI model.

Within the THWP boundary, there were 1,491 features that were scored, with scores ranging from 5 to 18 (Figures 2 and 3). Seven hundred fourteen features scoring 12 or higher were present within the THWP itself (Figure 3).

Within a 10-mile buffer of the THWP and excluding the area within the Project boundary, 8,912 wetland features were scored by the TWI model (Figures 4 & 5). High-scoring (12+) features were present throughout the 10-mile buffer area (Figure 5). High-scoring features of note included the Missouri River/Lake Sharpe in the southwest, Collins Slough at the eastern edge of the 10-mile buffer area, Medicine Knoll Creek and its tributaries in the west, and wet areas associated with Wolf Creek in the northeast (Figure 5). These high-scoring features included rivers and streams, emergent wetlands, impoundments, ephemeral drainages, prairie potholes, and depressions in fields (Figure 5).

When comparing the TWI model results between the THWP area and the 10-mile buffer area, the areas are similar in that features scoring 11 or 12 were most common (Figures 2 and 4). The largest high-scoring features in terms of acreage, and the areas with the most densely occurring high-scoring features were outside of the THWP boundary to the south, west, and north. The widespread availability of suitable stopover habitat indicates that if cranes are displaced from suitable habitat by development of the THWP, they are likely to find similar habitat nearby. The lack of a concentration of high-scoring features within the THWP relative to the surrounding landscape also infers whooping cranes may not be more attracted to the THWP and risky areas near wind turbine blades.

Through fall of 2014, 10 whooping crane observations were confirmed within 10-miles of the THWP (CWCTP 2014; Figure 6). The Cooperative Whooping Crane Tracking Project (CWCTP) emphasizes that the whooping crane observation data are incidental sightings and not accurate documentations of absence in areas where no observations are recorded, nor are observation locations representative of all sites used by tracked cranes since only the location of the first observation is logged in the database.

The U.S. Geological Survey (USGS) evaluated spatial intensity of use by 58 whooping cranes fitted with platform transmitting terminals (PTT; Pearse et al. 2015). Stopover sites used during spring and fall migration were tracked over five years. Based on stopover site use density and duration, 20-square-kilometer grid cells were categorized as unoccupied, low use, core intensity, or extended-use core intensity. The resulting data are meant as a tool to identify areas that may be important for migrating whooping cranes. Overlaying the USGS site use intensity data with the THWP indicates that the THWP is located in an area with lower use intensity as higher intensity cells occur to the north and southeast (Figure 7).

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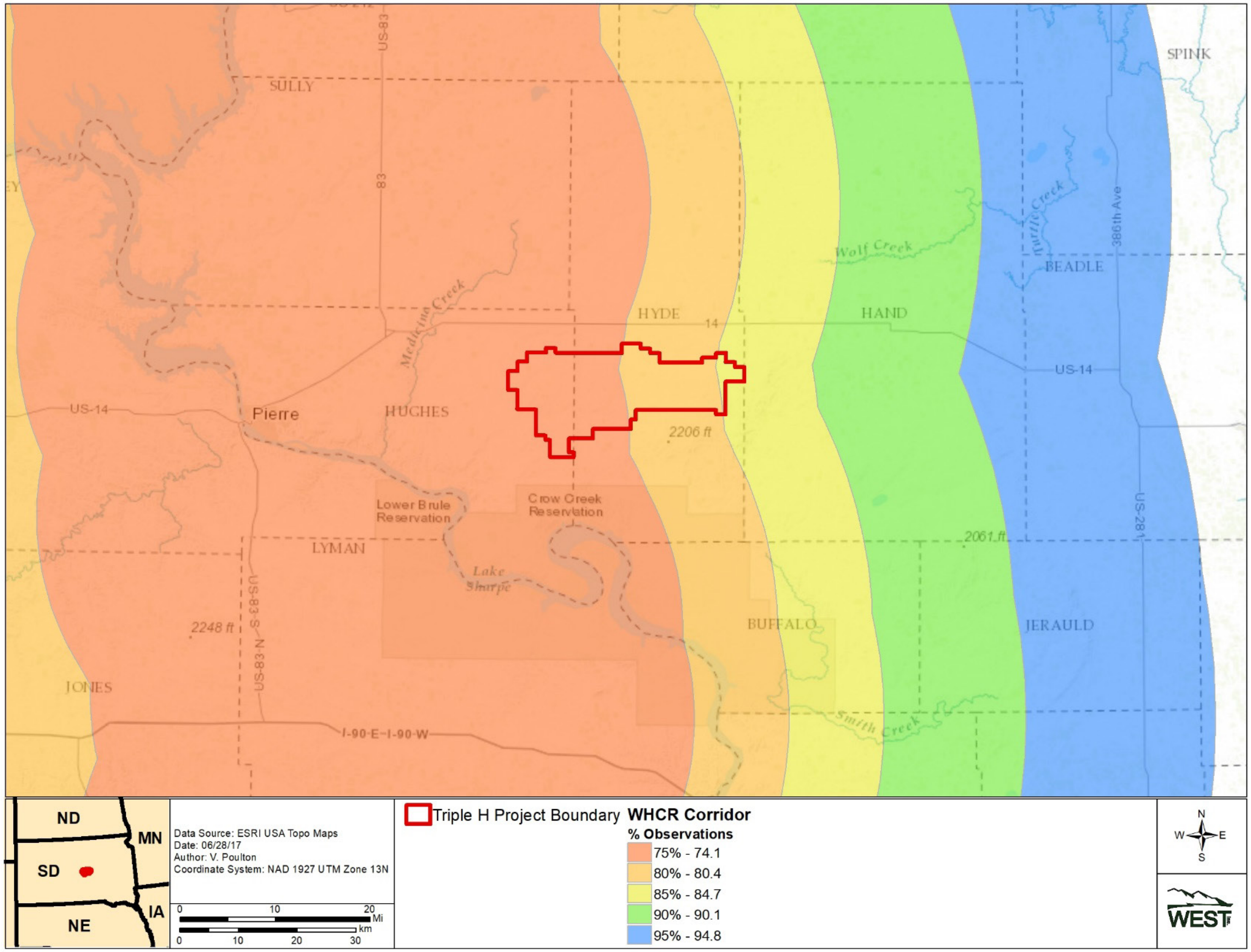

Figure 1. Triple H Wind Project evaluated for whooping crane stopover habitat.

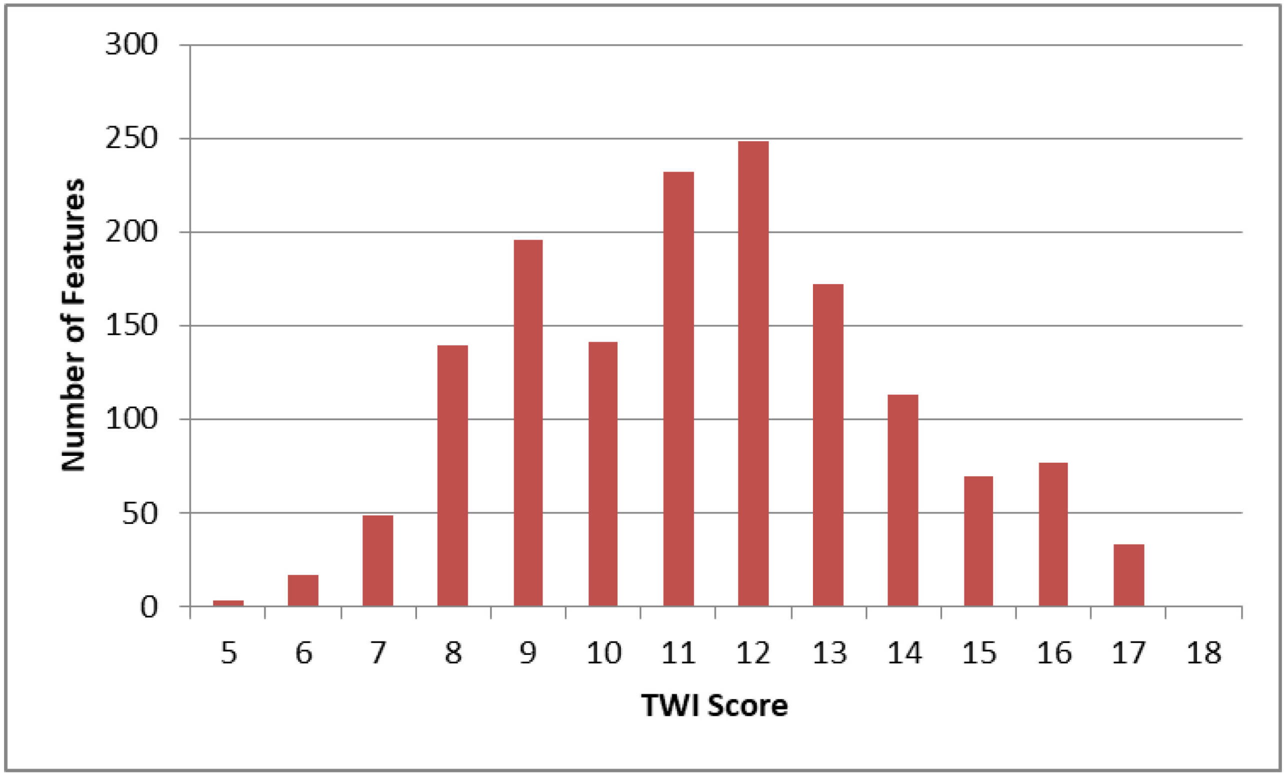

Figure 2. TWI scores for NWI wetland features within the Triple H Wind Project.

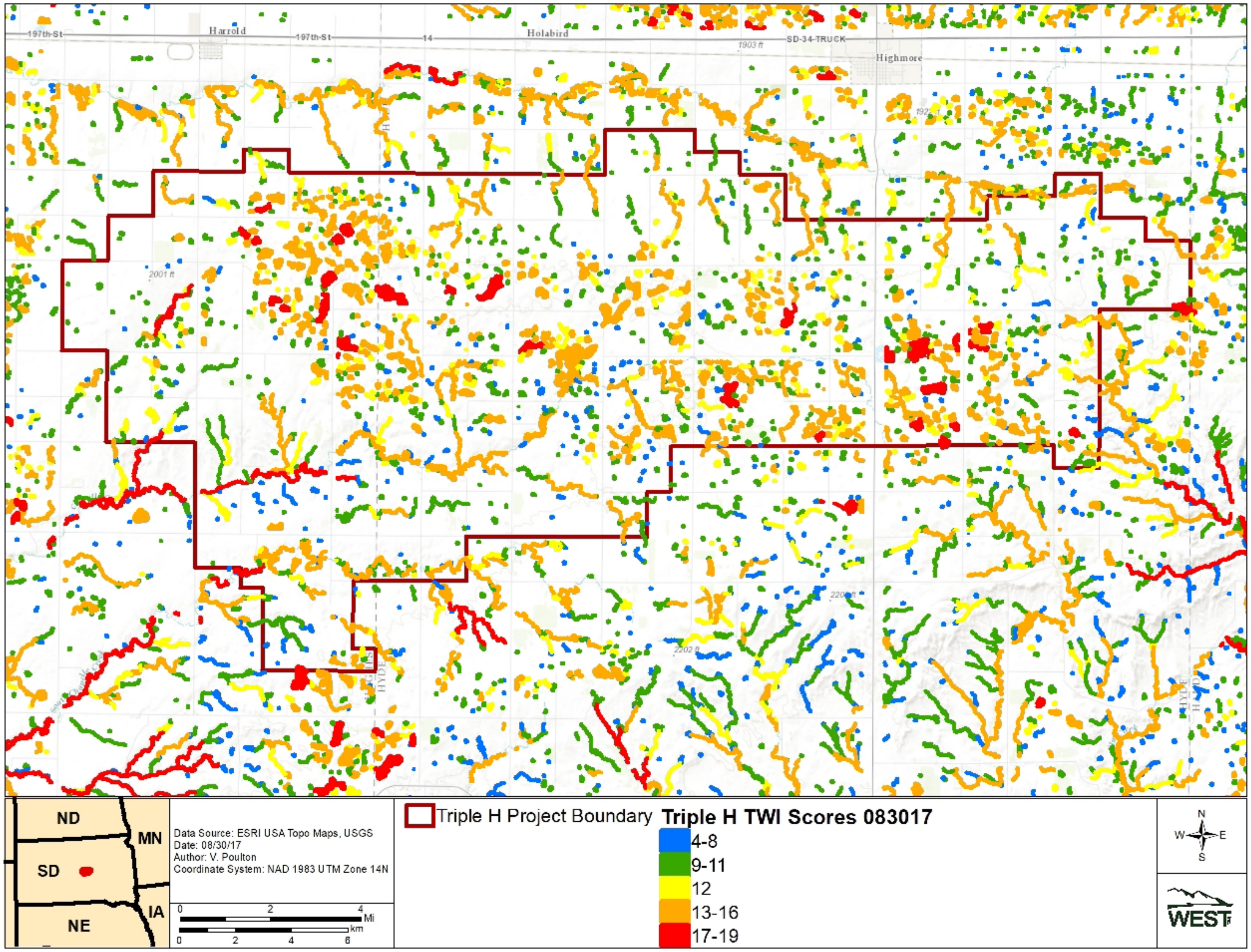

Figure 3. Wetland scores for the Triple H Wind Project using the TWI model.

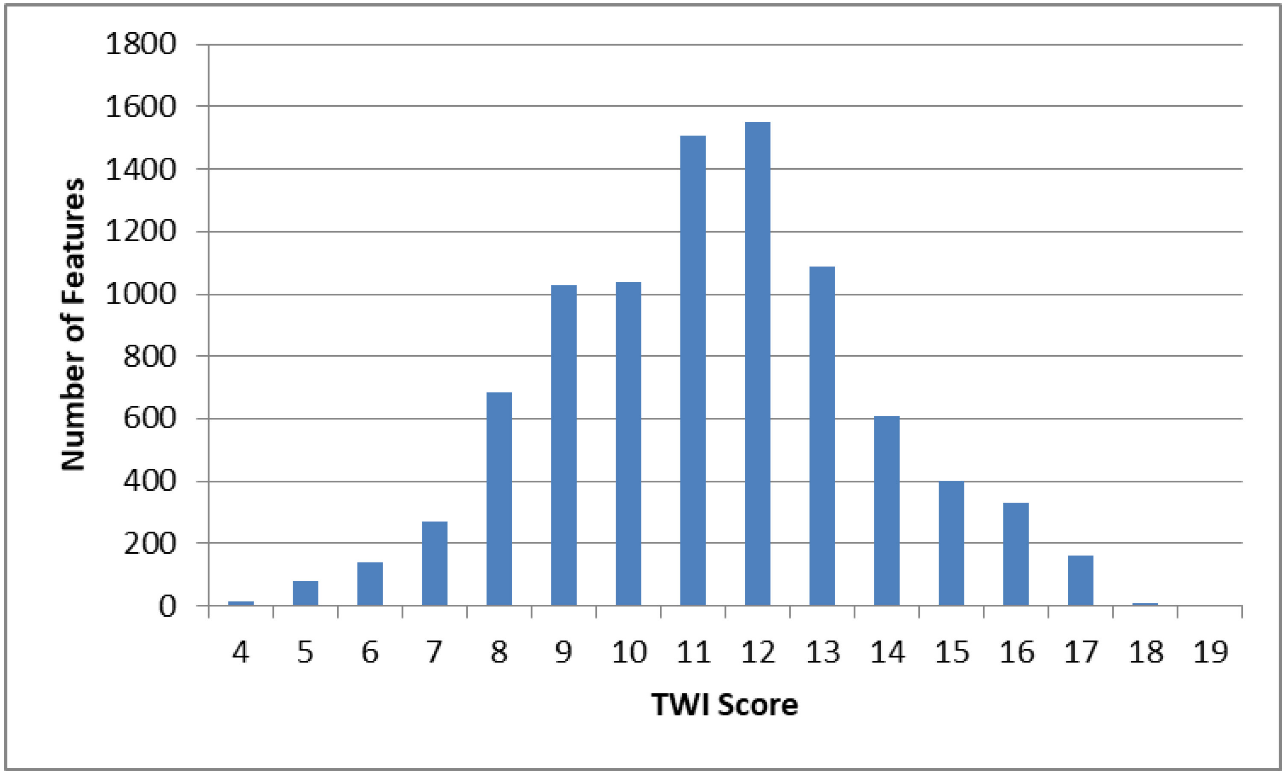

Figure 4. TWI scores for wetlands in the 10-mile buffer but excluding land within the Triple H Wind Project boundary.

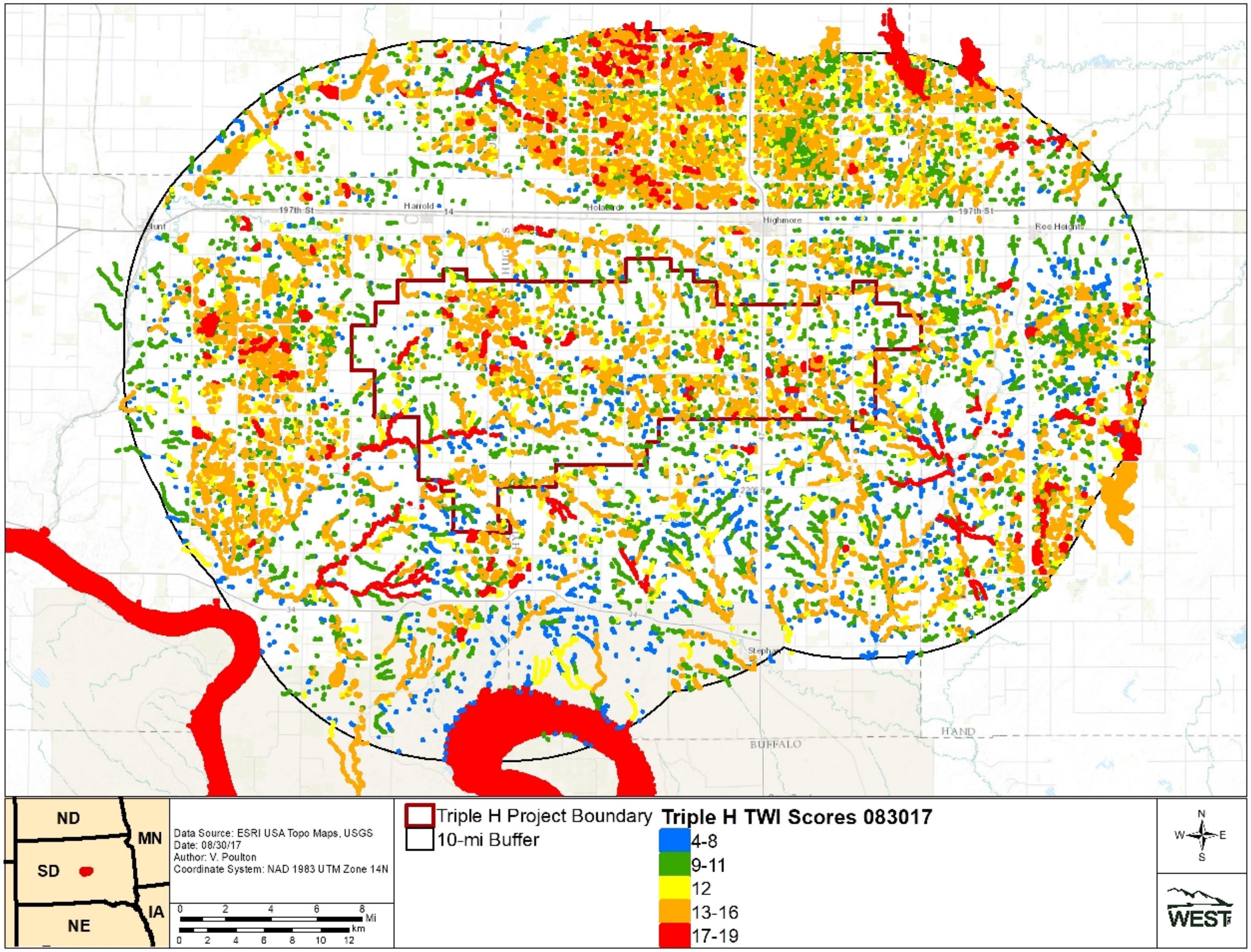

Figure 5. Map of wetlands scored using the TWI model for the Triple H Wind Project and 10-mile buffer.

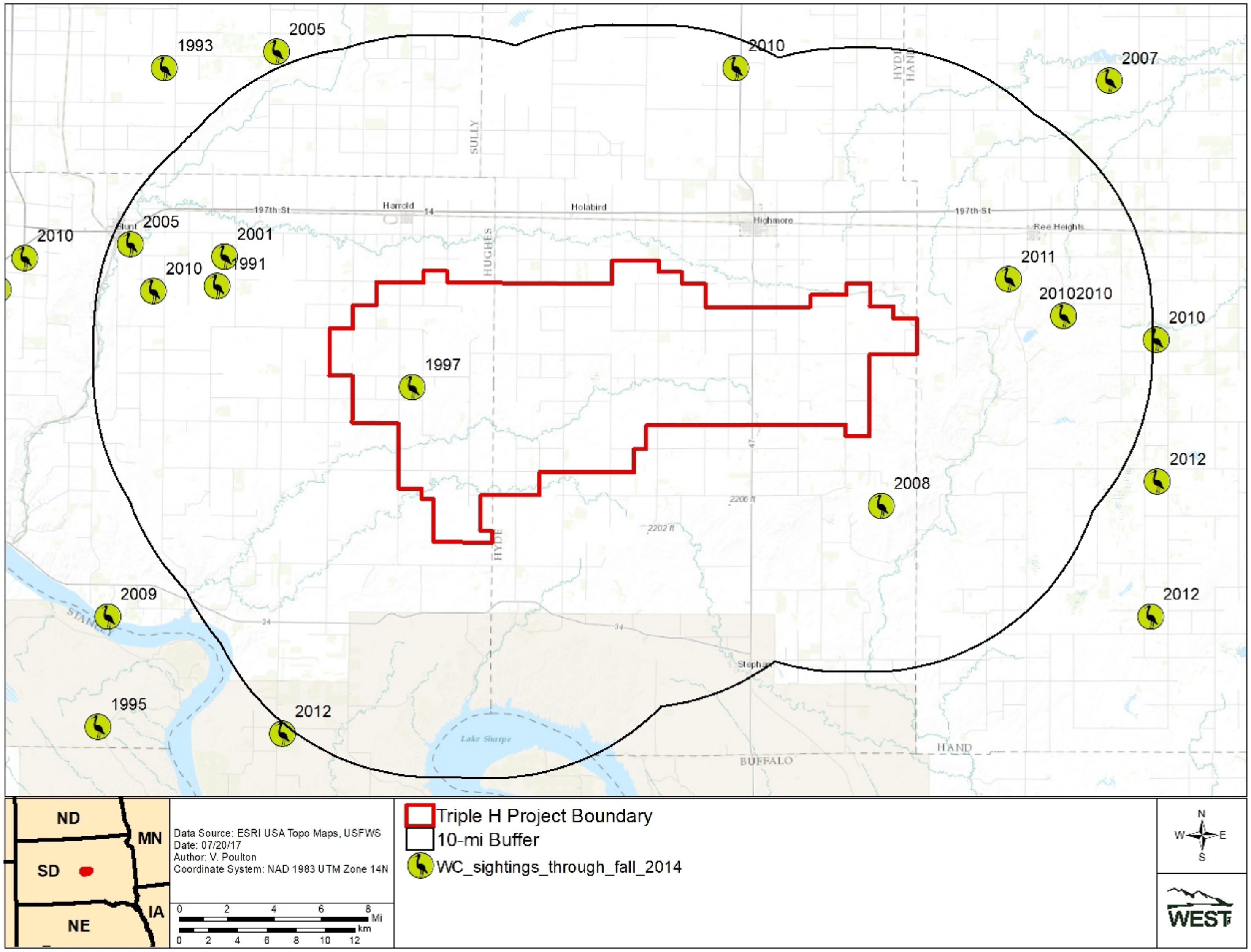

Figure 6. Whooping crane observations through Fall 2014, data from the USFWS Nebraska Ecological Services Field Office.

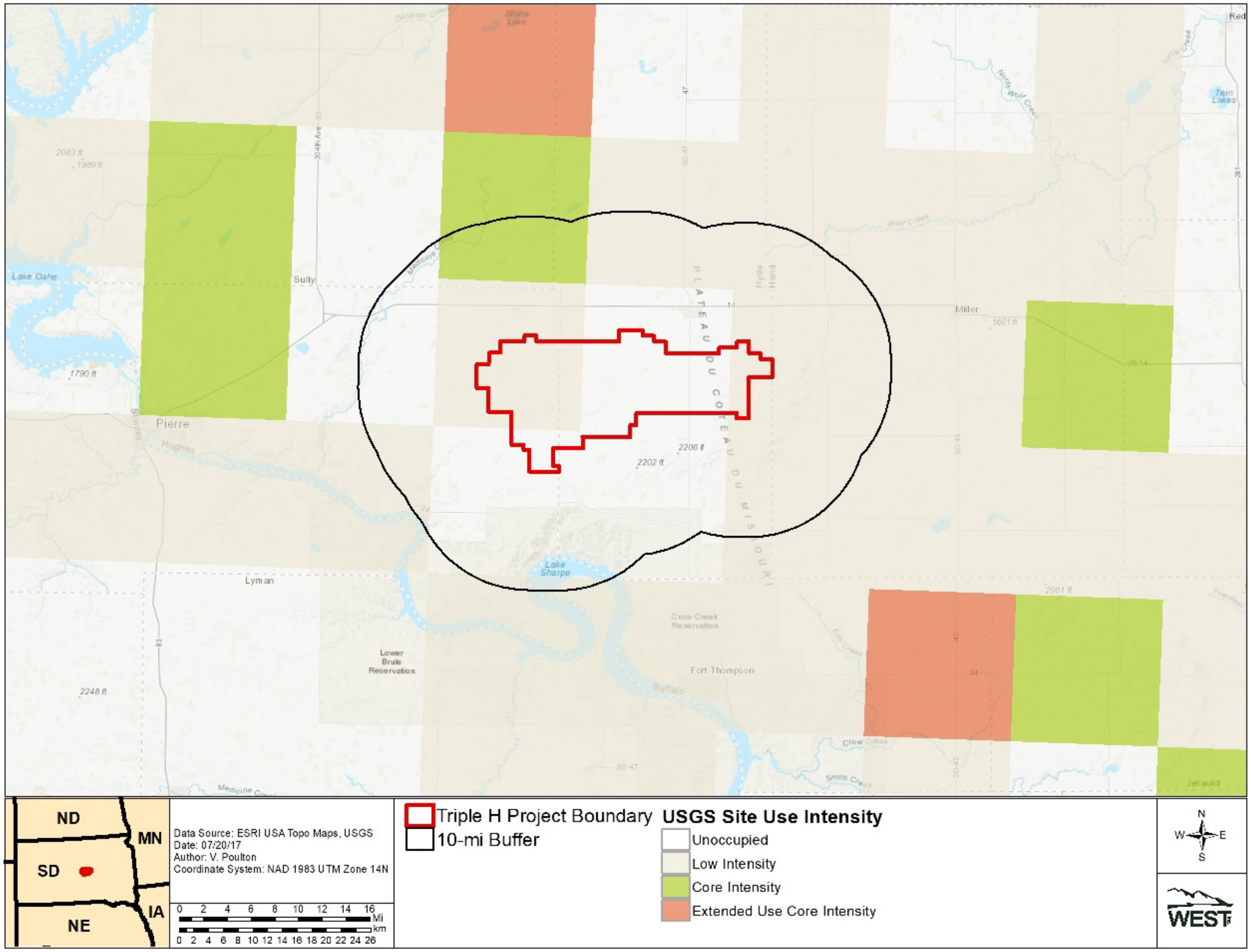

Figure 7. USGS site use intensity data for the vicinity of the THWP (USGS 2015).

Appendix A. Table of all wetlands scored by the TWI model for the Triple H Wind Project and 10-mile buffer (See Excel spreadsheet).

Appendix B. Cooperative Whooping Crane Tracking Project – Attachment 1 Required Reading for Users of the Whooping Crane Tracking Project Database.

Required Reading for Users of the Whooping Crane Tracking Project Database

CWCTP-GIS data or derivatives thereof (e.g., shape files, jpegs) may not be distributed or posted on the Internet without inclusion of this explanatory document.

The Cooperative Whooping Crane Tracking Project (CWCTP) was initiated in 1975 to collect a variety of information on whooping crane migration through the U.S. portion of the Central Flyway. Since its inception in 1975, a network of Federal and State cooperating agencies has collected information on whooping crane stopovers and funneled it to the U.S. Fish and Wildlife Service (Service) Nebraska Field Office where a database of sighting information is maintained. The WCTP database includes a hardcopy file of whooping crane sighting reports and a digital database in various formats based on those sighting reports. A subset of the database along with sight evaluation (habitat) information collected between 1975 and 1999 was summarized by Austin and Richert (2001).*

In the Fall of 2007, the CWCTP database was converted to a GIS format (ArcGIS 9.2) to facilitate input, updates, and provide output options in a spatial context. During this process, inconsistencies between the digital database and sighting report forms were identified and corrected. Location information in various formats was derived from data in the corrected database, and new fields were added to the corrected database (e.g., latitude and longitude in decimal degrees, an accuracy field, and location comment field). The attached file contains observation data through the 2008 Spring migration and is referred to as the CWCTP-GIS (2008a).

The appropriate use of the CWCTP-GIS is constrained by limitations inherent in both the GIS technology and bias inherent in any database comprised of incidental observations. Without an understanding of the assumptions and limitations of the data, analyses and output from the spatial database can result in faulty conclusions. The following assumptions and characteristics of the database are crucial to interpreting output correctly. Other, unknown biases also may exist in the data.

- First and foremost, the database is comprised of incidental sightings of whooping cranes during migration. Whooping cranes are largely opportunistic in their use of stopover sites along the Central Flyway, and will use sites with available habitat when weather or diurnal conditions require a break in migration. Because much of the Central Flyway is sparsely populated, only a small percent of stopovers are observed, those observed may not be identified, those identified may not be reported, and those reported may not be confirmed (only confirmed sightings are included in the database). Based on the crane population and average flight distances, as little as 4 percent of crane stopovers are reported. *Therefore, absence of documented whooping crane use of a given area in the Central Flyway does NOT mean that whooping cranes do not use that area or that various projects in the vicinity will not potentially adversely affect the species.*

- In the database, the location of each sighting is based on the first observation of the crane group even though, in many cases, the group was observed at multiple locations in a local area. For this and other reasons described below, only broad-scale analyses of whooping crane occurrences are appropriate. GIS **cannot** be legitimately used with this database for measurements of distance of whooping crane groups from various habitat types or geographic entities (i.e., using various available GIS data layers). In addition, point locations of whooping crane groups known to roost in various wetlands or rivers may not coincide with those wetlands. The user needs to refer to the attribute table or contact the Nebraska Field office for more specific information on individual observations.

- Precision of the data: When a "Cadastral" location (Township, Range, Section, ¼-Section) was provided on the original sighting form, the geographic point representing that sighting was placed in the center of the indicated Section or ¼-Section and the latitude and longitude of that point were recorded in degrees, minutes, and seconds (DMS). These records are indicated by "Cadastral" in the accuracy field. When Cadastral information was lacking, DMS latitude and longitude were derived by adding seconds (00) to the degrees and minutes of latitude and longitude originally estimated and recorded on the observation form. These observations are identified by "Historic" in the accuracy field. GPS latitude and longitude were used when available, but when none of the above were reported, the point was placed on text description of location (e.g., 3 miles N of Denton), and identified in the accuracy field with "Landmark". DMS latitude and longitude were converted to decimal degrees, which were used to populate the GIS data layer.

- Bias: Bias is an inherent characteristic of any data obtained through incidental sightings. That is, for the subset of crane use that is recorded, relatively more sightings are recorded in areas such as national wildlife refuges where knowledgeable observers are available to look for cranes and report their presence. Conversely, areas of high use may not be documented due to the absence of observers. However, use of areas such as national wildlife refuges is also determined to some extent by habitat management on the areas and availability of alternative habitat in the region. For these reasons, representations of the crane migration corridor based on percent of confirmed sightings should be interpreted conservatively, particularly in Oklahoma and Kansas where a high percent of sightings occur on a few national wildlife refuges. Whooping crane migration patterns and subsequent observations were also likely influenced by regional weather patterns such as wind and precipitation, as well as local farming practices which influence food availability. Factors such as these vary among regions and years and were not considered in this database.

The CWCTP-GIS will be updated annually following the Fall migration and distributed to State cooperators and Fish and Wildlife Service Ecological Services Field Offices in the Central Flyway. Contact information for these offices can be found at http://www.fws.gov. Federal regulatory agencies and project proponents should contact the appropriate Fish and Wildlife Service for help in evaluating potential project impacts to the endangered whooping crane.

***** Austin, E.A. and A.L. Richert. 2001. A comprehensive review of observational and site evaluation data of migrant whooping cranes in the United States, 1943-99. U.S. Geological Survey. Northern Prairie Wildlife Research Center, Jamestown, North Dakota, and State Museum, University of Nebraska, Lincoln, Nebraska. 157 pp.

Appendix D. Triple H Wind Project, Northern Long-eared Bat Desktop Summer Habitat Assessment, Hughes and Hyde Counties, South Dakota

Triple H Wind Project Northern Long-eared Bat Desktop Summer Habitat Assessment

Hughes and Hyde Counties, South Dakota

Prepared for:

Triple H Wind Project LLC

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Prepared by:

Western EcoSystems Technology, Inc.

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Cheyenne, Wyoming

December 21, 2017

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INTRODUCTION

Triple H Wind Project, LLC contracted Western EcoSystems Technology, Inc. (WEST) to identify potential suitable habitat for the federally threatened northern long-eared bat (*Myotis septentrionalis*; NLEB) within the proposed Triple H Wind Project (Project).

During the summer, suitable habitat for this species consists of forested areas where bats might roost, forage, and commute between roosting and foraging sites. NLEB primarily forage or travel in forest habitat and are typically constrained to forest features (Boyles et al. 2009). Therefore, habitat suitability was evaluated based primarily on the presence of forested areas that NLEB might use for roosting and foraging.

PROJECT AREA DESCRIPTION

In 2016, the original Project area was based on a 200 megawatt (MW) project and now has been expanded to include three separate 250 NW phases. The proposed total area of the original Project is approximately 39,099 acres (ac; 61.1 square miles [mi^2]; Figure 1). According to the U.S. Geological Survey National Land Cover Dataset (USGS NLCD 2011), the dominant land cover type within the original area of interest is herbaceous habitat, covering 62.4% of the land area (24,383 ac [38.1 mi^2]). The second most common cover type is cultivated cropland, primarily corn and soybeans (33.3%; 13,026 ac [20.4 mi^2]). Developed/open space (2.2%; 853 ac [1.3 mi^2]) and open water (1.5%; 574 ac [0.9 mi^2]) were the next highest habitat types. All other land cover types total less than 0.5% of the land area, individually. Deciduous forests are considered potential habitat for NLEB and combined make up approximately 0.01% (2.2 ac [0.003 mi^2]) of all land cover types within the original Project area.

The proposed total area that includes the expanded boundary of the Project is approximately 110,139 ac (172.1 mi^2; Figure 2). According to the USGS NLCD, the dominant land cover type within the expanded area of interest is herbaceous habitat, covering 68.9% of the land area (75,835 ac [118.5 mi^2]). The second most common cover type is cultivated cropland, primarily corn and soybeans (27.5%; 30,262 ac [47.3 mi^2]). Developed/open space (1.9%; 2,134 ac [3.3 mi^2]) and open water (1.5%; 1,153 ac [1.8 mi^2]) were the next highest habitat types. All other land cover types total less than 0.5% of the land area, individually. Deciduous forests combined make up approximately 0.02% (17 ac [0.03 mi^2]) of all land cover types within the expanded Project area.

METHODS

Desktop review of land cover data and aerial imagery was used to assess the presence of suitable habitat for NLEB within the original and expanded areas of interest. Our definition of suitable summer habitat for the NLEB is intended to describe typical habitat used by reproductive females and juveniles during the summer. The U.S. Fish and Wildlife Service (USFWS) *2017 Range-Wide Indiana Bat Summer Survey Guidelines* (USFWS 2017b) was used to define suitable habitat for NLEB.

WEST conducted a desktop assessment of potential suitable NLEB habitat by reviewing the USGS NLCD within a 2.5-mile buffer of the original and expanded Project areas, and delineating potential suitable habitat types (i.e., deciduous forest, evergreen forest, mixed forest, and woody wetlands) using Geographic Information Systems (GIS). The habitat delineations were then cross-checked and edited based on the most recent publicly available aerial imagery from the National Agriculture Imagery Program (NAIP) for the Project areas. The overall habitat layer was then edited to remove areas that had been cleared of trees and to refine habitat boundaries. Narrow commuting corridors not captured by the NLCD were also added based on the aerial imagery.

A habitat analysis was then conducted to assess connectivity of suitable foraging habitats (i.e., woodlots, forested riparian corridors, and natural vegetation communities adjacent to these habitats), roosting habitats, and commuting habitats (i.e., shelterbelts/tree-lines, wooded hedgerows) as suggested in the USFWS Indiana Bat Section 7 and Section 10 Guidance for Wind Energy Projects (USFWS 2011). The guidance suggests assessing the potential presence of Indiana bats (*Myotis sodalis*) and NLEB within the Projects based on availability of travel/commuting corridors within the Projects' boundaries, and connectivity to foraging or roosting habitat within a 2.5 mile buffer of the Projects. The minimum size for suitable foraging/roosting habitat is not well understood, but lower estimates are around 20 ac (Broders et al. 2006). We used a minimum patch size of 15 ac (0.2 mi^2) to assign potential roosting habitat. Trees up to 1,000 feet (ft) from the next nearest suitable roost tree, woodlot, or wooded fencerow were considered suitable habitat (USFWS 2011). The 1,000-ft distance is based on observations of NLEB behavior indicating that isolated trees might only be suitable as habitat when they are less than 1,000 ft from other forested/wooded habitats. These estimates are based on available telemetry data on foraging activity. Based on this informed guidance, it is reasonable to conclude that NLEB are unlikely to occur within project areas located more than 1,000 ft from the nearest connected suitable habitat (USFWS 2016; USFWS 2011).

Forested patches were sorted by size into the following groups: <15 ac: small forest patches, 15-50 ac: potential NLEB roost/foraging habitat, and >50 ac: large potential roost/foraging habitat. All polygons representing forested habitats were buffered by 500 ft and dissolved to group any habitat patches within 1000 ft of each other. This buffer, representing all forested habitats within 1,000 ft of each other, was then purged of small isolated patches by selecting only those connected habitats containing forested patches at least 15 acres in size. This selection of habitat patches was then buffered by 1,000 ft to represent the potential foraging area for NLEB.

In addition to desktop analysis, USFWS South Dakota Field Office and South Dakota Game, Fish, and Parks were contacted to learn more about NLEB occurrence within Hughes and Hyde Counties.

RESULTS

According to the South Dakota Listed Species by County List (updated January 11, 2017; USFWS 2017a) there are known occurrences of NLEB within Hughes County by either acoustic or netting survey documentation and possible NLEB occurrence in Hyde County. However, when WEST contacted the USFWS South Dakota field office and South Dakota Game, Fish, and Parks, it was expressed that there were no known occurrences of NLEB in either county and that surveys had not been conducted that were known.

The desktop NLEB bat habitat assessment of the original boundary resulted in zero forested patches greater than 15 ac within the original Project boundary (Figure 3). Additionally, five forested patches greater than 15 ac occurred outside of the project boundary within the 2.5 mile buffer. The NLEB bat habitat assessment of the expanded boundary resulted in four forested patches greater than 15 ac within the expanded Project boundary (Figure 4). Two additional forested patches greater than 15 ac occurred outside of the expanded Project boundary within the 2.5 mile buffer.

Given that there were 0 – 6 forested patches greater than 15 ac within the 2.5 mile buffer of the original and expanded Project boundaries, WEST recommends a follow up on-site habitat assessment by a WEST permitted NLEB bat biologist to determine the potential suitability for NLEB summer presence within and around the Project boundaries. Presence/probable absence may be warranted if forest connectivity to larger contiguous forested habitat is found within either Project boundary.

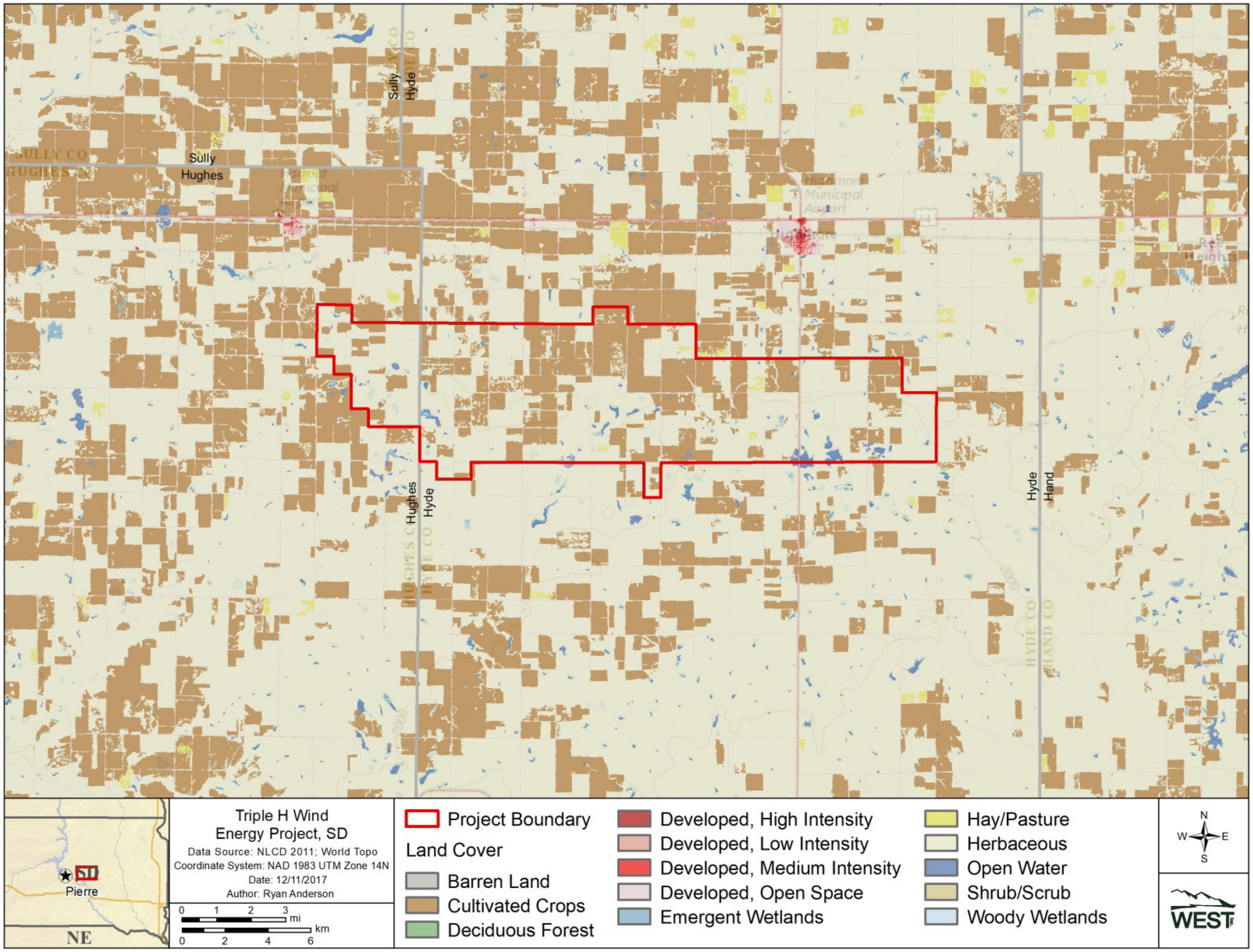

Figure 1. Land use and land cover at the Triple H Project.

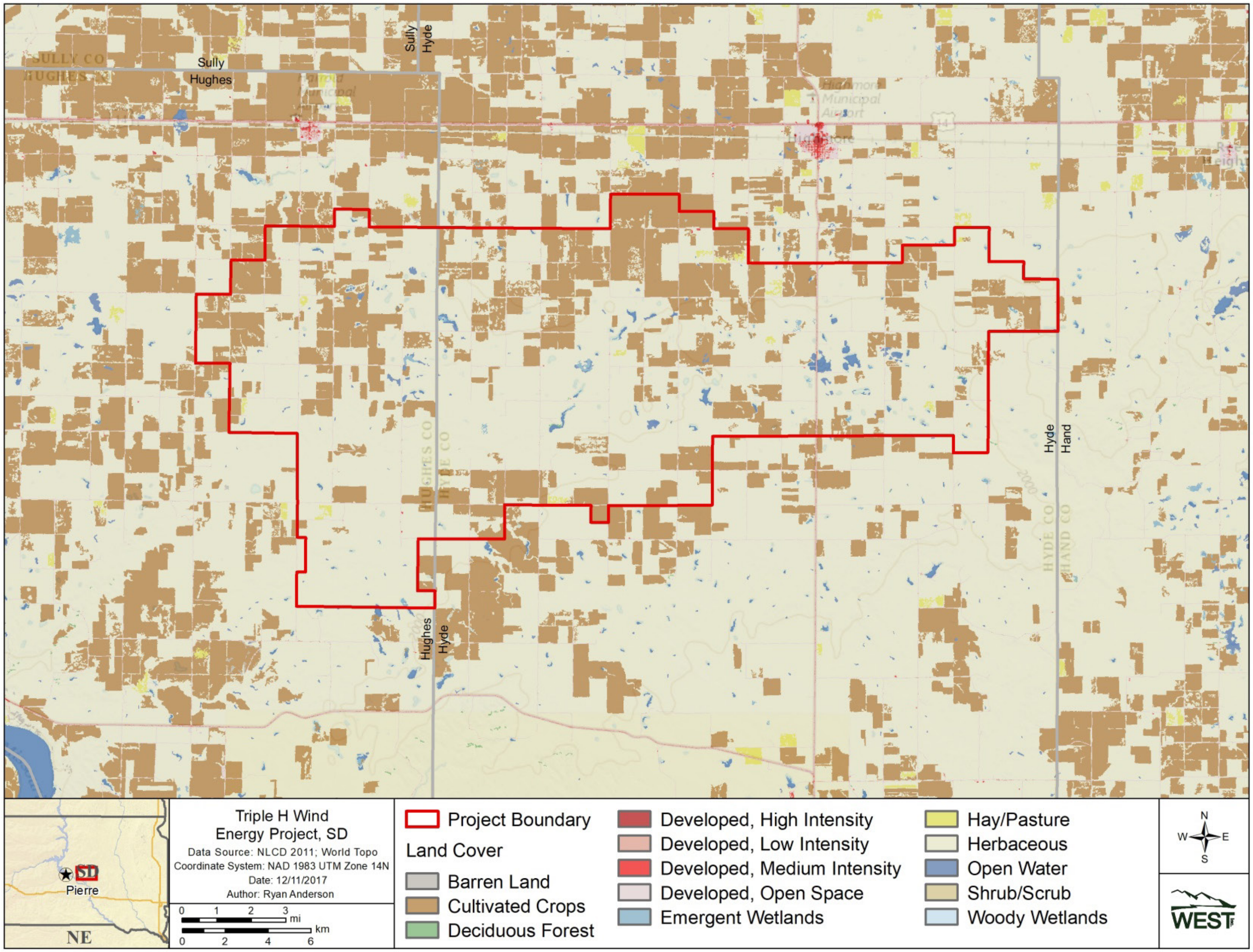

Figure 2. Land use and land cover at the expanded Triple H Project.

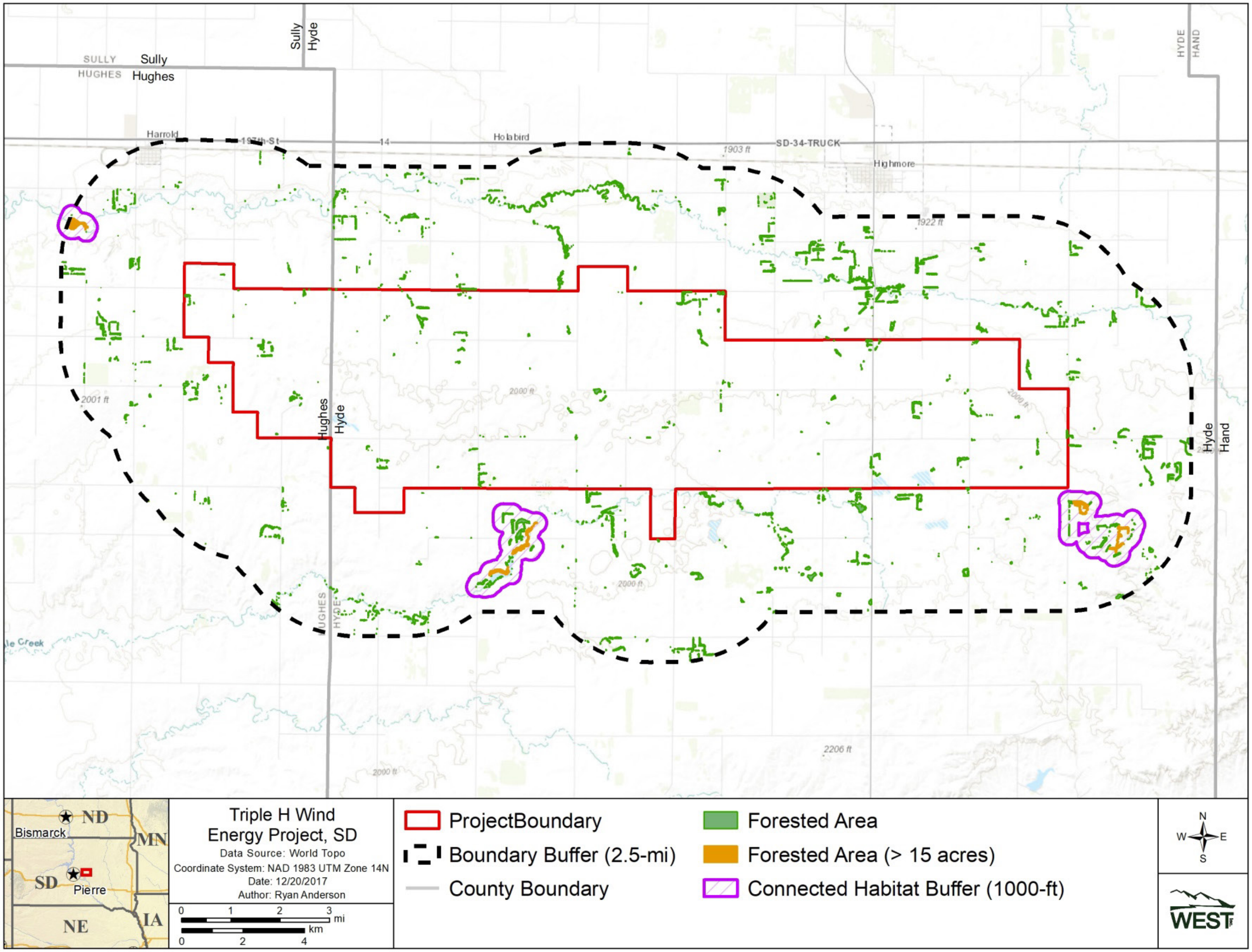

Figure 3. Northern long-eared bat habitat assessment of the Triple H Project.

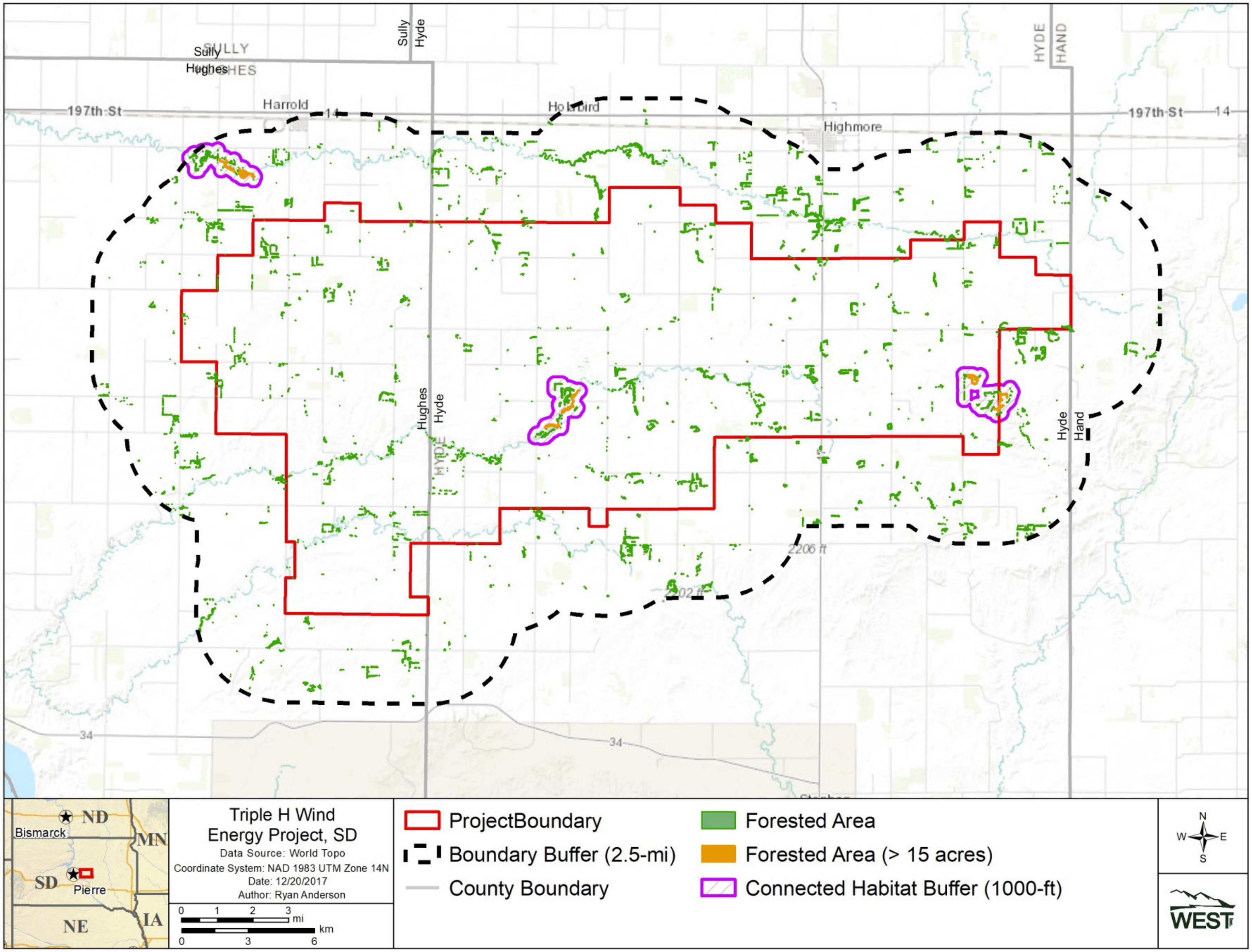

Figure 4. Northern long-eared bat habitat assessment of the expanded Triple H Project.

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Broders, H.G., G.J. Forbes, S. Woodley and I.D. Thompson. 2006. Range extent and stand selection for roosting and foraging in forest-dwelling northern long-eared bats and little brown bats in the Greater Fundy Ecosystem, New Brunswick. Journal of Wildlife Management 70:1174-1184.

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Appendix E. Avian Use Surveys for the Triple H Wind Project, Hughes and Hyde Counties, South Dakota – Final Report April 2016 – March 2017

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

3760 State Street, Suite 200
Santa Barbara, California 93105

Prepared by:

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September 19, 2017

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

Western EcoSystems Technology

Brian Heath	Project Manager
Carmen Boyd	Report Manager
Guy DiDonato	Statistician
Sarah Martinson	Data Analyst
Kristen Klaphake	GIS Technician
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Wendy Bruso	Technical Editing Manager
Katie Michaels	Technical Editing Coordinator
Carissa Goodman	Senior Technical Editor
Dave Klein	Technical Editor
Chris Fritchman	Field Supervisor
Brenda Weber	Field Technician
Michael Gerringer	Field Technician

REPORT REFERENCE

Heath, B. and G, DiDonato. 2017. Avian Use Surveys for the Triple H Wind Project, Hughes and Hyde Counties, South Dakota. DRAFT Final Report: April 2016 – March 2017. Prepared for Triple H Wind Project, LLC, Santa Barbara, California. Prepared by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming. September 19, 2017.

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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).

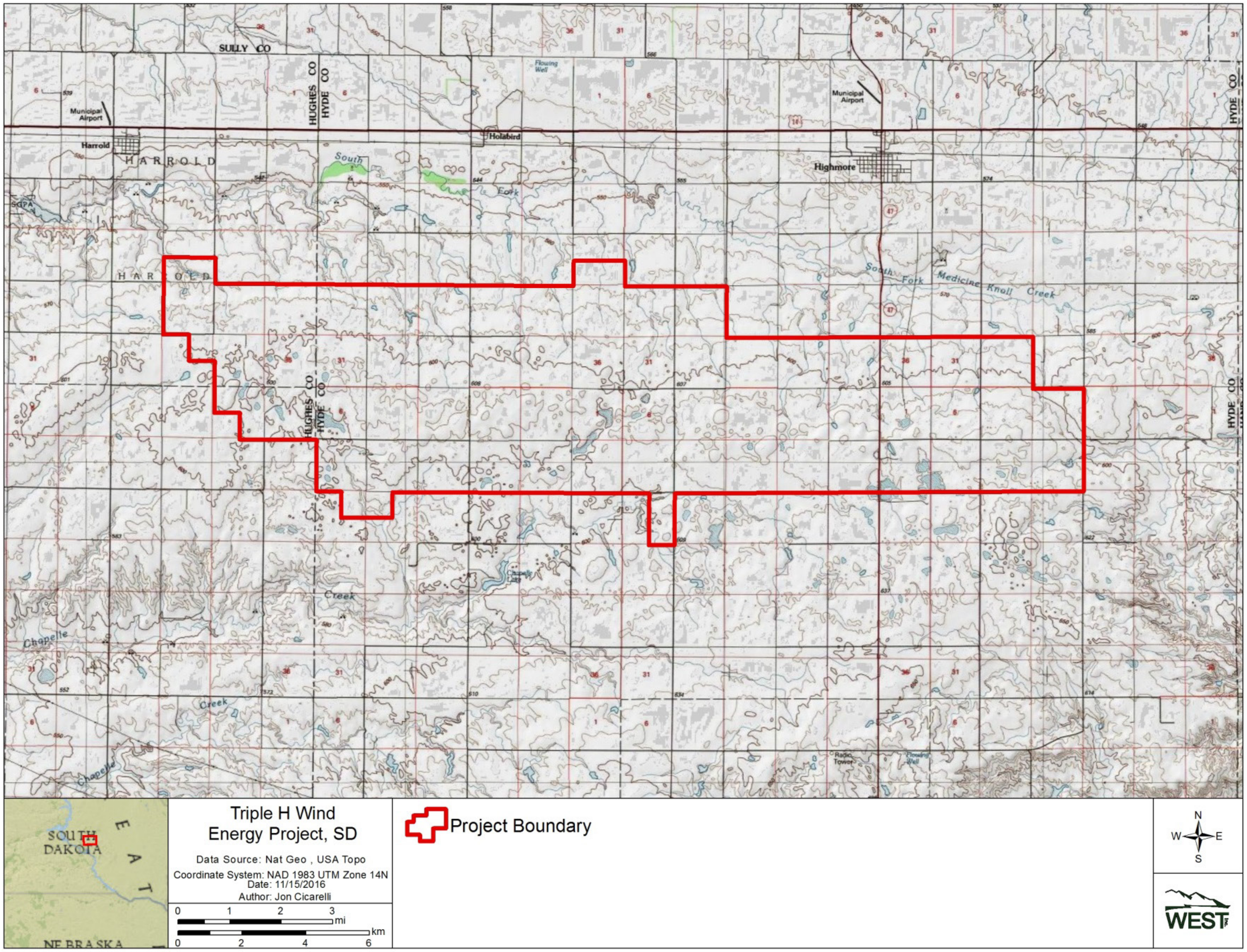

Figure 1. Overview of the Triple H Wind Project, Hughes and Hyde Counties, South Dakota.

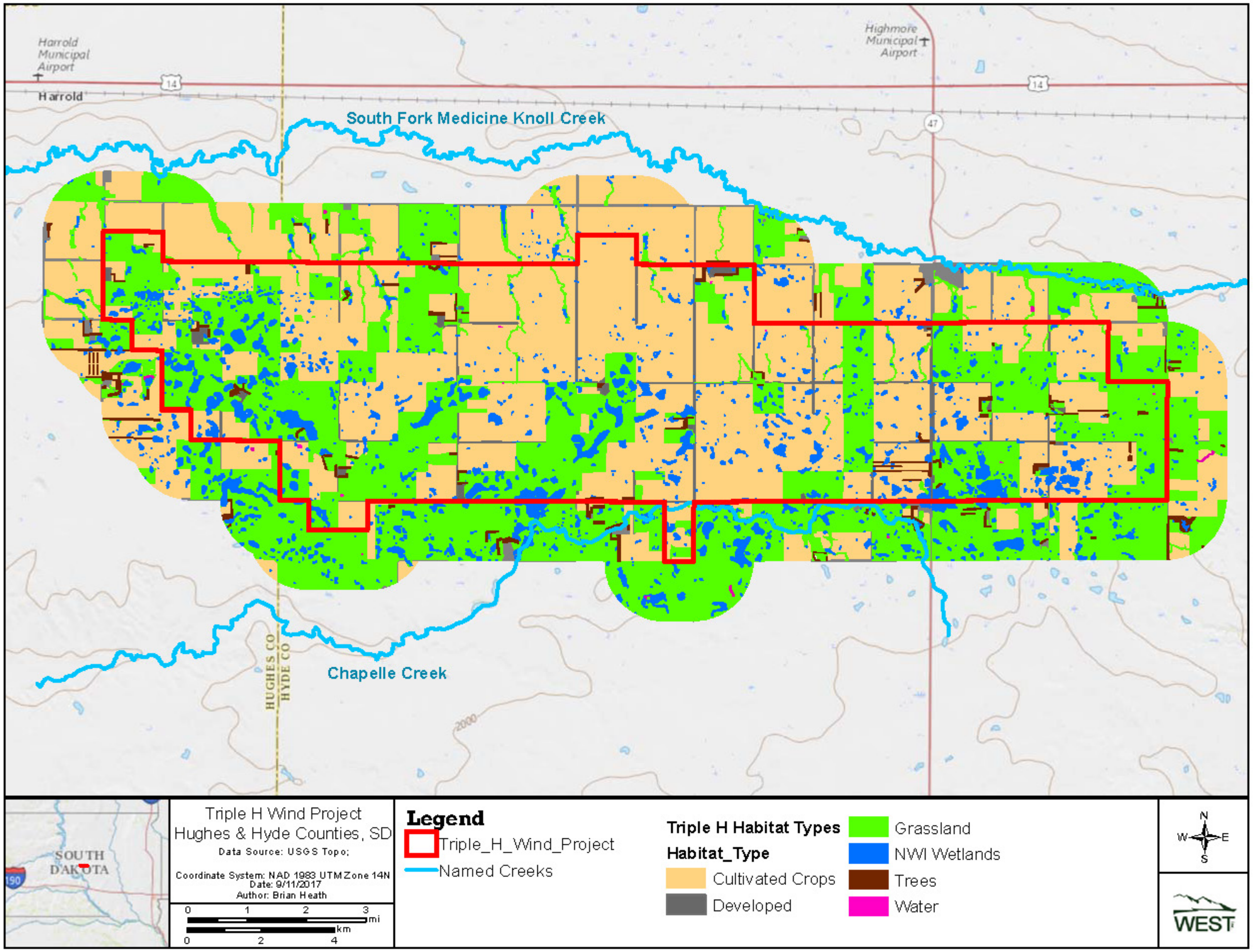

Figure 2. The land cover types and coverage within the Triple H Wind Project, Hughes and Hyde Counties, South Dakota (USGS NLCD 2011; Homer et al. 2015 and WEST habitat mapping Heath 2016b).

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.

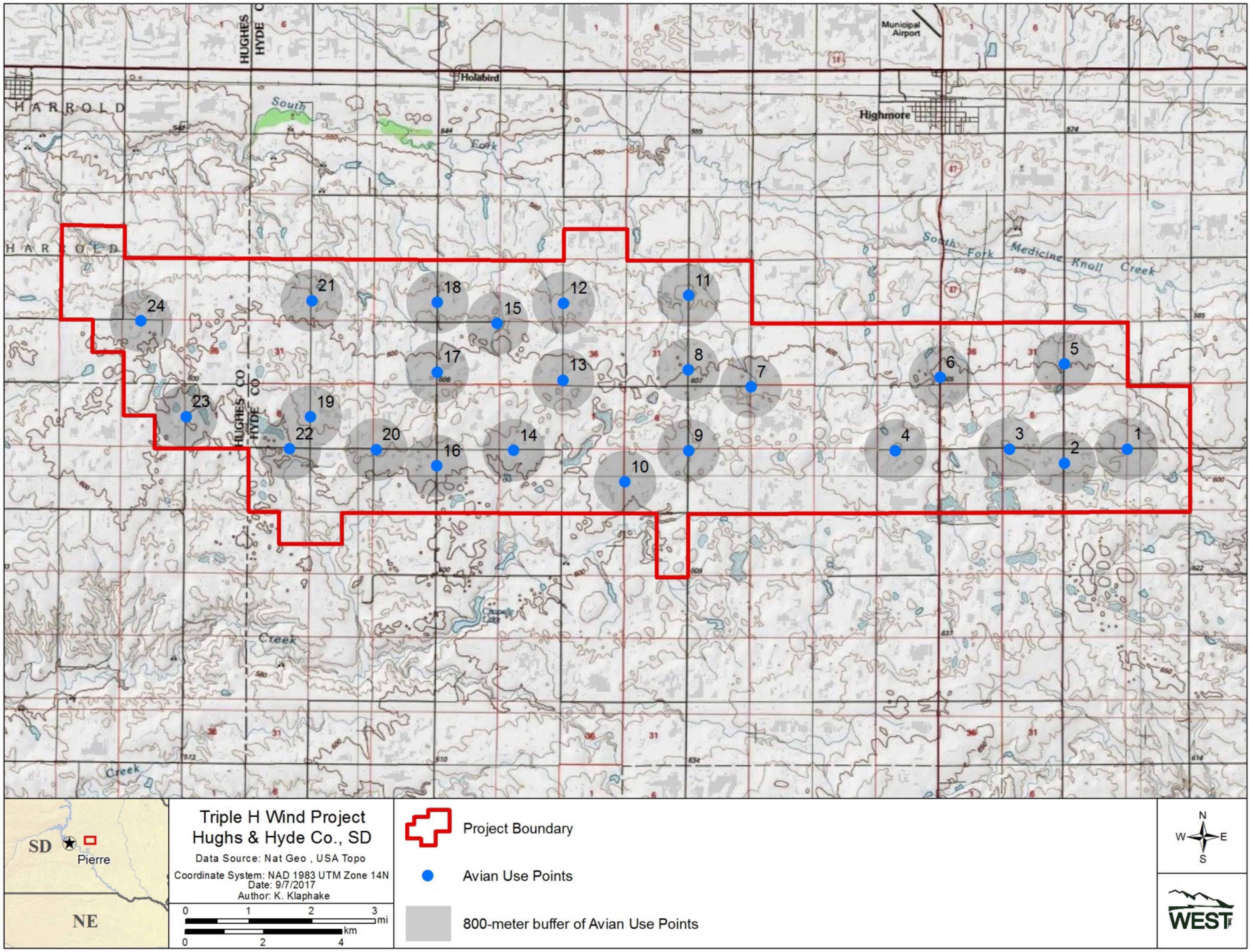

Figure 3. Locations of avian use survey points at the Triple H Wind Project, Hughes and Hyde Counties, South Dakota.

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.

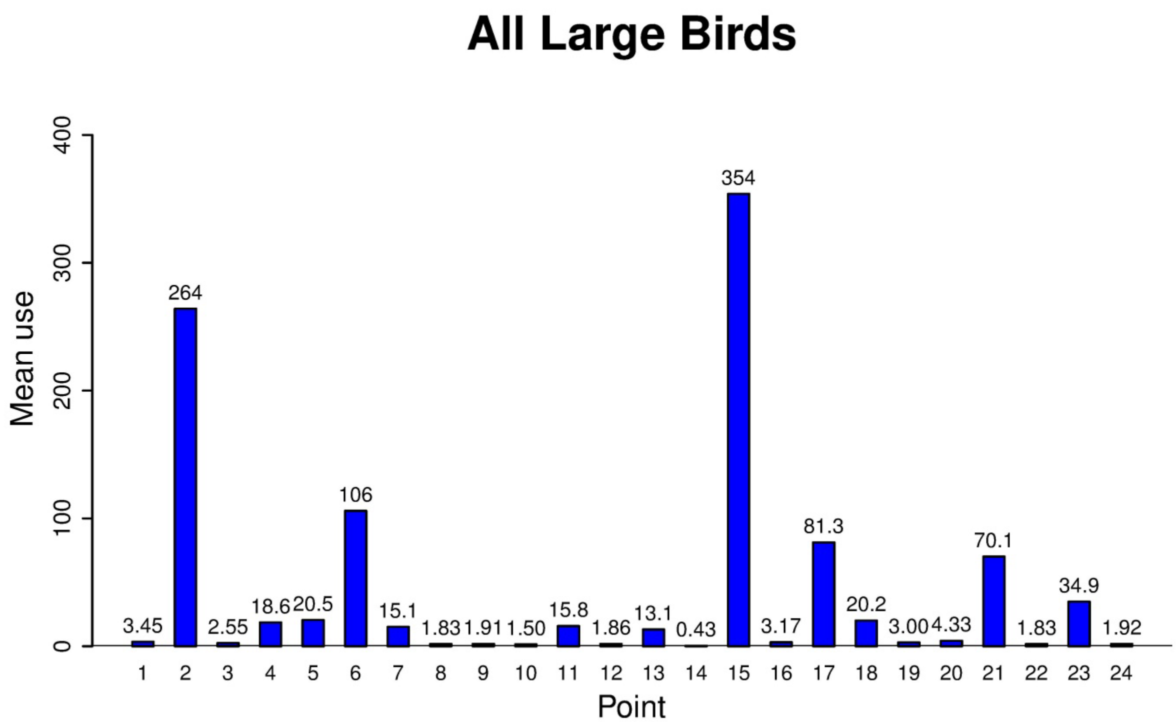

Figure 4a. Relative large bird use (birds/800-meter plot/60-minute survey) by observation point during avian use surveys at the Triple H Wind Project from April 18, 2016 to March 28, 2017.

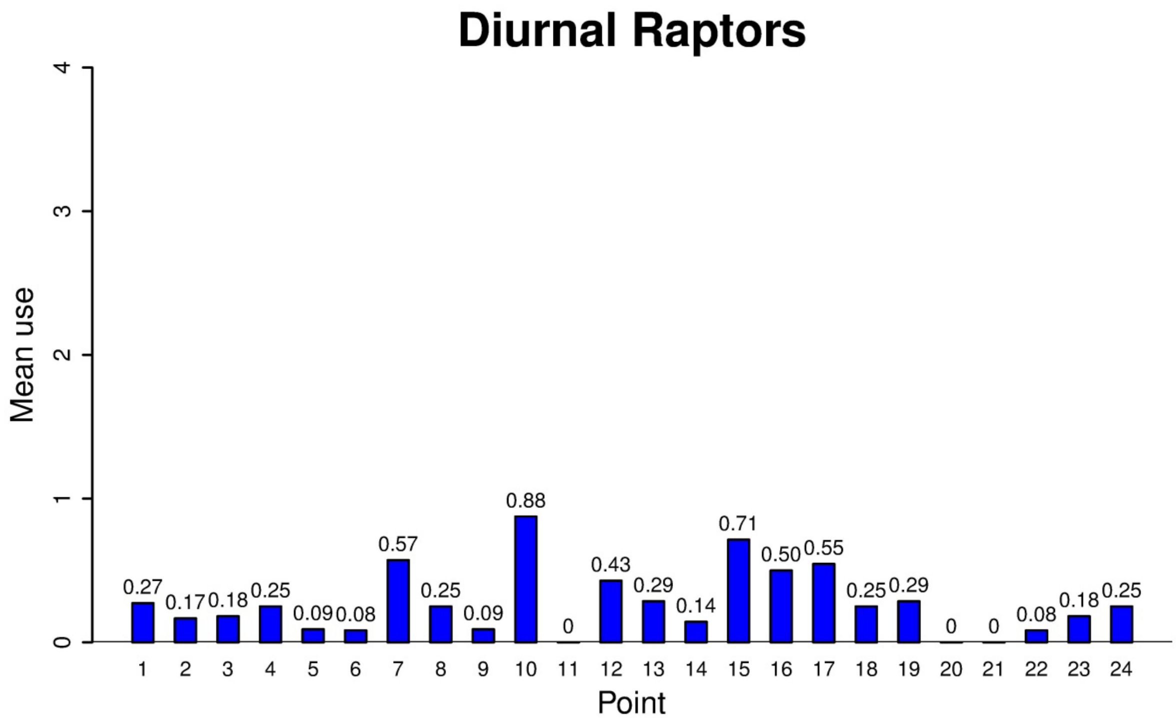

Figure 4b. Relative diurnal raptor use (raptors/800-meter plot/60-minute survey) by observation point during avian use surveys at the Triple H Wind Project from April 18, 2016 to March 28, 2017.

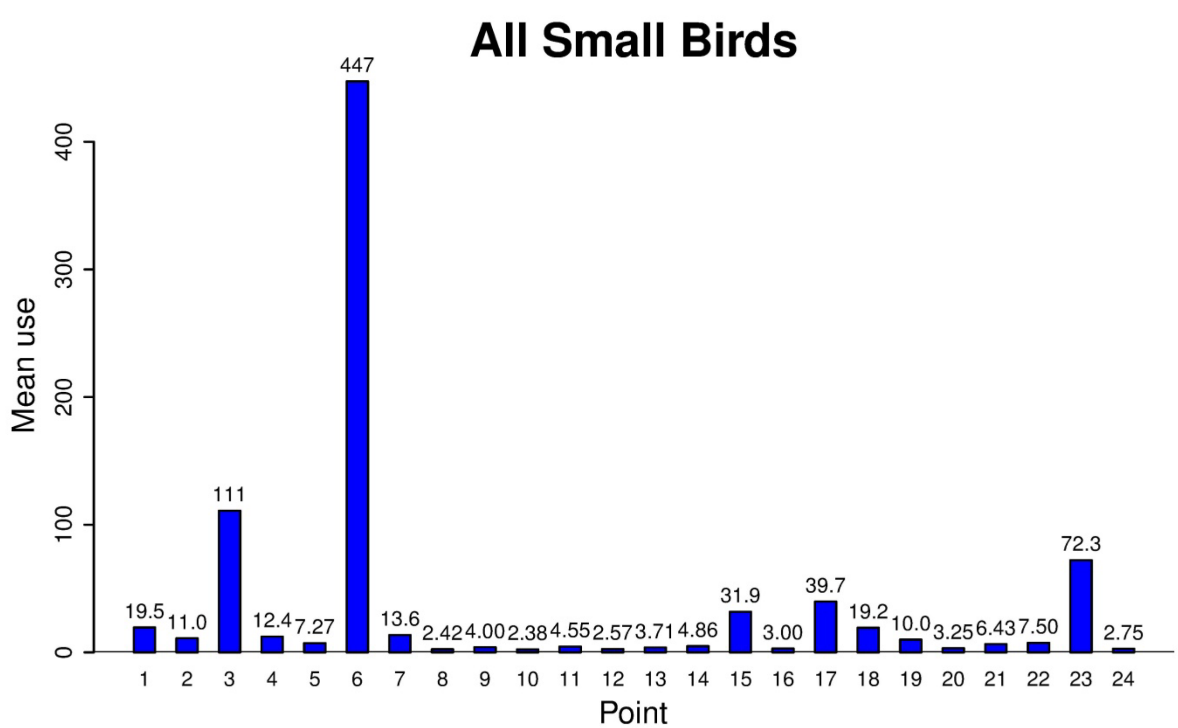

Figure 4c. Relative small bird use (birds/100-meter plot/20-minute survey) by observation point during avian use surveys at the Triple H Wind Project from April 18, 2016 to March 28, 2017.

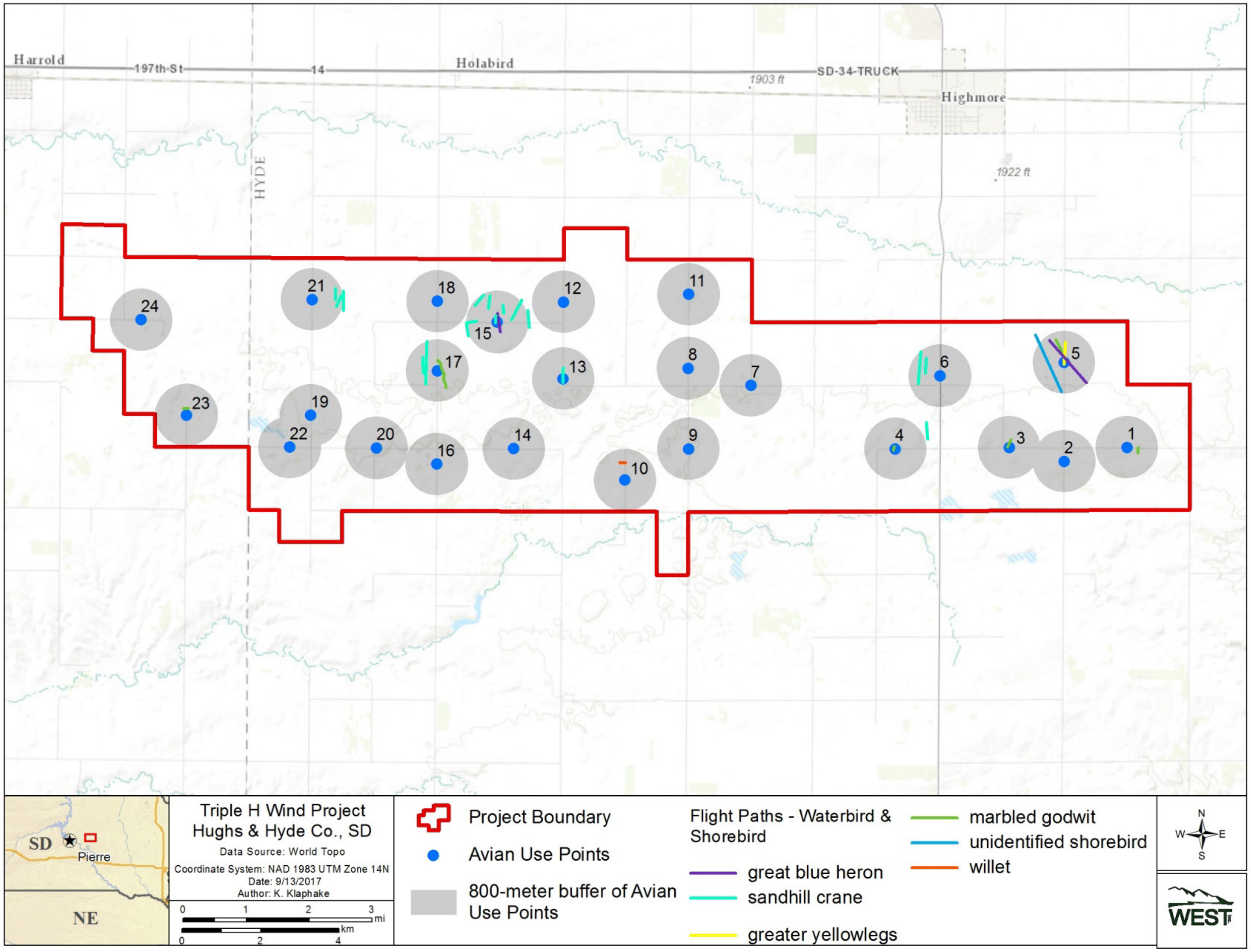

Figure 5a. Flight paths for waterbirds and shorebirds observed during avian use surveys at the Triple H Wind Project from April 18, 2016 to March 28, 2017.

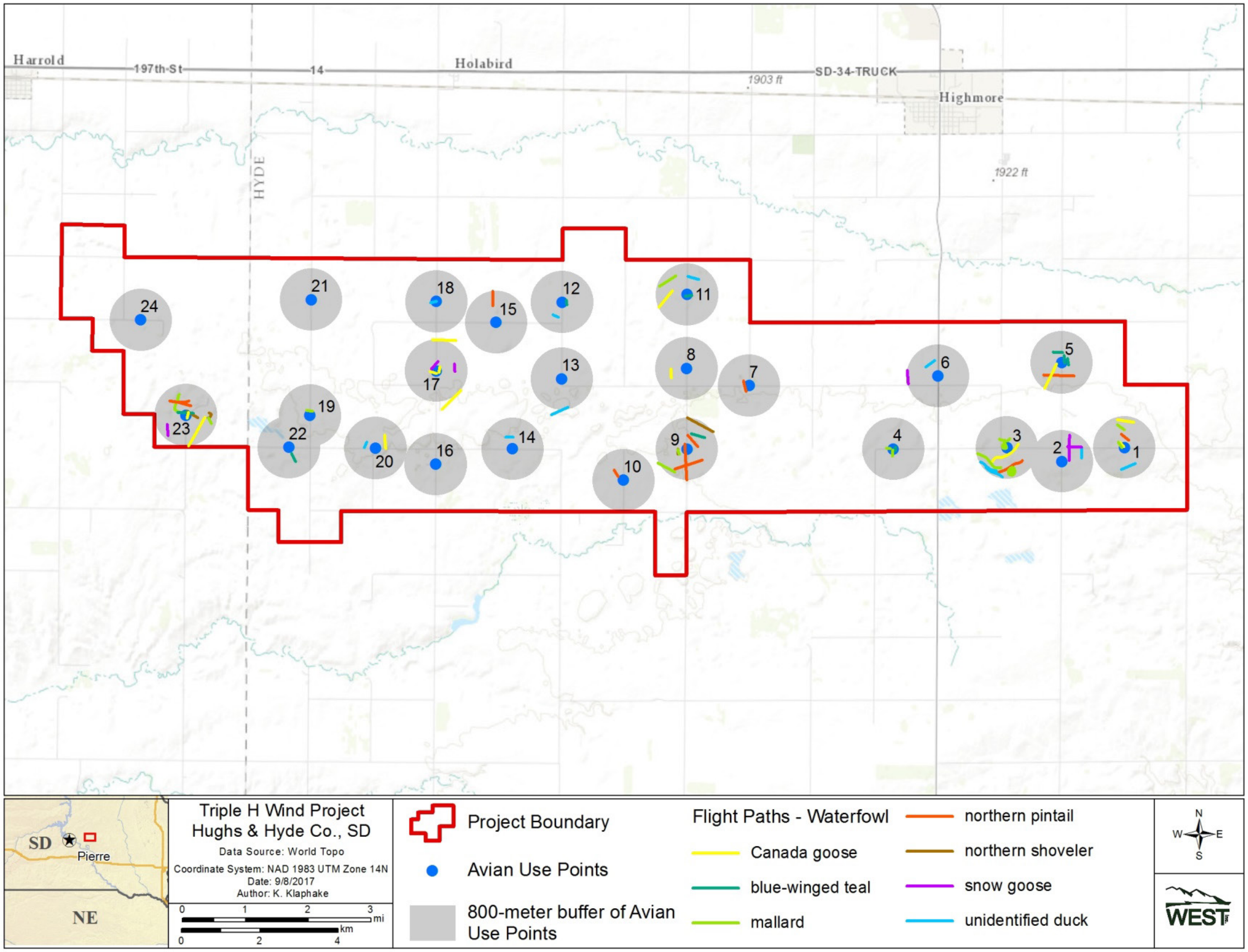

Figure 5b. Flight paths for waterfowl observed during avian use surveys at the Triple H Wind Project from April 18, 2016 to March 28, 2017.

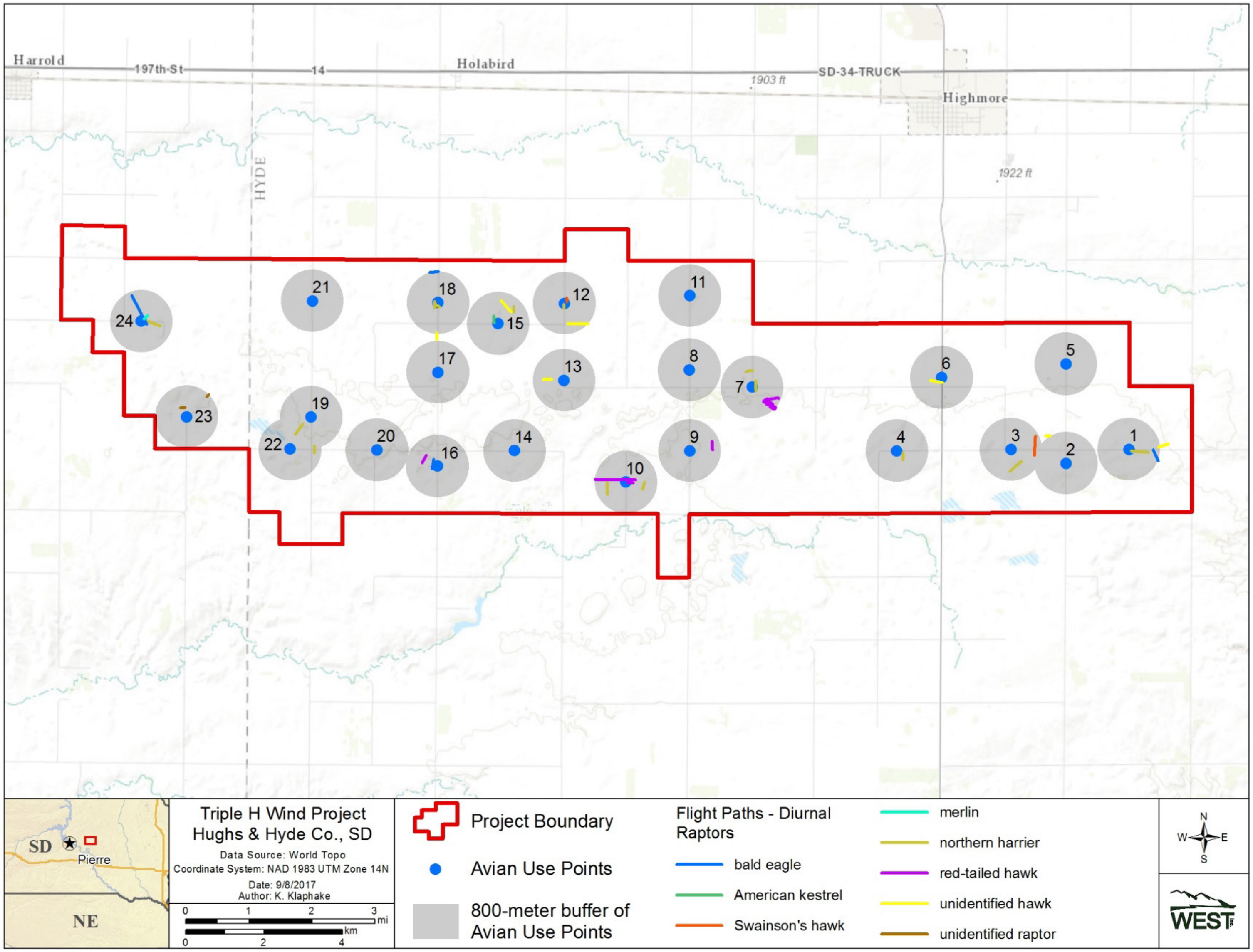

Figure 5c. Flight paths for diurnal raptors observed during avian use surveys at the Triple H Wind Project from April 18, 2016 to March 28, 2017.

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).

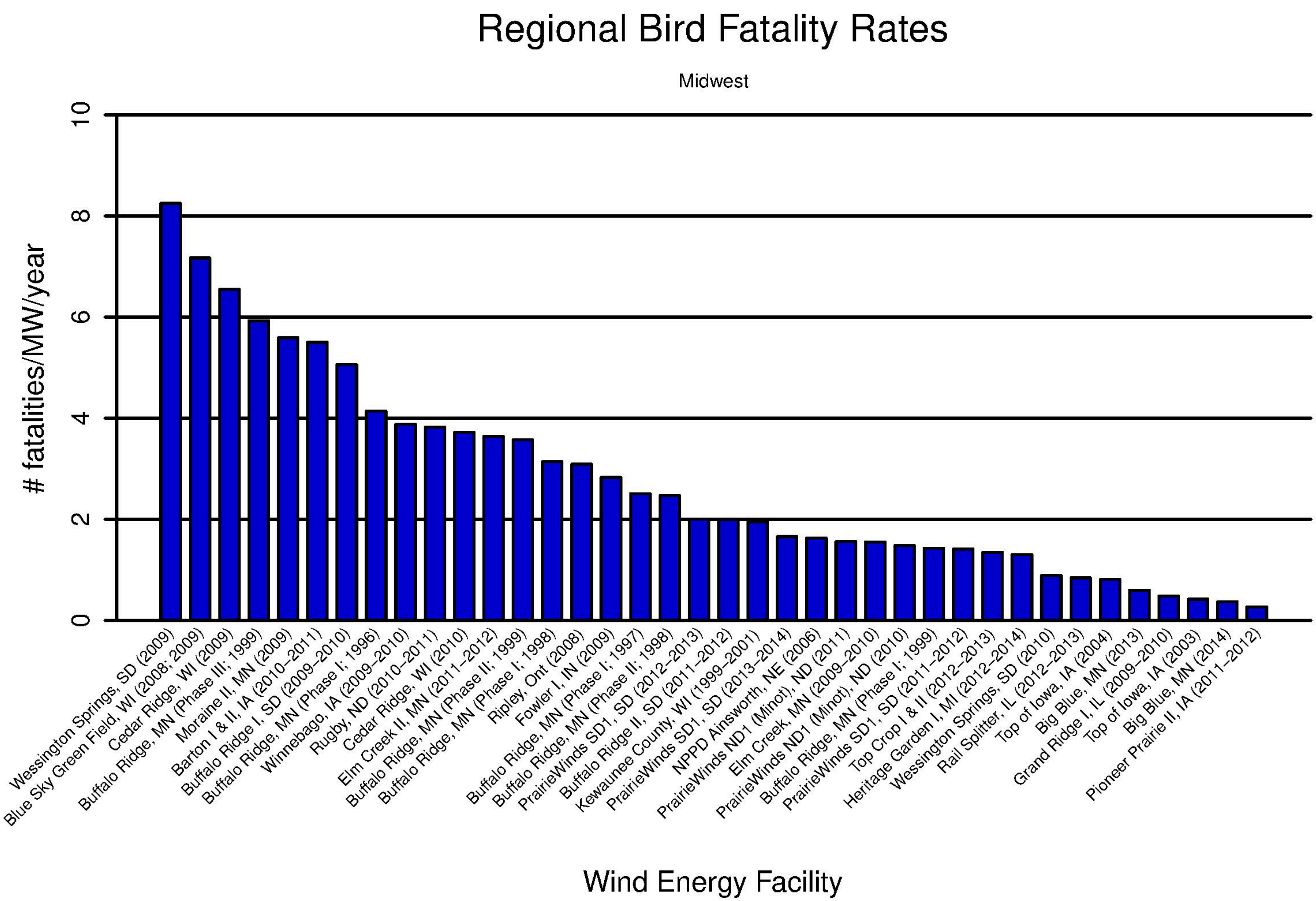

Figure 6. Fatality rates for all birds (number of birds per megawatt [MW] per year) from publicly available wind energy facilities in the Midwest region of North America.

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).

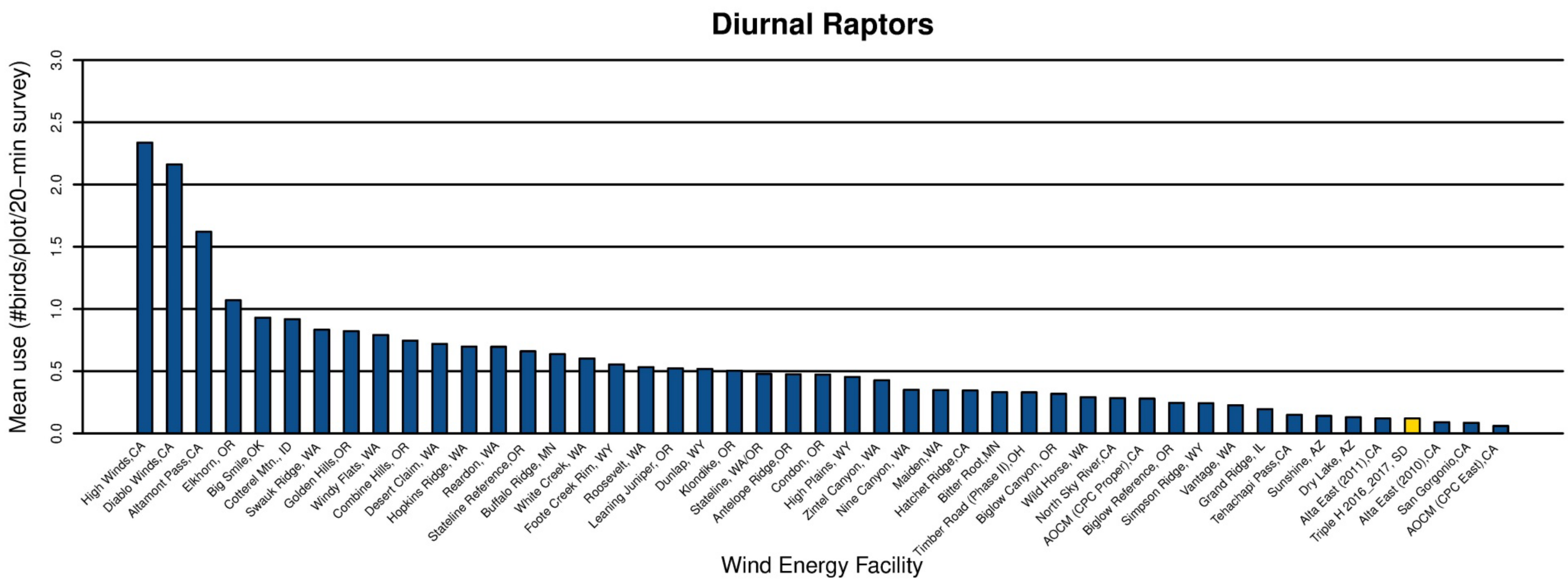

Figure 7. Comparison of annual diurnal raptor use during fixed-point avian use surveys at the Triple H Wind Project from April 18, 2016 to March 28, 2017, and annual diurnal raptor use recorded other North American wind energy facilities.

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.

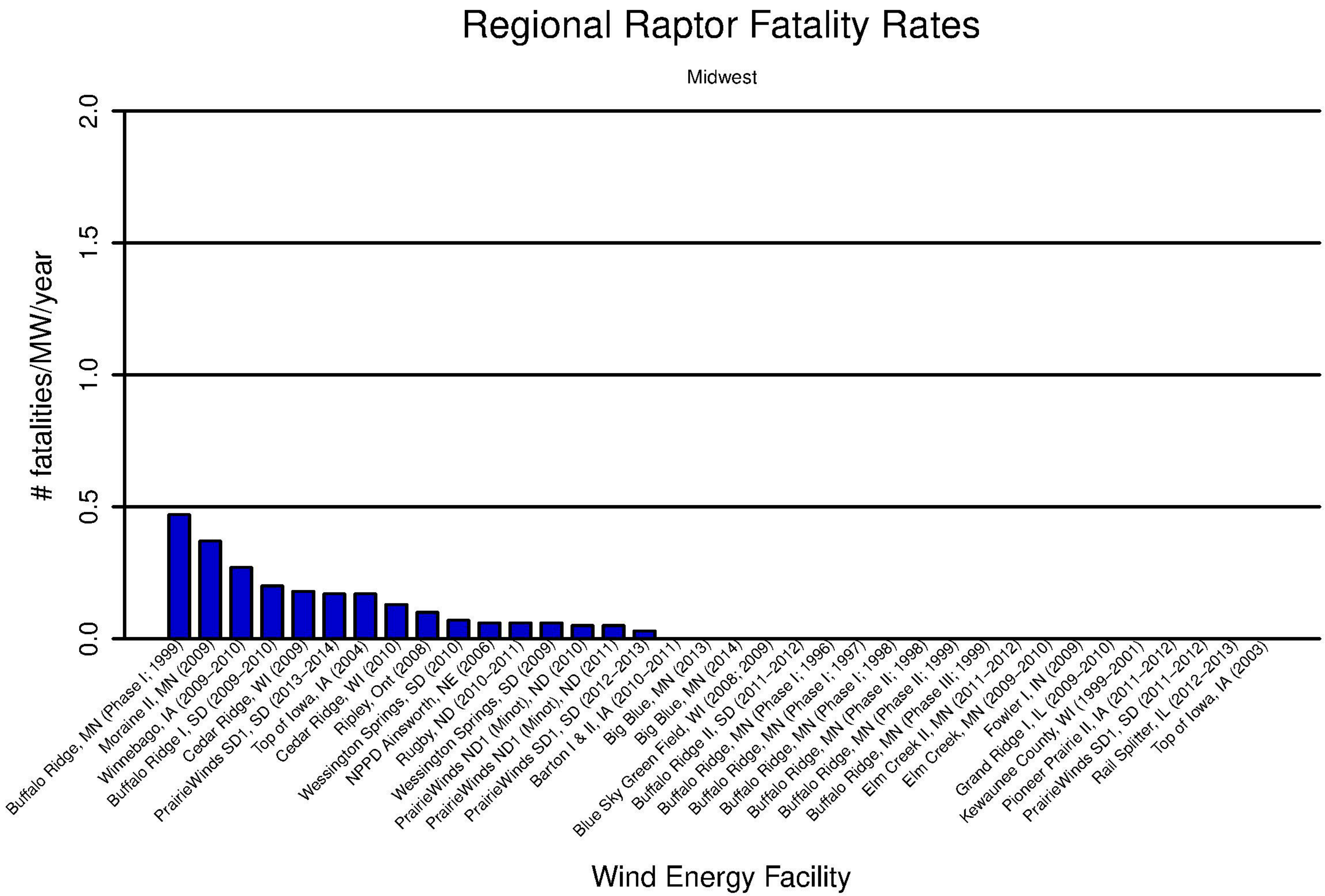

Figure 8. Fatality rates for diurnal raptors (number of raptors per MW per year) from publicly available wind energy facilities in the Midwest region of North America.

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.

		Spring		Summer		Fall		Winter		Total	
Type / Species	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# 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.

Type / Species	Scientific Name	Spring # grps	Spring # obs	Summer # grps	Summer # obs	Fall # grps	Fall # obs	Winter # grps	Winter # obs	Total # grps	Total # 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 fatality data for raptors.

Data from the following sources:

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

Appendix G. 2016 Triple H Wind Project Raptor Nest Surveys – Technical Memo

ENVIRONMENTAL & STATISTICAL CONSULTANTS
415 W. 17th Street, Suite 200, Cheyenne, WY82001
Phone: 307-634-1756 ◆ www.west-inc.com ◆ Fax: 307-632-3161

July 20, 2016

Christina White
Infinity Wind Power, LLC (Infinity)
3760 State Street, Suite 200
Santa Barbara, California 93105

RE: Triple H Wind Project Raptor Nest Survey

Dear Ms. White,

As part of Infinity's Tier 3 baseline field studies, surveys for raptor nests were completed at the Triple H Wind Project (Project) on March 28, 30 and April 1, 2016, by a biologist from Western EcoSystems Technology, Inc (WEST). Surveys were completed from the air in a helicopter before trees had leaves and when most raptors would be actively tending to a nest or incubating eggs. Aerial surveys were supplemented with a one-day ground survey along county roads, when mechanical issues temporarily delayed the start of helicopter surveys.

In general, the methodology followed the USFWS's Eagle Conservation Plan Guidance and Golden Eagle Inventory and Monitoring Protocols; and Other Recommendations[1]. Raptors are defined here as kites, accipiters, buteos, harriers, eagles, falcons, and owls. Surveys focused on locating large, stick nest structures in suitable raptor nesting substrate (trees, power poles, etc.) within the proposed Project and a 1-mile buffer. Additionally, surveys were conducted to document all potential eagles nest structures within the area between 1 to 10 miles of the Project boundary. Efforts were made to minimize disturbance to nesting raptors; the greatest possible distance at which the species could be identified was maintained, with distances varying depending upon nest location and wind conditions. Photographs were taken of possible eagle nests.

Potential raptor nest habitat in the proposed Project and associated buffers typically included small stands of deciduous trees and shelterbelts with smaller diameter deciduous and evergreen trees. Raptor nest surveys were conducted between 800 and 1800 hours on days without heavy precipitation, good visibility and mild temperatures. The locations of all raptor

[1] Pagel, J.E., D.M. Whittington, and G.T. Allen. 2010. Interim Golden Eagle inventory and monitoring protocols; and other recommendations. Division of Migratory Bird Management, U.S. Fish and Wildlife Service

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nests and flight paths were recorded using an onboard hand-held Global Positioning System receiver. To determine the status of a nest, the biologist relied on clues that included behavior of adults and presence of eggs, young, accumulated feces (whitewash), or new greenery within the nest. Attempts were made to identify the species of raptor associated with each active nest. Additionally, date, nest condition, and nest substrate were recorded.

During the 2016 aerial survey, 16 raptor nests were documented within the Project and 1-mile buffer (Figure 1, Table 1). Three nests were occupied by red-tailed hawks and one was occupied by a great-horned owl, while all the remaining nests were unoccupied. No eagle nests were located during the survey within the Project area or 10-mile survey area.

If you have any questions or require additional information, please call me at 307-631-1545.

Sincerely,

Brian Heath

Brian Heath
Project Manager

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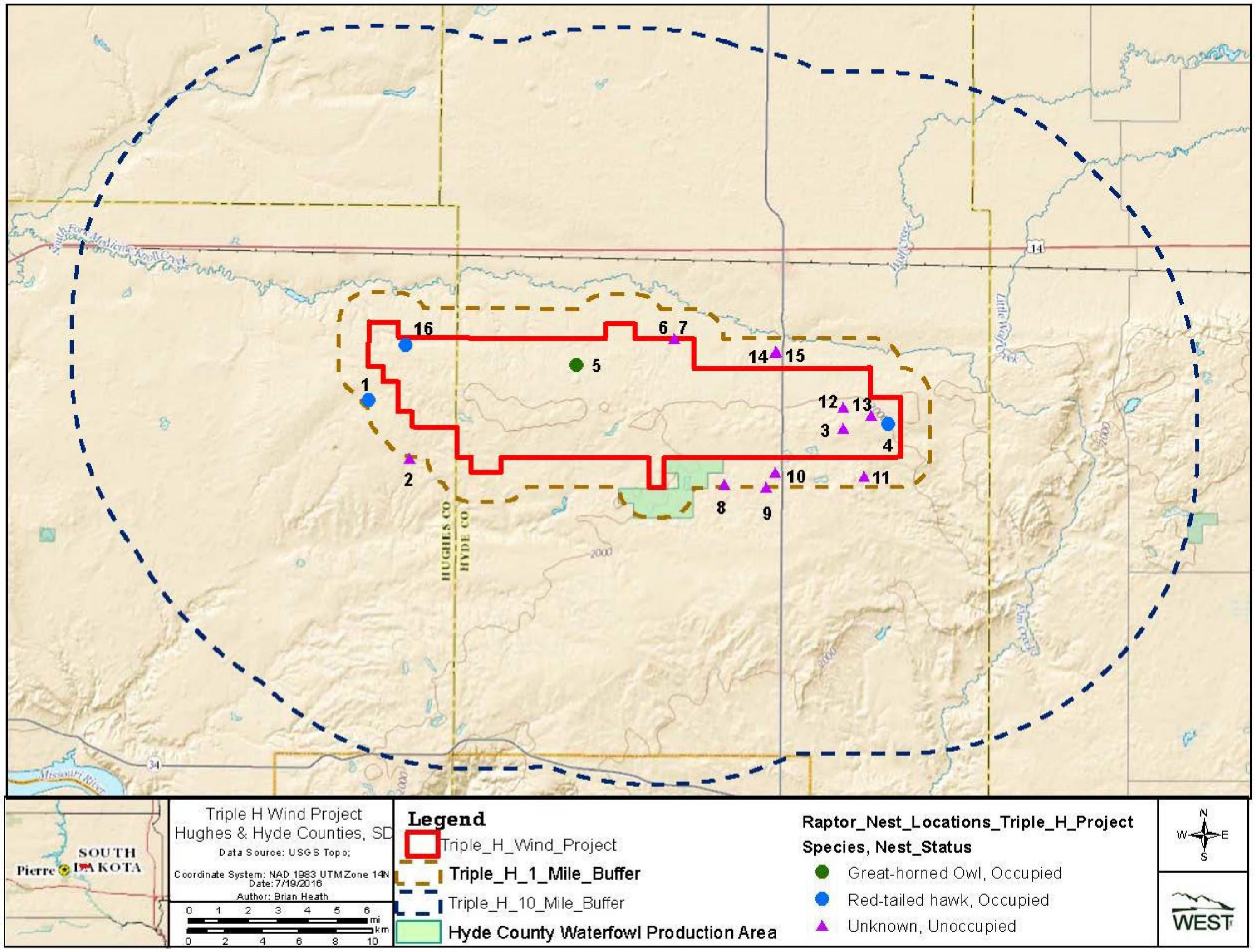

Figure 1. Location of raptor nests identified during surveys on March 28, 30 and April 1, 2106 within the Triple H Wind Project area and 1-mile buffer. No eagle nests were identified during the surveys.

ENVIRONMENTAL & STATISTICAL CONSULTANTS

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Table 1. Raptor nests identified within the Triple H Wind Project Area and 1-mile buffer on March 28, 30 and April 1, 2016 surveys. (Northing and Easting projection: UTM, NAD83, Zones 14N).

NEST ID	DATE	SPECIES*	SUBSTRATE	STATUS	CONDITION	UTM_N	UTM_E
1	3/28/2016	RTHA	Tree	Occupied	Good	4922347	442383
2	3/28/2016	UNRA	Tree	Unoccupied	Fair	4919242	444594
3	3/28/2016	UNRA	Tree	Unoccupied	Fair	4920871	468109
4	3/28/2016	RTHA	Tree	Occupied	Good	4921044	470555
5	3/28/2016	GHOW	Tree	Occupied	Good	4924269	453643
6	3/28/2016	UNRA	Tree	Unoccupied	Poor	4925752	458950
7	3/28/2016	UNRA	Tree	Unoccupied	Poor	4925751	458959
8	3/30/2016	UNRA	Tree	Unoccupied	Good	4917797	461664
9	3/30/2016	UNRA	Tree	Unoccupied	Poor	4917677	463979
10	3/30/2016	UNRA	Tree	Unoccupied	Good	4918491	464427
11	3/30/2016	UNRA	Tree	Unoccupied	Good	4918237	469249
12	3/30/2016	UNRA	Tree	Unoccupied	Fair	4921987	468129
13	3/30/2016	UNRA	Tree	Unoccupied	Fair	4921559	469633
14	3/30/2016	UNRA	Tree	Unoccupied	Poor	4924984	464450
15	3/30/2016	UNRA	Tree	Unoccupied	Good	4925019	464478
16	4/1/2016	RTHA	Tree	Occupied	Good	4925361	444423

*=RTHA = red-tailed hawk; GHOW = great-horned owl; UNRA=unknown raptor.

Appendix H. 2018 Triple H Wind Project Raptor Nest Surveys – Technical Memo

NATURAL RESOURCES ◆ SCIENTIFIC SOLUTIONS
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TECHNICAL MEMORANDUM

Date: October 2, 2018

To: Casey Willis, Engie IR Holdings.

From: Brian Heath, WEST, Inc.

Subject: 2018 Triple H Wind Project Raptor Nest Surveys

Engie IR Holdings (Engie) is proposing to develop the Triple H Wind Project (Project) in Hughes and Hyde Counties, South Dakota. In 2016, baseline wildlife studies were completed within a Project area encompassing 39,068 acres based on a 200 MW project. Engie has now expanded the Project boundary to encompass approximately 110,059 acres, including the initial 39,068 acre Project.

One of the baseline studies completed in 2016 was a survey to document raptor and eagle nests within the initial Project area. Sixteen raptor nests and no eagle nests were documented during the 2016 surveys. As part of Engie's 2018 Tier 3 baseline field study efforts, surveys for raptor nests were completed at the expanded Project from March 9-14, 2018, by biologists from Western EcoSystems Technology, Inc (WEST). The objective of the nest survey was to gather information on eagle nest locations and other raptor species nesting in the area which may be subject to disturbance or displacement effects from wind facility construction and operation. Concentrated prey sources were also recorded during surveys. This memo provides a summary of the methods and survey results for the 2018 raptor nest surveys.

Methodology for the raptor nest surveys generally followed the US Fish and Wildlife Services (USFWS) Eagle Conservation Plan Guidance (ECPG; USFWS 2013) and USFWS Wind Energy Guidelines (WEG; USFWS 2012). An aerial survey was conducted to document whether nests identified during 2016 were still present and search for raptor nests within one-mile of the expanded Project area. Surveys were also conducted to document eagle nests within 10-miles of the Project. Prior to the surveys, topographic and aerial maps were evaluated to determine where raptor and eagle nesting habitat is likely to occur (e.g., riparian habitat along creeks, open lakes with large trees, etc) so that these areas could be targeted during the aerial surveys. A biologist conducted the surveys in a helicopter operated by a pilot experienced in conducting low-altitude wildlife surveys. Surveys were conducted on days with good visibility and no precipitation except when light snow occurred on March 10, 2018 from 1350-1410 hours. The locations of all raptor nests and survey paths were recorded using a hand-held onboard Global

Positioning System (GPS) receiver. Raptor nests detected from the ground while conducting other field surveys were also recorded.

For all raptor and eagle nest structures detected, the biologist recorded nest location coordinates with the GPS receiver, species present (if any), condition of the nest, presence of eggs or young (if present and visible), and the substrate of the nest (e.g., tree, power pole, rock outcrop). The status of each nest was determined as either: Occupied - an adult in incubating position, eggs, a newly constructed or refurbished stick nest and/or the presence of one or more adults on or immediately adjacent to, the nest structure(s); or Inactive - a nest with no evidence of recent use, or attendance by adult raptors. Efforts were made to minimize disturbance to nesting raptors, livestock, or occupied dwellings to the greatest extent possible. Photographs were taken of possible eagle nests. Observations of non-nesting eagles, prey sources (prairie dog towns), and heron rookeries were also recorded during the aerial surveys. Aerial imagery was used to delineate the approximate perimeter of prairie dog towns.

<u>All Raptor Nest Survey within Project and One-Mile Buffer</u>
During the survey, 16 nests previously documented in 2016 were re-visited; 10 were confirmed to still be present and six could not be relocated. In addition, 38 previously undocumented raptor nests were detected within the expanded Project and one-mile buffer during surveys. Thirty-three were detected during the initial aerial survey in March 2018 and five were recorded from the ground while conducting other field work or re-checking known nests in early May 2018.

Of the 48 raptor nests documented, 27 were classified as occupied by the following: 12 great-horned owls, eight Swainson's hawk, and seven red-tailed hawks. All nests were located within deciduous trees. Generally, great-horned owls were observed occupying nests during the aerial survey; whereas, red-tailed hawks and Swainson's hawks were observed occupying nests during May. No eagle nests were documented within the Project or one-mile Project buffer. The location of each nest is depicted on Figure 1 and information on each nest is presented in Table 1.

<u>Eagle Nest Surveys</u>
Two occupied eagle nests were documented during surveys between one and 10-miles of the Project. A bald eagle nest was detected within a snag along the Missouri River approximately 8.7-miles southwest of the Project (Figure 2). During the first inspection of the nest, a bald eagle was observed circling the snag and then landed within an adjacent snag. There was no new greenery within the nest. The nest was re-checked the following day and an adult bald eagle was observed perched on the nest. No egg or fresh greenery was observed during the second observation as well. A golden eagle was observed incubating on a nest within a deciduous tree along Chapelle Creek on March 10, 2018. An inactive nest, assumed to be an alternate eagle nest site, was detected approximately 90-feet north of the occupied golden eagle nest. The nests are located approximately 7.2-miles southwest of the Project boundary. The bald eagle and golden eagle are listed as Species of Greatest Conservation Need (SGCN) in South Dakota, the golden eagle was recently added during the 2018 minor revision to the South Dakota Wildlife Action Plan.

A nest previously identified in 2016 as a Ferruginous hawk nest is located approximately 3.5-miles southeast of the Project and was inspected on March 9, 2018. The nest was inactive with no fresh twigs or greenery, but was large enough for use by nesting eagles. The nest was re-checked from the ground on May 5, 2018 to determine whether it had become occupied during the breeding season. The nest was visible from a county road approximately 1.2-miles south and an adult raptor was observed on the nest. However, the species could not be ascertained from the county road at this distance. Approximately 20-minutes after the initial inspection an adult Ferruginous hawk flew in and perched on the nest next to the incubating bird. Ferruginous hawks are also a SGCN in South Dakota. The location of each nest is depicted on Figure 2 and information on each nest is presented in Table 2. Photographs of the eagle nests are not included in this report but can be made available upon request.

Non-Nesting Eagle Observations, Prey Sources, and Heron Rookeries

Twenty-two bald eagles within 17 groups and 14 golden eagles within 12 groups were recorded during surveys (Figure 3). Twelve of the 36 observations, six bald eagles in five groups and six golden eagles in five groups, were recorded within the Project area. All observations in the Project were adult eagles perched within trees.

Active prairie dog towns may attract raptors such as eagles, ferruginous hawks, and golden eagles since they provide a concentrated prey source and provide nesting habitat or structure for burrowing owls. Five active black-tailed prairie dog towns were recorded within the Project area and 10 other towns were documented within 10-miles of the Project. Three heron rookeries were also recorded during aerial surveys and great-blue herons were observed tending nests within each rookery during ground checks in early May 2018. Three burrowing owls, a SGCN in South Dakota, were observed incidentally during other field work in early May 2018. All observations were within active black-tailed prairie dog towns.

SUMMARY

The results of the 2018 nest surveys indicate raptors use the deciduous trees scattered across the project for nesting. Although no eagle nests were located within the Project, two occupied nests were located 7.2-miles and 8.7-miles southwest of the Project and several observations of non-nesting eagles were recorded during the surveys. Fixed-point avian use surveys are currently being conducted to further identify how raptors and eagles use the Project area throughout the year. Black-tailed prairie dog towns were noted within and adjacent to the Project and provide raptors with concentrated prey sources. Collectively this information can be used during Project planning to minimize potential impacts to raptors.

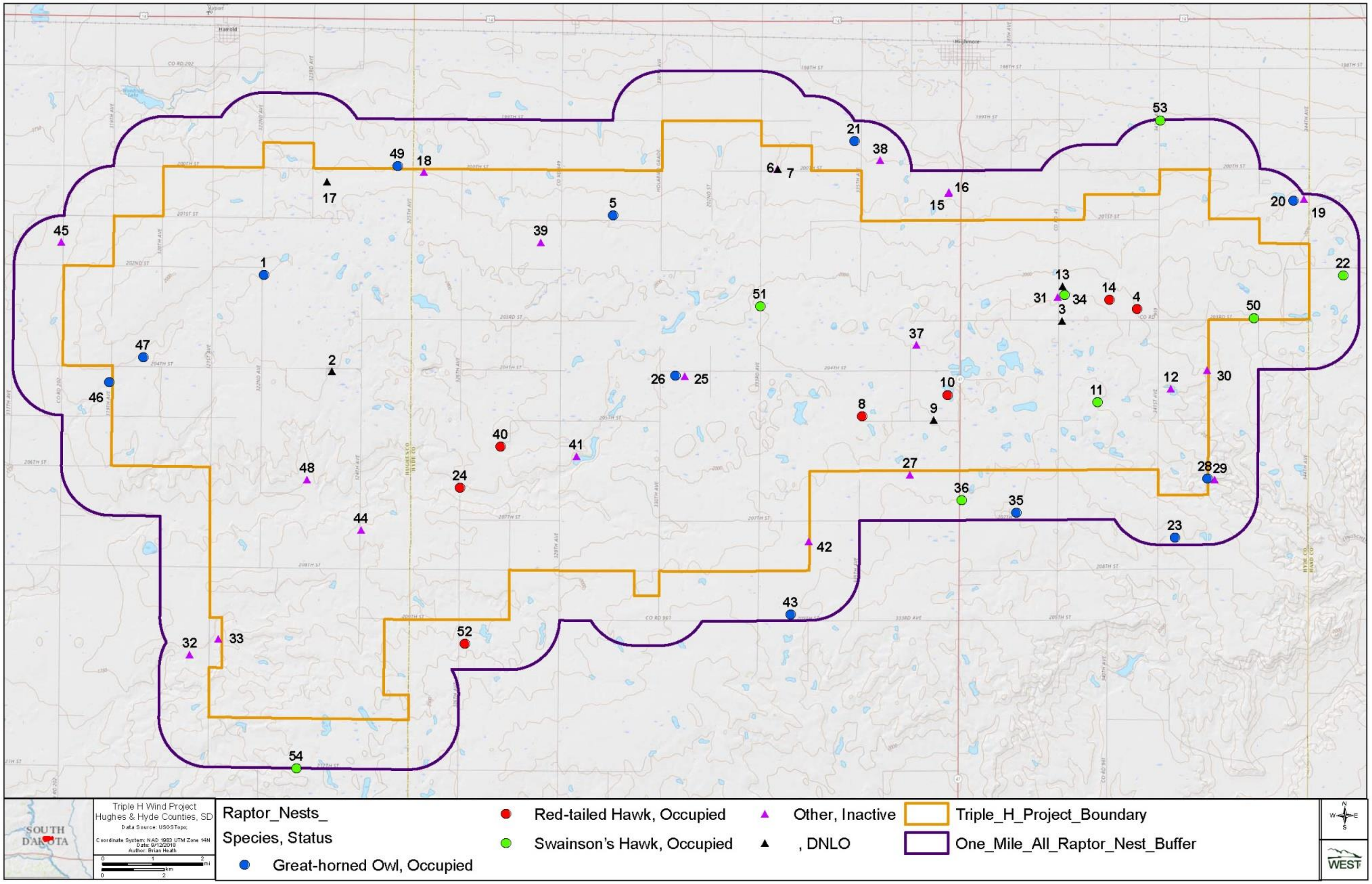

Figure 1. Location and status of raptor nests identified during surveys within the Triple H Wind Project area and 1-mile buffer in Spring 2018. No nests were occupied by eagles during the surveys.

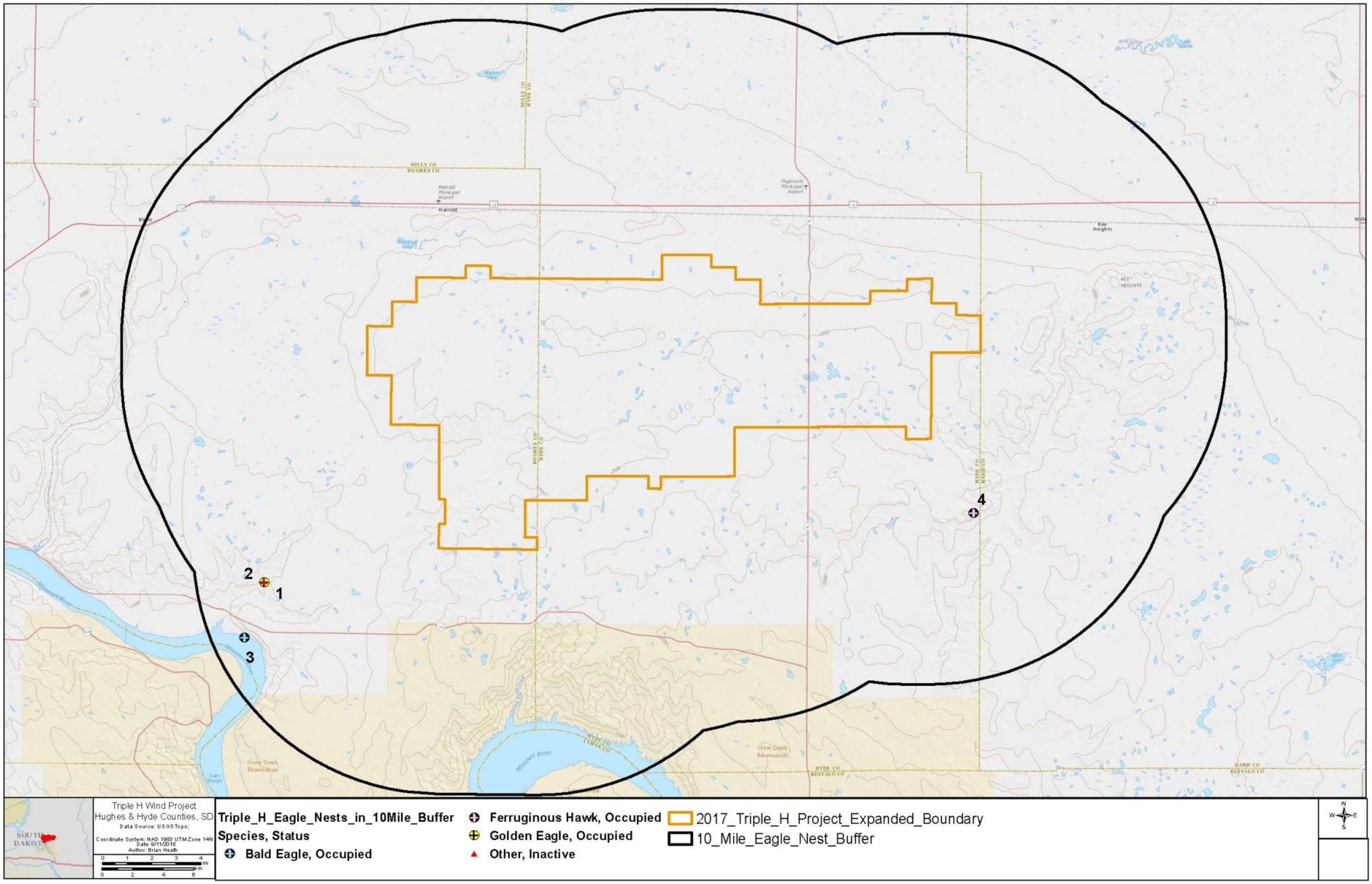

Figure 2. Location and status of eagle nests identified during surveys within the Triple H Wind Project area and 10-mile buffer. Includes a large stick nest suitable for nesting eagles that was later confirmed to be a Ferruginous hawk nest.

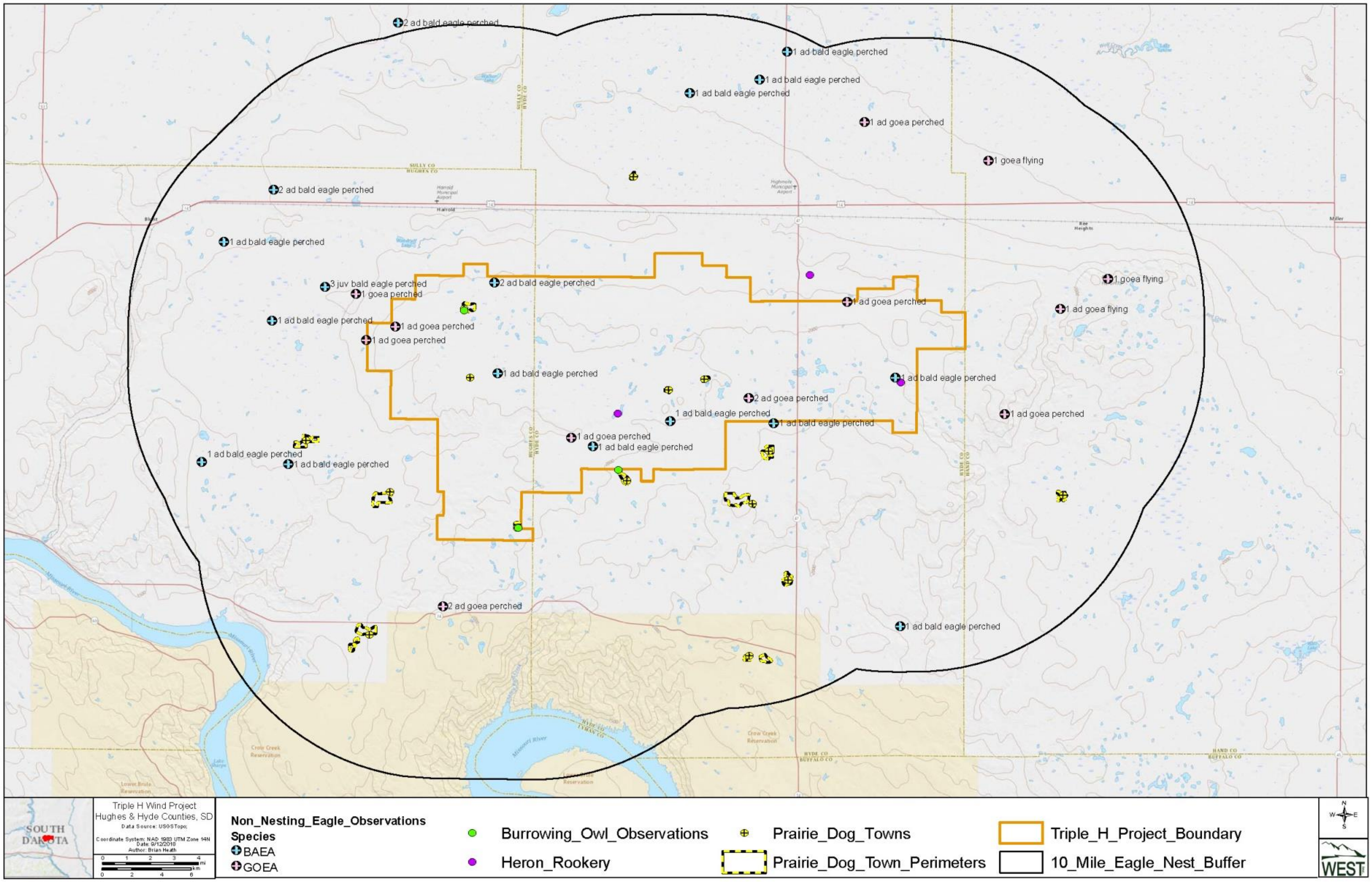

Figure 3. Location of non-nesting eagle observations, heron rookeries, burrowing owl observations, and prairie dog towns recorded during Triple H Wind Project surveys.

Table 1. Raptor nest observations during the aerial raptor nest surveys within Triple H Wind Project and one-mile buffer, March 2018. Observations include raptor nests identified in May 2018 documented during other field work or during nest re-checks to update productivity or nest status.

NestID[1]	Date	Species	Status[2]	Adults	Evidence	Eggs	Chicks	Condition	Substrate	Comment
1*	3/11/2018	Great-horned Owl	Occupied	2	Incubating			Good	Tree	
2*	3/11/2018		DNLO							
3*	3/10/2018		DNLO							
4*	5/4/2018	Red-tailed Hawk	Occupied	1	Incubating					3/10/2018 DNLO, nest later rebuilt and occupied by RTHA
5*	3/10/2018	Great-horned Owl	Occupied	1	Incubating	2	1	Good	Tree	
6*	3/10/2018	Other	Inactive					Fair	Tree	
7*	3/11/2018		DNLO							
8*	5/5/2018	Red-tailed Hawk	Occupied	1	Incubating			Good	Tree	3/10/2018 GRHO incubating, re-check indicated RTHA incubating
9*	3/10/2018		DNLO							
10*	5/1/2018	Red-tailed Hawk	Occupied	1	Incubating			Good	Tree	3/10/2018 Inactive, re-check RTHA incubating
11*	5/2/2018	Swainson's Hawk	Occupied	1	Tending Nest			Good	Tree	3/10/2018 remnant inactive, re-check SWHA tending nest.
12	3/10/2018	Other	Inactive					Good	Tree	Re-check 5/4/2018 inactive
13*	3/10/2018		DNLO							
14*	5/4/2018	Red-tailed Hawk	Occupied	1	Tending Nest			Good	Tree	3/10/2018 inactive, re-check RTHA tending
15*	3/9/2018	Other	Inactive					Fair	Tree	Re-check 5/3/2018 inactive
16*	3/10/2018	Other	Inactive					Fair	Tree	Re-check 5/3/2018 inactive
17*	3/11/2018		DNLO							
18	3/11/2018	Other	Inactive					Fair	Tree	Re-check 5/3/2018 inactive
19	3/9/2018	Other	Inactive					Fair	Tree	
20	3/9/2018	Great-horned Owl	Occupied	1	Incubating			Good	Tree	

NestID[1]	Date	Species	Status[2]	Adults	Evidence	Eggs	Chicks	Condition	Substrate	Comment
21	3/9/2018	Great-horned Owl	Occupied	1	Incubating	3		Good	Tree	
22	5/5/2018	Swainson's Hawk	Occupied	2	Territory Defense			Remnant	Tree	3/9/2018 inactive, re-check nest blew out tree, pair defending
23	3/9/2018	Great-horned Owl	Occupied	1	Incubating			Good	Tree	
24	5/4/2018	Red-tailed Hawk	Occupied	1	Incubating			Good	Tree	3/10/2018 GRHO incubating, re-check indicated RTHA incubating
25	3/10/2018	Other	Inactive					Fair	Tree	Re-check 5/3/2018 inactive
26	5/3/2018	Great-horned Owl	Occupied	1	Tending Chicks		1	Fair	Tree	3/10/2018 inactive, 1+ chicks in nest
27	3/10/2018	Other	Inactive					Fair	Tree	Re-check 5/2/2018 inactive
28	3/10/2018	Great-horned Owl	Occupied	2	Incubating			Good	Tree	
29	3/10/2018	Other	Inactive					Fair	Tree	
30	3/10/2018	Other	Inactive					Fair	Tree	
31	3/10/2018	Other	Inactive					Good	Tree	Re-check 5/1/2018 inactive
32	3/10/2018	Other	Inactive					Good	Tree	
33	3/10/2018	Other	Inactive					Good	Tree	
34	5/1/2018	Swainson's Hawk	Occupied	2	Tending			Good	Tree	3/10/2018 Inactive, re-check pair SWHA in nest tree
35	5/1/2018	Great-horned Owl	Occupied	1	Incubating			Good	Tree	3/10/2018 nest inactive, re-check GRHO in nest.
36	5/2/2018	Swainson's Hawk	Occupied	1	Incubating			Fair	Tree	3/10/2018 inactive, re-check adult SWHA incubating
37	3/10/2018	Other	Inactive					Good	Tree	5/3/2018 re-check inactive
38	3/10/2018	Other	Inactive					Fair	Tree	
39	3/10/2018	Other	Inactive					Good	Tree	
40	5/3/2018	Red-tailed Hawk	Occupied	1	Incubating			Good	Tree	3/10/2018 inactive, re-check adult RTHA incubating
41	3/11/2018	Other	Inactive					Fair	Tree	5/3/2018 Heron tending nests in area
42	3/11/2018	Other	Inactive					Fair	Tree	5/4/2018 re-check inactive
43	3/11/2018	Great-horned Owl	Occupied	1	Incubating			Fair	Tree	5/4/2018 re-check nest inactive

NestID[1]	Date	Species	Status[2]	Adults	Evidence	Eggs	Chicks	Condition	Substrate	Comment
44	3/11/2018	Other	Inactive					Poor	Tree	5/3/2018 re-check inactive
45	3/11/2018	Other	Inactive					Remnant	Tree	5/3/2018 re-check inactive
46	5/3/2018	Great-horned Owl	Occupied	1	Tending Chicks		1	Good	Tree	3/11/2018 inactive, re-check GRHO on nest
47	3/11/2018	Great-horned Owl	Occupied	1	Incubating	2		Good	Tree	5/3/2018 re-check nest inactive
48	3/11/2018	Other	Inactive					Good	Tree	
49	3/11/2018	Great-horned Owl	Occupied	1	Incubating			Good	Tree	5/3/2018 re-check nest inactive
50	5/5/2018	Swainson's Hawk	Occupied	1	Incubating			Good	Tree	Recorded during other filed work
51	5/5/2018	Swainson's Hawk	Occupied	1	Nest Tending			Good	Tree	Recorded during other filed work
52	5/4/2018	Red-tailed Hawk	Occupied	1	Incubating			Good	Tree	Recorded during other filed work
53	5/3/2018	Swainson's Hawk	Occupied	1	Territory Defense			Good	Tree	Recorded during other filed work
54	5/6/2018	Swainson's Hawk	Occupied	1	Incubating			Good	Tree	Recorded during other filed work

[1] * = Nests documented during 2016 surveys and re-checked in 2018
[2] DNLO = Did Not Locate Nest from 2016 Survey

Table 2. List of eagle nest observations during the aerial raptor nest surveys within 10-miles of the Triple H Wind Project, March 2018. Observations include a large stick nest suitable for use by nesting eagles that was later confirmed to be occupied by a Ferruginous hawk.

NestID	Date	Species	Status	Adults	Evidence	Condition	Substrate	LgStick	Comment
1	3/10/2018	Golden Eagle	Occupied	1	Incubating	Good	Tree	Yes	Active GOEA nest in valley adjacent to hill
2	3/10/2018	Other	Inactive			Good	Tree	Yes	Alternate GOEA Nest
3	3/11/2018	Bald Eagle	Occupied	1	Tending	Good	Tree	Yes	1 ad BAEA perched nearby briefly then gone, 1 ad BAEA standing in nest following day.
4	5/5/2018	Ferruginous Hawk	Occupied	2	Incubating	Good	Tree	Yes	3/9/2018 inactive but big enough for eagle. FEHA observed on nest 5/5/2018, adult FEHA also flew into nest.

Appendix I. Prairie Grouse Lek Surveys for the Triple H Wind Project, Hughes and Hyde Counties, South Dakota – 2016 Prairie Grouse Lek Report

Prairie Grouse Lek Surveys for the Triple H Wind Project Hughes and Hyde Counties, SD

2016 Prairie Grouse Lek Report

Prepared for:

Infinity Wind Power, LLC

3760 State Street, Suite 200
Santa Barbara, California 93105

Prepared by:

Brian Heath

Western EcoSystems Technology, Inc.
415 West 17th Street, Suite 200
Cheyenne, Wyoming 82001

August 1, 2016

EXECUTIVE SUMMARY

Infinity Wind Power, LLC (Infinity) is proposing a wind energy facility in Hughes and Hyde Counties, South Dakota referred to as the Triple H Wind Project (Project). Infinity contracted Western EcoSystems Technology, Inc. (WEST) to conduct surveys and monitor wildlife resources in the Spring 2016 to identify potential impacts of facility construction and operations on wildlife. The following report contains the results of greater prairie-chicken and sharp-tailed grouse (prairie grouse) lek surveys conducted at the Project. The objective of the prairie grouse lek survey is to collect pre-construction data that can be used to help site the wind turbines to minimize impacts on grouse.

Lek surveys were completed across the Project area and one-half mile buffer three times between March 29 and April 30, 2016. Initially three aerial surveys were proposed; however, due to flight cancelations because of weather a combination of aerial and ground-based surveys were used to document breeding prairie grouse locations. The first survey was ground-based and conducted on March 29-30 and April 2, 2016 by traveling accessible roads throughout the Project area and one-half mile buffer. Vehicles were driven along county roads and stops made at approximately one mile intervals to look and listen for breeding grouse. If a lek was visually located from a road, the observer marked the location on a hard copy map and recorded the species along with number of males, females, and birds of unknown sex attending the lek. For leks where only auditory detection occurred, biologists recorded the GPS location on the road and noted the bearing and estimated distance from the point to the lek. The observer then obtained a second bearing and distance to triangulate the lek location.

The second round of surveys were completed from April 20-21, 2016 by flying north/south transects spaced approximately 0.4-km apart across the survey area. An onboard GPS unit was used to keep the plane on transect, record lek locations, and document daily flight paths. Biologists recorded the number of birds on the lek and whether occupied by greater prairie-chicken or sharp-tailed grouse. The third round of surveys consisted of an aerial survey across the western-half of the Project area on April 28, 2016 and ground-based surveys within the eastern-half from April 29-30, 2016. All surveys commenced approximately 30 minutes before sunrise and lasted for approximately two hours after sunrise. Surveys primarily occurred on mornings with good visibility, clear skies, relatively calm winds (<15-20 mph) and no precipitation; although, fog was an issue during the April 29, 2016 ground survey.

Eight greater prairie-chicken leks were documented, all during ground surveys, within the Project area and one-half mile buffer. Five leks were located within the Project area and three were within one-half mile of the Project boundary. No sharp-tailed grouse leks were located. Observations of both greater prairie-chickens and sharp-tailed grouse occurred during surveys but detection of lekking activity was not confirmed at these locations. Two additional greater prairie-chicken leks were detected between one-half mile and one-mile of the Project and have been included within results to aide in Project planning.

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INTRODUCTION AND BACKGROUND

Infinity Wind Power, LLC (Infinity) is considering the development of the Triple H Wind Project (Project) in Hughes and Hyde Counties, South Dakota. The Project encompasses approximately 39,000 acres currently under or pending easement in central South Dakota (Figure 1). Infinity contracted Western EcoSystems Technology, Inc. (WEST) to conduct surveys and monitor wildlife resources in the Project area to evaluate the potential impacts of wind energy facility construction and operations on wildlife. The Project area occurs within the occupied range of the greater prairie-chicken and sharp-tailed grouse (hereafter prairie grouse) and Infinity requested WEST conduct surveys to evaluate if prairie grouse leks are located within the Project area.

There are more than 10 known or suspected greater prairie-chicken and sharp-tailed grouse leks within both Hughes and Hyde Counties (Flake et al. 2010). Male prairie grouse attend traditional breeding grounds or leks in the spring to display and perform ritualistic courtship behavior to attract females for mating. Leks are typically located on knolls, gentle rises, or openings within grassland habitats and greater prairie-chicken leks are sometimes located on flat bottomlands such as a dry wetland (SDGFP 2011).

In South Dakota, male prairie grouse begin defending territories on leks in late February with peak activity occurring in early April during peak hen attendance (SDGFP 2011). After mating, hens typically nest within a few miles of the lek but some may nest up to 10 miles or farther away (SDGFP 2011). The average distance from lek of capture to nest site for female greater prairie-chickens and sharp-tailed grouse fitted with radio-transmitters on the Fort Pierre National Grasslands was 1.978 km (1.23-miles) and 2.037 km (1.27-miles), respectively (Kirschenmann 2008). Prairie grouse are dependent upon grasslands for nearly all life cycle needs and typically nest in areas with dense or residual grass to conceal nests from predators (Bidwell et al. 2003, Prose et al. 2002). They will use grass and alfalfa hay fields during the spring and summer and both species will also utilize waste grain in agricultural fields primarily during the fall and winter (SDGFP 2011).

The object of this study was to document the location of prairie grouse leks within the Project area and within a one-half mile buffer of the Project area. Data collected during this study can be used to avoid or minimize impacts to prairie grouse leks when siting wind energy facilities.

STUDY AREA

The Project is located in Hughes and Hyde Counties, South Dakota (Figure 1) approximately three miles south of Highmore and Holabird, South Dakota, within various Sections in T111-112N–R71-74W. The Project area consists of a mixture of agricultural croplands and native and introduced grasslands. Topography is relatively flat with elevations ranging between 1,950 and 2,040 feet. The general land practices are crop production and livestock grazing.

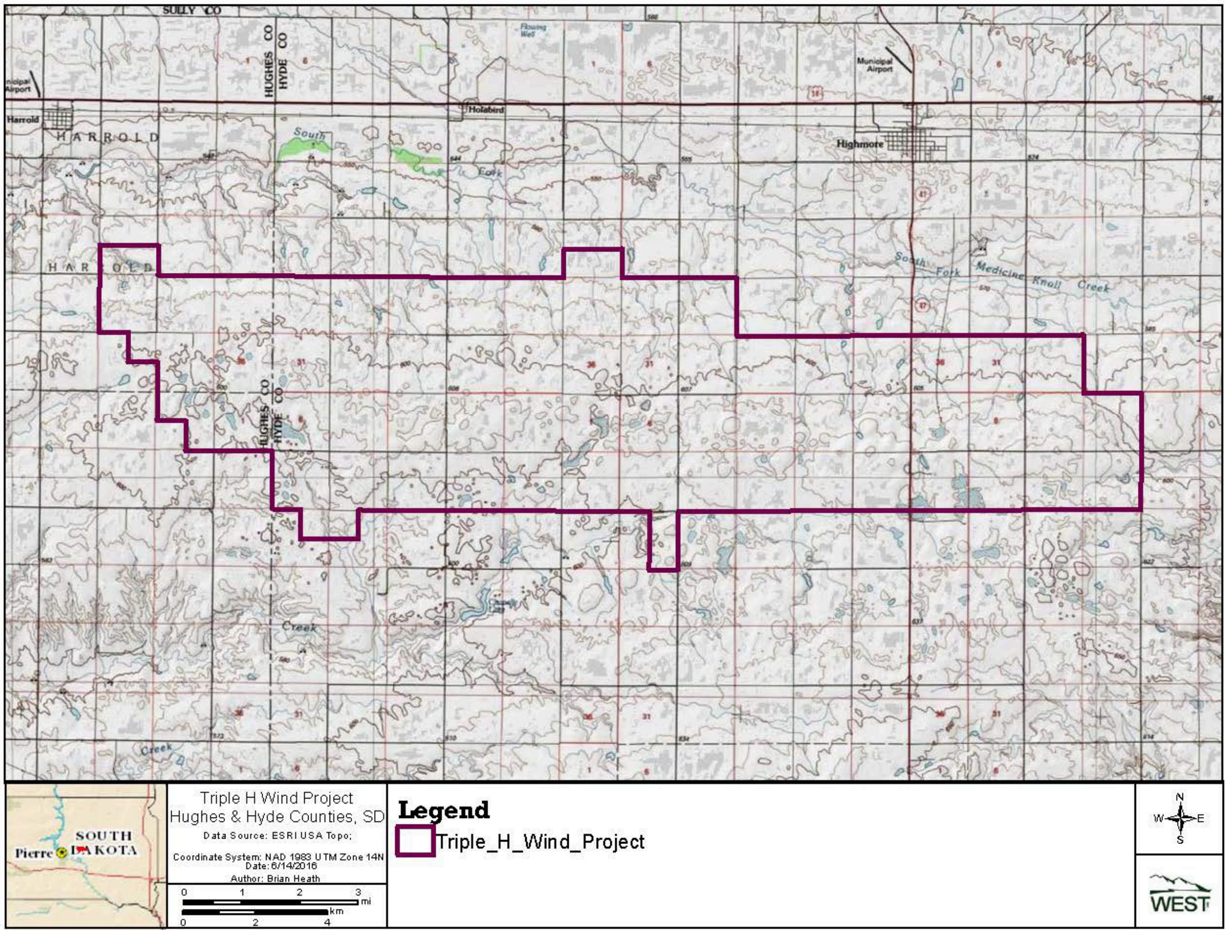

Figure 1. Location of the Triple H Wind Project, Hughes and Hyde Counties, South Dakota.

METHODS

Lek surveys were completed across the Project area and one-half mile buffer three times between March 30 and April 30, 2016. Initially three aerial surveys were proposed; however, due to flight cancelations because of weather a combination of aerial and ground-based surveys were used to search for breeding prairie grouse locations. The first survey was ground-based and conducted on March 29, 30, and April 2, 2016 by traveling accessible roads throughout the Project area and one-half mile buffer. Surveys commenced 30 minutes before sunrise and continued until two hours after sunrise. Four-wheel drive vehicles were driven along county roads and stops made at approximately one mile intervals or more frequently depending upon habitat type. The biologist walked ~5-10 meters from the vehicle and looked and listened for breeding grouse for approximately 5 minutes.

If a lek was visually located from a road, the observer marked the location on a hard copy map and recorded the distance and direction from the observation point along with the number of males, females, and birds of unknown sex attending the lek. For leks where only auditory detection occurred, biologists recorded the GPS location on the road and noted the bearing and estimated distance from the point. The observer then obtained a second bearing and distance to triangulate the lek location. Triangulated locations were plotted on a project map and later digitized by ArcMap geographical information system software to obtain coordinates.

The second survey was conducted from the air on April 20-21, 2016. A Cessna 172 flew north/south transects across the survey area spaced approximately 0.4-km apart at an altitude of approximately 100-150 feet above ground level. Surveys commenced approximately 30 minutes before sunrise and lasted for approximately two hours after sunrise on mornings with good visibility, clear skies, relatively calm winds (<15-20 mph) and no precipitation. An onboard GPS unit was used to keep the plane on transect, document lek locations, and record daily flight paths. Biologists recorded the number of birds on the lek and whether occupied by greater prairie-chicken or sharp-tailed grouse. The following characteristics were used to distinguish between these species from the air. A square-tail shape and dark, blocky body for greater prairie-chickens versus a pointed-tail with white under tail coverts and lighter body color for sharp-tailed grouse.

A combination of aerial and ground-based surveys was used to complete the third round of surveys within the Project area and one-half mile buffer from April 28-30, 2016. Aerial surveys were conducted within the western-half of the survey area on April 28, 2016 and ground-based surveys were conducted across the eastern-half of the survey area from April 29-30, 2016. The methods described above for aerial and ground-based surveys were again employed for these surveys.

RESULTS

Eight greater prairie-chicken leks were documented during 2016 surveys within the Project area and within a one-half mile buffer (Figure 2 – Table 1). Five leks were located within the Project area and three within one-half mile of the Project boundary. Two additional greater prairie-chicken leks were documented between one-half mile and one-mile of the Project and have been included within Table 1 (Lek ID's #9 & #10) and on Figure 2 to aide in Project planning. No sharp-tailed grouse leks were recorded.

All leks were initially detected audibly during ground-based surveys and biologists were able visually detect displaying males at seven of the eight locations from county roads. Visual detection of displaying males at Lek ID 5 was not possible from the county roads due to a ridge obstructing the view; however, birds were visually detected at this location during aerial surveys. Visual and/or auditory detections at a given location on two or more occasions was used to distinguish between a lek and an incidental observation. While the objective of the surveys was to document breeding locations to use in help siting the wind turbines, incidental observations of grouse were also recorded during surveys and provide an indication of use within the Project area. Information on incidental observations are not presented within this report but have been included within Appendix A along with all survey dates and results.

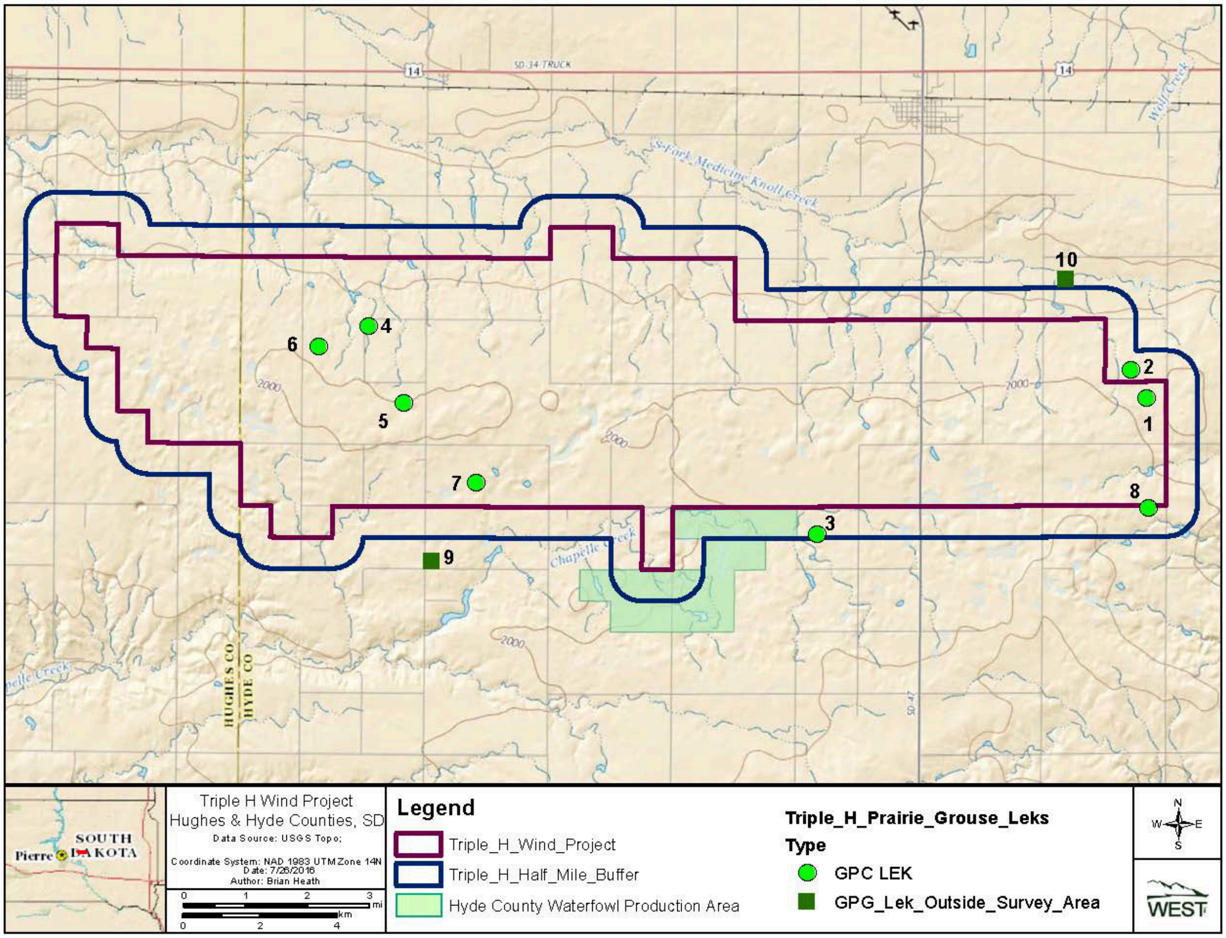

Figure 2. Location of greater prairie-chicken leks detected during surveys for the Triple H Wind Project, Hughes and Hyde counties, South Dakota, 2016.

Table 1. Greater prairie-chicken leks observed during aerial and ground surveys for the Triple H Wind Project, Spring 2016.

Lek ID	Date Observed	# Males Observed	Species	Qtr-Sec-T-R	Habitat	Location
1	3/30/2016	2	GPC	NE-4-111N-71W	Grassland	Project Area
2	3/29/2016	6	GPC	SW-33-112N-71W	Grassland	Half-Mile Buffer Area
3	3/30/2016	4	GPC	NW-15-111N-72W	Grassland	Half-Mile Buffer Area
4	4/2/2016	4	GPC	NW-33-112N-73W	Grassland	Project Area
5	4/2/2016	10*	GPC	SE-4-111N-73W	Grassland	Project Area
6	4/2/2016	4	GPC	NW-32-112N-73W	Wheatfield	Project Area
7	4/2/2016	3	GPC	SE-10-111N-73W	Grassland	Project Area
8	4/29/2016	3	GPC	NE-16-111N-71W	Grassland	Half-Mile Buffer
9	4/2/2016	11	GPC	SW-15-111N-73W	Grassland	Outside Survey Area
10	3/30/2016	3	GPC	NW-29-112N-71W	Grassland	Outside Survey Area

*= Total birds from aerial survey

Lek size varied from 2-6 males; however, it was difficult to obtain an accurate count of males during ground based surveys due to the topography and vegetation obstructing a view of the entire lek from the county roads. Aerial surveys often resulted in flushing of birds which made getting an accurate count of the birds in the air versus those remaining on the lek difficult. Therefore, numbers could be higher than reported. Seven of the leks were located within grassland habitats while the other lek was on a ridge within a wheat field. No sharp-tailed grouse leks were detected but two incidental observations were recorded during surveys.

Lek ID 1 was first detected on March 30 on a slight ridge in grassland habitat within the Project area. Only two males were visible but other booming was heard from the location. Two males were also observed from the ground on April 30 at this location but birds were not observed during the aerial surveys on April 20 or 21.

Six males were observed displaying at Lek ID 2 on March 29. The birds were located within a meadow approximately 280 m north of the Project area. A bird flushed from the location on April 20 during an aerial survey and five males were observed displaying on April 30 during the ground-based survey.

An auditory detection occurred at Lek ID 3 on March 29; however, visual detection of displaying greater prairie-chickens was not possible after several attempts to view from different positions along the county road. The location was re-surveyed again on March 30 and four males were visually detected displaying within grassland habitat. The lek is located approximately 710 m south of the Project and no birds were observed during subsequent aerial or ground surveys.

Lek ID 4 was first observed on April 2 when four males were observed booming near a fence corner in a grassland pasture in the Project area. The location was checked from the air on April 21 and a bird tentatively identified as a greater prairie-chicken flushed as the plane approached. The location was re-checked later that morning and no birds were observed. On April 28 two birds were observed along the fence in the same location.

Lek ID 5 was detected audibly from listening stops along county roads to the east and south on April 2. Based on the booming calls several males were in attendance on the morning of April 2. Greater prairie-chickens could not be visually detected and the location was estimated based on distance and bearing from the audible detection locations along the roads. The estimated location was inspected during an April 21 aerial survey and was flooded; however, two greater prairie-chickens were flushed from nearby the flooded area. Ten greater prairie-chickens were observed in the grassland habitat just north of the flooded area during the April 28 aerial survey. (See Discussion for further information on the location of this lek).

Four males were observed displaying on Lek ID 6 on April 2 on a ridge within a wheat field within the Project area. Birds were also confirmed at this location during aerial surveys on April 21 and 28. Lek ID 7 is located within the Project boundary and was initially detected during the April 2 ground survey within a pasture with short grass. Three males were observed displaying north of a fence near the center of the section. Three birds were observed at the same location during the April 21 aerial survey but birds were not observed during the April 28 aerial survey.

Lek ID 8 was first audibly detected during the third round of surveys on April 29 but fog precluded observing the birds. The location was re-surveyed on April 30 and three male prairie-chickens were visually detected booming within grassland habitat approximately 65 m south of the Project.

As noted above, Lek ID's #9 & #10 were located outside of the one-half mile survey buffer and both of these leks were located within grassland habitats. Eleven males were visually detected on Lek ID 9 on April 2 and birds were confirmed at the location during April 21 and April 28 aerial surveys. Three males were observed displaying on Lek ID 9 on March 30 and two birds were flushed from the same location during the April 21 aerial survey.

DISCUSSION

The SDGFP has identified wind energy as a potential threat to prairie grouse habitat and wind energy companies have identified South Dakota as a top location for development within the U.S. (SDGFP 2011). The SDGFP has established a strategy to collaborate with wind energy developers to site projects in areas that minimize impacts to prairie grouse. Although SDGFP has no specific setback requirements for siting wind turbines from leks, they recommend avoiding large, intact tracts of native vegetation and avoiding unnecessary ecological impacts through proper planning. The *Siting Guidelines for Wind Power Projects in South Dakota* recommend siting development within altered landscapes absent of native vegetation and avoiding construction of facilities, including mowing or clearing vegetation, during the breeding season (April to July) for ground-nesting birds.

Greater prairie-chicken leks were found in two general areas within the Project area; along the eastern edge and within the portion of the Project area located south of Holabird. Leks were primarily located within grassland habitats and within 1.5-miles of another lek. Because of the clustered occurrence of leks within the Project area, this information provides an indication of important greater prairie-chicken breeding habitats to avoid when siting wind turbines. Developing a general siting strategy that places turbines within agricultural fields and avoids disturbance or fragmentation to grassland habitats would reduce potential impacts to greater prairie-chickens and their breeding habitat within the Project area.

Visual detection for all leks, except Lek ID #5, occurred during ground-based surveys from county roads. Visual confirmation of the location where males displayed at Lek ID #5 could not be obtained from the ground; although, birds were observed within the general area during two aerial surveys. It is likely males moved where they displayed during the breeding season in response to the lowland area becoming flooded. While the coordinates provide a general location of the lek, the location used in micro-siting turbines should be considered approximate at this time and additional ground based surveys to pinpoint the lek location are suggested.

As noted above, the SDGFP does not mandate a distance wind turbines need to be setback from leks but recommends proper planning to avoid unnecessary impacts of wind power development. Results of the lek survey can be used during collaboration with the SDGFP to develop a wind turbine siting strategy that avoids or minimizes impacts to prairie grouse within the Project area.

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Appendix A. Survey Results by Date of Prairie Grouse Surveys, Triple H Wind Project, Spring 2016

Appendix A. Survey Results by Date of Prairie Grouse Surveys, Triple H Wind Project, Spring 2016.

Lek_ID	Date	Survey Method	# Observed	Time	Status	Species	UTM_N	UTM_E	Comments
1	3/30/2016	Ground	2	717	Active	GPC	4922100	470707	East of windmill not fully visible from road, observed two birds displaying after hearing them.
1	4/20/2016	Air	0	639	Inactive	GPC			No birds observed during aerial survey
1	4/21/2016	Air	0	846	Inactive	GPC			No birds observed during aerial survey
1	4/30/2016	Ground	2	612	Active	GPC			Confirmed birds from ground.
2	3/29/2016	Ground	6	720	Active	GPC	4922806	470285	In meadow east of pond.
2	4/20/2016	Air	1	636	Active	GPC			One flushed to cover, circled and didn't see any other birds
2	4/21/2016	Air	0	842	Inactive	GPC			No birds observed during aerial survey.
2	4/30/2016	Ground	5	635	Active	GPC			Confirmed birds from ground.
3	3/29/2016	Ground		750	Active	GPC			Auditory detection south of road could not observe.
3	3/30/2016	Ground	4	818	Active	GPC	4918549	462147	East of pond on ridge. Visual confirmation of 3/29 auditory.
3	4/20/2016	Air	0	625	Inactive	GPC			No birds observed during aerial survey.
3	4/21/2016	Air	0	852	Inactive	GPC			No birds observed during aerial survey.
3	4/30/2016	Ground	0	815	Inactive	GPC			No auditory or visual, cows / calves in pasture.
4	4/2/2016	Ground	4	709	Active	GPC	4923945	450474	Near fence corner in pasture. Spotted from road to east and birds were on east side of the fence.
4	4/21/2016	Air	0	630	Inactive	GPC			Possible GPC re-checked at 732 no birds observed.
4	4/28/2016	Air	2	751	Active	GPC			Observed during survey, GPS point not recorded but biologists indicated same location as point 4.
5	4/2/2016	Ground	0	734	Active	GPC			Auditory detection and could not get visual of birds after various stops. Birds heard from road to east and south but never could see them.
5	4/21/2016	Air	2	717	Active	GPC	4921643	451128	Observed near corner where fences intersect, area flooded, birds may have moved. Same general location as point 5 auditory.
5	4/28/2016	Air	10	745	Active	GPC	4921968	451387	Same general area a previous point 5, lowland flooded.
6	4/2/2016	Ground	4	808	Active	GPC	4923428	449195	Observed from road to southeast. Birds were observed on ridge in the green wheat field.
6	4/21/2016	Air	4	622	Active	GPC			In wheat field 1 flushed 3 loafing use original point 6
6	4/21/2016	Air	1	622	Active	GPC			Flushed keep with original point 6
6	4/28/2016	Air	2	803	Active	GPC			Near previous point 6 in wheat field.
7	4/2/2016	Ground	3	824	Active	GPC	4919903	453281	North of fence. Observed from road to west and was fairly due east and little north of ranch house. Short grass pasture.
7	4/21/2016	Air	3	641	Active	GPC			Same location as previous point
7	4/28/2016	Air	0	730	Inactive	GPC			No birds observed during aerial survey
8	4/29/2016	Ground		635	Active	GPC			Auditory only, foggy and could not get visual
8	4/30/2016	Ground	3	645	Active	GPC	4919239	470761	Visual of GPC display from ground.

Appendix A. Survey Results by Date of Prairie Grouse Surveys, Triple H Wind Project, Spring 2016.

Lek_ID	Date	Survey Method	# Observed	Time	Status	Species	UTM_N	UTM_E	Comments
9	4/2/2016	Ground	11	830	Active	GPC	4917870	452130	On small ridge can see from road, heard from survey area but lek located >1/2 mile from Project.
9	4/21/2016	Air	10	627	Active	GPC			Grassy pasture flushed north of road NE part of intersection.
9	4/28/2016	Air	2	738	Active	GPC			Same location as point 9
10	3/30/2016	Ground	3	755	Active	GPC	4925184	468613	West of fence in pasture. Observed from road to the west and birds were pretty close to fence in middle of section. Heard from project area, lek located >1/2 mile from project area.
10	4/20/2016	Air	0	631	Inactive	GPC			No birds observed during aerial survey.
10	4/21/2016	Air	2	837	Active	GPC			Flushed west of N/S fence in grassy pasture.

Additional Incidental Observations from ground surveys on March 29, 30, April 2 2016

Point ID	Date		Num_Obs	Lek	Status	Species	UTM_N	UTM_E	Comments
11	4/2/2016	Ground	2	842	Active	GPC	4920024	454113	North of pond could not see all the birds. Location hard to map could be north or south of this location.
11	4/20/2016	Air	0	840	Inactive	GPC			No birds observed during aerial survey
11	4/21/2016	Air	0	648	Inactive	GPC			No birds observed during aerial survey
11	4/28/2016	Air	0	629	Inactive	GPC			No birds observed during aerial survey, GPC flushed to north of location along CR 203.

Additional Incidental Observations from aerial surveys on April 20 & 21 2016

Point ID	Date		Num_Obs	Lek	Status	Species	UTM_N	UTM_E	Comments
12	4/21/2016	Air	1	731	Observ	STGR	4918437	450220	Flushed from grassy pasture to crops
12	4/28/2016	Air	0	655	Inactive				No birds observed during aerial survey.
13	4/21/2016	Air	1	737	Observ	STGR	4923362	448795	Flushed from grassy area. Bird located just west of point 7.
13	4/28/2016	Air	0	706	Inactive				No birds observed during aerial survey.
14	4/21/2016	Air	3	808	Observ	GPC	4920450	444714	Pilot observed birds flush from fence line
14	4/28/2016	Air	0	733	Inactive				No birds observed during aerial survey.

Additional Incidental Observations from aerial survey on April 28 2016

Point ID	Date		Num_Obs	Lek	Status	Species	UTM_N	UTM_E	Comments
15	4/28/2016	Air	2	715	Observ	GPC	4922969	453822	In wheat field
16	4/28/2016	Air	1	724	Observ	GPC	4920887	454021	Point on CR203
17	4/28/2016	Air	2	806	Observ	GPC	4922526	448762	Fence corner
18	4/28/2016	Air	2	807	Observ	GPC	4921725	448798	Fence corner

Appendix J. Prairie Grouse Lek Surveys for the Triple H Wind Project, Hughes and Hyde Counties, South Dakota – 2018 Prairie Grouse Lek Report

Prairie Grouse Lek Surveys for the Triple H Wind Project Hughes and Hyde Counties, SD

2018 Prairie Grouse Lek Report

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October 2, 2018

EXECUTIVE SUMMARY

Engie IR Holdings (Engie) is proposing a wind energy facility in Hughes and Hyde Counties, South Dakota referred to as the Triple H Wind Project (Project). Engie contracted Western EcoSystems Technology, Inc. (WEST) to conduct surveys and monitor wildlife resources to identify potential impacts of facility construction and operations on wildlife. The following report contains the results of greater prairie-chicken and sharp-tailed grouse (prairie grouse) lek surveys conducted at the Project. The objective of the prairie grouse lek survey is to collect pre- construction data that can be used to help site the wind turbines to minimize impacts on grouse.

In 2016, baseline wildlife studies were completed within a portion of the Project encompassing 39,068 acres, Engie has expanded the Project boundary to encompass approximately 110,059 acres. During 2016 studies, 10 greater prairie-chicken leks were documented within the initial Project area. WEST conducted surveys to document the 2018 breeding season status for the 10 previously identified leks and any prairie grouse leks within the expanded Project area.

Leks documented during 2016 surveys were visited at least three times between March 27 and May 6, 2018 to document current breeding season activity and record counts of prairie grouse attending the leks, if active. The date, time, status, number and species of prairie grouse were recorded during each visit.

Surveys for leks were also conducted three times between March 27 and May 6, 2018 within the entire expanded Project area and extend to a one-mile buffer of the expanded Project area excluding areas that were previously surveyed in 2016. Initially three aerial surveys were proposed; however, due to flight cancelations because of various issues a combination of ground-based and aerial surveys were used to document breeding prairie grouse locations.

The first survey was ground-based and conducted from March 27-30, 2018 by traveling accessible roads throughout the Project area and one-mile buffer. Vehicles were driven along county roads and stops made at approximately one-half to one-mile intervals to look and listen for breeding grouse. If a lek was visually located, the observer marked the location on a hard copy map and recorded the distance and direction from the observation point along with the number of males, females, and birds of unknown sex attending the lek. For potential leks where only auditory detection occurred, biologists recorded the global positioning system location on the road and noted the bearing and estimated distance to the lek from their location. The observer attempted to pinpoint the lek location by stopping at other locations to triangulate the location. On lands currently under easement or to which access could otherwise be obtained, biologists walked into lek locations to obtain a precise location of the lek during the middle of the day when birds were not at the lek. On lands where access could not be obtained, the location on the map was digitized by ArcMap geographical information system software. Observations of non-lekking prairie grouse were also recorded.

The second and third round of surveys were completed from April 23-27 and May 2-5, 2018 by flying north/south transects spaced approximately 0.25-miles apart across the survey area. An onboard GPS unit was used to keep the plane on transect, record lek locations, and document daily flight paths. Biologists recorded the number of birds on the lek and whether occupied by greater prairie-chicken or sharp-tailed grouse. Surveys commenced approximately 30 minutes before sunrise and lasted for approximately two hours after sunrise. Surveys primarily occurred on mornings with good visibility, clear skies, relatively calm winds (<10-15 mph) and no precipitation. Any suspected lek observed from the air was later re-checked from the ground to verify the presence of displaying males, confirm species, and obtain a count of the birds attending the lek. Where access to private land was granted, each lek was visited to record the approximate center of the lek with a GPS receiver. The presence of feathers, droppings, or trampled vegetation was used to confirm the location as a lek.

Of the 10 prairie grouse leks documented during 2016 surveys, six were active with displaying males and four were inactive during at least three lek activity checks. Sharp-tailed grouse were documented on one lek where greater prairie-chickens were observed in 2016. The other five active leks were in approximately the same locations as in 2016 and greater prairie-chickens were again observed displaying at each of the locations. No prairie grouse breeding displays were observed at the four inactive leks during the three visits in 2018. The grassland habitat remained intact at three of the inactive leks and the other inactive lek was located within a cropland. In 2018 the field contained corn stubble, whereas when documented in 2016 it was planted with winter wheat.

Thirty new leks, 29 greater prairie-chicken and one sharp-tailed grouse, were documented during 2018 surveys. Eighteen leks were located within the Project area and 11 within one-mile of the Project boundary, and one lek was located approximately 1.5-miles south of the Project boundary. Four leks were located within croplands and 26 were located within grassland habitats, primarily native grass pastures. The maximum number of birds on greater prairie- chicken leks varied from 3-20 birds with an average maximum count of 10 birds. Ten and six birds were the maximum count for the two sharp-tailed grouse leks.

The South Dakota Game, Fish and Parks Recommendations for Grouse Lek Buffers for wind development and associated infrastructure include: no new construction within one-mile buffer of a prairie grouse lek (NSO buffer), no activity within two-miles of a lek from March 1 to June 30 during construction and operations (TL buffer), and recommends avoiding placing wind development in large, continuous blocks of grasslands and maintaining habitat connectivity between leks. Based on 2018 survey results, approximately 36% of the Project area is located within one-mile of a prairie grouse lek NSO buffer where no new construction is recommended. Approximately 79% of the Project occurs within the recommended two-mile TL construction and operational buffers. These recommendation and results of the lek survey and can be used during collaboration with the SDGFP to develop a wind turbine siting strategy that minimizes impacts to prairie grouse within the Project area.

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INTRODUCTION AND BACKGROUND

Engie IR Holdings (Engie) is considering the development of the Triple H Wind Project (Project) in Hughes and Hyde Counties, South Dakota. In 2016, baseline wildlife studies were completed within a portion of the Project encompassing 39,068 acres based on a 200 MW project. Engie has expanded the Project boundary to encompass approximately 110,059 acres and may include three separate 250 MW phases. With the expansion, Engie contracted with Western EcoSystems Technology, Inc. (WEST) to conduct surveys and monitor wildlife resources in the expanded Project area to evaluate the potential impacts of wind energy facility construction and operations on wildlife. The Project area occurs within the occupied range of the greater prairie- chicken (*Tympanuchus cupido*) and sharp-tailed grouse (*T. phasianellus* [hereafter prairie grouse]) and during 2016 studies 10 leks were documented within the initial Project area. Greater prairie-chickens are listed as a Species of Greatest Conservation Need (SGCN) in South Dakota. Engie requested WEST conduct surveys to document the 2018 breeding season status for the 10 previously identified leks and any prairie grouse leks within the expanded Project area. The objective of the prairie grouse lek survey is to collect pre-construction data that can be used to help site the wind turbines to minimize impacts on grouse.

Male prairie grouse attend traditional breeding grounds or leks in the spring to display and perform ritualistic courtship behavior to attract females for mating. Leks are defined by the South Dakota Game Fish and Parks (SDGFP) as a “traditional display area where two or more male grouse have attended in two or more of the previous five years” (SDGFP 2017a). Leks are typically located on knolls, gentle rises, and greater prairie-chicken leks are sometimes located on flat bottomlands such as a dry wetland (SDGFP 2017b).

In South Dakota, male prairie grouse begin defending territories on leks in late February with peak activity occurring in early April during peak hen attendance (SDGFP 2017b). After mating, hens typically nest within a few miles of the lek but some may nest up to 10 miles or farther away (SDGFP 2017b). The average distance from lek of capture to nest site for female greater prairie-chickens and sharp-tailed grouse fitted with radio-transmitters on the Fort Pierre National Grasslands was 1.98 km (1.23-miles) and 2.03 km (1.27-miles), respectively (Kirschenmann 2008). Prairie grouse are dependent upon grasslands for nearly all life cycle needs and typically nest in areas with dense or residual grass to conceal nests from predators (Bidwell et al. 2003, Prose et al. 2002). They will use grass and alfalfa hay fields during the spring and summer and both species will also utilize waste grain in agricultural fields primarily during the fall and winter (SDGFP 2017b).

STUDY AREA

The Project is located in Hughes and Hyde Counties, South Dakota approximately three miles south of Highmore and Holabird, South Dakota (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 (USEPA 2015). This ecoregion is characterized by high concentrations of seasonal and semi-permanent wetlands (prairie potholes [USEPA 2015). The topography within the Project consists of rolling hills, with elevations ranging from 1,800 to 2,150 feet above sea level. Land ownership in the Project is primarily private with a few scattered State or County school public lands. The US Fish and Wildlife Services (USFWS) Harter-Cowan Waterfowl Production Area and State Chapelle Water Access Area are also located within the Project area. Chapelle Creek is the main drainage within the Project and prairie potholes occur across the area. The majority of the lands within the Project support agriculture, either as cultivated crop, hay, or pasture lands.

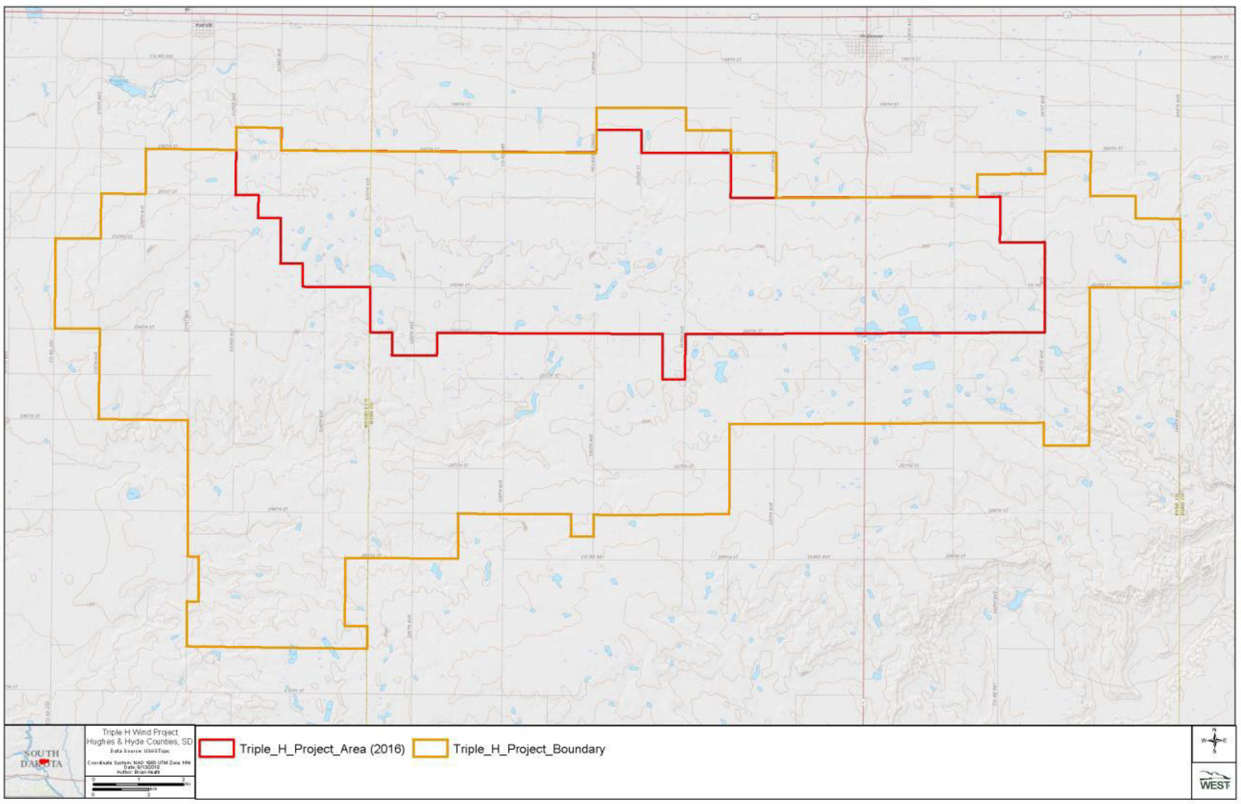

Figure 1. Location of the 2016 and expanded Triple H Wind Projects, Hughes and Hyde Counties, South Dakota.

METHODS

Leks documented during 2016 surveys were visited at least three times between March 27 and May 6, 2018 to document current breeding season activity and record counts of prairie grouse attending the leks, if active. The majority of visits occurred from the ground; however, some visits were conducted from the air for leks that were inactive during initial ground checks to survey the general area in the event the location of the lek moved since the previous survey. The date, time, status, number and species of prairie grouse were recorded during each visit.

Surveys for leks were also conducted three times between March 27 and May 6, 2018 within the entire expanded Project area and extend to a one-mile buffer of the expanded Project area excluding areas that were previously surveyed in 2016. Initially three aerial surveys were proposed; however, due to flight cancelations because of mechanical issues, severe weather, and delays with airplane licensing, a combination of ground-based and aerial surveys were used to search for breeding prairie grouse locations.

The first survey was ground-based and conducted between March 27-30, 2018 by traveling accessible roads throughout the Project area and one-mile buffer. Surveys commenced 30 minutes before sunrise and continued until approximately two hours after sunrise. Four-wheel drive vehicles were driven along county roads and stops made at approximately one-half to one-mile intervals or more frequently depending upon habitat type. Biologists walked ~10-20 feet from the vehicle and looked and listened for breeding grouse for approximately 5 minutes before progressing to the next location.

If a lek was visually located, the observer marked the location on a hard copy map and recorded the distance and direction from the observation point along with the number of males, females, and birds of unknown sex attending the lek. For potential leks where only auditory detection occurred, biologists recorded the global positioning system (GPS) location on the road and noted the bearing and estimated distance to the lek from their location. The observer attempted to pinpoint the lek location by stopping at other locations to triangulate the location. On lands currently under easement or to which access could otherwise be obtained, biologists walked into lek locations to obtain a precise GPS location of the lek during the middle of the day when birds were not at the lek. On lands where access could not be obtained, the location on the map was digitized by ArcMap geographical information system (GIS) software.

Observations of non-lekking prairie grouse were also recorded. Visual and/or auditory detections at a given location on two or more occasions was used to distinguish between a lek and an incidental observation. While the objective of the surveys was to document breeding locations to use in help siting the wind turbines, incidental observations of grouse were also recorded during surveys and provide an indication of use within the Project area.

A major blizzard occurred in mid-April and delayed the initial aerial survey. However, several county roads had been cleared and allowed some of the leks documented during the 2016 surveys and during the initial ground survey in March 2018 to be revisited and obtain counts of birds attending the leks. These counts were conducted from April 15-17, 2018 and any new leks detected during the surveys were also recorded.

Two rounds of aerial surveys were conducted from April 23-27 and May 2-5, 2018. A Cessna 172 flew north/south transects across the survey area spaced approximately 0.25-miles apart at an altitude of approximately 100-150 feet above ground level. Surveys commenced approximately 30 minutes before sunrise and lasted for approximately two hours after sunrise on mornings with good visibility, clear skies, relatively calm winds (<10-15 mph) and no precipitation. An onboard GPS unit was used to keep the plane on transect, document prairie grouse observations, and record daily flight paths. Biologists recorded the number of birds on the lek and whether occupied by greater prairie-chicken or sharp-tailed grouse when possible. The following characteristics were used to distinguish between these species from the air. A square-tail shape and dark, blocky body for greater prairie-chickens versus a pointed-tail with white under tail coverts and lighter body color for sharp-tailed grouse.

Any suspected lek observed from the air was later re-checked from the ground to verify the presence of displaying males, confirm species, and obtain a count of the birds attending the lek. Where access to private land was granted, each lek was visited to record the approximate center of the lek with a GPS receiver. The presence of feathers, droppings, or trampled vegetation was used to confirm the location as a lek.

RESULTS

Of the 10 prairie grouse leks documented during 2016 surveys, six were active with displaying males and four were inactive during at least three lek activity checks (Figure 2, Table1). Sharp-tailed grouse were documented on Lek #1 in 2018; whereas, in 2016 greater prairie-chickens were observed on the lek. The lek was in approximately the same location within grassland habitat that appeared to have been hayed in 2017. Leks #2, #4, #7, #9, #10 were active, in approximately the same locations as in 2016, and greater-prairie chickens were observed displaying at each of the locations at least three times during the breeding season (Appendix A). All active leks were within grasslands; however, the landowner broke the sod where Lek #4 was located during early May 2018. Greater prairie-chickens were still observed on the lek even after the ground had been broke. Leks #3, #5, #6, and #8 were documented as inactive during three visits. The grassland habitat remained intact where Leks #3, #5, and #8 were previously documented in 2016. In 2016, Lek #6 was located within a wheat field and the field contained corn stubble in 2018.

Thirty new leks, 29 greater prairie-chicken and one sharp-tailed grouse, and 28 incidental prairie grouse observations were documented during 2018 surveys. At 26 of the 30 locations, at least two males were observed on at least two occasions during the breeding season and were classified as leks. Leks #56, #58 and #59 were the exceptions and only had one observation each from the air during the final round of surveys in early May 2018. Lek #56 is located within a native grass pasture and is not visible from any road but was inspected from the ground where several feathers and droppings were noted confirming the location as a lek. Lek #58 is located approximately 1.5-miles south of the Project boundary and was observed when flying from one transect to another. Because the lek is located outside of the survey area no attempt to confirm breeding activity was made and the lek has been included for informational or potential future planning purposes. Lek #59 is located within the Harter-Cowan Waterfowl Production Area and is not visible from a road. However, during a ground inspection of the area several feathers, droppings, and trampled grass were noted confirming the location as a lek.

Eighteen leks were located within the Project area and 11 within one-mile of the Project boundary, as noted previously Lek #58 is located approximately 1.5-miles south of the Project boundary. Leks #17, #22, #37, and #63 were located within croplands and the 26 other leks were located within grassland habitats, primarily native grass pastures.

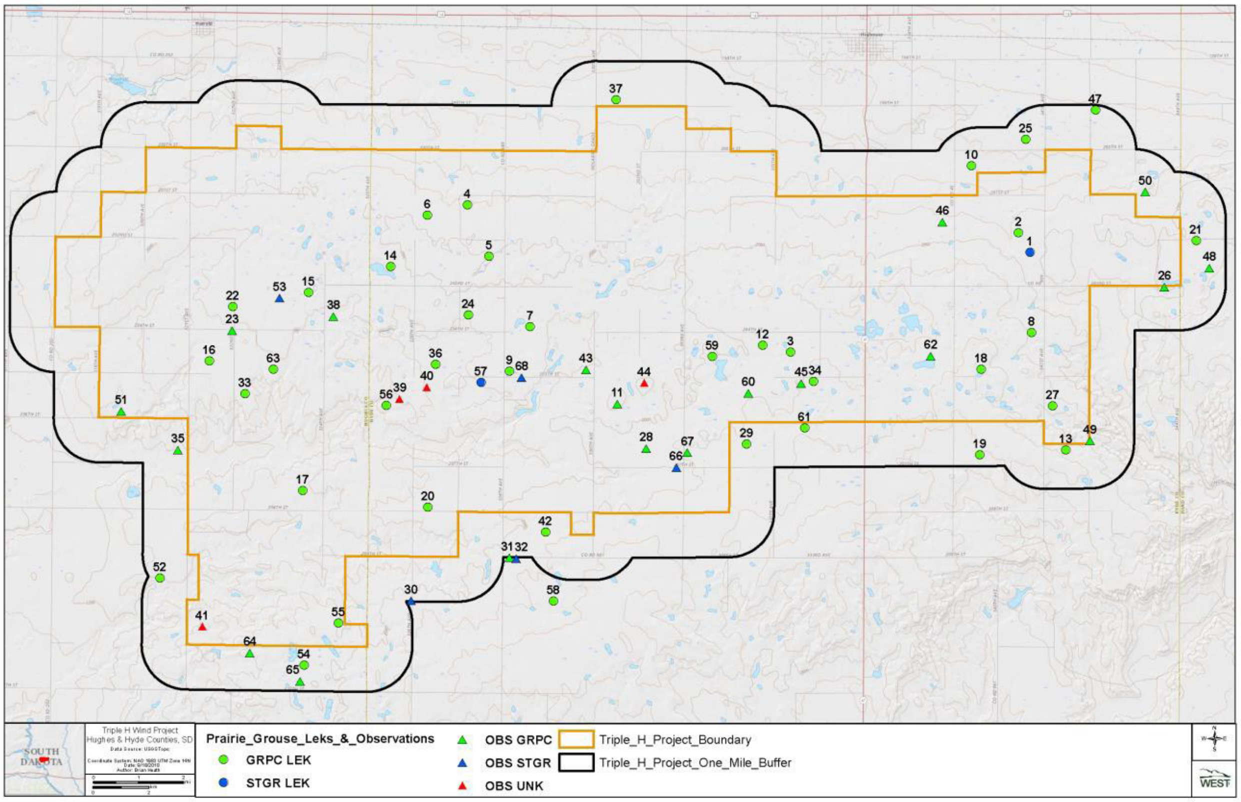

Figure 2. Location of prairie grouse leks and incidental observations detected during surveys for the Triple H Wind Project, Hughes and Hyde counties, South Dakota, Spring 2018.

Table 1. Location and maximum number of prairie grouse observed at leks during surveys for the Triple H Wind Project, Hughes and Hyde counties, South Dakota, Spring 2018.

Id[1]	Date	SPP[2]	Status	# Birds[3]	QQ	Sec	Twn	Rng	Habitat	Location
1*	3/27/2018	STGR LEK	Active	10	SWNE	4	111	71	Grassland	Project
2*	4/27/2018	GRPC LEK	Active	6	SESW	33	112	71	Grassland	Project
3*	3/27/2018	GRPC LEK	Inactive	0	SWNW	15	111	72	Grassland	Project
4*	4/15/2018	GRPC LEK	Active	14	NWNW	33	112	72	Grassland	Project
5*	3/28/2018	GRPC LEK	Inactive	0	SWNE	4	112	73	Grassland	Project
6*	3/29/2018	GRPC LEK	Inactive	0	SWNW	32	112	73	Cropland	Project
7*	4/24/2018	GRPC LEK	Active	7	NESE	10	111	73	Grassland	Project
8*	3/27/2018	GRPC LEK	Inactive	2	NENE	16	111	71	Grassland	Project
9*	4/27/2018	GRPC LEK	Active	19	SWSW	15	111	73	Grassland	Project
10*	3/27/2018	GRPC LEK	Active	18	SENW	29	112	71	Grassland	One-Mile Buffer
12	4/15/2018	GRPC LEK	Active	13	SWNE	16	111	72	Grassland	Project
13	4/16/2018	GRPC LEK	Active	6	NWSW	27	111	71	Grassland	One-Mile Buffer
14	3/28/2018	GRPC LEK	Active	12	NWSW	6	111	73	Grassland	Project
15	4/24/2018	GRPC LEK	Active	5	NWNE	11	111	74	Grassland	Project
16	4/15/2018	GRPC LEK	Active	10	NWSW	16	111	74	Grassland	Project
17	3/30/2018	GRPC LEK	Active	10	NWSE	25	111	74	Cropland	Project
18	3/29/2018	GRPC LEK	Active	10	SWSE	17	111	71	Grassland	Project
19	3/29/2018	GRPC LEK	Active	6	SESE	30	111	71	Grassland	One-Mile Buffer
20	3/28/2019	GRPC LEK	Active	8	SESW	32	111	73	Grassland	Project
21	3/28/2017	GRPC LEK	Active	11	NWNE	6	111	70	Grassland	One-Mile Buffer
22	4/24/2018	GRPC LEK	Active	7	SENE	22	111	74	Cropland	Project
24	4/24/2018	GRPC LEK	Active	7	NESW	9	111	73	Grassland	Project
25	4/15/2018	GRPC LEK	Active	9	SWSE	25	112	71	Grassland	One-Mile Buffer
27	4/16/2018	GRPC LEK	Active	7	NWSW	22	111	71	Grassland	Project
29	5/2/2018	GRPC LEK	Active	4	SENW	28	111	72	Grassland	One-Mile Buffer
33	4/24/2018	GRPC LEK	Active	7	SWNW	22	111	74	Grassland	Project
34	4/24/2018	GRPC LEK	Active	4	NENE	22	111	72	Grassland	Project
36	4/26/2018	GRPC LEK	Active	15	SESW	17	111	73	Grassland	Project
37	4/26/2018	GRPC LEK	Active	11	SESW	13	112	73	Cropland	One-Mile Buffer
42	5/2/2018	GRPC LEK	Active	10	SENE	3	110	73	Grassland	One-Mile Buffer
47	5/3/2018	GRPC LEK	Active	4	NWNW	23	112	71	Grassland	One-Mile Buffer
52	5/2/2018	GRPC LEK	Active	3	NESW	8	110	74	Grassland	One-Mile Buffer
54	5/3/2018	GRPC LEK	Active	5	SWNE	23	110	74	Grassland	One-Mile Buffer
55	5/3/2018	GRPC LEK	Active	20	SENW	13	110	74	Grassland	Project
56	5/3/2018	GRPC LEK	Active	15	NESW	19	111	73	Grassland	Project
57	5/6/2018	STGR LEK	Active	6	NWNE	21	111	73	Grassland	Project
58	5/4/2018	GRPC LEK	Active	15	SESE	11	110	73	Grassland	1.5 Mile Buffer
59	5/4/2018	GRPC LEK	Active	14	NWSE	17	111	72	Grassland	Project
61	5/5/2018	GRPC LEK	Active	4	NWNE	27	111	72	Grassland	One-Mile Buffer
63	5/5/2018	GRPC LEK	Active	10	SESE	15	111	74	Cropland	Project

[1] – * Denotes leks documented during 2016 surveys and re-visited in 2018

[2] Species – GRPC LEK = greater prairie-chicken lek; STGR Lek = sharp-tailed grouse lek.

[3] # Birds – Maximum number of prairie grouse observed at a lek during surveys regardless of sex.

Of the 28 prairie grouse incidental observations, 19 were of greater-prairie chickens, five sharp-tailed grouse, and four observations where the species of grouse was not ascertained during aerial surveys. The incidental observations are presented on Figure 2 and included within Appendix A with the other survey results.

It was often difficult to obtain an accurate count of males versus females during aerial surveys as most birds flushed when the plane approached the lek as well as from the ground due to the vegetation and distance from the county roads when attempting to get counts of the birds. Therefore, the maximum number of birds is reported and not maximum number of males; however, in several counts the maximum count represents the number of males observed displaying.

The maximum number of birds on greater prairie-chicken leks varied from 3-20 birds with an average maximum count of 10 birds. Ten and six birds were the maximum count for the two sharp-tailed grouse leks which were even more difficult to distinguish between males and females.

DISCUSSION

The SDGFP has identified wind energy as a potential threat to prairie grouse habitat and wind energy companies have identified South Dakota as a top location for development within the U.S. (SDGFP 2017b). The SDGFP Recommendations for Grouse Lek Buffers (SDGFP 2017a) for wind development and associated infrastructure include:

- "No-surface Occupancy (NSO) – Use or occupancy of the land surface for wind development and associated infrastructure is prohibited in order to protect identified resource values." The NSO for prairie grouse leks is at least one-mile as measure from the center of the lek where no new construction is recommended.

- "Timing Limitation (TL) – Use and disturbance of the land surface are prohibited during specified time periods to protect identified resource values." The recommended TL buffer during construction is March 1 to June 30 within two-miles of a lek where no activity is recommended to protect leks and nests. When the wind farm is in operation, the recommended TL is 3 hours after sunrise between March 1 and June 30 again to protect leks and no activity is recommended.

- SDGFP also recommends avoiding placing wind development in large, continuous blocks of grasslands and maintaining habitat connectivity between leks. Existing roads should be used where possible, minimize the volume of traffic on roads, and where possible close and re-vegetate travel ways.

Based on 2018 survey results, approximately 36% of the Project area is located within one-mile of a prairie grouse lek NSO buffer where no new construction is recommended (Figure 3). Approximately 79% of the Project occurs within the recommended two-mile TL construction and operational buffers.

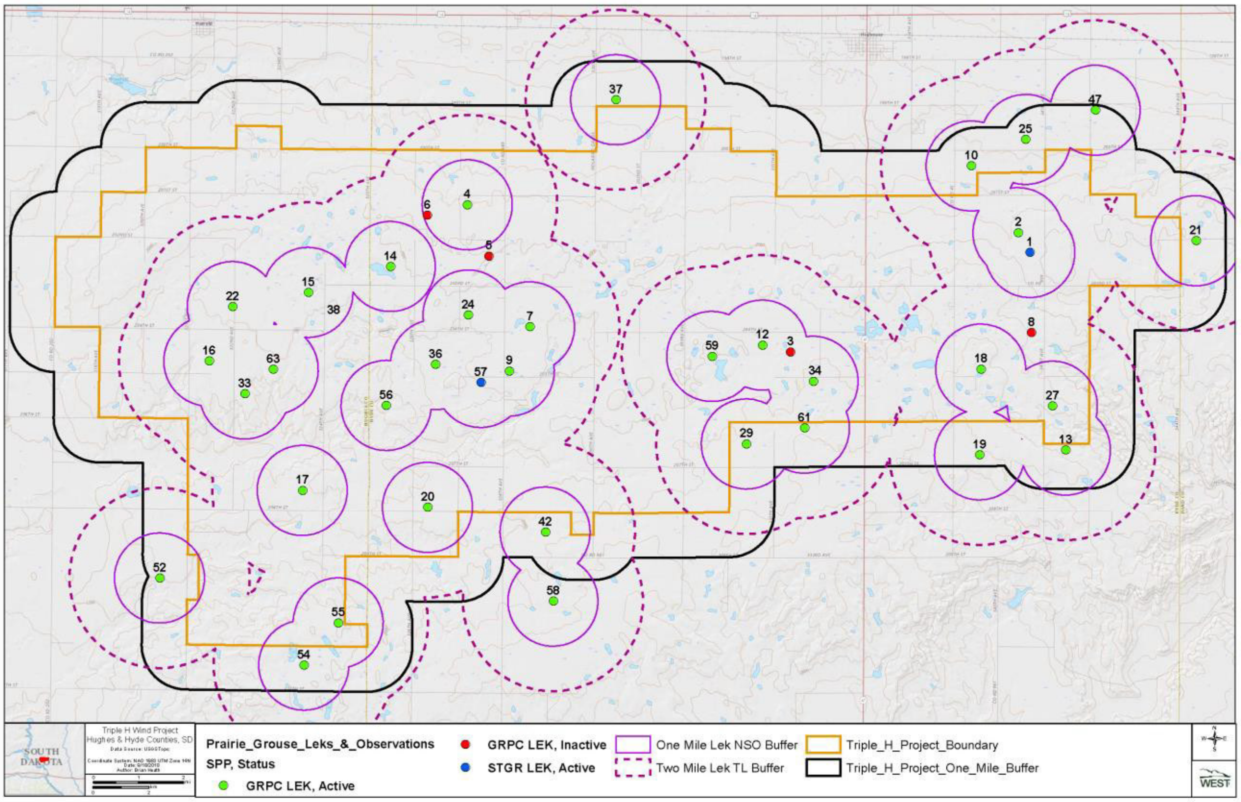

Figure 3. Prairie grouse leks No Surface Occupancy and Timing Limitation recommended buffers for the Triple H Wind Project, Hughes and Hyde counties, South Dakota, 2018.

Prairie grouse leks, primarily greater prairie-chicken leks, were found across the Project area; generally within larger blocks of grassland habitats and within one-mile of another lek. Higher lek density occurred within five general areas of the Project. Two “clusters” of six leks each are located east and west of the Hughes and Hyde County line within the west-central Project area. Another cluster of leks is located within and adjacent to the Cowan Waterfowl Production Area in the south-central Project area. The other two groups of leks are located within the northeastern and southeastern portions of the Project. Because of the clustered occurrence of leks within the Project area, the information provides an indication of important prairie grouse breeding habitats to avoid when siting wind turbines.

The results of the lek survey can be used during collaboration with the SDGFP to develop a wind turbine siting strategy that minimizes impacts to prairie grouse within the Project area. Developing a general siting strategy that places turbines within agricultural fields and avoids disturbance or fragmentation to grassland habitats would help reduce potential impacts to prairie grouse and their breeding habitat within the Project area.

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Appendix A. Survey Results by Date of Prairie Grouse Surveys, Triple H Wind Project, Spring 2018

ID	Date	Survey Method	# Birds[1]	Time	Status	Species[2]	Type[3]	Comments
1	3/27/2018	Ground	10	735	Active	STGR	Lek	Same general location as in 2016. Field was hayed in 2017.
1	4/16/2018	Ground	2	637	Active	STGR	Lek	
1	4/27/2018	Ground	8	614	Active	STGR	Lek	males displaying
2	3/27/2018	Ground	5	735	Active	GRPC	Lek	2016 lek active in 2018, coordinates good for this lek.
2	4/15/2018	Ground	4	1035	Active	GRPC	Lek	birds on lek but not displaying, late in morning for check
2	4/27/2018	Ground	6	619	Active	GRPC	Lek	Males displaying and calling
3	3/27/2018	Ground	0	810	Inactive			2016 GRPC lek, no birds observed or heard. Flock snow geese on pond
3	4/15/2018	Ground	0	910	Inactive			no birds observed or heard.
3	4/26/2018	Air	0		Inactive			No birds observed during aerial survey.
3	5/4/2018	Air	0		Inactive			No birds observed during aerial survey. 2 GRPC flushed from wheat field to south.
4	3/28/2018	Ground	5	740	Active	GRPC	Lek	2016 lek, ground verification and gps of lek on 3/29/2018
4	4/15/2018	Ground	14	814	Active	GRPC	Lek	birds active on snow
4	4/24/2018	Ground	6	920	Active	GRPC	Lek	4 males displaying, 2 unknown loafing
4	5/6/2018	Ground	5	837	Active	GRPC	Lek	farmer has broke sod on lek birds still on lek
5	3/28/2018	Ground	0	707	Inactive			2016 GRPC lek, no birds heard or observed. Also re-checked on 3/29/2018
5	4/15/2018	Ground	0	810	Inactive			No birds heard or observed.
5	4/26/2018	Ground	0	635	Inactive			No birds heard or observed
6	3/28/2019							2016 GRPC lek, unable to check from ground
6	4/17/2018	Ground	0	635	Inactive			Windy but ok light, no birds observed or heard
6	4/25/2016	Air	0		Inactive			Location in cut cornfield. Circled area no birds observed or flushed. Also checked grass qtr section to NE no birds.
6	5/3/2018	Air	0	825	Inactive			No birds observed, framer broke sod to NE.
7	3/28/2017	Ground	0	756	Inactive			2016 GRPC lek, no birds heard or observed. Re-checked on 3/29/2018
7	4/15/2018	Ground	3	824	Active	GRPC	Lek	One displaying 2 loafing. See updated location out from shed in 2018
7	4/17/2015	Ground	3	702	Active	GRPC	Lek	Windy not displaying. GPS of coordinates from ground.
7	4/24/2018	Ground	7	755	Active	GRPC	Lek	Wind not displaying but some standing
8	3/27/2018	Ground	2	750	Inactive	GRPC	Obs	2 birds observed but not displaying. Others heard but could not locate. Re-checked 3/29/2018 nothing heard but several deer in area.
8	4/16/2018	Ground	0	707	Inactive			No birds observed or heard.
8	4/26/2018	Ground	0	720	Inactive			No birds observed or heard.
9	3/27/2018	Ground	12	903	Active	GRPC	Lek	Same location as 2016. 12 males 2 females on 3/28/2018

ID	Date	Survey Method	# Birds[1]	Time	Status	Species[2]	Type[3]	Comments
9	4/15/2018	Ground	9	831	Active	GRPC	Lek	Some birds displaying others loafing, moderate calling.
9	4/24/2018	Ground	10	750	Active	GRPC	Lek	active display although 20mph winds
9	4/27/2018	Ground	19	839	Active	GRPC	Lek	6 males displaying, 13 unknown total 19 birds
9	5/2/2018	Ground	10	2111	Active	GRPC	Lek	displaying and then 9 flew off.
10	3/27/2018	Ground	18	710	Active	GRPC	Lek	2016 GRPC lek, along fence. Out of project area so didn't gps on ground
10	4/16/2017	Ground	13	815	Active	GRPC	Lek	
10	4/26/2018	Ground	8	628	Active	GRPC	Lek	displaying 20 mph winds
10	5/2/2018	Ground	7	1829	Active	GRPC	Lek	displaying and then loafing
11	3/28/2018	Ground	0	811	Inactive			No birds observed or heard, scanned ridge. Another lek heard in general area.
11	4/15/2018	Ground	0	840	Inactive			No brides observed or heard at lek. Hearing GRPC in distance again.
11	4/16/2018	Ground	0		Inactive			No birds observed or heard.
11	4/26/2018	Air	0		Inactive			No birds observed during flight
11	5/4/2018	Air			Inactive			No birds observed during flight
12	3/28/2018	Ground	7	830	Active	GRPC	Lek	More by vocalizations but could not see. GPS on ground 3/29/2018.
12	4/15/2018	Ground	13	915	Active	GRPC	Lek	Some birds displaying some loafing. Also might be birds in wheat stubble to south.
12	4/24/2018	Ground	7	725	Active	GRPC	Lek	Windy all loafing not displaying
12	5/4/2018	Air	0	730	Inactive			Area around lek burned on WPA controlled burn
13	3/29/2018	Ground	5	802	Active	GRPC	Lek	In grassy area, out of project area didn't gps on ground.
13	4/16/2018	Ground	6	731	Active	GRPC	Lek	
13	4/26/2018	Ground	0	748	Inactive			
13	5/4/2018	Ground	4	1924	Active	GRPC	Lek	2 displaying other 2 loafing
14	3/28/2018	Ground	12	802	Active	GRPC	Lek	On ridge north of shed, gps on ground.
14	4/15/2018	Ground	7	756	Active	GRPC	Lek	Others heard to further east but could not observe
14	4/24/2018	Ground	3	820	Active	GRPC	Lek	Windy no display all loafing
14	5/3/2018	Ground	5	2005	Active	GRPC	Lek	All displaying
15	3/30/208	Ground	5	826	Active	GRPC	Lek	GPS on ground
15	4/15/2018	Ground	2	747	Active	GRPC	Lek	Only 2 loafing at lek, but 6 others observed closer to road and flushed.
15	4/17/2018	Ground	4	654	Active	GRPC	Lek	Back to main lek.
15	4/24/2018	Ground	5	828	Active	GRPC	Lek	Four males displaying, one hen.
15	5/3/2018	Ground	3	2020	Active	GRPC	Lek	3 males displaying, could be a 4th bird loafing
16	3/28/2018	Ground	7	830	Active	GRPC	Lek	Also confirmed on 3/30/2018, gps on ground
16	4/15/2018	Ground	10	708	Active	GRPC	Lek	At least 4 males displaying.
16	4/27/2018	Ground	3	650	Active	GRPC	Lek	2 males displaying, one unknown
16	5/16/2018	Ground	4	636	Active	GRPC	Lek	
17	3/30/2018	Ground	10	716	Active	GRPC	Lek	GPS on round in harvest bean field east of fence.

ID	Date	Survey Method	# Birds[1]	Time	Status	Species[2]	Type[3]	Comments
17	4/15/2018	Ground	8	728	Active	GRPC	Lek	Same location, most loafing.
17	4/25/2018	Air	5	740	Active	GRPC	Lek	Five birds observed during aerial survey.
17	5/3/2018	Ground	8	1949	Active	GRPC	Lek	Some walking others loafing
18	3/29/2018	Ground	10	730	Active	GRPC	Lek	GPS coordinates from ground.
18	4/26/2018	Ground	3	711	Active	GRPC	Lek	Displaying
18	5/2/2018	Ground	4	1911	Active	GRPC	Lek	4 males displaying
19	3/29/2018	Ground	6	715	Active	GRPC	Lek	On ridge to east of road, visible at intersection, didn't gps not in project
19	4/15/2018	Ground	6	950	Active	GRPC	Lek	1 displaying rest feeding in bare ground area.
19	4/16/2018	Ground	3	830	Active	GRPC	Lek	displaying
19	4/26/2018	Ground	0	655	Inactive			
19	5/4/2018	Air	3	834	Active	GRPC	Lek	Good observation of males, gps updated from air.
20	3/28/2019	Ground	8	718	Active	GRPC	Lek	Also confirmed on 3/30/2018. GPS coordinates from ground
20	4/17/2018	Ground	8	718	Active	GRPC	Lek	
20	4/24/2018	Ground	7	835	Active	GRPC	Lek	3 males displaying others either hens or juvenile males
20	5/3/2018	Air	7	750	Active	GRPC	Lek	good count of birds from air
21	3/28/2017	Ground	11	1115	Active	GRPC	Lek	Observed displaying when walking road. Landowner confirmed as a lek.
21	4/27/2018	Air	11	811	Active	GRPC	Lek	At least 11 flushed when flew over.
21	5/4/2018	Ground	0	2020	Inactive			No birds on lek at night, also no birds observed 5/5/2018 from air
22	3/30/2018	Ground	2	753	Active	GRPC	Lek	Two males fighting and displaying in wheat field.
22	4/15/2018	Ground	3	656	Active	GRPC	Lek	Three males displaying in wheat field.
22	4/24/2018	Ground	7	719	Active	GRPC	Lek	3 males in wheat field.
23	3/30/2018	Ground	2	740	Active	GRPC	Obs	One male and one female just off road in field.
23	4/15/2018	Ground	0	656	Inactive			No birds observed at this location.
23	4/24/2018	Ground	0	719	Inactive			No birds observed at this location.
24	4/15/2018	Ground	5	805	Active	GRPC	Lek	Near ponds by spoil/berm in short grassy area.
24	4/17/2018	Ground	3	658	Active	GRPC	Lek	windy conditions
24	4/24/2018	Ground	7	810	Active	GRPC	Lek	Windy some displaying others loafing
24	5/6/2018	Ground	4	830	Active	GRPC	Lek	
25	4/15/2018	Ground	9	1050	Active	GRPC	Lek	Out of project, 1/2 mile west of road on grassy ridge. Loafing late in morning.
25	4/16/2017	Ground	7	745	Active	GRPC	Lek	3 unknowns flew off, but at least 7 GRPC displaying
25	4/26/2018	Ground	0	806	Inactive			
25	5/3/2018	Ground	7	620	Active	GRPC	Lek	updated location based on position from southern road.
26	4/16/2018	Ground		555	Active	GRPC	Obs	200m east auditory, snow on road and no access to get visual
26	4/26/2018	Ground	0	806	Inactive			
26	5/5/2018	Air			Inactive			No birds observed in vicinity during flight. Also checked from ground on 5/4/2018 in evening
27	4/16/2018	Ground	7	623	Active	GRPC	Lek	on grassy ridge, gps coordinates from ground later in day
27	4/26/2018	Ground	0	735	Inactive			
27	5/5/2018	Air	2	649	Active	GRPC	Lek	2 birds observed on lek from air
28	4/16/2018	Ground	5	811	Active	GRPC	Obs	~800m west /southwest from grain bin, birds observed, but went in on ground 4/17/2018 could not pinpoint lekking area. Same area birds heard before but cannot locate consistently.
28	4/26/2018	Air	0		Inactive			No birds observed or flushed.
28	5/4/2018	Air	0		Inactive			No birds observed or flushed.

ID	Date	Survey Method	# Birds[1]	Time	Status	Species[2]	Type[3]	Comments
29	4/16/2018	Ground	3	834	Active	GRPC	Lek	One male displaying, 2 others loafing on snow. West of stock tank. Out of project no ground access.
29	4/24/2018	Ground	3	707	Active	GRPC	Lek	On grassy ridge west of tanks, could have been more loafing.
29	5/2/2018	Ground	4	2010	Active	GRPC	Lek	4 males displaying
30	4/17/2017	Ground	4	825	Active	STGR	Obs	40m west of road in grass
30	4/27/2018	Ground	0	745	Inactive			No birds observed
30	5/6/2018	Ground	0	755	Inactive			No birds observed or heard
31	4/17/2018	Ground	2	845	Active	GRPC	Obs	One male displaying for hen. Not likely a lek.
31	4/27/2018	Ground	0	816	Inactive			No birds observed
31	5/2/2018	Ground	0	2049	Inactive			No birds observed
32	4/17/2018	Ground	2	850	Inactive	STGR	Obs	No displaying but birds observed on ridge in grass walking.
32	4/27/2018	Ground	0	816	Inactive			No birds observed or heard
32	5/2/2018	Ground	0	2049	Inactive			No birds observed or heard
33	4/24/2018	Ground	7	851	Active	GRPC	Lek	Males displaying and fighting on grassy area. gps from fence where access. Can see from ridge to northwest.
33	5/3/2018	Ground	3	2040	Active	GRPC	Lek	Birds walking around, not displaying
33	5/6/2018	Ground	3	550	Active	GRPC	Lek	
34	4/24/2018	Ground	4	624	Active	GRPC	Lek	4 males, gps ground, landowner said has been active 5-7 years. In grass
34	5/5/2018	Ground	4	1900	Active	GRPC	Lek	Two males displaying, two loafing.
35	4/23/2018	Air	2			GRPC	Obs	checked on ground no birds.
36	4/25/2018	Air	12	821	Active	GRPC	Lek	gps ground later in day
36	4/26/2018	Ground	15	627	Active	GRPC	Lek	14 males displaying, 1 unknown
36	5/3/2018	Air	12	753	Active	GRPC	Lek	
36	5/5/2018	Ground	14	613	Active	GRPC	Lek	14 males displaying
37	4/25/2018	Ground	10	755	Active	GRPC	Lek	~200m north of road, plane affected display
37	4/26/2018	Ground	11	609	Active	GRPC	Lek	Males displaying and calling
37	5/5/2018	Ground	9	550	Active	GRPC	Lek	Males displaying and calling
38	4/25/2018	Air	1	723	Active	GRPC	Obs	1 male displaying on stock dam
39	4/25/2018	Air	1	739		UNK	Obs	1 unknown grouse flushed
40	4/25/2018	Air	1	801		UNK	Obs	2 unknown grouse flushed
41	4/23/2018	Air	1	815		UNK	Obs	1 unknown grouse flushed
42	5/2/2018	Ground	10	2040	Active	GRPC	Lek	Males displaying in pdog town can also see from section road to south.
42	5/6/2018	Ground	8	808	Active	GRPC	Lek	Obs from section road to the south.
43	4/26/2018	Air	2	727		GRPC	Obs	2 birds flushed, no lek
44	4/26/2018	Air	2	741		UNK	Obs	2 unknown flushed no lek
45	4/26/2018	Air	2	833		GRPC	Obs	2 bids flushed from grass, no lek
46	4/26/2018	Ground	3	638	Active	GRPC	Obs	Birds displaying in grass field, not on ridge in flat area
46	5/2/2018	Ground	1	1840	Active	GRPC	Obs	one male displaying and loafing
47	4/27/2018	Air	5	742	Active	GRPC	Lek	flushed on ridge by pond, re-check from ground
47	5/3/2018	Ground	0	605	Inactive	GRPC		auditory, cows in pasture, possibly obs 3 GRPC but could not re-locate
47	5/4/2018	Ground	4	611	Active	GRPC	Lek	Observed birds displaying. Fairly accurate coordinates out of project
48	4/27/2018	Air	5	829	Active	GRPC	Obs	Observed during flight, out of project cannot ground verify
48	5/5/2018	Air	0		Inactive			No birds observed, possibly one on ground during a pass but nothing visible or flushed

ID	Date	Survey Method	# Birds[1]	Time	Status	Species[2]	Type[3]	Comments
49	4/27/2018	Air	2	735		GRPC	Obs	2 birds in draw, no lek
50	4/27/2018	Air	2	806		GRPC	Obs	2 birds in crop field, no lek
51	5/2/2018	Air	1	709		GRPC	Obs	single bird flushed, no lek
52	5/2/2018	Air	3	749	Active	GRPC	Lek	south of fence, out of project cannot ground verify.
52	5/6/2018	Ground	3	656	Active	GRPC	Lek	Observed from road south of the draw
53	5/3/2018	Air	2	648		STGR	Obs	flushed from fence, fairly positive id
54	5/3/2018	Air	5	656	Active	GRPC	Lek	south of reservoir on grassy ridge, did not have access to ground gps, but looked from fence line and fairly accurate
54	5/6/2018	Ground	5	717	Active	GRPC	Lek	clearly visible from road to south
55	5/3/2018	Air	20	710	Active	GRPC	Lek	Ground gps, lots of sign, in pdog, burrowing owl present
55	5/6/2018	Ground	8	729	Active	GRPC	Lek	Cannot see entire lek from road, spray plane also flying overhead
56	5/3/2018	Air	15	733	Active	GRPC	Lek	Ground gps, unlikely anyway to get counts from ground, lots of sign
57	5/3/2018	Air	4	811	Active	STGR	Lek	Ground gps, sign present, need to verify spp from ground
57	5/5/2018	Ground	1	605	Active	STGR	Lek	One grouse observed, other grouse heard, not sure if GRPC or STGR.
57	5/6/2018	Ground	6	819	Active	STGR	Lek	Birds flushed and positive ID of STGR
58	5/4/2018	Air	15	640	Active	GRPC	Lek	Out of project and 1 mile buffer
59	5/4/2018	Air	14	732	Active	GRPC	Lek	In Cowan WPA ground verified
60	5/4/2018	Air	2	744		GRPC	Obs	Flushed from wheat, not a lek but in area where birds observed before
61	5/4/2018	Air	3	800		GRPC	Lek	In grass, not sure if lek, need to ground verify
61	5/5/2018	Ground	4	1907	Active	GRPC	Lek	2 birds calling and displaying 2 others fly in while walking to lek. Ground sign indicative of a lek.
62	5/4/2018	Air	1	834		GRPC	Obs	Not a lek, single male on hill
63	5/5/2018	Ground	10	630	Active	GRPC	Lek	In crop field, gps from road to east
63	5/6/2018	Ground	7	602	Active	GRPC	Lek	Gps from road to east
64	5/6/2018	Ground	1	708		GRPC	Obs	One male observed, others heard but could not located
65	5/6/2018	Ground	2	717		GRPC	Obs	One male, one hen
66	3/28/2017	Ground	1	750		STGR	Obs	1 bird flushed from road
67	3/28/2018	Ground	2	800		GRPC	Obs	2 birds flushed from road
68	3/27/2018	Ground	7	900		STGR	Obs	7 birds flushed from road, re-checked several times no lek

[1] # Birds - Total number of birds observed on leks or during incidental observations regardless of sex.
[2] Species - GRPC = greater prairie-chicken; STGR = sharp-tailed grouse, UNK = unknown species
[3] Type – Lek = at least 2 males observed displaying during observation; Obs = Observation of prairie grouse where breeding activity was not confirmed during the observation.

Appendix K. Bat Activity Studies for the Triple H Wind Project, Hughes and Hyde Counties, South Dakota – Final Report May 26 – October 21, 2016

Bat Activity Studies for the Triple H Wind Project Hughes and Hyde Counties, South Dakota

Final Report

May 26 – October 21, 2016

Prepared for:

Triple H Wind Project, LLC

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Prepared by:

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February 6, 2017

Draft Pre-Decisional Document - Privileged and Confidential - Not For Distribution

EXECUTIVE SUMMARY

In May 2016, Western EcoSystems Technology, Inc. initiated a bat acoustic survey for the proposed Triple H Wind Project (Project) in Hughes and Hyde counties, South Dakota. The bat acoustic survey conducted at the Project was designed to estimate levels of bat activity throughout the project during summer and fall.

Acoustic surveys were conducted at four ground stations located in grassland or cropland habitat near features that could be attractive to bats (e.g., along hedge rows, deciduous trees, near ponds, etc.) from May 26 through October 21, 2016. The four monitoring stations used AnaBat SD2 ultrasonic detectors placed 1.5 meters (4.9 feet) above the ground to minimize insect noise. Station locations were selected to provide spatial coverage throughout the Project.

The AnaBat units recorded 1,663 bat passes during 291 detector-nights. All units recorded a combined mean (± standard error) of 5.64 ± 1.61 bat passes per detector-night. For all stations, 57.7% of bat passes were classified as high-frequency (HF; e.g., eastern red bats, and little brown bats), while 42.3% of bat passes were classified as low-frequency (LF; e.g., big brown bats, hoary bats, and silver-haired bats).

Bat activity varied between seasons, with lower activity in the summer and higher activity in fall. At these stations, LF and HF bat pass rates peaked during the first part September. Higher activity during the late summer and early fall may be due to the presence of migrating bats passing through the area.

Bat activity recorded at the Project by ground detectors during the standardized Fall Migration Period (July 30 – October 14; 9.08 ± 3.23 bat passes per detector-night) was similar to activity observed at publicly available and comparable studies at facilities in the Midwest, and the Project is expected to experience similar fatality rates to these other Midwestern facilities.

STUDY PARTICIPANTS

Western EcoSystems Technology

Brian Heath	Project Manager
Chris Fritchman	Field Supervisor
Donald Solick	Bat Biologist
Kristina Hammond	Bat Biologist/Bat Data Analyst
Carmen Boyd	Data and Report Manager
Matt Kwit	Statistician
Jon Cicarelli	GIS Technician
Kristina Hammond	Report Compiler
Andrea Palochak	Technical Editor
Carissa Goodman	Technical Editor
Brenda Jarski-Weber	Field Technician

REPORT REFERENCE

Heath, B., K. Hammond, and D. Solick. 2016. Bat Activity Studies for the Triple H Wind Project, Hughes and Hyde Counties, South Dakota. Final Report: May 26 – October 21, 2016. Prepared for Triple H Wind Project, LLC, Santa Barbara, California. Prepared by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming. February 6, 2017.

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This study was funded by Triple H Wind Project. We especially than Brenda Jarski-Weber for collecting field data for this project. We also appreciate the cooperation of landowners for allowing access to their lands for study purposes.

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INTRODUCTION

Triple H Wind Project, LLC is considering the development of the Triple H Wind Project (Project) in Hughes and Hyde counties, South Dakota. Triple H Wind Project, LLC contracted Western EcoSystems Technology, Inc. (WEST) to complete a study of bat activity following the recommendations of the US Fish and Wildlife Service's (USFWS) *Land-Based Wind Energy Guidelines* (USFWS 2012a) and Kunz et al. (2007a). WEST conducted acoustic monitoring surveys to estimate levels of bat activity throughout the Project during the summer and fall. The following report describes the results of acoustic monitoring surveys conducted at the Project between May 26 and October 21, 2016.

STUDY AREA

The proposed 39,069-acre (ac; 15,811-hectare [ha]) Project is located in central South Dakota and is situated northeast of the Missouri River (Figure 1). According to the US Geological Survey (USGS) National Land Cover Dataset (NLCD; USGS NLCD 2011; Homer et al. 2015), the Project is dominated by herbaceous plants (25,312 ac [10,243 ha; 64.8%]) and cultivated crops (12,373 ac [5,007 ha; 31.7%]; Figure 2, Table 1). Developed areas compose approximately 834 ac (341 ha; 2.1%) of the Project. The Project contains approximately 83 ac (34 ha; 0.2%) of emergent herbaceous wetlands, but only 1.44 ac (0.58 ha; less than 0.1%) of deciduous forest habitat (Table 1). Both emergent herbaceous wetlands and deciduous forest provide potential habitat for several bat species, including the federally threatened northern long-eared bat (*Myotis septentrionalis*; USFWS 2015a). The remainder of the Project is composed of approximately 266 ac (108 ha; 0.7%) of open water, 125 ac (51 ha; 0.3%) of pasture and hay fields, and 18 ac (7.2 ha; less than 0.1%) of barren land (Figure 2, Table 1).

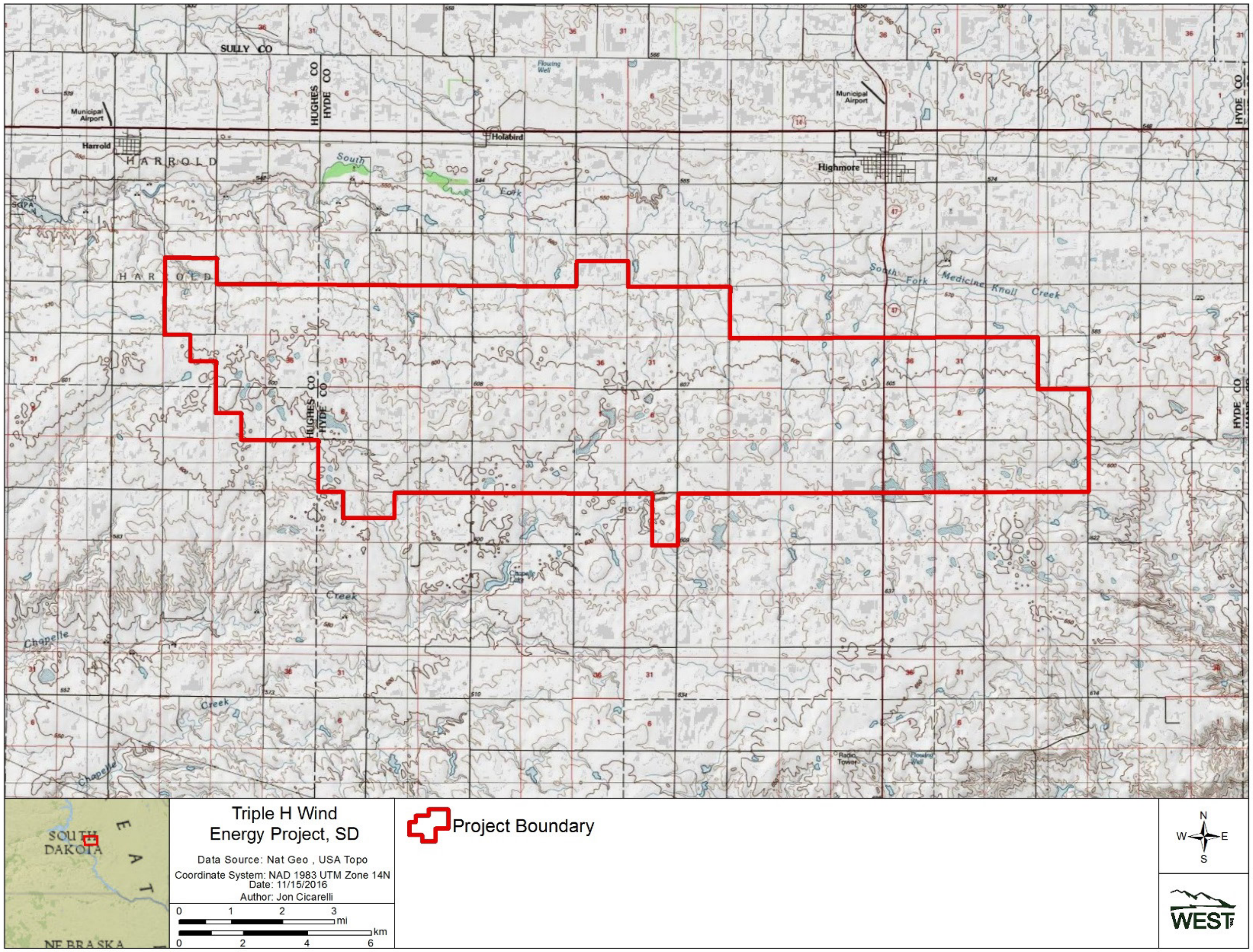

Figure 1. Topographic map showing the location of the Triple H Wind Project.

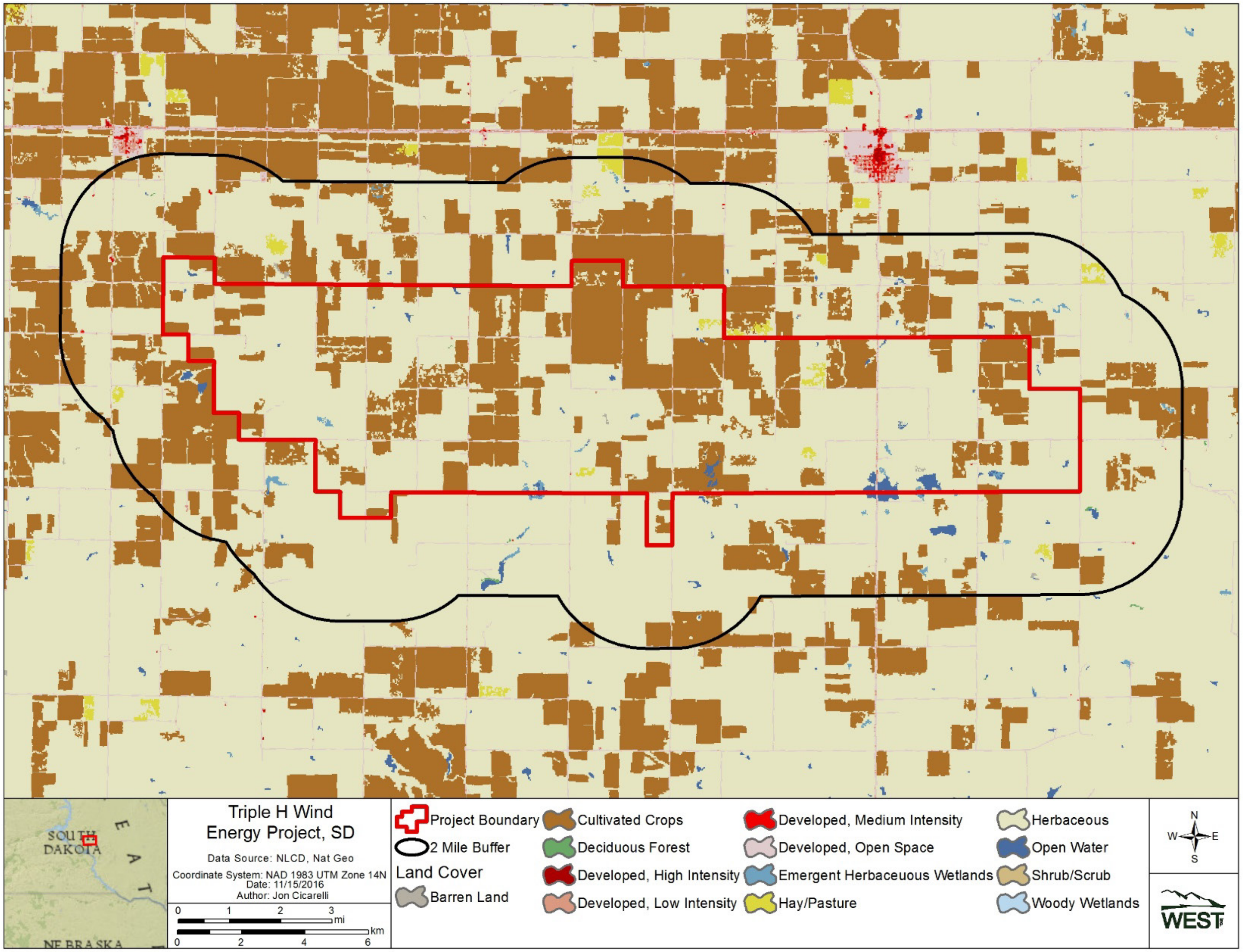

Figure 2. Land cover in the Triple H Wind Project (US Geological Survey National Land Cover Database [USGS] 2011, Homer et al. 2015).

Table 1. Land cover in the Triple Wind Project according to the United States Geological Survey (USGS) National Land Cover Dataset (NLCD; USGS NLCD 2011, Homer et al. 2015).

Land Cover	Acres	% Composition
Herbaceous	25,312.31	64.8
Cultivated Crops	12,373.00	31.7
Developed, Open Space	826.81	2.1
Open Water	265.92	0.7
Hay/Pasture	125.26	0.3
Emergent Herbaceous Wetlands	82.53	0.2
Developed, Low Intensity	58.28	0.1
Barren Land	17.63	<0.1
Developed, Medium Intensity	5.71	<0.1
Deciduous Forest	1.44	<0.1
Total	**39,068.90**	**100**

Overview of Bat Diversity

Seven species of bats potentially occur at the Project (Table 2). The northern long-eared bat is listed as a federally threatened species (USFWS 2015b). The range of the northern long-eared bat is considered to be across all of South Dakota, including Hughes and Hyde counties. Due to the relatively low presence of water and deciduous forest, it is unlikely the Project would be an area of high use by the northern long-eared bat. The Project is outside of the White-Nose Syndrome (WNS) Zone per the Final 4(d) Rule (USFWS 2016a), and therefore presence/probable absence surveys were not performed.

Table 2. Bat species with potential to occur within the Triple H Wind Project (International Union for Conservation of Nature [IUCN] 2016, US Fish and Wildlife Service [USFWS] 2016d) categorized by echolocation call frequency.

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

[1] species known to have been killed at wind energy facilities (Kunz et al. 2007b);
[2] federally threatened species (USFWS 2015b); and
[3] long-distance migrant.

White-Nose Syndrome

Bats that hibernate in North America are being severely impacted by WNS, an infectious mycosis in which bats are infected with a psychrophilic fungus from Europe (*Pseudogymnoascus* [formerly *Geomyces*] *destructans*) that is thought to act as a chronic disturbance during hibernation (USGS 2010, Minnis and Lindner 2013). Infected bats arouse frequently from hibernation, leading to premature loss of fat reserves and atypical behavior, which in turn leads to starvation prior to spring emergence (Boyles and Willis 2010, Reeder et al. 2012, Warnecke et al. 2012). WNS was first discovered in New York State in 2006 (Frick et al. 2010, USFWS 2011) and by 2010 had rapidly spread to over 115 caves and mines (Frick et al. 2010); WNS is now confirmed in 29 states and the causative fungus has been identified in an additional three states (White-Nose Syndrome.org 2016). To date, the WNS infection in bats has spread north into five Canadian provinces, reaching as far south as Alabama and as far west as Washington (Heffernan 2016). Currently WNS has not been found in South Dakota and only 12 of the counties in the southeast part of the state are included in the WNS Zone per the Final 4(d) Rule (USFWS 2016a, 2016c). It is estimated that between 5.7 and 6.7 million bats have died as a result of WNS (USFWS 2012b). WNS is the primary reason the USFWS recently listed the northern long-eared bat as threatened under the Endangered Species Act (USFWS 2015b), and the USFWS is currently reviewing the status of the little brown bat (*Myotis lucifugus*; USFWS 2013, 2016b).

METHODS

Bat Acoustic Surveys

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

Survey Stations

Four AnaBat™ SD2 ultrasonic bat detectors (Titley Scientific™, Columbia, Missouri) were used during the study. Detectors were placed at four fixed survey locations and were placed at 1.5 meters (m; 4.9 feet [ft]) above ground level (Figure 3). Species activity levels and composition can vary with altitude (Barclay et al. 2007, Baerwald and Barclay 2009, Collins and Jones 2009, Müeller et al. 2013). All stations were located in grassland or cropland habitat near features that could be attractive to bats (i.e., “bat features”), such as deciduous forest or water, and were spatially distributed throughout the Project area.

Each AnaBat unit was inside a plastic weather-tight container that had a hole cut in the side through which the microphone extended. Each microphone was encased in a 45-degree angle poly-vinyl chloride (PVC) tube, and holes were drilled in the PVC tube to allow water to drain.

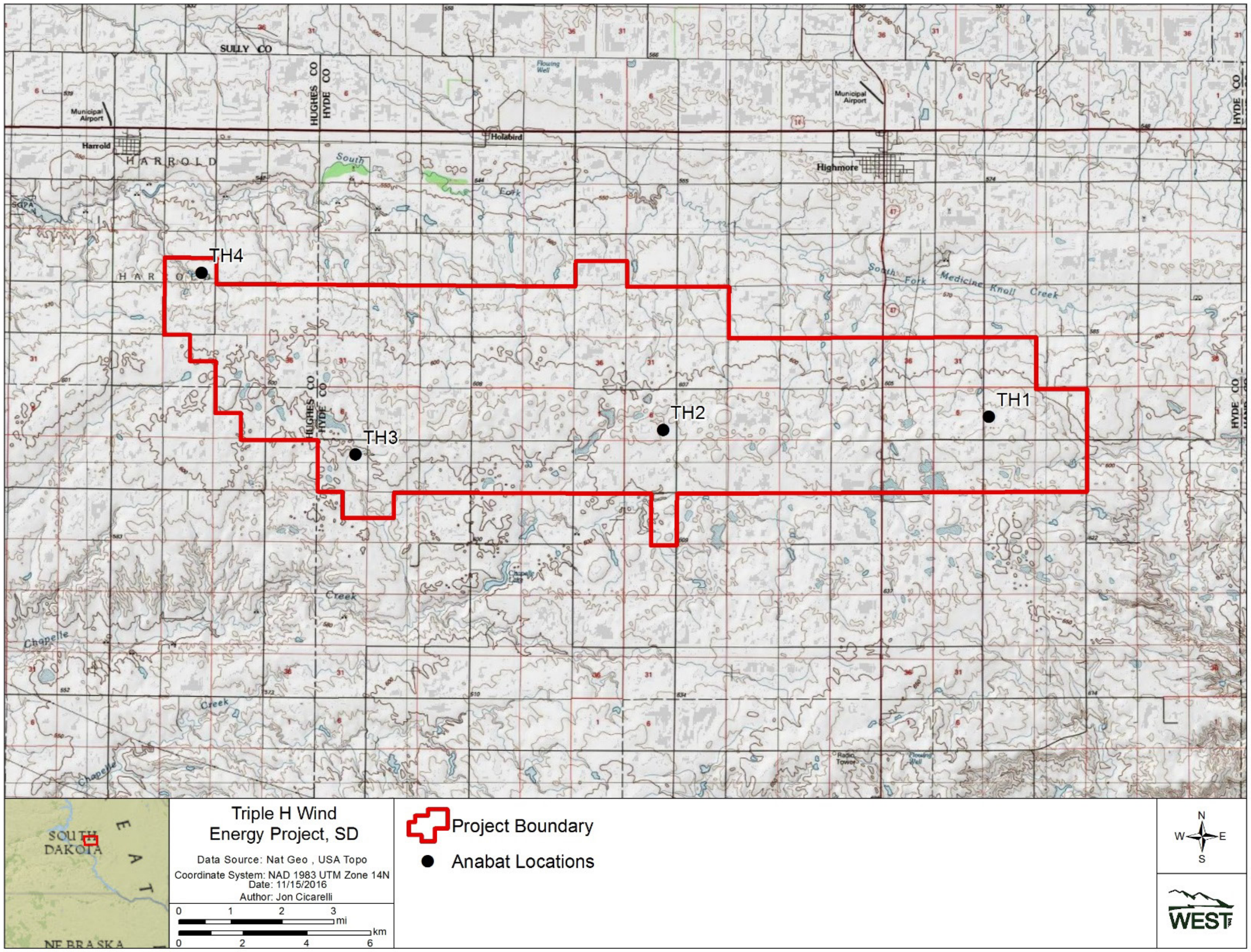

Figure 3. Location of fixed AnaBat stations in the Triple H Wind Project.

Survey Schedule

Bats were surveyed in the Project from May 26 to October 21, 2016, and detectors were programmed to turn on approximately 30 minutes before sunset and turn off approximately 30 min after sunrise each night. To highlight seasonal activity patterns, the study was divided into two survey periods: summer (May 26 – August 15) and fall (August 16 – October 21). Mean bat activity was also calculated for a standardized Fall Migration Period (FMP), defined here as July 30 – October 14. The FMP was defined by WEST as a standard for comparison with activity from other wind energy facilities. During this time bats begin moving toward wintering areas, and many species of bats initiate reproductive behaviors (Cryan 2008). This period of increased landscape-scale movement and reproductive behavior is often associated with increased levels of bat fatalities at operational wind energy facilities (Arnett et al. 2008, Arnett and Baerwald 2013).

Data Collection and Call Analysis

AnaBat detectors use a broadband high-frequency microphone to detect the echolocation calls of bats. Incoming echolocation calls are digitally processed and stored on a high-capacity compact flash card. The resulting files can be viewed in appropriate software (e.g., Analook© [2004]) as digital sonograms that show changes in echolocation call frequency over time. Frequency versus time displays were used to separate bat calls from other types of ultrasonic noise (e.g., wind, insects, etc.) and to determine the call frequency category and (when possible) the species of bat that generated the calls.

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

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

Statistical Analysis

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

The period of peak sustained bat activity was defined as the 7-day period with the highest average bat activity. If multiple 7-day periods equaled the peak sustained bat activity rate, all dates in these 7-day periods were reported. This and all multi-detector averages in this report were calculated as an unweighted average of total activity at each detector.

Risk Assessment

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

RESULTS

Bat Acoustic Surveys

Bat activity was monitored at four sampling locations for a total of 291 detector-nights between May 26 and October 21, 2016. AnaBat units were operating for 50.2% of the sampling period (Figure 4). The primary cause of lost data was battery failures, and excessive insect noise in the fall may also have contributed to lost nights of data collection due to filling the compact flash cards or by blocking bat calls. AnaBat units at the fixed ground stations recorded 1,663 bat passes on 291 detector-nights for a mean (± standard error) of 5.64 ± 1.61 bat passes per detector-night (Table 3).

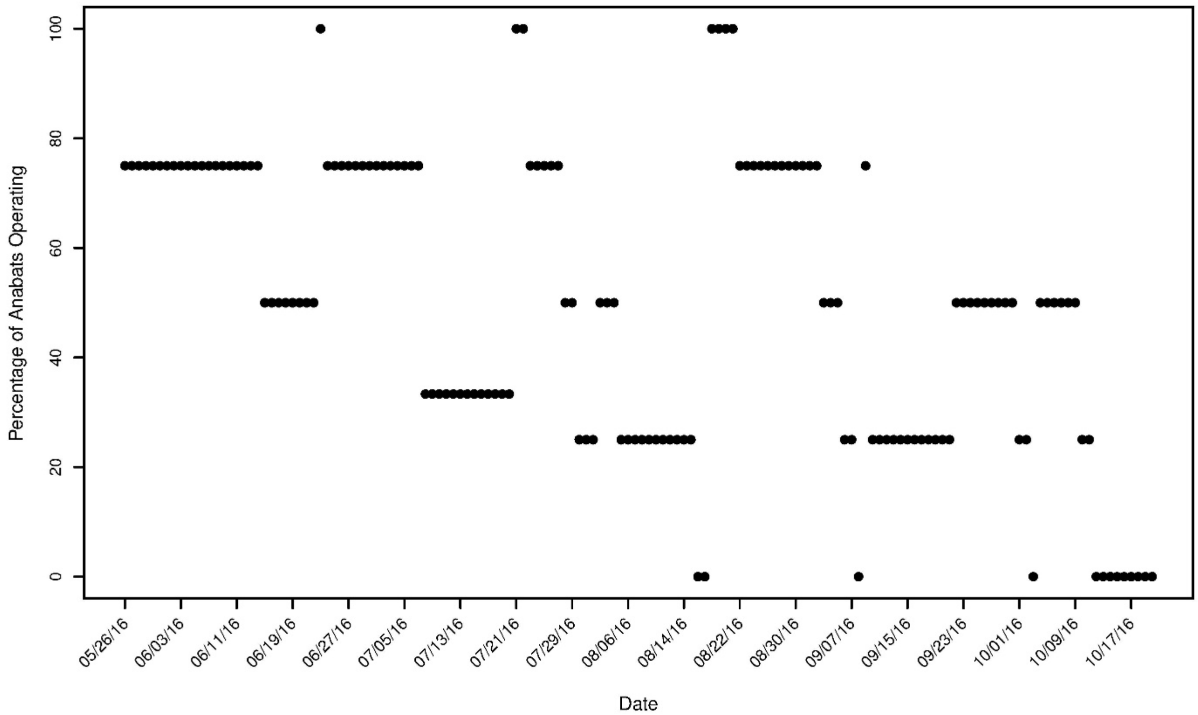

Figure 4. Operational status of bat detectors (n = 4) operating at the Triple H Wind Project during each night of the study period May 26 to October 21, 2016.

Table 3. Results of acoustic bat surveys conducted at fixed stations within the Triple H Wind Project from May 26 to October 21, 2016. Passes are separated by call frequency: high frequency (HF) and low frequency (LF).

AnaBat Station	# of HF Bat Passes	# of LF Bat Passes	Total Bat Passes	Detector-Nights	Bat Passes/ Night***
TH1	540	461	999	84	11.89 ± 3.00
TH2	244	95	339	51	6.65 ± 3.55
TH3	128	95	223	95	2.35 ± 0.37
TH4	49	53	102	61	1.67 ± 0.44
Total	**961**	**704**	**1663**	**291**	**5.64 ± 1.61**

*** ± bootstrapped standard error.

Spatial Variation

Bat activity in the Project was consistently higher at the TH1 and TH2 ground units compared to units TH3 and TH4 (Figure 5, Table 3). Units TH4 and TH3 recorded the fewest bat passes per detector-night (1.67 ± 0.44 and 2.35 ± 0.37 bat calls, respectively); unit TH2 recorded the second highest number of bat passes per detector-night (6.65 ± 3.55), while unit TH1 recorded the most (11.89 ± 3.00; Table 3).

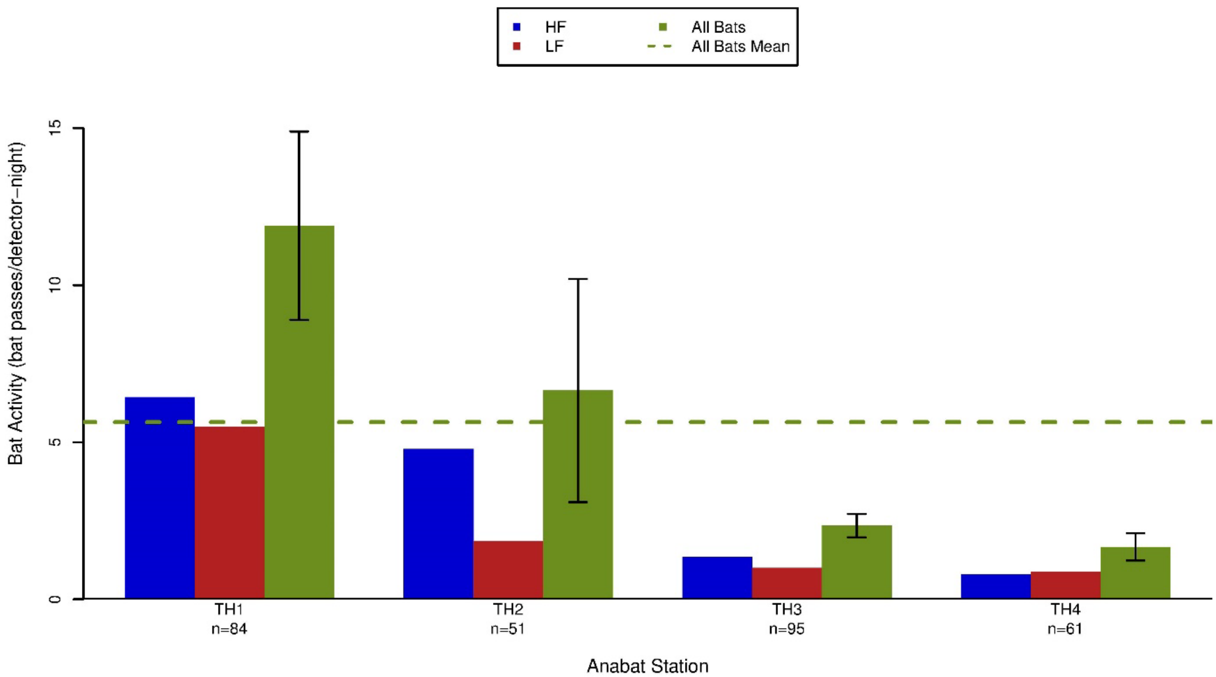

Figure 5. Number of high-frequency (HF) and low-frequency (LF) bat passes per detector-night recorded at AnaBat stations in the Triple H Wind Project between May 26 to October 21, 2016. The bootstrapped standard errors are represented by the black error bars on the 'All Bats' columns.

Temporal Variation

Bat activity at fixed stations was relatively low in the summer and increased in the fall (Table 4, Figure 6). Weekly acoustic activity was relatively low from May through July (Figure 7), peaking from September 2 to September 8 (31.61 bat passes per detector-night; Table 5; Figure 7). Overall bat activity decreased again in late September through the remainder of the study period (Figure 7).

Species Composition

At fixed stations, 42.3% of bat passes were classified as LF (e.g., big brown bats, hoary bats, and silver-haired bats), and 57.7% of bat passes were classified as HF (e.g., eastern red bats and *Myotis* species; Tables 2 and 3).

Table 4. The number of bat passes per detector-night recorded at ground stations in the Triple H Wind Project during each season in 2016, separated by call frequency: high-frequency (HF), low-frequency (LF), and all bats (AB).

Station	Call Frequency	Summer May 26 – Aug 15	Fall Aug 16 – Oct 21	Fall Migration Period July 30 – Oct 14
TH1	LF	3.56	7.33	7.07
	HF	4.41	8.35	8.67
	AB	7.98	15.63	15.7
TH2	LF	1.07	3	3
	HF	1.2	9.9	9.9
	AB	2.27	12.9	12.9
TH3	LF	0.92	1.16	1.16
	HF	0.51	3	3
	AB	1.43	4.16	4.16
TH4	LF	0.88	0.85	0.75
	HF	0.42	2.23	2.81
	AB	1.29	3.08	3.56
Overall	**LF**	**1.61 ± 0.28**	**3.08 ± 1.09**	**2.99 ± 0.98**
	HF	**1.63 ± 0.45**	**5.87 ± 2.34**	**6.10 ± 2.32**
	AB	**3.24 ± 0.60**	**8.94 ± 3.38**	**9.08 ± 3.23**

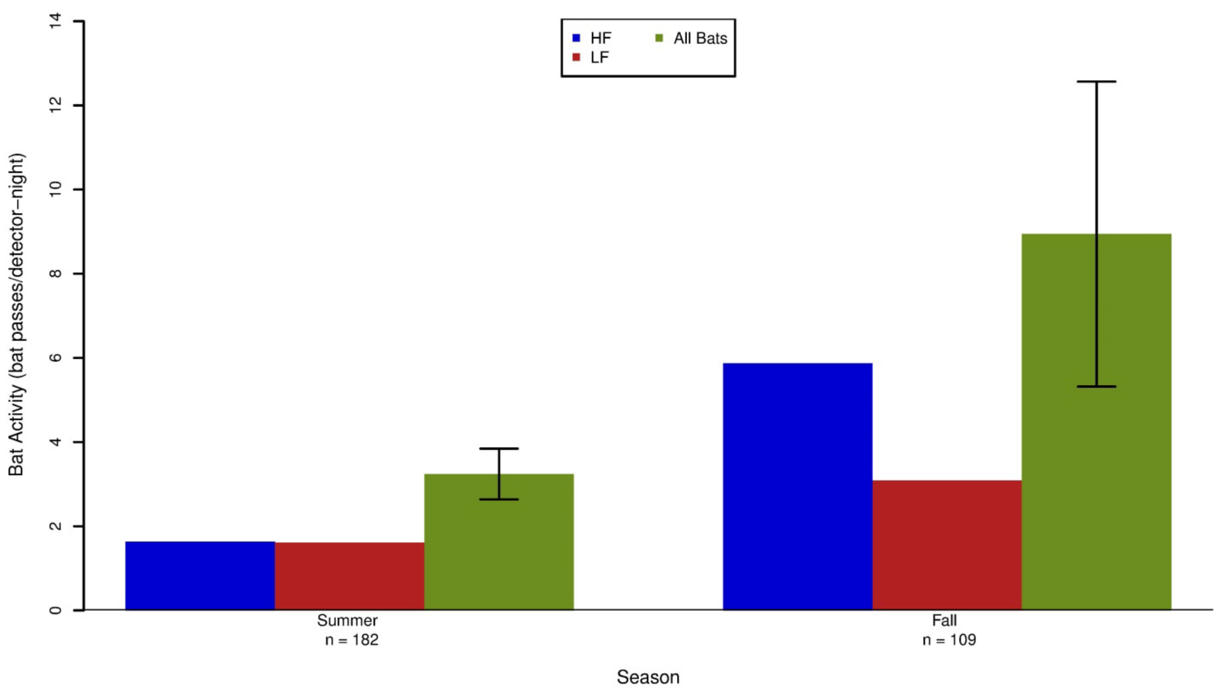

Figure 6. Seasonal bat activity by high-frequency (HF), low-frequency (LF), and all bats at the Triple H Wind Project from May 26 to October 21, 2016. The bootstrapped standard errors are represented on the 'All Bats' columns.

Table 5. Periods of peak activity for high-frequency (HF), low-frequency (LF), and all bats at the Triple H Wind Project for the study period May 26 – October 21, 2016.

Species Group	Start Date of Peak Activity	End Date of Peak Activity	Bat Passes per Detector-Night
HF	9/16/16	9/22/16	20.43
LF	9/5/16	9/11/16	12.17
All Bats	9/2/16	9/8/16	31.61

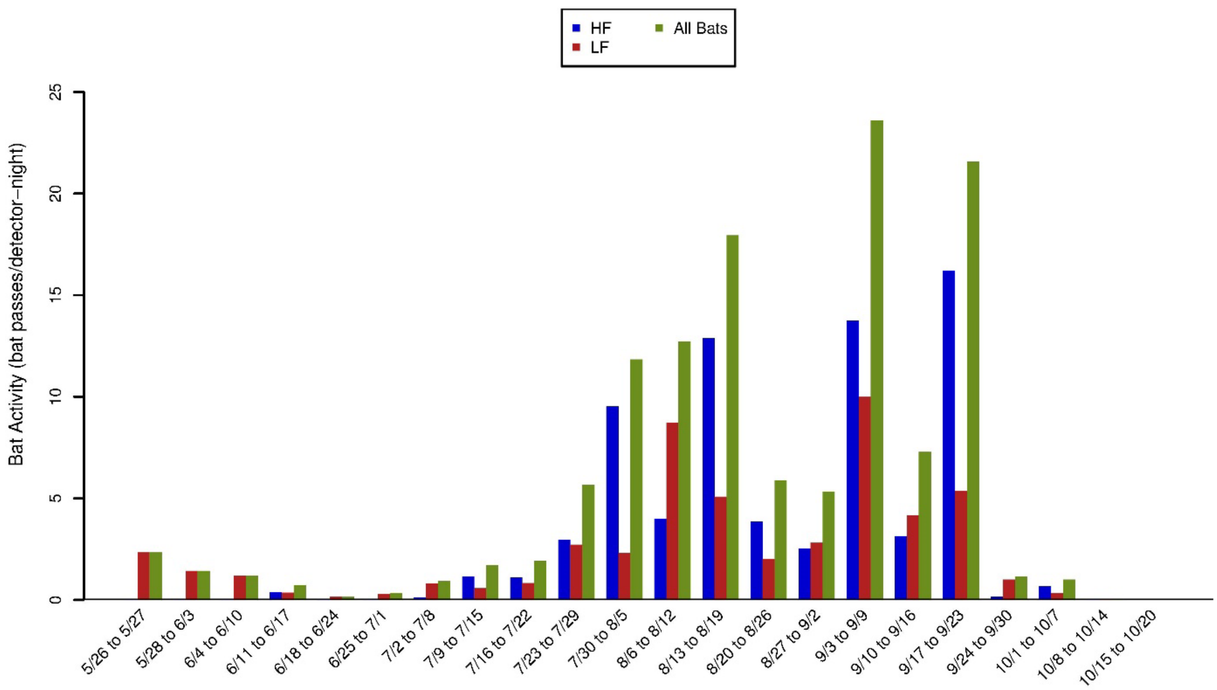

Figure 7. Weekly patterns of bat activity by high-frequency (HF), low-frequency (LF), and all bats at the Triple H Wind Project for the study period May 26 to October 21, 2016.

DISCUSSION

Bat fatalities have been discovered at most wind energy facilities monitored in North America, ranging from zero (Chatfield and Bay 2014) to 40.2 bat fatalities per megawatt (MW) per year (Hein et al. 2013b; Appendix A). In 2012, an estimated 600,000 bats died as a result of interactions with wind turbines in the US (Hayes 2013). Proximate causes of bat fatalities are primarily due to collisions with moving turbine blades (Grodsky et al. 2011,Rollins et al. 2012), but to a limited extent may also be caused by barotrauma (Baerwald et al. 2008). The underlying reasons for why bats come near turbines are still largely unknown (Cryan and Barclay 2009). To date, post-construction monitoring studies of wind energy facilities show that a) migratory tree-roosting species (e.g., eastern red bat, hoary, and silver-haired bat) compose approximately 78% of reported bat fatalities; b) the majority of fatalities occur during the fall migration season (August and September); and c) most fatalities occur on nights with relatively low wind speeds (e.g., less than 6.0 m per second [m/s; 19.7 ft/s]; Arnett et al. 2008, 2013; Arnett and Baerwald 2013).

It is generally expected that pre-construction bat activity is positively related to post-construction bat fatalities (Kunz et al. 2007b). However, to date, few studies of wind energy facilities have recorded both bat passes per detector-night and bat fatality rates are publicly available (Appendix A). Given the limited availability of pre- and post-construction data sets, differences in protocols among studies (Ellison 2012), and significant ecological differences between geographically diverse facilities, the relationship between activity and fatalities has not yet been empirically established, though Baerwald and Barclay (2009) found a significant positive association between bat pass rates measured at 30 m (98 ft) above the ground and fatality rates for hoary and silver-haired bats across five sites in southern Alberta.

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

Activity by HF bat species composed 57.7% of bat passes recorded at stations in the Project. Eastern red bats are usually the most common HF species found during carcass searches (Arnett et al. 2008, Arnett and Baerwald 2013). *Myotis* species are recorded less commonly than other species in the rotor-swept zone or as fatalities at most post-construction studies of wind energy facilities (Kunz et al. 2007b, Arnett et al. 2008), with a few notable exceptions (Kerns and Kerlinger 2004, Jain 2005, Brown and Hamilton 2006a, Gruver et al. 2009). Approximately 42.3% of bat passes recorded in the Project were emitted by LF bats (Table 3). These LF species may become casualties because they typically fly at higher altitudes (Aldridge and Rautenbach 1987, Norberg and Rayner 1987, Fenton and Bogdanowicz 2002). Given that hoary bats, eastern red bats, and silver-haired bats are among the most commonly found bat fatalities at many facilities (Arnett et al. 2008,, Arnett and Baerwald 2013), it is expected that these three species would likely be the most common fatalities at the Project.

Mean bat activity during the FMP at the fixed ground detectors (9.08 ± 3.23 bat passes per detector-night; Table 4) was about average for the majority of studies available from the Midwest (Appendix A). Based on available studies in the Midwest, observed bat activity rates may be indicative of fatality rates ranging from 0.16 to 30.61 bats/MW/year, and the Project is expected to have a low to moderate fatality rate. Overall bat activity was highest within the

Project during the FMP, peaking in early September. This timing is consistent with peak fatality periods for most wind energy facilities in the US, and suggests that bat fatalities at the Project will be highest during late summer to early fall, and may consist largely of migrating individuals.

Given that over two-thirds of bat fatality studies in the Midwest report fewer than five bat fatalities/MW/year (Appendix A; Figure 8), it is possible that similar fatality rates could be recorded at the Project. However, some studies indicate that facilities in agricultural settings in the Midwest can produce higher levels of bat fatalities (Jain 2005, Baerwald 2008, Gruver et al. 2009). The closest operating wind-energy facility to the Project with public post-construction fatality data is the PrairieWinds SD1 facility, located approximately 78.1 kilometers (48.5 miles) from the Project. Both the PrairieWinds SD1 facility and the Project are located in landscapes consisting mostly of grasslands and croplands, with little topography and few woodlots. No publicly available pre-construction bat activity estimates from ground based detectors are available for the PrairieWinds SD1 facility. The fatality estimates reported at PrairieWinds SD1 range from 1.05-1.39 bats/MW/year (Derby et al. 2012d, 2013a). The pre-construction bat studies completed at the Project will add to the growing body of research regarding the impacts of wind energy development on bats and will provide a valuable comparison to post-construction studies to be completed at Project.

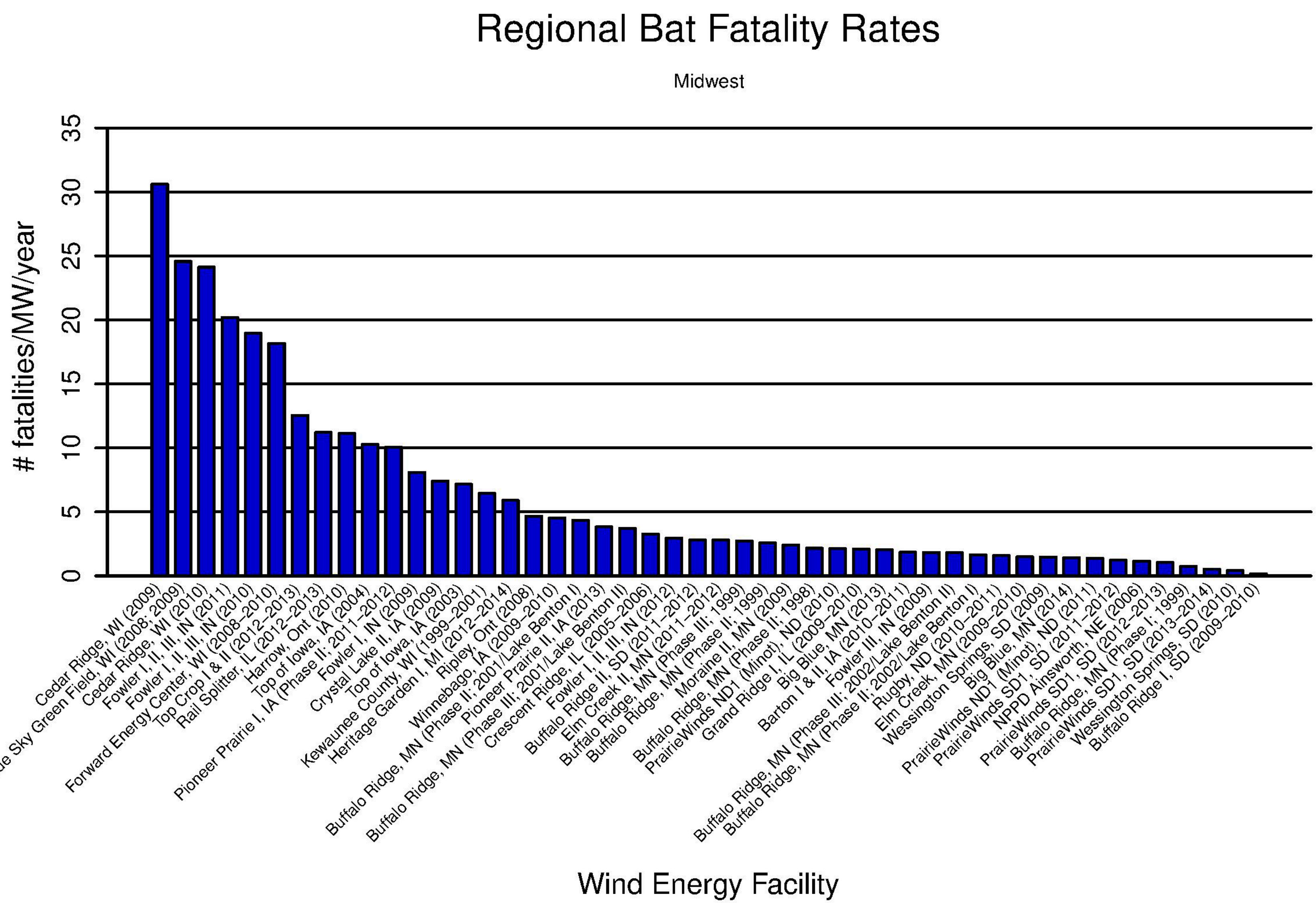

Figure 8. Fatality rates for bats (number of bats per megawatt per year) from publicly available studies at wind energy facilities in the Midwest.

Figure 8 (*continued*). Fatality rates for bats (number of bats per megawatt per year) from publicly available studies at wind energy facilities in the Midwest.

Data from the following sources:

Facility, Location	Reference	Facility, Location	Reference	Facility, Location	Reference
Cedar Ridge, WI (09)	BHE Environmental 2010	Ripley, Ont (08)	Jacques Whitford 2009	Barton I & II, IA (10-11)	Derby et al. 2011a
Blue Sky Green Field, WI (08; 09)	Gruver et al. 2009	Winnebago, IA (09-10)	Derby et al. 2010e	Fowler III, IN (09)	Johnson et al. 2010b
Cedar Ridge, WI (10)	BHE Environmental 2011	Buffalo Ridge, MN (Phase II; 01/Lake Benton I)	Johnson et al. 2004	Buffalo Ridge, MN (Phase III; 02/Lake Benton II)	Johnson et al. 2004
Fowler I, II, III, IN (11)	Good et al. 2012	Pioneer Prairie II, IA (13)	Chodachek et al. 2014	Buffalo Ridge, MN (Phase II; 02/Lake Benton I)	Johnson et al. 2004
Fowler I, II, III, IN (10)	Good et al. 2011	Buffalo Ridge, MN (Phase III; 01/Lake Benton II)	Johnson et al. 2004	Rugby, ND (10-11)	Derby et al. 2011b
Forward Energy Center, WI (08-10)	Grodsky and Drake 2011	Crescent Ridge, IL (05-06)	Kerlinger et al. 2007	Elm Creek, MN (09-10)	Derby et al. 2010c
Top Crop I & II (12-13)	Good et al. 2013a	Fowler I, II, III, IN (12)	Good et al. 2013c	Wessington Springs, SD (09)	Derby et al. 2010f
Rail Splitter, IL (12-13)	Good et al. 2013b	Buffalo Ridge II, SD (11-12)	Derby et al. 2012a	Big Blue, MN (14)	Fagen Engineering 2015
Harrow, Ont (10)	Natural Resource Solutions Inc. (NRSI) 2011	Elm Creek II, MN (11-12)	Derby et al. 2012b	PrairieWinds ND1 (Minot), ND (11)	Derby et al. 2012c
Top of Iowa, IA (04)	Jain 2005	Buffalo Ridge, MN (Phase III; 99)	Johnson et al. 2000	PrairieWinds SD1, SD (11-12)	Derby et al. 2012d
Pioneer Prairie I, IA (Phase II; 11-12)	Chodachek et al. 2012	Buffalo Ridge, MN (Phase II; 99)	Johnson et al. 2000	NPPD Ainsworth, NE (06)	Derby et al. 2007
Fowler I, IN (09)	Johnson et al. 2010a	Moraine II, MN (09)	Derby et al. 2010d	PrairieWinds SD1, SD (12-13)	Derby et al. 2013a
Crystal Lake II, IA (09)	Derby et al. 2010a	Buffalo Ridge, MN (Phase II; 98)	Johnson et al. 2000	Buffalo Ridge, MN (Phase I; 99)	Johnson et al. 2000
Top of Iowa, IA (03)	Jain 2005	PrairieWinds ND1 (Minot), ND (10)	Derby et al. 2011c	PrairieWinds SD1, SD (13-14)	Derby et al. 2014
Kewaunee County, WI (99-01)	Howe et al. 2002	Grand Ridge I, IL (09-10)	Derby et al. 2010g	Wessington Springs, SD (10)	Derby et al. 2011d
Heritage Garden I, MI (12-14)	Kerlinger et al. 2014	Big Blue, MN (13)	Fagen Engineering 2014	Buffalo Ridge I, SD (09-10)	Derby et al. 2010b

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Young, D.P., Jr., S. Nomani, W. Tidhar, and K. Bay. 2011b. Nedpower Mount Storm Wind Energy Facility, Post-Construction Avian and Bat Monitoring: July - October 2010. Prepared for NedPower Mount Storm, LLC, Houston, Texas. Prepared by Western EcoSystems Technology (WEST), Inc., Cheyenne, Wyoming. February 10, 2011.

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Appendix A: North American Fatality Summary Tables

Appendix A1. Wind energy facilities in North America with comparable activity and fatality data for bats, separated by geographic region.

Wind Energy Facility	Bat Activity Estimate[A]	Bat Activity Dates	Fatality Estimate[B]	No. of Turbines	Total MW
Triple H, South Dakota	**9.08**				
		Midwest			
Cedar Ridge, WI (2009)	9.97 [C,D,E,F]	7/16/07-9/30/07	30.61	41	67.6
Blue Sky Green Field, WI (2008; 2009)	7.7 [F]	7/24/07-10/29/07	24.57	88	145
Cedar Ridge, WI (2010)	9.97 [C,D,E,F]	7/16/07-9/30/07	24.12	41	68
Fowler I, II, III, IN (2011)			20.19	355	600
Fowler I, II, III, IN (2010)			18.96	355	600
Forward Energy Center, WI (2008-2010)	6.97	8/5/08-11/08/08	18.17	86	129
Top Crop I & II (2012-2013)			12.55	200 (68 Phase I, 132 Phase II)	300 (102 Phase I, 198 Phase II)
Rail Splitter, IL (2012-2013)			11.21	67	100.5
Harrow, Ont (2010)			11.13	24 (four 6-turb facilities)	39.6
Top of Iowa, IA (2004)	35.7	5/26/04-9/24/04	10.27	89	80
Pioneer Prairie I, IA (Phase II; 2011-2012)			10.06	62	102.3
Fowler I, IN (2009)			8.09	162	301
Crystal Lake II, IA (2009)			7.42	80	200
Top of Iowa, IA (2003)			7.16	89	80
Kewaunee County, WI (1999-2001)			6.45	31	20.46
Heritage Garden I, MI (2012-2014)			5.9	14	28
Ripley, Ont (2008)			4.67	38	76
Winnebago, IA (2009-2010)			4.54	10	20
Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)	2.2 [C]	6/15/01-9/15/01	4.35	143	107.25
Pioneer Prairie II, IA (2013)			3.83	62	102.3
Buffalo Ridge, MN (Phase III; 2001/Lake Benton II)	2.2 [C]	6/15/01-9/15/01	3.71	138	103.5
Crescent Ridge, IL (2005-2006)			3.27	33	49.5
Fowler I, II, III, IN (2012)			2.96	355	600
Elm Creek II, MN (2011-2012)			2.81	62	148.8
Buffalo Ridge II, SD (2011-2012)			2.81	105	210
Buffalo Ridge, MN (Phase III; 1999)			2.72	138	103.5
Buffalo Ridge, MN (Phase II; 1999)			2.59	143	107.25
Moraine II, MN (2009)			2.42	33	49.5
Buffalo Ridge, MN (Phase II; 1998)			2.16	143	107.25
PrairieWinds ND1 (Minot), ND (2010)			2.13	80	115.5
Grand Ridge I, IL (2009-2010)			2.1	66	99
Big Blue, MN (2013)			2.04	18	36
Barton I & II, IA (2010-2011)			1.85	80	160
Fowler III, IN (2009)			1.84	60	99
Buffalo Ridge, MN (Phase III; 2002/Lake Benton II)	1.9 [C]	6/15/02-9/15/02	1.81	138	103.5

Appendix A1. Wind energy facilities in North America with comparable activity and fatality data for bats, separated by geographic region.

Wind Energy Facility	Bat Activity Estimate[A]	Bat Activity Dates	Fatality Estimate[B]	No. of Turbines	Total MW
Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)	1.9 [C]	6/15/02-9/15/02	1.64	143	107.25
Rugby, ND (2010-2011)			1.6	71	149
Elm Creek, MN (2009-2010)			1.49	67	100
Wessington Springs, SD (2009)			1.48	34	51
Big Blue, MN (2014)			1.43	18	36
PrairieWinds ND1 (Minot), ND (2011)			1.39	80	115.5
PrairieWinds SD1, SD (2011-2012)			1.23	108	162
NPPD Ainsworth, NE (2006)			1.16	36	20.5
PrairieWinds SD1, SD (2012-2013)			1.05	108	162
Buffalo Ridge, MN (Phase I; 1999)			0.74	73	25
PrairieWinds SD1, SD (2013-2014)			0.52	108	162
Wessington Springs, SD (2010)			0.41	34	51
Buffalo Ridge I, SD (2009-2010)			0.16	24	50.4
Southern Plains					
Barton Chapel, TX (2009-2010)			3.06	60	120
Big Smile, OK (2012-2013)			2.9	66	132
Buffalo Gap II, TX (2007-2008)			0.14	155	233
Red Hills, OK (2012-2013)			0.11	82	123
Buffalo Gap I, TX (2006)			0.1	67	134
Rocky Mountains					
Summerview, Alb (2006; 2007)	7.7 [C]	07/15/06-07-09/30/06-07	11.42	39	70.2
Summerview, Alb (2005-2006)			10.27	39	70.2
Judith Gap, MT (2006-2007)			8.93	90	135
Foote Creek Rim, WY (Phase I; 1999)			3.97	69	41.4
Judith Gap, MT (2009)			3.2	90	135
Milford I, UT (2010-2011)			2.05	58	145
Milford I & II, UT (2011-2012)			1.67	107	160.5 (58.5 I, 102 II)
Foote Creek Rim, WY (Phase I; 2001-2002)	2.2 [C,D]	6/15/01-9/1/01	1.57	69	41.4
Foote Creek Rim, WY (Phase I; 2000)	2.2 [C,D]	6/15/00-9/1/00	1.05	69	41.4
Southwest					
Dry Lake I, AZ (2009-2010)	8.8	4/29/10-11/10/10	4.29	30	63
Dry Lake II, AZ (2011-2012)	11.5	5/11/11-10/26/11	1.66	31	65
California					
Shiloh I, CA (2006-2009)			3.92	100	150
Shiloh II, CA (2010-2011)			3.8	75	150
Shiloh II, CA (2009-2010)			2.6	75	150
High Winds, CA (2003-2004)			2.51	90	162
Dillon, CA (2008-2009)			2.17	45	45
Montezuma I, CA (2011)			1.9	16	36.8
High Winds, CA (2004-2005)			1.52	90	162
Alta Wind I, CA (2011-2012)	4.42 [G]	6/26/09 -10/31/09	1.28	100	150
Montezuma II, CA (2012-2013)			0.91	34	78.2
Montezuma I, CA (2012)			0.84	16	36.8
Diablo Winds, CA (2005-2007)			0.82	31	20.46

Appendix A1. Wind energy facilities in North America with comparable activity and fatality data for bats, separated by geographic region.

Wind Energy Facility	Bat Activity Estimate[A]	Bat Activity Dates	Fatality Estimate[B]	No. of Turbines	Total MW
Shiloh III, CA (2012-2013)			0.4	50	102.5
Solano III, CA (2012-2013)			0.31	55	128
Alite, CA (2009-2010)			0.24	8	24
Alta Wind I-V, CA (2013-2014)			0.2	290	720 (150 GE, 570 vestas)
Mustang Hills, CA (2012-2013)			0.1	50	150
Alta Wind II-V, CA (2011-2012)	0.78	6/26/09 -10/31/09	0.08	190	570
Pinyon Pines I & II, CA (2013-2014)			0.04	100	NA
Alta VIII, CA (2012-2013)			0	50	150
Pacific Northwest					
Palouse Wind, WA (2012-2013)			4.23	58	104.4
Biglow Canyon, OR (Phase II; 2009-2010)			2.71	65	150
Nine Canyon, WA (2002-2003)			2.47	37	48.1
Stateline, OR/WA (2003)			2.29	454	299
Elkhorn, OR (2010)			2.14	61	101
White Creek, WA (2007-2011)			2.04	89	204.7
Biglow Canyon, OR (Phase I; 2008)			1.99	76	125.4
Leaning Juniper, OR (2006-2008)			1.98	67	100.5
Big Horn, WA (2006-2007)			1.9	133	199.5
Combine Hills, OR (Phase I; 2004-2005)			1.88	41	41
Linden Ranch, WA (2010-2011)			1.68	25	50
Pebble Springs, OR (2009-2010)			1.55	47	98.7
Hopkins Ridge, WA (2008)			1.39	87	156.6
Harvest Wind, WA (2010-2012)			1.27	43	98.9
Elkhorn, OR (2008)			1.26	61	101
Vansycle, OR (1999)			1.12	38	24.9
Klondike III (Phase I), OR (2007-2009)			1.11	125	223.6
Stateline, OR/WA (2001-2002)			1.09	454	299
Stateline, OR/WA (2006)			0.95	454	299
Tuolumne (Windy Point I), WA (2009-2010)			0.94	62	136.6
Klondike, OR (2002-2003)			0.77	16	24
Combine Hills, OR (2011)			0.73	104	104
Hopkins Ridge, WA (2006)			0.63	83	150
Biglow Canyon, OR (Phase I; 2009)			0.58	76	125.4
Biglow Canyon, OR (Phase II; 2010-2011)			0.57	65	150
Hay Canyon, OR (2009-2010)			0.53	48	100.8
Windy Flats, WA (2010-2011)			0.41	114	262.2
Klondike II, OR (2005-2006)			0.41	50	75
Vantage, WA (2010-2011)			0.4	60	90
Wild Horse, WA (2007)			0.39	127	229
Goodnoe, WA (2009-2010)			0.34	47	94
Marengo II, WA (2009-2010)			0.27	39	70.2

Appendix A1. Wind energy facilities in North America with comparable activity and fatality data for bats, separated by geographic region.

Wind Energy Facility	Bat Activity Estimate[A]	Bat Activity Dates	Fatality Estimate[B]	No. of Turbines	Total MW
Biglow Canyon, OR (Phase III; 2010-2011)			0.22	76	174.8
Marengo I, WA (2009-2010)			0.17	78	140.4
Klondike IIIa (Phase II), OR (2008-2010)			0.14	51	76.5
Kittitas Valley, WA (2011-2012)			0.12	48	100.8
Southeast					
Buffalo Mountain, TN (2005)			39.70	18	28.98
Buffalo Mountain, TN (2000-2003)	23.7 [D]		31.54	3	1.98
Northeast					
Pinnacle, WV (2012)			40.2	23	55.2
Mountaineer, WV (2003)			31.69	44	66
Mount Storm, WV (2009)	30.09	7/15/09-10/7/09	17.53	132	264
Noble Wethersfield, NY (2010)			16.3	84	126
Criterion, MD (2011)			15.61	28	70
Mount Storm, WV (2010)	36.67 [H]	4/18/10-10/15/10	15.18	132	264
Locust Ridge, PA (Phase II; 2010)			14.38	51	102
Locust Ridge, PA (Phase II; 2009)			14.11	51	102
Casselman, PA (2008)			12.61	23	34.5
Maple Ridge, NY (2006)			11.21	120	198
Cohocton/Dutch Hills, NY (2010)			10.32	50	125
Wolfe Island, Ont (July-December 2010)			9.5	86	197.8
Cohocton/Dutch Hill, NY (2009)			8.62	50	125
Casselman, PA (2009)			8.6	23	34.5
Noble Bliss, NY (2008)			7.8	67	100
Criterion, MD (2012)			7.62	28	70
Mount Storm, WV (2011)			7.43	132	264
Maple Ridge, NY (2012)			7.3	195	321.75
Mount Storm, WV (Fall 2008)	35.2	7/20/08-10/12/08	6.62	82	164
Maple Ridge, NY (2007)			6.49	195	321.75
Wolfe Island, Ont (July-December 2009)			6.42	86	197.8
Criterion, MD (2013)			5.32	28	70
Maple Ridge, NY (2007-2008)			4.96	195	321.75
Noble Clinton, NY (2009)	1.9 [E]	8/1/09-09/31/09	4.5	67	100
Casselman Curtailment, PA (2008)			4.4	23	35.4
Noble Altona, NY (2010)			4.34	65	97.5
Noble Ellenburg, NY (2009)	16.1 [E]	8/16/09-09/15/09	3.91	54	80
Noble Bliss, NY (2009)			3.85	67	100
Lempster, NH (2010)			3.57	12	24
Noble Ellenburg, NY (2008)			3.46	54	80
Noble Clinton, NY (2008)	2.1 [E]	8/8/08-09/31/08	3.14	67	100
Lempster, NH (2009)			3.11	12	24
Record Hill, ME (2012)	24.6	4/16/12-10/23/12	2.96	22	50.6
Mars Hill, ME (2007)			2.91	28	42
Wolfe Island, Ont (July-December 2011)			2.49	86	197.8
Noble Chateaugay, NY (2010)			2.44	71	106.5
High Sheldon, NY (2010)			2.33	75	112.5
Stetson Mountain II, ME (2012)			2.27	17	25.5
Beech Ridge, WV (2012)			2.03	67	100.5

Appendix A1. Wind energy facilities in North America with comparable activity and fatality data for bats, separated by geographic region.

Wind Energy Facility	Bat Activity Estimate[A]	Bat Activity Dates	Fatality Estimate[B]	No. of Turbines	Total MW
Munnsville, NY (2008)			1.93	23	34.5
High Sheldon, NY (2011)			1.78	75	112.5
Stetson Mountain II, ME (2010)			1.65	17	25.5
Stetson Mountain I, ME (2009)	28.5; 0.3 [I]	7/10/09-10/15/09	1.4	38	57
Beech Ridge, WV (2013)			0.58	67	100.5
Record Hill, ME (2014)			0.55	22	50.6
Mars Hill, ME (2008)			0.45	28	42
Stetson Mountain I, ME (2011)			0.28	38	57
Stetson Mountain I, ME (2013)			0.18	38	57
Rollins, ME (2012)			0.18	40	60
Kibby, ME (2011)			0.12	44	132

A = Bat passes per detector-night
B = Number of fatalities per megawatt per year
C = Activity rate was averaged across phases and/or years
D = Activity rate calculated by WEST from data presented in referenced report
E = Activity rate based on data collected at various heights all other activity rates are from ground-based units only
F = Activity rate based on pre-construction monitoring; data for all other activity and fatality rates were collected concurrently
G = Average of ground-based detectors at CPC Proper (Phase I) for late summer/fall period only
H = Activity rate based on data collected from ground-based units excluding reference stations during the spring, summer and fall seasons
I = The overall activity rate of 28.5 is from reference stations located along forest edges which may be attractive to bats; the activity rate of 0.3 is from one unit placed on a nacelle

Appendix A1 (*continued*). Wind energy facilities in North America with comparable activity and fatality data for bats.

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

Appendix A1 (*continued*). Wind energy facilities in North America with comparable activity and fatality data for bats.

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

Appendix A2. Fatality estimates for North American wind-energy facilities.

Project	Bat Fatalities (bats/MW/ year)	Predominant Habitat Type	Citation
Alite, CA (2009-2010)	0.24	shrub/scrub & grassland	Chatfield et al. 2010
Alta VIII, CA (2012-2013)	0	grassland and riparian	Chatfield and Bay 2014
Alta Wind I, CA (2011-2012)	1.28	woodland, grassland, shrubland	Chatfield et al. 2012
Alta Wind I-V, CA (2013-2014)	0.2	NA	Chatfield et al. 2014
Alta Wind II-V, CA (2011-2012)	0.08	desert scrub	Chatfield et al. 2012
Barton I & II, IA (2010-2011)	1.85	agriculture	Derby et al. 2011a
Barton Chapel, TX (2009-2010)	3.06	agriculture/forest	WEST 2011
Beech Ridge, WV (2012)	2.03	forest	Tidhar et al. 2013b
Beech Ridge, WV (2013)	0.58	forest	Young et al. 2014b
Big Blue, MN (2013)	2.04	agriculture	Fagen Engineering 2014
Big Blue, MN (2014)	1.43	agriculture	Fagen Engineering 2015
Big Horn, WA (2006-2007)	1.9	agriculture/grassland	Kronner et al. 2008
Big Smile, OK (2012-2013)	2.9	grassland, agriculture	Derby et al. 2013b
Biglow Canyon, OR (Phase I; 2008)	1.99	agriculture/grassland	Jeffrey et al. 2009a
Biglow Canyon, OR (Phase I; 2009)	0.58	agriculture/grassland	Enk et al. 2010
Biglow Canyon, OR (Phase II; 2009-2010)	2.71	agriculture	Enk et al. 2011a
Biglow Canyon, OR (Phase II; 2010-2011)	0.57	grassland/shrub-steppe, agriculture	Enk et al. 2012b
Biglow Canyon, OR (Phase III; 2010-2011)	0.22	grassland/shrub-steppe, agriculture	Enk et al. 2012a
Blue Sky Green Field, WI (2008; 2009)	24.57	agriculture	Gruver et al. 2009
Buffalo Gap I, TX (2006)	0.1	grassland	Tierney 2007
Buffalo Gap II, TX (2007-2008)	0.14	forest	Tierney 2009
Buffalo Mountain, TN (2000-2003)	31.54	forest	Nicholson et al. 2005
Buffalo Mountain, TN (2005)	39.7	forest	Fiedler et al. 2007
Buffalo Ridge, MN (Phase I; 1999)	0.74	agriculture	Johnson et al. 2000
Buffalo Ridge, MN (Phase II; 1998)	2.16	agriculture	Johnson et al. 2000
Buffalo Ridge, MN (Phase II; 1999)	2.59	agriculture	Johnson et al. 2000
Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)	4.35	agriculture	Johnson et al. 2004
Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)	1.64	agriculture	Johnson et al. 2004
Buffalo Ridge, MN (Phase III; 1999)	2.72	agriculture	Johnson et al. 2000
Buffalo Ridge, MN (Phase III; 2001/Lake Benton II)	3.71	agriculture	Johnson et al. 2004
Buffalo Ridge, MN (Phase III; 2002/Lake Benton II)	1.81	agriculture	Johnson et al. 2004

Appendix A2. Fatality estimates for North American wind-energy facilities.

Project	Bat Fatalities (bats/MW/ year)	Predominant Habitat Type	Citation
Buffalo Ridge I, SD (2009-2010)	0.16	agriculture/grassland	Derby et al. 2010b
Buffalo Ridge II, SD (2011-2012)	2.81	agriculture, grassland	Derby et al. 2012a
Casselman, PA (2008)	12.61	forest	Arnett et al. 2009b
Casselman, PA (2009)	8.6	forest, pasture, grassland	Arnett et al. 2010
Casselman Curtailment, PA (2008)	4.4	forest	Arnett et al. 2009a
Cedar Ridge, WI (2009)	30.61	agriculture	BHE Environmental 2010
Cedar Ridge, WI (2010)	24.12	agriculture	BHE Environmental 2011
Cohocton/Dutch Hill, NY (2009)	8.62	agriculture/forest	Stantec 2010
Cohocton/Dutch Hills, NY (2010)	10.32	agriculture, forest	Stantec 2011a
Combine Hills, OR (Phase I; 2004-2005)	1.88	agriculture/grassland	Young et al. 2006
Combine Hills, OR (2011)	0.73	grassland/shrub-steppe, agriculture	Enz et al. 2012
Crescent Ridge, IL (2005-2006)	3.27	agriculture	Kerlinger et al. 2007
Criterion, MD (2011)	15.61	forest, agriculture	Young et al. 2012a
Criterion, MD (2012)	7.62	forest, agriculture	Young et al. 2013
Criterion, MD (2013)	5.32	forest, agriculture	Young et al. 2014a
Crystal Lake II, IA (2009)	7.42	agriculture	Derby et al. 2010a
Diablo Winds, CA (2005-2007)	0.82	NA	WEST 2006, 2008
Dillon, CA (2008-2009)	2.17	desert	Chatfield et al. 2009
Dry Lake I, AZ (2009-2010)	3.43	desert grassland/forested	Thompson et al. 2011
Dry Lake II, AZ (2011-2012)	1.66	desert grassland/forested	Thompson and Bay 2012
Elkhorn, OR (2008)	1.26	shrub/scrub & agriculture	Jeffrey et al. 2009b
Elkhorn, OR (2010)	2.14	shrub/scrub & agriculture	Enk et al. 2011b
Elm Creek, MN (2009-2010)	1.49	agriculture	Derby et al. 2010c
Elm Creek II, MN (2011-2012)	2.81	agriculture, grassland	Derby et al. 2012b
Foote Creek Rim, WY (Phase I; 1999)	3.97	grassland	Young et al. 2003a
Foote Creek Rim, WY (Phase I; 2000)	1.05	grassland	Young et al. 2003a
Foote Creek Rim, WY (Phase I; 2001-2002)	1.57	grassland	Young et al. 2003a
Forward Energy Center, WI (2008-2010)	18.17	agriculture	Grodsky and Drake 2011
Fowler I, IN (2009)	8.09	agriculture	Johnson et al. 2010a
Fowler I, II, III, IN (2010)	18.96	agriculture	Good et al. 2011
Fowler I, II, III, IN (2011)	20.19	agriculture	Good et al. 2012
Fowler I, II, III, IN (2012)	2.96	agriculture	Good et al. 2013c
Fowler III, IN (2009)	1.84	agriculture	Johnson et al. 2010b
Goodnoe, WA (2009-2010)	0.34	grassland and shrub-steppe	URS Corporation 2010a
Grand Ridge I, IL (2009-2010)	2.1	agriculture	Derby et al. 2010g

Appendix A2. Fatality estimates for North American wind-energy facilities.

Project	Bat Fatalities (bats/MW/ year)	Predominant Habitat Type	Citation
Harrow, Ont (2010)	11.13	agriculture	Natural Resource Solutions Inc. (NRSI) 2011
Harvest Wind, WA (2010-2012)	1.27	grassland/shrub-steppe	Downes and Gritski 2012a
Hay Canyon, OR (2009-2010)	0.53	agriculture	Gritski and Kronner 2010a
Heritage Garden I, MI (2012-2014)	5.9	agriculture	Kerlinger et al. 2014
High Sheldon, NY (2010)	2.33	agriculture	Tidhar et al. 2012a
High Sheldon, NY (2011)	1.78	agriculture	Tidhar et al. 2012b
High Winds, CA (2003-2004)	2.51	agriculture/grassland	Kerlinger et al. 2006
High Winds, CA (2004-2005)	1.52	agriculture/grassland	Kerlinger et al. 2006
Hopkins Ridge, WA (2006)	0.63	agriculture/grassland	Young et al. 2007
Hopkins Ridge, WA (2008)	1.39	agriculture/grassland	Young et al. 2009c
Judith Gap, MT (2006-2007)	8.93	agriculture/grassland	TRC 2008
Judith Gap, MT (2009)	3.2	agriculture/grassland	Poulton and Erickson 2010
Kewaunee County, WI (1999-2001)	6.45	agriculture	Howe et al. 2002
Kibby, ME (2011)	0.12	forest; commercial forest	Stantec 2012a
Kittitas Valley, WA (2011-2012)	0.12	sagebrush-steppe, grassland	Stantec Consulting Services 2012
Klondike, OR (2002-2003)	0.77	agriculture/grassland	Johnson et al. 2003
Klondike II, OR (2005-2006)	0.41	agriculture/grassland	NWC and WEST 2007
Klondike III (Phase I), OR (2007-2009)	1.11	agriculture/grassland	Gritski et al. 2010
Klondike IIIa (Phase II), OR (2008-2010)	0.14	grassland/shrub-steppe and agriculture	Gritski et al. 2011
Leaning Juniper, OR (2006-2008)	1.98	agriculture	Gritski et al. 2008
Lempster, NH (2009)	3.11	grasslands/forest/rocky embankments	Tidhar et al. 2010
Lempster, NH (2010)	3.57	grasslands/forest/rocky embankments	Tidhar et al. 2011
Linden Ranch, WA (2010-2011)	1.68	grassland/shrub-steppe, agriculture	Enz and Bay 2011
Locust Ridge, PA (Phase II; 2009)	14.11	grassland	Arnett et al. 2011
Locust Ridge, PA (Phase II; 2010)	14.38	grassland	Arnett et al. 2011
Maple Ridge, NY (2006)	11.21	agriculture/forested	Jain et al. 2007
Maple Ridge, NY (2007)	6.49	agriculture/forested	Jain et al. 2009a
Maple Ridge, NY (2007-2008)	4.96	agriculture/forested	Jain et al. 2009d
Maple Ridge, NY (2012)	7.3	agriculture/forested	Tidhar et al. 2013a
Marengo I, WA (2009-2010)	0.17	agriculture	URS Corporation 2010b
Marengo II, WA (2009-2010)	0.27	agriculture	URS Corporation 2010c
Mars Hill, ME (2007)	2.91	forest	Stantec 2008a
Mars Hill, ME (2008)	0.45	forest	Stantec 2009a
Milford I, UT (2010-2011)	2.05	desert shrub	Stantec 2011b
Milford I & II, UT (2011-2012)	1.67	desert shrub	Stantec 2012b

Appendix A2. Fatality estimates for North American wind-energy facilities.

Project	Bat Fatalities (bats/MW/ year)	Predominant Habitat Type	Citation
Montezuma I, CA (2011)	1.9	agriculture and grasslands	ICF International 2012
Montezuma I, CA (2012)	0.84	agriculture and grasslands	ICF International 2013
Montezuma II, CA (2012-2013)	0.91	agriculture	Harvey & Associates 2013
Moraine II, MN (2009)	2.42	agriculture/grassland	Derby et al. 2010d
Mount Storm, WV (Fall 2008)	6.62	forest	Young et al. 2009b
Mount Storm, WV (2009)	17.53	forest	Young et al. 2009a, 2010b
Mount Storm, WV (2010)	15.18	forest	Young et al. 2010a, 2011b
Mount Storm, WV (2011)	7.43	forest	Young et al. 2011a, 2012b
Mountaineer, WV (2003)	31.69	forest	Kerns and Kerlinger 2004
Munnsville, NY (2008)	1.93	agriculture/forest	Stantec 2009b
Mustang Hills, CA (2012-2013)	0.1	grasslands and riparian	Chatfield and Bay 2014
Nine Canyon, WA (2002-2003)	2.47	agriculture/grassland	Erickson et al. 2003
Noble Altona, NY (2010)	4.34	forest	Jain et al. 2011b
Noble Bliss, NY (2008)	7.8	agriculture/forest	Jain et al. 2009e
Noble Bliss, NY (2009)	3.85	agriculture/forest	Jain et al. 2010a
Noble Chateaugay, NY (2010)	2.44	agriculture	Jain et al. 2011c
Noble Clinton, NY (2008)	3.14	agriculture/forest	Jain et al. 2009c
Noble Clinton, NY (2009)	4.5	agriculture/forest	Jain et al. 2010b
Noble Ellenburg, NY (2008)	3.46	agriculture/forest	Jain et al. 2009b
Noble Ellenburg, NY (2009)	3.91	agriculture/forest	Jain et al. 2010c
Noble Wethersfield, NY (2010)	16.3	agriculture	Jain et al. 2011a
NPPD Ainsworth, NE (2006)	1.16	agriculture/grassland	Derby et al. 2007
Palouse Wind, WA (2012-2013)	4.23	agriculture and grasslands	Stantec 2013a
Pebble Springs, OR (2009-2010)	1.55	grassland	Gritski and Kronner 2010b
Pinnacle, WV (2012)	40.2	forest	Hein et al. 2013b
Pinyon Pines I & II, CA (2013-2014)	0.04	NA	Chatfield and Russo 2014
Pioneer Prairie I, IA (Phase II; 2011-2012)	10.06	agriculture, grassland	Chodachek et al. 2012
Pioneer Prairie II, IA (2013)	3.83	agriculture	Chodachek et al. 2014
PrairieWinds ND1 (Minot), ND (2010)	2.13	agriculture	Derby et al. 2011c
PrairieWinds ND1 (Minot), ND (2011)	1.39	agriculture, grassland	Derby et al. 2012c
PrairieWinds SD1, SD (2011-2012)	1.23	grassland	Derby et al. 2012d
PrairieWinds SD1, SD (2012-2013)	1.05	grassland	Derby et al. 2013a
PrairieWinds SD1, SD (2013-2014)	0.52	grassland	Derby et al. 2014
Rail Splitter, IL (2012-2013)	11.21	agriculture	Good et al. 2013b
Record Hill, ME (2012)	2.96	forest	Stantec 2013b
Record Hill, ME (2014)	0.55	forest	Stantec 2015
Red Hills, OK (2012-2013)	0.11	grassland	Derby et al. 2013c
Ripley, Ont (2008)	4.67	agriculture	Jacques Whitford 2009
Rollins, ME (2012)	0.18	forest	Stantec 2013c

Appendix A2. Fatality estimates for North American wind-energy facilities.

Project	Bat Fatalities (bats/MW/ year)	Predominant Habitat Type	Citation
Rugby, ND (2010-2011)	1.6	agriculture	Derby et al. 2011b
Shiloh I, CA (2006-2009)	3.92	agriculture/grassland	Kerlinger et al. 2009
Shiloh II, CA (2009-2010)	2.6	agriculture	Kerlinger et al. 2010, 2013a
Shiloh II, CA (2010-2011)	3.8	agriculture	Kerlinger et al. 2013a
Shiloh III, CA (2012-2013)	0.4	NA	Kerlinger et al. 2013b
Solano III, CA (2012-2013)	0.31	NA	AECOM 2013
Stateline, OR/WA (2001-2002)	1.09	agriculture/grassland	Erickson et al. 2004
Stateline, OR/WA (2003)	2.29	agriculture/grassland	Erickson et al. 2004
Stateline, OR/WA (2006)	0.95	agriculture/grassland	Erickson et al. 2007
Stetson Mountain I, ME (2009)	1.4	forest	Stantec 2009c
Stetson Mountain I, ME (2011)	0.28	forest	Normandeau Associates 2011
Stetson Mountain I, ME (2013)	0.18	forest	Stantec 2014
Stetson Mountain II, ME (2010)	1.65	forest	Normandeau Associates 2010
Stetson Mountain II, ME (2012)	2.27	forest	Stantec 2013e
Summerview, Alb (2005-2006)	10.27	agriculture	Brown and Hamilton 2006b
Summerview, Alb (2006; 2007)	11.42	agriculture/grassland	Baerwald 2008
Top Crop I & II (2012-2013)	12.55	agriculture	Good et al. 2013a
Top of Iowa, IA (2003)	7.16	agriculture	Jain 2005
Top of Iowa, IA (2004)	10.27	agriculture	Jain 2005
Tuolumne (Windy Point I), WA (2009-2010)	0.94	grassland/shrub-steppe, agriculture and forest	Enz and Bay 2010
Vansycle, OR (1999)	1.12	agriculture/grassland	Erickson et al. 2000
Vantage, WA (2010-2011)	0.4	Shrub-steppe, grassland	Ventus Environmental Solutions 2012
Wessington Springs, SD (2009)	1.48	grassland	Derby et al. 2010f
Wessington Springs, SD (2010)	0.41	grassland	Derby et al. 2011d
White Creek, WA (2007-2011)	2.04	grassland/shrub-steppe, agriculture	Downes and Gritski 2012b
Wild Horse, WA (2007)	0.39	grassland	Erickson et al. 2008
Windy Flats, WA (2010-2011)	0.41	grassland/shrub-steppe, agriculture	Enz et al. 2011
Winnebago, IA (2009-2010)	4.54	agriculture/grassland	Derby et al. 2010e
Wolfe Island, Ont (July-December 2009)	6.42	grassland	Stantec Ltd. 2010b
Wolfe Island, Ont (July-December 2010)	9.5	grassland	Stantec Ltd. 2011b
Wolfe Island, Ont (July-December 2011)	2.49	grassland	Stantec Ltd. 2012

Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Alite, CA (2009-2010)	8	24	80	8	200 m x 200 m	1 year	weekly (spring, fall), bi-monthly (summer, winter)
Alta Wind I, CA (2011-2012)	100	150	80	25	120-m radius circle	12.5 months	every two weeks
Alta Wind I-V, CA (2013-2014)	290	720 (150 GE, 570 vestas)	80	55 (25 at Alta I, 30 at Alta II-V)	120 m radius circles	NA	monthly or bi-weekly
Alta Wind II-V, CA (2011-2012)	190	570	80	41	120-m radius circle	14.5 months	every two weeks
Alta VIII, CA (2012-2013)	50	150	90	12 plots (equivalent to 15 turbines)	240 x 240 m	1 year	bi-weekly
Barton I & II, IA (2010-2011)	80	160	100	35 (9 turbines were dropped in June 2010 due to landowner issues) 26 turbines were searched for the remainder of the study	200 m x 200 m	1 year	weekly (spring, fall; migratory turbines), monthly (summer, winter; non-migratory turbines)
Barton Chapel, TX (2009-2010)	60	120	78	30	200 m x 200 m	1 year	10 turbines weekly, 20 monthly
Beech Ridge, WV (2012)	67	100.5	80	67	40 m radius	7 months	every two days
Beech Ridge, WV (2013)	67	100.5	80	67	40 m radius	7.5 months	every two days
Big Blue, MN (2013)	18	36	78 or 90 (according to Gamesa website)	18	200m diameter	NA	weekly, monthly (Nov and Dec)
Big Blue, MN (2014)	18	36	78 or 90 (according to Gamesa website)	18	200m diameter	NA	weekly, monthly (Nov and Dec)
Big Horn, WA (2006-2007)	133	199.5	80	133	180 m x 180 m	1 year	bi-monthly (spring, fall), monthly (winter, summer)
Big Smile, OK (2012-2013)	66	132	78	17 (plus one met tower)	100 x 100	1 year	weekly (spring, summer, fall), monthly (winter)

Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Biglow Canyon, OR (Phase I; 2008)	76	125.4	80	50	110 m x 110 m	1 year	bi-monthly (spring, fall), monthly (winter, summer)
Biglow Canyon, OR (Phase I; 2009)	76	125.4	80	50	110 m x 110 m	1 year	bi-monthly (spring, fall), monthly (winter, summer)
Biglow Canyon, OR (Phase II; 2009-2010)	65	150	80	50	250 m x 250 m	1 year	bi-monthly (spring, fall), monthly (winter, summer)
Biglow Canyon, OR (Phase II; 2010-2011)	65	150	80	50	252 m x 252 m	1 year	bi-weekly(spring, fall), monthly (summer, winter)
Biglow Canyon, OR (Phase III; 2010-2011)	76	174.8	80	50	252 m x 252 m	1 year	bi-weekly(spring, fall), monthly (summer, winter)
Blue Sky Green Field, WI (2008; 2009)	88	145	80	30	160 m x 160 m	fall, spring	daily(10 turbines), weekly (20 turbines)
Buena Vista, CA (2008-2009)	38	38	45-55	38	75-m radius	1 year	monthly to bi-monthly starting in September 2008
Buffalo Gap I, TX (2006)	67	134	78	21	215 m x 215 m	10 months	every 3 weeks
Buffalo Gap II, TX (2007-2008)	155	233	80	36	215 m x 215 m	14 months	every 21 days
Buffalo Mountain, TN (2000-2003)	3	1.98	65	3	50-m radius	3 years	bi-weekly, weekly, bi-monthly
Buffalo Mountain, TN (2005)	18	28.98	V47 = 65; V80 = 78	18	50-m radius	1 year	bi-weekly, weekly, bi-monthly, and 2 to 5 day intervals
Buffalo Ridge, MN (1994-1995)	73	25	37	1994:10 plots (3 turbines/plot), 20 addition plots in Sept & Oct 1994, 1995: 30 turbines search every other week (Jan-Mar), 60 searched weekly (Apr, July, Aug) 73 searched weekly (May-June and Sept-Oct), 30 searched weekly (Nov-Dec)	100 x 100m	20 months	varies. See number turbines searched or page 44 of report

Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Buffalo Ridge, MN (Phase I; 1996)	73	25	36	21	126 m x 126 m	1 year	bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase I; 1997)	73	25	36	21	126 m x 126 m	1 year	bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase I; 1998)	73	25	36	21	126 m x 126 m	1 year	bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase I; 1999)	73	25	36	21	126 m x 126 m	1 year	bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase II; 1998)	143	107.25	50	40	126 m x 126 m	1 year	bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase II; 1999)	143	107.25	50	40	126 m x 126 m	1 year	bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)	143	107.25	50	83	60 m x 60 m	summer, fall	bi-monthly
Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)	143	107.25	50	103	60 m x 60 m	summer, fall	bi-monthly
Buffalo Ridge, MN (Phase III; 1999)	138	103.5	50	30	126 m x 126 m	1 year	bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase III; 2001/Lake Benton II)	138	103.5	50	83	60 m x 60 m	summer, fall	bi-monthly
Buffalo Ridge, MN (Phase III; 2002/Lake Benton II)	138	103.5	50	103	60 m x 60 m	summer, fall	bi-monthly
Buffalo Ridge I, SD (2009-2010)	24	50.4	79	24	200 m x 200 m	1 year	weekly (migratory), monthly (non-migratory)
Buffalo Ridge II, SD (2011-2012)	105	210	78	65 (60 road and pad, 5 turbine plots)	100 x 100m	1 year	weekly (spring, summer, fall), monthly (winter)
Casselman, PA (2008)	23	34.5	80	10	126 m x 120 m	7 months	daily
Casselman, PA (2009)	23	34.5	80	10	126 m x 120 m	7.5 months	daily searches
Casselman Curtailment, PA (2008)	23	35.4	80	12 experimental; 10 control	126 m x 120 m	2.5 months	daily
Castle River, Alb (2001)	60	39.6	50	60	50-m radius	2 years	weekly, bi-weekly
Castle River, Alb (2002)	60	39.6	50	60	50-m radius	2 years	weekly, bi-weekly

Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Cedar Ridge, WI (2009)	41	67.6	80	20	160 m x 160 m	spring, summer, fall	daily, every 4 days; late fall searched every 3 days
Cedar Ridge, WI (2010)	41	68	80	20	160 m x 160 m	1 year	Five turbines were surveyed daily, 15 turbines surveyed every 4 days in rotating groups each day. All 20 surveyed every three days during late fall
Cohocton/Dutch Hill, NY (2009)	50	125	80	17	130 m x 130 m	spring, summer, fall	daily (5 turbines), weekly (12 turbines)
Cohocton/Dutch Hills, NY (2010)	50	125	80	17	120 m x 120 m	spring, summer, fall	daily, weekly
Combine Hills, OR (Phase I; 2004-2005)	41	41	53	41	90-m radius	1 year	monthly
Combine Hills, OR (2011)	104	104	53	52 (plus 1 MET tower)	180 m x 180 m	1 year	bi-weekly(spring, fall), monthly (summer, winter)
Condon, OR	84	NA	NA	NA	NA	NA	NA
Crescent Ridge, IL (2005-2006)	33	49.5	80	33	70-m radius	1 year	weekly (fall, spring)
Criterion, MD (2011)	28	70	80	28	40-50m radius	7.3 months	daily
Criterion, MD (2012)	28	70	80	14	40-50m radius	7.5 months	weekly
Criterion, MD (2013)	28	70	80	14	40-50m radius	7.5 months	weekly
Crystal Lake II, IA (2009)	80	200	80	16 turbines through week 6, and then 15 for duration of study	100 m x 100 m	spring, summer, fall	3 times per week for 26 weeks
Diablo Winds, CA (2005-2007)	31	20.46	50 and 55	31	75 m x 75 m	2 years	monthly
Dillon, CA (2008-2009)	45	45	69	15	200 m x 200 m	1 year	weekly, bi-monthly in winter
Dry Lake I, AZ (2009-2010)	30	63	78	15	160 m x 160 m	1 year	bi-monthly (spring, fall), monthly (winter, summer)
Dry Lake II, AZ (2011-2012)	31	65	78	31: 5 (full plot), 26 (road & pad)	160 m x 160 m	1 year	twice weekly (spring, summer, fall), weekly (winter)
Elkhorn, OR (2008)	61	101	80	61	220 m x 220 m	1 year	monthly
Elkhorn, OR (2010)	61	101	80	31	220 m x 220 m	1 year	bi-monthly (spring, fall), monthly (winter, summer)

Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Elm Creek, MN (2009-2010)	67	100	80	29	200 m x 200 m	1 year	weekly, monthly
Elm Creek II, MN (2011-2012)	62	148.8	80	30	200 x 200m (2 random migration search areas 100 x 100m)	1 year	20 searched every 28 days, 10 turbines every 7 days during migration)
Erie Shores, Ont (2006)	66	99	80	66	40-m radius	2 years	weekly, bi-monthly, 2-3 times weekly (migration)
Foote Creek Rim, WY (Phase I; 1999)	69	41.4	40	69	126 m x 126 m	1 year	monthly
Foote Creek Rim, WY (Phase I; 2000)	69	41.4	40	69	126 m x 126 m	1 year	monthly
Foote Creek Rim, WY (Phase I; 2001-2002)	69	41.4	40	69	126 m x 126 m	1 year	monthly
Forward Energy Center, WI (2008-2010)	86	129	80	29	160 m x 160 m	2 years	11 turbines daily, 9 every 3 days, 9 every 5 days
Fowler I, IN (2009)	162	301	78 (Vestas), 80 (Clipper)	25	160 m x 160 m	spring, summer, fall	weekly, bi-weekly
Fowler I, II, III, IN (2010)	355	600	Vestas = 80, Clipper = 80, GE = 80	36 turbines, 100 road and pads	80 m x 80 m for turbines ; 40-m radius for roads and pads	spring, fall	daily, weekly
Fowler I, II, III, IN (2011)	355	600	Vestas = 80, Clipper = 80, GE = 80	177 road and pads (spring), 9 turbines & 168 roads and pads (fall)	turbines (80 m circular plot), roads and pads (out to 80 m)	spring, fall	daily, weekly
Fowler I, II, III, IN (2012)	355	600	Vestas = 80, Clipper = 80, GE = 80	118 roads and pads	roads and pads (out to 80 m)	2.5 months	weekly
Fowler III, IN (2009)	60	99	78	12	160 m x 160 m	10 weeks	weekly, bi-weekly
Goodnoe, WA (2009-2010)	47	94	80	24	180 m x 180 m	1 year	14 days during migration periods, 28 days during non-migration periods

Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Grand Ridge I, IL (2009-2010)	66	99	80	30	160 m x 160 m	1 year	weekly, monthly
Harrow, Ont (2010)	24 (four 6-turb facilities)	39.6	NA	12 in July, 24 Aug-Oct	50-m radius from turbine base	4 months	twice-weekly
Harvest Wind, WA (2010-2012)	43	98.9	80	32	180 m x 180 m & 240 m x 240 m	2 years	twice a week, weekly and monthly
Hay Canyon, OR (2009-2010)	48	100.8	79	20	180 m x 180 m	1 year	bi-monthly (spring, fall), monthly (winter, summer)
Heritage Garden I, MI (2012-2014)	14	28	90	14	120x120 m except one plot that was 280x280 m	1 years	weekly (spring, summer, and fall) and bi-weekly (winter)
High Sheldon, NY (2010)	75	112.5	80	25	115 m x 115 m	7 months	daily (8 turbines), weekly (17 turbines)
High Sheldon, NY (2011)	75	112.5	80	25	115 m x 115 m	7 months	daily (8 turbines), weekly (17 turbines)
High Winds, CA (2003-2004)	90	162	60	90	75-m radius	1 year	bi-monthly
High Winds, CA (2004-2005)	90	162	60	90	75-m radius	1 year	bi-monthly
Hopkins Ridge, WA (2006)	83	150	67	41	180 m x 180 m	1 year	monthly, weekly (subset of 22 turbines spring and fall migration)
Hopkins Ridge, WA (2008)	87	156.6	67	41-43	180 m x 180 m	1 year	bi-monthly (spring, fall), monthly (winter, summer)
Jersey Atlantic, NJ (2008)	5	7.5	80	5	130 m x 120 m	9 months	weekly
Judith Gap, MT (2006-2007)	90	135	80	20	190 m x 190 m	7 months	monthly
Judith Gap, MT (2009)	90	135	80	30	100 m x 100 m	5 months	bi-monthly
Kewaunee County, WI (1999-2001)	31	20.46	65	31	60 m x 60 m	2 years	bi-weekly (spring, summer), daily (spring, fall migration), weekly (fall, winter)

Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Kibby, ME (2011)	44	132	124	22 turbines	75-m diameter circular plots	22 weeks	avg 5-day
Kittitas Valley, WA (2011-2012)	48	100.8	80	48	100 m x 102 m	1 year	bi-weekly from Aug 15 - Oct 31 and March 16 - May 15; every 4 weeks from Nov 1 - March 15 and May 16 - Aug 14
Klondike, OR (2002-2003)	16	24	80	16	140 m x 140 m	1 year	monthly
Klondike II, OR (2005-2006)	50	75	80	25	180 m x 180 m	1 year	bi-monthly (spring, fall), monthly (summer, winter)
Klondike III (Phase I), OR (2007-2009)	125	223.6	GE = 80; Siemens= 80, Mitsubishi = 80	46	240 m x 240 m (1.5MW) 252 m x 252 m (2.3MW)	2 year	bi-monthly (spring, fall migration), monthly (summer, winter)
Klondike IIIa (Phase II), OR (2008-2010)	51	76.5	GE = 80	34	240 m x 240 m	2 years	bi-monthly (spring, fall), monthly (summer, winter)
Lakefield Wind, MN (2012)	137	205.5	80	26	100 m x 100 m	7.5 months	3 times per week
Leaning Juniper, OR (2006-2008)	67	100.5	80	17	240 m x 240 m	2 years	bi-monthly (spring, fall), monthly (winter, summer)
Lempster, NH (2009)	12	24	78	4	120 m x 130 m	6 months	daily
Lempster, NH (2010)	12	24	78	12	120 m x 130 m	6 months	weekly
Linden Ranch, WA (2010-2011)	25	50	80	25	110 m x 110 m	1 year	bi-weekly(spring, fall), monthly (summer, winter)
Locust Ridge, PA (Phase II; 2009)	51	102	80	15	120m x 126m	6.5 months	daily
Locust Ridge, PA (Phase II; 2010)	51	102	80	15	120m x 126m	6.5 months	daily
Madison, NY (2001-2002)	7	11.55	67	7	60-m radius	1 year	weekly (spring, fall), monthly (summer)
Maple Ridge, NY (2006)	120	198	80	50	130 m x 120 m	5 months	daily (10 turbines), every 3 days (10 turbines), weekly (30 turbines)
Maple Ridge, NY (2007)	195	321.75	80	64	130 m x 120 m	7 months	weekly

Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Maple Ridge, NY (2007-2008)	195	321.75	80	64	130 m x 120 m	7 months	weekly
Maple Ridge, NY (2012)	195	321.75	80	105 (5 turbines, 100 roads/pads)	100 m x 100 m	3 months	weekly
Marengo I, WA (2009-2010)	78	140.4	67	39	180 m x 180 m	1 year	bi-monthly (spring, fall), monthly (winter, summer)
Marengo II, WA (2009-2010)	39	70.2	67	20	180 m x 180 m	1 year	bi-monthly (spring, fall), monthly (winter, summer)
Mars Hill, ME (2007)	28	42	80.5	28	76-m diameter, extended plot 238-m diameter	spring, summer, fall	daily (2 random turbines), weekly (all turbines): extended plot searched once per season
Mars Hill, ME (2008)	28	42	80.5	28	76-m diameter, extended plot 238-m diameter	spring, summer, fall	weekly: extended plot searched once per season
McBride, Alb (2004)	114	75	50	114	4 parallel transects 120-m wide	1 year	weekly, bi-weekly
Melancthon, Ont (Phase I; 2007)	45	NA	NA	45	35m radius	5 months	weekly, twice weekly
Meyersdale, PA (2004)	20	30	80	20	130 m x 120 m	6 weeks	daily (half turbines), weekly (half turbines)
Milford I, UT (2010-2011)	58	145	80	24	120x120	NA	weekly
Milford I & II, UT (2011-2012)	107	160.5 (58.5 I, 102 II)	80	43	120x120	NA	every 10.5 days
Montezuma I, CA (2011)	16	36.8	80	16	105 m radius	1 year	Weekly and bi-Weekly
Montezuma I, CA (2012)	16	36.8	80	16	105 m radius	1 year	Weekly and bi-Weekly
Montezuma II, CA (2012-2013)	34	78.2	80	17	105 m radius	1 year	Weekly
Moraine II, MN (2009)	33	49.5	82.5	30	200 m x 200 m	1 year	weekly (migratory), monthly (non-migratory)

Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Mount Storm, WV (Fall 2008)	82	164	78	27	varied	3 months	weekly (18 turbines), daily (9 turbines)
Mount Storm, WV (2009)	132	264	78	44	varied	4.5 months	weekly (28 turbines), daily (16 turbines)
Mount Storm, WV (2010)	132	264	78	24	20 to 60 m from turbine	6 months	daily
Mount Storm, WV (2011)	132	264	78	24	varied	6 months	daily
Mountaineer, WV (2003)	44	66	80	44	60-m radius	7 months	weekly, monthly
Mountaineer, WV (2004)	44	66	80	44	130 m x 120 m	6 weeks	daily, weekly
Munnsville, NY (2008)	23	34.5	69.5	12	120 m x 120 m	spring, summer, fall	weekly
Mustang Hills, CA (2012-2013)	50	150	90	13 plots (equivalent to 15 turbines)	240 x 240 m	1 year	bi-weekly
Nine Canyon, WA (2002-2003)	37	48.1	60	37	90-m radius	1 year	bi-monthly (spring, summer, fall), monthly (winter)
Nine Canyon II, WA (2004)	12	15.6	60	12	90 m x 90 m	3 months	once every two weeks
Noble Altona, NY (2010)	65	97.5	80	22	120 m x 120 m	spring, summer, fall	daily, weekly
Noble Altona, NY (2011)	65	97.5	80	22	120m x 120m	2 months	daily
Noble Bliss, NY (2008)	67	100	80	23	120 m x 120 m	spring, summer, fall	daily (8 turbines), 3-day (8 turbines), weekly (7 turbines)
Noble Bliss, NY (2009)	67	100	80	23	120 m x 120 m	spring, summer, fall	weekly, 8 turbines searched daily from July 1 to August 15
Noble Bliss/Wethersfield, NY (2011)	151	226	80	48 (24 from each site:12 ag, 12 forest)	road & pad 70 m out from turbine	2 months	daily
Noble Chateaugay, NY (2010)	71	106.5	80	24	120 m x 120 m	spring, summer, fall	weekly

Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Noble Clinton, NY (2008)	67	100	80	23	120 m x 120 m	spring, summer, fall	daily (8 turbines), 3-day (8 turbines), weekly (7 turbines)
Noble Clinton, NY (2009)	67	100	80	23	120 m x 120 m	spring, summer, fall	daily (8 turbines), weekly (15 turbines), all turbines weekly from July 1 to August 15
Noble Ellenburg, NY (2008)	54	80	80	18	120 m x 120 m	spring, summer, fall	daily (6 turbines), 3-day (6 turbines), weekly (6 turbines)
Noble Ellenburg, NY (2009)	54	80	80	18	120 m x 120 m	spring, summer, fall	daily (6 turbines), weekly (12 turbines), all turbines weekly from July 1 to August 15
Noble Wethersfield, NY (2010)	84	126	80	28	120 m x 120 m	spring, summer, fall	weekly
NPPD Ainsworth, NE (2006)	36	20.5	70	36	220 m x 220 m	spring, summer, fall	bi-monthly
Oklahoma Wind Energy Center, OK (2004; 2005)	68	102	70	68	20m radius	3 months (2 years)	bi-monthly
Pacific, CA (2012-2013)	70	140	78.5	20	126 m radius	NA	Twice weekly (fall), and biweekly
Palouse Wind, WA (2012-2013)	58	104.4	80, 90, or 105 M (according to the Vestas website)	19	120m x 120m	1 year	Montly (Winter) and Weekly (Spring-Fall)
Pebble Springs, OR (2009-2010)	47	98.7	79	20	180 m x 180 m	1 year	bi-monthly (spring, fall), monthly (winter, summer)
Pine Tree, CA (2009-2010, 2011)	90	135	65	40	100 m radius	1.5 year	bi-weekly, weekly
Pinnacle, WV (2012)	23	55.2	80	11	126 m x 120m	9 months	weekly

Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Pinnacle Operational Mitigation Study (2012)	23	55.2	80	12	126m x 120m	2.5 months	daily
Pinyon Pines I & II, CA (2013-2014)	100	NA	90	25 plots (aprox 31 turbines)	240x240 m	NA	bi-weekly
Pioneer Prairie II, IA (2013)	62	102.3	80	62	80x80 m (5 turbines), road and pad within 100 m of turbine (57 turbines)	NA	weekly
Pioneer Prairie I, IA (Phase II; 2011-2012)	62	102.3	80	62 (57 road/pad) 5 full search plots	80 x 80m	1 year	weekly (spring and fall), every two weeks (summer), monthly (winter)
Pioneer Trail, IL (2012-2013)	94	150.5	NA	50	80x80m	fall, spring	weekly
Prairie Rose, MN (2014)	119	200	80	10	100x100m	6 months	weekly
PrairieWinds ND1 (Minot), ND (2010)	80	115.5	89	35	minimum of 100 m x 100 m	3 seasons	bi-monthly
PrairieWinds ND1 (Minot), ND (2011)	80	115.5	80	35	minimum 100 x 100m	3 season	twice monthly
PrairieWinds SD1, SD (2011-2012)	108	162	80	50	200 x 200m	1 year	twice monthly (spring, summer, fall), monthly (winter)
PrairieWinds SD1, SD (2012-2013)	108	162	80	50	200 x 200m	1 year	bi-weekly
PrairieWinds SD1, SD (2013-2014)	108	162	80	45	200 x 200m	1 year	twice monthly (spring, summer, fall), monthly (winter)
Rail Splitter, IL (2012-2013)	67	100.5	80	34	60 m radius	1 year	weekly (spring, summer, and fall) and bi-weekly (winter)
Record Hill, ME (2012)	22	50.6	80	22	126.5x126.5	5 months	three times every two weeks
Record Hill, ME (2014)	22	50.6	80	10	varied due to steep terrain and heavily vegetated areas	4.5 months	daily for 5 days a week

Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Red Canyon, TX (2006-2007)	56	84	70	28	200 m x 200 m in fall and winter; 160 m x 160 m in spring and summer	1 year	every 14 days in fall and winter; 7 days in spring, 3 days in summer
Red Hills, OK (2012-2013)	82	123	80	20 (plus one met tower)	100 x 100	1 year	weekly (spring, summer, fall), monthly (winter)
Ripley, Ont (2008)	38	76	64	38	80 m x 80 m	spring, fall	twice weekly for odd turbines; weekly for even turbines.
Ripley, Ont (2008-2009)	38	76	64	38	80 m x 80 m	6 weeks	twice weekly for odd turbines; weekly for even turbines.
Rollins, ME (2012)	40	60	80	20	varied; turbine laydown area and gravel access roads out to 60m	6 months	weekly
Roth Rock, MD (2011)	20	50	80	10	80m x 80m	3 months	daily
Rugby, ND (2010-2011)	71	149	78	32	200 m x 200 m	1 year	weekly (spring, fall; migratory turbines), monthly (non-migratory turbines)
San Gorgonio, CA (1997-1998; 1999-2000)	3000	NA	24.4-42.7	NA	50-m radius	2 years	quarterly
Searsburg, VT (1997)	11	7	65	11	20- to 55-m radius	spring, fall	weekly (fall migration)
Sheffield, VT (2012)	16	40	80	8	126m x 120m	3 months	daily
Sheffield Operational Mitigation Study (2012)	16	40	80	16	126m x 120m	4 months	daily
Shiloh I, CA (2006-2009)	100	150	65	100	105-m radius	3 years	weekly
Shiloh II, CA (2009-2010)	75	150	80	25	100m radius	1 year	weekly
Shiloh II, CA (2010-2011)	75	150	80	25	100 m radius	1 year	weekly

Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Shiloh III, CA (2012-2013)	50	102.5	78.5	25	100 m radius	NA	weekly
SMUD Solano, CA (2004-2005)	22	15	65	22	60-m radius	1 year	bi-monthly
Solano III, CA (2012-2013)	55	128	80	19	100 m radius	NA	bi-Weekly
Spruce Mountain, ME (2012)	10	20	78	10	100 m x 100 m	7 months	weekly
Stateline, OR/WA (2001-2002)	454	299	50	124	minimum 126 m x 126 m	17 months	bi-weekly, monthly
Stateline, OR/WA (2003)	454	299	50	153	minimum 126 m x 126 m	1 year	bi-weekly, monthly
Stateline, OR/WA (2006)	454	299	50	39	variable turbine strings	1 year	bi-weekly
Steel Winds I & II, NY (2012)	14	35	80	8 (1 was just gravel pad)	120m x 120m	6 months	weekly, bi-weekly (November only)
Steel Winds I, NY (2007)	8	20	80	8	176m x 176m	6.5 months	every 10 days (spring, fall) every 21 days (summer)
Stetson Mountain I, ME (2009)	38	57	80	19	76-m diameter	27 weeks (spring, summer, fall)	weekly
Stetson Mountain I, ME (2011)	38	57	80	19	79.45x79.45m	6 months	weekly
Stetson Mountain I, ME (2013)	38	57	80	19	76 m diameter	6 months	weekly
Stetson Mountain II, ME (2010)	17	25.5	80	17	74.5x74.5m	6 months	weekly (3 turbines twice a week)
Stetson Mountain II, ME (2012)	17	25.5	80	17	laydown area and road up to 60m	6 months	weekly
Summerview, Alb (2005-2006)	39	70.2	67	39	140 m x 140 m	1 year	weekly, bi-weekly (May to July, September)
Summerview, Alb (2006; 2007)	39	70.2	65	39	52-m radius; 2 spiral transects 7 m apart	summer, fall (2 years)	daily (10 turbines), weekly (29 turbines)

Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Tehachapi, CA (1996-1998)	3300	NA	14.7 to 57.6	201	50-m radius	20 months	quarterly
Top Crop I & II (2012-2013)	200 (68 Phase I, 132 Phase II)	300 (102 Phase I, 198 Phase II)	65 (Phase I) 80 (Phase II)	100	61 m radius	1 year	weekly (spring, summer, and fall) and bi-weekly (winter)
Top of Iowa, IA (2003)	89	80	71.6	26	76 m x 76 m	spring, summer, fall	once every 2 to 3 days
Top of Iowa, IA (2004)	89	80	71.6	26	76 m x 76 m	spring, summer, fall	once every 2 to 3 days
Tuolumne (Windy Point I), WA (2009-2010)	62	136.6	80	21	180 m x 180 m	1 year	monthly throughout the year, a sub-set of 10 turbines were also searched weekly during the spring, summer, and fall
Vansycle, OR (1999)	38	24.9	50	38	126 m x 126 m	1 year	monthly
Vantage, WA (2010-2011)	60	90	80	30	240 m x 240 m	1 year	monthly, a subset of 10 searched weekly during migration
Vasco, CA (2012-2013)	34	78.2	80	34	105 m radius	1 year	weekly, monthly
Wessington Springs, SD (2009)	34	51	80	20	200 m x 200 m	spring, summer, fall	bi-monthly
Wessington Springs, SD (2010)	34	51	80	20	200 m x 200 m	8 months	bi-weekly (spring, summer, fall)
White Creek, WA (2007-2011)	89	204.7	80	89	180 m x 180 m & 240 m x 240 m	4 years	twice a week, weekly and monthly
Wild Horse, WA (2007)	127	229	67	64	110 m from two turbines in plot	1 year	monthly, weekly (fall, spring migration at 16 turbines)
Windy Flats, WA (2010-2011)	114	262.2	80	36 (plus 1 MET tower)	180 m x 180 m (120m at MET tower)	1 year	monthly (spring, summer, fall, and winter), weekly (spring and fall migration)
Winnebago, IA (2009-2010)	10	20	78	10	200 m x 200 m	1 year	weekly (migratory), monthly (non-migratory)
Wolfe Island, Ont (May-June 2009)	86	197.8	80	86	60-m radius	spring	43 twice weekly, 43 weekly

Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Wolfe Island, Ont (July-December 2009)	86	197.8	80	86	60-m radius	summer, fall	43 twice weekly, 43 weekly
Wolfe Island, Ont (January-June 2010)	86	197.8	80	86	60-m radius	6 months	43 twice weekly, 43 weekly
Wolfe Island, Ont (July-December 2010)	86	197.8	80	86	50-m radius	6 months	43 twice weekly, 43 weekly
Wolfe Island, Ont (January-June 2011)	86	197.8	80	86	50m radius	6 months	43 twice weekly, 43 weekly
Wolfe Island, Ont (July-December 2011)	86	197.8	80	86	50m radius	6 months	43 twice weekly, 43 weekly
Wolfe Island, Ont (January-June 2012)	86	197.8	NA	86	50 m radius	NA	1/2 searched twice weekly, 1/2 searched weekly

Appendix A3 (*continued*). All post-construction monitoring studies, project characteristics, and select study methodology.

Data from the following sources:

Project, Location	Reference	Project, Location	Reference
Alite, CA (09-10)	Chatfield et al. 2010	Marengo I, WA (09-10)	URS Corporation 2010b
Alta Wind I, CA (11-12)	Chatfield et al. 2012	Marengo II, WA (09-10)	URS Corporation 2010c
Alta Wind I-V, CA (13-14)	Chatfield et al. 2014	Mars Hill, ME (07)	Stantec 2008a
Alta Wind II-V, CA (11-12)	Chatfield et al. 2012	Mars Hill, ME (08)	Stantec 2009a
Alta VIII, CA (12-13)	Chatfield and Bay 2014	McBride, Alb (04)	Brown and Hamilton 2004
Barton I & II, IA (10-11)	Derby et al. 2011a	Melancthon, Ont (Phase I; 07)	Stantec Ltd. 2008
Barton Chapel, TX (09-10)	WEST 2011	Meyersdale, PA (04)	Arnett et al. 2005
Beech Ridge, WV (12)	Tidhar et al. 2013b	Milford I, UT (10-11)	Stantec 2011b
Beech Ridge, WV (13)	Young et al. 2014b	Milford I & II, UT (11-12)	Stantec 2012b
Big Blue, MN (13)	Fagen Engineering 2014	Montezuma I, CA (11)	ICF International 2012
Big Blue, MN (14)	Fagen Engineering 2015	Montezuma I, CA (12)	ICF International 2013
Big Horn, WA (06-07)	Kronner et al. 2008	Montezuma II, CA (12-13)	Harvey & Associates 2013
Big Smile, OK (12-13)	Derby et al. 2013b	Moraine II, MN (09)	Derby et al. 2010d
Biglow Canyon, OR (Phase I; 08)	Jeffrey et al. 2009a	Mount Storm, WV (Fall 08)	Young et al. 2009b
Biglow Canyon, OR (Phase I; 09)	Enk et al. 2010	Mount Storm, WV (09)	Young et al. 2009a, 2010b
Biglow Canyon, OR (Phase II; 09-10)	Enk et al. 2011a	Mount Storm, WV (10)	Young et al. 2010a, 2011b
Biglow Canyon, OR (Phase II; 10-11)	Enk et al. 2012b	Mount Storm, WV (11)	Young et al. 2011a, 2012b
Biglow Canyon, OR (Phase III; 10-11)	Enk et al. 2012a	Mountaineer, WV (03)	Kerns and Kerlinger 2004
Blue Sky Green Field, WI (08; 09)	Gruver et al. 2009	Mountaineer, WV (04)	Arnett et al. 2005
Buena Vista, CA (08-09)	Insignia Environmental 2009	Munnsville, NY (08)	Stantec 2009b
Buffalo Gap I, TX (06)	Tierney 2007	Mustang Hills, CA (12-13)	Chatfield and Bay 2014
Buffalo Gap II, TX (07-08)	Tierney 2009	Nine Canyon, WA (02-03)	Erickson et al. 2003
Buffalo Mountain, TN (00-03)	Nicholson et al. 2005	Nine Canyon II, WA (04)	Erickson et al. 2005
Buffalo Mountain, TN (05)	Fiedler et al. 2007	Noble Altona, NY (10)	Jain et al. 2011b
Buffalo Ridge, MN (94-95)	Osborn et al. 1996, 2000	Noble Altona, NY (11)	Kerlinger et al. 2011b
Buffalo Ridge, MN (Phase I; 96)	Johnson et al. 2000	Noble Bliss, NY (08)	Jain et al.2009e
Buffalo Ridge, MN (Phase I; 97)	Johnson et al. 2000	Noble Bliss, NY (09)	Jain et al. 2010a
Buffalo Ridge, MN (Phase I; 98)	Johnson et al. 2000	Noble Bliss/Wethersfield, NY (11)	Kerlinger et al. 2011a
Buffalo Ridge, MN (Phase I; 99)	Johnson et al. 2000	Noble Chateaugay, NY (10)	Jain et al. 2011c
Buffalo Ridge, MN (Phase II; 98)	Johnson et al. 2000	Noble Clinton, NY (08)	Jain et al. 2009c
Buffalo Ridge, MN (Phase II; 99)	Johnson et al. 2000	Noble Clinton, NY (09)	Jain et al. 2010b
Buffalo Ridge, MN (Phase II; 01/Lake Benton I)	Johnson et al. 2004	Noble Ellenburg, NY (08)	Jain et al. 2009b
Buffalo Ridge, MN (Phase II; 02/Lake Benton I)	Johnson et al. 2004	Noble Ellenburg, NY (09)	Jain et al. 2010c
Buffalo Ridge, MN (Phase III; 99)	Johnson et al. 2000	Noble Wethersfield, NY (10)	Jain et al. 2011a
Buffalo Ridge, MN (Phase III; 01/Lake Benton II)	Johnson et al. 2004	NPPD Ainsworth, NE (06)	Derby et al. 2007
Buffalo Ridge, MN (Phase III; 02/Lake Benton II)	Johnson et al. 2004	Oklahoma Wind Energy Center, OK (04; 05)	Piorkowski and O'Connell 2010
Buffalo Ridge I, SD (09-10)	Derby et al. 2010b	Pacific, CA (12-13)	Sapphos 2014
Buffalo Ridge II, SD (11-12)	Derby et al. 2012a	Palouse Wind, WA (12-13)	Stantec 2013a
Casselman, PA (08)	Arnett et al. 2009b	Pebble Springs, OR (09-10)	Gritski and Kronner 2010b
Casselman, PA (09)	Arnett et al. 2010	Pine Tree, CA (09-10, 11)	BioResource Consultants 2012
Casselman Curtailment, PA (08)	Arnett et al. 2009a	Pinnacle, WV (12)	Hein et al. 2013b
Castle River, Alb. (01)	Brown and Hamilton 2006a	Pinnacle Operational Mitigation Study (12)	Hein et al. 2013c
Castle River, Alb. (02)	Brown and Hamilton 2006a	Pinyon Pines I & II, CA (13-14)	Chatfield and Russo 2014
Cedar Ridge, WI (09)	BHE Environmental 2010	Pioneer Prairie I, IA (Phase II; 11-12)	Chodachek et al. 2012
Cedar Ridge, WI (10)	BHE Environmental 2011	Pioneer Prairie II, IA (13)	Chodachek et al. 2014
Cohocton/Dutch Hill, NY (09)	Stantec 2010	Pioneer Trail, IL (12-13)	ARCADIS 2013
Cohocton/Dutch Hills, NY (10)	Stantec 2011a	Prairie Rose, MN (14)	Chodachek et al. 2015
Combine Hills, OR (Phase I; 04-05)	Young et al. 2006	PrairieWinds ND1 (Minot), ND (10)	Derby et al. 2011c
Combine Hills, OR (11)	Enz et al. 2012	PrairieWinds ND1 (Minot), ND (11)	Derby et al. 2012c
Condon, OR	Fishman Ecological Services 2003	PrairieWinds SD1 (Crow Lake), SD (11-12)	Derby et al. 2012d
Crescent Ridge, IL (05-06)	Kerlinger et al. 2007	PrairieWinds SD1 (Crow Lake), SD (12-13)	Derby et al. 2013a
Criterion, MD (11)	Young et al. 2012a	PrairieWinds SD1 (Crow Lake), SD (13-14)	Derby et al. 2014
Criterion, MD (12)	Young et al. 2013	Rail Splitter, IL (12-13)	Good et al. 2013b
Criterion, MD (13)	Young et al. 2014a	Record Hill, ME (12)	Stantec 2013b
Crystal Lake II, IA (09)	Derby et al. 2010a	Record Hill, ME (14)	Stantec 2015
Diablo Winds, CA (05-07)	WEST 2006, 2008	Red Canyon, TX (06-07)	Miller 2008
Dillon, CA (08-09)	Chatfield et al. 2009	Red Hills, OK (12-13)	Derby et al. 2013c
Dry Lake I, AZ (09-10)	Thompson et al. 2011	Ripley, Ont (08)	Jacques Whitford 2009
Dry Lake II, AZ (11-12)	Thompson and Bay 2012	Ripley, Ont (08-09)	Golder Associates 2010
Elkhorn, OR (08)	Jeffrey et a. 2009b	Rollins, ME (12)	Stantec 2013c
Elkhorn, OR (10)	Enk et al. 2011b	Roth Rock, MD (11)	Atwell 2012
Elm Creek, MN (09-10)	Derby et al. 2010c	Rugby, ND (10-11)	Derby et al. 2011b
Elm Creek II, MN (11-12)	Derby et al. 2012b	San Gorgonio, CA (97-98; 99-00)	Anderson et al. 2005
Erie Shores, Ont. (06)	James 2008	Searsburg, VT (97)	Kerlinger 2002a

Appendix A3 (*continued*). All post-construction monitoring studies, project characteristics, and select study methodology.

Data from the following sources:

Project, Location	Reference	Project, Location	Reference
Foote Creek Rim, WY (Phase I; 99)	Young et al. 2003a	Sheffield, VT (12)	Martin et al. 2013
Foote Creek Rim, WY (Phase I; 00)	Young et al. 2003a	Sheffield Operational Mitigation Study (12)	Martin et al. 2013
Foote Creek Rim, WY (Phase I; 01-02)	Young et al. 2003a	Shiloh I, CA (06-09)	Kerlinger et al. 2009
Forward Energy Center, WI (08-10)	Grodsky and Drake 2011	Shiloh II, CA (09-10)	Kerlinger et al. 2010
Fowler I, IN (09)	Johnson et al. 2010a	Shiloh II, CA (10-11)	Kerlinger et al. 2013a
Fowler I, II, III, IN (10)	Good et al. 2011	Shiloh III, CA (12-13)	Kerlinger et al. 2013b
Fowler I, II, III, IN (11)	Good et al. 2012	SMUD Solano, CA (04-05)	Erickson and Sharp 2005
Fowler I, II, III, IN (12)	Good et al. 2013c	Solano III, CA (12-13)	AECOM 2013
Fowler III, IN (09)	Johnson et al. 2010b	Spruce Mountain, ME (12)	Tetra Tech 2013
Goodnoe, WA (09-10)	URS Corporation 2010a	Stateline, OR/WA (01-02)	Erickson et al. 2004
Grand Ridge I, IL (09-10)	Derby et al. 2010g	Stateline, OR/WA (03)	Erickson et al. 2004
Harrow, Ont (10)	Natural Resource Solutions 2011	Stateline, OR/WA (06)	Erickson et al. 2007
Harvest Wind, WA (10-12)	Downes and Gritski 2012a	Steel Winds I, NY (07)	Grehan 2008
Hay Canyon, OR (09-10)	Gritski and Kronner 2010a	Steel Winds I & II, NY (12)	Stantec 2013d
Heritage Garden I, MI (12-14)	Kerlinger et al. 2014	Stetson Mountain I, ME (09)	Stantec 2009c
High Sheldon, NY (10)	Tidhar et al. 2012a	Stetson Mountain I, ME (11)	Normandeau Associates 2011
High Sheldon, NY (11)	Tidhar et al. 2012b	Stetson Mountain I, ME (13)	Stantec 2014
High Winds, CA (03-04)	Kerlinger et al. 2006	Stetson Mountain II, ME (10)	Normandeau Associates 2010
High Winds, CA (04-05)	Kerlinger et al. 2006	Stetson Mountain II, ME (12)	Stantec 2013e
Hopkins Ridge, WA (06)	Young et al. 2007	Summerview, Alb (05-06)	Brown and Hamilton 2006b
Hopkins Ridge, WA (08)	Young et al. 2009c	Summerview, Alb (06; 07)	Baerwald 2008
Jersey Atlantic, NJ (08)	NJAS 2008a, 2008b, 2009	Tehachapi, CA (96-98)	Anderson et al. 2004
Judith Gap, MT (06-07)	TRC 2008	Top Crop I & II, IL (12-13)	Good et al. 2013a
Judith Gap, MT (09)	Poulton and Erickson 2010	Top of Iowa, IA (03)	Jain 2005
Kewaunee County, WI (99-01)	Howe et al. 2002	Top of Iowa, IA (04)	Jain 2005
Kibby, ME (11)	Stantec 2012a	Tuolumne (Windy Point I), WA (09-10)	Enz and Bay 2010
Kittitas Valley, WA (11-12)	Stantec Consulting 2012	Vansycle, OR (99)	Erickson et al. 2000
Klondike, OR (02-03)	Johnson et al. 2003	Vantage, WA (10-11)	Ventus Environmental Solutions 2012
Klondike II, OR (05-06)	NWC and WEST 2007	Vasco, CA (12-13)	Brown et al. 2013
Klondike III (Phase I), OR (07-09)	Gritski et al. 2010	Wessington Springs, SD (09)	Derby et al. 2010f
Klondike IIIa (Phase II), OR (08-10)	Gritski et al. 2011	Wessington Springs, SD (10)	Derby et al. 2011d
Lakefield Wind, MN (12)	MPUC 2012	White Creek, WA (07-11)	Downes and Gritski 2012b
Leaning Juniper, OR (06-08)	Gritski et al. 2008	Wild Horse, WA (07)	Erickson et al. 2008
Lempster, NH (09)	Tidhar et al. 2010	Windy Flats, WA (10-11)	Enz et al. 2011
Lempster, NH (10)	Tidhar et al. 2011	Winnebago, IA (09-10)	Derby et al. 2010e
Linden Ranch, WA (10-11)	Enz and Bay 2011	Wolfe Island, Ont (May-June 09)	Stantec Ltd. 2010a
Locust Ridge, PA (Phase II; 09)	Arnett et al. 2011	Wolfe Island, Ont (July-December 09)	Stantec Ltd. 2010b
Locust Ridge, PA (Phase II; 10)	Arnett et al. 2011	Wolfe Island, Ont (January-June 10)	Stantec Ltd. 2011a
Madison, NY (01-02)	Kerlinger 2002b	Wolfe Island, Ont (July-December 10)	Stantec Ltd. 2011b
Maple Ridge, NY (06)	Jain et al. 2007	Wolfe Island, Ont (January-June 11)	Stantec Ltd. 2011c
Maple Ridge, NY (07)	Jain et al. 2009a	Wolfe Island, Ont (July-December 11)	Stantec Ltd. 2012
Maple Ridge, NY (07-08)	Jain et al. 2009d	Wolfe Island, Ont (January-June 12)	Stantec Ltd. 2014
Maple Ridge, NY (12)	Tidhar et al. 2013a		

Appendix L. Bat Activity Survey for the Triple Wind Project, Hyde and Hughes Counties, South Dakota – Final Report April 25 – October 25, 2018

Bat Activity Survey for the Triple H Wind Project Hyde and Hughes Counties, South Dakota

Final Report

April 25 – October 25, 2018

Prepared for:

Triple H Wind Project, LLC.

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February 4, 2019

EXECUTIVE SUMMARY

In 2018, Western EcoSystems Technology, Inc. initiated a bat acoustic survey for the proposed Triple H Wind Project (Project) in Hyde and Hughes counties, South Dakota. The bat acoustic survey was designed based on a larger Project area (Project), however, Triple H is proposing to initially develop an area located within the northcentral portion of the Project area that will be Triple H Phase I. The bat acoustic survey was designed to estimate levels of bat activity during spring, summer, and fall within the larger Project area.

Acoustic surveys were conducted from April 25 – October 25, 2018 at six monitoring stations where AnaBat SD2 detectors were placed near the ground at 5.0 feet (ft; 1.5 meters [m]). Four monitoring stations were located in croplands or herbaceous grassland habitat, which are the dominant land cover types within the Project area and therefore representative of future turbine placement ('representative stations'). Two additional detectors were designated as 'bat feature stations" and were located near habitat potentially attractive to bats (e.g., ponds, deciduous trees, shelterbelts, etc.).

Detectors in representative habitat recorded an average bat activity of 0.29 ± 0.04 bat passes per detector-night over 670 detector nights. Bat feature stations recorded 256 bat passes during 309 detector-nights (0.86 ± 0.12 bat passes per detector-night).

Bat activity at representative stations varied little among seasons with the lowest activity in the spring and highest activity in summer and fall. At these stations, activity by low-frequency (LF; e.g., big brown bats, hoary bats, and silver-haired bats) and high-frequency (HF; e.g., eastern red bats and *Myotis* species) bats peaked during the end of July and first week of August. Bat activity at bat feature stations had similar temporal patterns with bat activity being lowest in the spring and higher in the summer and fall. Bat feature stations had peak activity in late August and early September.

Approximately 62.1% and 64.1% of bat passes recorded at representative and bat feature stations in the Project area were classified as LF bats. Bat activity throughout the Project area was similar to the bat activity recorded at the two stations within the Triple H Phase I boundary. Bat activity recorded at the Project area at ground representative stations during the Fall Migration Period (0.39 ± 0.06 bat passes per detector-night) was lower than activity at facilities in the Midwest. The precise level of fatalities at this site is difficult to predict given the broad range of fatality rates observed at other wind-energy facilities in the Midwest, and the lack of a direct link between pre-construction bat activity and post-construction fatality rates.

STUDY PARTICIPANTS

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REPORT REFERENCE

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INTRODUCTION

Triple H Wind Project, LLC (Triple H) is considering the development of the Triple H Wind Project (Project) in Hyde and Hughes counties, South Dakota (Figure 1). Triple H contracted Western EcoSystems Technology, Inc. (WEST) to complete a bat activity survey following the recommendations of the US Fish and Wildlife Service (USFWS) *Land-based Wind Energy Guidelines* (USFWS 2012a) and Kunz et al. (2007).

Objectives for the bat activity survey included acoustic monitoring surveys to estimate levels of bat activity throughout the Project area during spring, summer, and fall. The bat acoustic surveys were designed based on a larger Project area; however, Triple H is proposing to initially develop an area located within the northcentral portion of the Project area (Triple H Phase I; Figure 1). This report describes the results of the acoustic monitoring conducted within both the overall Project area as well as the initial proposed Phase I Project area from April 25 – October 25, 2018.

PROJECT AREA

The Project area (110,058.9 acres [ac]; 44,539.3 hectares [ha]) is located approximately 3.0 miles (mi; 4.8 kilometers [km]) south of Highmore, Holabird, and Harrold South Dakota (Figure 1). The topography within the Project area consists of rolling hills, with elevations ranging from 1,850 to 2,100 feet (ft; 564-640 meters [m]) above mean sea level. The Triple H Phase I will consist of 27,226.5 ac (11,018.2 ha) in the northcentral portion of the Project area.

The dominant land cover types, based on digitized land cover mapping, are cropland, comprising 47.03% of the Project area (51,759.38 ac [20,946.28 ha]); followed by grassland pasture (46,064.68 ac [18,641.72 ha; 41.85%]), NWI wetlands (5,985.64 ac [2,422.30 ha; 5.44%]), grass hay (2,789.08 ac [1,128.70 ha; 2.53%]), and developed space (2,377 ac [961.94 ha; 2.16%]). Trees accounted for 1,042.91 ac (422.05 ha; 0.95%) and 40.23 ac (16.28 ha; 0.04%) of water sources were digitized within the Project area (Table 1: Figure 2).

Land cover type within the Triple H Phase I Project area is comprised of more cropland and less grassland pastures than within the overall Project area (Table 1). The percentage of the remaining land cover types were approximately the same between the overall Project area and Triple H Phase I Project area. Deciduous forest provides potential roosting and foraging habitat for several bat species, including the federally threatened northern long-eared bat (*Myotis septentrionalis*; USFWS 2007).

Table 1. Digitized land cover types, coverage, and percent (%) composition within the overall Triple H Wind Project area and Triple H Phase I Project area, Hyde and Hughes counties, South Dakota.

	Triple H Project		Triple H Phase I	
Land Cover Type	**Coverage (Acres)**	**% Composition**	**Coverage Acres**	**% Composition**
Cropland	51,759.38	47.03%	17,060.5	62.7
Grassland Pasture	46,064.68	41.85%	7,027.3	25.8
NWI Wetlands[a]	5,985.64	5.44%	1,670.3	6.1
Grass Hay	2,789.08	2.53%	701.0	2.6
Developed	2,377.00	2.16%	516.4	1.9
Trees	1,042.91	0.95%	250.9	0.9
Water	40.23	0.04%	0.1	< 0.1
Total	**110,058.9**	**100**	**27,226.5**	**100**

[a]US Fish and Wildlife Service National Wetlands Inventory 2017.

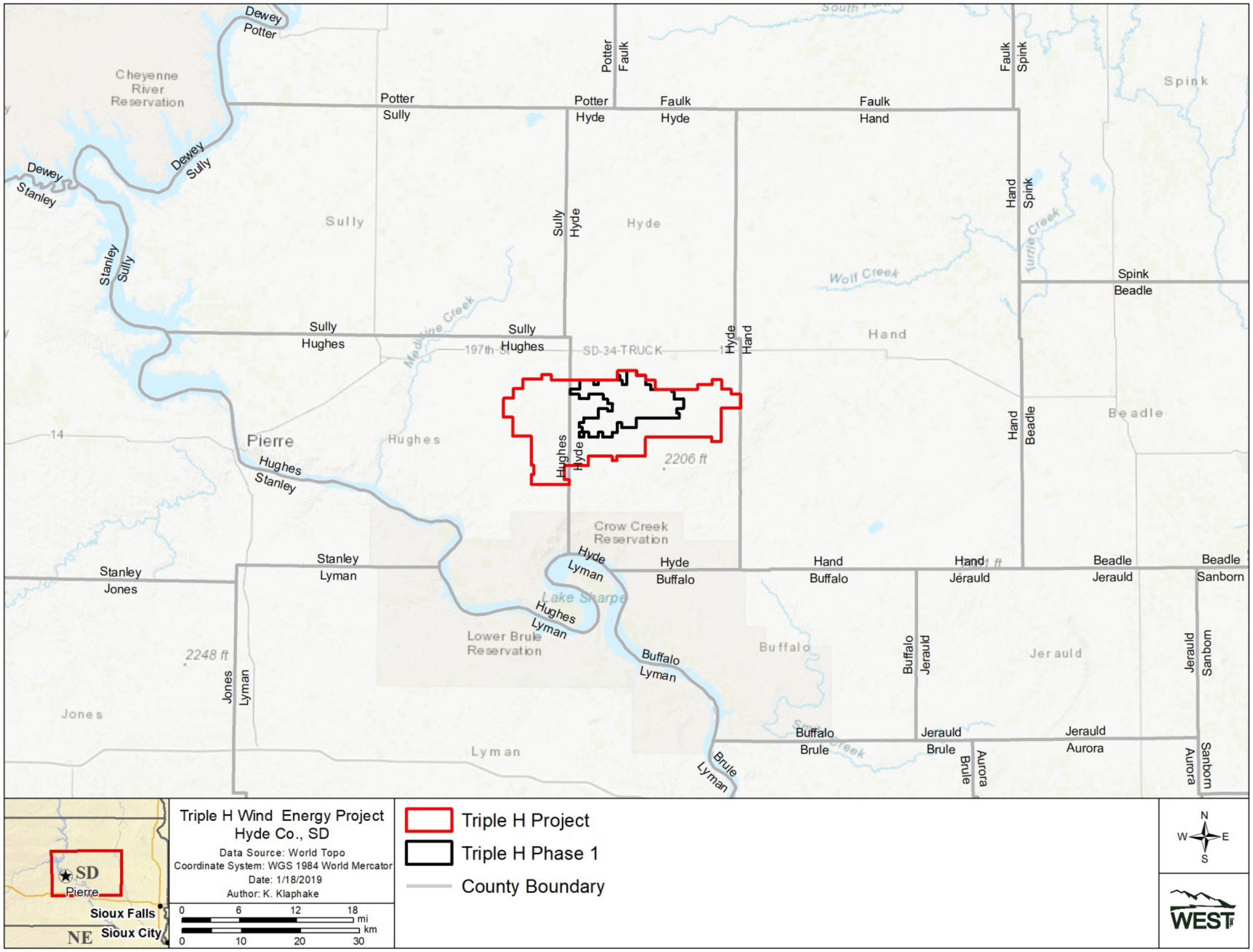


Figure 1. Location the Triple H Wind Project areas, Hyde and Hughes counties, South Dakota.

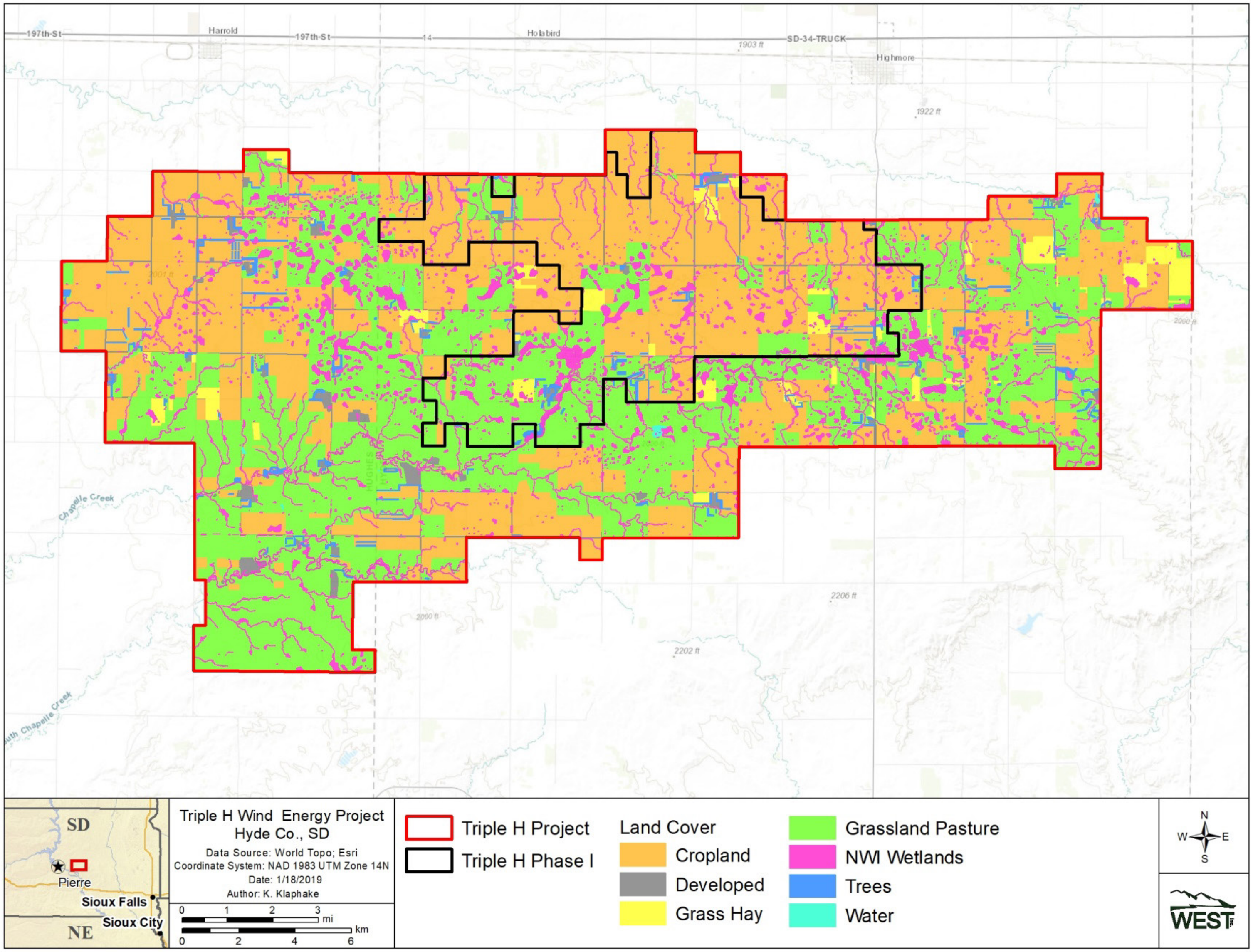


Figure 2. Digitized land cover types within the Triple H Wind Project Area, Hyde and Hughes counties, South Dakota.

Overview of Bat Diversity

Seven bat species potentially occur within the Project area (Table 2; International Union for Conservation of Nature 2017; USFWS 2017), one of which is federally listed at threatened, the northern long-eared bat (USFWS 2007). No bat species have state-protected status in South Dakota (South Dakota Game, Fish and Parks 2018).

Table 2. Bat species with potential to occur within the Triple H Wind Project area, Hyde and Hughes counties, South Dakota categorized by echolocation call frequency.

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

[1] species known to have been killed at wind energy facilities (American Wind Wildlife Institute 2018);
[2] federally threatened species (US Fish and Wildlife Service [USFWS] 2015); and
[3] long-distance migrant.
Sources: International Union for Conservation of Nature 2017; USFWS 2017.

White-Nose Syndrome

Hibernating bats in North America are being severely impacted by white-nose syndrome (WNS) an infectious mycosis in which bats are infected with a psychrophilic fungus from Europe (*Pseudogymnoascus* [formerly *Geomyces*] *destructans*) thought to act as a chronic disturbance during hibernation (USGS 2010; Minnis and Lindner 2013). Infected bats arouse frequently from hibernation, leading to premature loss of fat reserves and atypical behavior, which in turn can lead to starvation prior to spring emergence (Boyles and Willis 2010; Reeder et al. 2012; Warnecke et al. 2012). Data suggests in 2012 that between 5.7 and 6.7 million bats died as a result of WNS (USFWS 2012b).

WNS is the primary reason the USFWS recently listed the northern long-eared bat as threatened under the Endangered Species Act (USFWS 2015). WNS was first discovered in New York State in 2006 and to date the disease has spread to 33 states and seven Canadian provinces, reaching as far south as Alabama, as far north as Newfoundland, and as far west as Washington (Heffernan 2016; https://www.whitenosesyndrome.org). Recently, the causative fungus was identified in an additional three states including Wyoming, Texas, and Mississippi. The nearest county to confirm WNS is Custer County, South Dakota, approximately 156 mi (252 km) to the southwest of the Project area. The nearest county with suspected WNS is Jackson County, South Dakota, approximately 76 mi (122 km) southwest of the Project area (https://www.whitenosesyndrome.org).

METHODS

Bat Activity Survey

The bat activity acoustic monitoring was conducted to estimate the level of bat activity throughout the current Project area from April 25 – October 25, 2018.

Survey Stations

Six AnaBat SD2 ultrasonic bat detectors (Titley™ Scientific, Columbia, Missouri) were used during the surveys (Figure 3). All six AnaBat detectors were placed approximately 5.0 ft [1.5 m] above ground level [AGL] and were considered ground stations. Since species activity levels and composition can vary with altitude (Baerwald and Barclay 2009; Collins and Jones 2009; Müeller et al. 2013), microphones at ground stations likely detect a more complete sample of the bat species present within the Project area, whereas microphones at raised stations may give a more accurate assessment of risk to bat species flying at rotor swept heights (Kunz et al. 2007b; Collins and Jones 2009; Müeller et al. 2013; Roemer et al. 2017).

Four of the stations were located in habitat representative of potential turbine locations (‘representative stations’). Of those four, two stations were located in croplands (TH5 and TH6; Figure 3) and two within grassland habitat (TH1 and TH3; Figure 3), which are the dominant land cover types (Table 1) within the Project area. Representative stations TH3 and TH6 were located specifically in the Triple H Phase I Project area and stations TH1 and TH3 were located at meteorological (met) towers.

Two stations (TH2 and TH4; Figure 3) were placed in habitat with features attractive to bats for foraging, drinking, or roosting opportunities (‘bat feature stations’; e.g., ponds, deciduous trees, and shelterbelts). Monitoring at these features provides an upper threshold for bat activity in the Project area for comparison with representative stations. An experienced bat biologist selected locations of bat feature stations. Both bat feature stations were ground stations near ponds offering a potentially attractive perennial water source for bats.

Each AnaBat detector was enclosed within a plastic weather-tight container with a hole cut in the side through which the microphone extended. Each microphone was encased in a 45-degree angle PVC tube and holes were drilled in the PVC tube to allow water to drain. The container was placed on a PVC pole approximately 5.0 ft AGL and secured to the ground with guy lines and tent stakes.

Survey Schedule

Bat activity surveys were conducted from April 25 – October 25, 2018 and detectors were programmed to turn on 30 minutes (min) before sunset and turn off 30 min after sunrise each night. To highlight seasonal activity patterns, the surveys were divided into three survey periods: spring (April 25 – May 31), summer (June 1 – August 15), and fall (August 16 – October 25). Mean bat activity was also calculated for a standardized Fall Migration Period (FMP), defined here as July 30 – October 14. WEST defined the FMP as a standard for comparison with activity from other wind projects. During this time, bats begin moving toward wintering areas, and many species of bats initiate reproductive behaviors (Cryan 2008). This period of increased landscape-scale movement and reproductive behavior is often associated with increased levels of bat fatalities at operational wind energy facilities (Arnett et al. 2008; Cryan 2008; Arnett and Baerwald 2013; Barclay et al. 2017).

Data Collection and Call Analysis

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

For each survey location, bat passes were sorted into two groups based on their minimum call frequency. A bat pass was defined as a sequence of at least two echolocation calls (pulses) produced by an individual bat with no pause between calls of more than one second (Fenton 1980, Gannon et al. 2003). High-frequency (HF) bats such as eastern red bats (*Lasiurus borealis*) and *Myotis* species have minimum frequencies greater than 30 kHz. Low-frequency (LF) bats such as big brown bats (*Eptesicus fuscus*), silver-haired bats (*Lasionycteris noctivagans*), and hoary bats (*Lasiurus cinereus)* typically emit echolocation calls with minimum frequencies equal to or below 30 kHz. HF and LF species that may occur in the Project area are listed in Table 2.

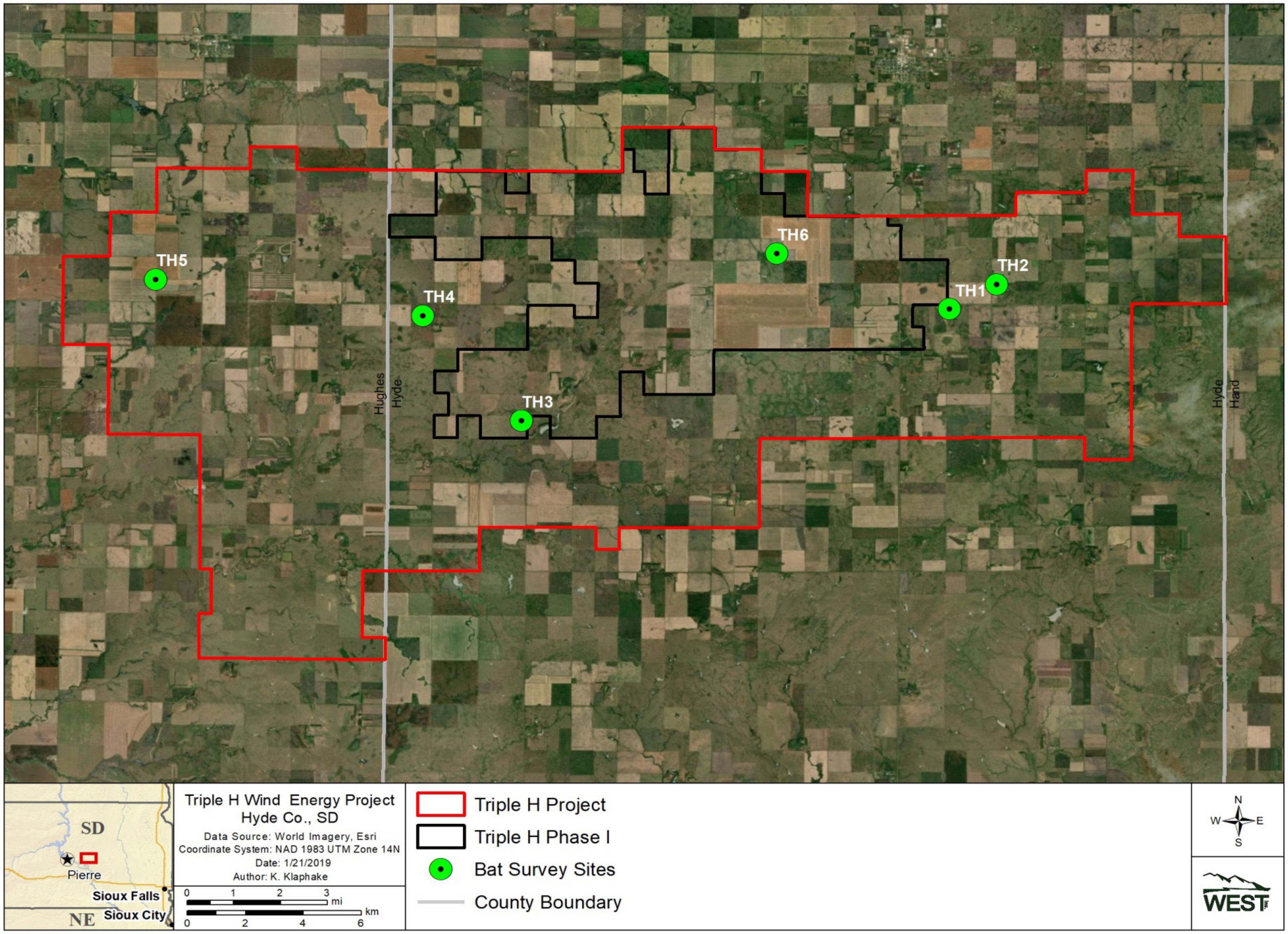


Figure 3. Location of bat stations within the Triple H Wind Project area, Hyde and Hughes counties, South Dakota.

Statistical Analysis

The standard metric used for measuring bat activity is the number of bat passes per detector-night; this metric was used as an index of bat activity in the Project area. A detector-night was defined as one detector operating for one entire night. Bat passes per detector-night were calculated for all bats, HF bats, and LF bats. Bat pass rates represent indices of bat activity and do not represent numbers of individuals. An experienced bat biologist determined the number of bat passes using Analook.

The period of peak sustained bat activity was defined as the seven-day period with the highest average bat activity. If multiple seven day periods equaled the peak sustained bat activity rate, all dates in these seven-day periods were reported. This and all multi-detector averages in this report were calculated as an unweighted average of total activity at each detector. Comparisons were made of mean bat activity during the spring, summer, and fall, to evaluate seasonal variation in bat activity during the study period and compared to the FMP. Comparisons between the representative stations and bat feature stations were not made due to bias caused by how the locations were selected.

RESULTS

Bat Activity Surveys

Bat activity was monitored at six stations for a total of 979 detector-nights from April 25 – October 25, 2018. All detectors and microphones were operating for 89.2% of the sampling period for all stations (Figure 4). The primary cause of lost data was excessive wind and insect noise in early August that filled up data cards and prevented further recording.

Spatial Variation

Bat activity within the overall Project area had low variation amongst representative stations (TH1, TH3, TH5, and TH6; Figure 5; Table 3). Station TH5 recorded the fewest bat passes per detector-night (0.11 ± 0.04) while station TH3 recorded the most (0.56 ± 0.08; Table 3, Figure 5). The two stations within the Triple H Phase I recorded 0.56 (TH3) and 0.23 (TH6) bat passes per detector-night.

Activity at bat feature stations (TH2 and TH4) was approximately three times higher (0.86 ± 0.12 bat passes per detector-night) than at representative ground stations (0.29 ± 0.04; Table 3). Variation amongst the bat feature station also was low with bat activity highest at TH4 (1.05 ± 0.20) compared to TH2 (0.68 ± 0.12; Table 3).

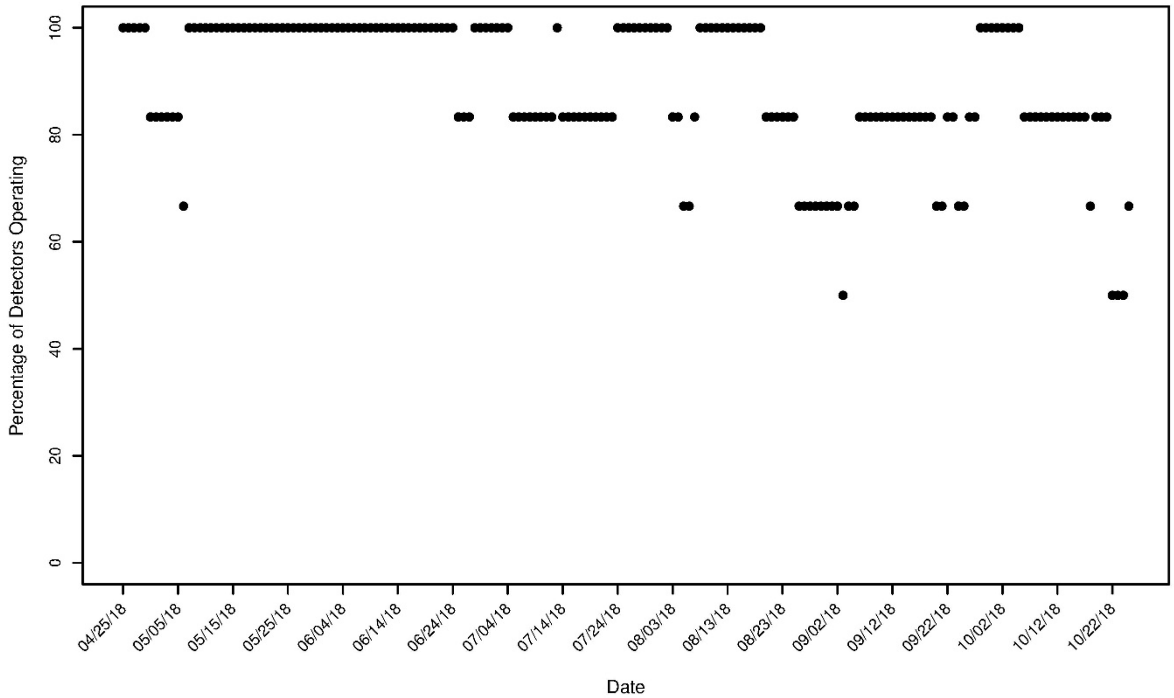


Figure 4. Operational status of all bat detectors and microphones (n=6) operating at the Triple H Wind Project area, Hyde and Hughes counties, South Dakota during each night of the survey period April 25 – October 25, 2018.

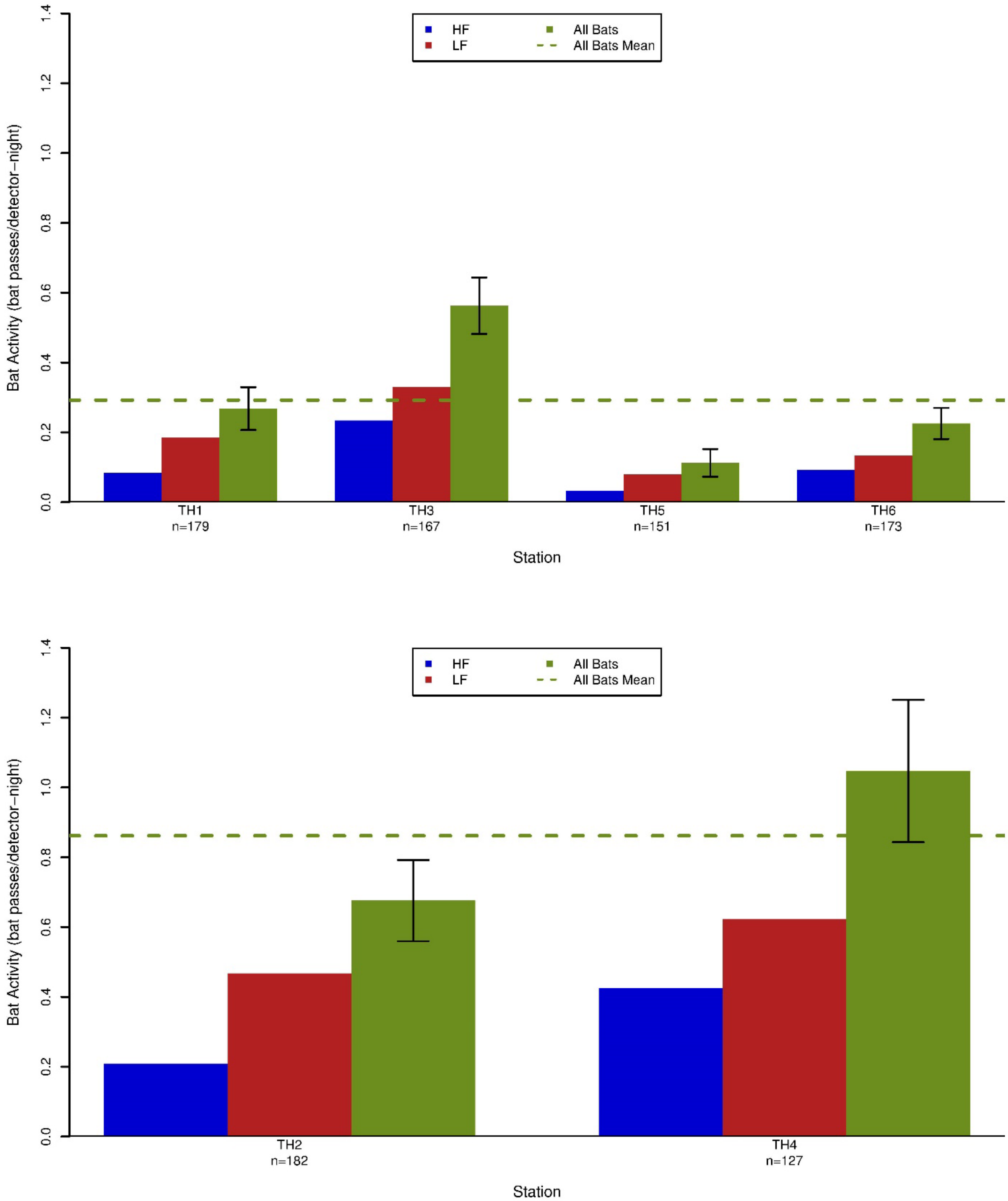


Figure 5. Number of high-frequency (HF) and low-frequency (LF) and all bats recorded bat passes per detector-night recorded at representative stations (top) and bat feature stations (bottom) within the Triple H Wind Project area, Hyde and Hughes counties, South Dakota from April 25 – October 25, 2018. The bootstrapped standard errors are represented by the black error bars on the 'All Bats' columns.

Table 3. Results of bat activity surveys conducted at stations within the Triple H Wind Project area, Hyde and Hughes counties, South Dakota from April 25 – October 25, 2018. Passes are separated by call frequency: high frequency (HF) and low frequency (LF).

Station	Type	# of HF Bat Passes	# of LF Bat Passes	Total Bat Passes	Detector-Nights	Bat Passes/ Night[1]
TH1	representative	15	33	48	179	0.27 ± 0.06
TH3[2]	representative	39	55	94	167	0.56 ± 0.08
TH5	representative	5	12	17	151	0.11 ± 0.04
TH6[2]	representative	16	23	39	173	0.23 ± 0.04
TH2	bat feature	38	85	123	182	0.68 ± 0.12
TH4	bat feature	54	79	133	127	1.05 ± 0.20
Total Representative		**75**	**123**	**198**	**670**	**0.29 ± 0.04**
Total Bat Feature		**92**	**164**	**256**	**309**	**0.86 ± 0.12**
Total		**167**	**287**	**454**	**979**	**---**

[1]± bootstrapped standard error.

[2]Stations within the Triple H Phase I project area

---Total not given due to differences in how stations were selected and their objectives

Temporal Variation

Bat activity at representative stations was relatively low (less than one bat pass per detector-night) across all seasons (Table 4a; Figure 6). Weekly acoustic activity at representative stations was relatively low from April through mid-July (Figure 7), but increased in late July through the second week in September, peaking from July 26 – August 1 (1.29 bat passes per detector-night; Table 5; Figure 7). Individually, HF and LF bat activity did not exceed one bat pass per detector night throughout the entire duration of the study. Overall bat activity declined sharply after the week of September 10 and remained relatively low, with low to no bat activity, for the remainder of the survey period (Figure 7). Bat activity at representative stations was 0.39 ± 0.06 during the FMP (Table 4a).

Bat activity at bat feature stations was relatively low in the spring and summer and higher in fall (Table 4b; Figure 6). Weekly acoustic activity at representative stations was relatively low from April through early July (Figure 7), but increased in mid-July through the second week in September, peaking from August 26 – September 1 (3.86 bat passes per detector-night; Table 5; Figure 7). HF bat activity peaked earlier, from July 15 – July 21 (2.00 bat passes per detector-night; Table 5; Figure 7). Overall bat activity declined sharply by the week of September 10 and remained relatively low, with low to no bat activity, for the remainder of the survey period (Figure 7). Bat activity at bat feature stations was 1.24 ± 0.29 during the FMP (Table 4b).

Table 4a. The number of bat passes per detector-night recorded at representative stations within the Triple H Wind Project area, Hyde and Hughes counties, South Dakota during each season, separated by call frequency: high-frequency (HF), low-frequency (LF), and all bats (AB).

Station	Call Frequency	Spring Apr 25 – May 31	Summer Jun 1 – Aug 15	Fall Aug 16 – Oct 25	Fall Migration Period Jul 30 – Oct 14
TH1	LF	0.19	0.10	0.27	0.31
	HF	0	0.10	0.11	0.18
	AB	0.19	0.20	0.38	0.49
TH3[1]	LF	0.28	0.29	0.39	0.47
	HF	0	0.29	0.27	0.32
	AB	0.28	0.59	0.66	0.79
TH5	LF	0.17	0.03	0.08	0.07
	HF	0	0.06	0.02	0.03
	AB	0.17	0.09	0.10	0.10
TH6[1]	LF	0.25	0.13	0.07	0.10
	HF	0	0.18	0.03	0.08
	AB	0.25	0.32	0.10	0.18
Representative Totals	**LF**	**0.22 ± 0.05**	**0.14 ± 0.02**	**0.20 ± 0.05**	**0.23 ± 0.04**
	HF	**0.00 ± 0.00**	**0.16 ± 0.05**	**0.11 ± 0.03**	**0.16 ± 0.04**
	AB	**0.22 ± 0.05**	**0.30 ± 0.07**	**0.31 ± 0.06**	**0.39 ± 0.06**

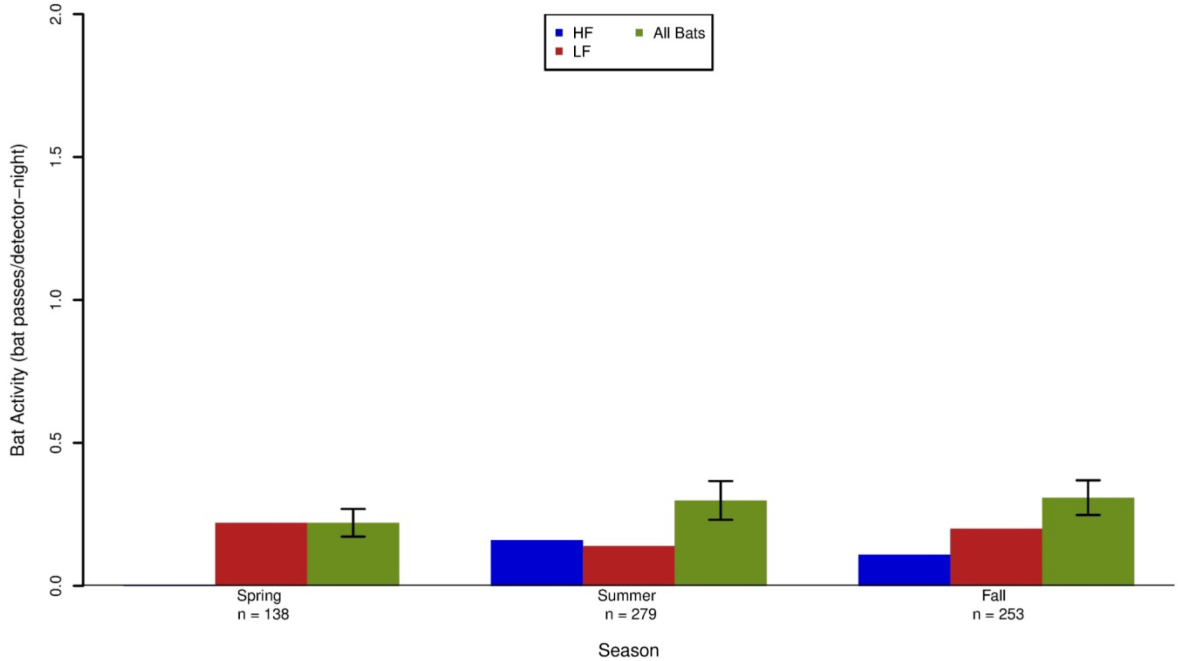
[1]Stations within the Triple H Phase I project area

Table 4b. The number of bat passes per detector-night recorded at bat feature stations within the Triple H Wind Project area, Hyde and Hughes counties, South Dakota during each season, separated by call frequency: high-frequency (HF), low-frequency (LF), and all bats (AB).

Station	Call Frequency	Spring Apr 25 – May 31	Summer Jun 1 – Aug 15	Fall Aug 16 – Oct 25	Fall Migration Period Jul 30 – Oct 14
TH2	LF	0.53	0.25	0.67	0.66
	HF	0.03	0.28	0.23	0.28
	AB	0.56	0.53	0.90	0.93
TH4	LF	0.75	0.38	1.33	0.89
	HF	0	0.64	0.39	0.66
	AB	0.75	1.03	1.72	1.54
Bat Feature Totals	**LF**	**0.64 ± 0.14**	**0.32 ± 0.05**	**1.00 ± 0.46**	**0.77 ± 0.24**
	HF	**0.01 ± 0.01**	**0.46 ± 0.10**	**0.31 ± 0.11**	**0.47 ± 0.12**
	AB	**0.65 ± 0.14**	**0.78 ± 0.13**	**1.31 ± 0.50**	**1.24 ± 0.29**

Table 5. Periods of peak activity at representative and bat feature stations for high-frequency (HF), low-frequency (LF), and all bats at the Triple H Wind Project area, Hyde and Hughes counties, South Dakota from April 25 – October 25, 2018.

Station Type	Species Group	Start Date of Peak Activity	End Date of Peak Activity	Bat Passes per Detector-Night
Representative	HF	July 26	August 1	0.96
	LF	August 21	August 27	0.95
	All Bats	July 26	August 1	1.29
Bat Feature	HF	July 15	July 21	2.00
	LF	August 26	September 1	3.14
	All Bats	August 26	September 1	3.86



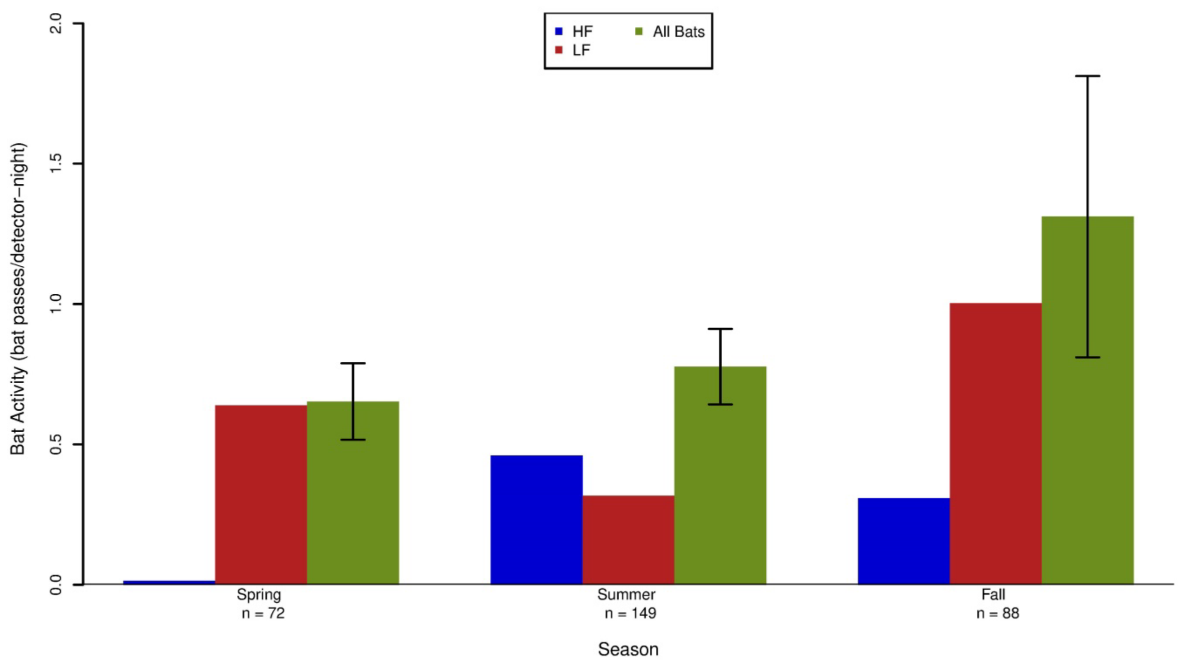
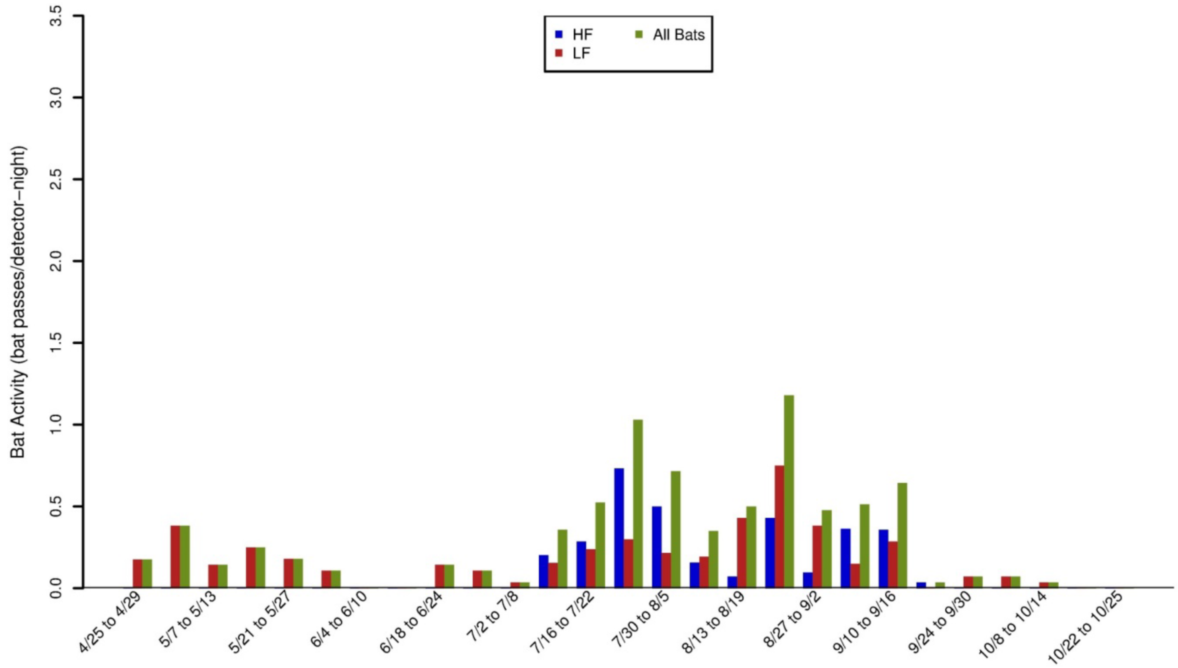


Figure 6. Seasonal bat activity at representative stations (top) and bat feature stations (bottom) by high-frequency (HF), low-frequency (LF), and all bats at the Triple H Wind Project area, Hyde and Hughes counties, South Dakota from April 25 – October 25, 2018. The bootstrapped standard errors are represented on the 'All Bats' columns. HF column is absent in the spring because no HF bat passes were recorded.



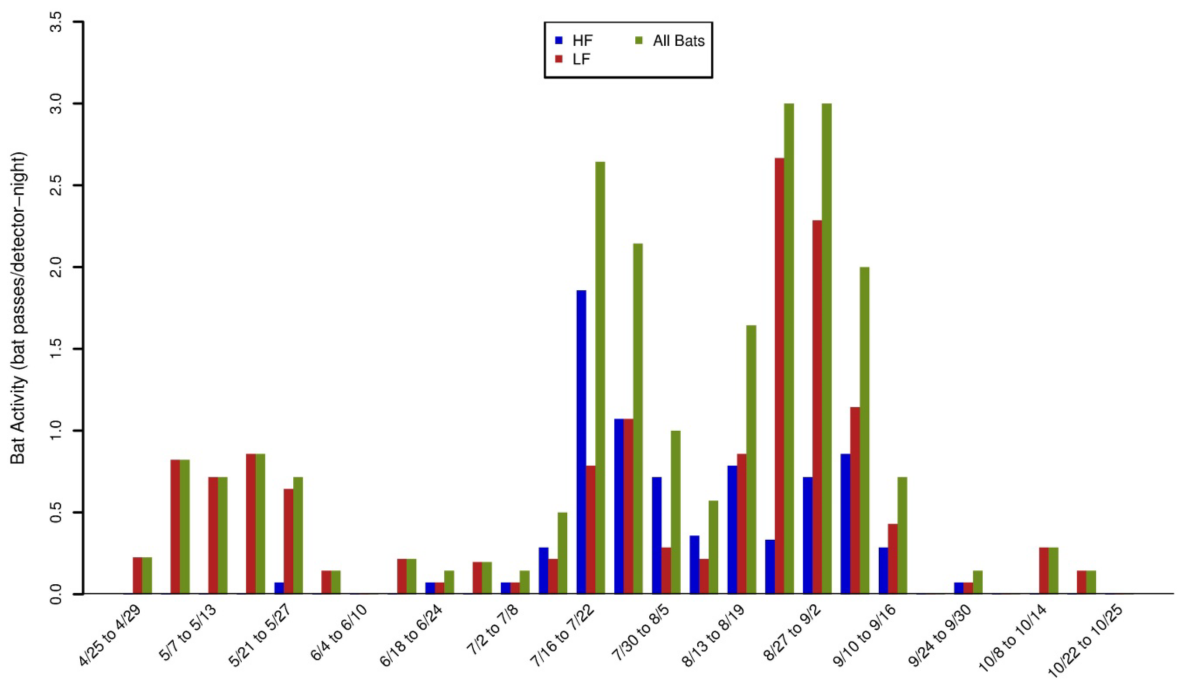


Figure 7. Weekly patterns of bat activity at representative stations (top) and bat feature stations (bottom) by high-frequency (HF), low-frequency (LF), and all bats at the Triple H Wind Project area, Hyde and Hughes counties, South Dakota from April 25 – October 25, 2018. HF columns are absent in the spring and early summer because no HF bat passes were recorded.

Species Composition

Of the total bat passes recorded at representative stations, 62.1% were classified as LF (e.g., big brown bats, hoary bats, and silver-haired bats), and 37.9% of bat passes were classified as HF (e.g., eastern red bats and *Myotis* species; Tables 2 and 3; Figure 6). At bat feature stations, the majority of recorded calls also were produced by LF bats (64.1%; Table 3; Figure 6).

DISCUSSION

Bat fatalities have been discovered at most wind energy facilities monitored in North America, with fatality estimates ranging from 0 to 49.70 bat fatalities/megawatt (MW)/year (American Wind Wildlife Institute [AWWI] 2018). A summary of 202 studies at 137 wind energy facilities in the US found that the majority of wind energy facilities reported fewer than five bat fatalities/MW/year, with a nationwide median of 2.66 bat fatalities/MW/year (AWWI 2018). In 2012, an estimated 600,000 bats died as a result of interactions with wind turbines in the US (Hayes 2013). Wind development may pose a threat to populations of migratory bats in particular. Projection models estimate that populations of hoary bats could decline as much as 90% in the next 50 years (Frick et al. 2017). Proximate causes of bat fatalities are primarily due to collisions with moving turbine blades (Grodsky et al. 2011; Rollins et al. 2012). The underlying reason(s) why bats come near turbines is still largely unknown (Cryan and Barclay 2009; Barclay et al. 2017).

To date, post-construction monitoring studies of wind energy facilities in the US show the following: a) migratory tree-roosting species (e.g., eastern red bat, hoary bat, and silver-haired bat) compose approximately 72% of reported bat fatalities; b) the majority of fatalities occur during the fall migration season (August and September); and c) most fatalities occur on nights with relatively low wind speeds (e.g., <6.0 m/s; Arnett et al.2008; Arnett et al. 2013; AWWI 2018; Thompson et al. 2017).

Overall bat activity was low at the Project (0.29 bat passes per detector-night at representative stations and 0.86 bat passes per detector-night at bat feature stations). Mean bat activity during the FMP, the time period when most bats are migrating, at representative stations (0.39 ± 0.06 bat passes per detector-night; Table 4) was lower than the national median (7.68 bat passes per detector-night) and lower than the median of the studies available from the Midwest (6.97 bat passes per detector-night; Appendix A). Bat activity was highest within the Project area during the fall migration period, peaking from late July to early August at representative stations. This timing is slightly earlier than peak fatality periods for most wind energy facilities in the US (AWWI 2018), and suggests that bat fatalities at the Project maybe higher during late summer to early fall.

Bat activity at the two stations within the Triple H Phase I Project area (TH3 and TH6) had similar bat activity to the other representative stations within the overall Project area; therefore, the data indicates that patterns seen at the Phase I Project area are similar to the overall Project area.

Activity by HF bat species composed 37.9% of bat passes recorded at representative stations and 35.9% at bat feature stations in the Project area. Eastern red bats are usually the most common HF species found during carcass searches (Arnett et al. 2008; Arnett and Baerwald 2013; AWWI 2018). *Myotis* species are recorded less commonly than other species in the rotor-swept zone or as fatalities at most post-construction studies of wind energy facilities (Kunz et al. 2007b; Arnett et al. 2008; AWWI 2018), with a few notable exceptions (Kerns and Kerlinger 2004; Jain 2005; Brown and Hamilton 2006; Gruver et al. 2009).

Approximately 62.1% and 64.1% of bat passes recorded at representative and bat feature stations in the Project area were emitted by LF bats. LF species may become casualties because they fly at higher altitudes (Table 3; Figure 6). Given that hoary bats, eastern red bats, and silver-haired bats are among the most common bat fatalities at many facilities (Arnett et al. 2008; Arnett and Baerwald 2013; AWWI 2018), it is expected that these three species would be the most common fatalities at the Project.

Over two-thirds of bat fatality studies in the Midwest report fewer than five bat fatalities/MW/year (Appendix A; Figure 8), it is possible that similar fatality rates could be recorded at the Project. However, some studies indicate that facilities in agricultural settings in the Midwest can produce higher levels of bat fatalities (Jain 2005, Baerwald 2008, Gruver et al. 2009). The closest operating wind-energy facility to the Project with public post-construction fatality data is the Prairie Winds SD, located approximately 50 mi (80 km) southeast of the Project. The Prairie Winds SD wind-energy facility is primarily composed of herbaceous grassland habitat, whereas the Project is primarily composed of cropland and grassland habitat. Bat casualty rates at Prairie Winds SD have ranged from 0.52–1.23 bats/MW/study period (Derby et al. 2012d, 2013a, and 2014a); it is likely that Triple H will have similar fatality rates.

In summary, bat activity rates within the Project area are much lower than other wind projects in the Midwest. The bat activity patterns within the overall Project area were similar to the bat activity recorded within the Triple H Phase I Project area. Data suggests that most bat fatalities within the overall Project area and the Triple H Phase I Project area will occur during the fall consisting primarily of hoary, eastern red, and silver-haired bats. The pre-construction bat activity surveys completed within the Project area will add to the growing body of research regarding the impacts of wind energy development on bats.

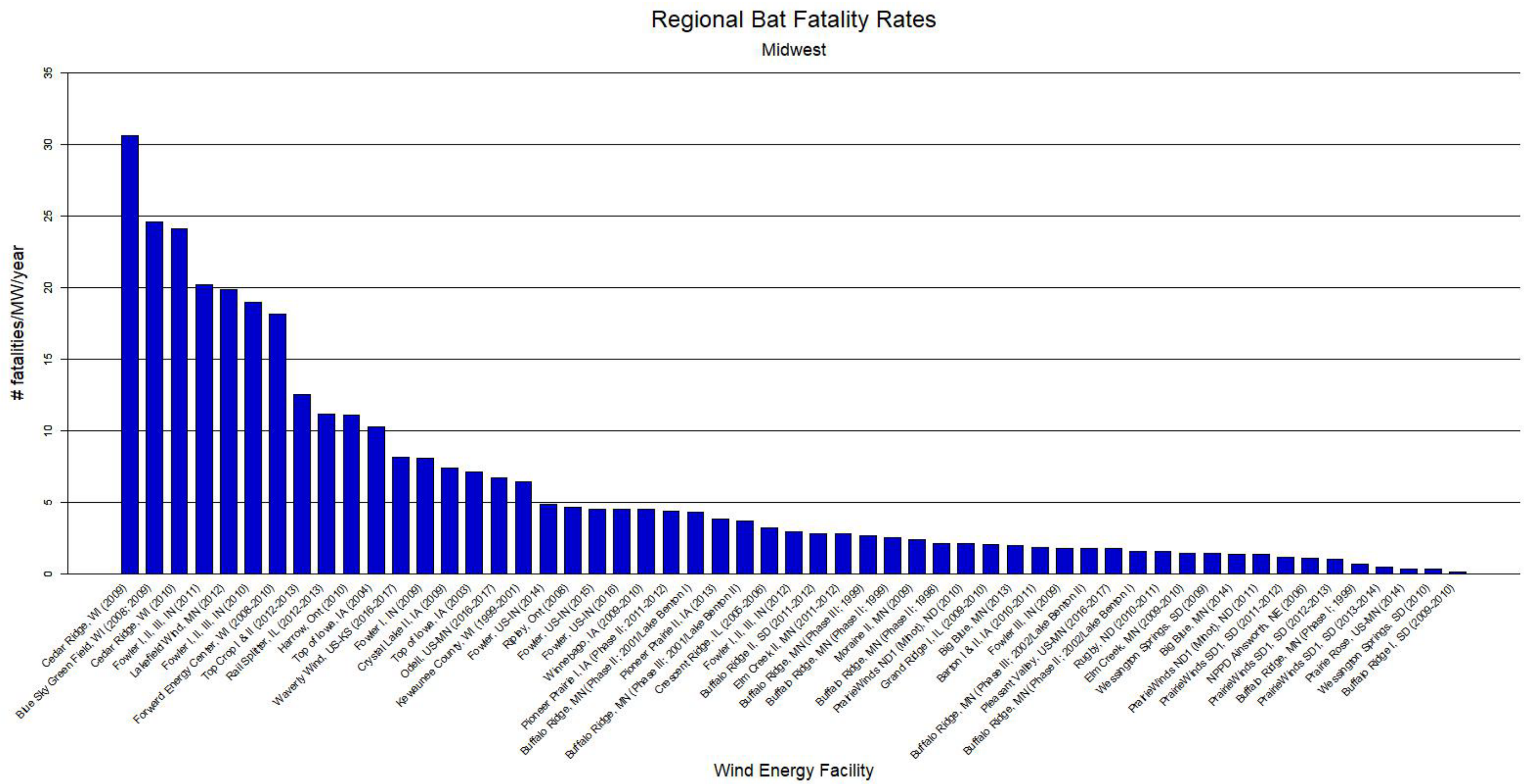


Figure 8. Fatality rates for bats (number of bats per megawatts per year) from publically available wind energy facilities in the Midwest Region of North America.

Figure 8. Fatality rates for bats (number of bats per megawatts per year) from publically available wind energy facilities in the Midwest region of North America.

Facility Study	Activity Estimate Citation	Fatality Estimate Citation	Facility Study	Activity Estimate Citation	Fatality Estimate Citation
Triple H, SD		This study			
Cedar Ridge, WI (2009)	BHE Environmental 2008	BHE Environmental 2010	Buffalo Ridge II, SD (2011-2012)		Derby et al. 2012a
Blue Sky Green Field, WI (2008; 2009)	Gruver 2008	Gruver et al. 2009	Elm Creek II, MN (2011-2012)		Derby et al. 2012b
Cedar Ridge, WI (2010)	BHE Environmental 2008	BHE Environmental 2011	Buffalo Ridge, MN (Phase III; 1999)		Johnson et al. 2000
Fowler I, II, III, IN (2011)		Good et al. 2012	Buffalo Ridge, MN (Phase II; 1999)		Johnson et al. 2000
Lakefield Wind, MN (2012)		Minnesota Public Utilities Commission 2012	Moraine II, MN (2009)		Derby et al. 2010f
Fowler I, II, III, IN (2010)		Good et al. 2011	Buffalo Ridge, MN (Phase II; 1998)		Johnson et al. 2000
Forward Energy Center, WI (2008-2010)	Watt and Drake 2011	Grodsky and Drake 2011	PrairieWinds ND1 (Minot), ND (2010)		Derby et al. 2011d
Top Crop I & II, IL (2012-2013)		Good et al. 2013c	Grand Ridge I, IL (2009-2010)		Derby et al. 2010a
Rail Splitter, IL (2012-2013)		Good et al. 2013b	Big Blue, MN (2013)		Fagen Engineering 2014
Harrow, Ont (2010)		Natural Resources Solutions Inc. (NRSI) 2011	Barton I & II, IA (2010-2011)		Derby et al. 2011b
Top of Iowa, IA (2004)	Jain 2005	Jain 2005	Fowler III, IN (2009)		Johnson et al. 2010b
Waverly Wind, KS (2016-2017)		Tetra Tech 2017a	Buffalo Ridge, MN (Phase III; 2002/Lake Benton II)	Johnson et al. 2004	Johnson et al. 2004
Fowler I, IN (2009)		Johnson et al. 2010a	Pleasant Valley, MN (2016-2017)		Tetra Tech 2017b
Crystal Lake II, IA (2009)		Derby et al. 2010b	Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)	Johnson et al. 2004	Johnson et al. 2004
Top of Iowa, IA (2003)		Jain 2005	Rugby, ND (2010-2011)		Derby et al. 2011c
Odell, MN (2016-2017)		Chodachek and Gustafson 2018	Elm Creek II, MN (2011-2012)		Derby et al. 2012b

Figure 8. Fatality rates for bats (number of bats per megawatts per year) from publically available wind energy facilities in the Midwest region of North America.

Facility Study	Activity Estimate Citation	Fatality Estimate Citation	Facility Study	Activity Estimate Citation	Fatality Estimate Citation
Triple H, SD		This study			
Kewaunee County, WI (1999-2001)		Howe et al. 2002	Wessington Springs, SD (2009)		Derby et al. 2010c
Fowler, IN (2014)		Good et al. 2015	Big Blue, MN (2014)		Fagen Engineering 2015
Ripley, Ont (2008)		Jacques Whitford 2009	PrairieWinds ND1 (Minot), ND (2011)		Derby et al. 2012d
Fowler, IN (2015)		Good et al. 2016	PrairieWinds SD1, SD (2011-2012)		Derby et al. 2012c
Fowler, IN (2016)		Good et al. 2017	NPPD Ainsworth, NE (2006)		Derby et al. 2007
Winnebago, IA (2009-2010)		Derby et al. 2010g	PrairieWinds SD1, SD (2012-2013)		Derby et al. 2013a
Pioneer Prairie I, IA (Phase II; 2011-2012)		Chodachek et al. 2012	Buffalo Ridge, MN (Phase I; 1999)		Johnson et al. 2000
Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)	Johnson et al. 2004	Johnson et al. 2004	PrairieWinds SD1, SD (2013-2014)		Derby et al. 2014b
Pioneer Prairie II, IA (2013)		Chodachek et al. 2014	Prairie Rose, MN (2014)		Chodachek et al. 2015
Buffalo Ridge, MN (Phase III; 2001/Lake Benton II)	Johnson et al. 2004	Johnson et al. 2004	Wessington Springs, SD (2010)		Derby et al. 2011a
Crescent Ridge, IL (2005-2006)		Kerlinger et al. 2007	Buffalo Ridge I, SD (2009-2010)		Derby et al. 2010d
Fowler I, II, III, IN (2012)		Good et al. 2013a			

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Appendix A: North American Fatality Summary Tables

Appendix A1. Wind energy facilities in North America with comparable activity and fatality data for bats, separated by geographic region.

Wind Energy Facility	Bat Activity Estimate[A]	Bat Activity Dates	Fatality Estimate[B]	No. of Turbines	Total MW
Triple H, SD	**0.39**	**4/25/18-10/25/18**			
		Midwest			
Cedar Ridge, WI (2009)	9.97	7/16/07-9/30/07	30.61	41	67.6
Blue Sky Green Field, WI (2008; 2009)	7.7	7/24/07-10/29/07	24.57	88	145
Cedar Ridge, WI (2010)	9.97	7/16/07-9/30/07	24.12	41	68
Fowler I, II, III, IN (2011)	NA	NA	20.19	355	600
Fowler I, II, III, IN (2010)	NA	NA	18.96	355	600
Forward Energy Center, WI (2008-2010)	6.97	8/5/08-11/08/08	18.17	86	129
Top Crop I & II (2012-2013)	NA	NA	12.55	68 (phase I) 132 (phase (II)	300 (102 (phase I) 198 (phase II))
Rail Splitter, IL (2012-2013)	NA	NA	11.21	67	100.5
Harrow, Ont (2010)	NA	NA	11.13	24 (four 6-turb facilities)	39.6
Top of Iowa, IA (2004)	35.7	5/26/04-9/24/04	10.27	89	80
Heritage Garden I, MI (2013-2014)	NA	NA	8.2	14	28
Fowler I, IN (2009)	NA	NA	8.09	162	301
Crystal Lake II, IA (2009)	NA	NA	7.42	80	200
Top of Iowa, IA (2003)	NA	NA	7.16	89	80
Kewaunee County, WI (1999-2001)	NA	NA	6.45	31	20.46
Heritage Garden I, MI (2012-2013)	NA	NA	5.9	14	28
Ripley, Ont (2008)	NA	NA	4.67	38	76
Winnebago, IA (2009-2010)	NA	NA	4.54	10	20
Pioneer Prairie II, IA (2011-2012)	NA	NA	4.43	62	102.3
Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)	2.2	6/15/01-9/15/01	4.35	143	107.25
Pioneer Prairie II, IA (2013)	NA	NA	3.83	62	102.3
Buffalo Ridge, MN (Phase III; 2001/Lake Benton II)	2.2	6/15/01-9/15/01	3.71	138	103.5
Crescent Ridge, IL (2005-2006)	NA	NA	3.27	33	49.5
Fowler I, II, III, IN (2012)	NA	NA	2.96	355	600
Elm Creek II, MN (2011-2012)	NA	NA	2.81	62	148.8
Buffalo Ridge II, SD (2011-2012)	NA	NA	2.81	105	210
Buffalo Ridge, MN (Phase III; 1999)	NA	NA	2.72	138	103.5
Buffalo Ridge, MN (Phase II; 1999)	NA	NA	2.59	143	107.25
Moraine II, MN (2009)	NA	NA	2.42	33	49.5
Buffalo Ridge, MN (Phase II; 1998)	NA	NA	2.16	143	107.25
PrairieWinds ND1 (Minot), ND (2010)	NA	NA	2.13	80	115.5
Grand Ridge I, IL (2009-2010)	NA	NA	2.1	66	99
Big Blue, MN (2013)	NA	NA	2.04	18	36
Barton I & II, IA (2010-2011)	NA	NA	1.85	80	160
Fowler III, IN (2009)	NA	NA	1.84	60	99
Buffalo Ridge, MN (Phase III; 2002/Lake Benton II)	1.9	6/15/02-9/15/02	1.81	138	103.5
Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)	1.9	6/15/02-9/15/02	1.64	143	107.25
Rugby, ND (2010-2011)	NA	NA	1.6	71	149
Elm Creek, MN (2009-2010)	NA	NA	1.49	67	100

Appendix A1. Wind energy facilities in North America with comparable activity and fatality data for bats, separated by geographic region.

Wind Energy Facility	Bat Activity Estimate[A]	Bat Activity Dates	Fatality Estimate[B]	No. of Turbines	Total MW
Wessington Springs, SD (2009)	NA	NA	1.48	34	51
Big Blue, MN (2014)	NA	NA	1.43	18	36
PrairieWinds ND1 (Minot), ND (2011)	NA	NA	1.39	80	115.5
PrairieWinds SD1, SD (2011-2012)	NA	NA	1.23	108	162
NPPD Ainsworth, NE (2006)	NA	NA	1.16	36	20.5
PrairieWinds SD1, SD (2012-2013)	NA	NA	1.05	108	162
Buffalo Ridge, MN (Phase I; 1999)	NA	NA	0.74	73	25
PrairieWinds SD1, SD (2013-2014)	NA	NA	0.52	108	162
Wessington Springs, SD (2010)	NA	NA	0.41	34	51
Buffalo Ridge I, SD (2009-2010)	NA	NA	0.16	24	50.4
California					
Shiloh I, CA (2006-2009)	NA	NA	3.92	100	150
Shiloh II, CA (2010-2011)	NA	NA	3.8	75	150
Shiloh II, CA (2011-2012)	NA	NA	3.4	75	150
Shiloh II, CA (2009-2010)	NA	NA	2.6	75	150
High Winds, CA (2003-2004)	NA	NA	2.51	90	162
Dillon, CA (2008-2009)	NA	NA	2.17	45	45
Montezuma I, CA (2011)	NA	NA	1.9	16	36.8
High Winds, CA (2004-2005)	NA	NA	1.52	90	162
Alta I, CA (2011-2012)	4.42	6/26/2009 - 10/31/2009	1.28	100	150
Montezuma II, CA (2012-2013)	NA	NA	0.91	34	78.2
Montezuma I, CA (2012)	NA	NA	0.84	16	36.8
Diablo Winds, CA (2005-2007)	NA	NA	0.82	31	20.46
Shiloh III, CA (2012-2013)	NA	NA	0.4	50	102.5
Solano III, CA (2012-2013)	NA	NA	0.31	55	128
Alite, CA (2009-2010)	NA	NA	0.24	8	24
Mustang Hills, CA (2012-2013)	NA	NA	0.1	50	150
Alta II-V, CA (2011-2012)	0.78	6/26/2009 - 10/31/2009	0.08	190	570
Pinyon Pines I & II, CA (2013-2014)	NA	NA	0.04	100	NA
Alta VIII, CA (2012-2013)	NA	NA	0	50	150
Pacific Northwest					
Palouse Wind, WA (2012-2013)	NA	NA	4.23	58	104.4
Biglow Canyon, OR (Phase II; 2009-2010)	NA	NA	2.71	65	150
Nine Canyon, WA (2002-2003)	NA	NA	2.47	37	48.1
Stateline, OR/WA (2003)	NA	NA	2.29	454	299
Elkhorn, OR (2010)	NA	NA	2.14	61	101
White Creek, WA (2007-2011)	NA	NA	2.04	89	204.7
Biglow Canyon, OR (Phase I; 2008)	NA	NA	1.99	76	125.4
Leaning Juniper, OR (2006-2008)	NA	NA	1.98	67	100.5
Big Horn, WA (2006-2007)	NA	NA	1.9	133	199.5
Combine Hills, OR (Phase I; 2004-2005)	NA	NA	1.88	41	41
Linden Ranch, WA (2010-2011)	NA	NA	1.68	25	50
Pebble Springs, OR (2009-2010)	NA	NA	1.55	47	98.7
Hopkins Ridge, WA (2008)	NA	NA	1.39	87	156.6
Harvest Wind, WA (2010-2012)	NA	NA	1.27	43	98.9
Elkhorn, OR (2008)	NA	NA	1.26	61	101
Vansycle, OR (1999)	NA	NA	1.12	38	24.9
Klondike III (Phase I), OR (2007-2009)	NA	NA	1.11	125	223.6
Stateline, OR/WA (2001-2002)	NA	NA	1.09	454	299
Stateline, OR/WA (2006)	NA	NA	0.95	454	299

Appendix A1. Wind energy facilities in North America with comparable activity and fatality data for bats, separated by geographic region.

Wind Energy Facility	Bat Activity Estimate[A]	Bat Activity Dates	Fatality Estimate[B]	No. of Turbines	Total MW
Tuolumne (Windy Point I), WA (2009-2010)	NA	NA	0.94	62	136.6
Klondike, OR (2002-2003)	NA	NA	0.77	16	24
Combine Hills, OR (2011)	NA	NA	0.73	104	104
Hopkins Ridge, WA (2006)	NA	NA	0.63	83	150
Biglow Canyon, OR (Phase I; 2009)	NA	NA	0.58	76	125.4
Biglow Canyon, OR (Phase II; 2010-2011)	NA	NA	0.57	65	150
Hay Canyon, OR (2009-2010)	NA	NA	0.53	48	100.8
Windy Flats, WA (2010-2011)	NA	NA	0.41	114	262.2
Klondike II, OR (2005-2006)	NA	NA	0.41	50	75
Vantage, WA (2010-2011)	NA	NA	0.4	60	90
Wild Horse, WA (2007)	NA	NA	0.39	127	229
Goodnoe, WA (2009-2010)	NA	NA	0.34	47	94
Marengo II, WA (2009-2010)	NA	NA	0.27	39	70.2
Biglow Canyon, OR (Phase III; 2010-2011)	NA	NA	0.22	76	174.8
Marengo I, WA (2009-2010)	NA	NA	0.17	78	140.4
Klondike IIIa (Phase II), OR (2008-2010)	NA	NA	0.14	51	76.5
Kittitas Valley, WA (2011-2012)	NA	NA	0.12	48	100.8
Rocky Mountains					
Summerview, Alb (2006; 2007)	7.65	07/15/06-07-09/30/06-07	11.42	39	70.2
Summerview, Alb (2005-2006)	NA	NA	10.27	39	70.2
Judith Gap, MT (2006-2007)	NA	NA	8.93	90	135
Foote Creek Rim, WY (Phase I; 1999)	NA	NA	3.97	69	41.4
Judith Gap, MT (2009)	NA	NA	3.2	90	135
Milford I, UT (2010-2011)	NA	NA	2.05	58	145
Milford I & II, UT (2011-2012)	NA	NA	1.67	107	160.5 (58.5 I, 102 II)
Foote Creek Rim, WY (Phase I; 2001-2002)	2.2	6/15/01-9/1/01	1.57	69	41.4
Foote Creek Rim, WY (Phase I; 2000)	2.2	6/15/00-9/1/00	1.05	69	41.4
Southern Plains					
Barton Chapel, TX (2009-2010)	NA	NA	3.06	60	120
Big Smile, OK (2012-2013)	NA	NA	2.9	66	132
Buffalo Gap II, TX (2007-2008)	NA	NA	0.14	155	233
Red Hills, OK (2012-2013)	NA	NA	0.11	82	123
Buffalo Gap I, TX (2006)	NA	NA	0.1	67	134
Southwest					
Dry Lake I, AZ (2009-2010)	8.8	4/29/10-11/10/10	3.43	30	63
Dry Lake II, AZ (2011-2012)	11.5	5/11/11-10/26/11	1.66	31	65
Southeast					
Buffalo Mountain, TN (2005)	NA	NA	39.7	18	28.98
Buffalo Mountain, TN (2000-2003)	23.7	NA	31.54	3	1.98
Northeast					
Pinnacle, WV (2012)	NA	NA	40.2	23	55.2
Mountaineer, WV (2003)	NA	NA	31.69	44	66
Mount Storm, WV (2009)	30.09	7/15/09-10/7/09	17.53	132	264
Noble Wethersfield, NY (2010)	NA	NA	16.3	84	126
Criterion, MD (2011)	NA	NA	15.61	28	70
Mount Storm, WV (2010)	36.67	4/18/10-10/15/10	15.18	132	264
Locust Ridge, PA (Phase II; 2010)	NA	NA	14.38	51	102
Locust Ridge, PA (Phase II; 2009)	NA	NA	14.11	51	102

Appendix A1. Wind energy facilities in North America with comparable activity and fatality data for bats, separated by geographic region.

Wind Energy Facility	Bat Activity Estimate[A]	Bat Activity Dates	Fatality Estimate[B]	No. of Turbines	Total MW
Casselman, PA (2008)	NA	NA	12.61	23	34.5
Maple Ridge, NY (2006)	NA	NA	11.21	120	198
Cohocton/Dutch Hills, NY (2010)	NA	NA	10.32	50	125
Wolfe Island, Ont (July-December 2010)	NA	NA	9.5	86	197.8
Cohocton/Dutch Hill, NY (2009)	NA	NA	8.62	50	125
Casselman, PA (2009)	NA	NA	8.6	23	34.5
Noble Bliss, NY (2008)	NA	NA	7.8	67	100
Criterion, MD (2012)	NA	NA	7.62	28	70
Mount Storm, WV (2011)	NA	NA	7.43	132	264
Maple Ridge, NY (2012)	NA	NA	7.3	195	321.75
Mount Storm, WV (Fall 2008)	35.2	7/20/08-10/12/08	6.62	82	164
Maple Ridge, NY (2007)	NA	NA	6.49	195	321.75
Wolfe Island, Ont (July-December 2009)	NA	NA	6.42	86	197.8
Criterion, MD (2013)	NA	NA	5.32	28	70
Maple Ridge, NY (2007-2008)	NA	NA	4.96	195	321.75
Noble Clinton, NY (2009)	1.9	8/1/09-09/31/09	4.5	67	100
Casselman Curtailment, PA (2008)	NA	NA	4.4	23	35.4
Noble Altona, NY (2010)	NA	NA	4.34	65	97.5
Noble Ellenburg, NY (2009)	16.1	8/16/09-09/15/09	3.91	54	80
Noble Bliss, NY (2009)	NA	NA	3.85	67	100
Lempster, NH (2010)	NA	NA	3.57	12	24
Noble Ellenburg, NY (2008)	NA	NA	3.46	54	80
Noble Clinton, NY (2008)	2.1	8/8/08-09/31/08	3.14	67	100
Lempster, NH (2009)	NA	NA	3.11	12	24
Record Hill, ME (2012)	24.6	4/16/12-10/23/12	2.96	22	50.6
Mars Hill, ME (2007)	NA	NA	2.91	28	42
Wolfe Island, Ont (July-December 2011)	NA	NA	2.49	86	197.8
Noble Chateaugay, NY (2010)	NA	NA	2.44	71	106.5
High Sheldon, NY (2010)	NA	NA	2.33	75	112.5
Stetson Mountain II, ME (2012)	NA	NA	2.27	17	25.5
Beech Ridge, WV (2012)	NA	NA	2.03	67	100.5
Munnsville, NY (2008)	NA	NA	1.93	23	34.5
High Sheldon, NY (2011)	NA	NA	1.78	75	112.5
Stetson Mountain II, ME (2010)	NA	NA	1.65	17	25.5
Stetson Mountain I, ME (2009)	28.5; 0.3	7/10/09-10/15/09	1.4	38	57
Beech Ridge, WV (2013)	NA	NA	0.58	67	100.5
Record Hill, ME (2014)	NA	NA	0.55	22	50.6
Mars Hill, ME (2008)	NA	NA	0.45	28	42
Stetson Mountain I, ME (2011)	NA	NA	0.28	38	57
Stetson Mountain I, ME (2013)	NA	NA	0.18	38	57
Rollins, ME (2012)	NA	NA	0.18	40	60
Kibby, ME (2011)	NA	NA	0.12	44	132

A = Bat passes per detector-night
B = Number of fatalities per megawatt per year
C = Activity rate based on data collected at various heights all other activity rates are from ground-based units only
D = Activity rate was averaged across phases and/or years
E = Activity rate calculated by WEST from data presented in referenced report
F= Activity rate based on pre-construction monitoring; data for all other activity and fatality rates were collected concurrently
G = The overall activity rate of 28.5 is from reference stations located along forest edges which may be attractive to bats; the activity rate of 0.3 is from one unit placed on a nacelle

Appendix A1 (*continued*). Wind energy facilities in North America with comparable fatality data for bats.

Project, Location	Activity Reference	Fatality Reference	Project, Location	Activity Reference	Fatality Reference
Alite, CA (2009-2010)		Chatfield et al. 2010	Lempster, NH (2010)		Tidhar et al. 2011
Alta I, CA (2011-2012)	Solick et al. 2010	Chatfield et al. 2012	Linden Ranch, WA (2010-2011)		Enz and Bay 2011
Alta II-V, CA (2011-2012)	Solick et al. 2010	Chatfield et al. 2012	Locust Ridge, PA (Phase II; 2009)		Arnett et al. 2011
Alta VIII, CA (2012-2013)	Chatfield and Bay 2014	Chatfield and Bay 2014	Locust Ridge, PA (Phase II; 2010)		Arnett et al. 2011
Barton Chapel, TX (2009-2010)		WEST 2011	Maple Ridge, NY (2006)		Jain et al. 2007
Barton I & II, IA (2010-2011)		Derby et al. 2011b	Maple Ridge, NY (2007)		Jain et al. 2009a
Beech Ridge, WV (2012)		Tidhar et al. 2013a	Maple Ridge, NY (2007-2008)		Jain et al. 2009b
Beech Ridge, WV (2013)		Young et al. 2014a	Maple Ridge, NY (2012)		Tidhar et al. 2013b
Big Blue, MN (2013)		Fagen Engineering 2014	Marengo I, WA (2009-2010)		URS 2010b
Big Blue, MN (2014)		Fagen Engineering 2015	Marengo II, WA (2009-2010)		URS 2010c
Big Horn, WA (2006-2007)		Kronner et al. 2008	Mars Hill, ME (2007)		Stantec 2008a
Big Smile, OK (2012-2013)		Derby et al. 2013b	Mars Hill, ME (2008)		Stantec 2009a
Biglow Canyon, OR (Phase I; 2008)		Jeffrey et al. 2009b	Milford I & II, UT (2011-2012)		Stantec 2012b
Biglow Canyon, OR (Phase I; 2009)		Enk et al. 2010	Milford I, UT (2010-2011)		Stantec 2011b
Biglow Canyon, OR (Phase II; 2009-2010)		Enk et al. 2011b	Montezuma I, CA (2011)		ICF International 2013
Biglow Canyon, OR (Phase II; 2010-2011)		Enk et al. 2012b	Montezuma I, CA (2012)		ICF International 2013
Biglow Canyon, OR (Phase III; 2010-2011)		Enk et al. 2012a	Montezuma II, CA (2012-2013)		Harvey & Associates 2013
Blue Sky Green Field, WI (2008; 2009)	Gruver 2008	Gruver et al. 2009	Moraine II, MN (2009)		Derby et al. 2010f
Buffalo Gap I, TX (2006)		Tierney 2007	Mount Storm, WV (2009)	Young et al. 2009a, 2010b	Young et al. 2009a, 2010b
Buffalo Gap II, TX (2007-2008)		Tierney 2009	Mount Storm, WV (2010)	Young et al. 2010a, 2011b	Young et al. 2010a, 2011b
Buffalo Mountain, TN (2000-2003)	Fiedler 2004	Nicholson et al. 2005	Mount Storm, WV (2011)		Young et al. 2011a, 2012a
Buffalo Mountain, TN (2005)		Fiedler et al. 2007	Mount Storm, WV (Fall 2008)	Young et al. 2009c	Young et al. 2009c
Buffalo Ridge I, SD (2009-2010)		Derby et al. 2010d	Mountaineer, WV (2003)		Kerns and Kerlinger 2004
Buffalo Ridge II, SD (2011-2012)		Derby et al. 2012a	Munnsville, NY (2008)		Stantec 2009b

Appendix A1 (*continued*). Wind energy facilities in North America with comparable fatality data for bats.

Project, Location	Activity Reference	Fatality Reference	Project, Location	Activity Reference	Fatality Reference
Buffalo Ridge, MN (Phase I; 1999)		Johnson et al. 2000	Mustang Hills, CA (2012-2013)		Chatfield and Bay 2014
Buffalo Ridge, MN (Phase II; 1998)		Johnson et al. 2000	Nine Canyon, WA (2002-2003)		Erickson et al. 2003
Buffalo Ridge, MN (Phase II; 1999)		Johnson et al. 2000	Noble Altona, NY (2010)		Jain et al. 2011a
Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)	Johnson et al. 2004	Johnson et al. 2004	Noble Bliss, NY (2008)		Jain et al.2009c
Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)	Johnson et al. 2004	Johnson et al. 2004	Noble Bliss, NY (2009)		Jain et al. 2010c
Buffalo Ridge, MN (Phase III; 1999)		Johnson et al. 2000	Noble Chateaugay, NY (2010)		Jain et al. 2011b
Buffalo Ridge, MN (Phase III; 2001/Lake Benton II)	Johnson et al. 2004	Johnson et al. 2004	Noble Clinton, NY (2008)	Reynolds 2010a	Jain et al. 2009d
Buffalo Ridge, MN (Phase III; 2002/Lake Benton II)	Johnson et al. 2004	Johnson et al. 2004	Noble Clinton, NY (2009)	Reynolds 2010a	Jain et al. 2010a
Casselman Curtailment, PA (2008)		Arnett et al. 2009a	Noble Ellenburg, NY (2008)		Jain et al. 2009e
Casselman, PA (2008)		Arnett et al. 2009b	Noble Ellenburg, NY (2009)	Reynolds 2010b	Jain et al. 2010b
Casselman, PA (2009)		Arnett et al. 2010	Noble Wethersfield, NY (2010)		Jain et al. 2011c
Cedar Ridge, WI (2009)	BHE Environmental 2008	BHE Environmental 2010	NPPD Ainsworth, NE (2006)		Derby et al. 2007
Cedar Ridge, WI (2010)	BHE Environmental 2008	BHE Environmental 2011	Palouse Wind, WA (2012-2013)		Stantec 2013a
Cohocton/Dutch Hill, NY (2009)		Stantec 2010	Pebble Springs, OR (2009-2010)		Gritski and Kronner 2010b
Cohocton/Dutch Hills, NY (2010)		Stantec 2011a	Pinnacle, WV (2012)		Hein et al. 2013
Combine Hills, OR (2011)		Enz et al. 2012	Pinyon Pines I & II, CA (2013-2014)		Chatfield and Russo 2014
Combine Hills, OR (Phase I; 2004-2005)		Young et al. 2006	Pioneer Prairie II, IA (2011-2012)		Chodachek et al. 2012
Crescent Ridge, IL (2005-2006)		Kerlinger et al. 2007	Pioneer Prairie II, IA (2013)		Chodachek et al. 2014
Criterion, MD (2011)		Young et al. 2012b	PrairieWinds ND1 (Minot), ND (2010)		Derby et al. 2011d
Criterion, MD (2012)		Young et al. 2013	PrairieWinds ND1 (Minot), ND (2011)		Derby et al. 2012d
Criterion, MD (2013)		Young et al. 2014b	PrairieWinds SD1, SD (2011-2012)		Derby et al. 2012c

Appendix A1 (*continued*). Wind energy facilities in North America with comparable fatality data for bats.

Project, Location	Activity Reference	Fatality Reference	Project, Location	Activity Reference	Fatality Reference
Crystal Lake II, IA (2009)		Derby et al. 2010b	PrairieWinds SD1, SD (2012-2013)		Derby et al. 2013a
Diablo Winds, CA (2005-2007)		WEST 2006, 2008	PrairieWinds SD1, SD (2013-2014)		Derby et al. 2014b
Dillon, CA (2008-2009)		Chatfield et al. 2009	Rail Splitter, IL (2012-2013)		Good et al. 2013b
Dry Lake I, AZ (2009-2010)	Thompson et al. 2011	Thompson et al. 2011	Record Hill, ME (2012)	Stantec 2008b	Stantec 2013b
Dry Lake II, AZ (2011-2012)	Thompson and Bay 2012	Thompson and Bay 2012	Record Hill, ME (2014)		Stantec 2015a
Elkhorn, OR (2008)		Jeffrey et a. 2009a	Red Hills, OK (2012-2013)		Derby et al. 2013c
Elkhorn, OR (2010)		Enk et al. 2011a	Ripley, Ont (2008)		Jacques Whitford 2009
Elm Creek II, MN (2011-2012)		Derby et al. 2010e	Rollins, ME (2012)		Stantec 2013c
Elm Creek, MN (2009-2010)		Derby et al. 2012b	Rugby, ND (2010-2011)		Derby et al. 2011c
Foote Creek Rim, WY (Phase I; 1999)		Young et al. 2003	Shiloh I, CA (2006-2009)		Kerlinger et al. 2009
Foote Creek Rim, WY (Phase I; 2000)	Gruver 2002	Young et al. 2003	Shiloh II, CA (2009-2010)		Kerlinger et al. 2010, 2013a
Foote Creek Rim, WY (Phase I; 2001-2002)	Gruver 2002	Young et al. 2003	Shiloh II, CA (2010-2011)		Kerlinger et al. 2013a
Forward Energy Center, WI (2008-2010)	Watt and Drake 2011	Grodsky and Drake 2011	Shiloh II, CA (2011-2012)		Kerlinger et al. 2013a
Fowler I, II, III, IN (2010)		Good et al. 2011	Shiloh III, CA (2012-2013)		Kerlinger et al. 2013b
Fowler I, II, III, IN (2011)		Good et al. 2012	Solano III, CA (2012-2013)		AECOM 2013
Fowler I, II, III, IN (2012)		Good et al. 2013a	Stateline, OR/WA (2001-2002)		Erickson et al. 2004
Fowler I, IN (2009)		Johnson et al. 2010a	Stateline, OR/WA (2003)		Erickson et al. 2004
Fowler III, IN (2009)		Johnson et al. 2010b	Stateline, OR/WA (2006)		Erickson et al. 2007
Goodnoe, WA (2009-2010)		URS Corporation (URS) 2010a	Stetson Mountain I, ME (2009)	Stantec 2009c	Stantec 2009c
Grand Ridge I, IL (2009-2010)		Derby et al. 2010a	Stetson Mountain I, ME (2011)		Normandeau Associates 2011
Harrow, Ont (2010)		Natural Resources Solutions Inc. (NRSI) 2011	Stetson Mountain I, ME (2013)		Stantec 2014d
Harvest Wind, WA (2010-2012)		Downes and Gritski 2012a	Stetson Mountain II, ME (2010)		Normandeau Associates 2010
Hay Canyon, OR (2009-2010)		Gritski and Kronner 2010a	Stetson Mountain II, ME (2012)		Stantec 2013d
High Sheldon, NY (2010)		Tidhar et al. 2012a	Summerview, Alb (2005-2006)		Brown and Hamilton 2006

Appendix A1 (*continued*). Wind energy facilities in North America with comparable fatality data for bats.

Project, Location	Activity Reference	Fatality Reference	Project, Location	Activity Reference	Fatality Reference
High Sheldon, NY (2011)		Tidhar et al. 2012b	Summerview, Alb (2006; 2007)	Baerwald 2008	Baerwald 2008
High Winds, CA (2003-2004)		Kerlinger et al. 2006	Top Crop I & II (2012-2013)		Good et al. 2013c
High Winds, CA (2004-2005)		Kerlinger et al. 2006	Top of Iowa, IA (2003)		Jain 2005
Hopkins Ridge, WA (2006)		Young et al. 2007	Top of Iowa, IA (2004)	Jain 2005	Jain 2005
Hopkins Ridge, WA (2008)		Young et al. 2009b	Tuolumne (Windy Point I), WA (2009-2010)		Enz and Bay 2010
Judith Gap, MT (2006-2007)		TRC Environmental Corporation 2008	Vansycle, OR (1999)		Erickson et al. 2000
Judith Gap, MT (2009)		Poulton and Erickson 2010	Vantage, WA (2010-2011)		Ventus Environmental Solutions 2012
Kewaunee County, WI (1999-2001)		Howe et al. 2002	Wessington Springs, SD (2009)		Derby et al. 2010c
Kibby, ME (2011)		Stantec 2012a	Wessington Springs, SD (2010)		Derby et al. 2011a
Kittitas Valley, WA (2011-2012)		Stantec Consulting Services 2012	White Creek, WA (2007-2011)		Downes and Gritski 2012b
Klondike II, OR (2005-2006)		Northwest Wildlife Consultants (NWC) and WEST 2007	Wild Horse, WA (2007)		Erickson et al. 2008
Klondike III (Phase I), OR (2007-2009)		Gritski et al. 2010	Windy Flats, WA (2010-2011)		Enz et al. 2011
Klondike IIIa (Phase II), OR (2008-2010)		Gritski et al. 2011	Winnebago, IA (2009-2010)		Derby et al. 2010g
Klondike, OR (2002-2003)		Johnson et al. 2003	Wolfe Island, Ont (July-December 2009)		Stantec Ltd. 2010
Leaning Juniper, OR (2006-2008)		Gritski et al. 2008	Wolfe Island, Ont (July-December 2010)		Stantec Ltd. 2011
Lempster, NH (2009)		Tidhar et al. 2010	Wolfe Island, Ont (July-December 2011)		Stantec Ltd. 2012

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

Study	Bat Fatalities (bats/ MW/year)	Predominant Habitat Type	Citation
Alite, CA (2009-2010)	0.24	Shrub/scrub and grassland	Chatfield et al. 2010
Alta I, CA (2011-2012)	1.28	Woodland, grassland, shrubland	Chatfield et al. 2012
Alta I, CA (2013-2014)	0.36		Chatfield et al. 2014
Alta I, CA (2015-2016)	0.7		Thompson et al. 2016a
Alta II-V, CA (2011-2012)	0.08	Desert scrub	Chatfield et al. 2012
Alta II-V, CA (2013-2014)	0		Chatfield et al. 2014
Alta II-V, CA (2015-2016)	0		Thompson et al. 2016a
Alta VIII, CA (2012-2013)	0	Grassland and riparian	Chatfield and Bay 2014
Alta VIII, CA (2014-2015)	0.17		Western EcoSystems Technology, Inc. (WEST) 2016c
Alta X, CA (2014-2015)	0.42		Chatfield et al. 2015
Alta X, CA (2015-2016)	0.8	Desert scrub	Thompson et al. 2016b
Barton I & II, IA (2010-2011)	1.85	Agriculture	Derby et al. 2011b
Barton Chapel, TX (2009-2010)	3.06	Agriculture/forest	WEST 2011
Beech Ridge, WV (2012)	2.03	Forest	Tidhar et al. 2013a
Beech Ridge, WV (2013)	0.58	Forest	Young et al. 2014a
Big Blue, MN (2013)	2.04	Agriculture	Fagen Engineering 2014
Big Blue, MN (2014)	1.43	Agriculture	Fagen Engineering 2015
Big Horn, WA (2006-2007)	1.9	Agriculture/grassland	Kronner et al. 2008
Big Smile, OK (2012-2013)	2.9	Grassland, agriculture	Derby et al. 2013b
Biglow Canyon, OR (Phase I; 2008)	1.99	Agriculture/grassland	Jeffrey et al. 2009b
Biglow Canyon, OR (Phase I; 2009)	0.58	Agriculture/grassland	Enk et al. 2010
Biglow Canyon, OR (Phase II; 2009-2010)	2.71	Agriculture	Enk et al. 2011b
Biglow Canyon, OR (Phase II; 2010-2011)	0.57	Grassland/shrub-steppe, agriculture	Enk et al. 2012b
Biglow Canyon, OR (Phase III; 2010-2011)	0.22	Grassland/shrub-steppe, agriculture	Enk et al. 2012a
Bingham Wind Project, ME (2017)	0.23	NA	TRC 2017a
Blue Sky Green Field, WI (2008; 2009)	24.57	Agriculture	Gruver et al. 2009
Buffalo Gap I, TX (2006)	0.1	Grassland	Tierney 2007
Buffalo Gap II, TX (2007-2008)	0.14	Forest	Tierney 2009
Buffalo Mountain, TN (2000-2003)	31.54	Forest	Nicholson et al. 2005
Buffalo Mountain, TN (2005)	39.7	Forest	Fiedler et al. 2007
Buffalo Ridge, MN (Phase I; 1999)	0.74	Agriculture	Johnson et al. 2000
Buffalo Ridge, MN (Phase II; 1998)	2.16	Agriculture	Johnson et al. 2000
Buffalo Ridge, MN (Phase II; 1999)	2.59	Agriculture	Johnson et al. 2000
Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)	4.45	Agriculture	Johnson et al. 2004
Buffalo Ridge, MN (Phase II; 2002/Lake Benton II)	1.64	Agriculture	Johnson et al. 2004
Buffalo Ridge, MN (Phase III; 1999)	2.72	Agriculture	Johnson et al. 2000
Buffalo Ridge, MN (Phase III; 2001/Lake Benton I)	3.71	Agriculture	Johnson et al. 2004
Buffalo Ridge, MN (Phase III; 2002/Lake Benton II)	1.81	Agriculture	Johnson et al. 2004
Buffalo Ridge I, SD (2009-2010)	0.16	Agriculture/grassland	Derby et al. 2010d
Buffalo Ridge II, SD (2011-2012)	2.81	Agriculture, grassland	Derby et al. 2012a
Bull Hill, ME (2013)	1.62	Forest	Stantec Consulting (Stantec) 2014a
Cameron Ridge/Section 15, CA (2014-2015)	0.15		WEST 2016b
Cameron Ridge/Section 15, CA (2015-2016)	0.19		Rintz and Thompson 2017

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

Study	Bat Fatalities (bats/ MW/year)	Predominant Habitat Type	Citation
Casselman, PA (2008)	12.61	Forest	Arnett et al. 2009b
Casselman, PA (2009)	8.6	Forest, pasture, grassland	Arnett et al. 2010
Casselman Curtailment, PA (2008)	4.4	Forest	Arnett et al. 2009a
Cedar Ridge, WI (2009)	30.61	Agriculture	BHE Environmental 2010
Cedar Ridge, WI (2010)	24.12	Agriculture	BHE Environmental 2011
Chopin, OR (2016-2017)	1.9	Agriculture	Hallingstad and Riser-Espinoza 2017
Cohocton/Dutch Hill, NY (2009)	8.62	Agriculture/forest	Stantec 2010
Cohocton/Dutch Hill, NY (2013)	1.37	Agriculture, forest	Stantec 2011a
Cohocton/Dutch Hills, NY (2010)	10.32	Agriculture, forest	Stantec 2014b
Combine Hills, OR (Phase I; 2004-2005)	1.88	Agriculture/grassland	Young et al. 2006
Combine Hills, OR (2011)	0.73	Grassland/shrub-steppe, agriculture	Enz et al. 2012
Crescent Ridge, IL (2005-2006)	3.27	Agriculture	Kerlinger et al. 2007
Criterion, MD (2011)	15.61	Forest, agriculture	Young et al. 2012b
Criterion, MD (2012)	7.62	Forest, agriculture	Young et al. 2013
Criterion, MD (2013)	5.32	Forest, agriculture	Young et al. 2014b
Crystal Lake II, IA (2009)	7.42	Agriculture	Derby et al. 2010b
Diablo Winds, CA (2005-2007)	0.82	NA	WEST 2006, 2008
Dillon, CA (2008-2009)	2.17	Desert	Chatfield et al. 2009
Dry Lake I, AZ (2009-2010)	3.43	Desert grassland/forested	Thompson et al. 2011
Dry Lake II, AZ (2011-2012)	1.66	Desert grassland/forested	Thompson and Bay 2012
Elkhorn, OR (2008)	1.26	Shrub/scrub and agriculture	Jeffrey et a. 2009a
Elkhorn, OR (2010)	2.14	Shrub/scrub and agriculture	Enk et al. 2011a
Elm Creek, MN (2009-2010)	1.49	Agriculture	Derby et al. 2010e
Elm Creek II, MN (2011-2012)	2.81	Agriculture, grassland	Derby et al. 2012b
Foote Creek Rim, WY (Phase I; 1999)	3.97	Grassland	Young et al. 2003
Foote Creek Rim, WY (Phase I; 2000)	1.05	Grassland	Young et al. 2003
Foote Creek Rim, WY (Phase I; 2001-2002)	1.57	Grassland	Young et al. 2003
Forward Energy Center, WI (2008-2010)	18.17	Agriculture	Grodsky and Drake 2011
Fowler I, IN (2009)	8.09	Agriculture	Johnson et al. 2010a
Fowler I, II, III, IN (2010)	18.96	Agriculture	Good et al. 2011
Fowler I, II, III, IN (2011)	20.19	Agriculture	Good et al. 2012
Fowler I, II, III, IN (2012)	2.96	Agriculture	Good et al. 2013a
Fowler III, IN (2009)	1.84	Agriculture	Johnson et al. 2010b
Fowler, IN (2014)	4.86	Agriculture	Good et al. 2015
Fowler, IN (2015)	4.54	Agriculture	Good et al. 2016
Fowler, IN (2016)	4.54	Agriculture	Good et al. 2017
Goodnoe, WA (2009-2010)	0.34	Grassland and shrub-steppe	URS Corporation (URS) 2010a
Grand Ridge I, IL (2009-2010)	2.1	Agriculture	Derby et al. 2010a
Groton, NH (2013)	1.31	Foothills, forest	Stantec and WEST 2014
Groton, NH (2014)	1.63	Foothills, forest	Stantec and WEST 2015a
Groton, NH (2015)	1.74	Foothills, forest	Stantec and WEST 2015b
Hancock, ME (2017)	0.3	Gravel, grassland	TRC 2017b
Harrow, Ont (2010)	11.13	Agriculture	Natural Resources Solutions Inc. 2011
Harvest Wind, WA (2010-2012)	1.27	Grassland/shrub-steppe	Downes and Gritski 2012a
Hatchet Ridge, CA (2011)	2.23		Tetra Tech 2013
Hatchet Ridge, CA (2012)	5.22		Tetra Tech 2013
Hatchet Ridge, CA (2012-2013)	4.2		Tetra Tech 2014
Hay Canyon, OR (2009-2010)	0.53	Agriculture	Gritski and Kronner 2010a

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

Study	Bat Fatalities (bats/ MW/year)	Predominant Habitat Type	Citation
High Sheldon, NY (2010)	2.33	Agriculture	Tidhar et al. 2012a
High Sheldon, NY (2011)	1.78	Agriculture	Tidhar et al. 2012b
High Winds, CA (2003-2004)	2.51	Agriculture/grassland	Kerlinger et al. 2006
High Winds, CA (2004-2005)	1.52	Agriculture/grassland	Kerlinger et al. 2006
Hopkins Ridge, WA (2006)	0.63	Agriculture/grassland	Young et al. 2007
Hopkins Ridge, WA (2008)	1.39	Agriculture/grassland	Young et al. 2009b
Howard, NY (2012)	10	Agriculture	Tidhar et al. 2013c
Howard, NY (2013)	2.13	Agriculture	Lukins et al. 2014
Judith Gap, MT (2006-2007)	8.93	Agriculture/grassland	TRC Environmental Corporation 2008
Judith Gap, MT (2009)	3.2	Agriculture/grassland	Poulton and Erickson 2010
Kewaunee County, WI (1999-2001)	6.45	Agriculture	Howe et al. 2002
Kibby, ME (2011)	0.12	Forest; commercial forest	Stantec 2012a
Kittitas Valley, WA (2011-2012)	0.12	Sagebrush-steppe, grassland	Stantec Consulting Services 2012
Klondike, OR (2002-2003)	0.77	Agriculture/grassland	Johnson et al. 2003
Klondike II, OR (2005-2006)	0.41	Agriculture/grassland	Northwest Wildlife Consultants (NWC) and WEST 2007
Klondike III (Phase I), OR (2007-2009)	1.11	Agriculture/grassland	Gritski et al. 2010
Klondike IIIa (Phase II), OR (2008-2010)	0.14	Grassland/shrub-steppe and agriculture	Gritski et al. 2011
Lakefield Wind, MN (2012)	19.87	Agriculture	Minnesota Public Utilities Commission 2012
Leaning Juniper, OR (2006-2008)	1.98	Agriculture	Gritski et al. 2008
Lempster, NH (2009)	3.11	Grasslands/forest/rocky embankments	Tidhar et al. 2010
Lempster, NH (2010)	3.57	Grasslands/forest/rocky embankments	Tidhar et al. 2011
Linden Ranch, WA (2010-2011)	1.68	Grassland/shrub-steppe, agriculture	Enz and Bay 2011
Locust Ridge, PA (Phase II; 2009)	14.11	Grassland	Arnett et al. 2011
Locust Ridge, PA (Phase II; 2010)	14.38	Grassland	Arnett et al. 2011
Lower West, CA (2012-2013)	2.17		Levenstein and Bay 2013a
Lower West, CA (2014-2015)	1.13		Levenstein and DiDonato 2015
Lower West, CA (2016-2017)	0	Desert scrub, Joshua tree	WEST 2017b
Maple Ridge, NY (2006)	11.21	Agriculture/forested	Jain et al. 2007
Maple Ridge, NY (2007)	6.49	Agriculture/forested	Jain et al. 2009a
Maple Ridge, NY (2007-2008)	4.96	Agriculture/forested	Jain et al. 2009b
Maple Ridge, NY (2012)	7.3	Agriculture/forested	Tidhar et al. 2013b
Marengo I, WA (2009-2010)	0.17	Agriculture	URS 2010b
Marengo II, WA (2009-2010)	0.27	Agriculture	URS 2010c
Mars Hill, ME (2007)	2.91	Forest	Stantec 2008a
Mars Hill, ME (2008)	0.45	Forest	Stantec 2009a
Milford I, UT (2010-2011)	2.05	Desert shrub	Stantec 2011b
Milford I & II, UT (2011-2012)	1.67	Desert shrub	Stantec 2012b
Montezuma I, CA (2011)	1.9	Agriculture and grasslands	ICF International 2012
Montezuma I, CA (2012)	0.84	Agriculture and grasslands	ICF International 2013
Montezuma II, CA (2012-2013)	0.91	Agriculture	Harvey & Associates 2013
Moraine II, MN (2009)	2.42	Agriculture/grassland	Derby et al. 2010f
Mount Storm, WV (2008)	6.62	Forest	Young et al. 2009c

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

Study	Bat Fatalities (bats/ MW/year)	Predominant Habitat Type	Citation
Mount Storm, WV (2009)	17.53	Forest	Young et al. 2009a, 2010b
Mount Storm, WV (2010)	15.18	Forest	Young et al. 2010a, 2011b
Mount Storm, WV (2011)	7.43	Forest	Young et al. 2011a, 2012a
Mountaineer, WV (2003)	31.69	Forest	Kerns and Kerlinger 2004
Munnsville, NY (2008)	1.93	Agriculture/forest	Stantec 2009b
Mustang Hills, CA (2012-2013)	0.1	Grasslands and riparian	Chatfield and Bay 2014
Mustang Hills, CA (2014-2015)	0	NA	WEST 2016c
Mustang Hills, CA (2016-2017)	0.33	Desert scrub, Joshua tree	WEST 2018
Nine Canyon, WA (2002-2003)	2.47	Agriculture/grassland	Erickson et al. 2003
Noble Altona, NY (2010)	4.34	Forest	Jain et al. 2011a
Noble Bliss, NY (2008)	7.8	Agriculture/forest	Jain et al.2009c
Noble Bliss, NY (2009)	3.85	Agriculture/forest	Jain et al. 2010c
Noble Chateaugay, NY (2010)	2.44	Agriculture	Jain et al. 2011b
Noble Clinton, NY (2008)	3.14	Agriculture/forest	Jain et al. 2009d
Noble Clinton, NY (2009)	4.5	Agriculture/forest	Jain et al. 2010a
Noble Ellenburg, NY (2008)	3.46	Agriculture/forest	Jain et al. 2009e
Noble Ellenburg, NY (2009)	3.91	Agriculture/forest	Jain et al. 2010b
Noble Wethersfield, NY (2010)	16.3	Agriculture	Jain et al. 2011c
NPPD Ainsworth, NE (2006)	1.16	Agriculture/grassland	Derby et al. 2007
Oakfield, ME (2017)	0.51	Grassland	TRC 2018
Odell, MN (2016-2017)	6.74	Agriculture	Chodachek and Gustafson 2018
Pacific Wind, CA (2014-2015)	0.21		WEST 2016a
Pacific Wind, CA (2015-2016)	0		WEST 2017a
Palouse Wind, WA (2012-2013)	4.23	Agriculture and grasslands	Stantec 2013a
Pebble Springs, OR (2009-2010)	1.55	Grassland	Gritski and Kronner 2010b
Pinnacle, WV (2012)	40.2	Forest	Hein et al. 2013
Pinyon Pines I & II, CA (2013-2014)	0.04		Chatfield and Russo 2014
Pinyon Pines I & II, CA (2015-2016)	0.18		Rintz and Starcevich 2016
Pioneer Prairie II, IA (2011-2012)	4.43	Agriculture, grassland	Chodachek et al. 2012
Pioneer Prairie II, IA (2013)	3.83	Agriculture	Chodachek et al. 2014
Pleasant Valley, MN (2016-2017)	1.8		Tetra Tech 2017b
Prairie Rose, MN (2014)	0.41	Agriculture	Chodachek et al. 2015
PrairieWinds ND1 (Minot), ND (2010)	2.13	Agriculture	Derby et al. 2011d
PrairieWinds ND1 (Minot), ND (2011)	1.39	Agriculture, grassland	Derby et al. 2012d
PrairieWinds SD1, SD (2011-2012)	1.23	Grassland	Derby et al. 2012c
PrairieWinds SD1, SD (2012-2013)	1.05	Grassland	Derby et al. 2013a
PrairieWinds SD1, SD (2013-2014)	0.52	Grassland	Derby et al. 2014b
Rail Splitter, IL (2012-2013)	11.21	Agriculture	Good et al. 2013b
Record Hill, ME (2012)	2.96	Forest	Stantec 2013b
Record Hill, ME (2014)	0.55	Forest	Stantec 2015a
Record Hill, ME (2016)	1.25	Forest	Stantec 2017
Red Hills, OK (2012-2013)	0.11	Grassland	Derby et al. 2013c
Ripley, Ont (2008)	4.67	Agriculture	Jacques Whitford 2009
Rising Tree, CA (2017-2018)	0	Desert scrub, woodland	Chatfield et al. 2018
Rollins, ME (2012)	0.18	Forest	Stantec 2013c
Rollins, ME (2014)	0.33	Gravel	Stantec 2015b
Roth Rock, MD (2011)	6.24	Rocky	Atwell, LLC 2012
Rugby, ND (2010-2011)	1.6	Agriculture	Derby et al. 2011c
Shiloh I, CA (2006-2009)	3.92	Agriculture/grassland	Kerlinger et al. 2009
Shiloh II, CA (2009-2010)	2.6	Agriculture	Kerlinger et al. 2010, 2013a
Shiloh II, CA (2010-2011)	3.8	Agriculture	Kerlinger et al. 2013a

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

Study	Bat Fatalities (bats/ MW/year)	Predominant Habitat Type	Citation
Shiloh II, CA (2011-2012)	3.4	Agriculture	Kerlinger et al. 2013a
Shiloh III, CA (2012-2013)	0.4		Kerlinger et al. 2013b
Solano III, CA (2012-2013)	0.31		AECOM 2013
Spring Valley, NV (2012-2013)	3.73	Grassland, shrub steppe	WEST 2014
Spruce Mountain Wind Project, ME (2014)	0.31		Tetra Tech 2015
Stateline, OR/WA (2001-2002)	1.09	Agriculture/grassland	Erickson et al. 2004
Stateline, OR/WA (2003)	2.29	Agriculture/grassland	Erickson et al. 2004
Stateline, OR/WA (2006)	0.95	Agriculture/grassland	Erickson et al. 2007
Steel Winds I & II, NY (2013)	6.14	Steel Winds I: grassland, shrub forest; Steel Wind II: gravel, steel slag	Stantec 2014c
Stetson II, ME (2014)	0.83	Forest	Stantec 2015c
Stetson Mountain I, ME (2009)	1.4	Forest	Stantec 2009c
Stetson Mountain I, ME (2011)	0.28	Forest	Normandeau Associates 2011
Stetson Mountain I, ME (2013)	0.18	Forest	Stantec 2014d
Stetson Mountain II, ME (2010)	1.65	Forest	Normandeau Associates 2010
Stetson Mountain II, ME (2012)	2.27	Forest	Stantec 2013d
Summerview, Alb (2005-2006)	10.27	Agriculture	Brown and Hamilton 2006
Summerview, Alb (2006; 2007)	11.42	Agriculture	Baerwald 2008
Top Crop I & II (2012-2013)	12.55	Agriculture	Good et al. 2013c
Top of Iowa, IA (2003)	7.16	Agriculture	Jain 2005
Top of Iowa, IA (2004)	10.27	Agriculture	Jain 2005
Top of the World, WY (2010-2011)	2.74	Scrub-shrub, grassland	Rintz and Bay 2012
Top of the World, WY (2011-2012)	2.43	Scrub-shrub, grassland	Rintz and Bay 2013
Top of the World, WY (2012-2013)	2.34	Scrub-shrub, grassland	Rintz and Bay 2014
Tucannon River, WA (2015)	2.22	Agriculture	Hallingstad et al. 2016
Tuolumne (Windy Point I), WA (2009-2010)	0.94	Grassland/shrub-steppe, agriculture and forest	Enz and Bay 2010
Vansycle, OR (1999)	1.12	Agriculture/grassland	Erickson et al. 2000
Vantage, WA (2010-2011)	0.4	Shrub-steppe, grassland	Ventus Environmental Solutions 2012
Waverly Wind, KS (2016-2017)	8.2	NA	Tetra Tech 2017a
Wessington Springs, SD (2009)	1.48	Grassland	Derby et al. 2010c
Wessington Springs, SD (2010)	0.41	Grassland	Derby et al. 2011a
White Creek, WA (2007-2011)	2.04	Grassland/shrub-steppe, agriculture	Downes and Gritski 2012b
Wild Horse, WA (2007)	0.39	Grassland	Erickson et al. 2008
Windstar, CA (2012-2013)	0		Levenstein and Bay 2013b
Windy Flats, WA (2010-2011)	0.41	Grassland/shrub-steppe, agriculture	Enz et al. 2011
Winnebago, IA (2009-2010)	4.54	Agriculture/grassland	Derby et al. 2010g
Wolfe Island, Ont (July-December 2009)	6.42	Grassland	Stantec Consulting Ltd. (Stantec Ltd.) 2010
Wolfe Island, Ont (July-December 2010)	9.5	Grassland	Stantec Ltd. 2011
Wolfe Island, Ont (July-December 2011)	2.49	Grassland	Stantec Ltd. 2012

Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.

Study	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Alite, CA (2009-2010)	8	24	80	8	200 m x 200 m	1 year	Weekly (spring, fall), bi-monthly (summer, winter)
Alta I, CA (2011-2012)	100	150	80	25	120-m radius circle	12.5 months	Every 2 weeks
Alta I, CA (2013-2014)	290	720	80		120m radius circle		Monthly ; bi-monthly
Alta I, CA (2015-2016)	290	720	80		120-m radius circle		Monthly; bi-monthly
Alta II-V, CA (2011-2012)	190	570	80	41	120-m radius circle	14.5 months	Every two weeks
Alta II-V, CA (2013-2014)	290	720	80		120-m radius circle		Monthly ; bi-monthly
Alta II-V, CA (2015-2016)	290	720	80		120-m radius circle		Monthly; bi-monthly
Alta VIII, CA (2012-2013)	50	150	90	12 plots (equivalent to 15 turbines)	240 m x 240 m	1 year	Bi-weekly
Alta VIII, CA (2014-2015)	100	300	90	NA	240 m x 240m	NA	Bi-monthly
Alta VIII, CA (2016-2017)	100	300	100	NA	240 m x 240m	1 year	Bi-weekly
Alta X, CA (2014-2015)	48	137	100	NA	240 m x 240m	NA	Bi-monthly
Alta X, CA (2015-2016)	48	137	100	NA	240 m x 240m	NA	Bi-monthly
Barton Chapel, TX (2009-2010)	60	120	78	30	200 m x 200 m	1 year	10 turbines weekly, 20 monthly
Barton I & II, IA (2010-2011)	80	160	100	35 (9 turbines were dropped in June 2010 due to landowner issues) 26 turbines were searched for the remainder of the study	200 m x 200 m	1 year	Weekly (spring, fall; migratory turbines), monthly (summer, winter; non-migratory turbines)
Beech Ridge, WV (2012)	67	100.5	80	67	40-m radius	7 months	Every 2 days
Beech Ridge, WV (2013)	67	100.5	80	67	40-m radius	7.5 months	Every 2 days
Big Blue, MN (2013)	18	36	78 or 90 (according to Gamesa website)	18	200-m diameter		Weekly, monthly (Nov and Dec)

Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.

Study	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Big Blue, MN (2014)	18	36	78 or 90 (according to Gamesa website)	18	200-m diameter	NA	Weekly, monthly (Nov and Dec)
Big Horn, WA (2006-2007)	133	199.5	80	133	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Big Smile, OK (2012-2013)	66	132	78	17 (plus one met tower)	100 m x 100 m	1 year	Weekly (spring, summer, fall), monthly (winter)
Biglow Canyon, OR (Phase I; 2008)	76	125.4	80	50	110 m x 110 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Biglow Canyon, OR (Phase I; 2009)	76	125.4	80	50	110 m x 110 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Biglow Canyon, OR (Phase II; 2009-2010)	65	150	80	50	250 m x 250 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Biglow Canyon, OR (Phase II; 2010-2011)	65	150	80	50	252 m x 252 m	1 year	Bi-weekly(spring, fall), monthly (summer, winter)
Biglow Canyon, OR (Phase III; 2010-2011)	76	174.8	80	50	252 m x 252 m	1 year	Bi-weekly(spring, fall), monthly (summer, winter)
Bingham Wind Project, ME (2017)	56	185			within 80 m; within 140 m	7 months	Twice weekly
Blue Sky Green Field, WI (2008; 2009)	88	145	80	30	160 m x 160 m	fall, spring	Daily(10 turbines), weekly (20 turbines)
Buffalo Gap I, TX (2006)	67	134	78	21	215 m x 215 m	10 months	Every 3 weeks
Buffalo Gap II, TX (2007-2008)	155	233	80	36	215 m x 215 m	14 months	Every 21 days
Buffalo Mountain, TN (2000-2003)	3	1.98	65	3	50-m radius	3 years	Bi-weekly, weekly, bi-monthly
Buffalo Mountain, TN (2005)	18	28.98	V47 = 65; V80 = 78	18	50-m radius	1 year	Bi-weekly, weekly, bi-monthly, and 2 to 5 day intervals
Buffalo Ridge, MN (Phase I; 1996)	73	25	36	21	126 m x 126 m	1 year	Bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase I; 1997)	73	25	36	21	126 m x 126 m	1 year	Bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase I; 1998)	73	25	36	21	126 m x 126 m	1 year	Bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase I; 1999)	73	25	36	21	126 m x 126 m	1 year	Bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase II; 1998)	143	107.25	50	40	126 m x 126 m	1 year	Bi-monthly (spring, summer, and fall)

Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.

Study	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Buffalo Ridge, MN (Phase II; 1999)	143	107.25	50	40	126 m x 126 m	1 year	Bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)	143	107.25	50	83	60 m x 60 m	summer, fall	Bi-monthly
Buffalo Ridge, MN (Phase II; 2002/Lake Benton II)	143	107.25	50	103	60 m x 60 m	summer, fall	Bi-monthly
Buffalo Ridge, MN (Phase III; 1999)	138	103.5	50	30	126 m x 126 m	1 year	Bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase III; 2001/Lake Benton I)	138	103.5	50	83	60 m x 60 m	summer, fall	Bi-monthly
Buffalo Ridge, MN (Phase III; 2002/Lake Benton II)	138	103.5	50	103	60 m x 60 m	summer, fall	Bi-monthly
Buffalo Ridge I, SD (2009-2010)	24	50.4	79	24	200 m x 200 m	1 year	Weekly (migratory), monthly (non-migratory)
Buffalo Ridge II, SD (2011-2012)	105	210	78	65 (60 road and pad, 5 turbine plots)	100 m x 100 m	1 year	Weekly (spring, summer, fall), monthly (winter)
Bull Hill, ME (2013)	19	34	95	19	80-m radius	6 months	Weekly (spring), daily and weekly (fall)
Cameron Ridge/Section 15, CA (2014-2015)	34	102	80		62.5-m radius circle		Weekly
Cameron Ridge/Section 15, CA (2015-2016)	34	102	80		125-m radius circle		Weekly
Casselman, PA (2008)	23	34.5	80	10	126 m x 120 m	7 months	Daily
Casselman, PA (2009)	23	34.5	80	10	126 m x 120 m	7.5 months	Daily searches
Cedar Ridge, WI (2009)	41	67.6	80	20	160 m x 160 m	spring, summer, fall	Daily, every 4 days; late fall searched every 3 days
Casselman Curtailment, PA (2008)	23	35.4	80	12 experimental; 10 control	126 m x 120 m	2.5 months	Daily
Cedar Ridge, WI (2010)	41	68	80	20	160 m x 160 m	1 year	Five turbines were surveyed daily, 15 turbines surveyed every 4 days in rotating groups each day. All 20 surveyed every 3 days during late fall
Chopin, OR (2016-2017)	6	10			270 m x 270 m	1 year	Monthly
Cohocton/Dutch Hill, NY (2009)	50	125	80	17	130 m x 130 m	spring, summer, fall	Daily (5 turbines), weekly (12 turbines)

Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.

Study	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Cohocton/Dutch Hill, NY (2013)	50	125	NA	NA	120 m x 120 m	late summer, fall	Weekly
Cohocton/Dutch Hills, NY (2010)	50	125	80	17	120 m x 120 m	spring, summer, fall	Daily, weekly
Combine Hills, OR (Phase I; 2004-2005)	41	41	53	41	90-m radius	1 year	Monthly
Combine Hills, OR (2011)	104	104	53	52 (plus 1 MET tower)	180 m x 180 m	1 year	Bi-weekly(spring, fall), monthly (summer, winter)
Crescent Ridge, IL (2005-2006)	33	49.5	80	33	70-m radius	1 year	Weekly (fall, spring)
Criterion, MD (2011)	28	70	80	28	40- to 50-m radius	7.3 months	Daily
Criterion, MD (2012)	28	70	80	14	40- to 50-m radius	7.5 months	Weekly
Criterion, MD (2013)	28	70	80	14	40- to 50-m radius	7.5 months	Weekly
Crystal Lake II, IA (2009)	80	200	80	16 turbines through week 6, and then 15 for duration of study	100 m x 100 m	spring, summer, fall	3 times per week for 26 weeks
Diablo Winds, CA (2005-2007)	31	20.46	50 and 55	31	75 m x 75 m	2 years	Monthly
Dillon, CA (2008-2009)	45	45	69	15	200 m x 200 m	1 year	Weekly, bi-monthly in winter
Dry Lake I, AZ (2009-2010)	30	63	78	15	160 m x 160 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Dry Lake II, AZ (2011-2012)	31	65	78	31: 5 (full plot), 26 (road & pad)	160 m x 160 m	1 year	Twice weekly (spring, summer, fall), weekly (winter)
Elkhorn, OR (2008)	61	101	80	61	220 m x 220 m	1 year	Monthly
Elkhorn, OR (2010)	61	101	80	31	220 m x 220 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Elm Creek, MN (2009-2010)	67	100	80	29	200 m x 200 m	1 year	Weekly, monthly
Elm Creek II, MN (2011-2012)	62	148.8	80	30	200 m x 200m (2 random migration search areas 100 m x 100 m)	1 year	20 searched every 28 days, 10 turbines every 7 days during migration)
Foote Creek Rim, WY (Phase I; 1999)	69	41.4	40	69	126 m x 126 m	1 year	Monthly
Foote Creek Rim, WY (Phase I; 2000)	69	41.4	40	69	126 m x 126 m	1 year	Monthly
Foote Creek Rim, WY (Phase I; 2001-2002)	69	41.4	40	69	126 m x 126 m	1 year	Monthly

Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.

Study	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Foote Creek Rim, WY (UV study; 1999-2000)	105	67.5	Mitsubishi = 40, NEG = 50	105	120 m x 120 m	17 months	Monthly
Forward Energy Center, WI (2008-2010)	86	129	80	29	160 m x 160 m	2 years	11 turbines daily, 9 every 3 days, 9 every 5 days
Fowler I, IN (2009)	162	301	78 (Vestas), 80 (Clipper)	25	160 m x 160 m	spring, summer, fall	Weekly, bi-weekly
Fowler I, II, III, IN (2010)	355	600	Vestas = 80, Clipper = 80, GE = 80	36 turbines, 100 road and pads	80 m x 80 m for turbines ; 40-m radius for roads and pads	spring, fall	Daily, weekly
Fowler I, II, III, IN (2011)	355	600	Vestas = 80, Clipper = 80, GE = 80	177 road and pads (spring), 9 turbines & 168 roads and pads (fall)	turbines (80 m circular plot), roads and pads (out to 80 m)	spring, fall	Daily, weekly
Fowler I, II, III, IN (2012)	355	600	Vestas = 80, Clipper = 80, GE = 80	118 roads and pads	roads and pads (out to 80 m)	2.5 months	Weekly
Fowler III, IN (2009)	60	99	78	12	160 m x 160 m	10 weeks	Weekly, bi-weekly
Fowler, IN (2014)	355	600			roads and pads	2.5 months	Twice weekly
Fowler, IN (2015)	420	NA			roads and pads	2.5 months	Weekly
Fowler, IN (2016)	420	750	80		roads and pads (out to 80 m)	3 months	Weekly
Goodnoe, WA (2009-2010)	47	94	80	24	180 m x 180 m	1 year	14 days during migration periods, 28 days during non-migration periods
Grand Ridge I, IL (2009-2010)	66	99	80	30	160 m x 160 m	1 year	Weekly, monthly
Groton, NH (2013)	24	48	NA	NA	roads and pads	7 months	Weekly
Groton, NH (2014)	NA	48	NA	NA	roads and pads	6 months	Weekly
Groton, NH (2015)	24	48	NA	NA	roads and pads	6 months	Weekly
Hancock, ME (2017)	17	51	80	NA	within 80 m; within 140 m	7 months	Twice weekly
Harrow, Ont (2010)	24 (four 6-turbine facilities)	39.6		12 in July, 24 Aug-Oct	50-m radius from turbine base	4 months	Twice-weekly
Harvest Wind, WA (2010-2012)	43	98.9	80	32	180 m x 180 m & 240 m x 240 m	2 years	Twice a week, weekly and monthly

Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.

Study	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Hatchet Ridge, CA (2011)	44	101	80		127 m x 127 m (bi-monthly), 190 m x 190 m (monthly)	NA	Half bi-monthly; half monthly
Hatchet Ridge, CA (2012-2013)	44		80		127 m x 127 m	1 year	Bi-weekly
Hatchet Ridge, CA (2012)	44	101	80		127 m x 127 m (bi-monthly), 190 m x 190 m (monthly)		Half bi-monthly; half monthly
Hay Canyon, OR (2009-2010)	48	100.8	79	20	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
High Sheldon, NY (2010)	75	112.5	80	25	115 m x 115 m	7 months	Daily (8 turbines), weekly (17 turbines)
High Sheldon, NY (2011)	75	112.5	80	25	115 m x 115 m	7 months	Daily (8 turbines), weekly (17 turbines)
High Winds, CA (2003-2004)	90	162	60	90	75-m radius	1 year	Bi-monthly
High Winds, CA (2004-2005)	90	162	60	90	75-m radius	1 year	Bi-monthly
Hopkins Ridge, WA (2006)	83	150	67	41	180 m x 180 m	1 year	Monthly, weekly (subset of 22 turbines spring and fall migration)
Hopkins Ridge, WA (2008)	87	156.6	67	41-43	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Howard, NY (2012)	27	54	78.5		120 m x 120 m	7 months	Daily; weekly
Howard, NY (2013)	27	54	78.5		120 m x 120 m	6 months	Daily; weekly
Judith Gap, MT (2006-2007)	90	135	80	20	190 m x 190 m	7 months	Monthly
Judith Gap, MT (2009)	90	135	80	30	100 m x 100 m	5 months	Bi-monthly
Kewaunee County, WI (1999-2001)	31	20.46	65	31	60 m x 60 m	2 years	Bi-weekly (spring, summer), daily (spring, fall migration), weekly (fall, winter)
Kibby, ME (2011)	44	132	124	22 turbines	75-m diameter circular plots	22 weeks	Avg. 5-day
Kittitas Valley, WA (2011-2012)	48	100.8	80	48	100 m x 102 m	1 year	Bi-weekly from Aug 15 - Oct 31 and March 16 - May 15; every 4 weeks from Nov 1 - March 15 and May 16 - Aug 14
Klondike II, OR (2005-2006)	50	75	80	25	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (summer, winter)

Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.

Study	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Klondike III (Phase I), OR (2007-2009)	125	223.6	GE = 80; Siemens= 80, Mitsubishi = 80	46	240 m x 240 m (1.5 MW) 252 m x 252 m (2.3 MW)	2 year	Bi-monthly (spring, fall migration), monthly (summer, winter)
Klondike IIIa (Phase II), OR (2008-2010)	51	76.5	GE = 80	34	240 m x 240 m	2 years	Bi-monthly (spring, fall), monthly (summer, winter)
Klondike, OR (2002-2003)	16	24	80	16	140 m x 140 m	1 year	Monthly
Lakefield Wind, MN (2012)	137	205.5	80	26	100 m x 100 m	7.5 months	3 times per week
Laurel Mountain, WV (2014)	61	98	80	NA	90 m x 90 m	7 months	Every 3 days; daily
Leaning Juniper, OR (2006-2008)	67	100.5	80	17	240 m x 240 m	2 years	Bi-monthly (spring, fall), monthly (winter, summer)
Lempster, NH (2009)	12	24	78	4	120 m x 130 m	6 months	Daily
Lempster, NH (2010)	12	24	78	12	120 m x 130 m	6 months	Weekly
Linden Ranch, WA (2010-2011)	25	50	80	25	110 m x 110 m	1 year	Bi-weekly(spring, fall), monthly (summer, winter)
Locust Ridge, PA (Phase II; 2009)	51	102	80	15	120 m x 126 m	6.5 months	Daily
Locust Ridge, PA (Phase II; 2010)	51	102	80	15	120 m x 126 m	6.5 months	Daily
Lower West, CA (2012-2013)	7	14	110.5		120-m radius circle		Bi-monthly
Lower West, CA (2014-2015)	7	14	110.5		120-m radius circle		Bi-monthly
Lower West, CA (2016-2017)	7	14	110.5		120-m radius	1 year	Twice weekly
Maple Ridge, NY (2006)	120	198	80	50	130 m x 120 m	5 months	Daily (10 turbines), every 3 days (10 turbines), weekly (30 turbines)
Maple Ridge, NY (2007)	195	321.75	80	64	130 m x 120 m	7 months	Weekly
Maple Ridge, NY (2007-2008)	195	321.75	80	64	130 m x 120 m	7 months	Weekly
Maple Ridge, NY (2012)	195	321.75	80	105 (5 turbines, 100 roads/pads)	100 m x 100 m	3 months	Weekly
Marengo I, WA (2009-2010)	78	140.4	67	39	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Marengo II, WA (2009-2010)	39	70.2	67	20	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Mars Hill, ME (2007)	28	42	80.5	28	76-m diameter, extended plot 238-m diameter	spring, summer, fall	Daily (2 random turbines), weekly (all turbines): extended plot searched once per season

Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.

Study	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Mars Hill, ME (2008)	28	42	80.5	28	76-m diameter, extended plot 238-m diameter	spring, summer, fall	Weekly: extended plot searched once per season
Milford I, UT (2010-2011)	58	145	80	24	120 m x 120 m		Weekly
Milford I & II, UT (2011-2012)	107	160.5 (58.5 Phase I, 102 Phase II)	80	43	120 m x120 m		Every 10.5 days
Montezuma I, CA (2011)	16	36.8	80	16	105-m radius	1 year	Weekly and bi-Weekly
Montezuma I, CA (2012)	16	36.8	80	16	105-m radius	1 year	Weekly and bi-Weekly
Montezuma II, CA (2012-2013)	34	78.2	80	17	105-m radius	1 year	Weekly
Moraine II, MN (2009)	33	49.5	82.5	30	200 m x 200 m	1 year	Weekly (migratory), monthly (non-migratory)
Mount Storm, WV (2008)	82	164	78	27	varied	3 months	Weekly (18 turbines), daily (9 turbines)
Mount Storm, WV (2009)	132	264	78	44	varied	4.5 months	Weekly (28 turbines), daily (16 turbines)
Mount Storm, WV (2010)	132	264	78	24	20 m to 60 m from turbine	6 months	Daily
Mount Storm, WV (2011)	132	264	78	24	varied	6 months	Daily
Mountaineer, WV (2003)	44	66	80	44	60-m radius	7 months	Weekly, monthly
Munnsville, NY (2008)	23	34.5	69.5	12	120 m x 120 m	spring, summer, fall	Weekly
Mustang Hills, CA (2012-2013)	50	150	90	13 plots (equivalent to 15 turbines)	240 m x 240 m	1 year	Bi-weekly
Mustang Hills, CA (2014-2015)	100	300	90		240 m x 240 m		Bi-monthly
Mustang Hills, CA (2016-2017)	100	300	100		240 m x 240 m	1 year	Bi-weekly
Nine Canyon, WA (2002-2003)	37	48.1	60	37	90-m radius	1 year	Bi-monthly (spring, summer, fall), monthly (winter)
Noble Altona, NY (2010)	65	97.5	80	22	120 m x 120 m	spring, summer, fall	Daily, weekly
Noble Bliss, NY (2008)	67	100	80	23	120 m x 120 m	spring, summer, fall	Daily (8 turbines), 3-day (8 turbines), weekly (7 turbines)
Noble Bliss, NY (2009)	67	100	80	23	120 m x 120 m	spring, summer, fall	Weekly, 8 turbines searched daily from July 1 to August 15

Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.

Study	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Noble Chateaugay, NY (2010)	71	106.5	80	24	120 m x 120 m	spring, summer, fall	Weekly
Noble Clinton, NY (2008)	67	100	80	23	120 m x 120 m	spring, summer, fall	Daily (8 turbines), 3-day (8 turbines), weekly (7 turbines)
Noble Clinton, NY (2009)	67	100	80	23	120 m x 120 m	spring, summer, fall	Daily (8 turbines), weekly (15 turbines), all turbines weekly from July 1 to August 15
Noble Ellenburg, NY (2008)	54	80	80	18	120 m x 120 m	spring, summer, fall	Daily (6 turbines), 3-day (6 turbines), weekly (6 turbines)
Noble Ellenburg, NY (2009)	54	80	80	18	120 m x 120 m	spring, summer, fall	Daily (6 turbines), weekly (12 turbines), all turbines weekly from July 1 to August 15
Noble Wethersfield, NY (2010)	84	126	80	28	120 m x 120 m	spring, summer, fall	Weekly
NPPD Ainsworth, NE (2006)	36	20.5	70	36	220 m x 220 m	spring, summer, fall	Bi-monthly
Oakfield, ME (2017)	48	148	94		within 80 m; within 140 m	7 months	Every other day
Odell, MN (2016-2017)	100	200			120 m x 120 m	1 year	Monthly; weekly
Pacific Wind, CA (2014-2015)	70	144			126-m radius circle		Weekly
Pacific Wind, CA (2015-2016)	70	144	78.5		126-m diameter circle		Weekly
Palouse Wind, WA (2012-2013)	58	104.4	80, 90, or 105 m (according to the Vestas website)	19	120 m x 120 m	1 year	Monthly (winter) and weekly (spring-fall)
Passadumkeag, ME (2016)	13	43			80-m radius	6 months	Every 3 days
Pebble Springs, OR (2009-2010)	47	98.7	79	20	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Pine Tree, CA (2009-2010, 2011)	90	135	65	40	100-m radius	1.5 year	Bi-weekly, weekly
Pinnacle, WV (2012)	23	55.2	80	11	126 m x 120m	9 months	Weekly
Pinyon Pines I & II, CA (2013-2014)	100		90	25 plots (approx. 31 turbines)	240 m x 240 m		Bi-weekly

Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.

Study	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Pinyon Pines I & II, CA (2015-2016)	100	300	90	NA	240 m x 240 m	NA	Bi-monthly
Pinyon Pines I & II, CA (2017-2018)	100	300	90	NA	240 m x 240 m	1 year	Bi-weekly
Pioneer Prairie II, IA (2011-2012)	62	102.3	80	62 (57 road/pad) 5 full search plots	80 m x 80 m	1 year	Weekly (spring and fall), every two weeks (summer), monthly (winter)
Pioneer Prairie II, IA (2013)	62	102.3	80	62	80x80 m (5 turbines), road and pad within 100 m of turbine (57 turbines)		Weekly
Pleasant Valley, MN (2016-2017)	100	200	95		160 m x 160 m		Weekly
Prairie Rose, MN (2014)	119	200	80		100 m x 100 m (spring); roads and pads (fall)	1 year	Weekly
PrairieWinds ND1 (Minot), ND (2010)	80	115.5	89	35	minimum of 100 m x 100 m	3 seasons	Bi-monthly
PrairieWinds ND1 (Minot), ND (2011)	80	115.5	80	35	minimum 100 m x 100m	3 season	Twice monthly
PrairieWinds SD1, SD (2011-2012)	108	162	80	50	200 m x 200m	1 year	Twice monthly (spring, summer, fall), monthly (winter)
PrairieWinds SD1, SD (2012-2013)	108	162	80	50	200 m x 200 m	1 year	Bi-weekly
PrairieWinds SD1, SD (2013-2014)	108	162	80	45	200 m x 200 m	1 year	Twice monthly (spring, summer, fall), monthly (winter)
Rail Splitter, IL (2012-2013)	67	100.5	80	34	60-m radius	1 year	Weekly (spring, summer, and fall) and bi-weekly (winter)
Record Hill, ME (2012)	22	50.6	80	22	126.5 m x 126.5 m	5 months	Three times every two weeks
Record Hill, ME (2014)	22	50.6	80	10	varied due to steep terrain and heavily vegetated areas	4.5 months	Daily for 5 days a week
Record Hill, ME (2016)	22	51	80		85-m diameter	7 months	3 times every 2 weeks
Red Hills, OK (2012-2013)	82	123	80	20 (plus one met tower)	100 m x 100 m	1 year	Weekly (spring, summer, fall), monthly (winter)

Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.

Study	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Ripley, Ont (2008)	38	76	64	38	80 m x 80 m	spring, fall	Twice weekly for odd turbines; weekly for even turbines.
Rising Tree, CA (2015-2016)	60	198	84		280 m x 280 m		Bi-monthly
Rising Tree, CA (2017-2018)	60	198	84		280 m x 280 m	1 year	Bi-weekly
Rollins, ME (2012)	40	60	80	20	varied; turbine laydown area and gravel access roads out to 60 m	6 months	Weekly
Rollins, ME (2014)	40	60			60-m radius	6 months	Weekly
Roth Rock, MD (2011)	20	50	80		80 m x 80 m	3 months	Daily
Rugby, ND (2010-2011)	71	149	78	32	200 m x 200 m	1 year	Weekly (spring, fall; migratory turbines), monthly (non-migratory turbines)
Shiloh I, CA (2006-2009)	100	150	65	100	105-m radius	3 years	Weekly
Shiloh II, CA (2009-2010)	75	150	80	25	100-m radius	1 year	Weekly
Shiloh II, CA (2010-2011)	75	150	80	25	100-m radius	1 year	Weekly
Shiloh II, CA (2011-2012)	75	150	80	25	100-m radius	1 year	Weekly
Shiloh III, CA (2012-2013)	50	102.5	78.5	25	100-m radius		Weekly
Solano III, CA (2012-2013)	55	128	80	19	100-m radius		Bi-Weekly
Spring Valley, NV (2012-2013)					126 m x 126 m	14 months	Bi-weekly; daily
Spruce Mountain Wind Project, ME (2014)	10	20			roads and pads	A	Twice weekly
Stateline, OR/WA (2001-2002)	454	299	50	124	minimum 126 m x 126 m	17 months	Bi-weekly, monthly
Stateline, OR/WA (2003)	454	299	50	153	minimum 126 m x 126 m	1 year	Bi-weekly, monthly
Stateline, OR/WA (2006)	454	299	50	39	variable turbine strings	1 year	Bi-weekly
Steel Winds I & II, NY (2013)	14	35	80		120 m x 120 m	5 months	Twice weekly
Stetson II, ME (2014)	17	26			60-m radius	6 months	Weekly
Stetson Mountain I, ME (2009)	38	57	80	19	76-m diameter	27 weeks (spring, summer, fall)	Weekly
Stetson Mountain I, ME (2011)	38	57	80	19	79.45 m x79.45 m	6 months	Weekly
Stetson Mountain I, ME (2013)	38	57	80	19	76-m diameter	6 months	Weekly

Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.

Study	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Stetson Mountain II, ME (2010)	17	25.5	80	17	74.5 m x 74.5 m	6 months	Weekly (3 turbines twice a week)
Stetson Mountain II, ME (2012)	17	25.5	80	17	laydown area and road up to 60 m	6 months	Weekly
Summerview, Alb (2005-2006)	39	70.2	67	39	140 m x 140 m	1 year	Weekly, bi-weekly (May to July, September)
Summerview, Alb (2006; 2007)	39	70.2	65	39	52-m radius; 2 spiral transects 7 m apart	summer, fall (2 years)	Daily (10 turbines), weekly (29 turbines)
Thunder Spirit, ND (2016-2017)	43	108	80		160m x 160m; roads and pads	10 months	Twice monthly
Top Crop I & II (2012-2013)	68 (Phase I), 132 (Phase (II)	300 (102 Phase I, 198 Phase II)	65 (Phase I), 80 (Phase II)	100	61-m radius	1 year	Weekly (spring, summer, and fall) and bi-weekly (winter)
Top of Iowa, IA (2003)	89	80	71.6	26	76 m x 76 m	spring, summer, fall	Once every 2 to 3 days
Top of Iowa, IA (2004)	89	80	71.6	26	76 m x 76 m	spring, summer, fall	Once every 2 to 3 days
Top of the World, WY (2010-2011)	110	200			160 m x 160 m	1 year	Weekly; bi-monthly
Top of the World, WY (2011-2012)	110	200			160 m x 160 m	1 year	Weekly; bi-monthly
Top of the World, WY (2012-2013)	110	200			160 m x 160 m	1 year	Weekly; bi-monthly
Tucannon River, WA (2015)	116	267			134-m radius	1 year	Na
Tuolumne (Windy Point I), WA (2009-2010)	62	136.6	80	21	180 m x 180 m	1 year	Monthly throughout the year, a sub-set of 10 turbines were also searched weekly during the spring, summer, and fall
Vansycle, OR (1999)	38	24.9	50	38	126 m x 126 m	1 year	Monthly
Vantage, WA (2010-2011)	60	90	80	30	240 m x 240 m	1 year	Monthly, a subset of 10 searched weekly during migration
Waverly Wind, KS (2016-2017)	95	199	93		160 m x 160 m; roads and pads	1 year	Weekly, bi-weekly
Wessington Springs, SD (2009)	34	51	80	20	200 m x 200 m	spring, summer, fall	Bi-monthly

Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.

Study	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Wessington Springs, SD (2010)	34	51	80	20	200 m x 200 m	8 months	Bi-weekly (spring, summer, fall)
White Creek, WA (2007-2011)	89	204.7	80	89	180 m x 180 m & 240 m x 240 m	4 years	Twice a week, weekly and monthly
Wild Horse, WA (2007)	127	229	67	64	110 m from 2 turbines in plot	1 year	Monthly, weekly (fall, spring migration at 16 turbines)
Windstar, CA (2012-2013)	53	106	107 /110.5	NA	120-m radius circle	NA	Monthly; bi-monthly
Windy Flats, WA (2010-2011)	114	262.2	80	36 (plus 1 MET tower)	180 m x 180 m (120 m at MET tower)	1 year	Monthly (spring, summer, fall, and winter), weekly (spring and fall migration)
Winnebago, IA (2009-2010)	10	20	78	10	200 m x 200 m	1 year	Weekly (migratory), monthly (non-migratory)
Wolfe Island, Ont (July-December 2009)	86	197.8	80	86	60-m radius	summer, fall	43 twice weekly, 43 weekly
Wolfe Island, Ont (July-December 2010)	86	197.8	80	86	50-m radius	6 months	43 twice weekly, 43 weekly
Wolfe Island, Ont (July-December 2011)	86	197.8	80	86	50m radius	6 months	43 twice weekly, 43 weekly

Appendix A3 (*continued*). All post-construction monitoring studies, project characteristics, and select survey methodology.

Data from the following sources:

Project, Location	Reference	Project, Location	Reference
Alite, CA	Chatfield et al. 2010	Kewaunee County, WI	Howe et al. 2002
Alta Wind I, CA (11)	Chatfield et al. 2012	Kibby, ME (11)	Stantec 2012a
Alta Wind II-V, CA (11)	Chatfield et al. 2012	Kittitas Valley, WA (11-12)	Stantec Consulting Services 2012
Barton I&II, IA	Derby et al. 2011b	Klondike, OR	Johnson et al. 2003
Barton Chapel, TX	WEST 2011	Klondike II, OR	Northwest Wildlife Consultants (NWC) and WEST 2007
Beech Ridge, WV	Tidhar et al. 2013a	Klondike III (Phase I), OR	Gritski et al. 2010
Big Horn, WA	Kronner et al. 2008	Klondike IIIa (Phase II), OR	Gritski et al. 2011
Big Smile, OK	Derby et al. 2013b	Leaning Juniper, OR	Gritski et al. 2008
Biglow Canyon, OR (Phase I; 08)	Jeffrey et al. 2009b	Lempster, NH (09)	Tidhar et al. 2010
Biglow Canyon, OR (Phase I; 09)	Enk et al. 2010	Lempster, NH (10)	Tidhar et al. 2011
Biglow Canyon, OR (Phase II; 09/10)	Enk et al. 2011b	Linden Ranch, WA	Enz and Bay 2011
Biglow Canyon, OR (Phase II; 10/11)	Enk et al. 2012b	Locust Ridge, PA (Phase II; 09)	Arnett et al. 2011
Biglow Canyon, OR (Phase III; 10/11)	Enk et al. 2012a	Locust Ridge, PA (Phase II; 10)	Arnett et al. 2011
Blue Sky Green Field, WI	Gruver et al. 2009	Maple Ridge, NY (06)	Jain et al. 2007
Buffalo Gap I, TX	Tierney 2007	Maple Ridge, NY (07)	Jain et al. 2009a
Buffalo Gap II, TX	Tierney 2009	Maple Ridge, NY (08)	Jain et al. 2009b
Buffalo Mountain, TN (00-03)	Nicholson et al. 2005	Marengo I, WA (09)	URS 2010b
Buffalo Mountain, TN (05)	Fiedler et al. 2007	Marengo II, WA (09)	URS 2010c
Buffalo Ridge, MN (Phase I; 96)	Johnson et al. 2000	Mars Hill, ME (07)	Stantec 2008a
Buffalo Ridge, MN (Phase I; 97)	Johnson et al. 2000	Mars Hill, ME (08)	Stantec 2009a
Buffalo Ridge, MN (Phase I; 98)	Johnson et al. 2000	Moraine II, MN	Derby et al. 2010f
Buffalo Ridge, MN (Phase I; 99)	Johnson et al. 2000	Mount Storm, WV (Fall 08)	Young et al. 2009c
Buffalo Ridge, MN (Phase II;98)	Johnson et al. 2000	Mount Storm, WV (09)	Young et al. 2009a, 2010b
Buffalo Ridge, MN (Phase II; 99)	Johnson et al. 2000	Mount Storm, WV (10)	Young et al. 2010a, 2011b
Buffalo Ridge, MN (Phase II; 01/Lake Benton I)	Johnson et al. 2004	Mount Storm, WV (11)	Young et al. 2011a, 2012a
Buffalo Ridge, MN (Phase II; 02/Lake Benton I)	Johnson et al. 2004	Mountaineer, WV (03)	Kerns and Kerlinger 2004
Buffalo Ridge, MN (Phase III; 99)	Johnson et al. 2000	Munnsville, NY (08)	Stantec 2009b
Buffalo Ridge, MN (Phase III; 01/Lake Benton II)	Johnson et al. 2004	Nine Canyon, WA	Erickson et al. 2003
Buffalo Ridge, MN (Phase III; 02/Lake Benton II)	Johnson et al. 2004	Noble Altona, NY	Jain et al. 2011a
Buffalo Ridge I, SD (10)	Derby et al. 2010d	Noble Bliss, NY (08)	Jain et al.2009c
Buffalo Ridge II, SD (11)	Derby et al. 2012a	Noble Bliss, NY (09)	Jain et al. 2010c
Casselman, PA (08)	Arnett et al. 2009b	Noble Chateaugay, NY	Jain et al. 2011b
Casselman, PA (09)	Arnett et al. 2010	Noble Clinton, NY (08)	Jain et al. 2009d
Casselman Curtailment, PA (08)	Arnett et al. 2009a	Noble Clinton, NY (09)	Jain et al. 2010a
Cedar Ridge, WI (09)	BHE Environmental 2010	Noble Ellenburg, NY (08)	Jain et al. 2009e
Cedar Ridge, WI (10)	BHE Environmental 2011	Noble Ellenburg, NY (09)	Jain et al. 2010b
Cohocton/Dutch Hill, NY (09)	Stantec 2010	Noble Wethersfield, NY	Jain et al. 2011c
Cohocton/Dutch Hills, NY (10)	Stantec 2011a	NPPD Ainsworth, NE	Derby et al. 2007
Combine Hills, OR	Young et al. 2006	Pebble Springs, OR	Gritski and Kronner 2010b
Combine Hills, OR (11)	Enz et al. 2012	Pine Tree, CA	BioResource Consultants 2012
Crescent Ridge, IL	Kerlinger et al. 2007	Pioneer Prairie I, IA (Phase II)	Chodachek et al. 2012
Criterion, MD (11)	Young et al. 2012b	PrairieWinds ND1 (Minot), ND	Derby et al. 2011d
Criterion, MD (12)	Young et al. 2013	PrairieWinds ND1 (Minot), ND (11)	Derby et al. 2012d

Appendix A3 (*continued*). All post-construction monitoring studies, project characteristics, and select survey methodology.

Data from the following sources:

Project, Location	Reference	Project, Location	Reference
Crystal Lake II, IA	Derby et al. 2010b	PrairieWinds SD1, SD	Derby et al. 2012c
Diablo Winds, CA	WEST 2006, 2008	Prince Wind Farm, Ont (06)	Natural Resource Solutions 2009
Dillon, CA	Chatfield et al. 2009	Prince Wind Farm, Ont (07)	Natural Resource Solutions 2009
Dry Lake I, AZ	Thompson et al. 2011	Prince Wind Farm, Ont (07)	Natural Resource Solutions 2009
Dry Lake II, AZ	Thompson and Bay 2012	Red Hills, OK	Derby et al. 2013c
Elkhorn, OR (08)	Jeffrey et a. 2009a	Ripley, Ont (08)	Jacques Whitford 2009
Elkhorn, OR (10)	Enk et al. 2011a	Rugby, ND	Derby et al. 2011c
Elm Creek, MN	Derby et al. 2010e	Shiloh I, CA	Kerlinger et al. 2009
Elm Creek II, MN	Derby et al. 2012b	Shiloh II, CA	Kerlinger et al. 2010, 2013a
Foote Creek Rim, WY (Phase I; 99)	Young et al. 2003	Stateline, OR/WA (02)	Erickson et al. 2004
Foote Creek Rim, WY (Phase I; 00)	Young et al. 2003	Stateline, OR/WA (03)	Erickson et al. 2004
Foote Creek Rim, WY (Phase I; 01-02)	Young et al. 2003	Stateline, OR/WA (06)	Erickson et al. 2007
Forward Energy Center, WI	Grodsky and Drake 2011	Stetson Mountain I, ME (09)	Stantec 2009c
Fowler I, IN (09)	Johnson et al. 2010a	Stetson Mountain I, ME (11)	Normandeau Associates 2011
Fowler I, II, III, IN (10)	Good et al. 2011	Stetson Mountain II, ME (10)	Normandeau Associates 2010
Fowler I, II, III, IN (11)	Good et al. 2012	Summerview, Alb (06)	Brown and Hamilton 2006
Fowler I, II, III, IN (12)	Good et al. 2013a	Summerview, Alb (08)	Baerwald 2008
Fowler III, IN (09)	Johnson et al. 2010b	Top of Iowa, IA (03)	Jain 2005
Goodnoe, WA	URS Corporation (URS) 2010a	Top of Iowa, IA (04)	Jain 2005
Grand Ridge I, IL	Derby et al. 2010a	Tuolumne (Windy Point I), WA	Enz and Bay 2010
Harrow, Ont (10)	Natural Resources Solutions Inc. 2011	Vansycle, OR	Erickson et al. 2000
Harvest Wind, WA (10-12)	Downes and Gritski 2012a	Vantage, WA	Ventus Environmental Solutions 2012
Hay Canyon, OR	Gritski and Kronner 2010a	Wessington Springs, SD (09)	Derby et al. 2010c
High Sheldon, NY (10)	Tidhar et al. 2012a	Wessington Springs, SD (10)	Derby et al. 2011a
High Sheldon, NY (11)	Tidhar et al. 2012b	White Creek, WA (07-11)	Downes and Gritski 2012b
High Winds, CA (04)	Kerlinger et al. 2006	Wild Horse, WA	Erickson et al. 2008
High Winds, CA (05)	Kerlinger et al. 2006	Windy Flats, WA	Enz et al. 2011
Hopkins Ridge, WA (06)	Young et al. 2007	Winnebago, IA	Derby et al. 2010g
Hopkins Ridge, WA (08)	Young et al. 2009b	Wolfe Island, Ont (July-Dec 09)	Stantec Ltd. 2010
Judith Gap, MT (06-07)	TRC Environmental Corporation 2008	Wolfe Island, Ont (July-Dec 10)	Stantec Ltd. 2011
Judith Gap, MT (09)	Poulton and Erickson 2010	Wolfe Island, Ont (July-Dec 11)	Stantec Ltd. 2012

Appendix M. Whooping Crane Operational Procedure and Monitoring Program for the North Bend Wind Project,

WHOOPING CRANE MONITORING PLAN AND TURBINE SHUT-DOWN PROTOCOL NORTH BEND WIND PROJECT,
Hughes and Hyde Counties, South Dakota

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June 13, 2022

WEST

Pre-Decisional Document – Business Confidential Information – Not for Distribution

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1 INTRODUCTION

North Bend Wind Project, LLC (North Bend) is proposing to develop the North Bend Wind Project (Project) in Hughes and Hyde counties, South Dakota (Figure 1). As currently proposed, the Project would have a generation capacity of approximately 200 megawatts (MW), consisting of up to 71 GE 2.8MW wind turbines encompassing approximately 47,000 acres. The Project would also include electric underground collection lines and communication lines, a transmission line, a Project substation, a switchyard, access roads connecting turbines and associated facilities, a permanent meteorological tower, and a temporary laydown yard. The location of the Project in Hughes and Hyde counties has been sited and initially developed with coordination between US Fish and Wildlife Service (FWS), South Dakota Game, Fish, and Parks (GFP), and Western Area Power Administration (WAPA).

The Project is located within the migration corridor of the federally endangered whooping crane (*Grus americana)*. North Bend conducted a stopover habitat assessment to identify suitable wetland habitat for whooping crane, using The Watershed Institute model (TWI 2012) and a scoring threshold of wetlands that scored 12 or better (Figure 2). The project layout was also evaluated using a stopover habitat model developed by Niemuth et al. (2018; Niemuth Model) to create a predictive map of relative probability of use by whooping cranes (Figure 3). The stopover habitat assessment analyses using the Niemuth Model and the TWI model show similar results. Suitable stopover habitat for whooping cranes (TWI scored wetlands 12 or greater) occurs in limited amounts within a mile of proposed turbines at the Project (Figure 2), and the Niemuth Model shows a low probability of whooping crane use as compared to the surrounding landscape (Figure 3).

North Bend has developed a whooping crane monitoring and voluntary activity shut-down protocol to minimize the potential for impacts to whooping cranes during spring and fall migration seasons, when the species may potentially be present. This study plan is based on commitments provided in the North Bend Bird and Bat Conservation Strategy (BBCS).

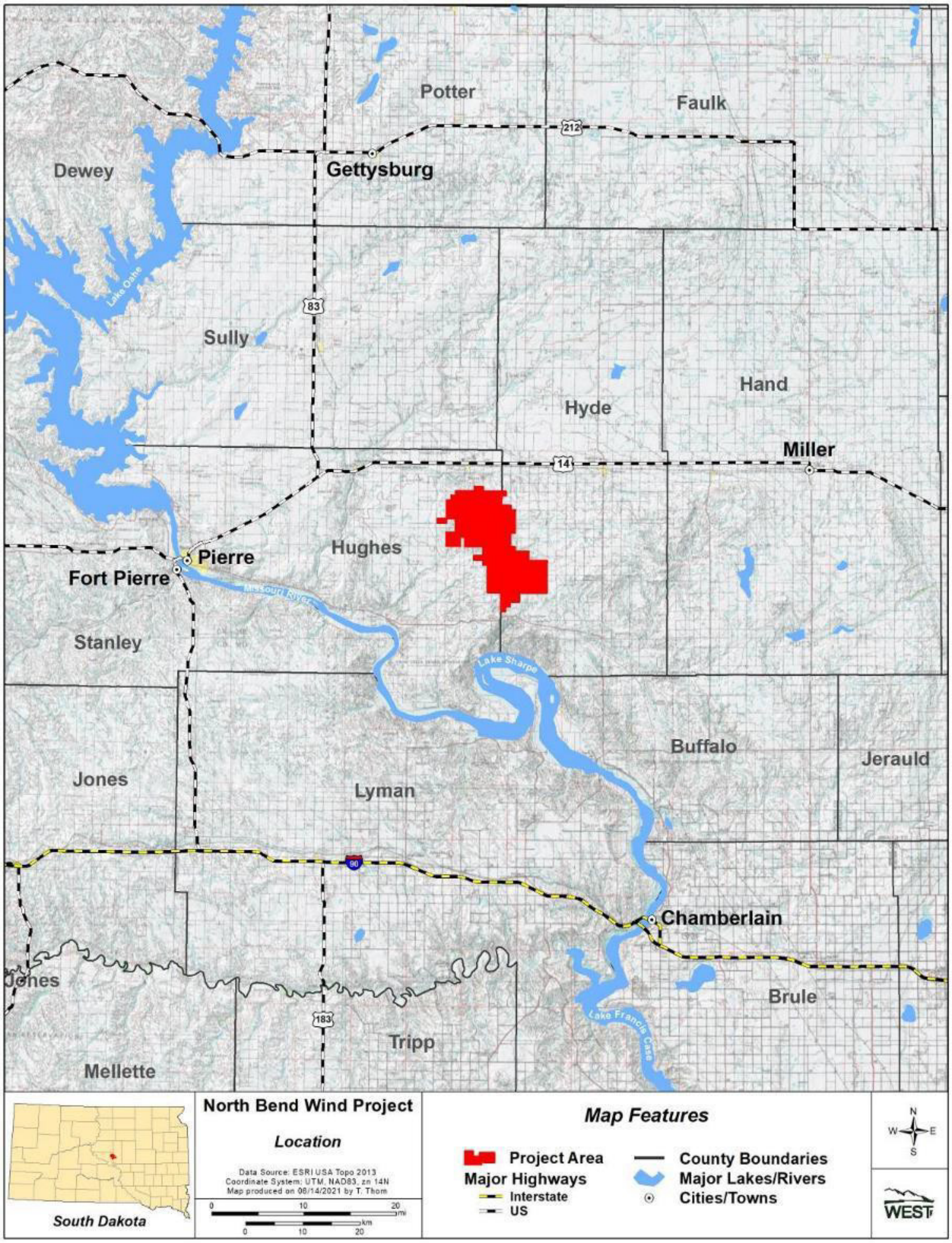

Figure 1. Location of the North Bend Wind Project, Hughes and Hyde counties, South Dakota.

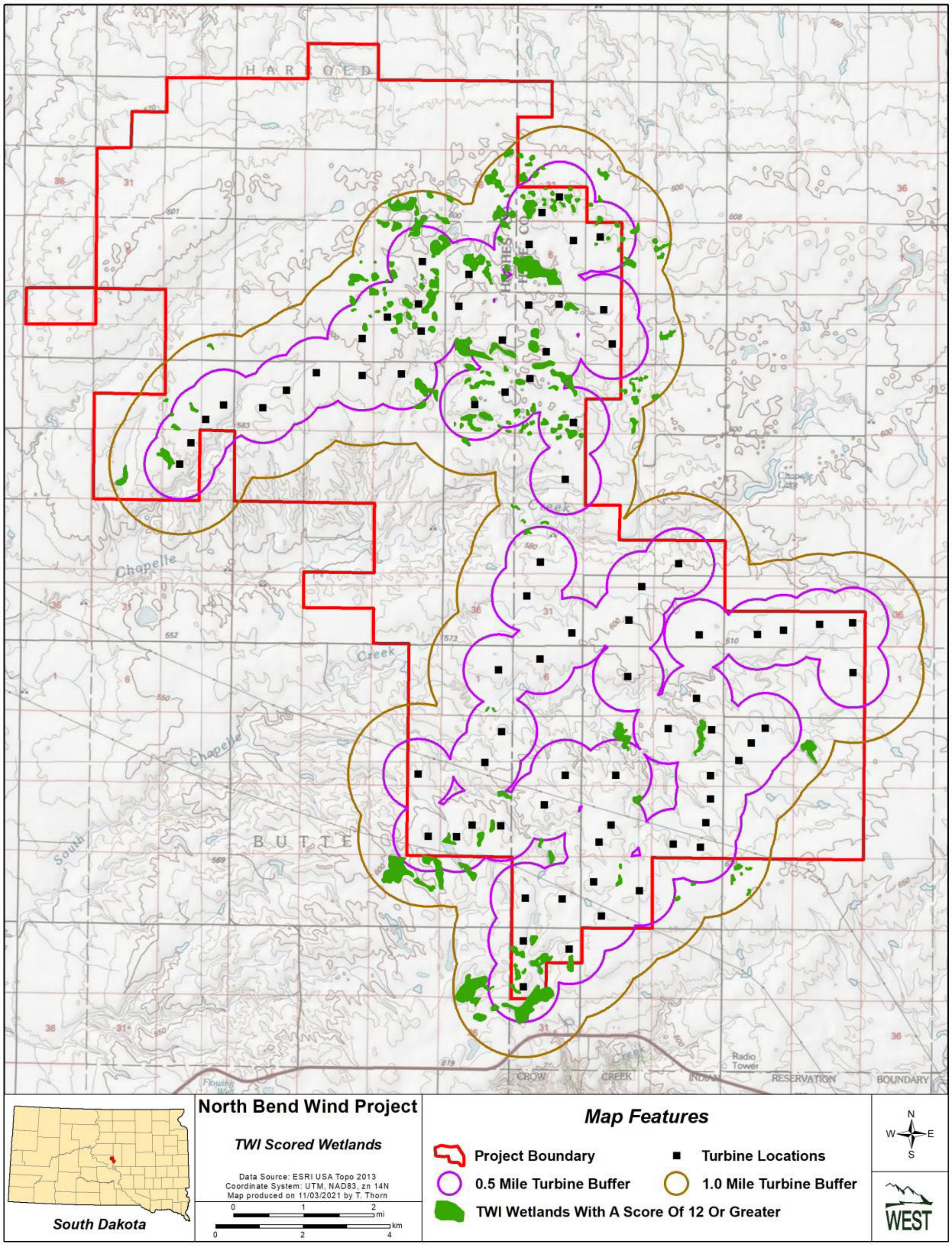

Figure 2. The Watershed Institute suitable whooping crane stopover habitat wetlands (scores >12; TWI [2012]) for the North Bend Wind Project within one mile of proposed turbines.

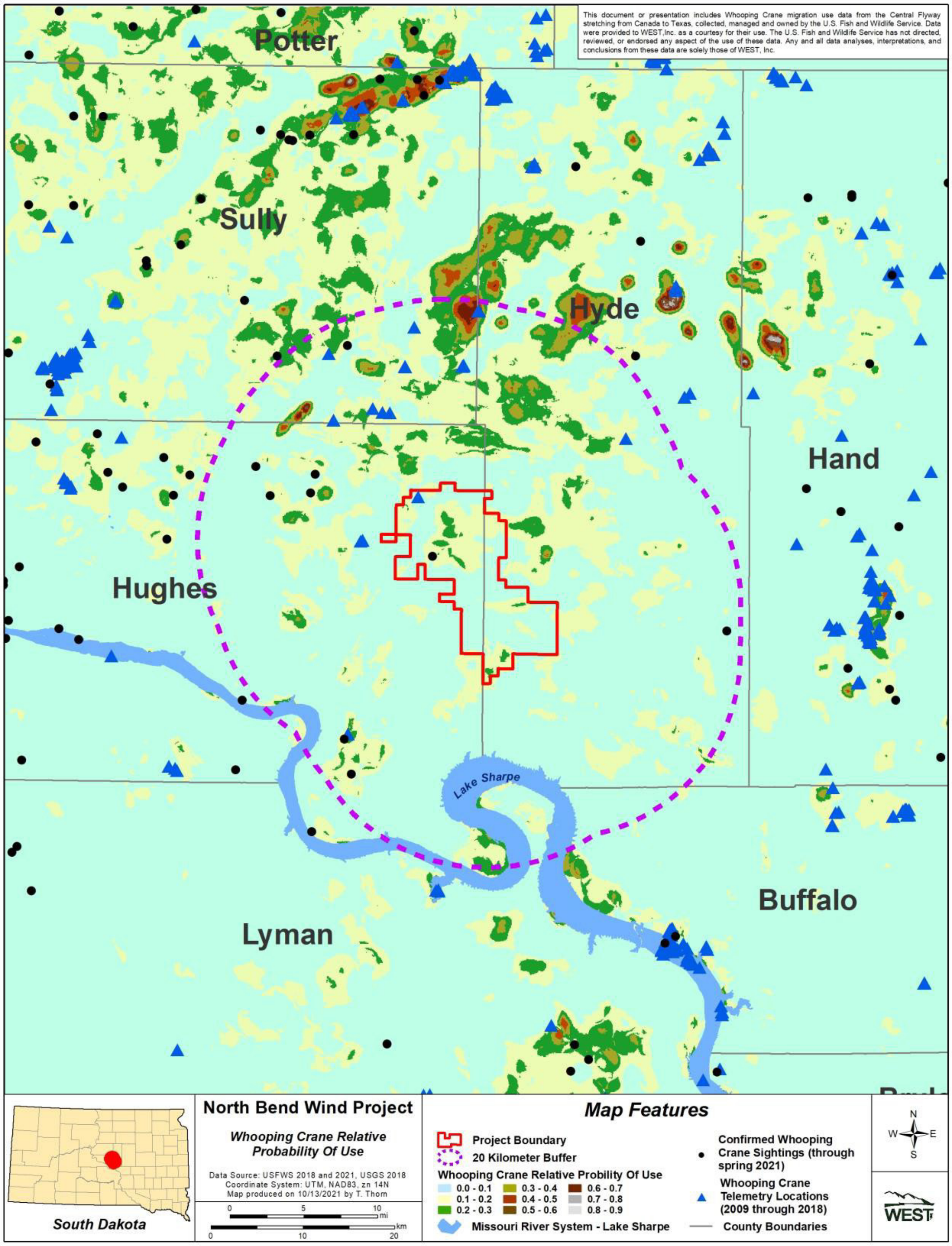

Figure 3. Relative probability of whooping crane use within the North Bend Wind Project based on Niemuth et al. (2018).

2 WHOOPING CRANE MONITORING

Whooping crane monitoring will be focused during the spring and fall migration seasons during construction and operation of the Project. The spring migration season is defined as approximately April 1 to May 15, and the fall migration season is September 10 to October 31. South Dakota Ecological Services Field Office may be contacted to define the timing of annual whooping crane migration in subsequent years. Monitoring will take place daily, and because whooping cranes are diurnal migrants, will primarily focus with the first and last two hours of daylight each day. A Project Construction Manager or Site Manager (or their designee) will drive along public roads and Project access roads within two miles of turbine locations and visually scan the skies, fields, grasslands, wetlands, and other open areas for the presence of cranes, using binoculars or a spotting scope on a daily basis. If any whooping cranes are observed, the number of cranes, UTM location coordinates, and behavior will be recorded, along with maps depicting any flight paths in the Project. Any flocks of sandhill cranes (*Grus canadensis*) will also be examined closely because whooping cranes sometimes travel with sandhill cranes.

The whooping crane monitoring protocol applies to both construction and operation periods as stated below:

- Construction Manager or their designee will conduct construction monitoring during the above defined spring and fall migration seasons, and stop construction activities (see shut-down protocol below) within two miles of observed whooping cranes until the area is vacated.
- Site Manager or their designee will conduct operational monitoring during the above defined spring and fall migration seasons. Operations staff will be trained to identify whooping cranes, and if any are noted in the Project, turbines within two miles of the whooping crane(s) will be shut down (see shut down protocol below) until whooping cranes have vacated the area.

3 ACTIVITY SHUT-DOWN PROTOCOL

Construction, and Operation and Maintenance (O&M) personnel will be made aware of potential for the species to occur during spring and fall migration and the process to follow if a whooping crane(s) is believed to have been observed in the Project. A whooping crane identification poster will be permanently posted in the O&M facility for reference, and tri-fold identification pamphlets will be made available for personnel to carry on their person. A communication calling tree will be developed for any confirmed sightings of whooping cranes within two miles.

If construction personnel observe a crane(s) within two miles of the Project, the Construction Manager or their designee will halt construction activities within two miles of the observed crane(s) until cranes(s) are greater than two miles away. North Bend will inform the US Fish and Wildlife Service and South Dakota Game Fish and Parks of any whooping crane observations and any construction modification made based on the location of the observation.

Similarly, if operations personnel observe a crane(s) within 2-miles of the Project, the Site Manager or their designee will halt all turbine operations within two miles of the observed crane(s) until whooping cranes(s) are more than two miles away for more than two hours. North Bend will inform the agencies of any whooping crane observations and any corresponding shut-down of turbines.

4 REFERENCES

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Niemuth, N. D., A. J. Ryba, A. T. Pearse, S. M. Kvas, D. A. Brandt, B. Wangler, J. E. Austin, and M. J. Carlisle. 2018. Opportunistically Collected Data Reveal Habitat Selection by Migrating Whooping Cranes in the U.S. Northern Plains. Condor 120(2): 343-356. doi: 10.1650/CONDOR-17-80.1.

North American Datum (NAD). 1983. Nad83 Geodetic Datum.

The Watershed Institute, Inc. (TWI) 2012. Potentially suitable habitat assessment for the whooping crane (*Grus americana*). Topeka, KS.

Appendix N. North Bend Wind Project Field Studies and Habitat Assessments Summary 2016 – 2021 Hughes and Hyde Counties, South Dakota

North Bend Wind Project

Field Studies and Habitat Assessments

Summary 2016 – 2021

Hughes and Hyde Counties, South Dakota

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INTRODUCTION

North Bend Wind Project, LLC (North Bend) is considering the development of the North Bend Wind Project (Project) in Hughes and Hyde counties, South Dakota. North Bend contracted with Western EcoSystems Technology, Inc. (WEST) to conduct baseline wildlife and habitat studies to evaluate potential impacts of wind energy facility construction and operations on wildlife.

In 2016, baseline wildlife studies were completed within a previous defined wind resources area encompassing 15,822.9 hectares (ha; 39,099.3 acres [ac]) based on a 200-megawatt (MW) project. In 2017, this wind resource area was expanded to encompass 44,573.0 ha (110,142.3 ac) based on up to three separate 250 MW phases. This expanded wind resource area was the largest of the proposed boundaries. North Bend recently refined the area for the Project, which is primarily located along the western portion of the previously surveyed wind resource area and encompasses approximately 18,978.7 ha (46,897.1 ac; Figure 1, Table 1).

Baseline wildlife studies within the Project area 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 Stage 2 of the USFWS *Eagle Conservation Plan Guidance* (ECPG; USFWS 2013). Studies conducted within the Project area from 2016 to 2021 include avian use surveys, raptor and eagle nest surveys, prairie grouse lek surveys, general bat acoustic monitoring, northern long-eared bat (NLEB; *Myotis septentrionalis*) summer habitat analysis, whooping crane (*Grus americana*) stopover habitat analysis, and a land cover characterization study.

The studies conducted to date also incorporate WEST's experience working in South Dakota with USFWS Ecological Services, the USFWS Region 6 Ecological Services Field Office, and South Dakota Game, Fish, and Parks (SDGFP). The following provides a summary of studies conducted, in progress, or applicable to the current Project area.

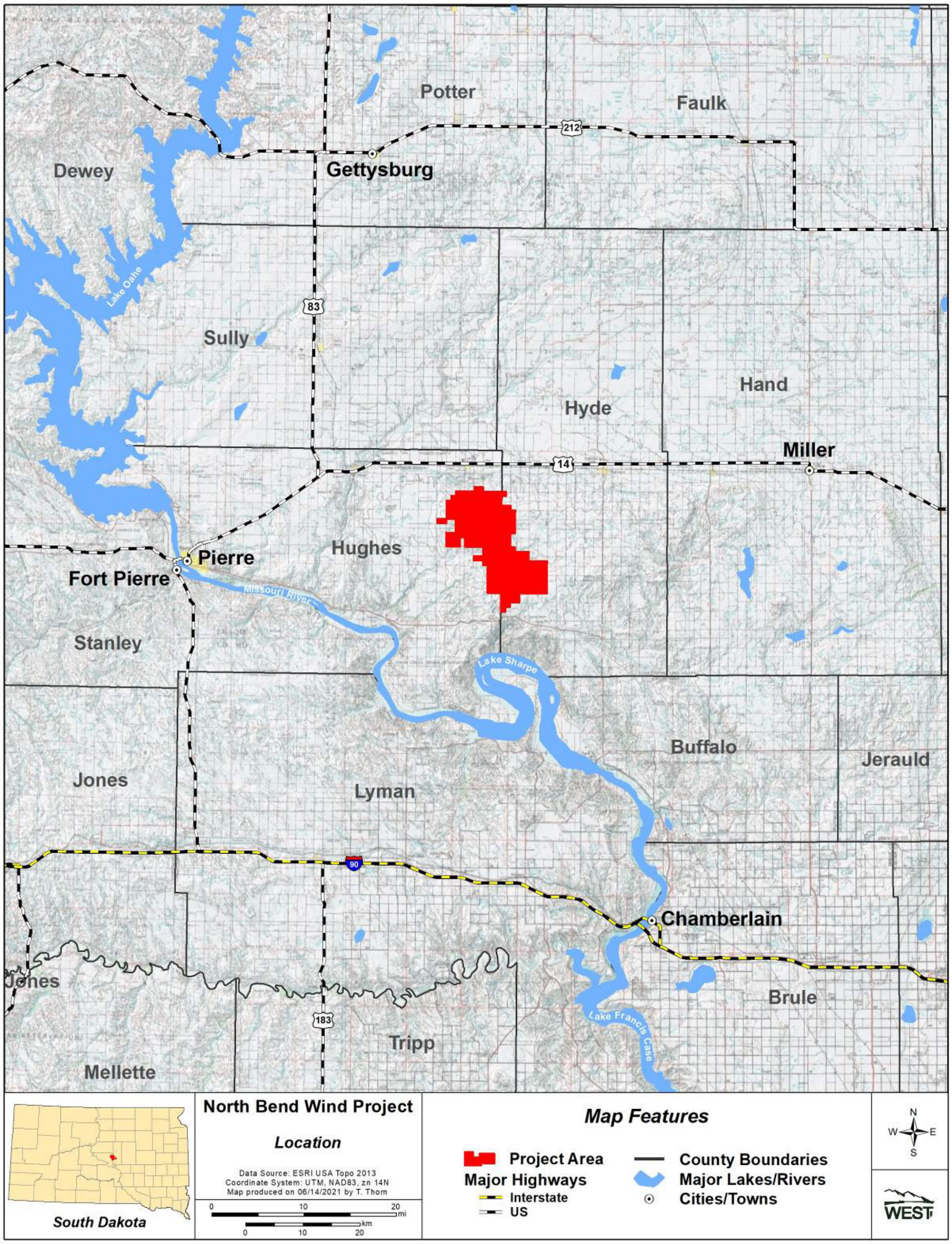

Figure 1. Location of the North Bend Wind Project, Hughes and Hyde counties, South Dakota.

PROJECT AREA DESCRIPTION

The Project area is located in Hughes and Hyde counties, South Dakota, approximately six kilometers (km; four miles [mi]) south of Harrold, South Dakota. This area is within the intersection of the Northwestern Great Plains Level III Ecoregions (US Environmental Protection Agency [USEPA] 2017) and the Bird Conservation Region (BCR 11; Prairie Potholes [Bird Studies Canada and NABCI 2014]). The Northwestern Glaciated Plains ecoregion has significant surface irregularity and dense concentrations of wetlands. In contrast, this area along the Southern Missouri Coteau exhibits a topography of gentle, rolling hills rather than steep hummocks, with fewer areas of high wetland density, and more stream erosion (USEPA 2017) much of which has been converted to cultivated crops. The river breaks landform is also common near riparian areas and consists of uplands with broken terraces that descend to the Missouri River and its major tributaries. This rough and broken river break topography, with its wooded draws and uncultivated areas, provides habitat for wildlife.

The topography within the Project area consists of rolling hills, with elevations ranging from 548.5–653.8 meters (m; 1,800.0–2,145.0 feet [ft]) above mean sea level (US Geological Survey [USGS] Digital Elevation Model 2017). Land ownership within the Project area is primarily private with a few scattered State Resource Management Areas (USGS Protected Areas Database of the US 2019) one of which fall within the Project area (Figure 2). Chapelle Creek and South Chapelle Creek are the named creeks within the Project area (Figure 2; USGS National Hydrography Dataset 2019). Wetlands are dispersed throughout the Project area, but most are located in the northeastern portion of the Project area (Figure 2; National Wetlands Inventory [NWI] 2019). The majority of wetlands are herbaceous wetlands, followed by open water (i.e., freshwater pond, and lakes; Table 1).

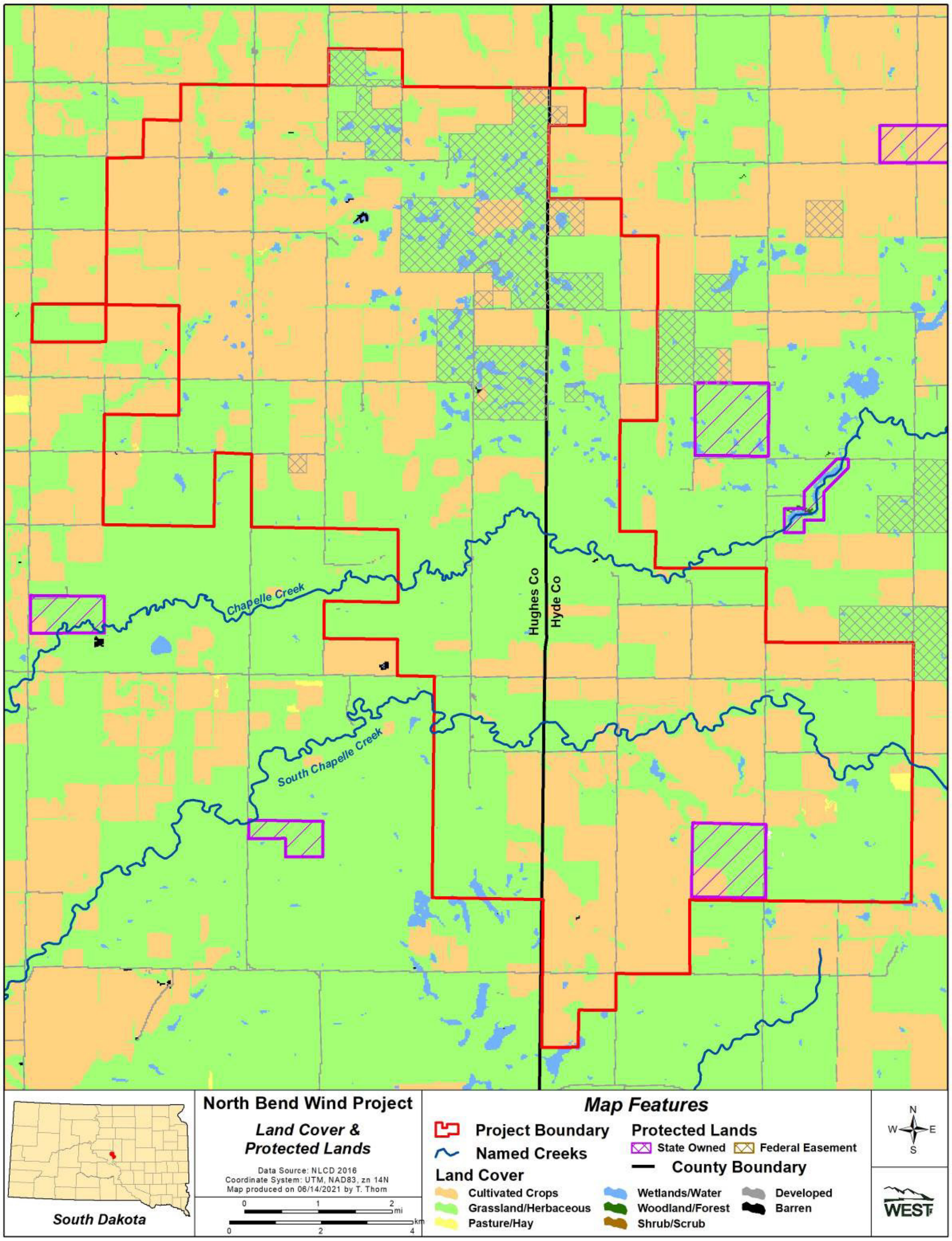

Figure 2. Land cover types and protected lands within the current North Bend Wind Project boundary located in Hughes and Hyde counties, South Dakota.

Land Cover

Land cover types were digitized using ArcGIS (version 10.4) within the current Project area. Using US Department of Agriculture (USDA) National Agriculture Imagery Program (NAIP [USDA 2019]) aerial imagery in combination with 2011 South Dakota Land Cover Patterns (National Land Cover Database (NLCD; 2016), USDA National Agricultural Statistics Service (NASS) National Cropland Layer (USDA NASS 2018) cropland classification, and field inspections, all lands within the current Project area were digitized and assigned one of seven cover types (Table 1). NWI data were used to represent water for the purpose of mapping within the current Project area. Water features visible on the aerial imagery, but not located in the NWI data tables, were digitized as "Wetland/Water" on the map (Figure 2).

The dominant land cover type within the current Project area is herbaceous, representing 51.9% of the land cover (9,846.3 ha [24,330.7 ac]) followed by cultivated crops (8,334.6 ha [20,595.2 ac]; 43.9%; Table 1, Figure 2). Additional land cover types included developed (389.7 ha [963.0 ac]; 2.1%) followed by herbaceous wetlands (347.7 ha [859.1 ac]; 1.8%). All remaining land cover types in the Project area were less than 0.15% (Table 1).

Table 1. Land cover, coverage, and percent (%) composition within the North Bend Wind Project, Hughes and Hyde counties, South Dakota.

Land Cover	Coverage (Hectares)	% Composition
Herbaceous	9,846.3	51.9
Cultivated crops	8,334.6	43.9
Developed	389.7	2.1
Herbaceous wetlands	347.7	1.8
Open water	29.1	0.15
Hay/Pasture	22.9	0.12
Barren land	6.6	<0.1
Shrub/Scrub	1.8	<0.1
Total	**18,978.7**	**100**

Source: National Land Cover Database (2016).

AVIAN USE SURVEYS

Avian point-count surveys are the most widely used methodology for pre-construction avian use characterization and turbine siting considerations (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 Project area by birds over the four-year period surveys were conducted. Project boundaries changed over time, and therefore altered avian use survey locations. Unless otherwise noted, surveys were conducted once a month for 70 minutes (min) each. Small bird species were recorded during the first 10 min of the survey period, and then only large bird species were recorded for the next 60 min. The initial 10-min surveys allowed for comparison of small use with the majority of wind projects in the region. The 60-min surveys encompassing large birds were consistent with the

ECPG and used to obtain a stronger dataset with which to evaluate large bird use, particularly for eagles.

Survey plots were selected to survey representative habitats and topography of the Project area, while meeting ECPG spatial sampling recommendations. The ECPG recommended at least 30% coverage of areas within 1.0 km (0.6 mi) of turbine locations or within the minimum convex polygon (MCP) of the complete turbine array (USFWS 2013) should be surveyed. As location of turbines were unknown at the time of sampling, survey coverage attempted to include 30% coverage of the Project area, at the time. Base on the final turbine layout survey coverage included 28.1% of the proposed MCP. Large birds observed within an 800-m (2,625-ft) plot and small birds within a 100-m (328-ft) plot were used for quantitative analysis and other comparative metrics. During surveys, 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. Additionally, for all eagle observations, data were collected following ECPG methodology (USFWS 2013).

A number of avian protected or species of concern (SOC) have the potential to occur within South Dakota. This includes bald and golden eagles, two federally listed species, and four additional state-listed species (SDGFP 2014). Recently the USFWS has updated the Birds of Conservation Concern (BCC) for each BCR (USFWS 2021). There are 34 BCC species and 8 Tier 2a South Dakota species of greatest conservation need (SDGFP 2014).

The Project area has shifted numerous times during development (Figure 3) due to various logistic constraints. As such, avian use information from 2016 to 2019 is synthesized to provide a high level overview of the methods and results as limited sampling points overlap the most recent and constricted Project area. The conclusion of this section provides preliminary survey results of ongoing avian use efforts focused on the southern portion of the current proposed Project area.

Fixed-point Survey Efforts (2016 – 2017)

The following provides a summary of the avian use survey effort conducted April 18, 2016 – March 28, 2017 within the current Project area (Figure 3). Surveys covered approximately 34% of the 2016 Project area (Figure 3). During this effort, surveys were conducted for 60 min at each survey point location with all birds recorded for the first 20 min and only large birds recorded for the following 40 min. While this methodology differs from later surveys, results from these previous efforts can provide general information on species composition and diversity within the current Project area. Sixty hours (hr) of surveys were completed at five point count locations. This effort resulted in 41 unique species being observed during surveys, regardless of bird size, with horned lark (*Eremophila alpestris*; 387 observations, 9 groups), Canada goose (*Branta canadensis*; 201, 5), and Franklin's gull (*Leucophaeus pipixcan*; 95, 1), being the most commonly observed species. Northern harrier (*Circus hudsonius*; 4, 4), bald eagle (*Haliaeetus leucocephalus*; 1, 1) and merlin (*Falco columbarius*; 1, 1) were the only identified diurnal raptors during surveys. No golden eagles (*Aquila chrystaetos*) were documented during survey effort. No federally or state-listed species were observed during surveys.

Fixed-point Survey Efforts (2018 – 2019)

The following provides a summary of avian use survey effort conducted January 23, 2018 – January 14, 2019 within the current Project area (Figure 3). There were 27 survey locations resulting in 324 fixed-point surveys completed for each large and small bird surveys. This effort resulted in 60 unique large bird species being observed. The most commonly recorded large bird species were snow goose (*Anser caerulescens*; 19,515 observations, 19 groups), Canada goose (6,007, 31), and greater white-fronted goose (*A. albifrons*; 4,870, 14). Nine diurnal raptor species were documented during surveys with northern harrier (*Circus hudsonius*; 17, 17) as the most frequently recorded species. For small birds, western meadowlark (*Sturnella neglecta*; 197, 102) was the most regularly observed species, followed by red-winged blackbird (*Agelaius phoeniceus*; 91, 25), and brown-headed cowbird (*Molothrus ater*; 90, 31). Six golden eagles and four bald eagles were documented during survey efforts. No federally or state-listed species were observed while conducting surveys.

Fixed-point Survey Efforts (2019 – 2020)

Surveys were conducted from April 5, 2019 – March 31, 2020 at 19 survey points (Figure 3). There were 212 fixed-point surveys completed for each large and small bird survey. Sixty unique species were recorded during surveys including 38 unique large bird and 22 unique small bird species. The most common large bird species were sandhill crane (*Antigone Canadensis*; 2,950 observations, 15 groups), Canada goose (674, 26), and mallard (*Anas platyrhynchos*; 175, 45). The most abundance raptors identified within the Project area were red-tailed hawk (*Buteo jamaicensis*; 48, 30) followed by northern harrier (16, 15). Red-winged blackbird (714, 84), brown-headed cowbird (274, 58), and western meadowlark (251, 145) were the most frequently recorded small bird species. One bald eagle was observed during fixed-point surveys. No other eagle, federal- or state-listed species were observed while conducting surveys within the Project area during the 2019 – 2020 survey year. There were four species that are identified as both BCC and SGCN including: marbled godwit (*Limosa fedoa*; 22 observations), black tern (*Chlidonias niger;* 16), greater prairie-chicken (*Tympanuchus cupido*; 1), and chestnut-collared longspur (*Calcarius ornatus*; 11). Five species identified are categorized as BCC species only including: Franklin's gull (65 observations), northern harrier (27), bobolink (*Dolichonyx oryzivorus*; 73), grasshopper sparrow (*Ammodramus savannarum*; 36), and red-headed woodpecker (*Melanerpes erythrocephalus;* 2). There was also lark buntings observed (*Calamospiza melanocorys;* 45 observations) which is categorized as a SGCN species only.

Fixed-point Survey Efforts (2020 – 2021)

Surveys were conducted from April 6, 2020 through March 13, 2021 at 23 survey points (Figure 3). There were 276 fixed-point surveys completed for large and small birds each. Sixty-nine unique species were recorded during surveys, including 37 unique large bird and 32 unique small bird species. For large birds, the most common species recorded included Canada goose (589 observations, 27 groups), snow goose (428, 6) and sandhill crane (94, 5). Five diurnal raptor species were identified within the Project area, with northern harrier (31, 31) and red-tailed hawk (25, 25) being the most abundant. For small bird species, red-winged blackbirds (211 observations, 39 groups), western meadowlark (192, 192), horned lark (177, 38) and brown-headed cowbird (101, 22) were the most common. No eagle, federal- or state-listed species have been observed while conducting surveys within the Project area during this effort. There were three species that are identified as both BCC and SGCN including: marbled godwit (1 observation), black tern (5), and chestnut-collared longspur (26). Five species identified are categorized as BCC species only including: Franklin's gull (9 observations), northern harrier (31), bobolink (4), grasshopper sparrow (56), and red-headed woodpecker (4).

Fixed-point Survey Efforts (2021 - 2022): Ongoing

An additional 11 points were surveyed in the southern portion of the Project area (Figure 3; orange squares in 2019 for a brief time but were later stopped due to anticipated project development. In early 2021, it was determined that there could be potential development in this area again. These 11 survey locations were again surveyed starting February 25, 2021, and this summary includes preliminary data collected through April 2021. There were 33 fixed-point surveys completed for each large and small bird survey. Forty-four unique species were recorded during surveys including 28 unique large bird and 16 unique small bird species. The most common large bird species were Franklin's gull (153 observations, 3 groups), Canada goose (100, 5), and ring-necked pheasant *(Phasianus colchicus*; 21, 19). The most abundance raptors identified within the Project area were red-tailed hawk (9, 9) followed by northern harrier (4, 4). Red-winged blackbird (71, 10), western meadowlark (57, 57), and brown-headed cowbird (53, 20) were the most frequently recorded small bird species. No eagles, federal- or state-listed species were observed while conducting surveys within the Project area during this survey effort. There were two species that are identified as both BCC and SGCN including: marbled godwit (7 observations) and chestnut-collared longspur (24). Four species identified are categorized as BCC species only including: Franklin's gull (153 observations), northern harrier (4), bobolink (4), and grasshopper sparrow (11).

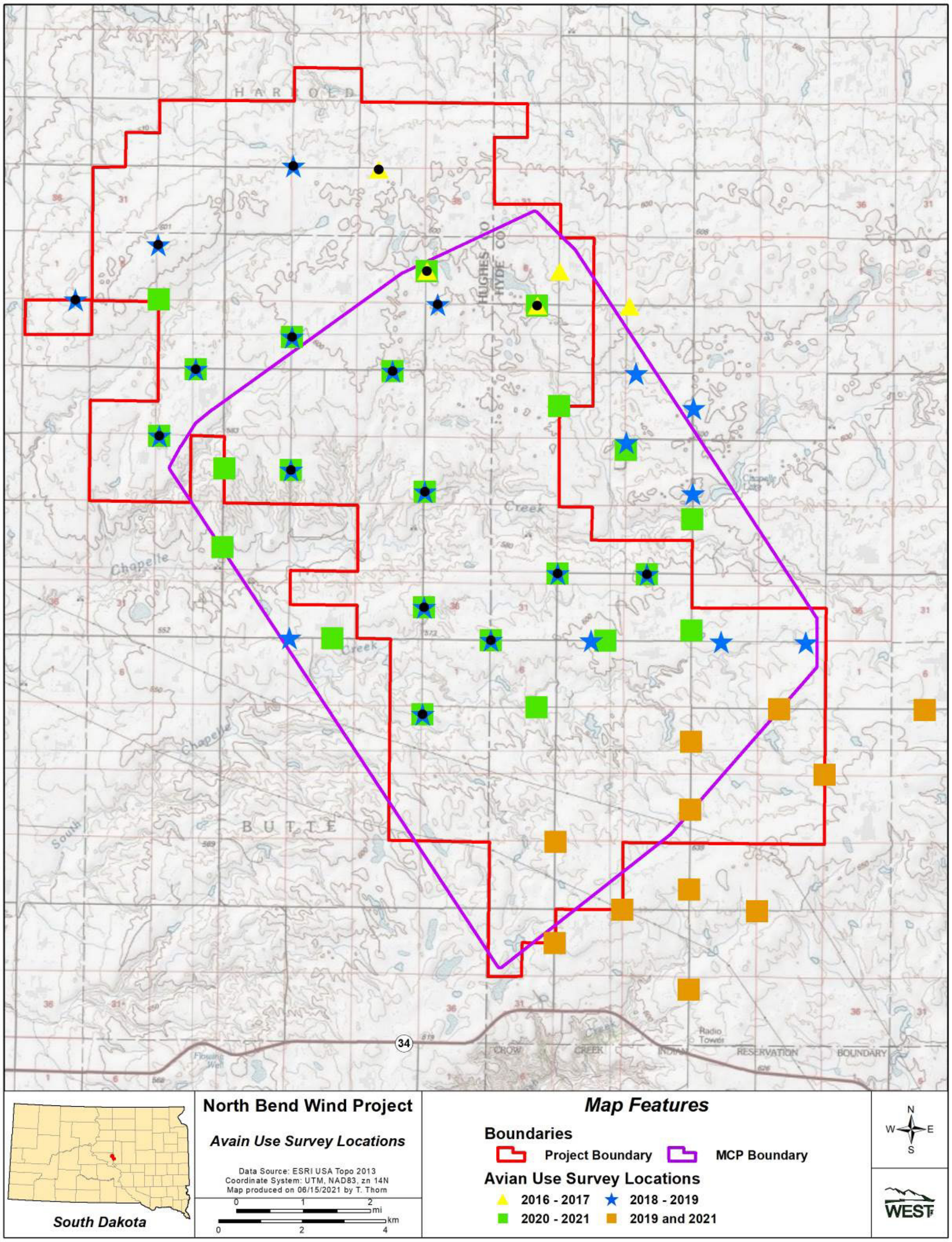

Figure 3. Location of fixed-point avian use survey stations completed in from 2016-2021 throughout the North Bend Wind Project boundary located in Hughes and Hyde counties, South Dakota. The MCP Boundary (purple outline) encapsulates the final proposed turbine layout.

RAPTOR NEST SURVEYS

Raptor nest surveys were conducted in the spring of 2016, 2018, 2019, and 2020. The objectives of the nest surveys were to gather information on eagle nest locations and other raptor species nesting in the area, which may be subject to disturbance or displacement effects from wind facility construction and operation. Surveys were conducted within the Project area and a 1.0-mi buffer for all raptors. Due to various guidance from USFWS over the past several years, additional eagle nest survey efforts have included various buffers from 16.1-km (10-mi; USFWS 2013), 6.4-km (4-mi; USFWS 2020b) and 3.2-km (2-mi; USFWS 2020c). For the purposes of this section, the current 2-mi buffer was used to summarize the results of these efforts. Prior to the surveys, topographic and aerial maps were evaluated to determine where raptor and eagle nesting habitat is likely to occur (e.g., riparian habitat along creeks, open lakes with large trees) so these areas could be targeted during the aerial surveys. A biologist conducted the surveys in a helicopter operated by a pilot experienced in conducting low-altitude wildlife surveys. Surveys were generally conducted on days with good visibility and no precipitation. The locations of all raptor nests and survey paths were recorded using a hand-held onboard Global Positioning System (GPS) receiver.

For all raptor and eagle nest structures detected, the biologist recorded nest location coordinates with the GPS receiver, species present (if any), condition of the nest, presence of eggs or young (if present and visible), and the substrate of the nest (e.g., tree, power pole, rock outcrop). The status of each nest was determined as either: Occupied – an adult in incubating position, eggs, nestlings or fledglings, a newly constructed or refurbished stick nest and/or the presence of one or more adults on or immediately adjacent to the nest structure(s), or Unoccupied – a nest with no evidence of recent use, or attendance by adult raptors. Efforts were made to minimize disturbance to nesting raptors, livestock, or occupied dwellings to the greatest extent possible. Photographs were taken of possible eagle nests.

2016 Surveys

Aerial surveys were conducted from March 28 – April 1, 2016, to search for eagle and raptor nests. During the 2016 aerial survey, three raptor nests were documented within the Project area (Figure 4; Table 2). Two nests were occupied by red-tailed hawks, while one nest was inactive. No eagle or potential eagle nests were located within the Project area and 2-mi buffer.

Table 2. Location of raptor nest sites observed during 2016 surveys located in the current North Bend Wind Project and surrounding 3.2-kilometer (2.0-mile) buffer, Hughes and Hyde counties, South Dakota.

Nest ID	Northing	Easting	Species[1]	2016 Status
1	442383	4922347	RTHA	Occupied
2	444594	4919242	UNRA	Unoccupied
16	444423	4925361	RTHA	Occupied

[1.] RTHA = red-tailed hawk, UNRA = unknown raptor.

ID = Identification.

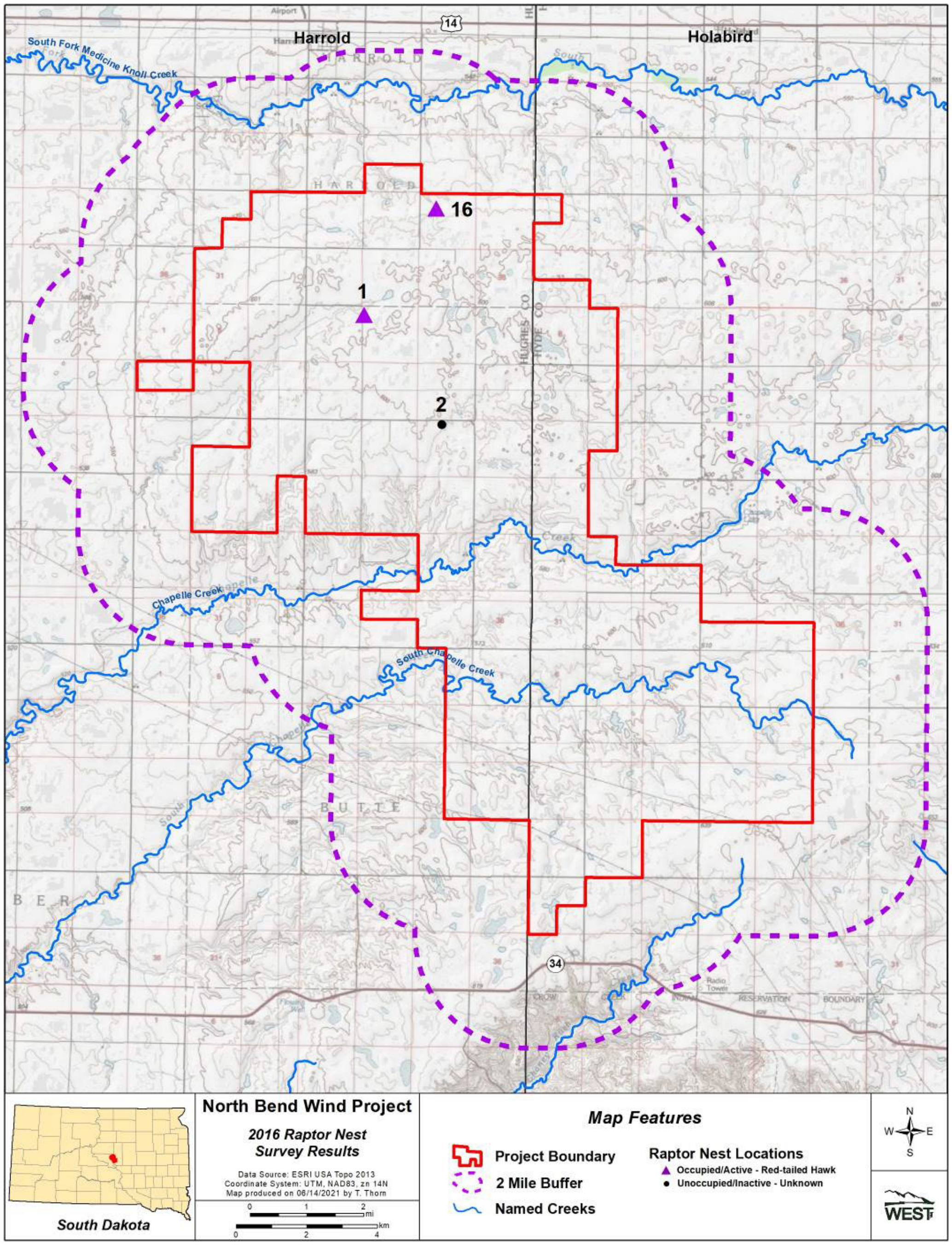

Figure 4. Location of raptor nests identified during surveys in 2016 for the North Bend Wind Project and 3.2-kilometer (km; 2.0-mile [mi]) buffer in Hughes and Hyde counties, South Dakota.

2018 Surveys

An aerial survey for raptor nests was completed for the Project from March 9 – 14, 2018, with follow-up ground surveys conducted in conjunction with other work in May 2018. During these surveys, 15 raptor nests were identified (Figure 5). All three of the previously documented nests from 2016 were re-visited; one was confirmed occupied with a great-horned owl (*Bubo virginianus*) and two could not be relocated. No potential eagle nests were identified within the Project area or 2-mi buffer. Nine of the 15 nests were classified as unoccupied nests of unknown raptor. The remaining occupied nests included four great-horned owls, one Swainson's hawk (*Buteo swainsoni*), and one red-tailed hawk (Table 3).

Table 3. Location of raptor nest sites surveyed and/or observed during 2018 surveys located in the current North Bend Wind Project and surrounding 3.2-kilometer (2.0-mile) buffer, Hughes and Hyde counties, South Dakota.

Nest ID	Northing	Easting	Species[1]	2018 Status
1	442383	4922347	GHOW	Occupied
2	444594	4919242	DNL	n/a
17[2]	444423	4925361	DNL	n/a
19	447561	4925661	UNRA	Unoccupied
30	448709	4915493	GHOW	Occupied
46	451315	4923410	UNRA	Unoccupied
47	450147	4927430	UNRA	Unoccupied
48	450012	4916820	UNRA	Unoccupied
53	452476	4916512	UNRA	Unoccupied
58	445523	4914147	UNRA	Unoccupied
59	435866	4923410	UNRA	Unoccupied
60	437402	4918910	UNRA	Unoccupied
61	438491	4919700	GHOW	Occupied
62	443789	4915766	UNRA	Unoccupied
63	446691	4925852	GHOW	Occupied
69	448861	4910473	RTHA	Occupied
70	443433	4906458	SWHA	Occupied

[1.] DNL = did not locate, GHOW = great horned owl, UNRA = unknown raptor, RTHA = red-tailed hawk, SWHA = Swainson's hawk.

[2] Originally labeled Nest ID 16 in 2016 survey efforts.

ID = Identification.

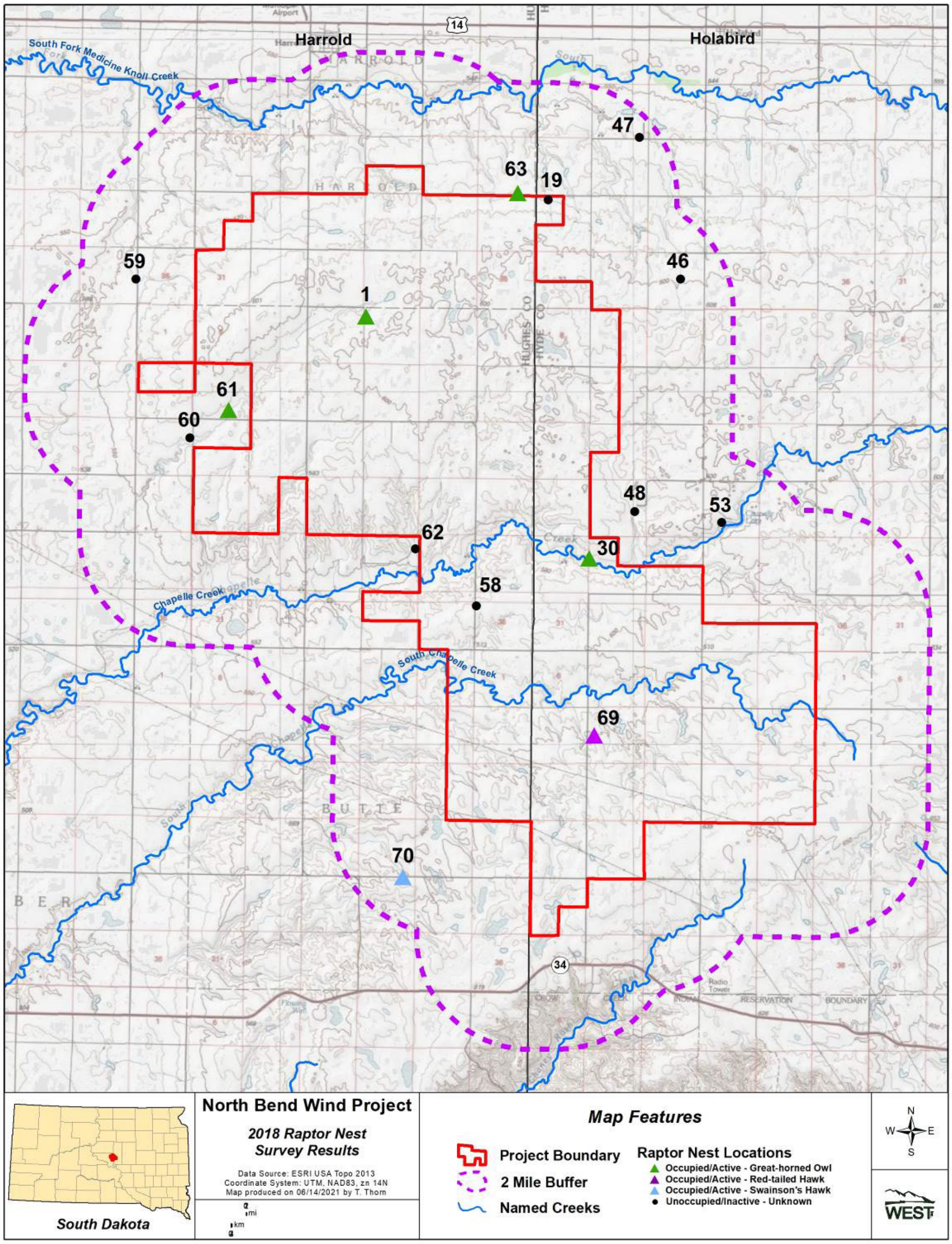

Figure 5. Location of raptor nests identified during surveys in 2018 for the North Bend Wind Project and 3.2-kilometer (km; 2.0-mile [mi]) buffer in Hughes and Hyde counties, South Dakota.

2019 Surveys

Two aerial surveys for the Project were conducted on March 26 and April 16 – 17, 2019. Eighteen nests were documented during surveys (Figure 6) and seven previously identified nests were either not present or excluded from surveys due to safety considerations (Figure 6; No Fly Areas). Eleven nests were determined to be occupied with adults in the nest, perched in the same tree, or eggs in the nest. Seven nests were considered unoccupied as no activity was recorded during either survey in accordance with the ECPG (Figure 6; Table 4). Of occupied nests, five were occupied by great horned owl, one by ferruginous hawk (*Buteo regalis*), three by red-tailed hawk, and two by unidentified raptors (eggs were present in the nest or adults were not identified; Table 4). No eagle or potential eagle nests were identified within the Project area or 2-mi buffer.

Table 4. Location of raptor nest sites surveyed and/or observed during 2019 surveys located in the current North Bend Wind Project and surrounding 3.2-kilometer (2.0-mile) buffer, Hughes and Hyde counties, South Dakota.

Nest ID	Northing	Easting	Species	2019 Status
2	444594	4919242	DNL	n/a
17	444423	4925361	DNL	n/a
19	444179	4925747	DNL	n/a
30	448709	4915493	UNRA	Occupied
46	451315	4923410	UNRA	Unoccupied
47	450147	4927430	GHOW	Occupied
48	450012	4916820	DNL	n/a
56	459961	4913766	DNL	n/a
58	445523	4914147	UNRA	Unoccupied
59	435866	4923410	DNL	n/a
60	437402	4918910	UNRA	Unoccupied
61	438491	4919700	GHOW	Occupied
62	443789	4915766	RTHA	Occupied
63	446691	4925852	DNL	n/a
70	443433	4906458	UNRA	Unoccupied
73	437079	4918884	UNRA	Unoccupied
75	447665	4925512	RTHA	Occupied
86	447117	4911890	RTHA	Occupied
87	442263	4909846	FEHA	Occupied
89	440967	4914462	GHOW	Occupied
90	439921	4917768	UNRA	Occupied
91	439620	4917741	GHOW	Occupied
92	456143	4916029	GHOW	Occupied
94	437892	4926281	UNRA	Unoccupied
95	435635	4920750	UNRA	Unoccupied

[1.] DNL = did not locate, UNRA = unknown raptor, GHOW = great horned owl, RTHA = red-tailed hawk, FEHA = ferruginous hawk.

ID = Identification.

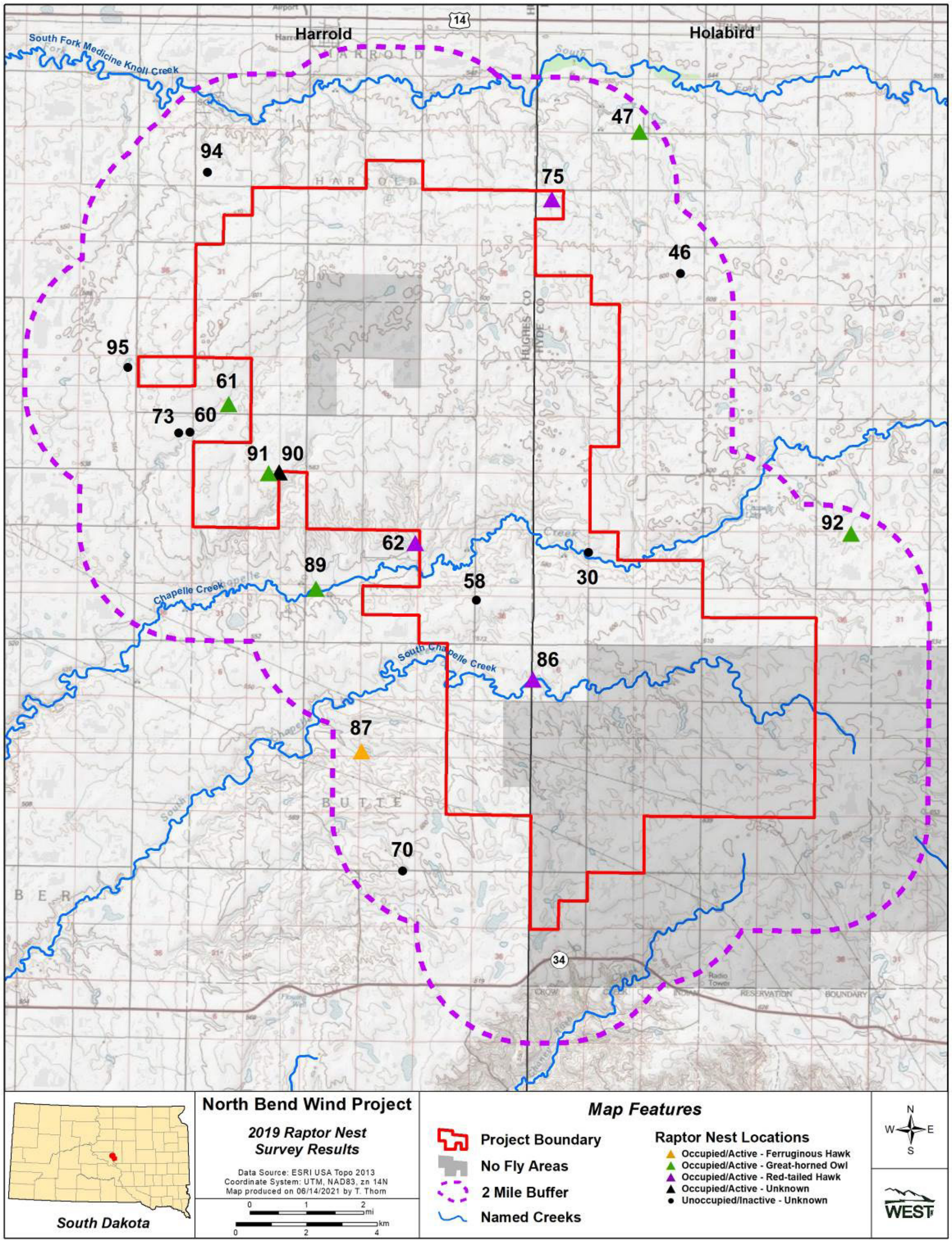

Figure 6. Location of raptor nests identified during surveys in 2019 for the North Bend Wind Project and 3.2-kilometer (km; 2.0-mile [mi]) buffer in Hughes and Hyde counties, South Dakota. Shaded "No Fly Areas" included lands not surveyed in 2019.

2020 Surveys

Three surveys for the Project area were conducted on March 2 – 3, March 12 and 20, and April 20, 2020. Thirty-five nests were documented during surveys. Nineteen nests were previously identified within the Project and associated 2-mi buffer, and four previously identified nests were either not present or excluded from surveys due to safety considerations. Of the 35 observed nests, seven were occupied by red-tailed hawks, five by great horned owls, and one by ferruginous hawks. One occupied nests could not be identified to species (i.e., unknown raptor). Of special interest, two nest locations were used by two different species (Table 5, Figure 7). Nest ID 62 and 90 were first occupied by great horned owls and then by red-tailed hawks. A final nest (Nest ID 108) was a raptor stick nest with a Canada goose occupying the nest. The remaining nests were considered unoccupied as no activity was recorded during either survey in accordance with the ECPG (Figure 7). No eagle or potential eagle nests were identified within the Project area or 2-mi buffer. Table 5 presents a cumulative summary of survey results in 2016, 2018, 2019, and 2020 for occupied nests within the Project area and 2-mi buffer.

Table 5. Yearly summary of all potential raptor nests[1] surveyed and/or observed during survey efforts for the North Bend Wind Project, Hughes and Hyde counties, South Dakota[2].

Nest ID	Northing	Easting	2016 Status	2018 Status	2019 Status	2020 Status
1	442383	4922347	RTHA	GHOW	n/a[3]	n/a
2	444594	4919242	UNRA	DNL	DNL	n/a
16[4]	444423	4925361	RTHA	DNL	DNL	n/a
19	447561	4925661		UNRA	DNL	
30	448709	4915493		GHOW	UNRA	RTHA
46	451315	4923410		UNRA	UNRA	UNRA
47	450147	4927430		UNRA	GHOW	
48	450012	4916820		UNRA	DNL	
53	452476	4916512		UNRA		RTHA
54	452741	4916572				GHOW
56	459961	4913766		UNRA	DNL	
58	445523	4914147		UNRA	UNRA	UNRA
59	435866	4923410		UNRA	DNL	n/a
60	437402	4918910		UNRA	UNRA	UNRA
61	438491	4919700		GHOW	GHOW	UNRA
62	443789	4915766		UNRA	DNL	GHOW
62	443789	4915766			RTHA	RTHA
63	446691	4925852		GHOW	DNL	
69	448861	4910473		RTHA	n/a	
70	443433	4906458		SWHA	UNRA	
73	437079	4918884			UNRA	UNRA
75	447665	4925512			RTHA	GHOW
86	447117	4911890			RTHA	RTHA
87	442263	4909846			FEHA	DNL
89	440967	4914462			GHOW	GHOW
90	439921	4917768			UNRA	GHOW
90	439921	4917768			UNRA	RTHA
91	439620	4917741			GHOW	UNRA
92	456143	4916029			GHOW	RTHA
94	437892	4926281			UNRA	UNRA

Table 5. Yearly summary of all potential raptor nests[1] surveyed and/or observed during survey efforts for the North Bend Wind Project, Hughes and Hyde counties, South Dakota[2].

Nest ID	Northing	Easting	2016 Status	2018 Status	2019 Status	2020 Status
95	435635	4920750			UNRA	UNRA
100	452654	4916585				UNRA
101	450680	4917677				GHOW
102	437420	4918824				UNRA
103	440497	4921656				RTHA
104	440905	4910925				UNRA
106	447119	4920622				GHOW
107	444593	4919229				UNRA
108[5]	452741	4916580				CAGO
109	443810	4915783				UNRA
110	448289	4920613				UNRA
111	447491	4926950				UNRA
113	450014	4916821				RTHA
114	441881	4911305				UNRA
115	443356	4906471				FEHA
116	454972	4914450				UNRA

1. UNRA = unknown raptor, GHOW = great horned owl, RTHA = red-tailed hawk, SWHA = Swainson's hawk, FEHA = ferruginous hawk, CAGO = Canada goose.

2. Occupied nest sites in a given year are denoted by species code of the individuals that nested there.

3. n/a denotes nests no longer available (e.g., due to being in a new No Fly Zone or falling out of a tree due to winds)

4. Nest ID 16 was changed to Nest ID 17 for 2018, 2019, and 2020.

5 Raptor stick nest identified with a nesting Canada goose.

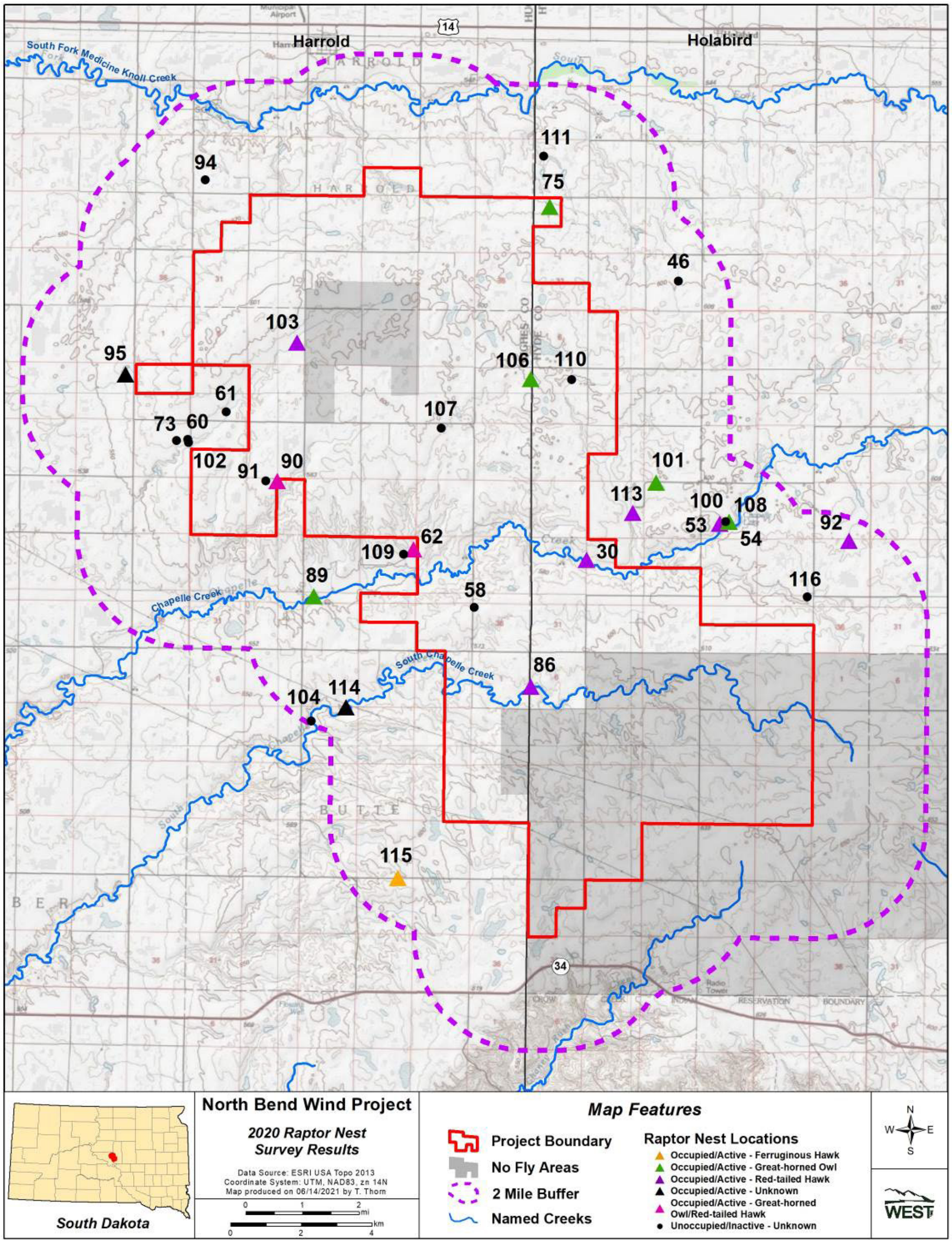

Figure 7. Location of raptor nests identified during surveys in 2020 for the North Bend Wind Project and 3.2-kilometer (km; 2.0-mile [mi]) buffer in Hughes and Hyde counties, South Dakota. Shaded "No Fly Area" included lands not surveyed in 2020.

PRAIRIE GROUSE LEK SURVEYS

The Project area occurs within the occupied range of the greater prairie-chicken and sharp-tailed grouse (*T. phasianellus*; combined as "prairie grouse"). Greater prairie-chickens are listed as a species of greatest conservation need in South Dakota, but both species are considered upland game birds and are hunted in South Dakota (SDGFP 2014). WEST conducted surveys to document prairie grouse leks during the breeding season within the Project area. The objective of the prairie grouse lek surveys was to identify potential leks and determine status of each to help inform Project siting decisions. These surveys were conducted in 2016, 2018, 2019, and 2020 and followed Project changes as described above in "Avian Use Surveys" for their respective years (Figure 3).

Surveys were conducted three times from late March to the end of the first week of May each year (with the exception of 2019 surveys) and included their respective Project areas and 1.6-km (1.0-mi) buffer. Surveys began approximately 30 min prior to sunrise until 90–120 min after sunrise. To the extent possible, all surveys were conducted on relatively calm mornings (winds less than 24–32 km [15–20 mi] per hr) and on days with no precipitation. Surveys were conducted to document the presence and the number of male and female birds attending leks. Because both sharp-tailed grouse and greater prairie-chickens are found within the area, identification of species during the survey was recorded, when possible. Information collected during all surveys included date, time, temperature, cloud cover, precipitation, and observer(s).

The SDGFP defines a lek as "a traditional display area where two or more male sage-grouse have attended in two or more of the previous five years" (Connelly et al. 2003). "Active leks" are locations where two or more birds have been observed or heard in courtship behavior during more than one survey period. "Potential leks" are locations where birds have been observed or heard engaging in courtship behavior during only one survey period, where birds were observed in more than one survey period but not in courtship behavior, or where number of birds could not be confirmed (e.g., heard at least one bird). If no birds were seen or heard in any of the three surveys, the lek was classified as inactive for the season. Results include a cumulative summary of all survey efforts across years as it relates to the current Project area and 1-mi buffer (Figure 8).

Aerial Surveys

Aerial surveys were conducted in 2016 and 2018 with a Cessna 172. Surveys included north/south transects across the Project area and 1-mi buffer spaced approximately 0.40 km (0.25 mi) apart at an altitude of approximately 30–45 m (100–150 ft) above ground level. An onboard GPS unit was used to keep the plane on transect, document lek locations, and record daily flight paths. Biologists recorded the number of birds on the lek and whether occupied by greater prairie-chicken or sharp-tailed grouse. The following characteristics were used to distinguish between these species from the air: a square-tail shape and dark, blocky body for greater prairie-chickens versus a pointed-tail shape with white under tail coverts and lighter body color for sharp-tailed grouse.

Ground Surveys

Ground visits were conducted in 2019 and 2020 by traveling publically accessible roads (or roads where permission was previously obtained) throughout the Project area and 1-mi buffer. During ground visits, the following information was recorded and included lek ID, location, species, type of detection (auditory or visual), number of males (if possible), and number of females (if possible). If a new lek was identified during this effort it was documented with the same information and identified using a new unique lek ID.

Sixteen prairie grouse leks were identified during a combination of aerial surveys and ground lek visits during the 2016, 2018, 2019, and 2020 breeding season within the Project area and 1-mi buffer (Figure 8). One lek location was active in 2016, fourteen in 2018, six in 2019, and eight in 2020 (Table 6). Of these active and potential leks, all were greater prairie-chicken leks (Table 6).

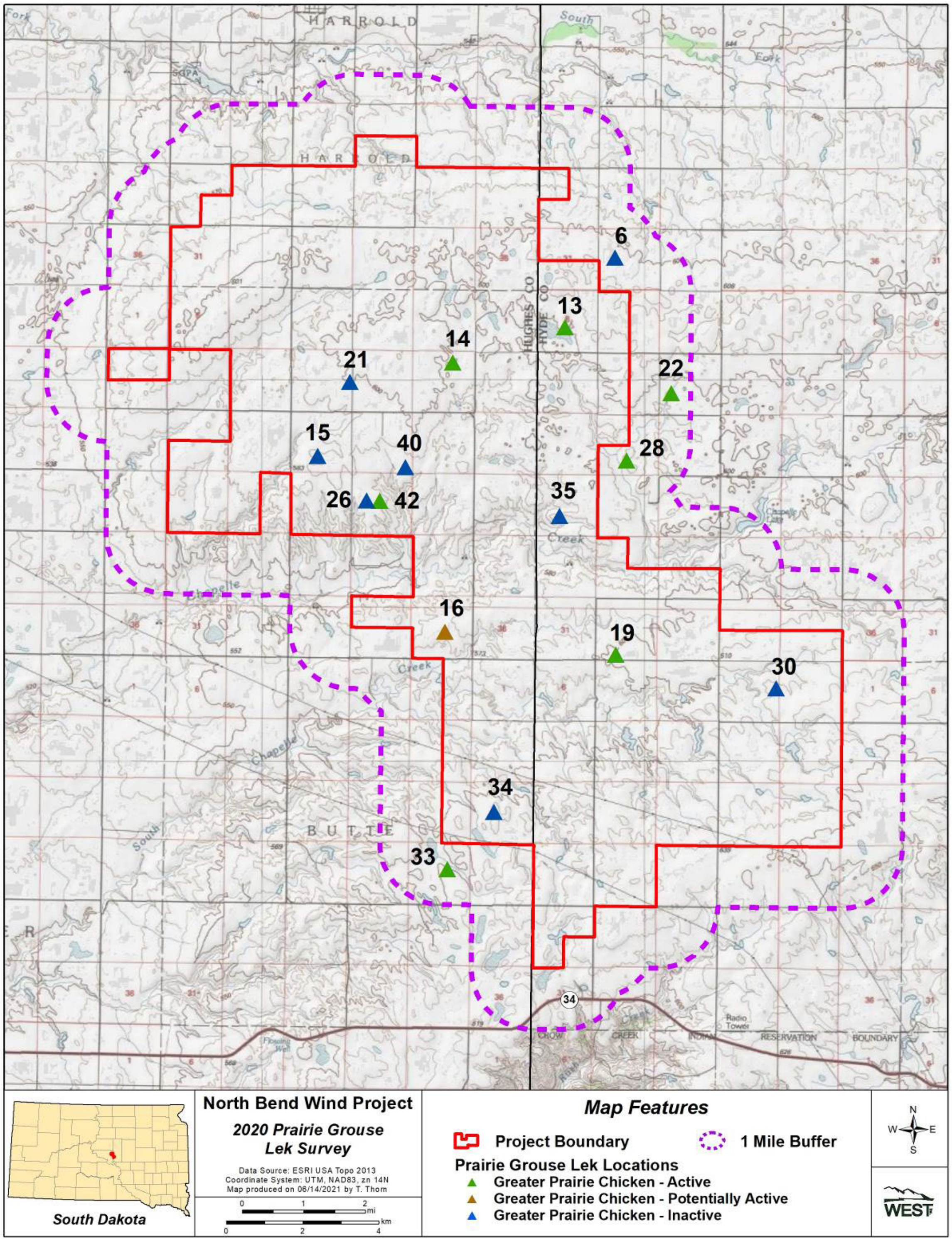

Figure 8. Location and 2020 status of potential prairie grouse leks identified during surveys within the North Bend Wind Project and 1.6-kilometer (1.0-mile) buffer from the 2016, 2018, 2019, and 2020 breeding seasons, Hughes and Hyde counties, South Dakota.

Table 6. Location and maximum number of prairie grouse observed at potential leks during surveys for the current North Bend Wind Project and 1.6-kilometer (1.0-mile) buffer, Hughes and Hyde counties, South Dakota.

Lek ID	Northing	Easting	Species	2016 Status	2018 Status	2019 Status	2020 Status	Grouse # (2020)
6	449195	4923428	GRPC	active	inactive	inactive	Inactive	0
13	447884	4921599	GRPC	NA	active	active	Active	5
14	444949	4920674	GRPC	NA	active	active	Active-Auditory Only	at least 3
15	441411	4918223	GRPC	NA	active	inactive	Inactive	0
16	444744	4913615	GRPC	NA	active	active-auditory only	Potentially Active	at least 1
19	449214	4913008	GRPC	NA	active	active	Active	4
21	442248	4920168	GRPC	NA	active	inactive	Inactive	0
22	450661	4919869	GRPC	NA	active	inactive	Active-Auditory Only	at least 2
26	442688	4917054	GRPC	NA	active	inactive	Inactive	0
28	449496	4918102	GRPC	NA	active	inactive	Active	5
30	453409	4912128	GRPC	NA	active	inactive	Inactive	0
33	444800	4907382	GRPC	NA	active	active	Active-Auditory Only	unknown
34	446025	4908887	GRPC	NA	active	inactive	Inactive	0
35	447735	4916644	GRPC	NA	active	inactive	Inactive	0
40	443708	4917928	GRPC	NA	active	inactive	Inactive	0
42	443038	4917050	GRPC	NA	NA	active	Active-Auditory Only	at least 3

ID = identification; GRPC = greater prairie-chicken

BAT ACOUSTIC SURVEYS

WEST conducted acoustic monitoring studies to estimate levels of bat activity within the Project area from May 26 through October 21, 2016 and April 25 – October 25, 2018 at three locations (two cropland [representative of the Project area] and one bat feature). The bat feature included proximity with water features, trees, hedge rows, and other bat-associated habitats. AnaBat™ SD2 ultrasonic bat detectors (Titley Scientific™, Columbia, Missouri) were placed 1.5 m (5.0 ft) above the ground, to minimize insect noise were used during the study. Studies of bat activity followed the recommendations of the WEG (USFWS 2012) and Kunz et al. (2007), detectors were programmed to turn on approximately 30 min before sunset and turn off approximately 30 min after sunrise each night. The study was divided into two primary seasons (summer and fall). WEST defined the fall migration period FMP as a standard for comparison with activity from other wind energy facilities. During the FMP (July 30 – October 14), bats begin moving toward wintering areas, and many species of bats initiate reproductive behaviors (Cryan 2008). This period of increased landscape-scale movement and reproductive behavior is often associated with increased levels of bat fatalities at operational wind energy facilities (WEST 2019).

For each survey location, bat passes were sorted into two groups based on their call's minimum frequency. High-frequency (HF) bats, such as eastern red bats (*Lasiurus borealis*) and *Myotis* species (such as northern long-eared bat [NLEB; *M. septentrionalis*]) have minimum frequencies greater than 30 kilohertz (kHz). Low-frequency (LF) bats, such as big brown bats (*Eptesicus fuscus*), silver-haired bats (*Lasionycteris noctivagans*), and hoary bats (*L. cinereus*), typically emit echolocation calls with minimum frequencies below 30 kHz.

Summarized Results

Summarized results of these efforts included three general trends. First overall bat activity varied by season with lower activity recorded in the summer and higher activity in the fall. Secondly, at all stations and frequencies, bat passes peaked during the first half of September. Finally, the bat feature recorded more bat passes/detector night than in the cropland as was expected. However, there was little variation in overall activity between seasons in croplands.

There was some variation between years in the composition of HF and LF activity. In 2016, there were more HF bat passes recorded while in 2018 more LF bat passes were recorded (Table 7). Generally, there was less activity in 2018 than in 2016.

Table 7. Results of bat activity surveys conducted at stations within the North Bend Wind Project area, Hughes and Hyde counties, South Dakota, from May 26 – October 21, 2016, and April 25 – October 25, 2018. Passes are separated by call frequency: high frequency (HF) and low frequency (LF).

Year	Station	Type	# of HF Bat Passes	# of LF Bat Passes	Total Bat Passes	Detector-Nights	Bat Passes/Night[1]
2016	West	representative	49	53	102	61	1.67 ± 0.44
	East	bat feature	128	95	223	95	2.35 ± 0.37
Total			**177**	**148**	**325**	**156**	**---**

Table 7. Results of bat activity surveys conducted at stations within the North Bend Wind Project area, Hughes and Hyde counties, South Dakota, from May 26 – October 21, 2016, and April 25 – October 25, 2018. Passes are separated by call frequency: high frequency (HF) and low frequency (LF).

Year	Station	Type	# of HF Bat Passes	# of LF Bat Passes	Total Bat Passes	Detector-Nights	Bat Passes/Night[1]
2018	West	representative	5	12	17	151	0.11 ± 0.04
	East	bat feature	54	79	133	127	1.05 ± 0.20
Total			**59**	**91**	**150**	**278**	**---**

[1]± bootstrapped standard error.

---Total not given due to differences in how stations were selected and their objectives.

Use of bat activity to predict post-construction mortality is difficult to relate and lacks any direct relationship based on pre-construction survey efforts (Solick et al. 2020). Furthermore, there is some evidence that activity increases from pre-construction to post-construction. Acoustic surveys can provide some level of species composition including the presence of HF bats within the Project area and possible presence of listed species such as NLEB. Though the study was not designed to survey specifically for NLEB, the presence of HF bats along with a habitat assessment for the species (see below) may help inform siting decisions for the Project.

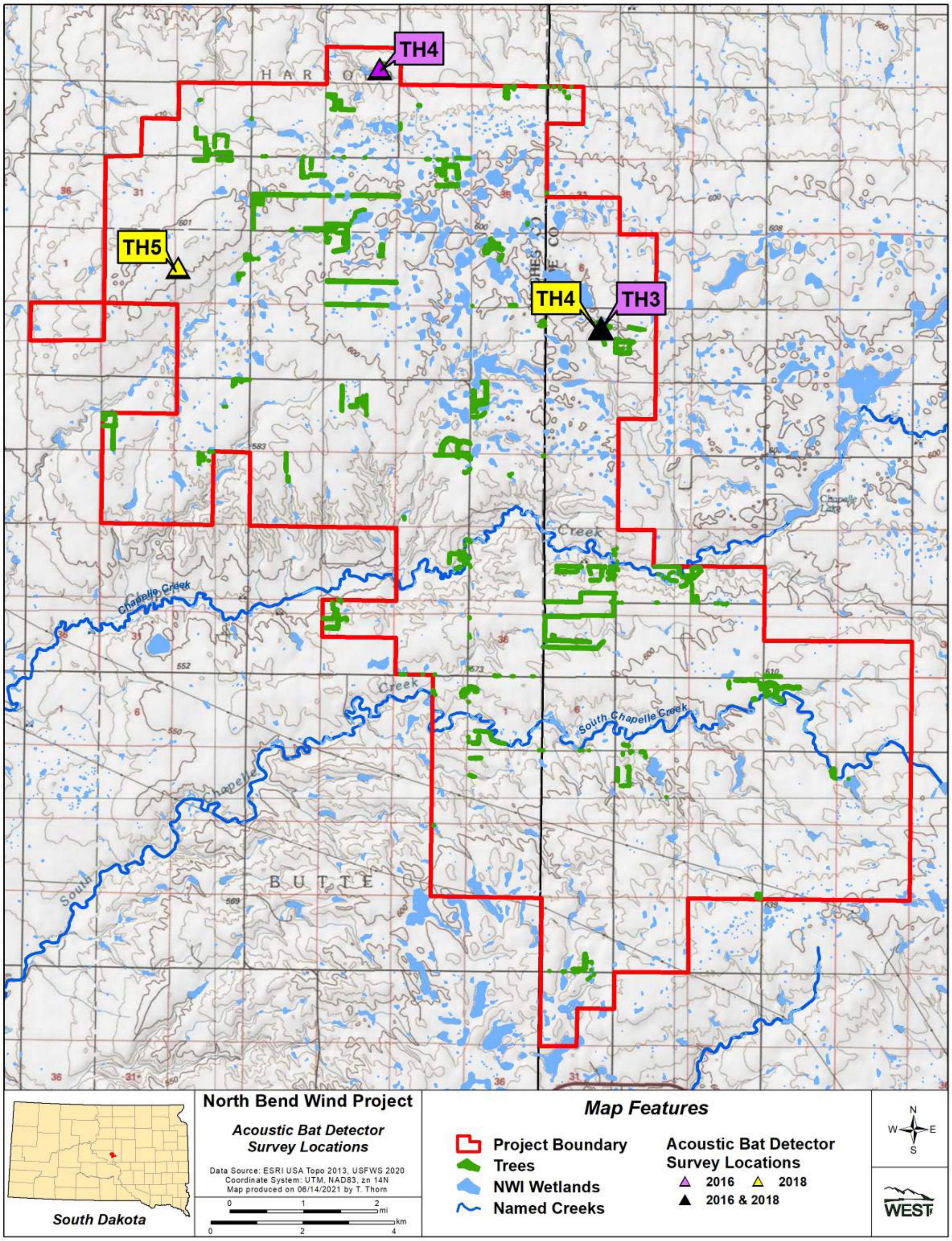

Figure 9. Location of AnaBat detectors deployed during 2016 and 2018 within the North Bend Wind Project boundary in Hughes and Hyde counties, South Dakota.

NORTHERN LONG-EARED BAT HABITAT ASSESSMENT

The NLEB is listed as a federally threatened species. The range of the NLEB is considered to be across all of South Dakota, including Hughes and Hyde counties. A desktop assessment of the presence of potentially suitable habitat for the NLEB was conducted across the Project area in 2017 and updated in 2020 using the USFWS *2020 Range-Wide Indiana Bat Summer Survey Guidelines* (USFWS 2020a; Figure 8). Suitable habitat for this species consists of forested areas where bats might roost, forage, and commute between roosting and foraging sites. NLEB primarily forage or travel in forest habitat and are typically constrained to forest features (Boyles et al. 2009). Therefore, habitat suitability was evaluated based primarily on the presence of forested areas that NLEB might use for roosting and foraging.

WEST conducted a desktop assessment of potentially suitable NLEB habitat by reviewing the NLCD within a 4.0-km (2.5-mi) buffer of the Project area, and delineating potential suitable habitat types (i.e., deciduous forest, evergreen forest, mixed forest, and woody wetlands) using ArcGIS (version 10.4). The habitat delineations were then cross-checked and edited based on the most recent publicly available aerial imagery from the USDA NAIP for the Project area. The overall habitat layer was edited to remove areas that had been cleared of trees and to refine habitat boundaries. Narrow commuting corridors not captured by the NLCD were also added based on the aerial imagery.

Once the desktop assessment was completed, a habitat analysis was conducted to assess connectivity of suitable foraging habitats (i.e., woodlots, forested riparian corridors, and natural vegetation communities adjacent to these habitats), roosting habitats, and commuting habitats (i.e., shelterbelts/tree-lines, wooded hedgerows) as suggested in the USFWS Indiana Bat Section 7 and Section 10 Guidance for Wind Energy Projects (USFWS 2011). The guidance suggests assessing the potential presence of Indiana bats (*Myotis sodalis*) and NLEB within a Project based on availability of travel/commuting corridors within the Project's boundary, and connectivity to foraging or roosting habitat within a 4.0-km buffer of the Project. The minimum size for suitable foraging/roosting habitat is not well understood, but lower estimates are approximately eight ha (20 ac; Broders et al. 2006). We used a minimum patch size of four ha (10 ac) to assign potential roosting habitat. Trees up to 305 m (1,000 ft) from the next nearest suitable roost tree, woodlot, or wooded fencerow were considered suitable habitat (USFWS 2011). The 305-m distance is based on observations of NLEB behavior indicating isolated trees might only be suitable as habitat when they are less than 305 m from other forested/wooded habitats (USFWS 2020a). Based on this informed guidance, it is reasonable to conclude NLEB are unlikely to occur within the Project area, beyond patches separated by more than 305 m from the nearest connected suitable habitat (USFWS 2011, 2020a Figure 10).

Forested patches were sorted by size into the following groups: less than four ha (small forest patches), four to 20 ha (10–50 ac; potential NLEB roost/foraging habitat), and greater than 20 ha (large potential roost/foraging habitat). All polygons representing forested habitats were buffered by 152 m (500 ft) and dissolved to group any habitat patches within 305 m of each other. This buffer, representing all forested habitats within 305 m of each other, was then purged of small isolated patches by selecting only those connected habitats containing forested patches at least four ha in size. This selection of habitat patches was then buffered by 305 m to represent the potential foraging area for NLEB resulting in eight patches covering 1,734.4 ha (4,285.7 total ac) within the Project area and 4.0-km buffer (Figure 10). Within the Project potentially suitable NLEB habitat was limited to two patches covered 277.6 ha (686.0 ac).

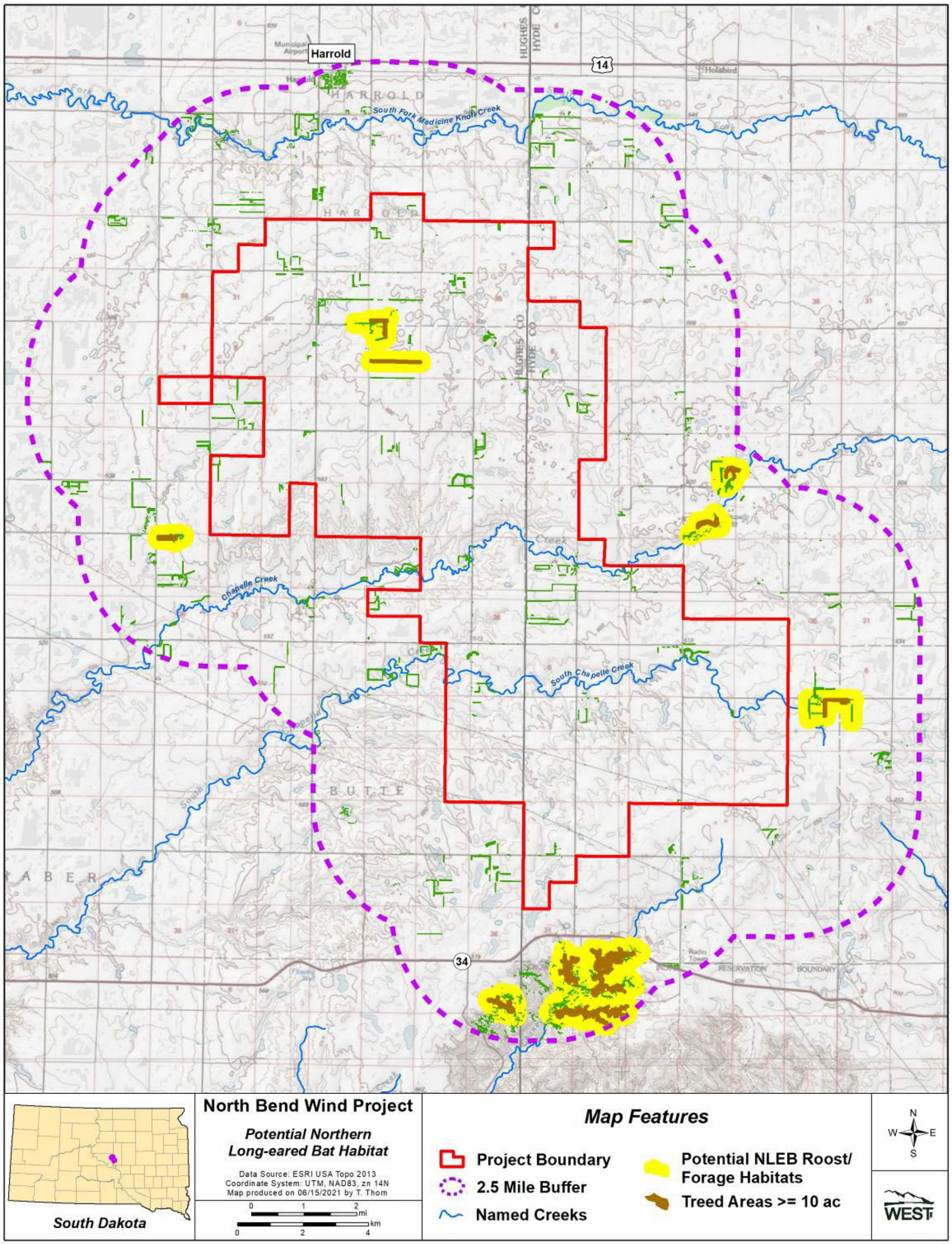

Figure 10. Northern long-eared bat habitat assessment of the North Bend Wind Project and 4.0-kilometer (2.5-mile) buffer, Hughes and Hyde counties, South Dakota.

WHOOPING CRANE STOPOVER HABITAT

Whooping crane use of habitat along their migration corridor has been poorly understood and resulted in numerous approaches to identify those habitats. Niemuth et al. (2018) developed a predictive model specific for North and South Dakota to help identify areas that may be used by whooping crane during migration. They used whooping crane sightings, landscape data, and statistical models to provide a better insight into habitat use within the Dakotas. Figure 9 displays the results of this model along with whooping crane sightings in the region through fall of 2019, and telemetry data from 2009 through 2018. The entire Project area is contained within the 50^{th} percentile of all sightings along the migration corridor (Niemuth et al. 2018, Pearse et al. 2018).

Based on this predictive model, potential stopover habitat varies across the Project area. The south and southwestern portion of the Project area has lower potential habitat quality, while the northcentral portion of the Project area potentially contains relatively high quality (Figure 11). There have been two confirmed whooping cranes within the Project area, one from telemetry data in the extreme northern portion of the Project area and one confirmed sighting along the western portion of the Project area (Figure 11). Though whooping cranes have been documented within the Project area and a 16.1-km (10-mi) buffer, most telemetry and sighting data indicated whooping crane are infrequently using the habitat within 16.1 km of the Project area. Although there is potential migratory stopover habitat within and around the Project area based on the Niemuth et al. (2018) model, only 16 whooping cranes have been confirmed within 16.1 km of the Project. In comparison, it appears that more confirmed habitat use has been to the northeast, east, and south of the Project (Figure 11).

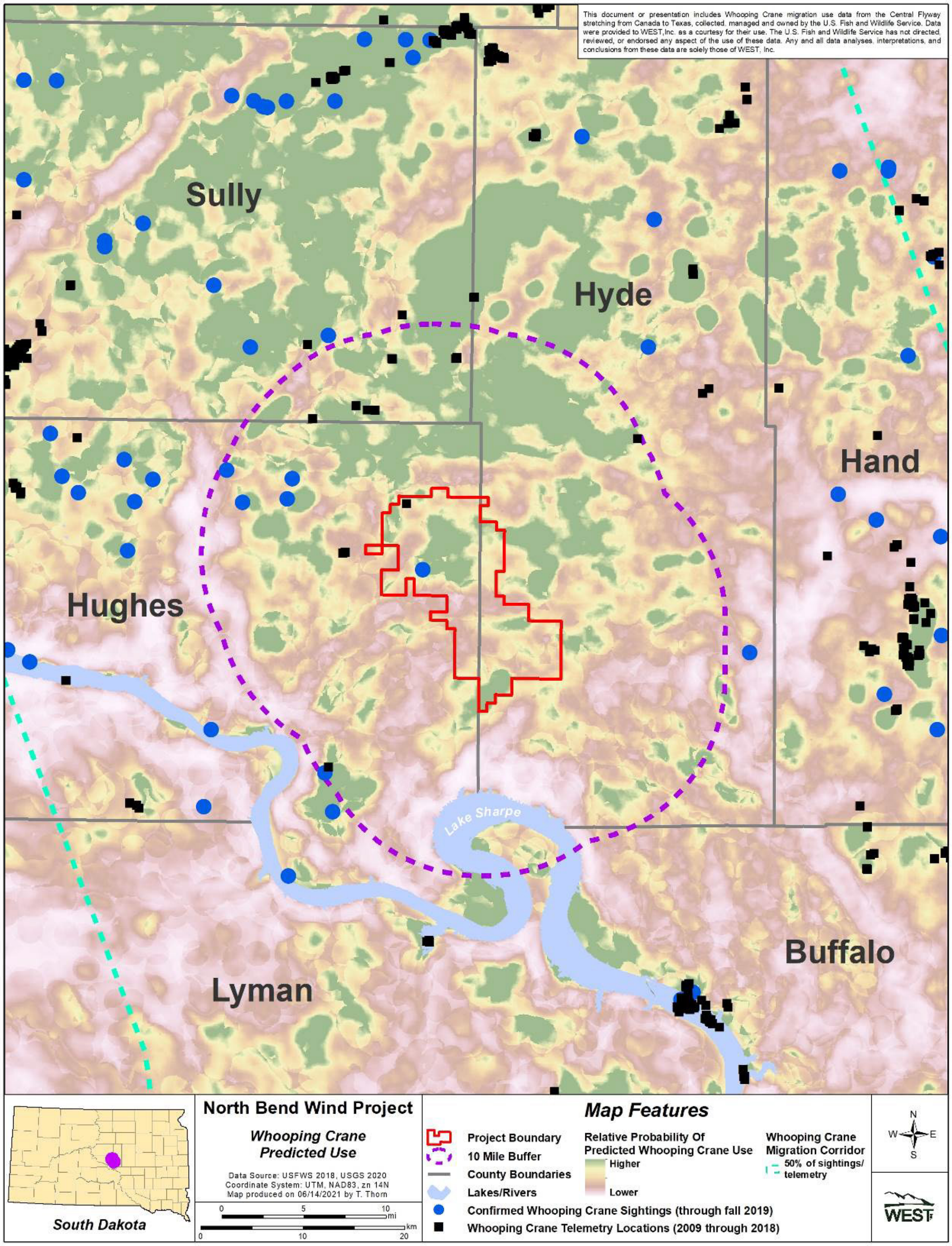

Figure 11. Map of wetlands scored using the predictive habitat use model (Niemuth et al. 2018) for the current North Bend Wind Project boundary and surrounding area in Hughes, Hyde, and Sully counties, South Dakota.

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Appendix O. Summary of Triple H Whooping Crane Monitoring Efforts: April 11 – 20, 2022, Hyde County, South Dakota

ENVIRONMENTAL & STATISTICAL CONSULTANTS

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TECHNICAL MEMORANDUM

Date: July 8, 2022

To: Carolyn Edwards, ENGIE North America

From: Martin Piorkowski, Western EcoSystems Technology, Inc.

Subject: Summary of Triple H WHCR Monitoring Efforts: April 11 – 20, 2022

BACKGROUND

At 2:28PM (all times are CST) on April 11, 2022, Darren Kearney (South Dakota Public Utility Commission [SD PUC]) contacted Casey Willis (*Senior Regional Director of Development*, ENGIE North America) by email to notify him of a reported observation of two Whooping Cranes (WHCR; *Grus americana*) within the Triple H Wind Project (Triple H), as per Condition 37 of the Triple H *Public Utility Commission (PUC)* permit. The report was called into to D. Kearney by a local resident, Leonard Spomer. At 2:40pm South Dakota Game, Fish and Parks (SDGFP) Hilary Morey contacted C. Willis via email that a SDGFP Conservation Officer (Cory Flor) was on site and confirmed the presence of two WHCR. At approximately 4:00pm, C. Willis contacted the Triple H site manager (Shane McDaniel) to shut down any turbines within 2-miles (mi) of the location provided by SDGFP until a professional biologist could reach the location to confirm the birds and appropriate protocol. At 4:16PM, Deb Gregg (SD PUC) emailed D. Kearney to confirm that Triple H had been contacted, as turbines apparently had not been shut down (as of approximately 3:00PM). Between 4:00PM and 5:00PM, turbines were identified within 2-miles of the provided location and shutdown protocols were initiated. All identified turbines were stopped and shutdown just after 5:00PM.

At approximately 6:00PM C. Willis contacted Carolyn Edwards (*Environmental Manager,* ENGIE North America), and discussed the steps taken to that point, including his contact via phone call to Martin Piorkowski, Western EcoSystems Technology, Inc. (WEST). C. Edwards then took leadership to determine next steps, including monitoring options. At 10:13PM on the same day, an initial plan was developed by M. Piorkowski that indicated WEST would provide monitoring support starting the following morning (4/12/2022). C. Edwards contacted SDGFD and US Fish and Wildlife Service (USFWS) by email as to the observations and procedures implemented to shut down turbines and monitor the birds. Response from USFWS was to continue monitoring until at least the following morning after the last sighting of the birds before repowering turbines.

Below is a description of the monitoring efforts and a timeline of the events that occurred, in chronological order.

MONITORING

Summary

Two WHCR were identified within approximately 1.75 miles (mi) of the Triple H Wind Project in Hughes County, South Dakota at a wetland adjacent to Highway 47 (Figure 1). One of the WHCR was outfitted with color bands and a GPS telemetry transmitter on the right leg. The color bands of the individual was: left leg (top to bottom) white, yellow and red. The other WHCR did not have a telemetry device or bands. The two birds stayed primarily in the areas adjacent to the wetland from April 11 through April 19, 2022 (9 days) with the last observation of either bird occurring at approximately 12:01 pm as the WHCR walked out of the monitor's sight into a cornfield; Figure 1. The primary habitats being used were cut corn fields and the wetland. The last day of monitoring was conducted on 4/20/2022, with no WHCR being observed. The site manager (Shane McDaniel) indicated by phone that they would continue to check on the wetland at least in the morning and evenings to confirm that the two WHCR did not return for the next week (through 4/27/2022). Images of the birds are provided at the end of this memo, along with a brief description of the photograph.

Turbine Shut-Down Procedures Implemented

4/11/2022 – Three turbines (D-08, D-09, and E-06) were shut down at approximately 5:00pm based on reported observations (see Background, above) of two WHCR within 2 miles of operating turbines.

4/12/2022 – Based on early morning WHCR movement from the initial wetland location to a corn field north of the wetland an additional five turbines were shut down beyond 2-mi out of an abundance of caution. These include D-07 to D-09 and E-05 to E-09.

4/18/2022 - 4/22/2022 – The entire wind project was shut down to complete maintenance to the substation.

4/22/2022 - After confirming WHCR were no longer in the area, all turbines were returned to operation at approximately 4:30pm.

Monitoring Details

Day 1: 4/11/2022

- 2:00pm – Initial report local resident of two WHCR located at 44.430˚ north, -99.444˚ west. No monitoring occurred.

Day 2: 4/12/2022: Professional monitoring initiated.

- 9:15am – Started searching at Triple H Operations and Maintenance Building. Searched areas to include county roads near original sighting and eastern half of the turbine access roads (survey tracks available).
- 2:00pm – Two WHCR observed in a field of corn stubble approximately 225 meters west of the wetland and walked out of sight.

- 5:00pm –One WHCR observed immediately west of the wetland with a small flock of sandhill cranes (SACR) in a field of small grain stubble. WHCR was loafing/sleeping.

Day 3: 4/13/2022

- 9:10am – Monitoring started at the wetland where the two WHCR were located along the edge of some cattails.
- 9:10am - 11:40am – The WHCR were generally standing, either preening, loafing or just standing.
- 11:40am - 4:45pm – No change. WHCR were in the same place nearly all day along the cattails.
- 4:47pm – Both WHCR flew to the corn field just north of the wetlands, where they primarily fed and stood around.

Day 4: 4/14/2022

- 9:12am - 1:17pm – WHCR located at the wetland in the same spot as the previous day. Winds were 30-40 mile-per-hour (mph). They did not move and were sleeping or loafing the entire time.
- 10:09am – Small flock of SACR walked out of the nearby cattails and walked towards the WHCR.
- 1:18pm – WHCR started walking north along the edge of the wetland for approximately 100 meters.
- 1:26pm – WHCR flew from the north end of the wetland back to their original spot at 9:12am.
- 1:27pm - 3:08pm – WHCR continued to loaf with periodic preening.
- 3:08pm – Stefan Jones (*Wind Technician*, Triple H Wind Project) drove up to where the monitor (A. Fryman, WEST) was to provide some contact information. WHCR moved and walked south along the edge of the wetland about 25 meters but did not fly.
- 3:19pm – WHCR slowly walked back to their locations after the Wind Technician departed.
- 4:04pm – WHCR started walking north out of the wetland into the adjacent grasses.
- 4:09pm – WHCR flew up and landed in the corn field directly north of the wetland.
- 4:10pm - 4:43pm – WHCR started walking out into the corn field and were out of view for this duration. Several attempts were made by the monitor to try to find other vantage points to observe this field with no success, and returned to the wetland.
- 4:44pm – 5:00pm – WHCR had moved back to the grasses on the north end of the wetland. Mostly feeding and preening.

Day 5: 4/15/2022

- 7:33am - 9:56am – WHCR not found at wetland. Continued to search area expanding out from the wetland focused on the adjacent cornfield.
- 9:57am – Two WHCR flew up from cornfield and seen flying approximately 30 meters in the air and heading northward along the eastern edge of the wind facility. Matt Wallace (WEST monitor) called M. Piorkowski (WEST) to report flight.

- 10:00am – While on the phone with M. Piorkowski (WEST) the two WHCR flew between turbines (E-08 and E-09; one turbine was not moving and the other was moving slowly). WHCR flew between the two turbines and disappeared in the distance.
- 10:02am - 10:55am – Searched area along the eastern edge of the wind facility scanning fields and isolated wetlands and headed northward towards Highmore, SD.
- 10:15am – M. Piorkowski (WEST) contacted Triple H site manager (S. McDaniel) to report the observation and indicated that the monitor was currently out trying to locate the WHCR as the two birds flew past the wind facility and were flying northward until they flew out of view.
- 10:56am – M. Wallace returned to the wetland and observed the two WHCR with a flock of about 150 SACR.
- 10:57am to 5:00pm – WHCR stayed with the SACR at the wetland all day primarily sleeping with some foraging and preening periodically.

Day 6: 4/16/2022

- 7:00am - 7:45am – WHCR were at the wetland upon monitor's arrival with a flock of approximately 400 SACR. They were primarily walking around the edge of the wetland foraging.
- 7:46am – 10:35am – WHCR and SACR walked along shelterbelt to the northern corn field and spent the time foraging.
- 10:35am – 10:45am – WHCR and SACR walked back to the wetland.
- 10:45am – 3:50pm – WHCR spent the time sleeping with a few periodic foraging events throughout the day.
- 3:50pm – 4:35pm – WHCR walked to the northern corn field and spent the time foraging.

Day 7: 4/17/2022

- 7:00am – 9:18am – WHCR were observed at the wetland. Foggy conditions with snow moving through.
- 9:19am – 12:00pm - Flew to the western corn field where a flock of SACR were. Primarily foraging while they were there. Observations were difficult due to the snow.
- 12:00pm – 4:15pm – WHCR walked back to the wetland. They primarily spent the time sleeping/loafing with occasional foraging.
- 4:16pm – 5:00pm – WHCR flew to the northern corn field with SACR primarily foraging.

Day 8: 4/18/2022

- 9:00am – WHCR not located at wetland.
- 9:12am - 10:18am – WHCR located in corn field north of the wetland with 200+ SACR. Primarily feeding with occasional loafing.
- 9:45am – SDGFP Conservation Officer (C. Flor) stopped by to confirm the presence of the monitor as SDGFP has regularly been receiving calls about people being close to the WHCR. He provided no changes or suggestions and stated that he was responding to local landowner calls and following up.
- 10:19am – WHCR flew from the corn field south back to the wetland.
- 10:20am – 10:46am – WHCR were primarily feeding along the edge of the wetland.

- 10:39am – Public observer came to look at the WHCR (stopped for about 30 seconds). No reaction from the WHCR.
- 10:47am – Slow moving farm equipment along the main road (highway 47, approximately 180 meters to the east) appeared to make the WHCR nervous. They moved towards the northern end of the wetland, but were looking around constantly.
- 10:50am – The WHCR moved closer to a small group of SACR and then resumed feeding.
- 11:18am – A large group of SACR (200+) flew in from northern corn field to the wetland. The WHCR showed had no obvious reaction when the SACR flew in.
- 11:19am - 12:16pm – WHCR were primarily sleeping.
- 12:16pm – Car stopped by for a few seconds to look at the WHCR from their car. No reaction by the WHCR.
- 12:20pm - 20-24 SACR flew in with the rest of the flock already there.
- 12:37pm - 1:15pm – Flock of SACR and the two WHCR flew to the northern most corn field. Primarily feeding. Tried to find a better spot to monitor them.
- 1:17pm – WHCR flew back to the wetland but were pacing around and restless.
- 1:20pm – WHCR flew west and out of view.
- 1:23pm – WHCR were observed at the western edge of the northern corn field.
- 1:24pm - 2:25pm – Difficult to observe their behaviors at the distance they were but generally seen loafing and feeding.
- 2:26pm – WHCR flew back to the wetland.
- 2:27pm - 3:03pm – WHCR were walking around along the edge of the wetland, and looking around.
- 3:04pm - 3:28pm – WHCR were primarily sleeping just inside the wetland, then at 3:28pm one started preening.
- 3:28pm - 4:14pm – WHCR moved a bit closer to the western edge of the wetland. Both were preening and loafing.
- 4:44pm – 250+ SACR flew in and landed close to the WHCR. No reaction by the WHCR.
- 5:02pm – Birds were sleeping within a flock of hundreds of SACR.

Day 9: 4/19/2022

- 7:50am – 9:38am – Large group of SACR still present at the wetland. No WHCR could be located at the wetland or in adjacent corn field. Continued surveying surrounding area.
- 9:39am - 9:57am – Observed WHCR in a large flock of SACR in the northern corn field, birds were generally walking around and feeding.
- 9:58am – WHCR started flying south towards wetland but lost sight of them.
- 10:10am – Observed WHCR at the wetland sleeping.
- 10:28am – Local resident stopped by to discuss the birds. Said he’s been keeping an eye on them for several days.
- 12:01pm – WHCR flew to corn field, but landed out of sight. Biomonitor stopped in at the O&M facility for about 15 minutes.

- 12:15pm - 1:00pm – Could not find the WHCR in the corn field. Drove back to the wetland and didn't find them there either.
- 1:00pm - 5:14pm – Drove around the area on the county roads and access roads slowly. Did not relocate the WHCR.
- 5:15pm – Returned to the wetland and could not locate the WHCR.

Day 10: 4/20/2022

- 7:50am - 10:30am – Did not locate the WHCR at the wetland. Drove the country roads and eastern half of the access roads and did not find the WHCR. Ended the survey back at the wetland and the WHCR were not there either.
- ~12:30pm – M. Piorkowski (WEST) contacted the site manager (S. McDaniel) by phone and updated him of the status of the WHCR and that they had not been seen since approximately 12:00 noon the day before. Site manager suggested that the operations personnel would continue to survey the wetland and adjacent corn fields in the mornings and evenings until the wind facility came back online (afternoon of 4/22/2022) to confirm that the WHCR did not return to the area.

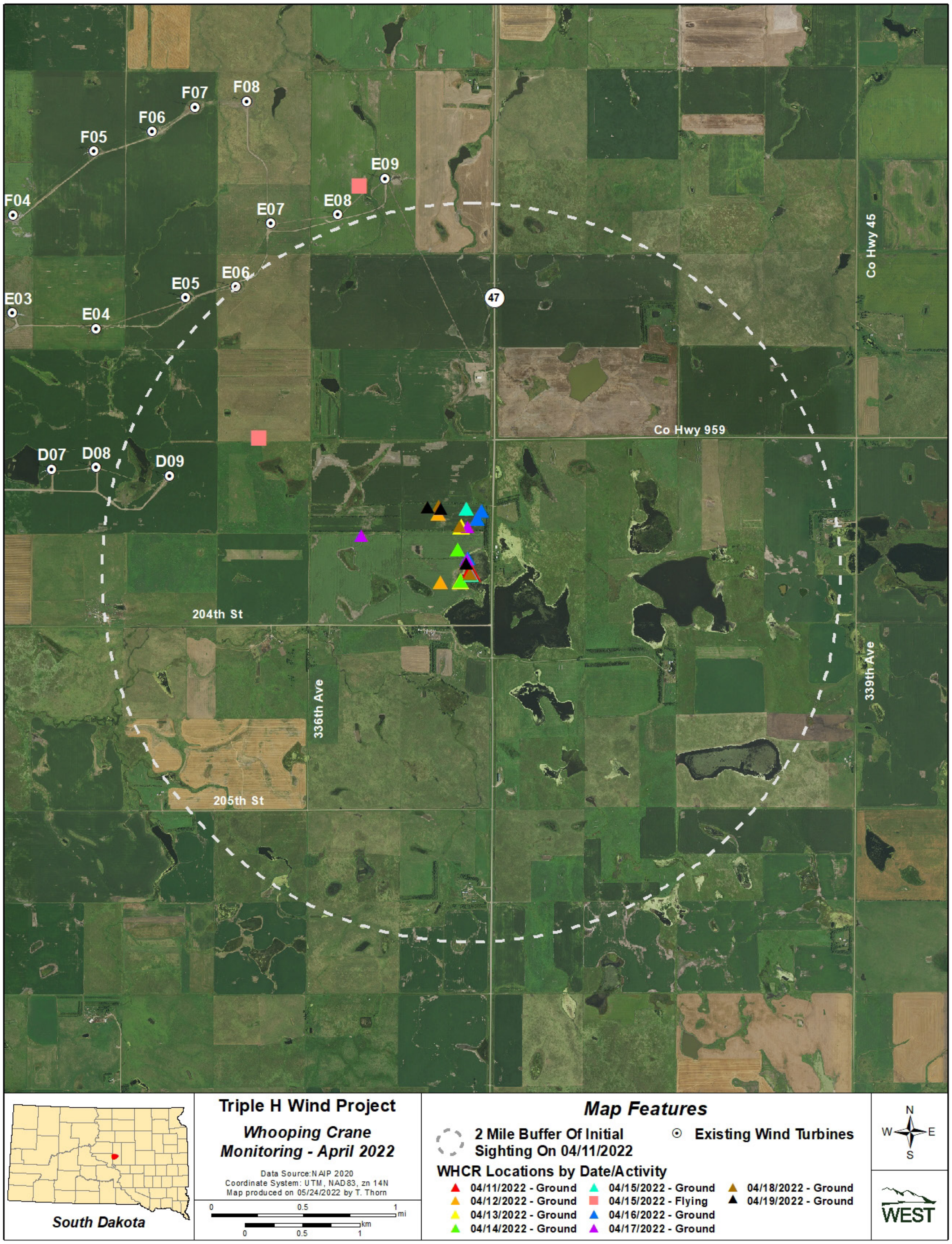

Figure 1. Whooping crane tracking log, of positions identified during 10 days of monitoring (April 11 – 20, 2022) with two mile buffer of the initial sighting locations.

Image 1. Photo from South Dakota Game, Fish and Parks Conservation Officer (C. Flor) taken in the afternoon of April 11, 2022.

Image 2. Photo taken by A. Fryman (WEST) adjacent to the wetland in a cut small grain field where one whooping crane primarily slept with some sandhill cranes. Photo was taken at 2:38pm on April 12, 2022.

Image 3. Photo taken by A. Fryman (WEST) at the wetland with two whooping cranes foraging along the edges of the wetland. Photo was taken at 5:24pm on April 13, 2022.

Image 4. Photo taken by A. Fryman (WEST) at the wetland of two whooping cranes walking along the edges of the wetland. Photo was taken at 1:42pm on April 14, 2022.

Image 5. Photo taken by M. Wallace (WEST) at the northern cornfield of two whooping cranes foraging alongside a small flock of sandhill cranes. Photo was taken on April 15, 2022.

Image 6. Photo taken by M. Wallace (WEST) along the wetland of two whooping cranes with approximately 400 sandhill cranes. Photo was taken on April 15, 2022.

Image 7. Photo taken by A. Fryman (WEST) at the northern cornfield with two whooping cranes foraging alongside a flock of sandhill cranes Photo was taken at 09:16am on April 18, 2022.

Appendix P. 2016 and 2018 Bat Acoustic Monitoring at the North Bend Wind Project, Hyde and Hughes Counties, South Dakota - Technical Memo

ENVIRONMENTAL & STATISTICAL CONSULTANTS
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TECHNICAL MEMORANDUM

Date: January 30, 2023

To: John Russell, Western Area Power Administration

From: Martin Piorkowski, Western EcoSystems Technology, Inc.

Subject: 2016 and 2018 Bat Acoustic Monitoring at the North Bend Wind Project

INTRODUCTION

North Bend Wind Project, LLC (North Bend) is considering the development of the North Bend Wind Project (Project) in Hughes and Hyde counties, South Dakota. The new facility would consist of 71 proposed wind turbines and associated facilities. North Bend contracted with Western EcoSystems Technology, Inc. (WEST) to conduct a bat acoustic review of data collected previously in 2016 and 2018. Details for bat acoustic data collection can be found in *Bat Activity Studies for the Triple H Wind Project, Hughes and Hyde Counties, South Dakota* (Heath et al. 2017) and *Bat Activity Surveys for the Triple H Wind Project, Hyde and Hughes Counties, South Dakota. Final Report: April 25 – October 25, 2018* (Heath et al. 2019), but a summary of the general methodologies and survey design are provided below for simplicity.

METHODS

WEST conducted acoustic monitoring studies to estimate levels of bat activity within the Project area from May 26 through October 21, 2016 and April 25 through October 25, 2018. For each year of survey two stations were surveyed, one representative station and one bat feature station. A representative station is placed in a location of future turbine locations, often in open areas of cropland or grassland habitat. While bat feature stations are placed in habitat with features considered attractive to bats for foraging, drinking, or roosting opportunities (, e.g., riparian forest, forest edges, ponds, streams, and forested flyways. The bat feature station remained the same between years, however, representative station changed between 2016 and 2018, resulting in three total locations being surveyed (Figure 1).

For each survey location, bat passes were sorted into two groups based on their call's minimum frequency. High-frequency (HF) bats, including eastern red bats (*Lasiurus borealis*) and *Myotis* species (northern long-eared bat [NLEB; *M. septentrionalis*], western small footed bat [*M. ciliolabrum*], and little brown bat [*M. lucifugus*]) have minimum frequencies greater than 30 kilohertz (kHz). Low-frequency (LF) bats, including big brown bats (*Eptesicus fuscus*), silver-haired bats (*Lasionycteris noctivagans*), and hoary bats (*L. cinereus*), typically emit echolocation calls with minimum frequencies below 30 kHz.

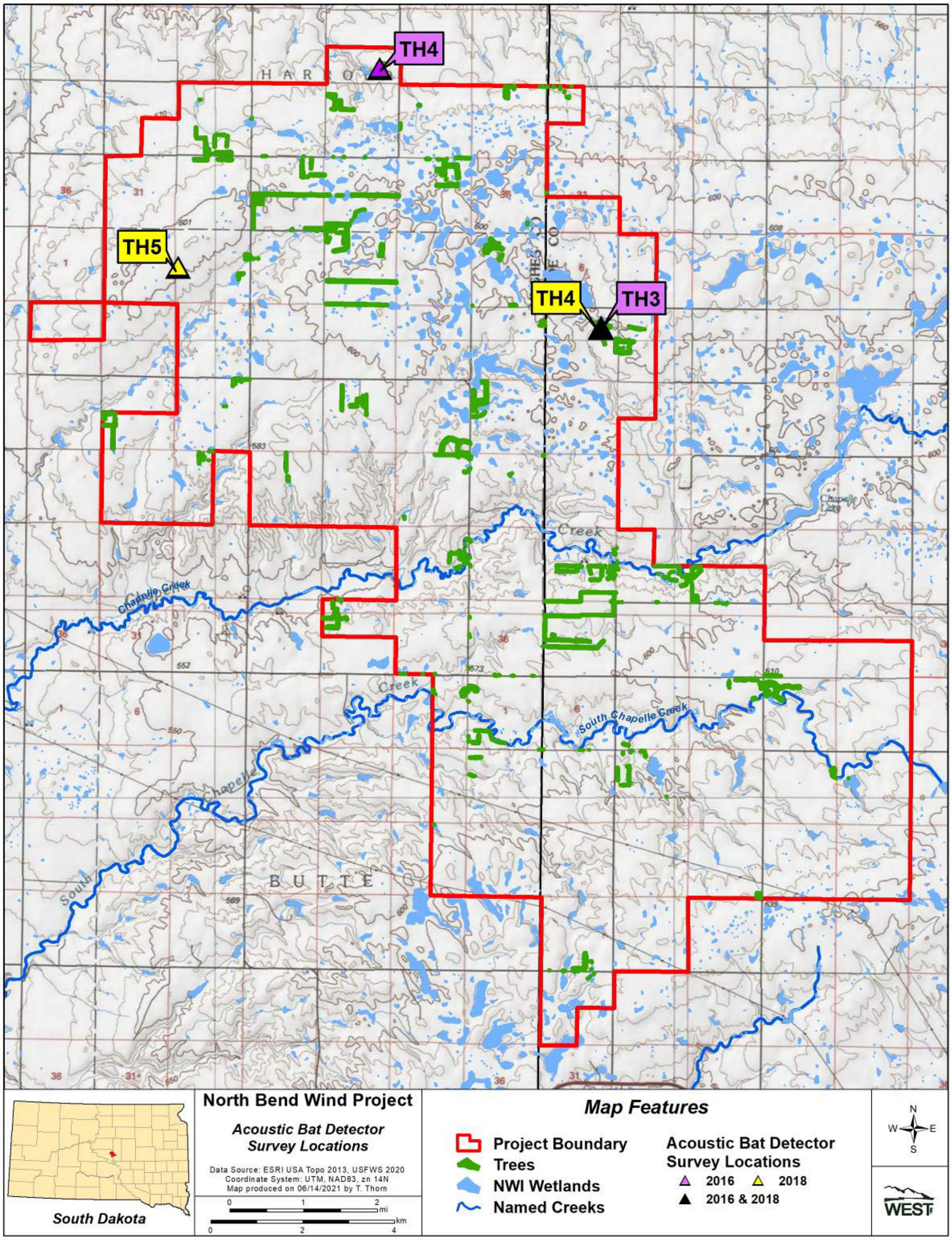

Figure 1. Location of AnaBat detectors deployed during 2016 and 2018 within the North Bend Wind Project boundary in Hughes and Hyde counties, South Dakota

Acoustic data was classified by Kaleidoscope Pro (Kaleidoscope; Wildlife Acoustics, Inc. 2022) and bat calls classified as potential NLEB received further qualitative review. In 2018 the acoustic analysis included processing the zero-cross acoustic files confirmed to contain bats through Kaleidoscope version 5.1.6 using the Bats of North America classifier 4.2.0 at the "0" balanced (neutral) sensitivity setting, meeting the approved USFWS settings and version in 2018. The 2016 acoustic data was originally only labeled to frequency group and not run through an automated identification program. In December of 2022, zero-cross calls confirmed to be bat passes were run through the automated identification feature in Kaleidoscope 5.4.7 using the Bats of North America classifier 5.4.7 at the -1 sensitivity setting (Wildlife Acoustics, Inc. 2022), meeting current USFWS approved automated acoustic bat ID software program standards (https://www.fws.gov/media/automated-acoustic-bat-id-software-program).

A qualified acoustic analyst (Kevin Murray) qualitatively reviewed calls identified as NLEB through visual comparison of echolocation call metrics (e.g., minimum frequency, slope, and duration) to reference calls of known bats (O'Farrell and Gannon 1999, Murray et al. 2001, Yates and Muzika 2006).

RESULTS

Some variation between 2016 and 2018 occurred in the composition of HF and LF activity. In 2016, more HF bat passes were recorded, and in 2018 more LF bat passes were recorded (Table 1). Generally, there was more bat activity in 2016 than in 2018 at both station types.

Table 1. Results of bat activity surveys conducted at stations within the North Bend Wind Project area, Hughes and Hyde counties, South Dakota, from May 26 – October 21, 2016, and April 25 – October 25, 2018. Passes are separated by call frequency: high frequency (HF) and low frequency (LF).

Year	Station	Type	# of HF Bat Passes	# of LF Bat Passes	Total Bat Passes[1]	Detector-Nights	Bat Passes/Night[2]
2016	TH4	representative	49	53	102	61	1.67 ± 0.44
	TH3	bat feature	128	95	223	95	2.35 ± 0.37
Total			**177**	**148**	**325**	**156**	**---**
2018	TH5	representative	5	12	17	151	0.11 ± 0.04
	TH4	bat feature	54	79	133	127	1.05 ± 0.20
Total			**59**	**91**	**150**	**278**	**---**

[1] Data on bat pass rates represent indices of bat activity and does not necessarily represent numbers of individuals.

[2] ± bootstrapped standard error.

---Total not given due to differences in how stations were selected and their objectives.

In 2016, Kaleidoscope flagged three potential NLEB files, which upon qualitative review were determined not to be NLEB. In 2018, no NLEB were identified by Kaleidoscope and therefore no qualitative review was required.

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