APPENDIX G

Wildlife Studies

ENVIRONMENTAL & STATISTICAL CONSULTANTS
7575 Golden Valley Road, Suite 300, Golden Valley, Minnesota 55427
Phone: 612.655.1726 ♦ www.west-inc.com

COVER MEMORANDUM

Date: June 10, 2020

To: Walleye Wind Project, LLC

From: Western EcoSystems Technology, Inc.

Subject: Walleye Wind Project – 2016 Raptor Nest Survey Report Cover Memo

INTRODUCTION

Walleye Wind Project, LLC is developing the Walleye Wind Project (Project) in Rock County, Minnesota (Figure 1). The 2016 Raptor Nest Survey Report attached to this memorandum was initially prepared for a study area that preceded the current Project, which included infrastructure in South Dakota. The Project now being proposed by Walleye Wind, LLC will have no infrastructure or any part of the Project in South Dakota. Therefore, references in this report to South Dakota are no longer applicable to the current Project. However, this report is provided due to the study area's proximity to and partial overlap with the current Project, as it provides information pertinent to Minnesota state agency review. The study area and current Project boundary are depicted in Figure 1, below.

Please also note that in the attached 2016 Raptor Nest Survey Report, all references to "Project" and "Project boundary" refer to the area delineated by the 2016 Raptor Nest Survey study area as shown on Figure 1.

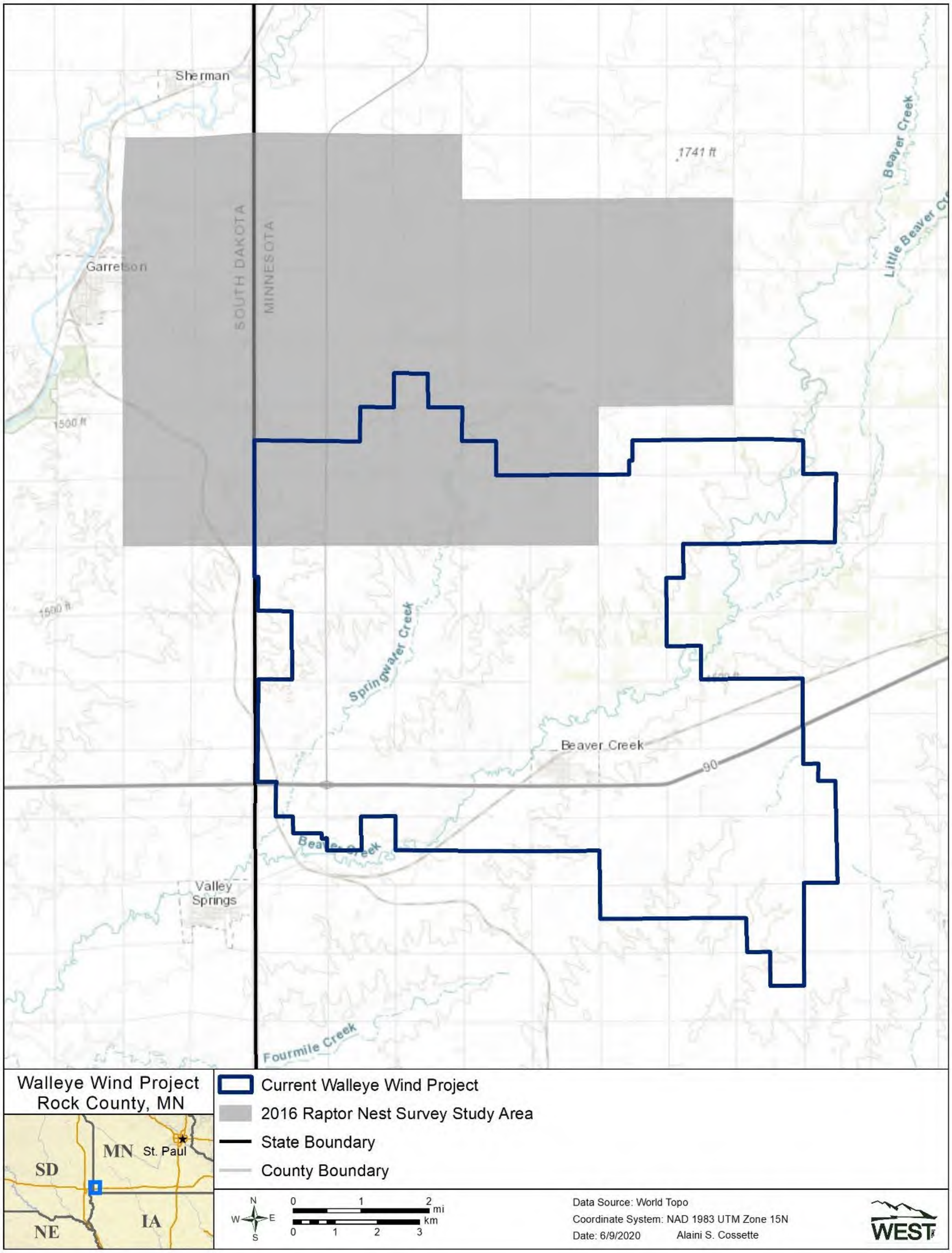

Figure 1. 2016 Raptor Nest Survey study area in comparison to the current Walleye Wind Project, Rock County, Minnesota.

Raptor Nest Survey Results for the Walleye Wind Project
Rock County, Minnesota and Minnehaha County, South Dakota

Prepared for:

Renewable Energy Systems, Inc.
12 South 6th Street, Suite 930
Minneapolis, Minnesota 55402

Prepared by:

Western EcoSystems Technology, Inc.
1710 Douglas, Suite 283
Golden Valley, MN 55422

May 25, 2016

STUDY PARTICIPANTS

Western EcoSystems Technology

Joyce Pickle	Project Manager
Chad Rittenhouse	Research Biologist
Adam Kreger	GIS Specialist

REPORT REFERENCE

Pickle, J., C. Rittenhouse and A. Kreger. 2016. Raptor Nest Survey Results for the Walleye Wind Project, Rock County, Minnesota and Minnehaha County, South Dakota. May 25, 2016. Prepared for Renewable Energy Systems Americas, Inc. Prepared by Western EcoSystems Technology, Inc. (WEST), Golden Valley, Minnesota.

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INTRODUCTION

Renewable Energy Systems Americas (RES) is developing the Walleye Wind Project (Project) in Rock County, Minnesota and Minnehaha County, South Dakota (Figure 1). RES requested that Western EcoSystems Technology, Inc. (WEST) conduct an aerial based raptor nest survey to help evaluate the potential impacts of construction on nesting raptors. This report provides results of the general raptor nest survey conducted at the Project on March 24 – 25, 2016.

STUDY AREA

The Project is located on the South Dakota-Minnesota border, just east of the town of Garreston, South Dakota (Figure 1). The Project falls in the Western Corn Belt Plains Ecoregion (USEPA 2013, 2015). The Western Corn Belt Plains Ecoregion is composed of glaciated till plains and undulating loess plains. Much of the region was originally dominated by tall-grass prairie, riparian forest, and woody and herbaceous wetlands. Today, most of the area has been cleared for farms producing corn, soybeans, and livestock. Many smaller streams in this ecoregion have been tiled, ditched, and tied into existing drainage systems, which caused a reduction in the amount of aquatic habitat. The majority of the Project is composed of cropland and developed areas (89%) with sparse forest patches and wetlands.

METHODS

Aerial Raptor Nest Survey

One aerial survey was conducted from a helicopter in late March (March 24 – 25, 2016), a period before leaf out when raptors would be actively tending to a nest or incubating eggs. Aerial surveys were conducted in accordance with the guidance provided in the U.S. Fish and Wildlife Service (USFWS) *Eagle Conservation Plan Guidance: Module 1 – Land-based Wind Energy, Version 2* (ECPG; USFWS 2013) and the USFWS Inventory and Monitoring Protocols (Pagel et al. 2010). An experienced raptor ecologist and a skilled helicopter pilot conducted the survey. Raptors are defined here as kites, accipiters, buteos, harriers, eagles, falcons, and owls. However, the main focus of the survey was to identify bald eagle nests. Bald eagle nest surveys focused on locating eyries (large, stick nest structures) in suitable eagle nesting substrate (trees, transmission lines, cliff faces, etc.) within and around the proposed Project (Figure 1), considering a 1-mi and a 10-mi buffer (Figure 1).

Surveys within the project boundary and 1-mi buffer documented all potential raptor nests, including bald eagles, while the surveys up to the 10-mi buffer focused only on identifying potential bald eagle nests. Efforts were made to minimize disturbance to breeding raptors; the greatest possible distance at which the species could be identified was maintained, with distances varying depending upon nest location and wind conditions.

In general, all potential bald eagle and raptor nest habitat was surveyed by flying transects between 0.25 and 0.5 mi (0.4 and 0.8 km) apart, flying at speeds of 60 to 75 mi per hour (mph; 97 to 121 km per hour) throughout the proposed Project and associated 10-mi buffer. Surveys were typically conducted between 07:00 hours and 18:00 hours. The locations of all potential raptor nests were recorded using a hand-held Global Positioning System (GPS); coordinates were set at Latitude/Longitude (hddd.ddddd°) World Geodetic System (WGS) 84 unit. The survey included all confirmed and potential nests regardless of their activity status. To determine the status of a nest, the biologist relied on clues that included behavior of adults and presence of eggs, young, or whitewash. Attempts were made to identify the species of raptor associated with each active nest. Raptor species, nest type, nest status, nest condition, and substrate, were recorded at each nest location to the extent possible.

Terminology

Included below are descriptions of terms used during the documentation of nests (see Results section).

Nest ID - WEST assigned a unique nest identification number for each nest documented.

Species - A species was assigned to each nest when possible, otherwise, it was classified as an unknown raptor nest. Nests documented as unknown raptor species are defined as any stick nest that did not have an occupant associated with it at the time of the survey. Many times nests will become abandoned or no longer used, and over time, may become a historic nest site. Unknown raptor nests, including old nests or nests that could become suitable for raptors, are documented in order to populate a nest database to ensure that future surveys include all potentially suitable nest sites.

Nest Condition - Nest condition was categorized using descriptions ranging from poor to excellent. Although the determination of nest condition can be subjective and may vary between observers, it gives a general sense of when a nest or nest site may have last been used. Nests in poor to fair condition are typically in disrepair, sloughing, or sagging heavily, and would require some level of effort to rebuild in order to be suitable for successful nesting. Nests in good to excellent condition are those that appear to have been well maintained, have a well-defined bowl shape, are not sagging or sloughing, and appear to be suitable for nesting.

Substrate - The substrate in which a nest was observed was recorded to provide observers a visual reference. Substrates range from manmade structures (such as power lines, nest platforms, and dock hoists) to biological and physical structures (conifer and deciduous tree species, cliff faces).

Nest Status - WEST categorizes basic nest use consistent with definitions from the ECPG. Nests were classified as occupied if any of the following were observed at the nest structure: (1) an adult in an incubating position, (2) eggs, (3) nestlings or fledglings, (4) occurrence of a pair of adults (or, sometimes sub-adults), (5) a newly constructed or refurbished stick nest in the area where territorial behavior of a raptor had been observed early in the breeding season, or (6) a recently repaired nest with fresh sticks (clean breaks) or fresh boughs on top, and/or droppings and/or molted feathers on its rim or underneath. Occupied nests were further classified as active if an egg or eggs had been laid or nestlings were observed, or inactive if no eggs or chicks were present. A nest that does not meet the above criteria for "occupied" was classified as "unoccupied".

RESULTS

Aerial Raptor Nest Survey

A WEST biologist detected a total of 38 raptor nests representing three raptor species (Table 1) during aerial surveys conducted on March 24 – 25, 2016. Two occupied bald eagle nests, two occupied red-tailed hawk (*Buteo jamaicensis*) nests, one occupied great-horned owl (*Bubo virginianus*) nest, and 33 unoccupied, inactive unknown raptor nests were identified (Table 1; Figure 1).

No occupied or potential bald eagle nests were located within the Project (Figure 1). No bald eagles were observed during the survey within the Project. Two occupied active bald eagle nests were documented in this survey, within riparian habitat along the Big Sioux River (Figure 1). No federal or state-listed threatened or endangered raptor species were observed nesting within the Project or the associated buffers. The following section provides a description of the bald eagle nests that were identified. Appendix A contains photos of all potential bald eagle nests. Table 1 summarizes the data collected at all observed raptor nests.

Nest 37 – this nest is located approximately 8.44 mi (13.58 km) southwest of the Project boundary. The nest was in excellent condition. Two bald eagles were observed; one was perched and one was observed in a nesting position. The nest is therefore considered occupied and active in 2016 (Appendix A, Figure 1).

Nest 38 – this nest is located approximately 7.76 mi (12.49 km) southwest of the Project boundary. The nest was in excellent condition. An adult bald eagle was observed in a nesting position. The nest is therefore considered occupied and active in 2016 (Appendix A, Figure 2).

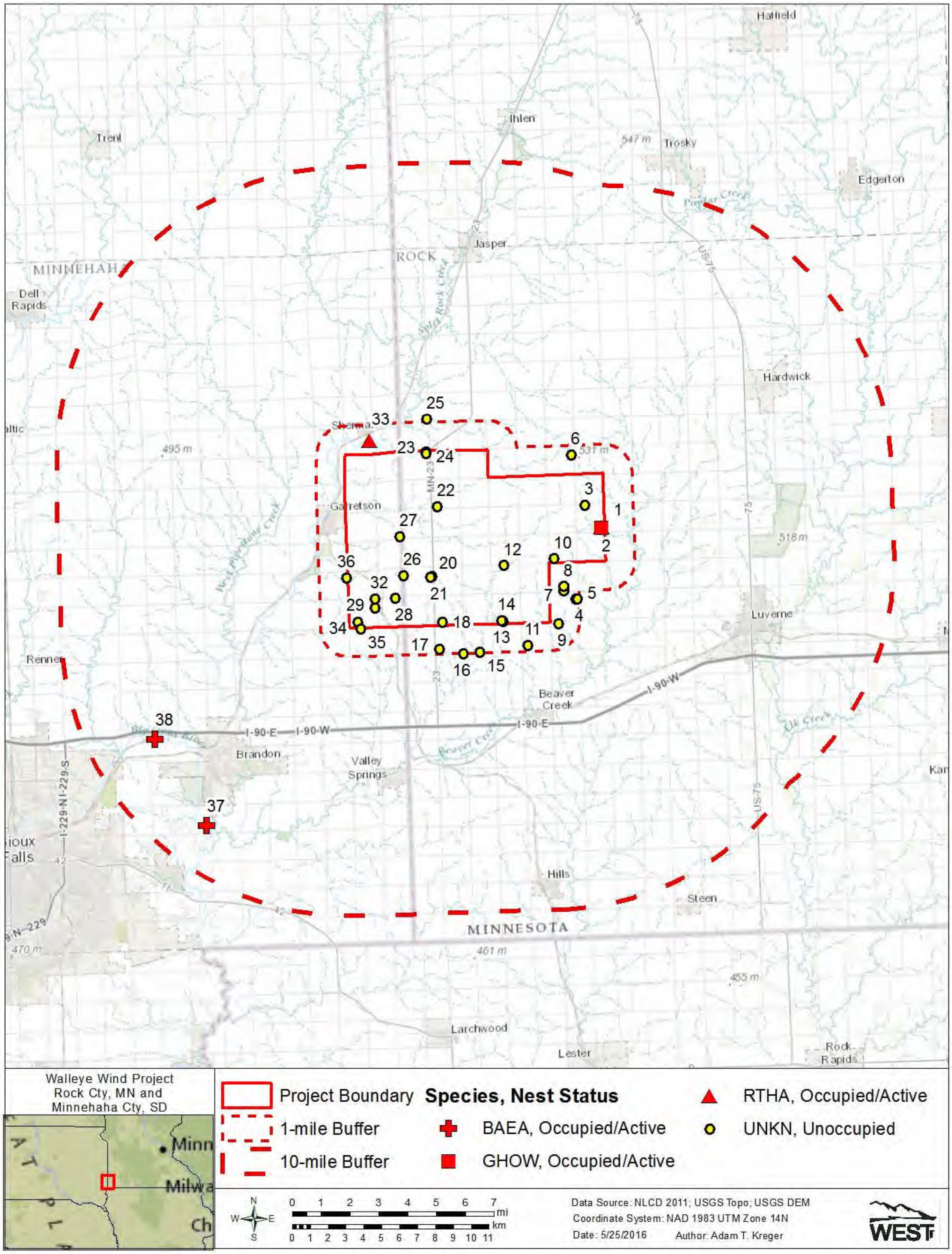

Figure 1. Locations of raptor nests observed at the Walleye Wind Project, Rock County, Minnesota, and Minnehaha County, South Dakota, and associated 1-mi and 10-mi buffers March 24 – 25, 2016.

Table 1. Raptor nest unique ID (NEST ID), locations (Lat/Long, hddd.dddd°; WGS 84) and features for identified nests during the March 24 – 25, 2016 survey for the Walleye Wind Project, Rock County, Minnesota, and Minnehaha County, South Dakota. Bald eagle (BAEA), Red-tailed hawk (RTHA), great-horned owl (GHOW), and unknown raptor (UNKN) nests were located.

Nest	Nest ID	Species	Nest substrate	Latitude	Longitude	Status at time of survey	Condition
1	032416-RTHA-MN-144	Red-tailed Hawk	Tree	43.707691	-96.312949	Occupied, active	Excellent
2	032416-GHOW-MN-145	Great-horned Owl	Tree	43.70629	-96.314637	Occupied, active	Excellent
3	032416-UNKN-MN-146	Unknown	Tree	43.717853	-96.325994	Unoccupied, inactive	Poor
4	032416-UNKN-MN-147	Unknown	Tree	43.670871	-96.334245	Unoccupied, inactive	Poor
5	032416-UNKN-MN-148	Unknown	Tree	43.671031	-96.333293	Unoccupied, inactive	Good
6	032416-UNKN-MN-149	Unknown	Tree	43.743468	-96.334475	Unoccupied, inactive	Fair
7	032416-UNKN-MN-150	Unknown	Tree	43.675245	-96.34255	Unoccupied, inactive	Fair
8	032416-UNKN-MN-151	Unknown	Tree	43.677388	-96.342307	Unoccupied, inactive	Fair
9	032416-UNKN-MN-152	Unknown	Tree	43.658674	-96.34683	Unoccupied, inactive	Good
10	032416-UNKN-MN-153	Unknown	Tree	43.691466	-96.348498	Unoccupied, inactive	Good
11	032416-UNKN-MN-154	Unknown	Tree	43.648392	-96.368753	Unoccupied, inactive	Poor
12	032416-UNKN-MN-155	Unknown	Tree	43.688902	-96.383623	Unoccupied, inactive	Fair
13	032416-UNKN-MN-156	Unknown	Tree	43.660972	-96.385358	Unoccupied, inactive	Poor
14	032416-UNKN-MN-157	Unknown	Tree	43.661088	-96.38602	Unoccupied, inactive	Poor
15	032416-UNKN-MN-158	Unknown	Tree	43.645665	-96.401958	Unoccupied, inactive	Good
16	032416-UNKN-MN-159	Unknown	Tree	43.645285	-96.413562	Unoccupied, inactive	Good
17	032416-UNKN-MN-160	Unknown	Tree	43.647988	-96.429708	Unoccupied, inactive	Good
18	032416-UNKN-MN-161	Unknown	Tree	43.661306	-96.427314	Unoccupied, inactive	Good
19	032416-UNKN-MN-162	Unknown	Tree	43.684018	-96.434386	Unoccupied, inactive	Good
20	032416-UNKN-MN-163	Unknown	Tree	43.684492	-96.433582	Unoccupied, inactive	Poor
21	032416-UNKN-MN-164	Unknown	Tree	43.684014	-96.434355	Unoccupied, inactive	Poor
22	032416-UNKN-MN-165	Unknown	Tree	43.719569	-96.428248	Unoccupied, inactive	Poor
23	032416-UNKN-MN-166	Unknown	Tree	43.746996	-96.435082	Unoccupied, inactive	Good
24	032416-UNKN-MN-167	Unknown	Tree	43.746345	-96.434986	Unoccupied, inactive	Good
25	032416-UNKN-MN-168	Unknown	Tree	43.763592	-96.433858	Unoccupied, inactive	Poor
26	032416-UNKN-MN-169	Unknown	Tree	43.685432	-96.453486	Unoccupied, inactive	Poor
27	032416-UNKN-SD-170	Unknown	Tree	43.704884	-96.454916	Unoccupied, inactive	Fair
28	032416-UNKN-SD-171	Unknown	Tree	43.674099	-96.459338	Unoccupied, inactive	Fair
29	032416-UNKN-SD-172	Unknown	Tree	43.669676	-96.473876	Unoccupied, inactive	Fair
30	032416-UNKN-SD-173	Unknown	Tree	43.673952	-96.473378	Unoccupied, inactive	Fair
31	032416-UNKN-SD-174	Unknown	Tree	43.674035	-96.473232	Unoccupied, inactive	Fair
32	032416-UNKN-SD-175	Unknown	Tree	43.674108	-96.4734	Unoccupied, inactive	Fair
33	032416-RTHA-SD-176	Red-tailed Hawk	Tree	43.754718	-96.472122	Occupied, active	Excellent
34	032416-UNKN-SD-177	Unknown	Tree	43.662526	-96.485896	Unoccupied, inactive	Fair

Table 1. Raptor nest unique ID (NEST ID), locations (Lat/Long, hddd.dddd°; WGS 84) and features for identified nests during the March 24 – 25, 2016 survey for the Walleye Wind Project, Rock County, Minnesota, and Minnehaha County, South Dakota. Bald eagle (BAEA), Red-tailed hawk (RTHA), great-horned owl (GHOW), and unknown raptor (UNKN) nests were located.

Nest	Nest ID	Species	Nest substrate	Latitude	Longitude	Status at time of survey	Condition
35	032416-UNKN-SD-178	Unknown	Tree	43.659209	-96.483837	Unoccupied, inactive	Fair
36	032416-UNKN-SD-179	Unknown	Tree	43.685023	-96.492827	Unoccupied, inactive	Good
37	032516-BAEA-SD-180	Bald Eagle	Tree	43.562668	-96.594158	Occupied, active	Excellent
38	032516-BAEA-SD-181	Bald Eagle	Tree	43.606778	-96.628101	Occupied, active	Excellent

DISCUSSION/CONCLUSION

These surveys provided additional information on eagle and raptor use within the vicinity of the Project. Aerial surveys did not find bald eagle nests within the Project. The Project site is dominated by cultivated agricultural lands with relatively little forest cover. The Project does include small pond, river, and wetland systems that might provide foraging opportunities to eagles. Woody habitats with mature large trees, which may provide nesting habitat for bald eagles, exist along the Big Sioux River (Nest 37, Nest 38), to the southwest of the Project boundary.

The ECPG states that eagle pairs at nests within one-half the mean inter-nest distance from the Project area are susceptible to disturbance take and blade strike mortality. The mean inter-nest distance of all bald eagle nests observed during this survey is approximately 3.5 mi (5.6 km) with a half mean inter-nest distance of 1.8 mi (2.9 km). The closest eagle nest to the project boundary is approximately 7.7 miles to the southwest. Given their distance from the Project area and lack of intervening habitat, bald eagles inhabiting these nests are not expected to be at increased risk of disturbance take and blade strike mortality as a result of Project development.

LITERATURE CITED

Pagel, J.E., D.M. Whittington, and G.T. Allen. 2010. Interim Golden Eagle Technical Guidance: Inventory and Monitoring Protocols; and Other Recommendations in Support of Golden Eagle Management and Permit Issuance. US Fish and Wildlife Service (USFWS). February 2010. Available online at: http://steinadlerschutz.lbv.de/fileadmin/www.steinadlerschutz.de/terimGoldenEagleTechnicalGuidanceProtocols25March2010_1_.pdf

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U.S. Fish and Wildlife Service (USFWS). 2013. Eagle Conservation Plan Guidance. Module 1 - Land-Based Wind Energy. Version 2. Division of Migratory Bird Management, USFWS. April 2013. Available online at: http://www.fws.gov/migratorybirds/Eagle_Conservation_Plan_Guidance-Module%201.pdf

APPENDIX A: IMAGES OF EAGLE NESTS (OCCUPIED-ACTIVE AND UNOCCUPIED/INACTIVE) IN THE 10-MILE BUFFER OF THE WALLEYE WIND PROJECT, ROCK COUNTY, MINNESOTA AND MINNEHAHA COUNTY, SOUTH DAKOTA

Figure 1. Nest 37 is located approximately 8.44 mi (13.58 km) southwest of the Project boundary. The nest was in excellent condition. Two bald eagles were observed; one was perched and one was observed in a nesting position. The nest is therefore considered occupied and active in 2016.

Figure 2. Nest 2 is located approximately 7.76 mi (12.49 km) southwest of the Project boundary. The nest was in excellent condition. An adult bald eagle was observed in a nesting position. The nest is therefore considered occupied and active in 2016.

ENVIRONMENTAL & STATISTICAL CONSULTANTS
7575 Golden Valley Road, Suite 300, Golden Valley, Minnesota 55427
Phone: 612.655.1726 ♦ www.west-inc.com

COVER MEMORANDUM

Date: June 10, 2020

To: Walleye Wind Project, LLC

From: Western EcoSystems Technology, Inc.

Subject: Walleye Wind Project – 2018 Raptor Nest Survey Report Cover Memo

INTRODUCTION

Walleye Wind Project, LLC is developing the Walleye Wind Project (Project) in Rock County, Minnesota (Figure 1). The 2018 Raptor Nest Survey Report attached to this memorandum was initially prepared for a study area that preceded the current Project. This report is provided due to the study area's proximity to and partial overlap with the current Project, as it provides information pertinent to Minnesota state agency review. The 2018 Raptor Nest Survey study area and current Project are depicted in Figure 1, below.

Please also note that in the attached 2018 Raptor Nest Survey Report, all references to "Project" and "Project boundary" refer to the area delineated by the 2018 Raptor Nest Survey study area as shown in Figure 1.

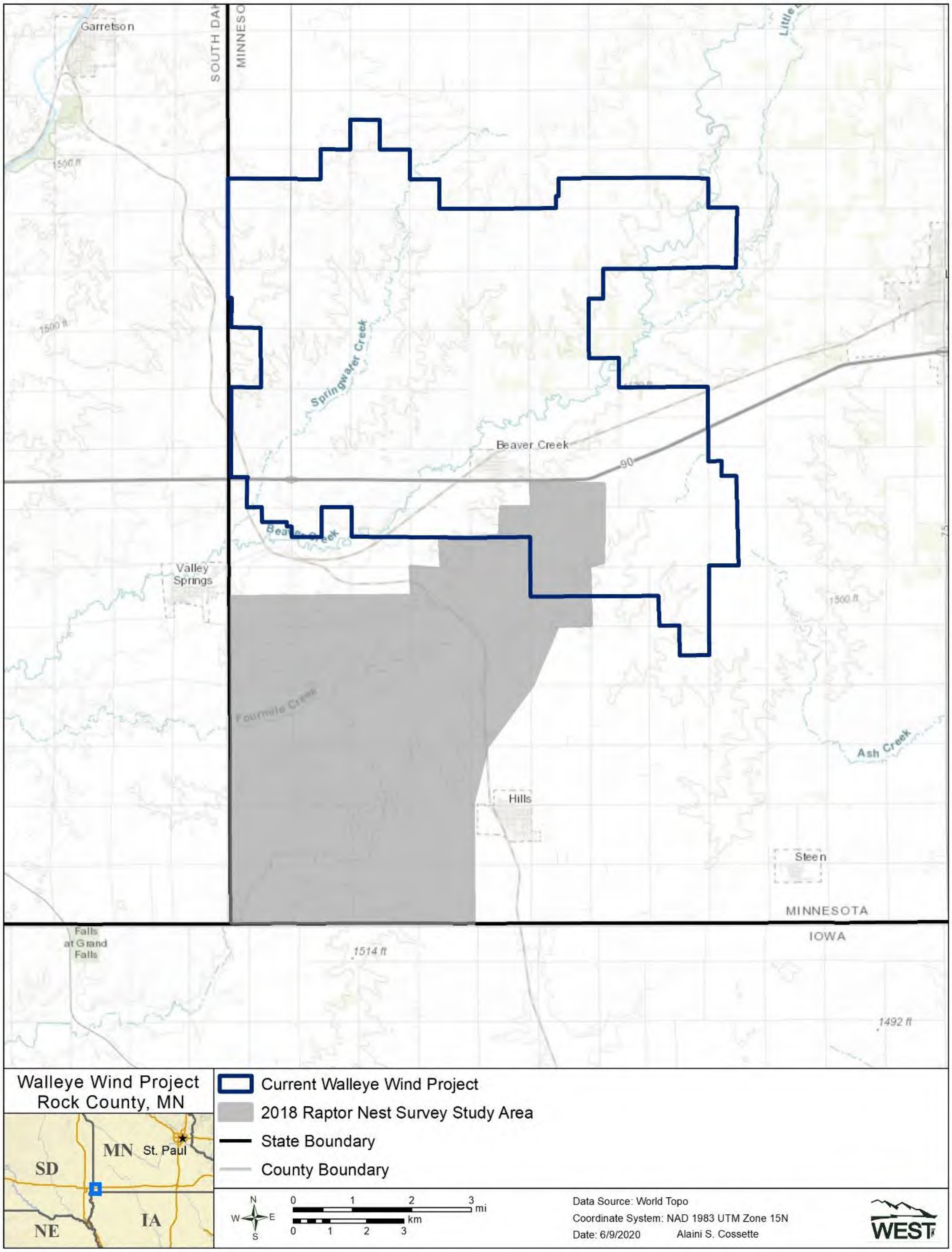

Figure 1. 2018 Raptor Nest Survey study area in comparison to the current Walleye Wind Project, Rock County, Minnesota.

2018 Raptor Nest Survey Report

Walleye Wind Energy Project

Rock County, Minnesota

Prepared for:

Walleye Wind Project, LLC

330 2nd Avenue South, Suite 820
Minneapolis, Minnesota 55401

Prepared by:

Western EcoSystems Technology, Inc.

7575 Golden Valley Road, Suite 350
Golden Valley, Minnesota 55427

August 15, 2018

UPDATED February 20, 2020

STUDY PARTICIPANTS

Western EcoSystems Technology, Inc.

Joyce Pickle	Senior Manager
Adam Kreger	Project Manager
Cecily Foo	Biologist
Aaron Suehring	Biologist/Report Writer
Alaini Schneider Cossette	Biologist/Report Writer
Carmen Boyd	Project Tracking and Data Manager
Fawn Hornsby	Data Manager
Brian Barbieri	GIS Specialist
David Klein	Technical Editing Manager
Katie Wynne	Technical Editing Coordinator
Natasha Wheeler	Technical Editor

REPORT REFERENCE

Western EcoSystems Technology, Inc. 2018. Raptor Nest Survey Report for the Walleye Wind Energy Project, Rock County, Minnesota. Prepared for Walleye Wind Project, LLC. Minneapolis, Minnesota. Prepared by Western EcoSystems Technology, Inc. (WEST), Golden Valley, Minnesota. August 15, 2018. Updated February 20, 2020.

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INTRODUCTION

Walleye Wind Project, LLC (Walleye Wind) is considering the development of a utility-scale wind energy project, the Walleye Wind Energy Project (Project), in Rock County, Minnesota. At the request of Walleye Wind, Western EcoSystems Technology, Inc. (WEST) conducted an aerial raptor nest survey to record bald eagle (*Haliaeetus leucocephalus*) and other raptor nests in the proximity of potential turbine siting areas. This survey will aid in assessing potential effects of the Project on eagles and other raptors. The survey was conducted in accordance with the guidance provided in the US Fish and Wildlife Service (USFWS) *Eagle Conservation Plan Guidance* (ECPG; USFWS 2013) and the USFWS *Interim Golden Eagle Technical Guidance* (Pagel et al. 2010).

SURVEY AREA

The boundary of the proposed Project area encompasses 18,890 acres (76.4 square kilometers, 29.5 square miles) in Rock County, Minnesota (Figure 1). The Project area falls within the Western Corn Belt Plains Ecoregion, which encompasses southern Minnesota (US Environmental Protection Agency 2013). The Western Corn Belt Plains Ecoregion is composed of glaciated till plains and undulating loess plains. Much of the region was originally dominated by tall-grass prairie, riparian forest, oak-prairie savannas, and brushy and herbaceous wetlands. Today, most of the area has been cleared for highly productive farms producing corn, soybeans and livestock. Many smaller streams in this ecoregion have been tilled, ditched and tied into existing drainage systems which has caused a reduction in the amount of aquatic habitat. The Project area is on the very southern edge of the Prairie Coteau in Minnesota.

The elevation of the Project area ranges from approximately 404 – 485 meters (1,325 – 1,591 feet). Topography of the Project is generally flat with some gently rolling hills; a majority of the site (88%) is cultivated for crop production. A number of streams are present within the Project area.

METHODS

Raptor Nest Survey

Raptor surveys were conducted from a helicopter from April 17 – 19, 2018, a period before leaf out when raptors are actively tending to a nest or incubating eggs. Aerial surveys were conducted in accordance with the guidance provided in the ECPG (USFWS 2013) and the USFWS *Interim Golden Eagle Technical Guidance* (Pagel et al. 2010). A raptor ecologist and a helicopter pilot conducted the surveys. Raptors are defined here as kites, accipiters, buteos, harriers, eagles, falcons, and owls (Buehler 2000). Pre-flight planning included the creation of field maps and mobile Geographic Information System files and review of relevant background information, such as previously recorded nest locations, topographic maps, and aerial photographs.

Surveys within the Project boundary and 1-mile (1.6-kilometer [km]) buffer documented all potential raptor nests, including bald eagles, while the surveys out to the 10-mi (16-km) buffer focused only on identifying potential bald eagle nests. Bald eagle nest surveys focused on locating eyries (large, stick nest structures) in suitable eagle nesting substrate (trees, transmission lines, cliff faces, etc.) within and around the proposed Project area (Figure 1). Efforts were made to minimize disturbance to breeding raptors; the greatest possible distance at which the species could be identified was maintained, with distances varying, depending upon nest location and wind conditions.

In general, all potential raptor nest habitat was surveyed by flying transects spaced 0.25 – 1.0 mi (0.8 – 1.6 km) apart, flying at speeds of approximately 46 mi per hour (74 km per hour) when actively scanning for nests. Surveys were typically conducted between 07:00 hours and 18:00 hours.

The survey track was recorded using a Global Positioning System (GPS) enabled tablet device to ensure that all areas were adequately covered. The helicopter was positioned to allow thorough visual inspection of the habitat, and in particular, to provide a view of the tops of the tallest dominant trees where bald eagles generally prefer to nest (Buehler 2000). The locations of all potential raptor nests were recorded using a GPS enabled tablet running locus pro software. This included all confirmed and potential nests regardless of their activity status.

To determine the status of a nest, the biologist evaluated behavior of adults on or near the nest, and presence of eggs, young, whitewash, or fresh building materials. Attempts were made to identify the species of raptor associated with each active nest. Raptor species, nest type, nest status, nest condition, and nest substrate were recorded at each nest location to the extent possible.

Terminology

Included below are descriptions of terms used during the documentation of nests (see Results section).

Nest ID – A unique nest identification number was assigned for each nest documented.

Species – A species was assigned to each nest when possible, otherwise, it was classified as an unidentified raptor nest. Nests documented as unidentified raptor species were defined as any stick nest not having an occupant associated with it at the time of the survey. Many times nests become abandoned or are no longer used, and over time, may become a historic nest site. Unidentified raptor nests, including old nests or nests that could become suitable for raptors, were documented in order to populate a nest database to ensure future surveys include all potentially suitable nest sites. Unidentified raptor species nests that appeared consistent in size and structure with bald eagle nests were further classified as potential alternate nest sites for bald eagles.

Nest Condition – Nest condition was categorized as good, fair, or poor. Although the determination of nest condition can be subjective and may vary between observers, it gives a general sense of when a nest or nest site was last used. Nests in good condition were excellently maintained with very well-defined bowl, no sagging, possible to use immediately or currently in use. Nests in fair condition had a fairly well-defined bowl, minor sagging, and might require some repair or addition to use immediately. Nests in poor condition were sloughing or sagging heavily and would require effort to restore for successful nesting.

Substrate – Nest substrate was recorded to provide observers a visual reference to re-locate the nest. Substrates may include manmade structures such as power lines, nest platforms, and dock hoists, and biological and physical structures such as conifer and deciduous tree species or cliff faces.

Nest Status – Nest status was categorized using definitions consistent with the USFWS ECPG. When applicable, bald eagle nests and potential bald eagle nests are further classified in the nest details section as “in-use” or “alternate” based on updated definitions of these terms in the final eagle rule effective January 17, 2017 (50 CFR Parts 13 and 22). Nests were classified as occupied if any of the following were observed at the nest structure: (1) an adult in an incubating position; (2) eggs; (3) nestlings or fledglings; (4) a pair of adults (sometimes sub-adults); (5) a newly constructed or refurbished stick nest in the area where territorial behavior of a raptor had been observed earlier in the breeding season; or (6) a recently repaired nest with fresh sticks (clean breaks) or fresh boughs on top, and/or droppings and/or molted feathers on its rim or underneath. Occupied nests were further classified as active if (1) an adult was present on the nest in incubating position, (2) an egg or eggs were present, or (3) nestlings were observed. Nests were classified as inactive if no eggs or chicks were present. Nests not meeting the above criteria for “Occupied” were classified as “Unoccupied”.

RESULTS

A total of 22 stick nests representing two identified raptor species and one colonial waterbird species were detected during aerial surveys conducted April 17 – 19, 2018 (Table 1). Three occupied active bald eagle nests and one occupied inactive bald eagle nest were documented along the Big Sioux River, all of which were more than 7.0 miles (11.3 km) from the Project. Five unidentified raptor nests appeared consistent in size and structure with bald eagle nests: one was occupied inactive and four were inactive. All of these potential bald eagle nests were more than 6.5 miles (10.4 km) from the Project. Additional raptor nests documented during the survey included four occupied active red-tailed hawk (*Buteo jamaicensis*) nests: one within the Project boundary, two within one mile of the Project, and one just outside of the 1-mile buffer of the Project. Seven inactive nests of unidentified raptor species were also documented: six within the Project boundary and one within one mile of the Project. One stick nest that may have been built by a raptor (but was occupied by American crow [*Corvus brachyrhynchos*]) was documented within one mile of the Project. One occupied active great blue heron (*Ardea herodias*) rookery was also observed 7.3 miles from the Project.

The following section provides more details on each eagle nest and nests consistent in size and structure with eagle nests documented during the aerial surveys:

Nest 16132 – This nest was located approximately 7.1 mi (11.4 km) west of the Walleye Wind Energy Project area. The nest was in good condition at the time of the aerial survey. One adult bald eagle was observed on the nest in an incubating position, and the nest was considered an occupied active bald eagle nest in 2018 (Figure 1, Appendix A1). WEST also documented this nest as an occupied active bald eagle nest in 2016 (previous recorded as Nest 37; Pickle et al. 2016).

Nest 16135 – This nest was located approximately 8.3 mi (13.4 km) southwest of the Walleye Wind Energy Project area and was a new nest documented by WEST in 2018. The nest was in good condition at the time of the aerial survey. One adult bald eagle was observed on the nest in an incubating position, and the nest was considered an occupied active bald eagle nest in 2018 (Figure 1, Appendix A2).

Nest 16138 – This nest was located approximately 9.0 mi (14.5 km) northwest of the Walleye Wind Energy Project area. The nest was in good condition at the time of the aerial survey. One adult bald eagle was observed on the nest in an incubating position. The nest was considered an occupied active bald eagle nest in 2018 (Figure 1, Appendix A3). WEST also documented this nest as an occupied active bald eagle nest in 2016 (previously recorded as Nest 38; Pickle et al. 2016).

Nest 16134 – This nest was located approximately 7.2 mi (11.6 km) west of the Walleye Wind Energy Project area and was a new nest documented by WEST in 2018. The nest was in good condition at the time of the aerial survey and appeared to be recently tended, with both greenery and wash (i.e., fresh/recent droppings) observed in the nest. One adult bald eagle was observed perched on the nest and flying near the nest. Since no eggs or chicks were observed, the nest was considered an occupied inactive bald eagle nest in 2018 (Figure 1, Appendix A4).

Nest 16133 – This nest was located approximately 7.3 mi (11.7 km) west of the Walleye Wind Energy Project area. The nest was in good condition and was consistent in size and structure with a bald eagle nest. No eagles were seen on the nest or in close proximity to the nest; however, wash and feathers were observed in the nest. The nest is therefore considered an occupied inactive unidentified raptor nest in 2018 (Figure 1, Appendix A5).

Nest 3099 – This nest was located approximately 6.6 mi (10.6 km) northeast of the Walleye Wind Energy Project area. The nest was in fair condition and consistent in size and structure with a bald eagle nest. No eagles were seen on the nest or in close proximity to the nest. The nest was therefore considered inactive in 2018 (Figure 1, Appendix A6).

Nest 3100 – This nest was located approximately 6.8 mi (10.9 km) northeast of the Walleye Wind Energy Project area. The nest was in fair condition and consistent in size and structure with a bald eagle nest. No eagles were seen on the nest or in close proximity to the nest. The nest was therefore considered inactive in 2018 (Figure 1, Appendix A7).

Nest 3101 - This nest was located approximately 7.8 mi (12.6 km) east of the Walleye Wind Energy Project area. The nest was in fair condition and consistent in size and structure with a bald eagle nest. No eagles were seen on the nest or in close proximity to the nest. The nest was therefore considered inactive in 2018 (Figure 1, Appendix A8).

Nest 16136 – This nest was located approximately 8.5 mi (13.7 km) southwest of the Walleye Wind Energy Project area. The nest was in good condition and was consistent in size and structure with a bald eagle nest. No eagles were seen on the nest or in close proximity to the nest. The nest was therefore considered inactive in 2018 (Figure 1, Appendix A9).

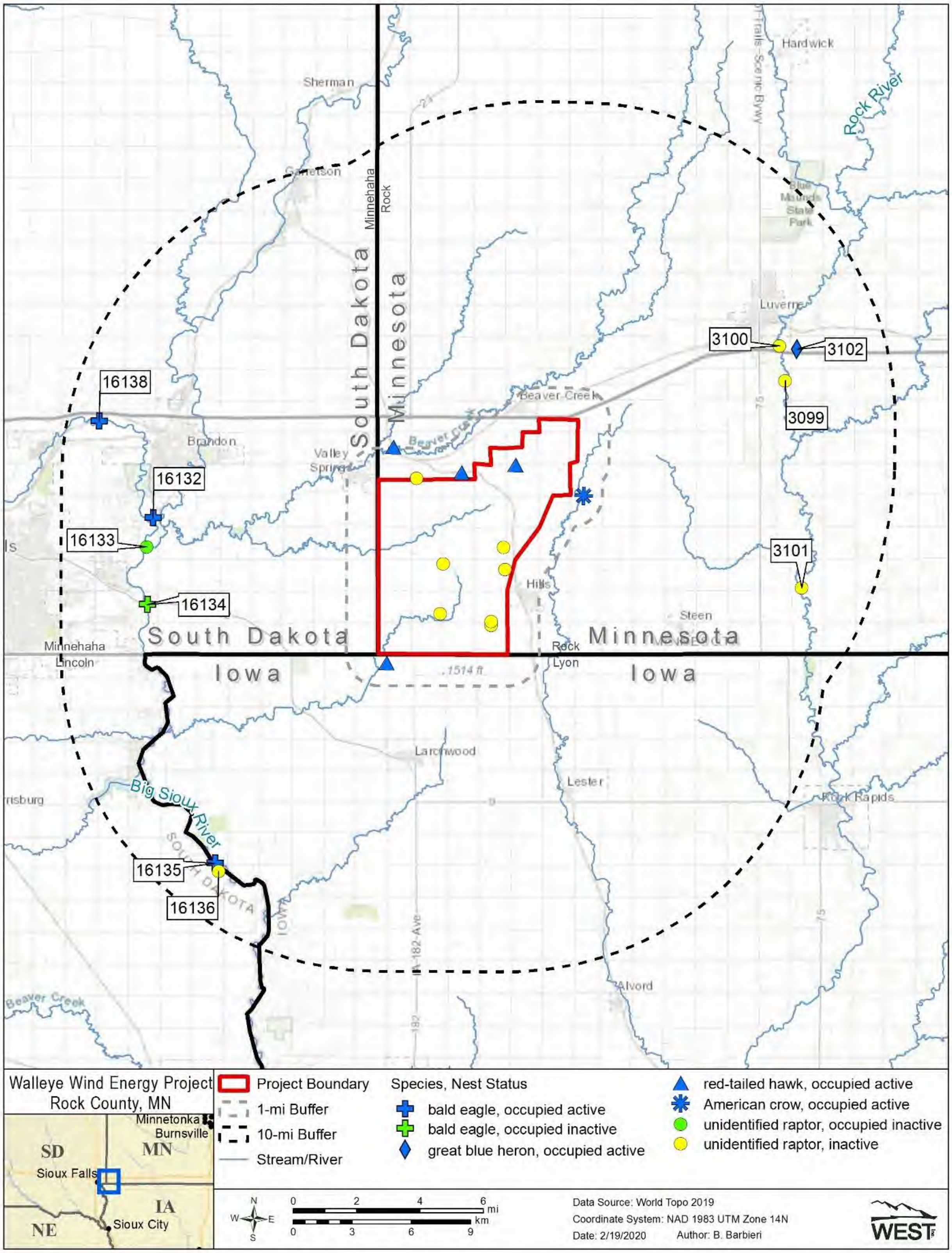

Figure 1. Stick nests documented April 17 – 19, 2018, near the Walleye Wind Energy Project, Rock County, Minnesota.

Table 1. Raptor nest ID, location, species, status, substrate, and condition of nests documented April 17 – 19, 2018, near the Walleye Wind Energy Project, Rock County, Minnesota.

Nest ID	Latitude	Longitude	Species[1]	Status at time of survey	Nest Substrate	Condition
16132	43.5627	-96.5942	BAEA	occupied active	deciduous tree	good
16135	43.4051	-96.5550	BAEA	occupied active	deciduous tree	good
16138	43.6068	-96.6281	BAEA	occupied active	deciduous tree	good
16134	43.5231	-96.5976	BAEA	occupied inactive	deciduous tree	good
16133	43.5495	-96.5983	UNRA*	occupied inactive	deciduous tree	good
3099	43.6250	-96.1971	UNRA*	inactive	deciduous tree	fair
3100	43.6410	-96.2005	UNRA*	inactive	deciduous tree	fair
3101	43.5306	-96.1871	UNRA*	inactive	deciduous tree	fair
16136	43.4016	-96.5528	UNRA*	inactive	deciduous tree	good
3102	43.6394	-96.1899	GBHE	occupied active	deciduous tree	good
3092	43.5833	-96.4004	RTHA	occupied active	deciduous tree	good
3097	43.5866	-96.3664	RTHA	occupied active	deciduous tree	good
16137	43.4964	-96.4475	RTHA	occupied active	deciduous tree	good
16139	43.5949	-96.4431	RTHA	occupied active	deciduous tree	good
3098	43.5727	-96.3239	AMCR	occupied active	deciduous tree	fair
3089	43.5810	-96.4286	UNRA	inactive	deciduous tree	fair
3090	43.5418	-96.4119	UNRA	inactive	deciduous tree	fair
3091	43.5191	-96.4139	UNRA	inactive	deciduous tree	fair
3093	43.5155	-96.3818	UNRA	inactive	deciduous tree	fair
3095	43.5495	-96.3740	UNRA	inactive	deciduous tree	fair
3096	43.5392	-96.3730	UNRA	inactive	deciduous tree	fair
3094	43.5138	-96.3819	UNRA	inactive	deciduous tree	poor

1. AMCR = American crow, BAEA = bald eagle, GBHE = great blue heron, RTHA = red-tailed hawk, UNRA = unidentified raptor species, UNRA* = unidentified species nest characteristic in structure and size of bald eagle and may be an alternate nest or historic nesting site.

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Appendix A. Images of Bald Eagle Nests and Nests Consistent in Size and Structure with Bald Eagle Nests Found April 17 – 19, 2018 within the 10-mile Buffer of the Walleye Wind Energy Project, Rock County, Minnesota

Appendix A1. Nest 16132 was located approximately 7.1 mi (11.4 km) west of the Walleye Wind Energy Project boundary. The nest was in good condition and one bald eagle was observed on the nest in an incubating position. The nest was considered occupied and active in 2018.

Appendix A2. Nest 16135 was located approximately 8.3 mi (13.4 km) southwest of the Walleye Wind Energy Project boundary. The nest was in good condition and one bald eagle was observed on the nest in an incubating position. The nest was considered occupied and active in 2018.

Appendix A3. Nest 16138 was located approximately 9.0 mi (14.5 km) northwest of the Walleye Wind Energy Project boundary. The nest was in good condition and one bald eagle was observed on the nest in an incubating position. The nest was considered occupied and active in 2018.

Appendix A4. Nest 16134 was located approximately 7.2 mi (11.6 km) west of the Walleye Wind Energy Project boundary. The nest was in good condition and greenery and wash were observed in the nest. One bald eagle was observed perched on and flying near the nest. The nest was considered an occupied inactive bald eagle nest in 2018.

Appendix A5. Nest 16133 was located approximately 7.3 mi (11.7 km) west of the Walleye Wind Energy Project boundary. The nest was in good condition and wash was observed in the nest. No bald eagles were observed on or near the nest, and it was considered an occupied inactive unidentified raptor nest in 2018.

Appendix A6. Nest 3099 was located approximately 6.6 mi (10.6 km) northeast of the Walleye Wind Energy Project boundary. The nest was in fair condition and consistent in size and structure with a bald eagle nest. No eagles were seen near the nest. The nest was considered inactive in 2018.

Appendix A7. Nest 3100 was located approximately 6.8 mi (10.9 km) northeast of the Walleye Wind Energy Project boundary. The nest was in fair condition and consistent in size and structure with a bald eagle nest. No eagles were seen near the nest. The nest was considered inactive in 2018.

Appendix A8. Nest 3101 was located approximately 7.8 mi (12.6 km) east of the Walleye Wind Energy Project boundary. The nest was in fair condition and consistent in size and structure with a bald eagle nest. No eagles were seen near the nest. The nest was considered inactive in 2018.

Appendix A9. Nest 16136 was located approximately 8.5 mi (13.7 km) southwest of the Walleye Wind Energy Project boundary. The nest was in good condition and consistent in size and structure with a bald eagle nest. No eagles were seen near the nest. The nest was considered inactive in 2018.

ENVIRONMENTAL & STATISTICAL CONSULTANTS
7575 Golden Valley Road, Suite 300, Golden Valley, Minnesota 55427
Phone: 612.655.1726 ♦ www.west-inc.com

COVER MEMORANDUM

Date: June 10, 2020

To: Walleye Wind Project, LLC

From: Western EcoSystems Technology, Inc.

Subject: Walleye Wind Project – 2018 Avian Use Survey Report Cover Memo

INTRODUCTION

Walleye Wind Project, LLC is developing the Walleye Wind Project (Project) in Rock County, Minnesota (Figure 1). The 2018 Avian Use Survey Report attached to this memorandum was initially prepared for a study area that preceded the current Project. This report is provided due to the study area's proximity to and partial overlap with the current Project, as it provides information pertinent to Minnesota state agency review. The 2018 Avian Use Survey study area and current Project boundary are depicted in Figure 1, below.

Please also note that in the attached 2018 Avian Use Study Report, all references to "Project" and "current Project area" refer to the likely buildable area that was anticipated at the time of the 2018 surveys as defined by the study area shown in Figure 1.

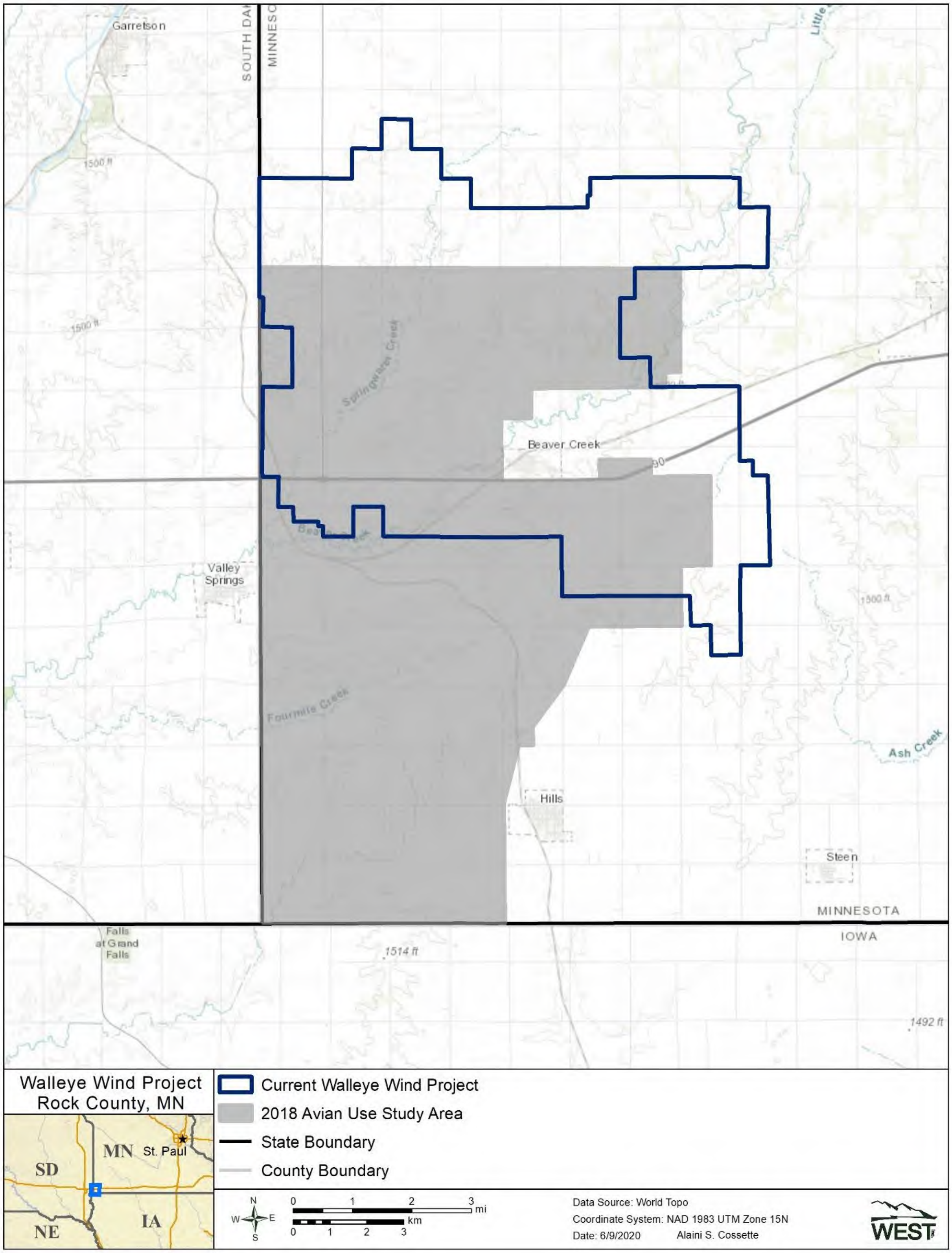

Figure 1. 2018 Avian Use Survey study area in comparison to the current Walleye Wind Project, Rock County, Minnesota.

Avian Use Study
Walleye Wind Energy Project
Rock County, Minnesota

Year 1 Report
January 2018 – December 2018

Prepared for:

Walleye Wind Project, LLC

12 South 6th Street, Suite 930
Minneapolis, Minnesota 55402

Prepared by:

Adam Kreger and Aaron Suehring

Western EcoSystems Technology, Inc.
7575 Golden Valley Road, Suite 300
Golden Valley, Minnesota 55427

May 2019

STUDY PARTICIPANTS

Todd Mattson	Senior Manager
Joyce Pickle	Research Biologist
Adam Kreger	Research Biologist
Catherine Read	Statistician
Aaron Suehring	Report Writer
Katie Wynne	Technical Editor
Jean-Paul Willson	Technical Editor
Carmen Boyd	Project Tracking and Data Manager
Ryan Anderson	GIS Specialist

REPORT REFERENCE

Kreger, A., and A. Suehring. 2019. Avian Use Study, Walleye Wind Energy Project, Rock County, Minnesota Year 1 Report January 2018 – December 2018. Prepared for Walleye Wind Project, LLC, Minneapolis, Minnesota. Prepared by Western EcoSystems Technology, Inc. (WEST), Golden Valley, Minnesota. May 2019.

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1 INTRODUCTION

Walleye Wind Project, LLC (Walleye) is developing the Walleye Wind Energy Project (Project) in Rock County, Minnesota (Figure 1)[1]. Walleye contracted Western EcoSystems Technology, Inc. (WEST) to conduct pre-construction baseline surveys to estimate temporal and spatial avian use of the Study Area (area where surveys were conducted). Methods were consistent with the US Fish and Wildlife Service (USFWS) *Eagle Conservation Plan Guidance* (ECPG; USFWS 2013), the USFWS *Land-Based Wind Energy Guidelines* (USFWS 2012), and Minnesota Department of Natural Resources (MNDNR) *Avian and Bat Survey Protocols for Large Wind Energy Conversion Systems in Minnesota* (MNDNR 2012).

Study objectives assessed: 1) species composition, relative abundance, and diversity; 2) overall avian use, percent of use, and frequency of occurrence; 3) flight height; and 4) spatial use for large and small birds. Additional objectives documented use of the Study Area by threatened, endangered, and sensitive bird species and eagles. This report describes the results of the avian use study that was conducted at the Study Area from January 29, 2018 – December 17, 2018.

2 STUDY AREA

The Study Area encompasses 15,954 hectares (39,424 acres) in Rock County, Minnesota (Figure 1). The Study Area falls within the Western Corn Belt Plains Ecoregion, which encompasses southern Minnesota (US Environmental Protection Agency 2017). The Western Corn Belt Plains Ecoregion is composed of glaciated till plains and undulating loess plains. Much of the region was originally dominated by tall-grass prairie, riparian forest, oak-prairie savannas, and brushy and herbaceous wetlands. Today, most of the area has been cleared for agricultural production and consists of cultivated cropland (Figure 2). Many smaller streams in this ecoregion have been tilled, ditched and tied into existing drainage systems, which has caused a reduction in the amount of aquatic habitat.

[1] The current Project Area depicted on Figure 1 represents the current likely buildable area, and the current Study Area represents the total area where surveys were conducted.

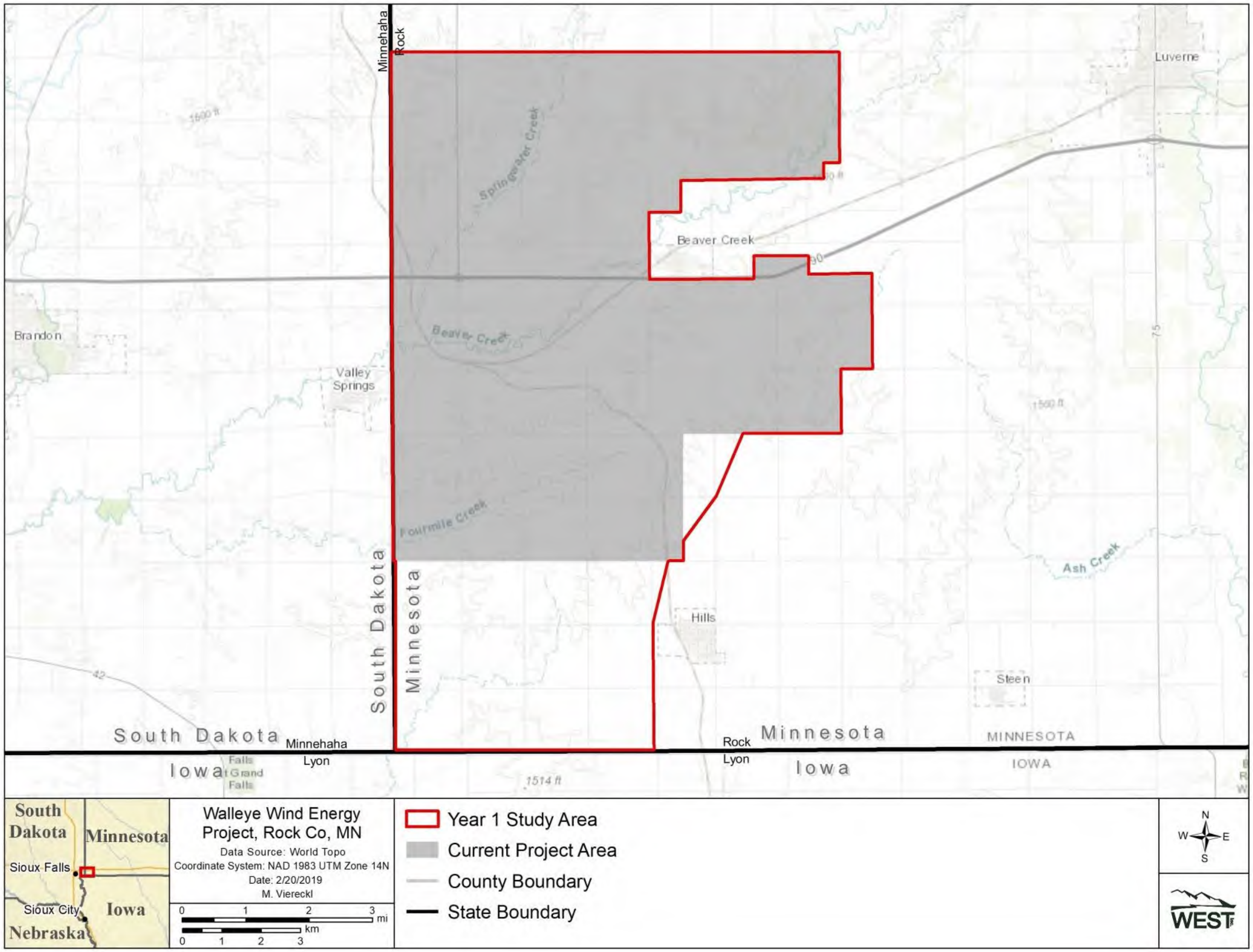

Figure 1. Location of the Walleye Wind Energy Project Study Area in Rock County, Minnesota.

According to the 2011 National Land Cover Database (NLCD; US Geological Survey [USGS] NLCD 2011, Homer et al. 2015), the majority of the Study Area consists of cultivated cropland (83.8%), followed by hay/pasture (6.7%), developed open space (5.6%), and herbaceous (2.2%); other land cover types compose less than 1.0% of the Study Area and include developed low intensity, deciduous forest, emergent herbaceous wetlands, developed medium intensity, open water, barren land, shrub/scrub, and developed high intensity (Table 1; Figure 2).

Table 1. National Land Cover Database (NLCD) land cover types within the Walleye Wind Energy Project Study Area, Rock County, Minnesota.

Cover Type	Hectares	Acres	% Composition
Cultivated Crops	13,362	33,018	83.8
Hay/Pasture	1,061	2,622	6.7
Developed, Open Space	889	2,197	5.6
Herbaceous	347	858	2.2
Developed, Low Intensity	94	233	0.6
Deciduous Forest	90	223	0.6
Emergent Herbaceous Wetlands	63	155	0.4
Developed, Medium Intensity	27	68	0.2
Open Water	9	23	0.1
Barren Land	8	20	0.1
Shrub/Scrub	1	3	<0.1
Developed, High Intensity	1	2	<0.1
Total[a]	**15,954**	**39,424**	**100**

Source: 2011 NLCD (US Geological Survey NLCD 2011, Homer et al. 2015).

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

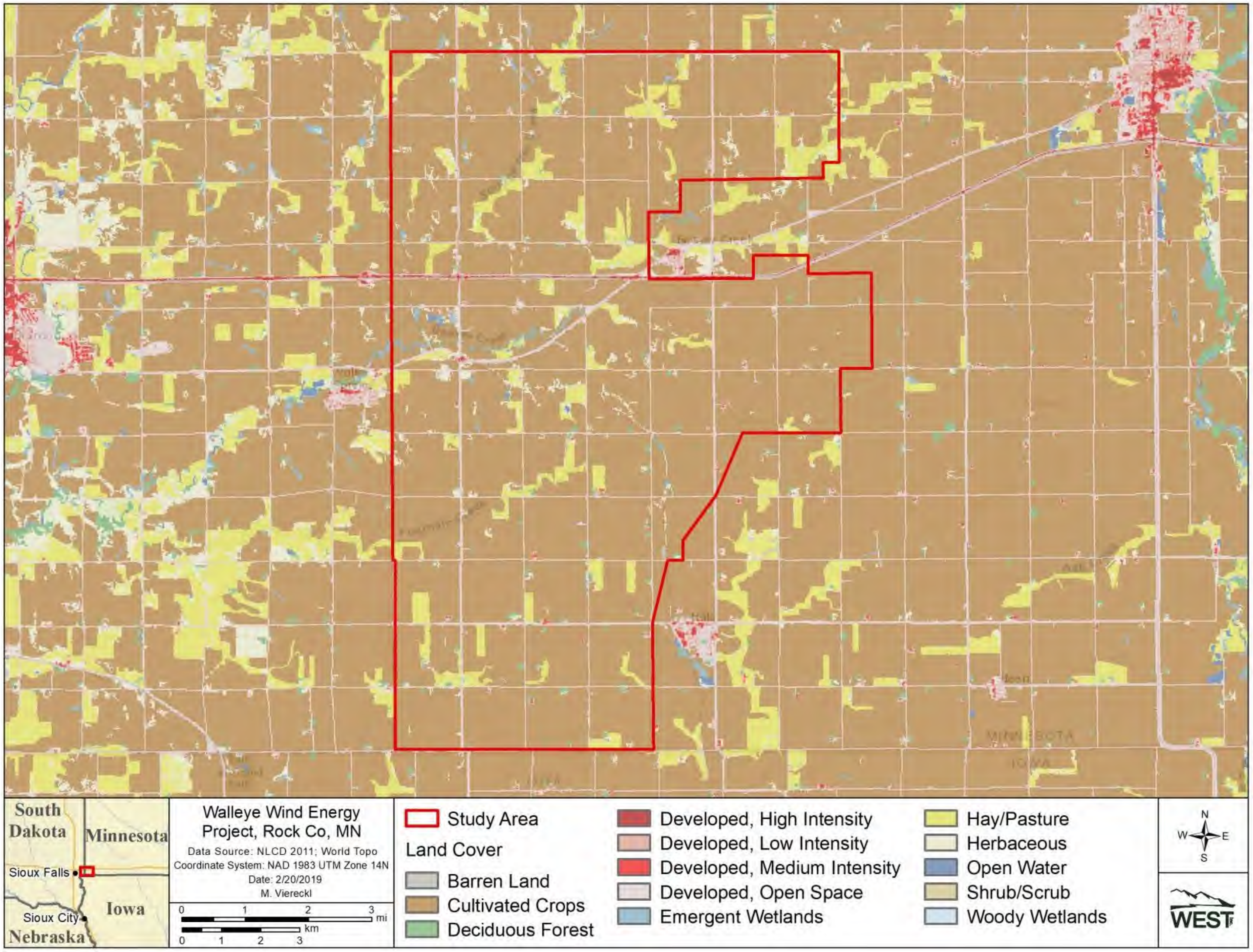

Figure 2. The land cover types within and adjacent to the Walleye Wind Energy Project Study Area in Rock County, Minnesota, (US Geological Survey National Land Cover Database 2011, Homer et al. 2015).

3 METHODS

3.1 Fixed-Point Bird Use Surveys

Fixed-point bird use surveys were conducted using methods described by Reynolds et al. (1980). Twenty-four[2] observation points consisting of 800-meter (m; 2,625-foot [ft]) radius circular plots were established within the Study Area. Circular plots covered approximately 30% of the Study Area (Figure 3). Observation points (the center of the 800-m plot) were separated by at least 1,600 m (5,249 ft) to avoid overlap and were located along public roads using a systematic sampling scheme with a random start in ArcGIS (a Geographic Information System software program).

Fixed-point bird use surveys were conducted once per month from January 29 – December 17, 2018, with seasons defined as: winter (January 29 – February 28 and December 1 – December 17), spring (March 1 – May 31), summer (June 1 – August 31), and fall (September 1 – November 30). Surveys were conducted during daylight hours; survey periods were varied to cover approximately all daylight hours during a season. Observation points were planned to be surveyed the same number of times. Surveys were missed on occasion due to poor visibility as a result of weather conditions or site access issues (e.g., sub-zero temperatures or impassable roads).

Separate surveys were conducted for large and small birds. Large bird surveys consisted of a 60-minute (min) survey period. During the first 20 min of the survey, all large bird species observed were recorded; during the remaining 40 min of the survey period, only eagles were recorded. The first 20 min of the 60-min survey period allowed for comparison of diurnal raptor use with other wind energy facilities in the region, while the full 60-min eagle use survey was consistent with the ECPG and was used to obtain a robust dataset with which to evaluate eagle use and potential collision risk. A separate 10-min small bird survey was conducted immediately prior to the 60-min large bird survey, during which time only small birds were recorded. Large birds included waterbirds, waterfowl, rails and coots, grebes and loons, gulls and terns, shorebirds, diurnal raptors, owls, vultures, upland game birds, doves and pigeons, large corvids (i.e., ravens, magpies, and crows), some cuckoos, and goatsuckers. Small birds were defined as cuckoos, hummingbirds, swifts, woodpeckers, and passerines.

All large and small birds seen were recorded during each survey using a unique observation number, regardless of distance from the observer. In some cases, observations represented repeated sightings of the same individual. Observations of large birds outside the 800-m plot, and of small birds outside the 100-m plot, were recorded. These data were included in the

[2] Points 1-5 were surveyed for the entire duration of the study (January – December, 2018). A Project boundary change in October 2018 resulted in the addition of 10 survey points (points 13-22; surveyed October – December, 2018) and the discontinuation of seven survey points (points 6-12; surveyed January – October, 2018). An additional boundary change in November 2018 resulted in the addition of two survey points (points 23 and 24; surveyed November – December, 2018).

development of species composition, relative abundance, and species diversity metrics, but were not included in analyses of avian use and flight heights.

The following information was recorded during each survey:

- date
- start and end time
- weather (i.e., temperature, wind speed, wind direction, precipitation, and cloud cover).

Additionally, the following data were recorded for each observation:

- Species (or best possible identification)
- number of individuals
- distance from observer (initial and closest)
- flight height above ground (initial, lowest, and highest)
- flight direction
- behavior (e.g., soaring, perched)

Approximate flight height and distance from plot center at first observation were recorded to the nearest 5-m (16-ft) interval.

Bald eagle (*Haliaeetus leucocephalus*) and golden eagle (*Aquila chrysaetos*) observations were recorded at 1-min intervals documenting when an eagle was within the 800-m plot and at or below 200-m (656-ft) above ground level, per the ECPG (i.e., eagle risk minutes). Flight height, distance, and activity (i.e., flying or perched) were also recorded during each 1-min interval. Eagles observed outside of plots or at heights greater than 200-m were recorded, but not included in the eagle risk minute analyses. The perch locations and flight paths of eagles were mapped to qualitatively assess areas of eagle use within the Study Area.

3.2 Incidental Wildlife Observations

Incidental observations provide records of avian use within the Study Area that were documented outside of the standardized surveys (e.g., large bird observations that did not occur within the 60-min survey window, particularly of sensitive or unique species). Incidental observations of sensitive species, rare species or behavior observations, and other notable birds 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, and flight height above ground were recorded. Biologists recorded the location of sensitive species by Universal Transverse Mercator coordinates using a hand-held Global Positioning System unit. Sensitive species include those listed on the federal Endangered Species Act of 1973, the Migratory Bird Treaty Act of 1918, those listed as threatened or endangered by the MNDNR (2018), and those designated as sensitive species by the MNDNR (2015).

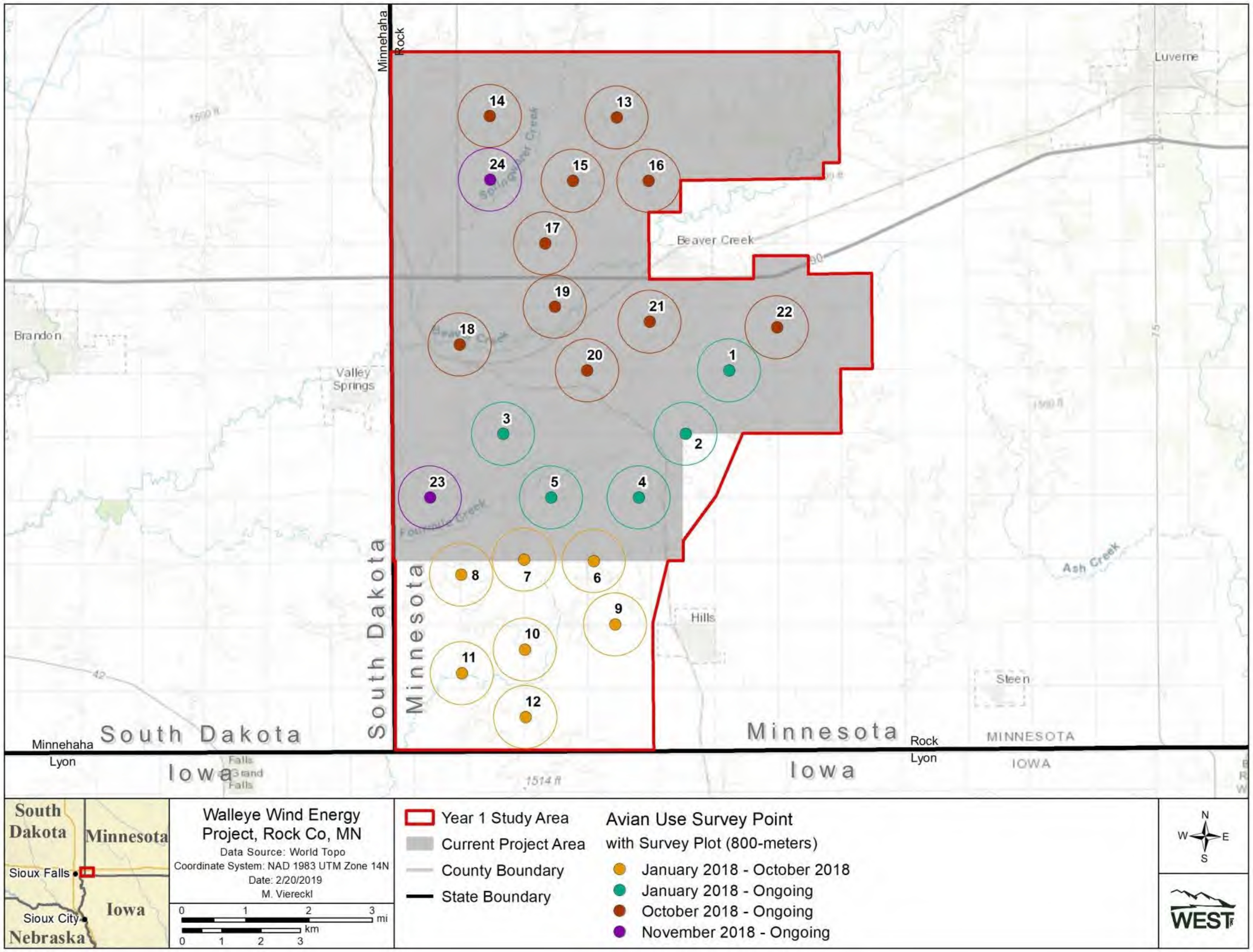

Figure 3. Locations of fixed-point bird use survey plots at the Walleye Wind Energy Project Study Area where surveys were conducted from January 29 – December 17, 2018.

3.3 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. A data technician then compared a sample of records from an electronic database to the raw data forms and corrected any errors. Irregular codes or data suspected as questionable were discussed with the observer or project manager. Errors, omissions, or problems identified in later stages of analysis were traced back to the raw data forms, and appropriate changes in all steps were made.

A Microsoft® SQL Server database was employed to store, organize, and retrieve survey data. Data were keyed into the electronic database using a pre-defined format to facilitate subsequent QA/QC and data analysis. All data forms and electronic data files were retained for reference. QA/QC measurements implemented for report writing included review of the final document by a technical editor, statistician, peer (research biologist), project manager, and senior manager.

4 DATA 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: a single visit had to be completed in a single season, and a visit could be spread across multiple dates, but a single date could not contain surveys from multiple visits.

4.1 Species Composition, Relative Abundance, and Diversity

Species composition (i.e., species and bird types observed during the surveys) and relative abundance (i.e., number of observations and groups of each species and bird type by season), and diversity (i.e., total number of species observed within each season) were compiled for all birds observed during the bird use surveys, irrespective of distance from observer (i.e., includes incidental observations). In addition, percent composition for each bird type was calculated by total percent of bird observations and total percent of bird observations by season to assess percent composition of bird types based on all bird observations, regardless of distance from observer. Species richness was calculated as the number of species per 800-m plot per survey for large birds and per 100-m plot for small birds, and then averaged across plots within each visit, followed by averaging across visits within a season. Overall species richness was calculated as a weighted average of seasonal values by the number of days in each season.

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

Large bird use was calculated as the number of birds/800-m plot/20-min survey, and small bird use was calculated as the number of birds/100-m plot/10-min survey. Bird use was calculated by season by first summing the number of birds seen within each plot during a visit, then averaging the number of birds/plot across plots within each visit, and finally by averaging the number of birds/visit across visits within the season. Overall bird use was calculated as a weighted average of seasonal values by the number of calendar days in each season (as defined by the season dates). Percent of use was calculated as the proportion of large bird use that was attributable to a particular bird type or species, and frequency of occurrence was calculated as the percent of surveys in which a particular bird type or species was observed.

Separate annual and seasonal estimates of eagle use were calculated for the full 60-min eagle survey period using the metric of eagle minutes. Consistent with guidance provided in the ECPG (USFWS 2013), eagle minutes are defined as the number of minutes (rounded to the next highest integer) an eagle is observed flying within the zone of risk (ZOR; defined for eagles as within 800 m of the observer and below 200 m [656 ft] above ground level) during the survey period.

4.3 Flight Height

Flight height data were used to identify the bird species and estimated bird use within an estimated rotor-swept height (RSH) ranging from 25-150 m (82-492 ft) above ground level. The group's (defined as a single bird or a flock of two or more individuals) flight height when first observed was used to calculate the percentage of the different groups flying at different height categories: below the RSH at zero to 25 m, within the RSH at 25-150 m, and above the RSH at 150 m.

4.4 Spatial Use

Spatial use was evaluated by comparing large bird use among plots. In addition, eagle and diurnal raptor flight paths were mapped to qualitatively show flight locations and flight direction within the survey plots. Aerial imagery was used to aid in recording flight path observations accurately.

5 RESULTS

5.1 Fixed-Point Bird Use Surveys

A total of 163 large bird surveys and 163 small bird surveys were completed at the Study Area over the course of 12 visits conducted from January 29 – December 17, 2018 (Tables 2a and 2b). This included approximately 54 hours of survey time for all large birds, 163 hours of survey time for eagles, and 27 hours of survey time for small birds. 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 20-min survey period for large birds and a 100-m plot and 10-min survey period for small birds. Results pertaining to eagles, recorded during the full 60-min survey period (i.e., eagle minutes), are presented separately in Section 5.1.4.

5.1.1 Species Composition, Relative Abundance, and Diversity

During fixed-point bird use surveys, a total of 673 large bird observations in 205 groups and 935 small birds in 358 groups were documented during fixed-point bird use surveys (Appendices A1 and A2). The most commonly recorded large bird type was doves/pigeons (235 observations), which composed 34.9% of overall large bird observations (Appendix A1). The majority of dove/pigeon observations were rock pigeon (*Columba livia*; 197 observations in 38 groups). The second most-abundant large bird type was large corvids with 210 observations in 50 groups, comprising solely American crow (*Corvus brachyrhynchos*). Other large bird types observed during surveys included waterfowl (108 observations), diurnal raptors (43 observations), shorebirds (33 observations), upland game birds (18 observations), vultures (12 observations), waterbirds (seven observations), gulls/terns (six observations), and owls (one observation). Small bird observations were dominated by passerine species (Appendix A2). The most commonly observed passerine was the horned lark (*Eremophila alpestris*) with a total of 271 observations in 33 groups. The majority of horned lark observations occurred during spring (141 observations in 14 groups).

Eight diurnal raptor species were identified during large bird surveys: red-tailed hawk (*Buteo jamaicensis*; 17 observations), Swainson's hawk (*Buteo swainsoni*; 10 observations), Cooper's hawk (*Accipiter cooperii*; three observations), northern harrier (*Circus hudsonius*; four observations), bald eagle (two observations), sharp-shinned hawk (*Accipiter striatus*; one observation), broad-winged hawk (*Buteo platypterus*; one observation), and American kestrel (*Falco sparverius*; one observation; Appendix A1). Additionally, one unidentified accipiter (*Accipiter* spp.), two unidentified buteos (*Buteo* spp.), and one unidentified raptor were recorded during surveys (Appendix A1). Diurnal raptor observations were most common during fall (21 observations), followed by spring (15), and summer (seven). No diurnal raptors were observed during winter. The two bald eagle observations that were documented during the 20-min large bird surveys were recorded during fall; additional information on eagle observations is presented in Section 5.1.4.

Most small birds recorded were passerines (927 observations in 352 groups), with grassland/sparrows composing a majority (49.6%) of passerine observations (Appendix A2). Other small bird types recorded during surveys included woodpeckers (three observations), swifts/hummingbirds (one observation), and four unidentified small birds.

In total, 30 large bird species and 47 small bird species were identified during fixed-point bird use surveys (Tables 2a and 2b). Large bird species richness was highest during summer (1.40 species/800-m plot/20-min survey), followed by spring (1.33), fall (1.10), and winter (0.47; Table 2a). Small bird species richness was highest during summer (3.78 species/100-m plot/10-min survey), followed by spring (2.11), fall (0.94), and winter (0.30; Table 2b).

Table 2a. Summary of large bird species richness (species/800-meter plot/20-minute survey), and sample size by season and overall recorded during fixed-point bird use surveys at the Walleye Wind Energy Project Study Area from January 29 – December 17, 2018.

Season	Visits	# Surveys Conducted	# Species	Large Bird Species Richness
Winter	3	41	4	0.47
Spring	3	36	20	1.33
Summer	3	35	14	1.40
Fall	3	51	16	1.10
Overall	**12**	**163**	**30**	**1.08**

Table 2b. Summary of small bird species richness (species/100-meter plot/10-minute survey), and sample size by season and overall recorded during fixed-point bird use surveys at the Walleye Wind Energy Project Study Area from January 29 – December 17, 2018.

Season	Visits	# Surveys Conducted	# Species	Small Bird Species Richness
Winter	3	41	3	0.30
Spring	3	36	26	2.11
Summer	3	35	34	3.78
Fall	3	51	18	0.94
Overall	**12**	**163**	**47**	**1.79**

5.1.2 Bird Seasonal Use, Percent of Use, and Frequency of Occurrence

Large bird use (observations/800-m plot/20-min survey) was highest during fall (6.26), followed by spring (5.42), winter (2.77), and summer (2.40; Table 3). Higher use in fall was largely attributed to use by doves/pigeons (2.64 observations/800-m plot/20-min survey in fall) and large corvids (2.25). Rock pigeon accounted for the majority of dove/pigeon use during fall (2.56 observations/800-m plot/20-min survey; Appendix B1). Small bird use was highest during summer (7.37 observations/100-m plot/10-min survey), followed by spring (6.94), fall (5.66), and winter (2.07; Table 3). Small bird use in all seasons was primarily influenced by passerines (Table 3, Appendix B2).

5.1.2.1 Waterbirds

Waterbird use was highest during spring (0.17 observations/800-m plot/20-min survey), followed by fall (0.02); waterbird use was not documented during summer or winter (Table 3; Appendix B1). Waterbird use accounted for 3.1% of large bird use in spring and 0.3% in fall. Great blue heron (*Ardea herodias*) accounted for all waterbird use during fall, and American white pelican (*Pelecanus erythrorhynchos*) accounted for all waterbird use during spring (Appendix B1). Waterbird use was documented more frequently during spring (2.8% of surveys) than fall (2.0% of surveys; Table 3).

5.1.2.2 Waterfowl

Waterfowl use was highest during spring (2.58 observations/800-m plot/20-min survey), followed by fall (0.33), and summer (0.09; Table 3; Appendix B1). Waterfowl use was not documented during winter (Table 3). Among large bird types, waterfowl accounted for the most large bird use in spring (47.7%; Table 3). Snow goose (*Chen caerulescens*) use accounted for the majority (45.1%) of large bird use in spring (Appendix B1). Waterfowl accounted for 5.3% of large bird use during fall and 3.8% during summer. Waterfowl were observed more frequently during spring (11.1% of surveys), followed by fall (5.6%), and summer (3.0%).

5.1.2.3 Shorebirds

Shorebird use in the Study Area was highest in fall (0.61 observation/800-m plot/20-min survey), followed by summer (0.17), and spring (0.14); shorebird use was not documented during winter (Table 3). Shorebird use composed 9.8% of large bird use in fall, 7.2% in summer, and 2.6% in spring. Shorebird use was documented during 14.4% of summer surveys, 11.1% of spring surveys, and 5.6% of fall surveys. Killdeer (*Charadrius vociferus*) use was the most commonly documented among shorebirds during summer and spring; unidentified shorebird use and killdeer use were the most commonly documented during fall (Appendix B1).

5.1.2.4 Gulls/Terns

Use of the Study Area by gulls/terns was only documented in spring (0.17 observation/800-m plot/20-min survey); gulls/tern use was not observed during summer, fall, and winter (Table 3, Appendix B1). Gull/tern use accounted for 3.1% of large bird use in spring, and use was documented during 8.3% of spring surveys. Ring-billed gull (*Larus delawarensis*) use and Franklin's gull (*Leucophaeus pipixcan*) use were the only two gull species documented (Appendix B1).

5.1.2.5 Diurnal Raptors

Use of the Study Area by diurnal raptors was highest during spring (0.42 observation/800-m plot/20-min survey), followed by fall (0.34), and summer (0.20); diurnal raptor use was not documented during winter (Table 3). Diurnal raptor use composed 8.4% of large bird use in summer, 7.7% in spring, and 5.5% in fall. Diurnal raptor use was documented most frequently during fall (26.2% of surveys), followed by spring (25.0%), and summer (20.2%).

Use of the Study Area by accipiters was documented during spring (0.06 observation/80-m plot/20-min survey), summer (0.03), and fall (0.03; Table 3). Accipiter use composed 1.2% of large bird use during summer, 1.0% during spring, and 0.6% during fall.

Use of the Study Area by buteos was highest in spring (0.33 observation/80-m plot/20-min survey), followed by fall (0.21), and summer (0.17; Table 3). Red-tailed hawk composed the majority of buteo use in spring and fall; Swainson's hawk use composed the majority of buteo use in summer (Appendix B1). Buteo use composed between 3.3% and 7.3% of large bird use among seasons when buteo use was documented (Table 3). Buteo use was observed during 22.2% of spring surveys, 17.8% of fall surveys, and 17.4% of summer surveys.

Use of the Study Area by northern harriers was only documented during fall (0.07 observation/800-m plot/20-min survey; Table 3). Northern harrier use composed 1.1% of overall large bird use during fall, and use was documented during 7.0% of fall surveys.

The only eagle species recorded during surveys was bald eagle (Appendix B1). During the 20-min large bird surveys, use of the Study Area by bald eagles was only documented during fall (0.02 observation/800-m plot/20-min survey). Bald eagle use composed 0.2% of overall large bird use during fall, and use was documented during 1.5% of fall surveys (Table 3).

Use of the Study Area by falcons was relatively low during spring (0.03 observation/800-m plot/20-min survey); falcon use was not documented during any other season (Table 3). Falcon use composed 0.5% of overall large bird use during spring, and use was documented during 2.8% of spring surveys.

Use of the Study Area by other raptors (i.e., unidentified raptors) was relatively low during fall (0.02 observation/800-m plot/20-min survey); other raptor use was not documented during other seasons (Table 3). Overall large bird use was composed of 0.2% use by other raptors during fall, and other raptor use was documented during 1.5% of fall surveys.

5.1.2.6 Owls

Owl use, consisting solely of short-eared owl (*Asio flammeus*) use, was only documented during spring (0.03 observation/800-m plot/20-min survey; Table 3, Appendix B1). Owl use composed 0.5% of overall large bird use during spring, and use was documented during 2.8% of spring surveys (Table 3).

5.1.2.7 Vultures

Vulture use (i.e., turkey vultures [*Cathartes aura*]) was highest in spring (0.25 observation/800-m plot/20-min survey), followed by summer (0.09); vulture use was not recorded during fall or winter (Table 3, Appendix B1). Vulture use accounted for 4.6% of large bird use in spring and 3.6% in summer. Vulture use was observed during 13.9% of spring surveys and 8.6% of summer surveys (Table 3).

5.1.2.8 Upland Game Birds

Use of the Study Area by upland game birds was documented during every season, and was highest during summer (0.34 observation/800-m plot/20-min survey), followed by fall (0.06), spring (0.03), and winter (0.02; Table 3). Upland game bird use represented 14.1% of large bird use in summer, 1.0% in fall, 0.7% in winter, and 0.5% during spring. Upland game bird use was observed during 16.9% of summer surveys, 2.8% of spring surveys, 2.0% of winter surveys, and 1.5% of fall surveys. Ring-necked pheasant (*Phasianus colchicus*) use represented the majority of use by upland game birds in all seasons; unidentified gamebird use was also documented (Appendix B1).

5.1.2.9 Doves/Pigeons

Use of the Study Area by doves/pigeons was documented during every season, and use was highest during fall (2.64 observations/800-m plot/20-min survey), followed by winter (1.61), summer (1.13), and spring (0.31; Table 3). Dove/pigeon use represented 58.2% of large bird use in winter, 47.3% in summer, 42.2% in fall, and 5.6% in spring. Dove/pigeon use was observed during 48.2% of summer surveys, 36.1% of fall surveys, 21.7% of winter surveys, and 16.7% of spring surveys. Doves/pigeons included Eurasian collared-doves (*Streptopelia decaocto*), mourning doves (*Zenaida macroura*), and rock pigeons (Appendix B1).

5.1.2.10 Large Corvids

Use of the Study Area by large corvids (i.e., American crow) was highest in fall (2.25 observations/800-m plot/20-min survey), followed by spring (1.33), winter (1.14), and summer (0.37; Table 3, Appendix B1). Large corvid use accounted for 41.1% of large bird use in winter, 35.9% in fall, 24.6% in spring, and 15.6% in summer (Table 3). Large corvid use was documented during 30.6% of spring surveys, 26.1% of fall surveys, 23.4% of winter surveys, and 14.6% of summer surveys.

5.1.2.11 Passerines

Use of the Study Area by passerines was highest during summer (7.31 observations/100-m plot/10-min survey), followed by spring (6.92), fall (5.58), and winter (2.05; Table 3). Passerine use represented 99.6% of small bird use in spring, 99.2% in summer, 99.1% in winter, and 98.7% in fall. Passerine use was observed most frequently during summer (91.4% of surveys), followed by spring (61.1%), fall (59.7%), and winter (28.4%; Table 3).

5.1.2.12 Swifts/Hummingbirds

Use of the Study Area by swifts/hummingbirds (i.e., chimney swift [*Chaetura pelagica*]) was only documented during spring (0.03 observation/100-m plot/10-min survey; Table 3, Appendix B2). Swift/hummingbird use accounted for 0.4% of small bird use during spring, and use was documented during 2.8% of spring surveys (Table 3).

5.1.2.13 Woodpeckers

Use of the Study Area by woodpeckers was highest in summer (0.03 observation/100-m plot/10-min survey), followed by fall and winter (0.02; Table 3). No woodpecker use was observed during spring. Woodpecker use composed 0.9% of small bird use in winter, 0.4% in summer, and 0.3% in fall. Woodpecker use was observed most frequently during summer (2.8% of surveys), followed by winter (2.0%), and fall (1.5%; Table 3).

Table 3. Mean bird use (number of birds/plot[a]/survey[b]), percent of total use (%), and frequency of occurrence (%) for each bird type and diurnal raptor subtype by season recorded during fixed-point bird use surveys at the Walleye Wind Energy Project Study Area from January 29 – December 17, 2018.

	Mean Use				% of Use				% Frequency			
Type/Subtype	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**
Waterbirds	0	0.17	0	0.02	0	3.1	0	0.3	0	2.8	0	2.0
Waterfowl	0	2.58	0.09	0.33	0	47.7	3.8	5.3	0	11.1	3.0	5.6
Shorebirds	0	0.14	0.17	0.61	0	2.6	7.2	9.8	0	11.1	14.4	5.6
Gulls/Terns	0	0.17	0	0	0	3.1	0	0	0	8.3	0	0
Diurnal Raptors	0	0.42	0.20	0.34	0	7.7	8.4	5.5	0	25.0	20.2	26.2
Accipiters	*0*	*0.06*	*0.03*	*0.03*	*0*	*1.0*	*1.2*	*0.6*	*0*	*5.6*	*2.8*	*3.5*
Buteos	*0*	*0.33*	*0.17*	*0.21*	*0*	*6.2*	*7.3*	*3.3*	*0*	*22.2*	*17.4*	*17.8*
Northern Harrier	*0*	*0*	*0*	*0.07*	*0*	*0*	*0*	*1.1*	*0*	*0*	*0*	*7.0*
Eagles	*0*	*0*	*0*	*0.02*	*0*	*0*	*0*	*0.2*	*0*	*0*	*0*	*1.5*
Falcons	*0*	*0.03*	*0*	*0*	*0*	*0.5*	*0*	*0*	*0*	*2.8*	*0*	*0*
Other Raptors	*0*	*0*	*0*	*0.02*	*0*	*0*	*0*	*0.2*	*0*	*0*	*0*	*1.5*
Owls	0	0.03	0	0	0	0.5	0	0	0	2.8	0	0
Vultures	0	0.25	0.09	0	0	4.6	3.6	0	0	13.9	8.6	0
Upland Game Birds	0.02	0.03	0.34	0.06	0.7	0.5	14.1	1.0	2.0	2.8	16.9	1.5
Doves/Pigeons	1.61	0.31	1.13	2.64	58.2	5.6	47.3	42.2	21.7	16.7	48.2	36.1
Large Corvids	1.14	1.33	0.37	2.25	41.1	24.6	15.6	35.9	23.4	30.6	14.6	26.1
Large Birds Overall[c]	**2.77**	**5.42**	**2.40**	**6.26**	**100**	**100**	**100**	**100**				
Passerines	2.05	6.92	7.31	5.58	99.1	99.6	99.2	98.7	28.4	61.1	91.4	59.7
Swifts/Hummingbirds	0	0.03	0	0	0	0.4	0	0	0	2.8	0	0
Woodpeckers	0.02	0	0.03	0.02	0.9	0	0.4	0.3	2.0	0	2.8	1.5
Unidentified Birds	0	0	0.03	0.06	0	0	0.4	1.0	0	0	2.8	2.0
Small Birds Overall[c]	**2.07**	**6.94**	**7.37**	**5.66**	**100**	**100**	**100**	**100**				

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

[b] per 20-minute (min) survey for large birds; 10-min survey for small birds

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

5.1.3 Flight Height Characteristics

During 20-min large bird surveys, 155 groups (558 observations) were recorded flying within the 800-m radius survey plots (Table 4, Appendices C1 and C2). Of these, 13.3% were recorded flying at heights within the estimated RSH, based upon initial observation. Large bird types that were most often recorded in the RSH were waterbirds (85.7%) and gulls/terns (66.7%). Half (50.0%) of vulture observations were recorded flying within the RSH, while 41.7% were recorded below the RSH and 8.3% were recorded above the RSH. The majority (61.8%) of flying diurnal raptors were documented below the RSH. Among the diurnal raptor subtypes, eagles and falcons were most often recorded within the RSH (100%; one observation within each subtype). Waterfowl was the only bird type flying above the RSH for the majority of observations (81.5%).

During small bird surveys, 203 groups (601 observations) were recorded flying within the survey plots (Table 4). Of these, 16.8% were observed flying at heights within the estimated RSH; the remaining 83.2% were recorded flying below the RSH.

Table 4. Flight height characteristics by bird type[a] and diurnal raptor subtype recorded during fixed-point bird use surveys[b] at the Walleye Wind Energy Project Study Area from January 29 – December 17, 2018.

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	2	7	25.00	100	14.3	85.7	0
Waterfowl	7	108	87.71	100	14.8	3.7	81.5
Shorebirds	9	29	3.56	87.9	100	0	0
Gulls/Terns	3	6	47.00	100	33.3	66.7	0
Diurnal Raptors	33	34	44.52	81.0	61.8	32.4	5.9
Accipiters	*4*	*4*	*8.50*	*80.0*	*100*	*0*	*0*
Buteos	*23*	*24*	*52.09*	*80.0*	*54.2*	*37.5*	*8.3*
Northern Harrier	*3*	*3*	*12.00*	*75.0*	*100*	*0*	*0*
Eagles	*1*	*1*	*50.00*	*100*	*0*	*100*	*0*
Falcons	*1*	*1*	*150.00*	*100*	*0*	*100*	*0*
Other Raptors	*1*	*1*	*1.00*	*100*	*100*	*0*	*0*
Owls	1	1	1.00	100	100	0	0
Vultures	10	12	59.30	100	41.7	50.0	8.3
Upland Game Birds	3	6	1.00	33.3	100	0	0
Doves/Pigeons	53	193	11.98	82.1	92.2	7.8	0
Large Corvids	34	162	12.91	77.1	82.7	17.3	0
Large Birds Overall	**155**	**558**	**25.66**	**83.0**	**70.4**	**13.3**	**16.3**
Passerines	199	595	14.99	64.2	83.2	16.8	0
Swifts/Hummingbirds	1	1	80.00	100	0	100	0
Woodpeckers	1	1	1.00	33.3	100	0	0
Unidentified Birds	2	4	6.00	100	100	0	0
Small Birds Overall	**203**	**601**	**15.16**	**64.3**	**83.2**	**16.8**	**0**

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

[b] per 20-minute (min) survey for large birds; per 10-min survey for small birds

[c.] The likely “rotor swept height” for potential collision with a turbine blade, or 25–150 m (82–492 feet) above ground level

Obs = observations

5.1.4 Spatial Use

Overall, large bird use (observations/800-m plot/20-min survey) was highest at Point 18 (14.00) and Point 9 (12.20), primarily due to high dove/pigeon use at Point 18 (13.00) and high large corvid use at Point 9 (6.30; Figure 4a, Appendix D1). Large bird use was not recorded at points 13 and 16; use ranged from 0.50-10.67 observation/800-m plot/20-min survey at the remaining survey points.

Waterbird use was only documented at Point 9 (0.60 observation/800-m plot/20-min survey) and Point 15 (0.33); waterfowl use was documented at six points, and ranged from 0.09 observation/800-m plot/20-min survey at Point 2 to 5.00 at Point 7 (Appendix D1). Shorebird use was documented at seven points; use was greatest at Point 5 (1.67 observations/800-m plot/20-min survey). Gull/tern use was only documented at points 4, 6, and 2 (0.33, 0.10, and 0.09 observation/800-m plot/20-min survey, respectively).

Diurnal raptor use was observed at 16 survey points (Figure 4b, Appendix D1). Use was greatest at Point 21 (1.00 observation/800-m plot/20-min survey), and ranged from 0.09-0.67 at the remaining points where use was documented. Accipiter use was documented at five survey points, and ranged from 0.08 observation/800-m plot/20-min survey at points 5 and 3 to 0.10 at points 6 and 7. Buteo use was documented at the most survey points among diurnal raptors (13 survey points); buteo use ranged from 0.10 observation/800-m plot/20-min survey at Point 6 to 1.00 at Point 21. Northern harrier use was documented at three survey points, and ranged from 0.10 observation/800-m plot/20-min survey at Point 11 to 0.67 at Point 17. During the 20-min large bird surveys, eagle use was only documented at Point 11, which is outside of the current Project Area (0.10 observation/800-m plot/20-min survey; Figure 4c). Similar to eagle use, falcon use was also only documented at Point 11 (0.10 observation/800-m plot/20-min survey).

Owl use was only documented at Point 2, and use was relatively low (0.09 observation/800-m plot/20-min survey; Appendix D1). Vulture use was observed at five survey points. Vulture use was greatest at Point 5 (0.33 observation/800-m plot/20-min survey), and ranged from 0.10-0.30 at the remaining four points where use was documented. Upland gamebird use was documented at eight surveys points, and ranged from 0.08 observation/800-m plot/20-min survey at Point 5 to 1.33 at Point 19. Dove/pigeon use was documented at 19 survey points. Dove/pigeon use was greatest at Point 18 (13.00 observations/800-m plot/20-min survey), and ranged from 0.08-6.67 at the remaining survey points where use was documented. Large corvid use was documented at 17 survey points. Large corvid use was greatest at Point 9 (6.30 observations/800-m plot/20-min survey) and ranged from 0.08-4.40 at the remaining points where large corvid use was documented.

Flight paths mapped during large bird surveys provide some indication of general spatial use within the Study Area. Diurnal raptor flight paths recorded during the 20-min large bird surveys were relatively concentrated in the southern portion of the Study Area (Appendix E1). During the 60-min eagle surveys, bald eagle activity was generally recorded in the southern portion of the Study Area; however, relatively few flight paths were documented (Appendix E2).

Passerine use was observed at 20 survey points; use ranged from 0.33-27.00 observations/100-m plot/10-min survey (Appendix D2). Passerine use was greatest at Point 21. Swift/hummingbird use was only documented at Point 1 (0.08 observation/100-m plot/10-min survey). Woodpecker use was only documented at Point 19 (0.33 observation/100-m plot/10-min survey), and points 3 and 4 (0.08 at each point).

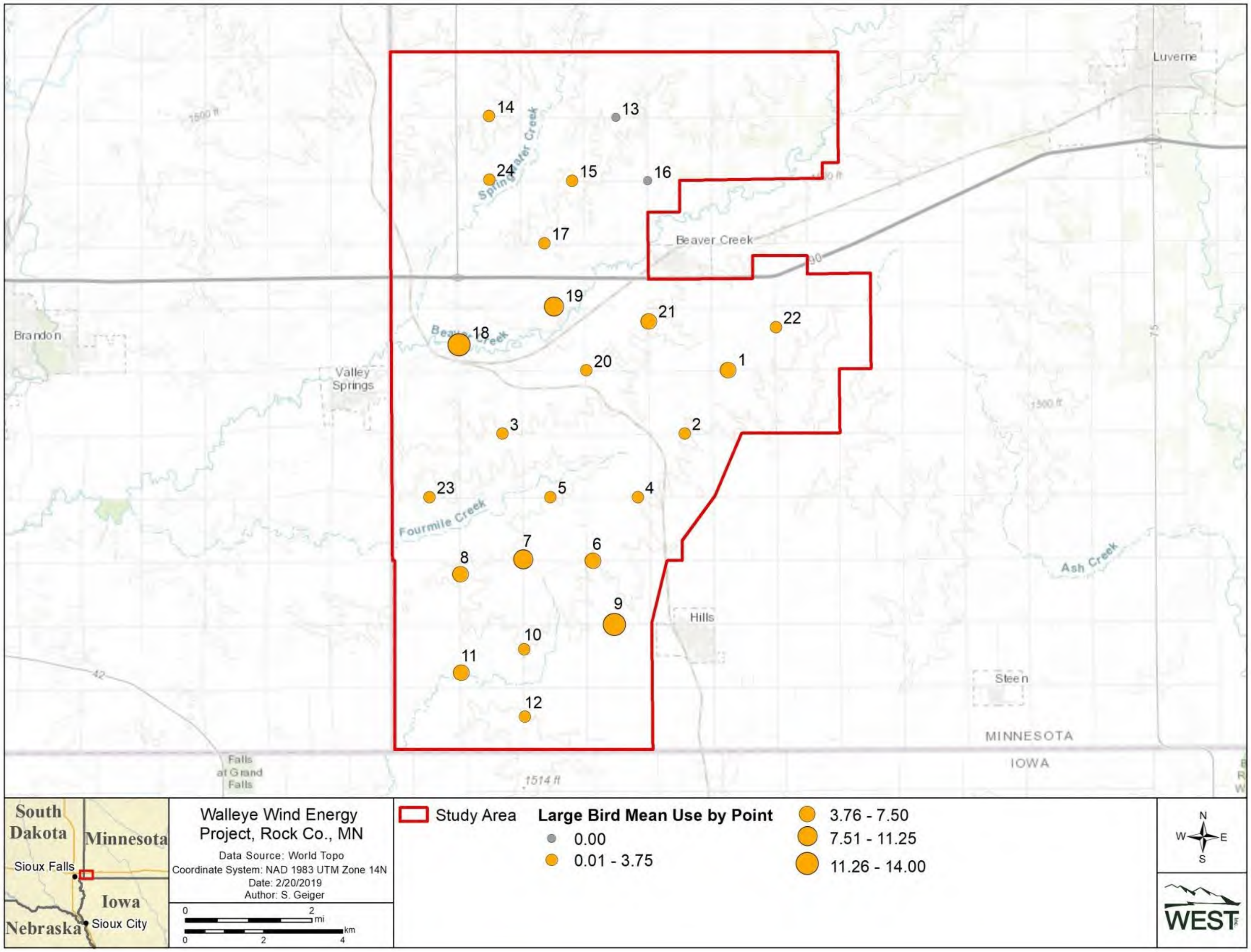

Figure 4a. Large bird use by observation point recorded during 20-minute large bird surveys at the Walleye Wind Energy Project Study Area from January 29 – December 17, 2018.

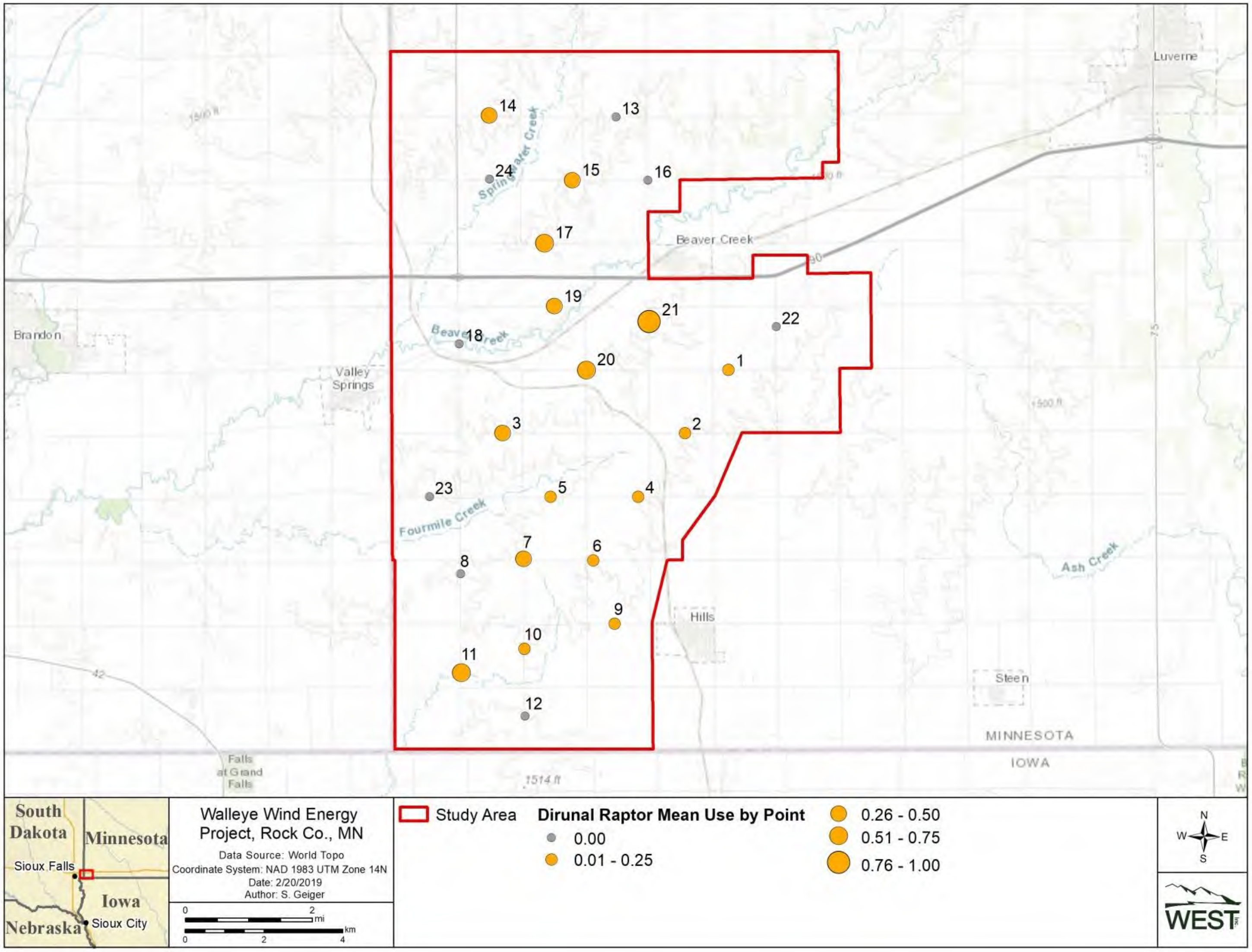

Figure 4b. Diurnal raptor use by observation point recorded during 20-minute large bird surveys at the Walleye Wind Energy Project Study Area from January 29 – December 17, 2018.

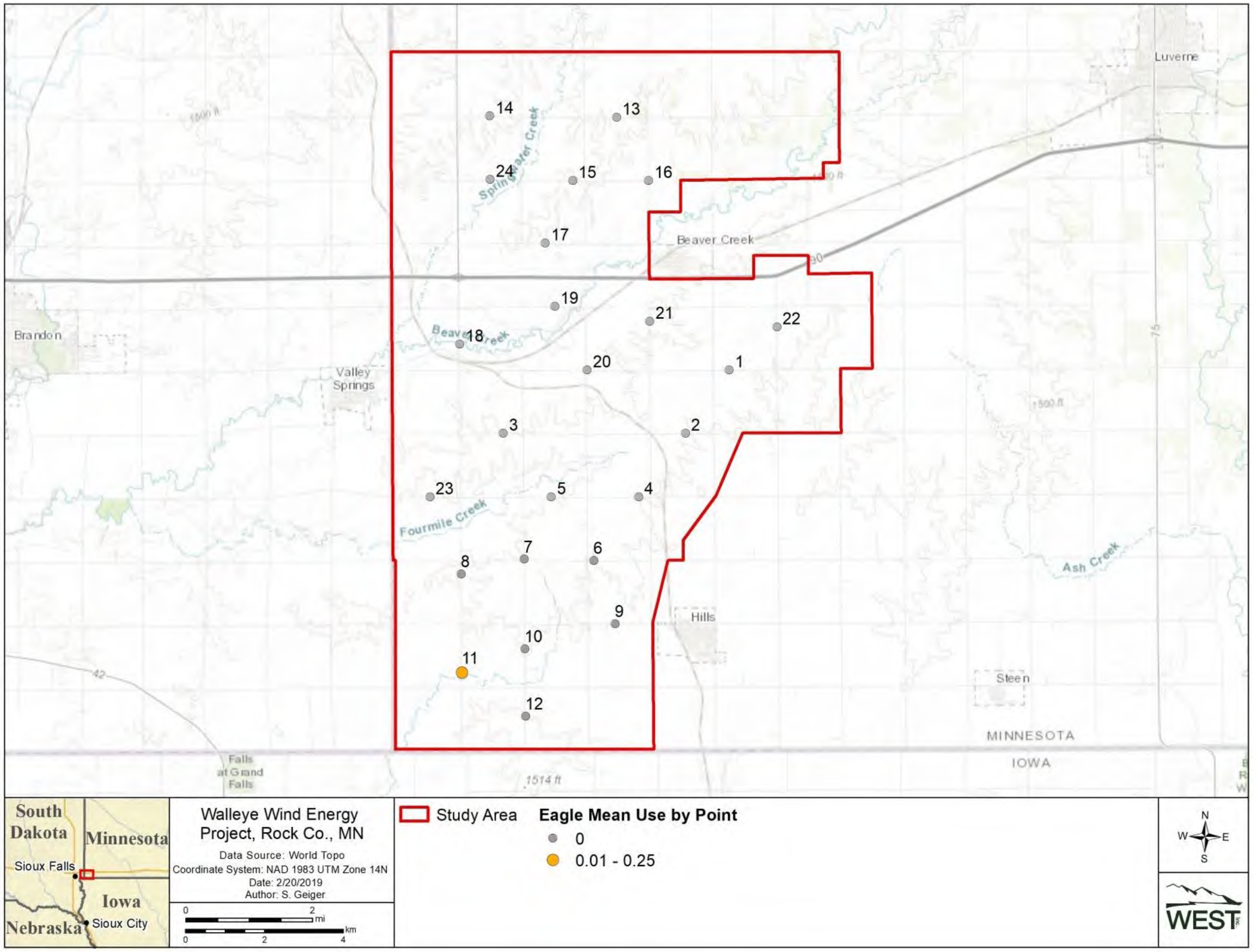

Figure 4c. Eagle use by observation point recorded during 20-minute large bird surveys at the Walleye Wind Energy Project Study Area from January 29 – December 17, 2018.

5.1.5 Eagle Minutes

Following the ECPG guidance for eagle use surveys, a total of 38 bald eagle minutes were documented during 163 hours of observation time, with the greatest number of total eagle minutes documented in October 2018 (25 eagle minutes; Tables 5 and 6). In total, six eagle minutes were documented in the ZOR; the majority of eagle minutes in the ZOR were recorded during October 2018 (four eagle minutes), followed by January and December 2018 (one eagle minute during each month; Table 5). Eagle minutes per minute of survey were greatest during fall (0.0013), followed by winter (0.0008; Table 6). No eagle minutes in the zone of risk were recorded during spring or summer. Most eagle minutes in the zone of risk were documented at Point 9 (three eagle minutes), followed by two points that are outside the current Project Area: Point 11 (two eagle minutes) and Point 19 (one eagle minute; Table 7).

Table 5. Bald eagle observations, total eagle minutes, and eagle minutes in the zone of risk by month recorded during 60-minute eagle surveys at the Walleye Wind Energy Project Study Area from January 29 – December 17, 2018.

Month/Year	Eagle Observations	Total Eagle Minutes	Eagle Minutes in Zone of Risk[a]
January 2018	2	3	1
February 2018	1	4	0
March 2018	0	0	0
April 2018	1	4	0
May 2018	0	0	0
June 2018	0	0	0
July 2018	0	0	0
August 2018	0	0	0
September 2018	0	0	0
October 2018	3	25	4
November 2018	0	0	0
December 2018	1	2	1
Total	**8**	**38**	**6**

[a] Bald eagles flying within 800 meters (m; 2,625 feet [ft]) of the observer and less than 200 m (656 ft) above ground level.

Table 6. Bald eagle minutes in the zone of risk and eagle minutes per minute of survey by season recorded during 60-minute eagle surveys at the Walleye Wind Energy Project Study Area from January 29 – December 17, 2018.

Season	Survey Hours	Survey Effort (Minutes)	Eagle Minutes in Zone of Risk[a]	Eagle Minutes per Minute of Survey
Winter[b] (1/29/18-2/28/18 & 12/1/18-12/17/18)	41	2,460	2	0.0008
Spring (3/1/18-5/31/18)	36	2,160	0	0
Summer (6/1/18-8/31/18)	35	2,100	0	0
Fall (9/1/18-11/30/18)	51	3,060	4	0.0013
Total	**163**	**9,780**	**6**	**0.0006**

[a] Bald eagles flying within 800 meters (m; 2,625 feet [ft]) of the observer and less than 200 m (656 ft) above ground level.

[b] Data combined for both seasons.

Table 7. Bald eagle minutes and eagle minutes in the zone of risk by point recorded during 60-minute eagle surveys at the Walleye Wind Energy Project Study Area from January 29 – December 17, 2018.

Survey Point	Total Eagle Minutes	Eagle Minutes in Zone of Risk[a]
1	4	0
2	0	0
3	0	0
4	0	0
5	4	0
6	0	0
7	0	0
8	0	0
9	24	3
10	0	0
11	4	2
12	0	0
13	0	0
14	0	0
15	0	0
16	0	0
17	0	0
18	0	0
19	2	1
20	0	0
21	0	0
22	0	0
23	0	0
24	0	0
Total	**38**	**6**

[a] Bald eagles flying within 800 meters (m; 2,625 feet [ft]) of the observer and less than 200 m (656 ft) above ground level.

5.2 Threatened, Endangered, and Sensitive Species Observations

No federally listed threatened or endangered species were observed during surveys or incidentally; however, sixteen sensitive species were observed (Table 8). Fifteen of these species were designated as Species of Greatest Conservation Need (SGCN; MNDNR 2015), while three of these species (American white pelican, Franklin's gull, and short-eared owl) were also designated as species of Special Concern (SPC; MNDNR 2015). The bald eagle, a species protected by the Bald and Golden Eagle Protection Act (BGEPA; 1940), was also documented (15 observations).

Table 8. Summary of sensitive species observed at the Walleye Wind Energy Project Study Area recorded during large bird (LB), eagle, and small bird (SB) surveys, or as incidental observations (Inc.) from January 29 – December 17, 2018.

			LB		Eagle[a]		SB		Inc.		Total	
Species	**Scientific Name**	**Status**	**# of grps**	**# of obs**	**# of grps**	**# of obs**	**# of grps**	**# of obs**	**# of grps**	**# of obs**	**# of grps**	**# of obs**
American kestrel	*Falco sparverius*	SGCN	2	2	0	0	0	0	5	6	7	8
American white pelican	*Pelecanus erythrorhynchos*	SGCN;SPC	1	6	0	0	0	0	0	0	1	6
bald eagle	*Haliaeetus leucocephalus*	BGEPA	0	0	8	8	0	0	6	7	14	15
bobolink	*Dolichonyx oryzivorus*	SGCN	0	0	0	0	7	10	0	0	7	10
brown thrasher	*Toxostoma rufum*	SGCN	0	0	0	0	1	1	0	0	1	1
chimney swift	*Chaetura pelagica*	SGCN	0	0	0	0	0	0	1	1	1	1
dickcissel	*Spiza americana*	SGCN	0	0	0	0	23	26	0	0	23	26
eastern meadowlark	*Sturnella magna*	SGCN	0	0	0	0	1	1	0	0	1	1
Franklin's gull	*Leucophaeus pipixcan*	SGCN;SPC	1	4	0	0	0	0	0	0	1	4
northern harrier	*Circus hudsonius*	SGCN	4	4	0	0	0	0	10	10	14	14
red-headed woodpecker	*Melanerpes erythrocephalus*	SGCN	0	0	0	0	1	1	0	0	1	1
sedge wren	*Cistothorus platensis*	SGCN	0	0	0	0	1	1	0	0	1	1
short-eared owl	*Asio flammeus*	SGCN;SPC	1	1	0	0	0	0	0	0	1	1
Swainson's hawk	*Buteo swainsoni*	SGCN	9	10	0	0	0	0	2	2	11	12
upland sandpiper	*Bartramia longicauda*	SGCN	3	3	0	0	0	0	0	0	3	3
western meadowlark	*Sturnella neglecta*	SGCN	0	0	0	0	13	21	0	0	13	21
Total	**16 species**		**21**	**30**	**8**	**8**	**47**	**61**	**24**	**26**	**100**	**125**

[a] The large-bird surveys were conducted during the first 20-minutes (min) of the 60-min eagle surveys; therefore, the count of eagle groups and observations documented during the 20-min large bird survey were included in the 60-min eagle survey columns.

SPC = Species of Special Concern, as designated in the Minnesota Wildlife Action Plan (2015)

SGCN = Species of Greatest Conservation Need, as designated in the Minnesota Wildlife Action Plan (2015)

BGEPA – Bald and Golden Eagle Protection Act (1940)

grps=groups, obs=observations

5.3 Incidental Observations

Six bird species were incidentally observed outside of the standardized fixed-point use surveys, totaling 61 observations within 58 separate groups (Table 9). These included seven observations of bald eagles in six groups.

Table 9. Wildlife species incidentally observed outside of the standardized fixed-point bird use surveys at the Walleye Wind Energy Project Study Area from January 29 – December 17, 2018.

Species	Scientific Name	# of groups	# of observations
American kestrel	*Falco sparverius*	5	6
bald eagle	*Haliaeetus leucocephalus*	6	7
northern harrier	*Circus hudsonius*	10	10
red-tailed hawk	*Buteo jamaicensis*	34	35
sharp-shinned hawk	*Accipiter striatus*	1	1
Swainson's hawk	*Buteo swainsoni*	2	2
Total	**6 species**	**58**	**61**

6 DISCUSSION

Studies of avian use at the Project provide a baseline of spatial and temporal bird use that can be compared to bird use at other proposed regional wind energy facilities with similarly collected data. Additionally, baseline avian use data provided by this study can be compared with future fatality monitoring studies conducted at the Project. In doing so, this study will help to better predict potential impacts of future wind energy development in Minnesota and the larger Midwest region.

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

6.1 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.

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 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 or decommissioning is most likely the potential destruction of nests of ground- and shrub-nesting species during initial site clearing, although this risk can be minimized through best management practices that include use of existing roads or previously developed land during the construction phase.

Mortality or injury due to collisions with turbines or guy wires of meteorological towers is the most probable direct impact to birds from wind energy facilities. Collisions may occur with resident birds foraging and flying within the Project Area, or with migrant birds seasonally moving through the area. Post-construction fatality monitoring reports from wind energy facilities in the Midwest show varying levels of bird mortality across the region, ranging from a low of 0.26 fatalities/megawatt (MW)/year at the Prince Wind Farm in Ontario, Canada (Natural Resource Solutions, Inc. 2008a), to a high of 8.25 fatalities/MW/year at the Wessington Springs facility in South Dakota (Derby et al. 2010a; Figure 5, Appendix F1). The highest publicly available estimated fatality rate among wind energy facilities in Minnesota was at the Buffalo Ridge facility with 5.93 fatalities/MW/year in 1999 (Johnson et al. 2000; Figure 5, Appendix F1). Fatality rates at the Walleye Wind Energy Project are likely to fall within the range of those reported at other facilities within the Midwest region and may be similar to rates reported at facilities in Minnesota (i.e., 0.37 to 5.93 fatalities/MW/year; Figure 5, Appendix F1).

In addition to direct effects through collision mortality, wind energy development can indirectly affect 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 less than 5% of the entire development area (US Department of the Interior 2005). Estimates of temporary construction impacts range from 0.2 to 1.0 ha (0.5 to 2.5 ac) per turbine (Strickland and Johnson 2006, Denholm et al. 2009). The Study Area is predominantly disturbed agricultural lands and developed areas. Therefore, the potential for indirect impacts through wildlife habitat fragmentation is anticipated to be relatively low.

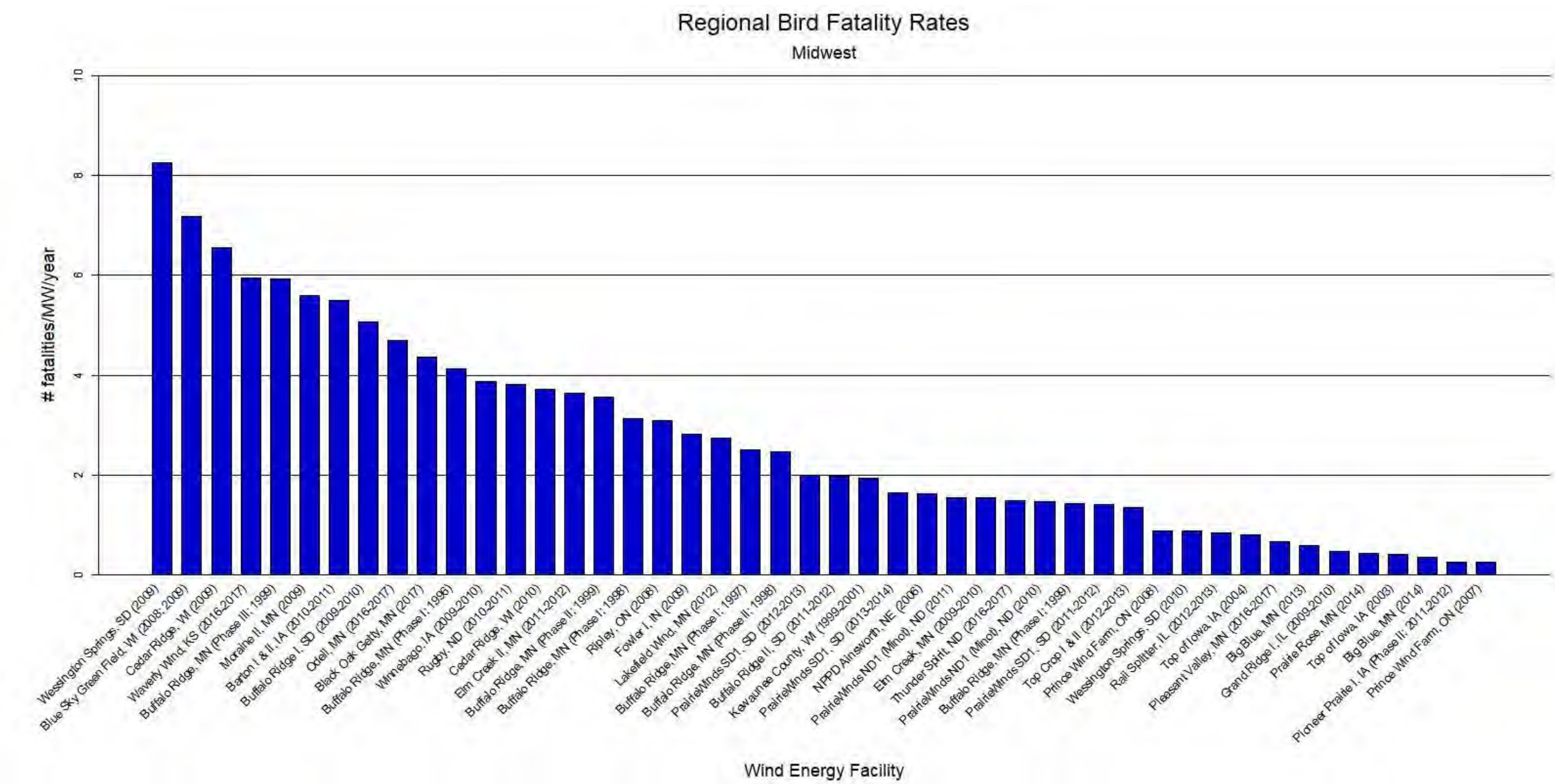

Figure 5. Fatality rates for all birds (number of birds per megawatt per year) reported in publicly available studies at wind energy facilities in the Midwest region of North America (Appendix F1).

Figure 5 (*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 (Appendix F1).

Data from the following sources:

Wind Energy Facility	Reference	Wind Energy Facility	Reference
Wessington Springs, SD (09)	Derby et al. 2010a	Buffalo Ridge II, SD (11-12)	Derby et al. 2012a
Blue Sky Green Field, WI (08; 09)	Gruver et al. 2009	Kewaunee County, WI (99-01)	Howe et al. 2002
Cedar Ridge, WI (09)	BHE Environmental 2010	PrairieWinds SD1, SD (13-14)	Derby et al. 2014
Waverly Wind, KS (16-17)	Tetra Tech 2017a	NPPD Ainsworth, NE (06)	Derby et al. 2007
Buffalo Ridge, MN (Phase III; 99)	Johnson et al. 2000	PrairieWinds ND1 (Minot), ND (11)	Derby et al. 2012b
Moraine II, MN (09)	Derby et al. 2010b	Elm Creek, MN (09-10)	Derby et al. 2010c
Barton I & II, IA (10-11)	Derby et al. 2011a	Thunder Spirit, ND (16-17)	Derby et al. 2018
Buffalo Ridge I, SD (09-10)	Derby et al. 2010d	PrairieWinds ND1 (Minot), ND (10)	Derby et al. 2011b
Odell, MN (16-17)	Chodachek and Gustafson 2018	Buffalo Ridge, MN (Phase I; 99)	Johnson et al. 2000
Black Oak Getty, MN (17)	Pickle et al. 2018	PrairieWinds SD1, SD (11-12)	Derby et al. 2012c
Buffalo Ridge, MN (Phase I; 96)	Johnson et al. 2000	Top Crop I & II (12-13)	Good et al. 2013a
Winnebago, IA (09-10)	Derby et al. 2010e	Prince Wind Farm, ON (06)	Natural Resource Solutions, Inc. 2008b
Rugby, ND (10-11)	Derby et al. 2011c	Wessington Springs, SD (10)	Derby et al. 2011d
Cedar Ridge, WI (10)	BHE Environmental 2011	Rail Splitter, IL (12-13)	Good et al. 2013b
Elm Creek II, MN (11-12)	Derby et al. 2012d	Top of Iowa, IA (04)	Jain 2005
Buffalo Ridge, MN (Phase II; 99)	Johnson et al. 2000	Pleasant Valley, MN (16-17)	Tetra Tech 2017b
Buffalo Ridge, MN (Phase I; 98)	Johnson et al. 2000	Big Blue, MN (13)	Fagen Engineering 2014
Ripley, ON (08)	Jacques Whitford 2009	Grand Ridge I, IL (09-10)	Derby et al. 2010f
Fowler I, IN (09)	Johnson et al. 2010a	Prairie Rose, MN (14)	Chodachek et al. 2015
Lakefield Wind, MN (12)	Minnesota Public Utilities Commission 2012	Top of Iowa, IA (03)	Jain 2005
Buffalo Ridge, MN (Phase I; 97)	Johnson et al. 2000	Big Blue, MN (14)	Fagen Engineering 2015
Buffalo Ridge, MN (Phase II; 98)	Johnson et al. 2000	Pioneer Prairie I, IA (Phase II; 11-12)	Chodachek et al. 2012
PrairieWinds SD1, SD (12-13)	Derby et al. 2013	Prince Wind Farm, ON (07)	Natural Resource Solutions, Inc. 2009

6.2 Bird Types of Concern

Two bird types are of concern in the region and were observed with some regularity during the study: waterfowl and diurnal raptors. Both bird types are discussed in more detail below.

6.2.1 Waterfowl

Waterfowl accounted for the greatest proportion of large bird use in spring; however, over 80% of flying waterfowl were observed above the RSH during the 20-min large bird surveys, and Canada goose (*Branta canadensis*) was the only waterfowl species among the 12 bird species documented flying within the RSH. Although seasonal risk to waterfowl may vary between years, risk is generally expected to be highest in spring and fall during migration due to the Project's location between the Mississippi and Central flyways.

Historically, waterfowl do not seem especially vulnerable to turbine collisions. In an analysis of 116 studies of bird mortality at over 70 facilities, waterfowl made up 2.7% of 4,975 fatalities found (Erickson et al. 2014). In a database of 60 publicly available wind energy facility studies in the Midwest region of North America, waterfowl made up 9.5% of 1,284 fatalities found (see Appendix G for a list of facilities and references).

6.2.2 Diurnal Raptors

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. However, this index does not 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. During this study, the diurnal raptor species with the highest exposure index was red-tailed hawk (0.04), followed by Swainson's hawk (<0.01).

Fatality Studies

Diurnal raptor fatality rates (fatalities/MW/year) at wind energy facilities in the Midwest with publicly available data have ranged from zero to 0.47 fatalities/MW/year, with a mean of 0.07 fatalities/MW/year (Figure 6, Appendix F2). Among facilities in Minnesota, the highest diurnal raptor fatality rate was recorded at the Buffalo Ridge facility in 1999 (0.47 fatalities/MW/year); however, 11 other facilities in Minnesota have reported a raptor fatality rate of zero (Appendix F2). Diurnal raptor fatality rates at the Project are likely to fall within the range of those reported at other facilities in the Midwest.

Across the Midwest, a total of 103 diurnal raptors representing nine identified species are documented as wind turbine fatalities in 40 studies of modern wind energy facilities with publicly available fatality data (Table 10; see Appendix F2 for a list of facilities and references), although not all facilities found diurnal raptor fatalities. Buteos were found most often as fatalities (79 fatalities; 76.7% of raptor fatalities), followed by falcons (12; 11.7%), accipiters (nine; 8.7%), and harriers (one; 1.0%). About 86% of all buteo fatalities were red-tailed hawk (68 fatalities), about 83% of falcon fatalities were American kestrel (10 fatalities), about 67% of accipiter fatalities were sharp-shinned hawk (six fatalities), and northern harrier represented the only harrier fatality. Combined, these four species accounted for about 83% of all diurnal raptor fatalities documented in the Midwest. Each remaining species individually accounted for four or fewer fatalities and less than 5% of the total fatalities (Table 10). During the study, red-tailed hawks composed approximately 40% of all diurnal raptor observations recorded during 20-min large bird surveys (Appendix A1). These observations, along with the relatively high number of red-tailed hawk fatalities at Midwestern facilities, suggest that red-tailed hawk may comprise the majority of raptor fatalities at the Project, should raptor fatalities occur.

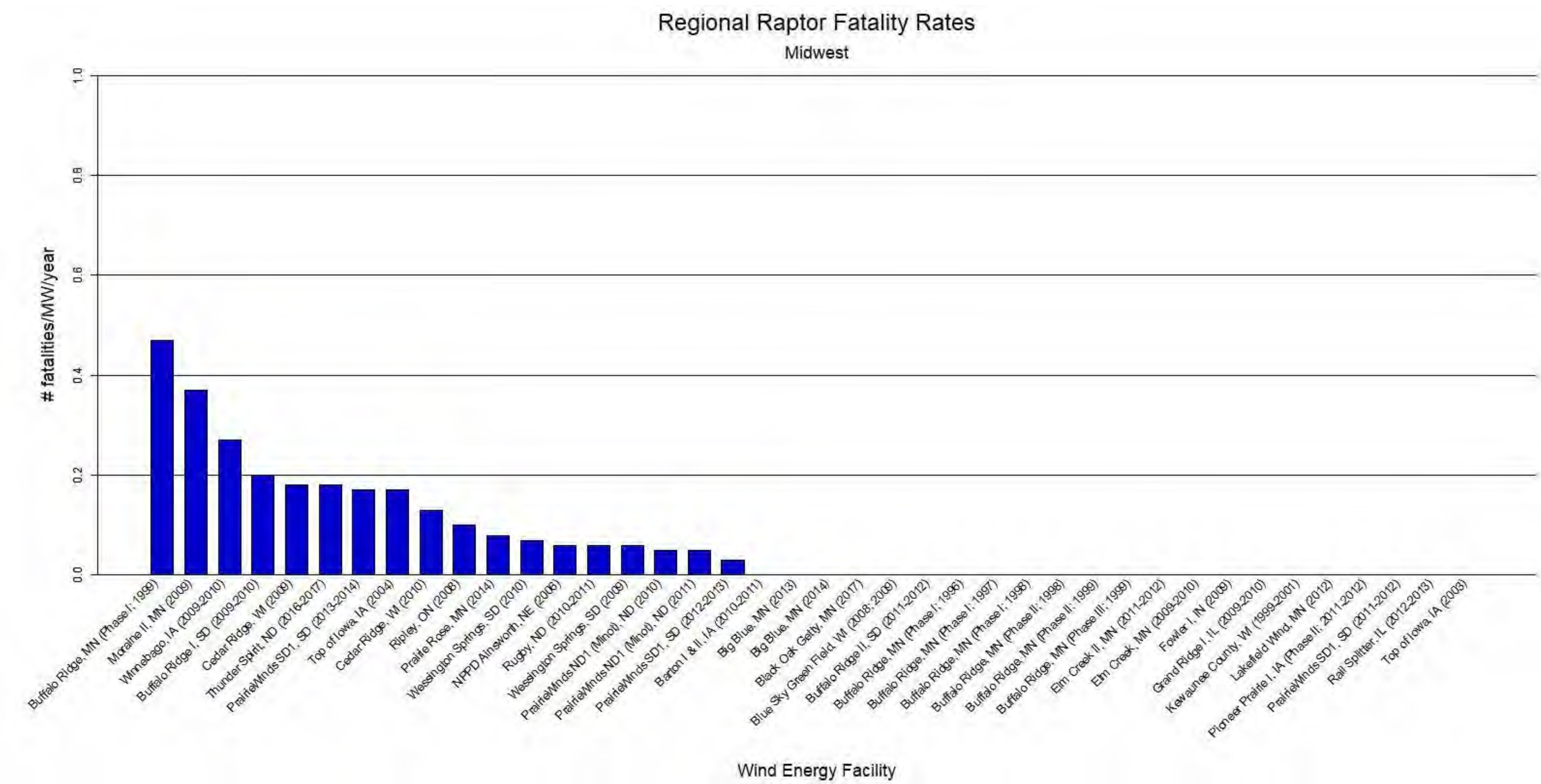

Figure 6. Fatality rates for diurnal raptors (number of raptors per megawatt per year) from publicly available studies at wind energy facilities in the Midwest region of North America (Appendix F2).

Figure 6 (*continued*). Fatality rates for diurnal raptors (number of raptors per megawatt per year) from publicly available studies at wind energy facilities in the Midwest region of North America (Appendix F2).

Data from the following sources:

Wind Energy Facility	Reference	Wind Energy Facility	Reference
Buffalo Ridge, MN (Phase I; 99)	Johnson et al. 2000	Big Blue, MN (14)	Fagen Engineering 2015
Moraine II, MN (09)	Derby et al. 2010b	Black Oak Getty, MN (17)	Pickle et al. 2018
Winnebago, IA (09-10)	Derby et al. 2010e	Blue Sky Green Field, WI (08; 09)	Gruver et al. 2009
Buffalo Ridge I, SD (09-10)	Derby et al. 2010d	Buffalo Ridge II, SD (11-12)	Derby et al. 2012a
Cedar Ridge, WI (09)	BHE Environmental 2010	Buffalo Ridge, MN (Phase I; 96)	Johnson et al. 2000
Thunder Spirit, ND (16-17)	Derby et al. 2018	Buffalo Ridge, MN (Phase I; 97)	Johnson et al. 2000
PrairieWinds SD1, SD (13-14)	Derby et al. 2014	Buffalo Ridge, MN (Phase I; 98)	Johnson et al. 2000
Top of Iowa, IA (04)	Jain 2005	Buffalo Ridge, MN (Phase II; 98)	Johnson et al. 2000
Cedar Ridge, WI (10)	BHE Environmental 2011	Buffalo Ridge, MN (Phase II; 99)	Johnson et al. 2000
Ripley, ON (08)	Jacques Whitford 2009	Buffalo Ridge, MN (Phase III; 99)	Johnson et al. 2000
Prairie Rose, MN (14)	Chodachek et al. 2015	Elm Creek II, MN (11-12)	Derby et al. 2012d
Wessington Springs, SD (10)	Derby et al. 2011d	Elm Creek, MN (09-10)	Derby et al. 2010c
NPPD Ainsworth, NE (06)	Derby et al. 2007	Fowler I, IN (09)	Johnson et al. 2010a
Rugby, ND (10-11)	Derby et al. 2011c	Grand Ridge I, IL (09-10)	Derby et al. 2010f
Wessington Springs, SD (09)	Derby et al. 2010a	Kewaunee County, WI (99-01)	Howe et al. 2002
PrairieWinds ND1 (Minot), ND (10)	Derby et al. 2011b	Lakefield Wind, MN (12)	Minnesota Public Utilities Commission 2012
PrairieWinds ND1 (Minot), ND (11)	Derby et al. 2012b	Pioneer Prairie I, IA (Phase II; 11-12)	Chodachek et al. 2012
PrairieWinds SD1, SD (12-13)	Derby et al. 2013	PrairieWinds SD1, SD (11-12)	Derby et al. 2012c
Barton I & II, IA (10-11)	Derby et al. 2011a	Rail Splitter, IL (12-13)	Good et al. 2013b
Big Blue, MN (13)	Fagen Engineering 2014	Top of Iowa, IA (03)	Jain 2005

Table 10. Diurnal raptor fatalities, by species, recorded at new-generation wind energy facilities in the Midwest.

Species	Scientific Name	Number of Raptor Fatalities*	Percent Composition of Raptor Fatalities
red-tailed hawk	*Buteo jamaicensis*	68	66.0
American kestrel	*Falco sparverius*	10	9.7
sharp-shinned hawk	*Accipiter striatus*	6	5.8
Swainson's hawk	*Buteo swainsoni*	4	3.9
rough-legged hawk	*Buteo lagopus*	3	2.9
Cooper's hawk	*Accipiter cooperii*	3	2.9
merlin	*Falco columbarius*	2	1.9
broad-winged hawk	*Buteo platypterus*	2	1.9
unidentified buteo	*Buteo spp*	2	1.9
northern harrier	*Circus hudsonius*	1	1.0
unidentified hawk		1	1.0
unidentified raptor		1	1.0
Total		**103**	**100**

* Number of raptor fatalities is unadjusted, raw counts (not corrected for searcher efficiency or scavenging). Percent composition may not total value shown due to rounding.

Cumulative fatalities and species from data compiled by Western EcoSystems Technology, Inc. from publicly available fatality documents (see Appendix F2).

Information on eagle fatalities may be found from the following sources: Allison 2012, Erickson et al. 2001, Pagel et al. 2013, Smallwood and Karas 2009, and US Department of Agriculture Rural Utilities Service and US Department of Energy Western Area Power Administration 2010; several of these accounts are discussing one or more of the same fatalities, and do not provide enough information for the total numbers to be definitively identified. Therefore, eagle fatality data is not presented in this table.

6.1 Species of Concern

Bald eagle was the only federally protected species (protected under the BGEPA) documented during the study. American white pelican, Franklin's gull, and short-eared owl were the only state-protected species, designated as SPC.

6.1.1 Bald Eagle

Bald eagles are typically associated with aquatic habitats (e.g., rivers, lakes, reservoirs, coastal areas) with mature forested shorelines or cliffs, though they may occur in arid regions of the southwestern US (Buehler 2000). Bald eagles, particularly when they are young, are opportunistic foragers, preferring to scavenge and pirate food rather than capture their own prey (Todd et al. 1982, Harmata 1984). Fish are preferred prey, but bald eagles will eat a variety of mammalian, avian, and reptilian species, and carrion (Todd et al. 1982, Stalmaster 1987, Mersmann 1989). Bald eagles primarily hunt from a perch or by soaring high over foraging areas, and may also hunt from the ground or while wading in water.

Most immature and dispersing eagles migrate and move nomadically, making it difficult to distinguish between true migration and general wandering (Buehler 2000). Adults begin fall migration when food becomes unavailable. Most bald eagles migrate alone; however, large concentrations can occur at communal feeding and roost sites; often hundreds or even thousands of eagles can congregate on wintering grounds (Buehler 2000). Suitable migration stopover habitat depends more upon food availability than vegetation composition or structural concentrations (Buehler 2000). The majority of wintering populations are located in the contiguous US, coastal Canada, and Alaska (Millsap 1986). Suitable winter habitats contain easy foraging opportunities, protected perches, and absence of human disturbance.

Bald eagle fatalities caused by wind turbine collisions have increased slightly over the past few years, yet remain relatively low. According to Kritz et al. (2018), a total of 45 bald eagle fatalities that had been found at wind farms were reported to the USFWS between 2013 and 2018; this is more than eight times the previous number of known reported bald eagle fatalities (six bald eagle fatalities reported from 1997-2012; Pagel et al. 2013). However, risk is still considered low despite this species large and increasing population and widespread distribution across North America (Buehler 2000, Allison 2012). Regionally, 31 of the 51 bald eagle fatalities were documented in the Midwest, including three in Minnesota (Kritz et al. 2018; Pagel et al. 2013). Although concerns over the trend in bald eagle fatalities exist, understanding is weakly substantiated due to lack of published documentation (Pagel et al. 2013). For a thorough discussion of the potential effects of wind energy development on eagles, please refer to the ECPG (USFWS 2013).

During 163 hours of surveys, eight bald eagles were documented for a total of 38 eagle minutes, six of which were within the ZOR. This suggests relatively low use of Study Area by bald eagles, with the majority of use occurring in fall. A second year of eagle use surveys at the Project is currently underway and will provide additional data to better inform an analysis of potential risk for bald eagles at the Project.

6.1.2 American White Pelican

American white pelicans inhabit shallow marshes, rivers, and lakes, feeding opportunistically on fish, crayfish and salamanders (Knopf and Evans 2004). American white pelicans are gregarious, frequently observed roosting, flying, and feeding in large flocks. Fluctuating water levels and human persecution have been cited as the primary causes of this species' decline in the late 19th and early 20th centuries (Wires et al. 2005, MNDNR 2019). American white pelican populations have since recovered and continue to increase approximately 3% per year (Knopf and Evans 2004).

Migration to the breeding grounds occurs in March, and egg laying begins about four to five days after nest site selection (Knopf and Evans 2004). Eggs are incubated for approximately 30 days before hatching, and both parents take turns incubating the eggs while the other forages for food. American white pelicans generally select sparsely vegetated nest sites, and construct nests in shallow depressions on the ground with a low rim of soil, gravel, or nearby vegetation (Knopf and Evans 2004). The Project occurs within the migration range of the American white pelican, suggesting they may use the Project as stopover habitat during migration in spring and fall. However, American white pelican use was only documented during the spring, and use was relatively low.

6.1.3 Franklin's Gull

Franklin's gulls are found throughout interior North America during breeding and migration in large flocks (Burger and Gochfeld 2009). This species generally migrates through the Great Plains region in spring and fall. This species is dependent on marshes during breeding, and is therefore sensitive to drought and anthropogenic water level fluctuations. Franklin's gulls experienced widespread population declines from habitat loss as a result of historic large-scale drainage projects; however, the population has begun to increase in recent years (Minnesota Breeding Bird Atlas 2019, Burger and Gochfeld 2009). Franklin's gulls forage in dense flocks over wet pastures and feed on fish, mice, insects, and other small invertebrates.

Franklin's gulls nests over water in freshwater marshes, on floating mats, muskrat houses, or other floating debris (Burger and Gochfeld 2009). They arrive at their nesting site around mid-April and begin nest-building immediately after establishing a nesting territory. Nests are constructed by both parents out of wet organic material; nesting material is frequently stolen from neighboring conspecific nests. After laying the eggs, they are incubated by both parents for approximately 26 days. The Project occurs within the migration range of the Franklin's gull, and breeding pairs have been documented in Minnesota; however, Franklin's gull use was only documented during spring, and use was relatively low. Use of the Project Area would likely be limited to infrequent occurrences during spring and fall migration.

6.1.4 Short-Eared Owl

The short-eared owl is one of the most widely distributed owls in North America. Short-eared owls are ground-nesting species that prefer open country, and inhabit grasslands and marshlands throughout the US (Wiggins et al. 2006). Because they nest on the ground, they are particularly susceptible to predation. Habitat fragmentation has been the primary threat to this species on the Great Plains, as grassland habitats have been converted to agricultural uses (Wiggins et al. 2006). This species hunts flying low to the ground, during day and night, and feeds primarily on small mammals, and occasionally other birds.

Short-eared owls are one of the few owls to construct their own nest (Wiggins et al. 2006). They nest on the ground, primarily in grasslands. Egg-laying occurs from March through June, with a peak in May. Although this species has potential to occur within the Project Area year-round, short-eared owl use was only documented during spring, and use was relatively low. Therefore, wind turbine collision risk to this species is anticipated to be low.

7 CONCLUSIONS

Over the 163 avian use surveys that occurred at the Study Area between January and December 2018, a total of 673 large bird observations and 935 small bird observations were recorded. Large bird use was higher in fall and spring (primarily due to higher use by waterfowl during spring, and doves/pigeons and large corvids during fall); with much lower levels of use in summer and winter. Currently, few published studies are available from the Midwest that would allow for a comparison of raptor use and fatality rates. Diurnal raptor fatality rates are expected to be within the range of fatality rates observed at other facilities in Minnesota and the larger Midwest region (Appendix F2). Diurnal raptor use was fairly even across the Study Area; waterfowl use was relatively higher at points 7 and 1.

Species of conservation concern observed in the Study Area included one species protected by BGEPA (bald eagle), three SPC species (American white pelican, Franklin's gull, and short-eared owl), and 12 additional species considered to be SGCN. Use of the Study Area by these species was relatively low. Eight bald eagle observations and 38 eagle minutes (six minutes in the ZOR) were recorded over 163 hours of survey at the Study Area, with seven additional bald eagle observations reported incidentally. Bald eagle observations were generally concentrated in the southern portion of the Study Area, which lies outside of the current Project Area. Bald eagles were only documented in fall during the 20-min large bird surveys. No golden eagles were documented during this study. WEST is currently conducting a second year of avian use surveys at the Project and will update the eagle use data in the second year report.

8 REFERENCES

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Appendix A. All Bird Types and Species Observed during Fixed-Point Bird Use Surveys at the Walleye Wind Energy Project Study Area from January 29 – December 17, 2018

Appendix A1. Summary of individuals and group observations by bird type and species recorded during 20-minute large bird use surveys at the Walleye Wind Energy Project Study Area[a] from January 29 – December 17, 2018.

		Winter		Spring		Summer		Fall		Total	
Type/Species	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Waterbirds		**0**	**0**	**1**	**6**	**0**	**0**	**1**	**1**	**2**	**7**
great blue heron	*Ardea herodias*	0	0	0	0	0	0	1	1	1	1
American white pelican	*Pelecanus erythrorhynchos*	0	0	1	6	0	0	0	0	1	6
Waterfowl		**0**	**0**	**4**	**93**	**1**	**3**	**2**	**12**	**7**	**108**
mallard	*Anas platyrhynchos*	0	0	0	0	1	3	0	0	1	3
Canada goose	*Branta canadensis*	0	0	1	4	0	0	2	12	3	16
common goldeneye	*Bucephala clangula*	0	0	1	1	0	0	0	0	1	1
snow goose	*Chen caerulescens*	0	0	2	88	0	0	0	0	2	88
Shorebirds		**0**	**0**	**4**	**5**	**6**	**6**	**3**	**22**	**13**	**33**
upland sandpiper	*Bartramia longicauda*	0	0	1	1	2	2	0	0	3	3
killdeer	*Charadrius vociferus*	0	0	3	4	4	4	2	2	9	10
unidentified shorebird		0	0	0	0	0	0	1	20	1	20
Gulls/Terns		**0**	**0**	**3**	**6**	**0**	**0**	**0**	**0**	**3**	**6**
ring-billed gull	*Larus delawarensis*	0	0	2	2	0	0	0	0	2	2
Franklin’s gull	*Leucophaeus pipixcan*	0	0	1	4	0	0	0	0	1	4
Diurnal Raptors		**0**	**0**	**13**	**15**	**7**	**7**	**21**	**21**	**41**	**43**
Accipiters		*0*	*0*	*2*	*2*	*1*	*1*	*2*	*2*	*5*	*5*
Cooper’s hawk	*Accipiter cooperii*	0	0	2	2	1	1	0	0	3	3
unidentified accipiter	*Accipiter* spp.	0	0	0	0	0	0	1	1	1	1
sharp-shinned hawk	*Accipiter striatus*	0	0	0	0	0	0	1	1	1	1
Buteos		*0*	*0*	*10*	*12*	*6*	*6*	*12*	*12*	*28*	*30*
red-tailed hawk	*Buteo jamaicensis*	0	0	5	6	1	1	10	10	16	17
broad-winged hawk	*Buteo platypterus*	0	0	1	1	0	0	0	0	1	1
unidentified buteo	*Buteo* spp.	0	0	0	0	1	1	1	1	2	2
Swainson’s hawk	*Buteo swainsoni*	0	0	4	5	4	4	1	1	9	10
Northern Harrier		*0*	*0*	*0*	*0*	*0*	*0*	*4*	*4*	*4*	*4*
northern harrier	*Circus hudsonius*	0	0	0	0	0	0	4	4	4	4
Eagles		*0*	*0*	*0*	*0*	*0*	*0*	*2*	*2*	*2*	*2*
bald eagle	*Haliaeetus leucocephalus*	0	0	0	0	0	0	2	2	2	2
Falcons		*0*	*0*	*1*	*1*	*0*	*0*	*0*	*0*	*1*	*1*
American kestrel	*Falco sparverius*	0	0	1	1	0	0	0	0	1	1
Other Raptors		*0*	*0*	*0*	*0*	*0*	*0*	*1*	*1*	*1*	*1*
unidentified raptor		0	0	0	0	0	0	1	1	1	1
Owls		**0**	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**1**	**1**

Appendix A1. Summary of individuals and group observations by bird type and species recorded during 20-minute large bird use surveys at the Walleye Wind Energy Project Study Area[a] from January 29 – December 17, 2018.

		Winter		Spring		Summer		Fall		Total	
Type/Species	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
short-eared owl	*Asio flammeus*	0	0	1	1	0	0	0	0	1	1
Vultures		**0**	**0**	**7**	**9**	**3**	**3**	**0**	**0**	**10**	**12**
turkey vulture	*Cathartes aura*	0	0	7	9	3	3	0	0	10	12
Upland Game Birds		**1**	**1**	**1**	**1**	**7**	**12**	**2**	**4**	**11**	**18**
ring-necked pheasant	*Phasianus colchicus*	1	1	1	1	6	7	2	4	10	13
unidentified gamebird		0	0	0	0	1	5	0	0	1	5
Doves/Pigeons		**10**	**70**	**7**	**11**	**28**	**40**	**22**	**114**	**67**	**235**
rock pigeon	*Columba livia*	9	69	3	6	6	11	20	111	38	197
Eurasian collared-dove	*Streptopelia decaocto*	1	1	1	1	3	4	0	0	5	6
mourning dove	*Zenaida macroura*	0	0	3	4	19	25	2	3	24	32
Large Corvids		**12**	**43**	**16**	**48**	**7**	**13**	**15**	**106**	**50**	**210**
American crow	*Corvus brachyrhynchos*	12	43	16	48	7	13	15	106	50	210
Large Birds Overall		**23**	**114**	**57**	**195**	**59**	**84**	**66**	**280**	**205**	**673**

[a] Regardless of distance from observer.

Note: grps = groups, obs = observations

Appendix A2. Summary of individuals and group observations by bird type and species recorded during 10-minute small bird use surveys at the Walleye Wind Energy Project[a] from January 29 – December 17, 2018.

		Winter		Spring		Summer		Fall		Total	
Type/Species	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Passerines		**15**	**92**	**91**	**249**	**182**	**257**	**64**	**329**	**352**	**927**
unidentified passerine		1	1	0	0	10	17	26	57	37	75
Blackbirds/Orioles		*0*	*0*	*42*	*63*	*57*	*78*	*12*	*76*	*111*	*217*
red-winged blackbird	*Agelaius phoeniceus*	0	0	14	18	16	23	1	20	31	61
bobolink	*Dolichonyx oryzivorus*	0	0	3	3	4	7	0	0	7	10
Brewer's blackbird	*Euphagus cyanocephalus*	0	0	0	0	1	1	0	0	1	1
Baltimore oriole	*Icterus galbula*	0	0	0	0	3	3	0	0	3	3
brown-headed cowbird	*Molothrus ater*	0	0	7	12	9	13	0	0	16	25
common grackle	*Quiscalus quiscula*	0	0	9	17	13	15	0	0	22	32
eastern meadowlark	*Sturnella magna*	0	0	0	0	1	1	0	0	1	1
western meadowlark	*Sturnella neglecta*	0	0	2	4	6	10	5	7	13	21
unidentified meadowlark	*Sturnella* spp.	0	0	2	2	0	0	0	0	2	2
European starling	*Sturnus vulgaris*	0	0	5	7	2	2	1	1	8	10
unidentified blackbird		0	0	0	0	2	3	5	48	7	51
Creepers/Nuthatches		*0*	*0*	*0*	*0*	*0*	*0*	*1*	*2*	*1*	*2*
white-breasted nuthatch	*Sitta carolinensis*	0	0	0	0	0	0	1	2	1	2
Finches/Crossbills		*0*	*0*	*4*	*5*	*13*	*19*	*3*	*3*	*20*	*27*
house finch	*Haemorhous mexicanus*	0	0	1	1	0	0	0	0	1	1
American goldfinch	*Spinus tristis*	0	0	3	4	13	19	3	3	19	26
Flycatchers		*0*	*0*	*0*	*0*	*3*	*3*	*0*	*0*	*3*	*3*
eastern kingbird	*Tyrannus tyrannus*	0	0	0	0	3	3	0	0	3	3
Grassland/Sparrows		*14*	*91*	*28*	*159*	*40*	*48*	*15*	*162*	*97*	*460*
American pipit	*Anthus rubescens*	0	0	0	0	0	0	2	60	2	60
Lapland longspur	*Calcarius lapponicus*	0	0	1	1	0	0	1	40	2	41
horned lark	*Eremophila alpestris*	14	91	14	141	1	1	4	38	33	271
dark-eyed junco	*Junco hyemalis*	0	0	1	2	0	0	0	0	1	2
song sparrow	*Melospiza melodia*	0	0	2	2	8	8	0	0	10	10
house sparrow	*Passer domesticus*	0	0	1	4	1	4	0	0	2	8
Savannah sparrow	*Passerculus sandwichensis*	0	0	3	3	2	2	0	0	5	5
vesper sparrow	*Pooecetes gramineus*	0	0	1	1	2	2	0	0	3	3
dickcissel	*Spiza americana*	0	0	2	2	21	24	0	0	23	26
clay-colored sparrow	*Spizella pallida*	0	0	1	1	0	0	0	0	1	1
chipping sparrow	*Spizella passerina*	0	0	2	2	1	1	0	0	3	3
American tree sparrow	*Spizelloides arborea*	0	0	0	0	0	0	1	4	1	4
Harris' sparrow	*Zonotrichia querula*	0	0	0	0	0	0	3	15	3	15
unidentified sparrow		0	0	0	0	4	6	4	5	8	11

Appendix A2. Summary of individuals and group observations by bird type and species recorded during 10-minute small bird use surveys at the Walleye Wind Energy Project[a] from January 29 – December 17, 2018.

		Winter		Spring		Summer		Fall		Total	
Type/Species	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Mimids		*0*	*0*	*0*	*0*	*1*	*1*	*0*	*0*	*1*	*1*
brown thrasher	*Toxostoma rufum*	0	0	0	0	1	1	0	0	1	1
Swallows		*0*	*0*	*11*	*12*	*35*	*63*	*1*	*1*	*47*	*76*
barn swallow	*Hirundo rustica*	0	0	6	7	13	16	1	1	20	24
cliff swallow	*Petrochelidon pyrrhonota*	0	0	1	1	19	44	0	0	20	45
bank swallow	*Riparia riparia*	0	0	1	1	0	0	0	0	1	1
tree swallow	*Tachycineta bicolor*	0	0	3	3	1	1	0	0	4	4
unidentified swallow		0	0	0	0	2	2	0	0	2	2
Tanagers		*0*	*0*	*0*	*0*	*1*	*1*	*0*	*0*	*1*	*1*
indigo bunting	*Passerina cyanea*	0	0	0	0	1	1	0	0	1	1
Thrushes		*0*	*0*	*4*	*6*	*12*	*15*	*5*	*26*	*21*	*47*
American robin	*Turdus migratorius*	0	0	4	6	12	15	5	26	21	47
Warblers		*0*	*0*	*0*	*0*	*5*	*5*	*0*	*0*	*5*	*5*
common yellowthroat	*Geothlypis trichas*	0	0	0	0	5	5	0	0	5	5
Wrens		*0*	*0*	*0*	*0*	*4*	*4*	*0*	*0*	*4*	*4*
sedge wren	*Cistothorus platensis*	0	0	0	0	1	1	0	0	1	1
house wren	*Troglodytes aedon*	0	0	0	0	3	3	0	0	3	3
Corvids		*0*	*0*	*2*	*4*	*1*	*3*	*1*	*2*	*4*	*9*
blue jay	*Cyanocitta cristata*	0	0	2	4	1	3	1	2	4	9
Swifts/Hummingbirds		**0**	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**1**	**1**
chimney swift	*Chaetura pelagica*	0	0	1	1	0	0	0	0	1	1
Woodpeckers		**1**	**1**	**0**	**0**	**1**	**1**	**1**	**1**	**3**	**3**
northern flicker	*Colaptes auratus*	0	0	0	0	0	0	1	1	1	1
red-headed woodpecker	*Melanerpes erythrocephalus*	0	0	0	0	1	1	0	0	1	1
downy woodpecker	*Picoides pubescens*	1	1	0	0	0	0	0	0	1	1
Unidentified Birds		**0**	**0**	**0**	**0**	**1**	**1**	**1**	**3**	**2**	**4**
unidentified bird (small)		0	0	0	0	1	1	1	3	2	4
Small Birds Overall		**16**	**93**	**92**	**250**	**184**	**259**	**66**	**333**	**358**	**935**

[a] Regardless of distance from observer.

Note: grps = groups, obs = observations

Appendix B. Mean Use, Percent of Use, and Frequency of Occurrence for Large and Small Birds Observed during Fixed-Point Bird Use Surveys at the Walleye Wind Energy Project Study Area from January 29 – December 17, 2018

Appendix B1. Mean large bird use (number of large birds/800-meter plot/20-minute survey), percent of total use (%), and frequency of occurrence (%) for each large bird type and species by season recorded during fixed-point bird use surveys at the Walleye Wind Energy Project Study Area from January 29 – December 17, 2018.

	Mean Use				% of Use				% Frequency			
Type/Species	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**
Waterbirds	**0**	**0.17**	**0**	**0.02**	**0**	**3.1**	**0**	**0.3**	**0**	**2.8**	**0**	**2.0**
great blue heron	0	0	0	0.02	0	0	0	0.3	0	0	0	2.0
American white pelican	0	0.17	0	0	0	3.1	0	0	0	2.8	0	0
Waterfowl	**0**	**2.58**	**0.09**	**0.33**	**0**	**47.7**	**3.8**	**5.3**	**0**	**11.1**	**3.0**	**5.6**
mallard	0	0	0.09	0	0	0	3.8	0	0	0	3.0	0
Canada goose	0	0.11	0	0.33	0	2.1	0	5.3	0	2.8	0	5.6
common goldeneye	0	0.03	0	0	0	0.5	0	0	0	2.8	0	0
snow goose	0	2.44	0	0	0	45.1	0	0	0	5.6	0	0
Shorebirds	**0**	**0.14**	**0.17**	**0.61**	**0**	**2.6**	**7.2**	**9.8**	**0**	**11.1**	**14.4**	**5.6**
upland sandpiper	0	0.03	0.06	0	0	0.5	2.3	0	0	2.8	2.8	0
killdeer	0	0.11	0.12	0.06	0	2.1	4.8	0.9	0	8.3	11.6	2.8
unidentified shorebird	0	0	0	0.56	0	0	0	8.9	0	0	0	2.8
Gulls/Terns	**0**	**0.17**	**0**	**0**	**0**	**3.1**	**0**	**0**	**0**	**8.3**	**0**	**0**
ring-billed gull	0	0.06	0	0	0	1.0	0	0	0	5.6	0	0
Franklin's gull	0	0.11	0	0	0	2.1	0	0	0	2.8	0	0
Diurnal Raptors	**0**	**0.42**	**0.20**	**0.34**	**0**	**7.7**	**8.4**	**5.5**	**0**	**25.0**	**20.2**	**26.2**
Accipiters	*0*	*0.06*	*0.03*	*0.03*	*0*	*1.0*	*1.2*	*0.6*	*0*	*5.6*	*2.8*	*3.5*
Cooper's hawk	0	0.06	0.03	0	0	1.0	1.2	0	0	5.6	2.8	0
unidentified accipiter	0	0	0	0.02	0	0	0	0.3	0	0	0	2.0
sharp-shinned hawk	0	0	0	0.02	0	0	0	0.2	0	0	0	1.5
Buteos	*0*	*0.33*	*0.17*	*0.21*	*0*	*6.2*	*7.3*	*3.3*	*0*	*22.2*	*17.4*	*17.8*
red-tailed hawk	0	0.17	0.03	0.16	0	3.1	1.3	2.6	0	13.9	3.0	15.0
broad-winged hawk	0	0.03	0	0	0	0.5	0	0	0	2.8	0	0
unidentified buteo	0	0	0.03	0.02	0	0	1.2	0.2	0	0	2.8	1.5
Swainson's hawk	0	0.14	0.12	0.03	0	2.6	4.8	0.4	0	8.3	11.6	2.8
Northern Harrier	*0*	*0*	*0*	*0.07*	*0*	*0*	*0*	*1.1*	*0*	*0*	*0*	*7.0*
northern harrier	0	0	0	0.07	0	0	0	1.1	0	0	0	7.0
Eagles	*0*	*0*	*0*	*0.02*	*0*	*0*	*0*	*0.2*	*0*	*0*	*0*	*1.5*
bald eagle	0	0	0	0.02	0	0	0	0.2	0	0	0	1.5
Falcons	*0*	*0.03*	*0*	*0*	*0*	*0.5*	*0*	*0*	*0*	*2.8*	*0*	*0*
American kestrel	0	0.03	0	0	0	0.5	0	0	0	2.8	0	0
Other Raptors	*0*	*0*	*0*	*0.02*	*0*	*0*	*0*	*0.2*	*0*	*0*	*0*	*1.5*
unidentified raptor	0	0	0	0.02	0	0	0	0.2	0	0	0	1.5
Owls	**0**	**0.03**	**0**	**0**	**0**	**0.5**	**0**	**0**	**0**	**2.8**	**0**	**0**
short-eared owl	0	0.03	0	0	0	0.5	0	0	0	2.8	0	0

Appendix B1. Mean large bird use (number of large birds/800-meter plot/20-minute survey), percent of total use (%), and frequency of occurrence (%) for each large bird type and species by season recorded during fixed-point bird use surveys at the Walleye Wind Energy Project Study Area from January 29 – December 17, 2018.

	Mean Use				% of Use				% Frequency			
Type/Species	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**
Vultures	**0**	**0.25**	**0.09**	**0**	**0**	**4.6**	**3.6**	**0**	**0**	**13.9**	**8.6**	**0**
turkey vulture	0	0.25	0.09	0	0	4.6	3.6	0	0	13.9	8.6	0
Upland Game Birds	**0.02**	**0.03**	**0.34**	**0.06**	**0.7**	**0.5**	**14.1**	**1.0**	**2.0**	**2.8**	**16.9**	**1.5**
ring-necked pheasant	0.02	0.03	0.20	0.06	0.7	0.5	8.3	1.0	2.0	2.8	14.1	1.5
unidentified gamebird	0	0	0.14	0	0	0	5.8	0	0	0	2.8	0
Doves/Pigeons	**1.61**	**0.31**	**1.13**	**2.64**	**58.2**	**5.6**	**47.3**	**42.2**	**21.7**	**16.7**	**48.2**	**36.1**
rock pigeon	1.59	0.17	0.31	2.56	57.5	3.1	13.0	40.9	19.8	8.3	16.9	30.6
Eurasian collared-dove	0.02	0.03	0.12	0	0.7	0.5	4.8	0	2.0	2.8	8.8	0
mourning dove	0	0.11	0.71	0.08	0	2.1	29.5	1.3	0	5.6	36.9	5.6
Large Corvids	**1.14**	**1.33**	**0.37**	**2.25**	**41.1**	**24.6**	**15.6**	**35.9**	**23.4**	**30.6**	**14.6**	**26.1**
American crow	1.14	1.33	0.37	2.25	41.1	24.6	15.6	35.9	23.4	30.6	14.6	26.1
Large Birds Overall[a]	**2.77**	**5.42**	**2.40**	**6.26**	**100**	**100**	**100**	**100**				

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

Appendix B2. Mean small bird use (number of small birds/100-meter plot/10-minute survey), percent of total use (%), and frequency of occurrence (%) for each small bird type and species by season recorded during fixed-point bird use surveys at the Walleye Wind Energy Project from January 29 – December 17, 2018.

	Mean Use				% of Use				% Frequency			
Type/Species	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**
Passerines	**2.05**	**6.92**	**7.31**	**5.58**	**99.1**	**99.6**	**99.2**	**98.7**	**28.4**	**61.1**	**91.4**	**59.7**
unidentified passerine	0.03	0	0.47	0.94	1.3	0	6.4	16.6	2.8	0	19.4	36.6
Blackbirds/Orioles	*0*	*1.75*	*2.26*	*1.27*	*0*	*25.2*	*30.7*	*22.4*	*0*	*41.7*	*52.0*	*12.8*
red-winged blackbird	0	0.50	0.67	0.39	0	7.2	9.2	6.9	0	25.0	20.7	2.0
bobolink	0	0.08	0.20	0	0	1.2	2.7	0	0	5.6	8.8	0
Brewer’s blackbird	0	0	0.03	0	0	0	0.4	0	0	0	2.8	0
Baltimore oriole	0	0	0.09	0	0	0	1.2	0	0	0	8.6	0
brown-headed cowbird	0	0.33	0.38	0	0	4.8	5.1	0	0	16.7	20.5	0
common grackle	0	0.47	0.44	0	0	6.8	6.0	0	0	13.9	32.3	0
eastern meadowlark	0	0	0.03	0	0	0	0.4	0	0	0	3.0	0
western meadowlark	0	0.11	0.28	0.13	0	1.6	3.8	2.3	0	5.6	8.6	4.3
unidentified meadowlark	0	0.06	0	0	0	0.8	0	0	0	5.6	0	0
European starling	0	0.19	0.06	0.02	0	2.8	0.8	0.3	0	13.9	5.8	2.0
unidentified blackbird	0	0	0.08	0.73	0	0	1.1	12.9	0	0	5.6	4.5
Creepers/Nuthatches	*0*	*0*	*0*	*0.04*	*0*	*0*	*0*	*0.7*	*0*	*0*	*0*	*2.0*
white-breasted nuthatch	0	0	0	0.04	0	0	0	0.7	0	0	0	2.0
Finches/Crossbills	*0*	*0.14*	*0.53*	*0.06*	*0*	*2.0*	*7.2*	*1.1*	*0*	*8.3*	*28.0*	*6.3*
house finch	0	0.03	0	0	0	0.4	0	0	0	2.8	0	0
American goldfinch	0	0.11	0.53	0.06	0	1.6	7.2	1.1	0	8.3	28.0	6.3
Flycatchers	*0*	*0*	*0.09*	*0*	*0*	*0*	*1.2*	*0*	*0*	*0*	*8.6*	*0*
eastern kingbird	0	0	0.09	0	0	0	1.2	0	0	0	8.6	0
Grassland/Sparrows	*2.02*	*4.42*	*1.37*	*2.77*	*97.7*	*63.6*	*18.6*	*49.0*	*25.7*	*44.4*	*63.6*	*18.4*
American pipit	0	0	0	0.91	0	0	0	16.1	0	0	0	1.5
Lapland longspur	0	0.03	0	0.78	0	0.4	0	13.9	0	2.8	0	2.0
horned lark	2.02	3.92	0.03	0.70	97.7	56.4	0.4	12.3	25.7	30.6	3.0	5.4
dark-eyed junco	0	0.06	0	0	0	0.8	0	0	0	2.8	0	0
song sparrow	0	0.06	0.23	0	0	0.8	3.1	0	0	5.6	17.2	0
house sparrow	0	0.11	0.12	0	0	1.6	1.6	0	0	2.8	3.0	0
Savannah sparrow	0	0.08	0.06	0	0	1.2	0.8	0	0	8.3	2.8	0
vesper sparrow	0	0.03	0.06	0	0	0.4	0.8	0	0	2.8	6.1	0
dickcissel	0	0.06	0.68	0	0	0.8	9.3	0	0	5.6	40.4	0
clay-colored sparrow	0	0.03	0	0	0	0.4	0	0	0	2.8	0	0
chipping sparrow	0	0.06	0.03	0	0	0.8	0.4	0	0	5.6	2.8	0
American tree sparrow	0	0	0	0.08	0	0	0	1.4	0	0	0	2.0
Harris’ sparrow	0	0	0	0.23	0	0	0	4.0	0	0	0	1.5

Appendix B2. Mean small bird use (number of small birds/100-meter plot/10-minute survey), percent of total use (%), and frequency of occurrence (%) for each small bird type and species by season recorded during fixed-point bird use surveys at the Walleye Wind Energy Project from January 29 – December 17, 2018.

	Mean Use				% of Use				% Frequency			
Type/Species	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**
unidentified sparrow	0	0	0.17	0.08	0	0	2.3	1.3	0	0	8.3	6.1
Mimids	*0*	*0*	*0.03*	*0*	*0*	*0*	*0.4*	*0*	*0*	*0*	*2.8*	*0*
brown thrasher	0	0	0.03	0	0	0	0.4	0	0	0	2.8	0
Swallows	*0*	*0.33*	*1.76*	*0.03*	*0*	*4.8*	*23.9*	*0.5*	*0*	*16.7*	*39.6*	*2.8*
barn swallow	0	0.19	0.45	0.03	0	2.8	6.1	0.5	0	16.7	28.3	2.8
cliff swallow	0	0.03	1.22	0	0	0.4	16.6	0	0	2.8	22.5	0
bank swallow	0	0.03	0	0	0	0.4	0	0	0	2.8	0	0
tree swallow	0	0.08	0.03	0	0	1.2	0.4	0	0	8.3	2.8	0
unidentified swallow	0	0	0.06	0	0	0	0.8	0	0	0	5.6	0
Tanagers	*0*	*0*	*0.03*	*0*	*0*	*0*	*0.4*	*0*	*0*	*0*	*2.8*	*0*
indigo bunting	0	0	0.03	0	0	0	0.4	0	0	0	2.8	0
Thrushes	*0*	*0.17*	*0.43*	*0.44*	*0*	*2.4*	*5.9*	*7.9*	*0*	*8.3*	*26.0*	*10.1*
American robin	0	0.17	0.43	0.44	0	2.4	5.9	7.9	0	8.3	26.0	10.1
Warblers	*0*	*0*	*0.14*	*0*	*0*	*0*	*2.0*	*0*	*0*	*0*	*14.4*	*0*
common yellowthroat	0	0	0.14	0	0	0	2.0	0	0	0	14.4	0
Wrens	*0*	*0*	*0.11*	*0*	*0*	*0*	*1.5*	*0*	*0*	*0*	*8.6*	*0*
sedge wren	0	0	0.03	0	0	0	0.4	0	0	0	2.8	0
house wren	0	0	0.09	0	0	0	1.2	0	0	0	5.8	0
Corvids	*0*	*0.11*	*0.08*	*0.03*	*0*	*1.6*	*1.1*	*0.5*	*0*	*2.8*	*2.8*	*1.5*
blue jay	0	0.11	0.08	0.03	0	1.6	1.1	0.5	0	2.8	2.8	1.5
Swifts/Hummingbirds	**0**	**0.03**	**0**	**0**	**0**	**0.4**	**0**	**0**	**0**	**2.8**	**0**	**0**
chimney swift	0	0.03	0	0	0	0.4	0	0	0	2.8	0	0
Woodpeckers	**0.02**	**0**	**0.03**	**0.02**	**0.9**	**0**	**0.4**	**0.3**	**2.0**	**0**	**2.8**	**1.5**
northern flicker	0	0	0	0.02	0	0	0	0.3	0	0	0	1.5
red-headed woodpecker	0	0	0.03	0	0	0	0.4	0	0	0	2.8	0
downy woodpecker	0.02	0	0	0	0.9	0	0	0	2.0	0	0	0
Unidentified Birds	**0**	**0**	**0.03**	**0.06**	**0**	**0**	**0.4**	**1.0**	**0**	**0**	**2.8**	**2.0**
unidentified bird (small)	0	0	0.03	0.06	0	0	0.4	1.0	0	0	2.8	2.0
Small Birds Overall[a]	**2.07**	**6.94**	**7.37**	**5.66**	**100**	**100**	**100**	**100**				

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

Appendix C. Flight Height Characteristics and Species Exposure Indices for Large and Small Birds Recorded during Fixed-Point Bird Use Surveys at the Walleye Wind Energy Project Study Area from January 29 – December 17, 2018

Appendix C1. Flight characteristics for each large bird species[a] recorded during fixed-point[b] bird use surveys at the Walleye Wind Energy Project Study Area from January 29 – December 17, 2018.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within RSH Based on Initial Obs	Exposure Index	% Within RSH at anytime
American crow	34	1.27	77.1	17.3	0.17	25.3
rock pigeon	33	1.15	83.8	7.9	0.08	17.0
turkey vulture	10	0.08	100	50.0	0.04	66.7
American white pelican	1	0.04	100	100	0.04	100
red-tailed hawk	12	0.09	76.5	53.8	0.04	61.5
Franklin's gull	1	0.03	100	100	0.03	100
Canada goose	3	0.11	100	25.0	0.03	25.0
mourning dove	17	0.23	75.0	8.3	0.01	8.3
Swainson's hawk	8	0.07	80.0	12.5	<0.01	75.0
American kestrel	1	<0.01	100	100	<0.01	100
unidentified buteo	2	0.01	100	50.0	<0.01	50.0
bald eagle	1	<0.01	100	100	<0.01	100
Eurasian collared-dove	3	0.04	66.7	0	0	0
ring-necked pheasant	3	0.08	46.2	0	0	0
short-eared owl	1	<0.01	100	0	0	0
unidentified raptor	1	<0.01	100	0	0	0
northern harrier	3	0.02	75.0	0	0	33.3
broad-winged hawk	1	<0.01	100	0	0	0
sharp-shinned hawk	1	<0.01	100	0	0	0
Cooper's hawk	3	0.02	100	0	0	33.3
ring-billed gull	2	0.01	100	0	0	0
killdeer	7	0.07	80.0	0	0	0
upland sandpiper	1	0.02	33.3	0	0	0
unidentified shorebird	1	0.14	100	0	0	0
snow goose	2	0.62	100	0	0	0
common goldeneye	1	<0.01	100	0	0	100
mallard	1	0.02	100	0	0	0
great blue heron	1	<0.01	100	0	0	0
unidentified gamebird	0	0.04	0	0	0	0
unidentified accipiter	0	<0.01	0	0	0	0

RSH: The likely "rotor-swept heights" for potential collision with a turbine blade, or 25-150 meters (82-492 feet) above ground level.

[a] 800-meter radius plot

[b] per 20-minute survey

Note: obs = observations

Appendix C2. Flight characteristics for each small bird species[a] recorded during fixed-point[b] bird use surveys at the Walleye Wind Energy Project Study Area from January 29 – December 17, 2018.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within RSH Based on Initial Obs	Exposure Index	% Within RSH at anytime
horned lark	23	1.67	76.4	30.4	0.39	35.3
common grackle	21	0.23	96.9	38.7	0.09	38.7
European starling	7	0.07	90.0	55.6	0.03	55.6
red-winged blackbird	18	0.39	73.8	11.1	0.03	11.1
American goldfinch	6	0.18	30.8	50.0	0.03	50.0
barn swallow	20	0.17	100	12.5	0.02	12.5
western meadowlark	6	0.13	33.3	28.6	0.01	28.6
eastern meadowlark	1	<0.01	100	100	<0.01	100
eastern kingbird	2	0.02	66.7	50.0	<0.01	50.0
bobolink	3	0.07	30.0	33.3	<0.01	33.3
chimney swift	1	<0.01	100	100	<0.01	100
tree swallow	4	0.03	100	25.0	<0.01	25.0
house finch	1	<0.01	100	100	<0.01	100
Lapland longspur	1	0.20	2.4	100	<0.01	100
unidentified bird (small)	2	0.02	100	0	0	0
northern flicker	1	<0.01	100	0	0	0
blue jay	1	0.06	22.2	0	0	0
American robin	14	0.26	83.0	0	0	0
bank swallow	1	<0.01	100	0	0	0
cliff swallow	20	0.32	100	0	0	0
unidentified swallow	2	0.01	100	0	0	0
Harris' sparrow	3	0.06	100	0	0	0
chipping sparrow	1	0.02	33.3	0	0	0
dickcissel	4	0.19	19.2	0	0	0
song sparrow	1	0.07	10.0	0	0	0
American pipit	2	0.23	100	0	0	0
unidentified sparrow	4	0.06	36.4	0	0	0
unidentified meadowlark	2	0.01	100	0	0	0
brown-headed cowbird	14	0.18	92.0	0	0	0
Brewer's blackbird	1	<0.01	100	0	0	0
unidentified blackbird	4	0.20	72.5	0	0	0
unidentified passerine	12	0.36	18.7	0	0	0
downy woodpecker	0	<0.01	0	0	0	0
red-headed woodpecker	0	<0.01	0	0	0	0
house wren	0	0.02	0	0	0	0
sedge wren	0	<0.01	0	0	0	0
common yellowthroat	0	0.04	0	0	0	0
indigo bunting	0	<0.01	0	0	0	0
brown thrasher	0	<0.01	0	0	0	0
American tree sparrow	0	0.02	0	0	0	0
clay-colored sparrow	0	<0.01	0	0	0	0
vesper sparrow	0	0.02	0	0	0	0
Savannah sparrow	0	0.04	0	0	0	0
house sparrow	0	0.06	0	0	0	0
dark-eyed junco	0	0.01	0	0	0	0
white-breasted nuthatch	0	<0.01	0	0	0	0
Baltimore oriole	0	0.02	0	0	0	0

Appendix C2. Flight characteristics for each small bird species[a] recorded during fixed-point[b] bird use surveys at the Walleye Wind Energy Project Study Area from January 29 – December 17, 2018.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within RSH Based on Initial Obs	Exposure Index	% Within RSH at anytime

RSH: The likely "rotor-swept heights" for potential collision with a turbine blade, or 25-150 meters (82-492 feet) above ground level.

[a] 100-meter radius plot

[b] per 10-minute survey

Note: obs = observations

Appendix D. Mean Use by Point for All Birds, Major Bird Types, and Diurnal Raptor Subtypes Recorded during Fixed-Point Bird Use Surveys at the Walleye Wind Energy Project Study Area from January 29 – December 17, 2018

Appendix D1. Mean use (number of birds/plot[a]/survey[b]) by point for all birds, major bird types, and diurnal raptor subtypes observed at the Walleye Wind Energy Project Study Area during fixed-point bird use surveys from January 29 – December 17, 2018.

	Survey Point											
Bird Type	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Waterbirds	0	0	0	0	0	0	0	0	0.60	0	0	0
Waterfowl	3.17	0.09	0	0.33	0	1.10	5.00	0	0.40	0	0	0
Shorebirds	0	0.09	0.08	0.33	1.67	0.10	0	0	0.30	0	0.30	0
Gulls/Terns	0	0.09	0	0.33	0	0.10	0	0	0	0	0	0
Diurnal Raptors	0.17	0.09	0.50	0.25	0.25	0.20	0.50	0	0.20	0.20	0.60	0
Accipiters	*0*	*0.09*	*0.08*	*0*	*0.08*	*0.10*	*0.10*	*0*	*0*	*0*	*0*	*0*
Buteos	*0.17*	*0*	*0.42*	*0.17*	*0.17*	*0.10*	*0.40*	*0*	*0.20*	*0.20*	*0.30*	*0*
Northern Harrier	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0.10*	*0*
Eagles	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0.10*	*0*
Falcons	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0.10*	*0*
Other Raptors	*0*	*0*	*0*	*0.08*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Owls	0	0.09	0	0	0	0	0	0	0	0	0	0
Vultures	0	0	0	0	0.33	0	0.20	0.30	0	0.10	0.20	0
Upland Game Birds	0	0.09	0	0.25	0.08	0.50	0	0.20	0	0	0.10	0
Doves/Pigeons	0.42	0.36	0.08	0.42	0.83	0.20	3.90	1.60	4.40	1.30	0.50	0.90
Large Corvids	0.08	1.18	0.08	0.17	0.17	2.30	0.30	3.60	6.30	0.70	4.40	0
All Large Birds[c]	**3.83**	**2.09**	**0.75**	**2.08**	**3.33**	**4.50**	**9.90**	**5.70**	**12.20**	**2.30**	**6.10**	**0.90**
Passerines	10.92	4.55	2.83	8.00	5.25	3.30	5.80	2.80	5.30	3.90	7.60	3.90
Swifts/Hummingbirds	0.08	0	0	0	0	0	0	0	0	0	0	0
Woodpeckers	0	0	0.08	0.08	0	0	0	0	0	0	0	0
Unidentified Birds	0	0	0	0	0	0	0	0	0	0.10	0	0
All Small Birds[c]	**11.00**	**4.55**	**2.92**	**8.08**	**5.25**	**3.30**	**5.80**	**2.80**	**5.30**	**4.00**	**7.60**	**3.90**

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

[b] per 20-minute (min) survey for large birds; per 10-min survey for small birds

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

Appendix D1 (*continued*). Mean use (number of birds/plot[a]/survey[b]) by point for all birds, major bird types, and diurnal raptor subtypes observed at the Walleye Wind Energy Project Study Area during fixed-point bird use surveys from January 29 – December 17, 2018.

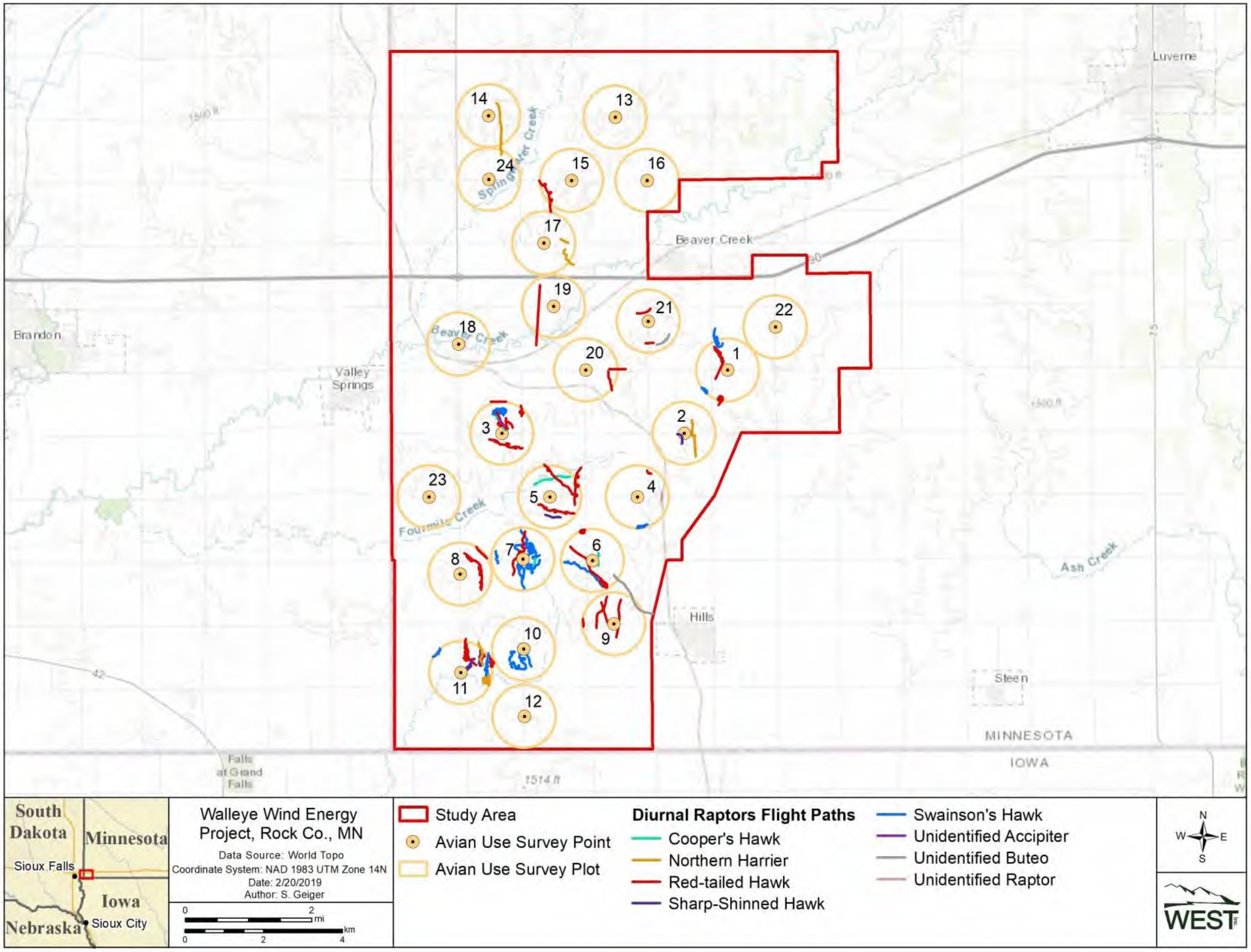
	Survey Point											
Bird Type	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
Waterbirds	0	0	0.33	0	0	0	0	0	0	0	0	0
Waterfowl	0	0	0	0	0	0	0	0	0	0	0	0
Shorebirds	0	0	0	0	0	0	0	0	0	0	0	0
Gulls/Terns	0	0	0	0	0	0	0	0	0	0	0	0
Diurnal Raptors	0	0.33	0.33	0	0.67	0	0.33	0.67	1.00	0	0	0
Accipiters	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Buteos	*0*	*0*	*0.33*	*0*	*0*	*0*	*0.33*	*0.67*	*1.00*	*0*	*0*	*0*
Northern Harrier	*0*	*0.33*	*0*	*0*	*0.67*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Eagles	*0*	*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*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Owls	0	0	0	0	0	0	0	0	0	0	0	0
Vultures	0	0	0	0	0	0	0	0	0	0	0	0
Upland Game Birds	0	0	0	0	0	0.33	1.33	0	0	0	0	0
Doves/Pigeons	0	2.00	0	0	0.67	13.00	6.67	1.00	3.67	0	0.50	0
Large Corvids	0	0.33	0.33	0	0	0.67	2.33	0	0	0.67	0	1.00
All Large Birds[c]	**0**	**2.67**	**1.00**	**0**	**1.33**	**14.00**	**10.67**	**1.67**	**4.67**	**0.67**	**0.50**	**1.00**
Passerines	16.67	7.67	0.33	0	1.33	3.33	2.00	17.33	27.00	0	0	0
Swifts/Hummingbirds	0	0	0	0	0	0	0	0	0	0	0	0
Woodpeckers	0	0	0	0	0	0	0.33	0	0	0	0	0
Unidentified Birds	0	0	0	0	0	1.00	0	0	0	0	0	0
All Small Birds[c]	**16.67**	**7.67**	**0.33**	**0**	**1.33**	**4.33**	**2.33**	**17.33**	**27.00**	**0**	**0**	**0**

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

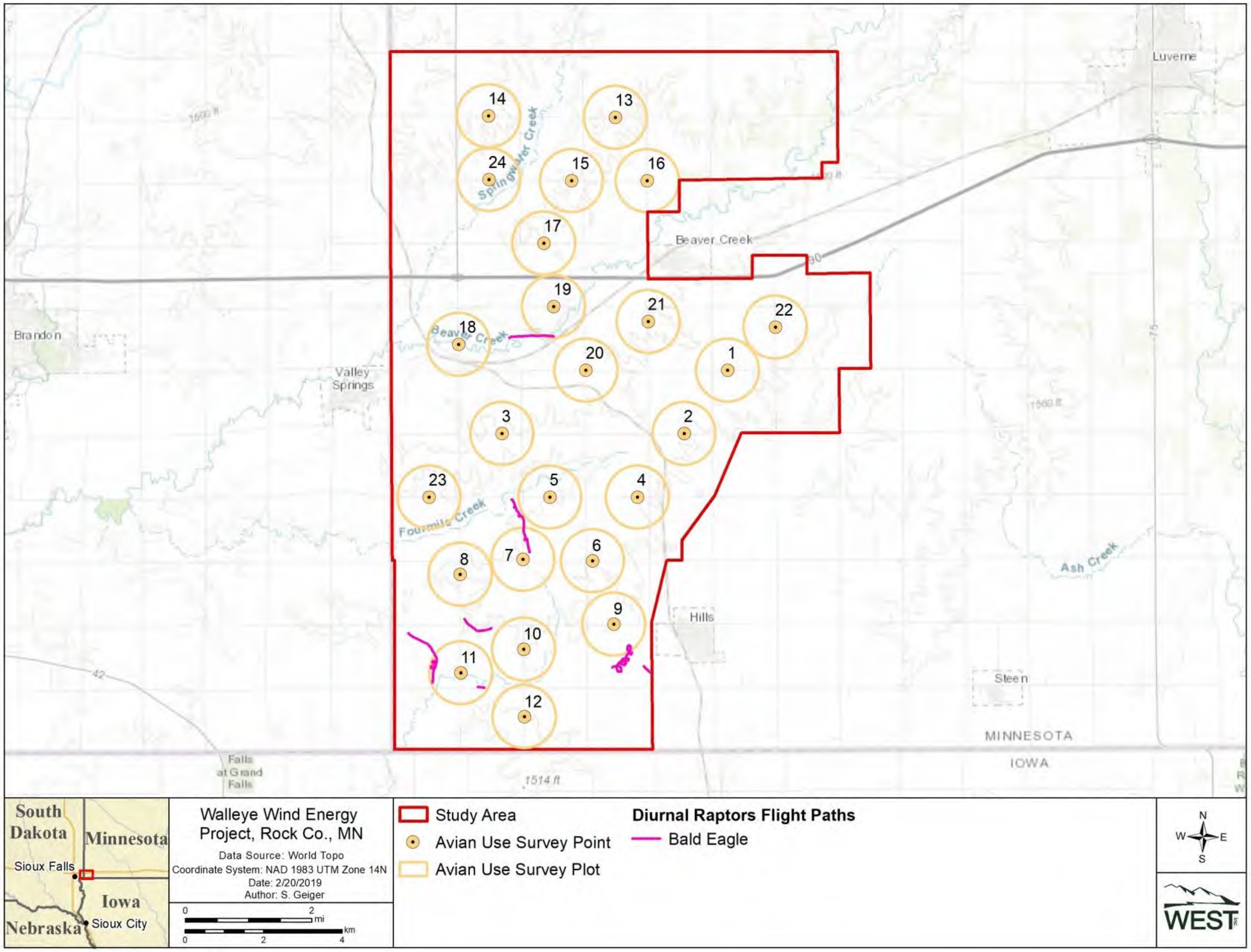
[b] per 20-minute (min) survey for large birds; per 10-min survey for small birds

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

Appendix E. Diurnal Raptor and Eagle Flight Paths Recorded during 20-Minute Large Bird and 60-Minute Eagle Surveys at the Walleye Wind Energy Project Study Area from January 29 – December 17, 2018



Appendix E1. Diurnal raptor (non-eagle) flight paths recorded at the Walleye Wind Energy Project Study Area during 20-minute large bird surveys from January 29 – December 17, 2018.



Appendix E2. Eagle flight paths recorded at the Walleye Wind Energy Project Study Area during 60-minute eagle surveys from January 29 – December 17, 2018.

Appendix F. Fatality Summary Tables for the Midwest Region of North America

Appendix F1. Wind energy facilities in the Midwest region of North America with publicly available and comparable fatality data for all bird species.

Wind Energy Facility	Fatality Estimate[a]	Number. of Turbines	Total Megawatts
	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
Waverly Wind, KS (2016-2017)	5.95	95	199
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
Odell, MN (2016-2017)	4.69	100	200
Black Oak Getty, MN (2017)	4.37	39	78
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, ON (2008)	3.09	38	76
Fowler I, IN (2009)	2.83	162	301
Lakefield Wind, MN (2012)	2.75	137	205.5
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
Thunder Spirit, ND (2016-2017)	1.49	43	108
PrairieWinds ND1 (Minot), ND (2010)	1.48	80	115.5
Buffalo Ridge, MN (Phase I; 1999)	1.43	73	25
PrairieWinds SD1, SD (2011-2012)	1.41	108	162
Top Crop I & II (2012-2013)	1.35	68 (phase I) 132 (phase (II)	300 (102 [phase I] 198 [phase II])
Prince Wind Farm, ON (2008)	0.89	126	189
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
Pleasant Valley, MN (2016-2017)	0.68	100	200
Big Blue, MN (2013)	0.6	18	36
Grand Ridge I, IL (2009-2010)	0.48	66	99
Prairie Rose, MN (2014)	0.44	119	200
Top of Iowa, IA (2003)	0.42	89	80
Big Blue, MN (2014)	0.37	18	36
Pioneer Prairie I, IA (Phase II; 2011-2012)	0.27	62	102.3
Prince Wind Farm, ON (2007)	0.26	126	189

[a] Number of bird fatalities/megawatt/year

Appendix F1 (*continued*). Wind energy facilities in the Midwest region of North America with publicly available and comparable fatality data for all bird species.

Data from the following sources:

Wind Energy Facility	Estimate Reference	Wind Energy Facility	Estimate Reference
Barton I & II, IA (2010-2011)	Derby et al. 2011a	NPPD Ainsworth, NE (2006)	Derby et al. 2007
Big Blue, MN (2013)	Fagen Engineering 2014	Odell, MN (2016-2017)	Chodachek and Gustafson 2018
Big Blue, MN (2014)	Fagen Engineering 2015	Pioneer Prairie I, IA (Phase II; 2011-2012)	Chodachek et al. 2012
Black Oak Getty, MN (2017)	Pickle et al. 2018	Pleasant Valley, MN (2016-2017)	Tetra Tech 2017b
Blue Sky Green Field, WI (2008; 2009)	Gruver et al. 2009	Prairie Rose, MN (2014)	Chodachek et al. 2015
Buffalo Ridge I, SD (2009-2010)	Derby et al. 2010d	PrairieWinds ND1 (Minot), ND (2010)	Derby et al. 2011b
Buffalo Ridge II, SD (2011-2012)	Derby et al. 2012a	PrairieWinds ND1 (Minot), ND (2011)	Derby et al. 2012b
Buffalo Ridge, MN (Phase I; 1996)	Johnson et al. 2000	PrairieWinds SD1, SD (2011-2012)	Derby et al. 2012c
Buffalo Ridge, MN (Phase I; 1997)	Johnson et al. 2000	PrairieWinds SD1, SD (2012-2013)	Derby et al. 2013
Buffalo Ridge, MN (Phase I; 1998)	Johnson et al. 2000	PrairieWinds SD1, SD (2013-2014)	Derby et al. 2014
Buffalo Ridge, MN (Phase I; 1999)	Johnson et al. 2000	Prince Wind Farm, ON (2007)	Natural Resource Solutions, Inc. 2008b
Buffalo Ridge, MN (Phase II; 1998)	Johnson et al. 2000	Prince Wind Farm, ON (2008)	Natural Resource Solutions, Inc. 2009
Buffalo Ridge, MN (Phase II; 1999)	Johnson et al. 2000	Rail Splitter, IL (2012-2013)	Good et al. 2013b
Buffalo Ridge, MN (Phase III; 1999)	Johnson et al. 2000	Ripley, ON (2008)	Jacques Whitford 2009
Cedar Ridge, WI (2009)	BHE Environmental 2010	Rugby, ND (2010-2011)	Derby et al. 2011c
Cedar Ridge, WI (2010)	BHE Environmental 2011	Thunder Spirit, ND (2016-2017)	Derby et al. 2018
Elm Creek II, MN (2011-2012)	Derby et al. 2012d	Top Crop I & II (2012-2013)	Good et al. 2013a
Elm Creek, MN (2009-2010)	Derby et al. 2010c	Top of Iowa, IA (2003)	Jain 2005
Fowler I, IN (2009)	Johnson et al. 2010a	Top of Iowa, IA (2004)	Jain 2005
Grand Ridge I, IL (2009-2010)	Derby et al. 2010f	Waverly Wind, KS (2016-2017)	Tetra Tech 2017a
Kewaunee County, WI (1999-2001)	Howe et al. 2002	Wessington Springs, SD (2009)	Derby et al. 2010a
Lakefield Wind, MN (2012)	Minnesota Public Utilities Commission 2012	Wessington Springs, SD (2010)	Derby et al. 2011d
Moraine II, MN (2009)	Derby et al. 2010b	Winnebago, IA (2009-2010)	Derby et al. 2010e

Appendix F2. Wind energy facilities in the Midwest region of North America with publicly-available and comparable use and fatality data for raptors.

Wind Energy Facility	Use Estimate[a]	Raptor Fatality Estimate[b]	Number of Turbines	Total Megawatts
Walleye Wind Energy Project, MN	**0.24**	**-**	**-**	**-**
	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
Thunder Spirit, ND (2016-2017)	NA	0.18	43	108
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, ON (2008)	NA	0.1	38	76
Prairie Rose, MN (2014)	NA	0.08	119	200
Wessington Springs, SD (2010)	0.232	0.07	34	51
NPPD Ainsworth, NE (2006)	NA	0.06	36	20.5
Rugby, ND (2010-2011)	NA	0.06	71	149
Wessington Springs, SD (2009)	0.232	0.06	34	51
PrairieWinds ND1 (Minot), ND (2010)	NA	0.05	80	115.5
PrairieWinds ND1 (Minot), ND (2011)	NA	0.05	80	115.5
PrairieWinds SD1, SD (2012-2013)	NA	0.03	108	162
Barton I & II, IA (2010-2011)	NA	0	80	160
Big Blue, MN (2013)	NA	0	18	36
Big Blue, MN (2014)	NA	0	18	36
Black Oak Getty, MN (2017)	NA	0	39	78
Blue Sky Green Field, WI (2008; 2009)	NA	0	88	145
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
Buffalo Ridge, MN (Phase II; 1998)	NA	0	143	107.25
Buffalo Ridge, MN (Phase II; 1999)	NA	0	143	107.25
Buffalo Ridge, MN (Phase III; 1999)	NA	0	138	103.5
Elm Creek II, MN (2011-2012)	NA	0	62	148.8
Elm Creek, MN (2009-2010)	NA	0	67	100
Fowler I, IN (2009)	NA	0	162	301
Grand Ridge I, IL (2009-2010)	0.195	0	66	99
Kewaunee County, WI (1999-2001)	NA	0	31	20.46
Lakefield Wind, MN (2012)	NA	0	137	205.5
Pioneer Prairie I, IA (Phase II; 2011-2012)	NA	0	62	102.3
PrairieWinds SD1, SD (2011-2012)	NA	0	108	162
Rail Splitter, IL (2012-2013)	NA	0	67	100.5
Top of Iowa, IA (2003)	NA	0	89	80

[a] Number of raptors/plot/20-minute survey

[b] Number of fatalities/megawatt/year

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

Data from the following sources:

Wind Energy Facility	Use Estimate	Fatality Estimate	Wind Energy Facility	Use Estimate	Fatality Estimate
Barton I & II, IA (2010-2011)		Derby et al. 2011a	Kewaunee County, WI (1999-2001)		Howe et al. 2002
Big Blue, MN (2013)		Fagen Engineering 2014	Lakefield Wind, MN (2012)		Minnesota Public Utilities Commission 2012
Big Blue, MN (2014)		Fagen Engineering 2015	Moraine II, MN (2009)		Derby et al. 2010b
Black Oak Getty, MN (2017)		Pickle et al. 2018	NPPD Ainsworth, NE (2006)		Derby et al. 2007
Blue Sky Green Field, WI (2008; 2009)		Gruver et al. 2009	Pioneer Prairie I, IA (Phase II; 2011-2012)		Chodachek et al. 2012
Buffalo Ridge I, SD (2009-2010)		Derby et al. 2010d	Prairie Rose, MN (2014)		Chodachek et al. 2015
Buffalo Ridge II, SD (2011-2012)		Derby et al. 2012a	PrairieWinds ND1 (Minot), ND (2010)		Derby et al. 2011b
Buffalo Ridge, MN (Phase I; 1996)		Johnson et al. 2000	PrairieWinds ND1 (Minot), ND (2011)		Derby et al. 2012b
Buffalo Ridge, MN (Phase I; 1997)		Johnson et al. 2000	PrairieWinds SD1, SD (2011-2012)		Derby et al. 2012c
Buffalo Ridge, MN (Phase I; 1998)		Johnson et al. 2000	PrairieWinds SD1, SD (2012-2013)		Derby et al. 2013
Buffalo Ridge, MN (Phase I; 1999)		Johnson et al. 2000	PrairieWinds SD1, SD (2013-2014)		Derby et al. 2014
Buffalo Ridge, MN (Phase II; 1998)		Johnson et al. 2000	Rail Splitter, IL (2012-2013)		Good et al. 2013b
Buffalo Ridge, MN (Phase II; 1999)		Johnson et al. 2000	Ripley, ON (2008)		Jacques Whitford 2009
Buffalo Ridge, MN (Phase III; 1999)		Johnson et al. 2000	Rugby, ND (2010-2011)		Derby et al. 2011c
Cedar Ridge, WI (2009)		BHE Environmental 2010	Thunder Spirit, ND (2016-2017)		Derby et al. 2018
Cedar Ridge, WI (2010)		BHE Environmental 2011	Top of Iowa, IA (2003)		Jain 2005
Elm Creek II, MN (2011-2012)		Derby et al. 2012d	Top of Iowa, IA (2004)		Jain 2005
Elm Creek, MN (2009-2010)		Derby et al. 2010c	Wessington Springs, SD (2009)	Derby et al. 2008	Derby et al. 2010a
Fowler I, IN (2009)		Johnson et al. 2010a	Wessington Springs, SD (2010)		Derby et al. 2011d
Grand Ridge I, IL (2009-2010)	Derby et al. 2009	Derby et al. 2010f	Winnebago, IA (2009-2010)		Derby et al. 2010e

Appendix G. Summary of Publicly Available Studies at Modern North American Wind Energy Facilities in the Midwest that Report Fatality and Species Data for Birds

Appendix G. Summary of publicly available studies at modern North American wind energy facilities in the Midwest that report cumulative fatality and species data for birds by individuals.

Data from the following sources:

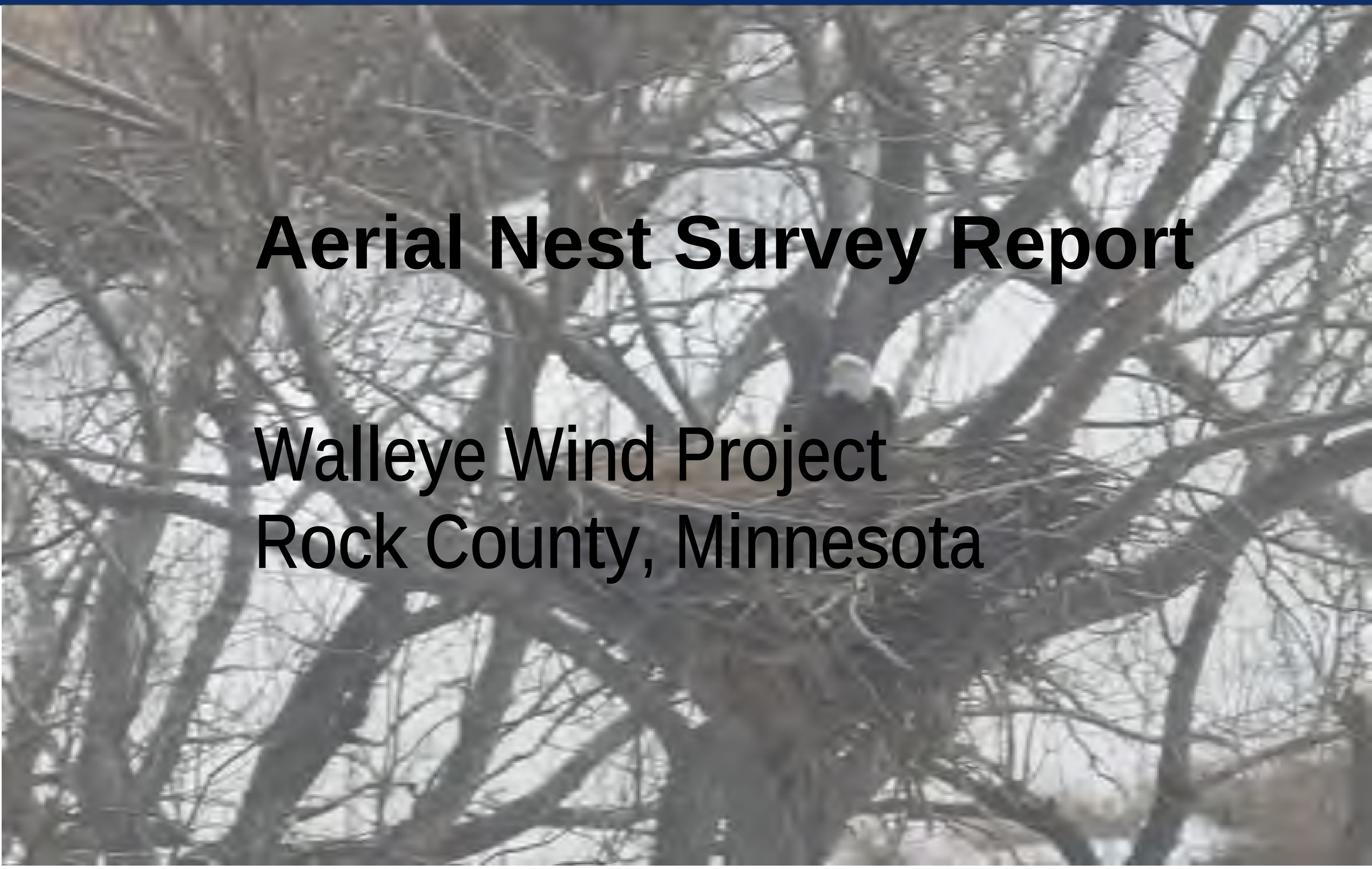
Project, Location	Reference	Project, Location	Reference
Barton I & II, IA (2010-2011)	Derby et al. 2011a	Fowler I, II, III, IN (2012)	Good et al. 2013c
Big Blue, MN (2013)	Fagen Engineering 2014	Fowler III, IN (2009)	Johnson et al. 2010b
Big Blue, MN (2014)	Fagen Engineering 2015	Grand Ridge I, IL (2009-2010)	Derby et al. 2010f
Blue Sky Green Field, WI (2008; 2009)	Gruver et al. 2009	Harrow, Ont (2010)	Natural Resource Solutions 2011
Buffalo Ridge, MN (1994-1995)	Osborn et al. 1996, 2000	Heritage Garden I, MI (2012-2013)	Kerlinger et al. 2014
Buffalo Ridge, MN (2000)	Johnson et al. 2000	Heritage Garden I, MI (2013-2014)	Kerlinger et al. 2014
Buffalo Ridge, MN (Phase I; 1996)	Johnson et al. 2000	Kewaunee County, WI (1999-2001)	Howe et al. 2002
Buffalo Ridge, MN (Phase I; 1997)	Johnson et al. 2000	Lakefield Wind, MN (2012)	Minnesota Public Utilities Commission 2012
Buffalo Ridge, MN (Phase I; 1998)	Johnson et al. 2000	Melancthon, Ont (Phase I; 2007)	Stantec Ltd. 2008
Buffalo Ridge, MN (Phase I; 1999)	Johnson et al. 2000	Moraine II, MN (2009)	Derby et al. 2010b
Buffalo Ridge, MN (Phase II; 1998)	Johnson et al. 2004	NPPD Ainsworth, NE (2006)	Derby et al. 2007
Buffalo Ridge, MN (Phase II; 1999)	Johnson et al. 2004	Pioneer Prairie I, IA (Phase II; 2011-2012)	Chodachek et al. 2012
Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)	Johnson et al. 2000	Pioneer Prairie II, IA (2013)	Chodachek et al. 2014
Buffalo Ridge, MN (Phase III; 1999)	Johnson et al. 2004	Pioneer Trail, IL (2012-2013)	ARCADIS 2013
Buffalo Ridge, MN (Phase III; 2001/Lake Benton II)	Johnson et al. 2004	Prairie Rose, MN (2014)	Chodachek et al. 2015
Buffalo Ridge I, SD (2009-2010)	Derby et al. 2010d	PrairieWinds ND1 (Minot), ND (2010)	Derby et al. 2011b
Buffalo Ridge II, SD (2011-2012)	Derby et al. 2012a	PrairieWinds ND1 (Minot), ND (2011)	Derby et al. 2012b
Cedar Ridge, WI (2009)	BHE Environmental 2010	PrairieWinds SD1 (Crow Lake), SD (2011-2012)	Derby et al. 2012c
Cedar Ridge, WI (2010)	BHE Environmental 2011	PrairieWinds SD1 (Crow Lake), SD (2012-2013)	Derby et al. 2013
Crescent Ridge, IL (2005-2006)	Kerlinger et al. 2007	PrairieWinds SD1 (Crow Lake), SD (2013-2014)	Derby et al. 2014
Crystal Lake II, IA (2009)	Derby et al. 2010g	Rail Splitter, IL (2012-2013)	Good et al. 2013b
Elm Creek, MN (2009-2010)	Derby et al. 2010c	Ripley, Ont (2008)	Jacques Whitford 2009
Elm Creek II, MN (2011-2012)	Derby et al. 2012d	Ripley, Ont (Fall 2009)	Golder Associates 2010
Forward Energy Center, WI (2008-2010)	Grodsky and Drake 2011	Rugby, ND (2010-2011)	Derby et al. 2011c

Appendix G. Summary of publicly available studies at modern North American wind energy facilities in the Midwest that report cumulative fatality and species data for birds by individuals.

Data from the following sources:

Project, Location	Reference	Project, Location	Reference
Fowler, IN (2014)	Good et al. 2014	Top Crop I & II, IL (2012-2013)	Good et al. 2013a
Fowler, IN (2015)	Good et al. 2016	Top of Iowa, IA (2003)	Jain 2005
Fowler, IN (2016)	Good et al. 2017	Top of Iowa, IA (2004)	Jain 2005
Fowler I, IN (2009)	Johnson et al. 2010a	Wessington Springs, SD (2009)	Derby et al. 2010a
Fowler I, II, III, IN (2010)	Good et al. 2011	Wessington Springs, SD (2010)	Derby et al. 2011d
Fowler I, II, III, IN (2011)	Good et al. 2012	Winnebago, IA (2009-2010)	Derby et al. 2010e

Environmental Consulting & Technology, Inc.
161 East Aurora Road, Northfield, OH 44067



Aerial Nest Survey Report

Walleye Wind Project
Rock County, Minnesota

Walleye Wind Project, LLC
Juno Beach, Florida

June 9, 2020
ECT No. 190497

Complex Challenges . . . *PRACTICAL SOLUTIONS*

Document Review

The dual signatory process is an integral part of Environmental Consulting & Technology, Inc.'s (ECT's) Document Review Policy No. 9.03. All ECT documents undergo technical/peer review prior to dispatching these documents to any outside entity.

This document has been authored and reviewed by the following employees:

Edward Keyel	Brian Ortman
Author	Reviewer
Signature	Signature
06/09/2020	06/09/2020
Date	Date

Table of Contents

List of Acronyms and Abbreviations

2020 Eagle Nest Survey Area	10-mile buffer surrounding and including the Wind Resource Area (based on 12/30/2019 Wind Resource Area boundary)
ECPG	Eagle Conservation Plan Guidance
ECT	Environmental Consulting & Technology, Inc.
GIS	Geographic Information System
IGEIMP	Interim Golden Eagle Inventory and Monitoring Protocols
Ft	Foot
MIND	Mean Inter-nest Distance
MW	Megawatt
Project	Walleye Wind Project
T&E	Threatened and Endangered
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
Walleye Wind	Walleye Wind Project, LLC
WEST	Western EcoSystems Technology, Inc.
WRA	Wind Resource Area

Executive Summary

Walleye Wind, LLC (Walleye Wind) contracted Environmental Consulting & Technology, Inc. (ECT), to conduct an aerial nest survey for the proposed, 110.8-megawatt (MW) wind energy facility, Walleye Wind Project (Project) located in Rock County, Minnesota. The purpose of this survey was to record bald eagle (*Haliaeetus leucocephalus*) nests within the Wind Resource Area (WRA) (31,095-acres (49 square miles) and an associated 10-mile buffer (2020 Eagle Nest Survey Area), and to record non-eagle raptor nests within the WRA and surrounding 1-mile buffer. It should be noted that limited data were collected for non-eagle raptor nests based on previously provided databases or incidental discoveries. This survey was conducted in accordance with the guidance provided in the U.S. Fish and Wildlife Service (USFWS) *Eagle Conservation Plan Guidance* (ECPG) and the USFWS *Interim Golden Eagle Inventory and Monitoring Protocols* (IGEIMP).

The 2020 aerial nest survey conducted by ECT, evaluated 1-mile transects within the 2020 Eagle Nest Survey Area and 0.5-mile transects within the WRA. The helicopter aerial nest survey was conducted between February 26 – 29, 2020 between 08:00 hours and 18:00 hours each day. A follow-up ground-based survey was conducted on April 1, 2020 for unknown nests within the WRA to ascertain which species were occupying the nests and activity of the nests.

The 2020 ECT surveys provide additional information on eagle and raptor use within the vicinity of the WRA in addition to previous studies completed throughout the area. A total of 88 nest structures, representing three (3) identified raptor species: red-tailed hawk (*Buteo jamaicensis*), great horned owl (*Bubo virginianus*), and bald eagle were detected as potential raptor nesting sites. There are two (2) inactive non-eagle raptor nests that are located within the WRA. The 2020 ECT survey effort identified eleven (11) active bald eagle nests within the 2020 Eagle Nest Survey Area. No federally or state-listed threatened or endangered raptor species were observed nesting within the WRA or the associated buffers.

1.0 Introduction

Walleye Wind, LLC (Walleye Wind) is proposing a 110.8 MW, wind energy facility, within Rock County, Minnesota. Walleye Wind contracted Environmental Consulting & Technology, Inc. (ECT), to conduct an aerial nest survey for the proposed Walleye Wind Project (Project), Wind Resource Area (WRA) in Rock County, Minnesota (**Figure 1**). The purpose of this survey was to record bald eagle (*Haliaeetus leucocephalus*) and other raptor nests in the proximity of potential turbine siting areas. This survey was conducted in accordance with the guidance provided in the U.S. Fish and Wildlife Service (USFWS) *Eagle Conservation Plan Guidance* (ECPG) (USFWS 2013) and the USFWS *Interim Golden Eagle Inventory and Monitoring Protocols* (IGEIMP) (Pagel et al. 2010).

2016 Raptor Nest Survey (WEST)

Western Ecosystems Technology, Inc. (WEST) conducted an aerial-based raptor nest survey to help evaluate the potential impacts of construction on nesting raptors within a 29,747-acre preliminary Project area on March 24-25, 2016 (**Figure 2**). Surveys within the Project area and 1-mile buffer documented all potential raptor nests, including bald eagles, while the surveys up to the 2016 10-mile buffer focused only on identifying potential bald eagle nests. A WEST biologist detected a total of 38 raptor nests representing three (3) raptor species during aerial surveys. These included two (2) occupied red-tailed hawk (*Buteo jamaicensis*) nests, one (1) occupied great-horned owl (*Bubo virginianus*) nest, and 33 unoccupied, inactive raptor nests of unknown species. No federal or state-listed threatened and endangered (T&E) raptor species were identified nesting within the 2016 Project area or 1-mile buffer (Pickle et al. 2016). Additionally, no occupied or potential bald eagle nests were located within the Project boundary and 1-mile buffer. Two (2) bald eagle nests classified by WEST as occupied active were documented within the 2016 10-mile buffer along the Big Sioux River in South Dakota to the southwest more than 7.5 miles away from the Project area.

2018 Raptor Nest Surveys (WEST)

Western Ecosystems Technology, Inc. conducted an additional raptor nest survey within a preliminary Project area encompassing 18,890 acres in Rock County Minnesota on April 17-19, 2018 (**Figure 2**) (Kreger and Suehring 2018). Raptor surveys were conducted from a helicopter along transects throughout the Project boundary and a 1-mile buffer for raptor nests and out to the 2018 10-mile buffer for eagle nests. The biologist evaluated the behavior of adults on or near the nest, and the presence of eggs, young, whitewash, or fresh building materials to determine the status of a nest. Attempts were made to identify the species of raptor associated with each active nest. A total of 22 stick nests were found representing two (2) identified non-raptor species, one (1) American crow (*Corvus brachyrhynchos*), and one (1) great blue heron (*Ardea herodias*), a colonial waterbird. Identified raptor nests were classified by WEST as: three (3) occupied active bald eagle nests, one (1) occupied inactive bald eagle nest, four (4) occupied red-tailed hawk nests, and 12 unoccupied unidentified raptor species. Both eagle nests identified during the 2016 surveys along the Big Sioux River to the southwest of the current WRA were included and considered active during the 2018 survey period. There were also five (5) unidentified raptor nests that WEST considered to be consistent in size and structure of a bald eagle nests more than 6.5 miles away from the Project area. Three (3) of these potential bald eagle nests were located east and southeast of the reviewed Project area along the Rock River, and the remaining two (2) nests were located to the southwest along the Big Sioux River. One (1) nest was classified by WEST as occupied, inactive and the other four (4) nests were classified by WEST as inactive.

2.0 Wind Resource Area Description

The WRA encompasses approximately 31,095-acres (approximately 49 square miles) in Springwater, Beaver Creek, Luverne, and Martin Townships, in Rock County, Minnesota. The WRA is located along the southwestern border of Minnesota with its western boundary along the Minnesota and South Dakota state line. The largest city near the WRA is Sioux Falls, South Dakota and is located approximately 14 miles southwest of the WRA. The WRA is also located approximately 4.5 miles west of the City of Luverne, Minnesota and encompasses the City of Beaver Creek, Minnesota (**Figure 1**).

The WRA is in a largely rural area dominated by cultivated cropland and pastures. Development in the WRA is low-density and generally concentrated along rural roads and highways. Undeveloped, natural areas within the WRA, such as woodland, wetlands, and grasslands, are not dominant features in the landscape. A network of watercourses covers the majority of the WRA. Topography of the region is generally flat but contains undulating terrain typical of southwestern Minnesota, northwestern Iowa, and eastern South Dakota, with approximate elevations ranging between 1,400-1,660 ft above mean sea level (USGS 2017a, b, 2019a, b, c).

3.0 Methods

3.1 Aerial Nest Survey

Aerial nest surveys were conducted in accordance with the guidance provided in the ECPG (USFWS 2013) and the IGEIMP (Pagel et al. 2010). A raptor ecologist and a helicopter pilot conducted the surveys. Raptors are defined here as kites, accipiters, buteos, harriers, eagles, falcons, and owls. Pre-flight planning included the creation of field maps and geographic information system (GIS) files and review of relevant background information, such as previously recorded nest locations, topographic maps, and aerial photographs.

Surveys within the WRA boundary and 1-mile buffer documented all potential raptor nests, including bald eagle nests, while the surveys within a 10-mile buffer, which was set based on the 12/30/19 WRA boundary, (2020 Eagle Nest Survey Area), focused on identifying potential bald eagle eyries (large, stick nest structures) in suitable eagle nesting substrate (trees, transmission lines, cliff faces, etc.).

The 2020 aerial nest survey conducted by ECT evaluated 1-mile transects within the 2020 Eagle Nest Survey Area and 0.5-mile transects within the WRA (USFWS 2013). Flight-line transects at 0.5-mile intervals were created across the WRA using a GIS (**Figure 3**). The helicopter aerial nest survey was conducted between February 26 – 29, 2020, which coincided with peak bald eagle detectability per that species' local breeding phenology (Buehler, D. 2000). Surveys were conducted between 08:00 hours and 18:00 hours. The helicopter was flown at relatively slow speeds (30 to 40 knots). No noticeable leaf-out of forest canopy was evident at the time of surveys. Efforts were made to minimize disturbance to breeding raptors. The greatest possible distance at which species could be identified was maintained, with distance varying, depending upon nest location and wind conditions.

The helicopter was positioned to allow thorough visual inspection of the habitat, especially to provide a view of the tops of the tallest, dominant, trees where bald eagles generally prefer to nest. The locations of all potential raptor nests were recorded using Fulcrum, an electronic data entry application (Spatial Networks 2020). All confirmed and potential nests were recorded regardless of their activity status. A unique nest identification number was assigned to each nest documented.

Bald eagle nests range from 4.9-5.9 ft in diameter and 2.3-3.9 ft in height. Nest shape is reported as conforming to the shape of the substrate tree and can be cylindrical, cone-shaped, or even platform-like (Buehler 2000). It can be difficult to judge such dimensions in the field, particularly when viewing nest structures from a distance through high-powered optics. Helicopters can be used to gain a better perspective for nest shape and size and to attain additional visual cues by hovering above each nest (Bird and Bildstein 2007).

The biologist evaluated the behavior of adults on or near the nest and documented the presence of eggs, young, whitewash, or fresh building materials to determine the status of a nest. Nest status was categorized using definitions consistent with the ECPG (USFWS 2013). Nests were classified as occupied if any of the following were observed at the nest structure: (1) an adult in an incubating position; (2) eggs; (3) nestlings or fledglings; (4) a pair of adults (sometimes sub-adults); (5) a newly constructed or refurbished stick nest in the area where territorial behavior of a raptor had been observed earlier in the breeding season; or (6) a recently repaired nest with fresh sticks (clean breaks) or fresh boughs on top, and/or droppings and/or molted feathers on its rim or underneath. Occupied nests were further classified as active if (1) an adult was present on the nest in incubating position, (2) an egg or eggs were present, or (3) nestlings were observed. Nests were classified as alternate if it was not being attended by eagles for breeding purposes. Nests not meeting the above criteria for “Occupied” were classified as “Unoccupied”.

Nest substrate was recorded to provide observers a visual reference to relocate the nest. Substrates may include manmade structures (e.g., power lines, nest platforms, or dock hoists), biological structures (e.g., coniferous trees, deciduous trees), and geological structures (e.g., cliff faces).

A species was assigned to each nest when possible, otherwise, it was classified as an unknown raptor nest. Nests documented as unknown raptor species were defined as any stick nest not having an occupant associated with it at the time of the survey. Nests may become abandoned over time or stop being used, becoming historic nest sites. Unknown raptor nests were documented in order to populate a database to ensure future surveys include all potentially suitable nest sites. Nests that appeared consistent in size and shape with bald eagle nests were further classified as potential alternate nest sites for bald eagles. Attempts were made to identify the species of raptor, nest status, and nest substrate at each nest location to the extent possible. A follow-up ground-based survey was conducted on April 1, 2020 for unknown nests within the WRA in an attempt to ascertain which species were occupying the nests and activity-level of the nests.

4.0 Results

A total of 88 nest structures representing three (3) identified raptor species: red-tail hawk, great horned owl, and bald eagle were detected as possible raptor nesting locations during the February 26 – 29, 2020 aerial nest survey period (**Table 1**). This total includes nests identified in 2016 and 2018 aerial surveys and represents the currently available raptor nest structures. No federally or state-listed threatened or endangered raptor species were observed nesting within the WRA or the associated buffers.

4.1 Bald Eagles

Ten (10) active bald eagle nests were located within the 2020 Eagle Nest Survey Area, (**Table 1, Figure 1**). One (1) alternate nest was previously active, failed May 2020 and one (1) possible historic eagle nest structure were also located within 10 miles of the WRA boundary. Five (5) of the 12 bald eagle nests within the 2020 Eagle Nest Survey Area of the WRA were newly identified during the 2020 survey effort.

One (1) bald eagle was identified as incidental migrating to the north in the WRA during the 2020 aerial nest survey and is not associated with any nest. An additional 33 bald eagles were observed as incidental (not associated with a nest) within the 2020 Eagle Nest Survey Area during the 2020 aerial nest survey.

The following section provides more details on each active and alternate eagle nest documented during the aerial nest surveys and are organized by activity (active, occupied, alternate) and then by distance to the WRA.

Nest Little Beaver Creek – This nest is located approximately 0.8 miles from the WRA. The nest was in excellent condition at the time of the survey with an adult bald eagle in the nest in an incubating position and a second adult bald eagle approximately 65 ft away (**Appendix A**). This alternate nest was previously active, failed May 2020. (**Table 1, Figure 1**).

Nest 3099 – This nest is located approximately 4.4 miles east of the WRA. The nest was in excellent condition at the time of the survey with an adult bald eagle in an incubating position and another adult bald eagle perched nearby. This nest was considered active in 2020 (**Table 1,**

Figure 1). This nest was originally documented during previous surveys and considered inactive by WEST in 2018 (**Appendix B**) (Kreger and Suehring 2018).

Nest 3100 – This nest is located approximately 4.4 miles east of the WRA. The nest was in fair condition at the time of the survey, with one (1) bald eagle in the nest. This nest was considered active in 2020 (**Table 1, Figure 1**). This nest was originally documented in previous aerial surveys and was considered inactive by WEST in 2018 (**Appendix B**) (Kreger and Suehring 2018).

Nest 3101 - This nest is located approximately 5.8 miles southeast of the WRA. The nest was in fair condition at the time of the survey with an adult bald eagle in an incubating position. This nest was considered active in 2020 (**Table 1, Figure 1**). This nest was originally documented in previous surveys and considered inactive by WEST in 2018 (**Appendix B**) (Kreger and Suehring 2018).

Nest Garretson – This nest is located approximately 5.9 miles northwest of the WRA. The nest was in good condition at the time of the survey, with one (1) bald eagle in the nest. This nest was considered active in 2020 (**Table 1, Figure 1**).

Nest Jasper-Sherman – This nest is located approximately 7.7 miles north of the WRA. The nest was in excellent condition at the time of the survey with an adult bald eagle in an incubating position (**Appendix A**). This nest was considered active in 2020 (**Table 1, Figure 1**).

Nest 16132 – This nest is located approximately 7.8 miles southwest of the WRA. This nest was in excellent condition at the time of the survey with an adult bald eagle in an incubating position. This nest was considered active in 2020 (**Table 1, Figure 1**). This nest was originally documented in previous surveys and considered active by WEST in 2016 (**Appendix C**) (Pickle et al. 2016).

Nest Kenneth-Luverne – This nest is located approximately 8.6 miles east of the WRA. The nest was in excellent condition at the time of the survey with an adult bald eagle in an incubating position and another adult bald eagle perched nearby. This nest was considered active in 2020 (**Table 1, Figure 1**).

Nest 16138 – This nest is located approximately 8.8 miles west of the WRA. The nest was in good condition at the time of the survey, with an adult bald eagle in an incubating position and a second adult bald eagle perched nearby. This nest was considered active in 2020 (**Table 1, Figure 1**). This nest was originally documented in previous surveys and considered active by WEST in 2016 and in 2018 (**Appendix B, Appendix C**) (Pickle et al. 2016, Kreger and Suehring 2018).

Nest 16134 – This nest is located approximately 9.4 miles southwest of the WRA. The nest was in good condition at the time of the survey, with an adult bald eagle in an incubating position. This nest was considered active in 2020 (**Table 1, Figure 1**). This nest was originally documented in previous surveys and considered occupied, inactive by WEST in 2018 (**Appendix B**) (Kreger and Suehring 2018).

Nest RocRap – This nest is located approximately 8.5 miles south-southeast of the WRA. The nest was in fair condition at the time of the survey with two (2) adult bald eagles close to the nest. This nest was considered occupied in 2020 (**Table 1, Figure 1**).

Nest 16133. A possible historic eagle nest structure was located approximately 8.3 miles southwest of the WRA. This nest was last observed in 2018 survey effort, and it was classified by WEST as occupied, inactive (Kreger and Suehring 2018). This nest was not detected during aerial surveys in 2020.

4.2 Non-Eagle Nests

Seven (7) nests were classified as “unknown raptor” nest structures within the WRA and 1-mile buffer (**Figure 4**). These unknown raptor nests may not have been active for the current breeding season or may have been active nests that, at the time of the raptor nest surveys, were either not yet in use, or activity was not detectable at the time of surveys. These “unknown raptor” nests were not consistent in size and shape with bald eagle nests.

In addition to raptor nests identified during the survey one (1) American crow nest structure was identified within the WRA and 1-mile buffer. These nest structures have the potential to provide nesting resources for raptors species.

5.0 Discussion

The 2020 aerial nest surveys add additional data to those surveys already conducted in 2016 and 2018. The 2020 ECT aerial nest survey searched for all known bald eagle nests within the 2020 Eagle Nest Survey Area and all known raptor nests within one (1) mile of the WRA. Some previously recorded nests not identified as being utilized by eagles, were not assessed during the 2020 survey, because those nests are located beyond 10 miles from the WRA (**Figure 2**).

The surveys conducted by ECT provided additional information on eagle and raptor use within the vicinity of the WRA. The 2020 raptor nest surveys found no bald eagle nests within the WRA and confirmed the presence of 10 active bald eagle nest within 10 miles of the WRA.

The USFWS uses a one-half the mean inter-nest distance (MIND) calculation for nests in the regional vicinity of a project to estimate areas with the potential for higher eagle use (USFWS 2013). The one-half MIND of all active bald eagle nests observed during this survey within the WRA and 10-mile buffer is approximately 1.91 mi.

Raptor nest resources identified during this aerial nest survey across the WRA and 2020 Eagle Nest Survey Area were limited to those species whose breeding phenology in southwest Minnesota overlaps with late-February/early-March. This aerial nest survey was timed to coincide with peak bald eagle detectability in accordance with the local bald eagle breeding phenology; however, it is unlikely that many other nests will become active eagle nests after this date. This time period is also good to capture nesting behavior for partial migrants such as red-tailed hawks and great horned owls which are the predominate species of nesting raptors within the open agricultural landscape of southwest Minnesota.

6.0 References

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USGS (2019b). Hills Quadrangle, Minnesota - Iowa.

USGS (2019c). Hills NE Quadrangle, Minnesota - Rock County.

Tables

Table 1. Nest structure locations within the Walleye Wind Project Wind Resource Area and 10-mile buffer.

Species	Nest	Latitude	Longitude	Status
American Crow	AMCR 004	43.7894	-96.2547	Occupied
American Crow	AMCR 006	43.6289	-96.6358	Occupied
American Crow	AMCR 001	43.7410	-96.4723	Unoccupied
American Crow	AMCR 002	43.8955	-96.3456	Unoccupied
American Crow	AMCR 003	43.8995	-96.3279	Unoccupied
American Crow	AMCR 005	43.8267	-96.2242	Unoccupied
American Crow	AMCR 007	43.6466	-96.6154	Unoccupied
American Crow	AMCR 008	43.7169	-96.5927	Unoccupied
American Crow	AMCR 009	43.8097	-96.5545	Unoccupied
Bald Eagle	BAEA 16132	43.5627	-96.5942	Active
Bald Eagle	BAEA 16134	43.5231	-96.5976	Active
Bald Eagle	BAEA 16138	43.6068	-96.6281	Active
Bald Eagle	BAEA 3099	43.6254	-96.1982	Active
Bald Eagle	BAEA JasSher	43.8049	-96.4522	Active
Bald Eagle	BAEA KenLuv	43.7140	-96.1198	Active
Bald Eagle	BAEA 3100	43.6410	-96.2005	Active
Bald Eagle	BAEA 3101	43.5306	-96.1871	Active
Bald Eagle	BAEA Gar	43.7390	-96.5413	Active
Bald Eagle	BAEA RocRap	43.4704	-96.1819	Occupied
Bald Eagle	BAEA LBC	43.6482	-96.3064	Alternate
Bald Eagle	BAEA 16133	43.5495	-96.5983	Alternate
Great Blue Heron	GBHE 001*	43.5565	-96.5800	Unoccupied
Great Blue Heron	GBHE 3102	43.6394	-96.1899	Unoccupied
Great Horned Owl	GHOW 001	43.8856	-96.3812	Active
Great Horned Owl	GHOW 002	43.6325	-96.1991	Active
Great Horned Owl	GHOW 3097	43.5864	-96.3672	Active
Great Horned Owl	GHOW 003	43.7063	-96.3146	Unoccupied
Red-tailed Hawk	RTHA 002	43.4950	-96.4671	Active
Red-tailed Hawk	RTHA 003	43.8360	-96.4248	Active
Red-tailed Hawk	RTHA 005	43.8719	-96.3725	Active
Red-tailed Hawk	RTHA 009	43.7251	-96.5654	Active
Red-tailed Hawk	RTHA 3089	43.5821	-96.4284	Active
Red-tailed Hawk	RTHA 3095	43.5495	-96.3740	Active
Red-tailed Hawk	RTHA 001	43.5408	-96.6366	Occupied
Red-tailed Hawk	RTHA 006	43.8110	-96.1936	Occupied
Red-tailed Hawk	RTHA 004	43.7982	-96.3934	Unoccupied
Red-tailed Hawk	RTHA 007	43.5490	-96.5918	Unoccupied
Red-tailed Hawk	RTHA 008	43.6155	-96.6182	Unoccupied

Species	Nest	Latitude	Longitude	Status
Red-tailed Hawk	RTHA 010	43.8711	-96.5458	Unoccupied
Red-tailed Hawk	RTHA 012	43.7077	-96.3129	Unoccupied
Red-tailed Hawk	RTHA 011	43.7547	-96.4721	Unoccupied
Unknown	UNKN 001	43.8081	-96.3773	Unoccupied
Unknown	UNKN 002	43.5267	-96.3753	Unoccupied
Unknown	UNKN 003	43.5275	-96.3659	Unoccupied
Unknown	UNKN 004	43.4625	-96.2034	Unoccupied
Unknown	UNKN 005	43.5521	-96.1985	Unoccupied
Unknown	UNKN 006	43.7003	-96.1528	Unoccupied
Unknown	UNKN 007	43.6114	-96.6431	Unoccupied
Unknown	UNKN 008	43.7369	-96.5972	Unoccupied
Unknown	UNKN 009	43.8739	-96.5693	Unoccupied
Unknown	UNKN 010	43.6675	-96.5778	Unoccupied
Unknown	UNKN 011	43.6470	-96.4606	Unoccupied
Unknown	UNKN 012	43.5439	-96.4397	Unoccupied
Unknown	UNKN 013	43.9008	-96.4035	Unoccupied
Unknown	UNKN 014	43.7175	-96.3771	Unoccupied
Unknown	UNKN 015	43.6936	-96.3718	Unoccupied
Unknown	UNKN 016	43.8790	-96.3222	Unoccupied
Unknown	UNKN 017	43.4681	-96.3343	Unoccupied
Unknown	UNKN 019	43.7688	-96.2670	Unoccupied
Unknown	UNKN 020	43.7912	-96.1775	Unoccupied
Unknown	UNKN 021	43.4897	-96.1359	Unoccupied
Unknown	UNKN 022	43.6438	-96.1132	Unoccupied
Unknown	UNKN 023	43.6626	-96.4870	Unoccupied
Unknown	UNKN 024	43.7552	-96.4727	Unoccupied
Unknown	UNKN 025	43.6816	-96.4685	Unoccupied
Unknown	UNKN 026	43.7472	-96.4462	Unoccupied
Unknown	UNKN 027	43.5835	-96.4088	Unoccupied
Unknown	UNKN 028	43.7902	-96.3811	Unoccupied
Unknown	UNKN 029	43.6303	-96.3864	Unoccupied
Unknown	UNKN 030	43.5729	-96.3868	Unoccupied
Unknown	UNKN 031	43.6584	-96.3468	Unoccupied
Unknown	UNKN 032	43.5550	-96.3549	Unoccupied
Unknown	UNKN 033	43.7073	-96.3113	Unoccupied
Unknown	UNKN 034	43.7537	-96.6379	Unoccupied
Unknown	UNKN 035	43.7534	-96.6142	Unoccupied
Unknown	UNKN 036	43.6625	-96.4859	Unoccupied
Unknown	UNKN 036	43.6026	-96.5373	Unoccupied
Unknown	UNKN 037	43.6587	-96.3468	Unoccupied

*There were 11 great blue heron nests within the rookery

Note: Species were identified where possible. Nests were given unique name codes, though nest names from 2018 were kept for consistency (**Appendix B**) (Kreger and Suehring 2018). All nests were found in deciduous trees.

Figures

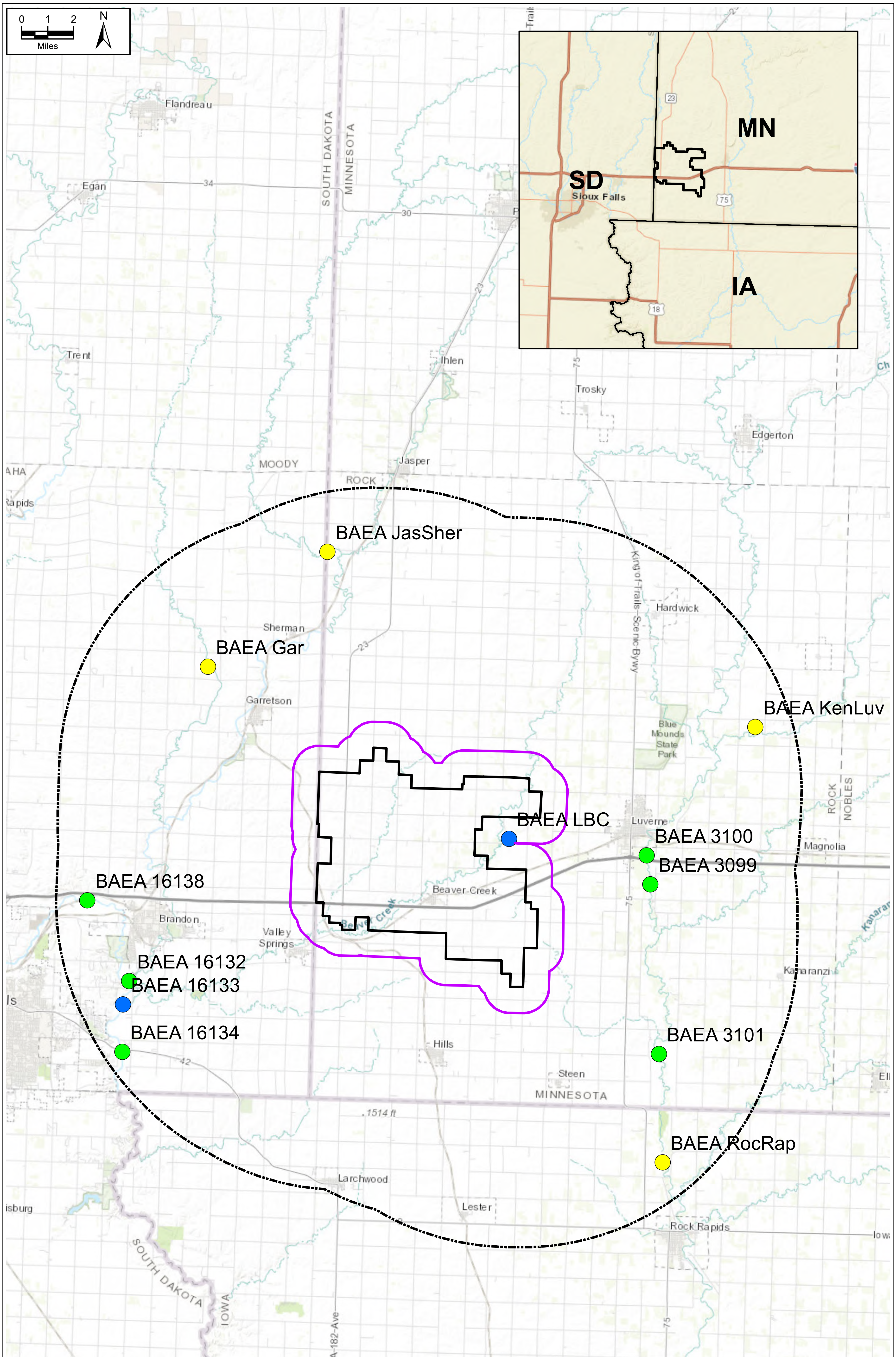

FIGURE 1.
ACTIVE EAGLE NEST LOCATION MAP
WALLEYE WIND PROJECT
WALLEYE WIND, LLC

Sources: ECT, 2020.

Eagle Nest Status
- 2020/Active 2020
- 2018/Active 2020
- Alternate 2020

- Project Boundary (06/03/20)
- 1 Mile Buffer (06/03/20)
- 10 Mile Buffer (06/03/20)

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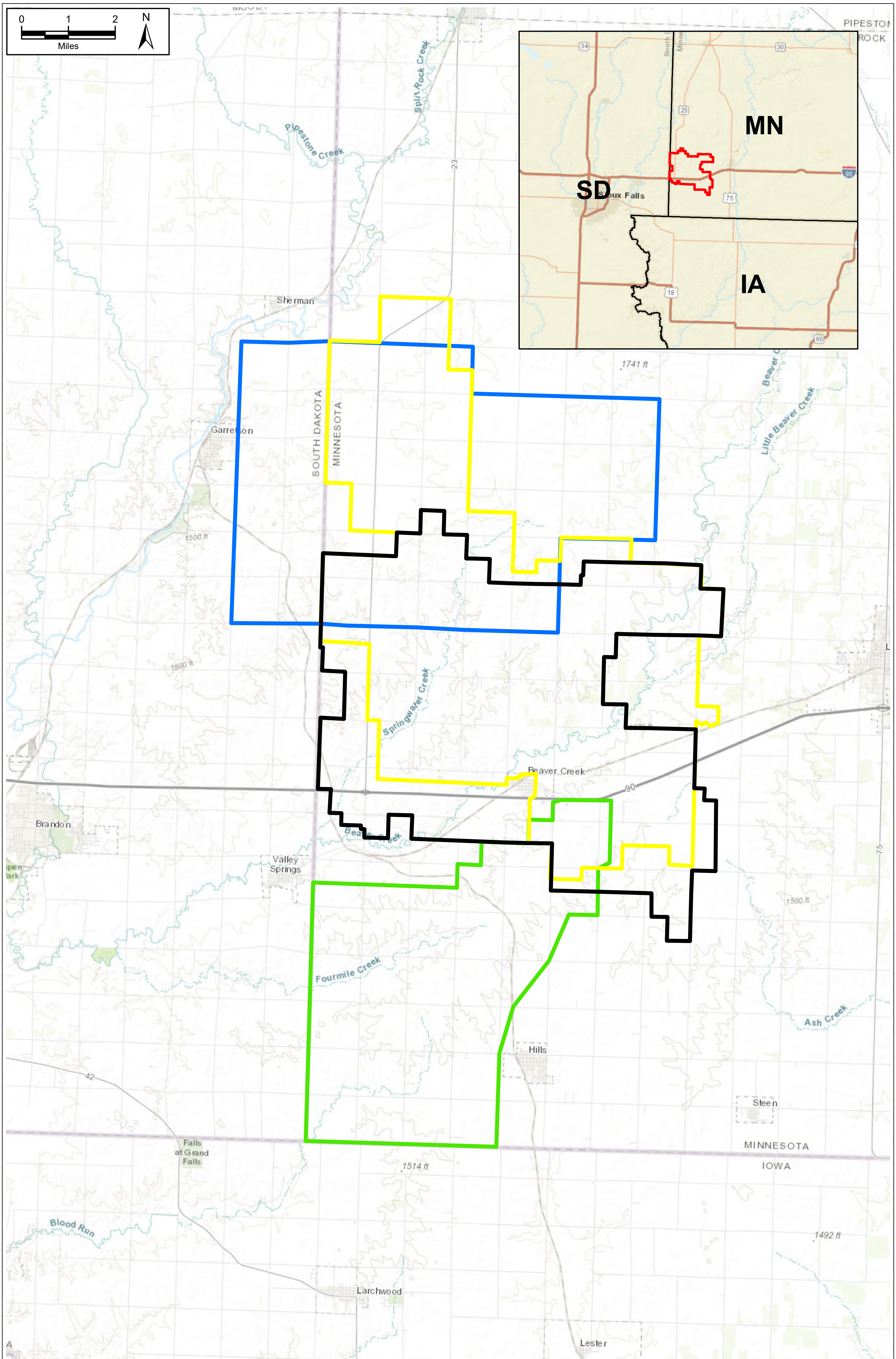

FIGURE 2.
PROJECT BOUNDARIES MAP
WALLEYE WIND PROJECT
WALLEYE WIND, LLC

Sources: ECT, 2020.

2020 Project Boundary (06/03/20)
2019 Project Boundary (12/30/19)
2018 Project Boundary
2016 Project Boundary

ECT

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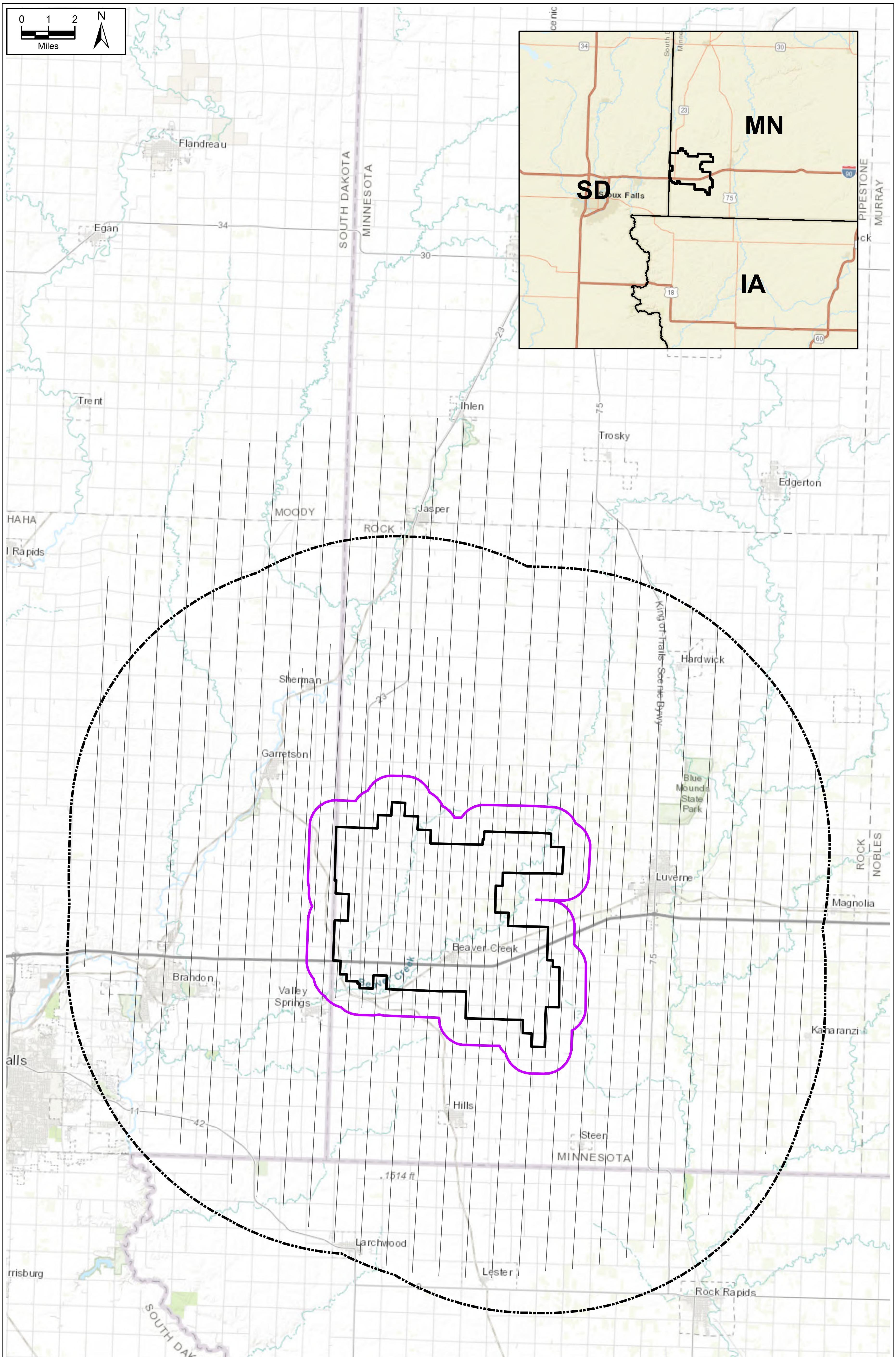

FIGURE 3.
SURVEY TRANSECTS MAP
WALLEYE WIND PROJECT
WALLEYE WIND, LLC

Sources: ECT, 2020.

Project Boundary (06/03/20)
Transects
1 Mile Buffer (06/03/20)
10 Mile Buffer (06/03/20)

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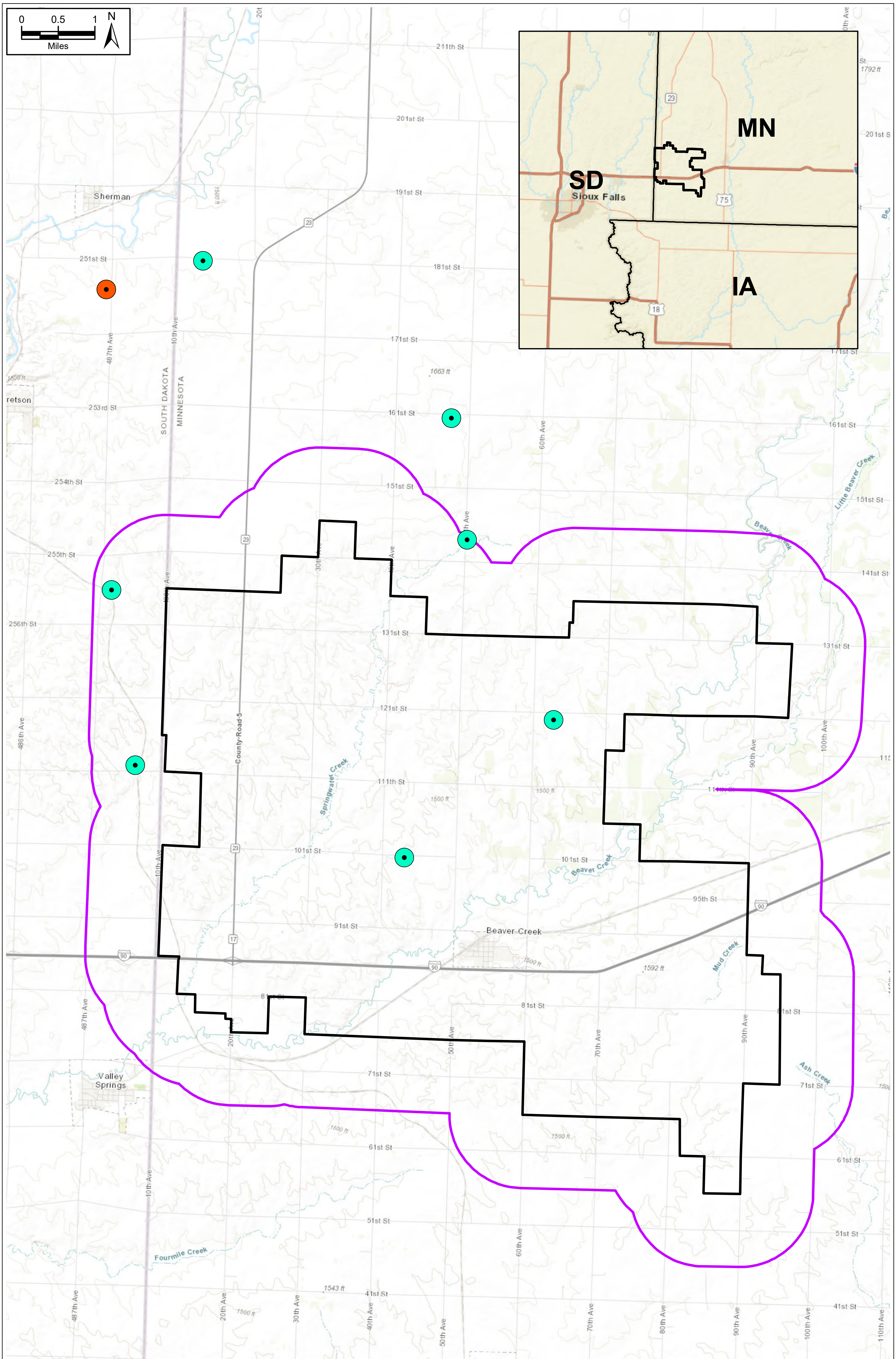

FIGURE 4.
ECT 2020 SURVEY
NON-EAGLE NEST LOCATION
WALLEYE WIND PROJECT
WALLEYE WIND, LLC

American Crow Nest
Non-Eagle Raptor Nest
Project Boundary (06/03/20)
1 Mile Buffer (06/03/20)

Sources: ECT, 2020.

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Appendix A

Representative Photographs

PHOTOGRAPHIC LOG

Photo #1	
Feature: Nest Little Beaver Creek	
Lat/Long: 43.6482, -96.3064	
Description: Nest Little Beaver Creek – This nest was located within the southeastern portion of the WRA. The nest was in excellent condition with an adult bald eagle in the nest and a second adult bald eagle approximately 20m away.	

Photo #2	
Feature: Representative Bald Eagle Nest Photograph	
Lat/Long: 43.8049, -96.4522	
Description: Nest Jasper-Sherman was located approximately 3.1 miles to the north of the WRA. The nest was in excellent condition, with fresh lining and an adult bald eagle perched on the nest. This nest was considered active in 2020.	

Appendix B

2018 West Aerial Nest Survey Report

2018 Raptor Nest Survey Report

Walleye Wind Energy Project

Rock County, Minnesota

Prepared for:

Walleye Wind Project, LLC

330 2nd Avenue South, Suite 820
Minneapolis, Minnesota 55401

Prepared by:

Western EcoSystems Technology, Inc.

7575 Golden Valley Road, Suite 350
Golden Valley, Minnesota 55427

August 15, 2018

UPDATED February 20, 2020

STUDY PARTICIPANTS

Western EcoSystems Technology, Inc.

Joyce Pickle	Senior Manager
Adam Kreger	Project Manager
Cecily Foo	Biologist
Aaron Suehring	Biologist/Report Writer
Alaini Schneider Cossette	Biologist/Report Writer
Carmen Boyd	Project Tracking and Data Manager
Fawn Hornsby	Data Manager
Brian Barbieri	GIS Specialist
David Klein	Technical Editing Manager
Katie Wynne	Technical Editing Coordinator
Natasha Wheeler	Technical Editor

REPORT REFERENCE

Western EcoSystems Technology, Inc. 2018. Raptor Nest Survey Report for the Walleye Wind Energy Project, Rock County, Minnesota. Prepared for Walleye Wind Project, LLC. Minneapolis, Minnesota. Prepared by Western EcoSystems Technology, Inc. (WEST), Golden Valley, Minnesota. August 15, 2018. Updated February 20, 2020.

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INTRODUCTION

Walleye Wind Project, LLC (Walleye Wind) is considering the development of a utility-scale wind energy project, the Walleye Wind Energy Project (Project), in Rock County, Minnesota. At the request of Walleye Wind, Western EcoSystems Technology, Inc. (WEST) conducted an aerial raptor nest survey to record bald eagle (*Haliaeetus leucocephalus*) and other raptor nests in the proximity of potential turbine siting areas. This survey will aid in assessing potential effects of the Project on eagles and other raptors. The survey was conducted in accordance with the guidance provided in the US Fish and Wildlife Service (USFWS) *Eagle Conservation Plan Guidance* (ECPG; USFWS 2013) and the USFWS *Interim Golden Eagle Technical Guidance* (Pagel et al. 2010).

SURVEY AREA

The boundary of the proposed Project area encompasses 18,890 acres (76.4 square kilometers, 29.5 square miles) in Rock County, Minnesota (Figure 1). The Project area falls within the Western Corn Belt Plains Ecoregion, which encompasses southern Minnesota (US Environmental Protection Agency 2013). The Western Corn Belt Plains Ecoregion is composed of glaciated till plains and undulating loess plains. Much of the region was originally dominated by tall-grass prairie, riparian forest, oak-prairie savannas, and brushy and herbaceous wetlands. Today, most of the area has been cleared for highly productive farms producing corn, soybeans and livestock. Many smaller streams in this ecoregion have been tilled, ditched and tied into existing drainage systems which has caused a reduction in the amount of aquatic habitat. The Project area is on the very southern edge of the Prairie Coteau in Minnesota.

The elevation of the Project area ranges from approximately 404 – 485 meters (1,325 – 1,591 feet). Topography of the Project is generally flat with some gently rolling hills; a majority of the site (88%) is cultivated for crop production. A number of streams are present within the Project area.

METHODS

Raptor Nest Survey

Raptor surveys were conducted from a helicopter from April 17 – 19, 2018, a period before leaf out when raptors are actively tending to a nest or incubating eggs. Aerial surveys were conducted in accordance with the guidance provided in the ECPG (USFWS 2013) and the USFWS *Interim Golden Eagle Technical Guidance* (Pagel et al. 2010). A raptor ecologist and a helicopter pilot conducted the surveys. Raptors are defined here as kites, accipiters, buteos, harriers, eagles, falcons, and owls (Buehler 2000). Pre-flight planning included the creation of field maps and mobile Geographic Information System files and review of relevant background information, such as previously recorded nest locations, topographic maps, and aerial photographs.

Surveys within the Project boundary and 1-mile (1.6-kilometer [km]) buffer documented all potential raptor nests, including bald eagles, while the surveys out to the 10-mi (16-km) buffer focused only on identifying potential bald eagle nests. Bald eagle nest surveys focused on locating eyries (large, stick nest structures) in suitable eagle nesting substrate (trees, transmission lines, cliff faces, etc.) within and around the proposed Project area (Figure 1). Efforts were made to minimize disturbance to breeding raptors; the greatest possible distance at which the species could be identified was maintained, with distances varying, depending upon nest location and wind conditions.

In general, all potential raptor nest habitat was surveyed by flying transects spaced 0.25 – 1.0 mi (0.8 – 1.6 km) apart, flying at speeds of approximately 46 mi per hour (74 km per hour) when actively scanning for nests. Surveys were typically conducted between 07:00 hours and 18:00 hours.

The survey track was recorded using a Global Positioning System (GPS) enabled tablet device to ensure that all areas were adequately covered. The helicopter was positioned to allow thorough visual inspection of the habitat, and in particular, to provide a view of the tops of the tallest dominant trees where bald eagles generally prefer to nest (Buehler 2000). The locations of all potential raptor nests were recorded using a GPS enabled tablet running locus pro software. This included all confirmed and potential nests regardless of their activity status.

To determine the status of a nest, the biologist evaluated behavior of adults on or near the nest, and presence of eggs, young, whitewash, or fresh building materials. Attempts were made to identify the species of raptor associated with each active nest. Raptor species, nest type, nest status, nest condition, and nest substrate were recorded at each nest location to the extent possible.

Terminology

Included below are descriptions of terms used during the documentation of nests (see Results section).

Nest ID – A unique nest identification number was assigned for each nest documented.

Species – A species was assigned to each nest when possible, otherwise, it was classified as an unidentified raptor nest. Nests documented as unidentified raptor species were defined as any stick nest not having an occupant associated with it at the time of the survey. Many times nests become abandoned or are no longer used, and over time, may become a historic nest site. Unidentified raptor nests, including old nests or nests that could become suitable for raptors, were documented in order to populate a nest database to ensure future surveys include all potentially suitable nest sites. Unidentified raptor species nests that appeared consistent in size and structure with bald eagle nests were further classified as potential alternate nest sites for bald eagles.

Nest Condition – Nest condition was categorized as good, fair, or poor. Although the determination of nest condition can be subjective and may vary between observers, it gives a general sense of when a nest or nest site was last used. Nests in good condition were excellently maintained with very well-defined bowl, no sagging, possible to use immediately or currently in use. Nests in fair condition had a fairly well-defined bowl, minor sagging, and might require some repair or addition to use immediately. Nests in poor condition were sloughing or sagging heavily and would require effort to restore for successful nesting.

Substrate – Nest substrate was recorded to provide observers a visual reference to re-locate the nest. Substrates may include manmade structures such as power lines, nest platforms, and dock hoists, and biological and physical structures such as conifer and deciduous tree species or cliff faces.

Nest Status – Nest status was categorized using definitions consistent with the USFWS ECPG. When applicable, bald eagle nests and potential bald eagle nests are further classified in the nest details section as "in-use" or "alternate" based on updated definitions of these terms in the final eagle rule effective January 17, 2017 (50 CFR Parts 13 and 22). Nests were classified as occupied if any of the following were observed at the nest structure: (1) an adult in an incubating position; (2) eggs; (3) nestlings or fledglings; (4) a pair of adults (sometimes sub-adults); (5) a newly constructed or refurbished stick nest in the area where territorial behavior of a raptor had been observed earlier in the breeding season; or (6) a recently repaired nest with fresh sticks (clean breaks) or fresh boughs on top, and/or droppings and/or molted feathers on its rim or underneath. Occupied nests were further classified as active if (1) an adult was present on the nest in incubating position, (2) an egg or eggs were present, or (3) nestlings were observed. Nests were classified as inactive if no eggs or chicks were present. Nests not meeting the above criteria for "Occupied" were classified as "Unoccupied".

RESULTS

A total of 22 stick nests representing two identified raptor species and one colonial waterbird species were detected during aerial surveys conducted April 17 – 19, 2018 (Table 1). Three occupied active bald eagle nests and one occupied inactive bald eagle nest were documented along the Big Sioux River, all of which were more than 7.0 miles (11.3 km) from the Project. Five unidentified raptor nests appeared consistent in size and structure with bald eagle nests: one was occupied inactive and four were inactive. All of these potential bald eagle nests were more than 6.5 miles (10.4 km) from the Project. Additional raptor nests documented during the survey included four occupied active red-tailed hawk (*Buteo jamaicensis*) nests: one within the Project boundary, two within one mile of the Project, and one just outside of the 1-mile buffer of the Project. Seven inactive nests of unidentified raptor species were also documented: six within the Project boundary and one within one mile of the Project. One stick nest that may have been built by a raptor (but was occupied by American crow [*Corvus brachyrhynchos*]) was documented within one mile of the Project. One occupied active great blue heron (*Ardea herodias*) rookery was also observed 7.3 miles from the Project.

The following section provides more details on each eagle nest and nests consistent in size and structure with eagle nests documented during the aerial surveys:

Nest 16132 – This nest was located approximately 7.1 mi (11.4 km) west of the Walleye Wind Energy Project area. The nest was in good condition at the time of the aerial survey. One adult bald eagle was observed on the nest in an incubating position, and the nest was considered an occupied active bald eagle nest in 2018 (Figure 1, Appendix A1). WEST also documented this nest as an occupied active bald eagle nest in 2016 (previous recorded as Nest 37; Pickle et al. 2016).

Nest 16135 – This nest was located approximately 8.3 mi (13.4 km) southwest of the Walleye Wind Energy Project area and was a new nest documented by WEST in 2018. The nest was in good condition at the time of the aerial survey. One adult bald eagle was observed on the nest in an incubating position, and the nest was considered an occupied active bald eagle nest in 2018 (Figure 1, Appendix A2).

Nest 16138 – This nest was located approximately 9.0 mi (14.5 km) northwest of the Walleye Wind Energy Project area. The nest was in good condition at the time of the aerial survey. One adult bald eagle was observed on the nest in an incubating position. The nest was considered an occupied active bald eagle nest in 2018 (Figure 1, Appendix A3). WEST also documented this nest as an occupied active bald eagle nest in 2016 (previously recorded as Nest 38; Pickle et al. 2016).

Nest 16134 – This nest was located approximately 7.2 mi (11.6 km) west of the Walleye Wind Energy Project area and was a new nest documented by WEST in 2018. The nest was in good condition at the time of the aerial survey and appeared to be recently tended, with both greenery and wash (i.e., fresh/recent droppings) observed in the nest. One adult bald eagle was observed perched on the nest and flying near the nest. Since no eggs or chicks were observed, the nest was considered an occupied inactive bald eagle nest in 2018 (Figure 1, Appendix A4).

Nest 16133 – This nest was located approximately 7.3 mi (11.7 km) west of the Walleye Wind Energy Project area. The nest was in good condition and was consistent in size and structure with a bald eagle nest. No eagles were seen on the nest or in close proximity to the nest; however, wash and feathers were observed in the nest. The nest is therefore considered an occupied inactive unidentified raptor nest in 2018 (Figure 1, Appendix A5).

Nest 3099 – This nest was located approximately 6.6 mi (10.6 km) northeast of the Walleye Wind Energy Project area. The nest was in fair condition and consistent in size and structure with a bald eagle nest. No eagles were seen on the nest or in close proximity to the nest. The nest was therefore considered inactive in 2018 (Figure 1, Appendix A6).

Nest 3100 – This nest was located approximately 6.8 mi (10.9 km) northeast of the Walleye Wind Energy Project area. The nest was in fair condition and consistent in size and structure with a bald eagle nest. No eagles were seen on the nest or in close proximity to the nest. The nest was therefore considered inactive in 2018 (Figure 1, Appendix A7).

Nest 3101 - This nest was located approximately 7.8 mi (12.6 km) east of the Walleye Wind Energy Project area. The nest was in fair condition and consistent in size and structure with a bald eagle nest. No eagles were seen on the nest or in close proximity to the nest. The nest was therefore considered inactive in 2018 (Figure 1, Appendix A8).

Nest 16136 – This nest was located approximately 8.5 mi (13.7 km) southwest of the Walleye Wind Energy Project area. The nest was in good condition and was consistent in size and structure with a bald eagle nest. No eagles were seen on the nest or in close proximity to the nest. The nest was therefore considered inactive in 2018 (Figure 1, Appendix A9).

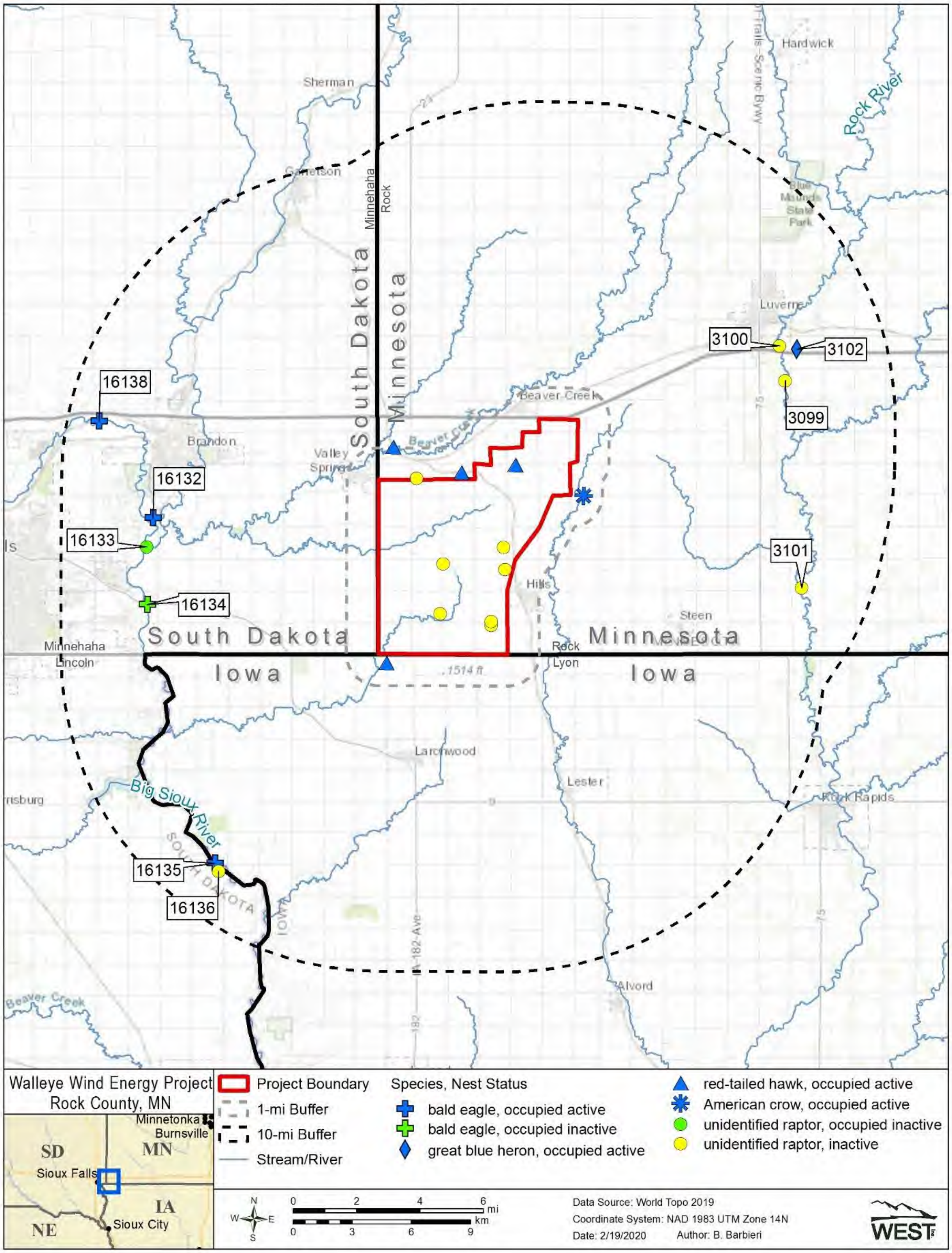

Figure 1. Stick nests documented April 17 – 19, 2018, near the Walleye Wind Energy Project, Rock County, Minnesota.

Table 1. Raptor nest ID, location, species, status, substrate, and condition of nests documented April 17 – 19, 2018, near the Walleye Wind Energy Project, Rock County, Minnesota.

Nest ID	Latitude	Longitude	Species[1]	Status at time of survey	Nest Substrate	Condition
16132	43.5627	-96.5942	BAEA	occupied active	deciduous tree	good
16135	43.4051	-96.5550	BAEA	occupied active	deciduous tree	good
16138	43.6068	-96.6281	BAEA	occupied active	deciduous tree	good
16134	43.5231	-96.5976	BAEA	occupied inactive	deciduous tree	good
16133	43.5495	-96.5983	UNRA*	occupied inactive	deciduous tree	good
3099	43.6250	-96.1971	UNRA*	inactive	deciduous tree	fair
3100	43.6410	-96.2005	UNRA*	inactive	deciduous tree	fair
3101	43.5306	-96.1871	UNRA*	inactive	deciduous tree	fair
16136	43.4016	-96.5528	UNRA*	inactive	deciduous tree	good
3102	43.6394	-96.1899	GBHE	occupied active	deciduous tree	good
3092	43.5833	-96.4004	RTHA	occupied active	deciduous tree	good
3097	43.5866	-96.3664	RTHA	occupied active	deciduous tree	good
16137	43.4964	-96.4475	RTHA	occupied active	deciduous tree	good
16139	43.5949	-96.4431	RTHA	occupied active	deciduous tree	good
3098	43.5727	-96.3239	AMCR	occupied active	deciduous tree	fair
3089	43.5810	-96.4286	UNRA	inactive	deciduous tree	fair
3090	43.5418	-96.4119	UNRA	inactive	deciduous tree	fair
3091	43.5191	-96.4139	UNRA	inactive	deciduous tree	fair
3093	43.5155	-96.3818	UNRA	inactive	deciduous tree	fair
3095	43.5495	-96.3740	UNRA	inactive	deciduous tree	fair
3096	43.5392	-96.3730	UNRA	inactive	deciduous tree	fair
3094	43.5138	-96.3819	UNRA	inactive	deciduous tree	poor

1. AMCR = American crow, BAEA = bald eagle, GBHE = great blue heron, RTHA = red-tailed hawk, UNRA = unidentified raptor species, UNRA* = unidentified species nest characteristic in structure and size of bald eagle and may be an alternate nest or historic nesting site.

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Appendix A. Images of Bald Eagle Nests and Nests Consistent in Size and Structure with Bald Eagle Nests Found April 17 – 19, 2018 within the 10-mile Buffer of the Walleye Wind Energy Project, Rock County, Minnesota

Appendix A1. Nest 16132 was located approximately 7.1 mi (11.4 km) west of the Walleye Wind Energy Project boundary. The nest was in good condition and one bald eagle was observed on the nest in an incubating position. The nest was considered occupied and active in 2018.

Appendix A2. Nest 16135 was located approximately 8.3 mi (13.4 km) southwest of the Walleye Wind Energy Project boundary. The nest was in good condition and one bald eagle was observed on the nest in an incubating position. The nest was considered occupied and active in 2018.

Appendix A3. Nest 16138 was located approximately 9.0 mi (14.5 km) northwest of the Walleye Wind Energy Project boundary. The nest was in good condition and one bald eagle was observed on the nest in an incubating position. The nest was considered occupied and active in 2018.

Appendix A4. Nest 16134 was located approximately 7.2 mi (11.6 km) west of the Walleye Wind Energy Project boundary. The nest was in good condition and greenery and wash were observed in the nest. One bald eagle was observed perched on and flying near the nest. The nest was considered an occupied inactive bald eagle nest in 2018.

Appendix A5. Nest 16133 was located approximately 7.3 mi (11.7 km) west of the Walleye Wind Energy Project boundary. The nest was in good condition and wash was observed in the nest. No bald eagles were observed on or near the nest, and it was considered an occupied inactive unidentified raptor nest in 2018.

Appendix A6. Nest 3099 was located approximately 6.6 mi (10.6 km) northeast of the Walleye Wind Energy Project boundary. The nest was in fair condition and consistent in size and structure with a bald eagle nest. No eagles were seen near the nest. The nest was considered inactive in 2018.

Appendix A7. Nest 3100 was located approximately 6.8 mi (10.9 km) northeast of the Walleye Wind Energy Project boundary. The nest was in fair condition and consistent in size and structure with a bald eagle nest. No eagles were seen near the nest. The nest was considered inactive in 2018.

Appendix A8. Nest 3101 was located approximately 7.8 mi (12.6 km) east of the Walleye Wind Energy Project boundary. The nest was in fair condition and consistent in size and structure with a bald eagle nest. No eagles were seen near the nest. The nest was considered inactive in 2018.

Appendix A9. Nest 16136 was located approximately 8.5 mi (13.7 km) southwest of the Walleye Wind Energy Project boundary. The nest was in good condition and consistent in size and structure with a bald eagle nest. No eagles were seen near the nest. The nest was considered inactive in 2018.

Appendix C

2016 West Aerial Nest Survey Report

Raptor Nest Survey Results for the Walleye Wind Project
Rock County, Minnesota and Minnehaha County, South Dakota

Prepared for:

Renewable Energy Systems, Inc.
12 South 6th Street, Suite 930
Minneapolis, Minnesota 55402

Prepared by:

Western EcoSystems Technology, Inc.
1710 Douglas, Suite 283
Golden Valley, MN 55422

May 25, 2016

STUDY PARTICIPANTS

Western EcoSystems Technology

Joyce Pickle	Project Manager
Chad Rittenhouse	Research Biologist
Adam Kreger	GIS Specialist

REPORT REFERENCE

Pickle, J., C. Rittenhouse and A. Kreger. 2016. Raptor Nest Survey Results for the Walleye Wind Project, Rock County, Minnesota and Minnehaha County, South Dakota. May 25, 2016. Prepared for Renewable Energy Systems Americas, Inc. Prepared by Western EcoSystems Technology, Inc. (WEST), Golden Valley, Minnesota.

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INTRODUCTION

Renewable Energy Systems Americas (RES) is developing the Walleye Wind Project (Project) in Rock County, Minnesota and Minnehaha County, South Dakota (Figure 1). RES requested that Western EcoSystems Technology, Inc. (WEST) conduct an aerial based raptor nest survey to help evaluate the potential impacts of construction on nesting raptors. This report provides results of the general raptor nest survey conducted at the Project on March 24 – 25, 2016.

STUDY AREA

The Project is located on the South Dakota-Minnesota border, just east of the town of Garreston, South Dakota (Figure 1). The Project falls in the Western Corn Belt Plains Ecoregion (USEPA 2013, 2015). The Western Corn Belt Plains Ecoregion is composed of glaciated till plains and undulating loess plains. Much of the region was originally dominated by tall-grass prairie, riparian forest, and woody and herbaceous wetlands. Today, most of the area has been cleared for farms producing corn, soybeans, and livestock. Many smaller streams in this ecoregion have been tiled, ditched, and tied into existing drainage systems, which caused a reduction in the amount of aquatic habitat. The majority of the Project is composed of cropland and developed areas (89%) with sparse forest patches and wetlands.

METHODS

Aerial Raptor Nest Survey

One aerial survey was conducted from a helicopter in late March (March 24 – 25, 2016), a period before leaf out when raptors would be actively tending to a nest or incubating eggs. Aerial surveys were conducted in accordance with the guidance provided in the U.S. Fish and Wildlife Service (USFWS) *Eagle Conservation Plan Guidance: Module 1 – Land-based Wind Energy, Version 2* (ECPG; USFWS 2013) and the USFWS Inventory and Monitoring Protocols (Pagel et al. 2010). An experienced raptor ecologist and a skilled helicopter pilot conducted the survey. Raptors are defined here as kites, accipiters, buteos, harriers, eagles, falcons, and owls. However, the main focus of the survey was to identify bald eagle nests. Bald eagle nest surveys focused on locating eyries (large, stick nest structures) in suitable eagle nesting substrate (trees, transmission lines, cliff faces, etc.) within and around the proposed Project (Figure 1), considering a 1-mi and a 10-mi buffer (Figure 1).

Surveys within the project boundary and 1-mi buffer documented all potential raptor nests, including bald eagles, while the surveys up to the 10-mi buffer focused only on identifying potential bald eagle nests. Efforts were made to minimize disturbance to breeding raptors; the greatest possible distance at which the species could be identified was maintained, with distances varying depending upon nest location and wind conditions.

In general, all potential bald eagle and raptor nest habitat was surveyed by flying transects between 0.25 and 0.5 mi (0.4 and 0.8 km) apart, flying at speeds of 60 to 75 mi per hour (mph; 97 to 121 km per hour) throughout the proposed Project and associated 10-mi buffer. Surveys were typically conducted between 07:00 hours and 18:00 hours. The locations of all potential raptor nests were recorded using a hand-held Global Positioning System (GPS); coordinates were set at Latitude/Longitude (hddd.ddddd°) World Geodetic System (WGS) 84 unit. The survey included all confirmed and potential nests regardless of their activity status. To determine the status of a nest, the biologist relied on clues that included behavior of adults and presence of eggs, young, or whitewash. Attempts were made to identify the species of raptor associated with each active nest. Raptor species, nest type, nest status, nest condition, and substrate, were recorded at each nest location to the extent possible.

Terminology

Included below are descriptions of terms used during the documentation of nests (see Results section).

Nest ID - WEST assigned a unique nest identification number for each nest documented.

Species - A species was assigned to each nest when possible, otherwise, it was classified as an unknown raptor nest. Nests documented as unknown raptor species are defined as any stick nest that did not have an occupant associated with it at the time of the survey. Many times nests will become abandoned or no longer used, and over time, may become a historic nest site. Unknown raptor nests, including old nests or nests that could become suitable for raptors, are documented in order to populate a nest database to ensure that future surveys include all potentially suitable nest sites.

Nest Condition - Nest condition was categorized using descriptions ranging from poor to excellent. Although the determination of nest condition can be subjective and may vary between observers, it gives a general sense of when a nest or nest site may have last been used. Nests in poor to fair condition are typically in disrepair, sloughing, or sagging heavily, and would require some level of effort to rebuild in order to be suitable for successful nesting. Nests in good to excellent condition are those that appear to have been well maintained, have a well-defined bowl shape, are not sagging or sloughing, and appear to be suitable for nesting.

Substrate - The substrate in which a nest was observed was recorded to provide observers a visual reference. Substrates range from manmade structures (such as power lines, nest platforms, and dock hoists) to biological and physical structures (conifer and deciduous tree species, cliff faces).

Nest Status - WEST categorizes basic nest use consistent with definitions from the ECPG. Nests were classified as occupied if any of the following were observed at the nest structure: (1) an adult in an incubating position, (2) eggs, (3) nestlings or fledglings, (4) occurrence of a pair of adults (or, sometimes sub-adults), (5) a newly constructed or refurbished stick nest in the area where territorial behavior of a raptor had been observed early in the breeding season, or (6) a recently repaired nest with fresh sticks (clean breaks) or fresh boughs on top, and/or droppings and/or molted feathers on its rim or underneath. Occupied nests were further classified as active if an egg or eggs had been laid or nestlings were observed, or inactive if no eggs or chicks were present. A nest that does not meet the above criteria for "occupied" was classified as "unoccupied".

RESULTS

Aerial Raptor Nest Survey

A WEST biologist detected a total of 38 raptor nests representing three raptor species (Table 1) during aerial surveys conducted on March 24 – 25, 2016. Two occupied bald eagle nests, two occupied red-tailed hawk (*Buteo jamaicensis*) nests, one occupied great-horned owl (*Bubo virginianus*) nest, and 33 unoccupied, inactive unknown raptor nests were identified (Table 1; Figure 1).

No occupied or potential bald eagle nests were located within the Project (Figure 1). No bald eagles were observed during the survey within the Project. Two occupied active bald eagle nests were documented in this survey, within riparian habitat along the Big Sioux River (Figure 1). No federal or state-listed threatened or endangered raptor species were observed nesting within the Project or the associated buffers. The following section provides a description of the bald eagle nests that were identified. Appendix A contains photos of all potential bald eagle nests. Table 1 summarizes the data collected at all observed raptor nests.

Nest 37 – this nest is located approximately 8.44 mi (13.58 km) southwest of the Project boundary. The nest was in excellent condition. Two bald eagles were observed; one was perched and one was observed in a nesting position. The nest is therefore considered occupied and active in 2016 (Appendix A, Figure 1).

Nest 38 – this nest is located approximately 7.76 mi (12.49 km) southwest of the Project boundary. The nest was in excellent condition. An adult bald eagle was observed in a nesting position. The nest is therefore considered occupied and active in 2016 (Appendix A, Figure 2).

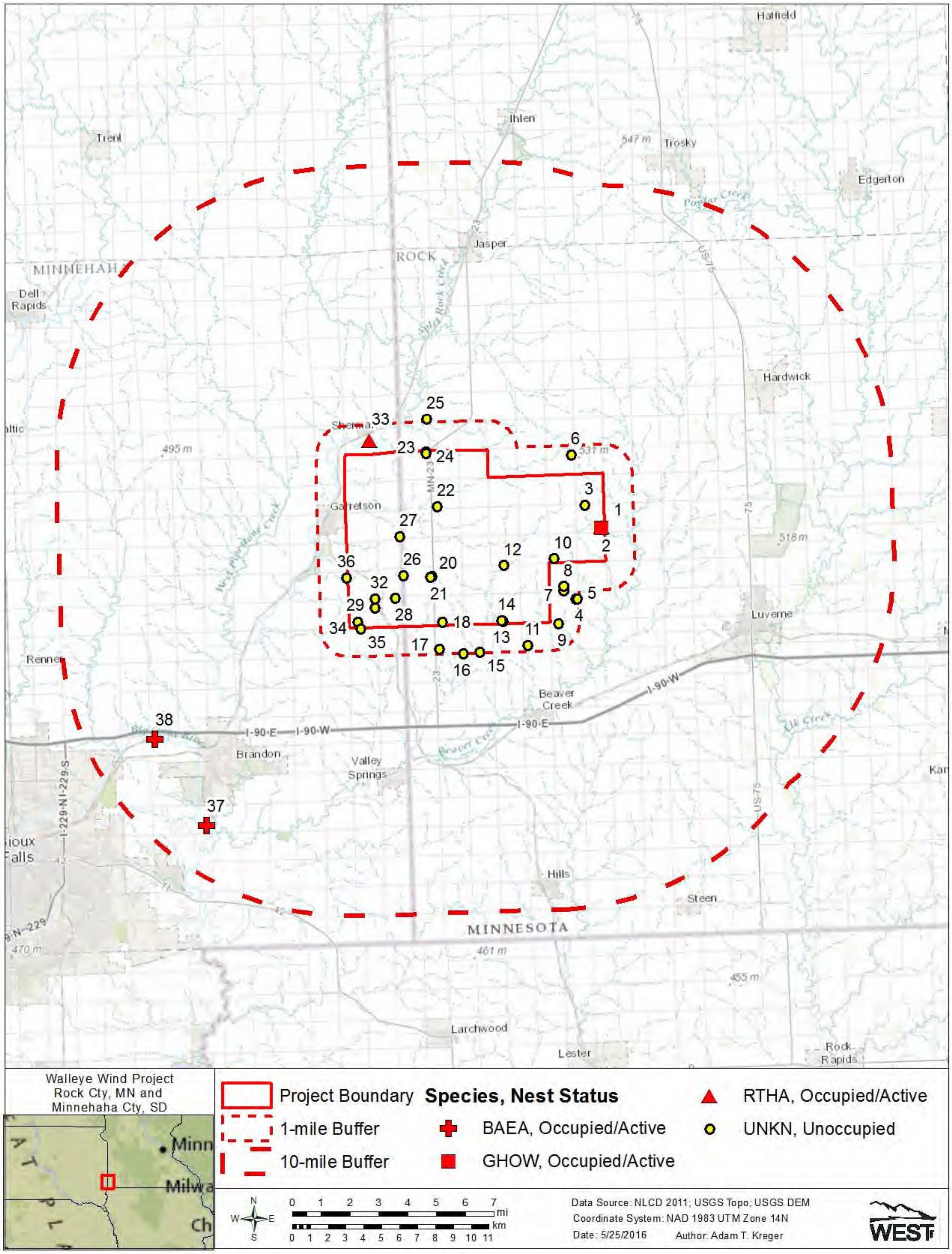

Figure 1. Locations of raptor nests observed at the Walleye Wind Project, Rock County, Minnesota, and Minnehaha County, South Dakota, and associated 1-mi and 10-mi buffers March 24 – 25, 2016.

Table 1. Raptor nest unique ID (NEST ID), locations (Lat/Long, hddd.dddd°; WGS 84) and features for identified nests during the March 24 – 25, 2016 survey for the Walleye Wind Project, Rock County, Minnesota, and Minnehaha County, South Dakota. Bald eagle (BAEA), Red-tailed hawk (RTHA), great-horned owl (GHOW), and unknown raptor (UNKN) nests were located.

Nest	Nest ID	Species	Nest substrate	Latitude	Longitude	Status at time of survey	Condition
1	032416-RTHA-MN-144	Red-tailed Hawk	Tree	43.707691	-96.312949	Occupied, active	Excellent
2	032416-GHOW-MN-145	Great-horned Owl	Tree	43.70629	-96.314637	Occupied, active	Excellent
3	032416-UNKN-MN-146	Unknown	Tree	43.717853	-96.325994	Unoccupied, inactive	Poor
4	032416-UNKN-MN-147	Unknown	Tree	43.670871	-96.334245	Unoccupied, inactive	Poor
5	032416-UNKN-MN-148	Unknown	Tree	43.671031	-96.333293	Unoccupied, inactive	Good
6	032416-UNKN-MN-149	Unknown	Tree	43.743468	-96.334475	Unoccupied, inactive	Fair
7	032416-UNKN-MN-150	Unknown	Tree	43.675245	-96.34255	Unoccupied, inactive	Fair
8	032416-UNKN-MN-151	Unknown	Tree	43.677388	-96.342307	Unoccupied, inactive	Fair
9	032416-UNKN-MN-152	Unknown	Tree	43.658674	-96.34683	Unoccupied, inactive	Good
10	032416-UNKN-MN-153	Unknown	Tree	43.691466	-96.348498	Unoccupied, inactive	Good
11	032416-UNKN-MN-154	Unknown	Tree	43.648392	-96.368753	Unoccupied, inactive	Poor
12	032416-UNKN-MN-155	Unknown	Tree	43.688902	-96.383623	Unoccupied, inactive	Fair
13	032416-UNKN-MN-156	Unknown	Tree	43.660972	-96.385358	Unoccupied, inactive	Poor
14	032416-UNKN-MN-157	Unknown	Tree	43.661088	-96.38602	Unoccupied, inactive	Poor
15	032416-UNKN-MN-158	Unknown	Tree	43.645665	-96.401958	Unoccupied, inactive	Good
16	032416-UNKN-MN-159	Unknown	Tree	43.645285	-96.413562	Unoccupied, inactive	Good
17	032416-UNKN-MN-160	Unknown	Tree	43.647988	-96.429708	Unoccupied, inactive	Good
18	032416-UNKN-MN-161	Unknown	Tree	43.661306	-96.427314	Unoccupied, inactive	Good
19	032416-UNKN-MN-162	Unknown	Tree	43.684018	-96.434386	Unoccupied, inactive	Good
20	032416-UNKN-MN-163	Unknown	Tree	43.684492	-96.433582	Unoccupied, inactive	Poor
21	032416-UNKN-MN-164	Unknown	Tree	43.684014	-96.434355	Unoccupied, inactive	Poor
22	032416-UNKN-MN-165	Unknown	Tree	43.719569	-96.428248	Unoccupied, inactive	Poor
23	032416-UNKN-MN-166	Unknown	Tree	43.746996	-96.435082	Unoccupied, inactive	Good
24	032416-UNKN-MN-167	Unknown	Tree	43.746345	-96.434986	Unoccupied, inactive	Good
25	032416-UNKN-MN-168	Unknown	Tree	43.763592	-96.433858	Unoccupied, inactive	Poor
26	032416-UNKN-MN-169	Unknown	Tree	43.685432	-96.453486	Unoccupied, inactive	Poor
27	032416-UNKN-SD-170	Unknown	Tree	43.704884	-96.454916	Unoccupied, inactive	Fair
28	032416-UNKN-SD-171	Unknown	Tree	43.674099	-96.459338	Unoccupied, inactive	Fair
29	032416-UNKN-SD-172	Unknown	Tree	43.669676	-96.473876	Unoccupied, inactive	Fair
30	032416-UNKN-SD-173	Unknown	Tree	43.673952	-96.473378	Unoccupied, inactive	Fair
31	032416-UNKN-SD-174	Unknown	Tree	43.674035	-96.473232	Unoccupied, inactive	Fair
32	032416-UNKN-SD-175	Unknown	Tree	43.674108	-96.4734	Unoccupied, inactive	Fair
33	032416-RTHA-SD-176	Red-tailed Hawk	Tree	43.754718	-96.472122	Occupied, active	Excellent
34	032416-UNKN-SD-177	Unknown	Tree	43.662526	-96.485896	Unoccupied, inactive	Fair

Table 1. Raptor nest unique ID (NEST ID), locations (Lat/Long, hddd.dddd°; WGS 84) and features for identified nests during the March 24 – 25, 2016 survey for the Walleye Wind Project, Rock County, Minnesota, and Minnehaha County, South Dakota. Bald eagle (BAEA), Red-tailed hawk (RTHA), great-horned owl (GHOW), and unknown raptor (UNKN) nests were located.

Nest	Nest ID	Species	Nest substrate	Latitude	Longitude	Status at time of survey	Condition
35	032416-UNKN-SD-178	Unknown	Tree	43.659209	-96.483837	Unoccupied, inactive	Fair
36	032416-UNKN-SD-179	Unknown	Tree	43.685023	-96.492827	Unoccupied, inactive	Good
37	032516-BAEA-SD-180	Bald Eagle	Tree	43.562668	-96.594158	Occupied, active	Excellent
38	032516-BAEA-SD-181	Bald Eagle	Tree	43.606778	-96.628101	Occupied, active	Excellent

DISCUSSION/CONCLUSION

These surveys provided additional information on eagle and raptor use within the vicinity of the Project. Aerial surveys did not find bald eagle nests within the Project. The Project site is dominated by cultivated agricultural lands with relatively little forest cover. The Project does include small pond, river, and wetland systems that might provide foraging opportunities to eagles. Woody habitats with mature large trees, which may provide nesting habitat for bald eagles, exist along the Big Sioux River (Nest 37, Nest 38), to the southwest of the Project boundary.

The ECPG states that eagle pairs at nests within one-half the mean inter-nest distance from the Project area are susceptible to disturbance take and blade strike mortality. The mean inter-nest distance of all bald eagle nests observed during this survey is approximately 3.5 mi (5.6 km) with a half mean inter-nest distance of 1.8 mi (2.9 km). The closest eagle nest to the project boundary is approximately 7.7 miles to the southwest. Given their distance from the Project area and lack of intervening habitat, bald eagles inhabiting these nests are not expected to be at increased risk of disturbance take and blade strike mortality as a result of Project development.

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APPENDIX A: IMAGES OF EAGLE NESTS (OCCUPIED-ACTIVE AND UNOCCUPIED/INACTIVE) IN THE 10-MILE BUFFER OF THE WALLEYE WIND PROJECT, ROCK COUNTY, MINNESOTA AND MINNEHAHA COUNTY, SOUTH DAKOTA

Figure 1. Nest 37 is located approximately 8.44 mi (13.58 km) southwest of the Project boundary. The nest was in excellent condition. Two bald eagles were observed; one was perched and one was observed in a nesting position. The nest is therefore considered occupied and active in 2016.

Figure 2. Nest 2 is located approximately 7.76 mi (12.49 km) southwest of the Project boundary. The nest was in excellent condition. An adult bald eagle was observed in a nesting position. The nest is therefore considered occupied and active in 2016.

ENVIRONMENTAL & STATISTICAL CONSULTANTS
7575 Golden Valley Road, Suite 300, Golden Valley, Minnesota 55427
Phone: 612.655.1726 ♦ www.west-inc.com

COVER MEMORANDUM

Date: June 10, 2020

To: Walleye Wind Project, LLC

From: Western EcoSystems Technology, Inc.

Subject: Walleye Wind Project – 2016 Bat Acoustic Survey Report Cover Memo

INTRODUCTION

Walleye Wind Project, LLC is developing the Walleye Wind Project (Project) in Rock County, Minnesota (Figure 1). The 2016 Bat Acoustic Survey Report attached to this memorandum was initially prepared for a study area that preceded the current Project, which included infrastructure in South Dakota. The Project now being proposed by Walleye Wind, LLC will have no infrastructure or any part of the Project in South Dakota. Therefore, references in this report to South Dakota are no longer applicable to the current Project. However, this report is provided due to the study area's proximity to and partial overlap with the current Project, as it provides information pertinent to Minnesota state agency review. The study area and current Project boundary are depicted in Figure 1, below.

Please also note that in the attached 2016 Bat Acoustic Survey Report, all references to "Project" and "Project boundary" refer to the area delineated by the 2016 Bat Acoustic Survey study area as shown on Figure 1.

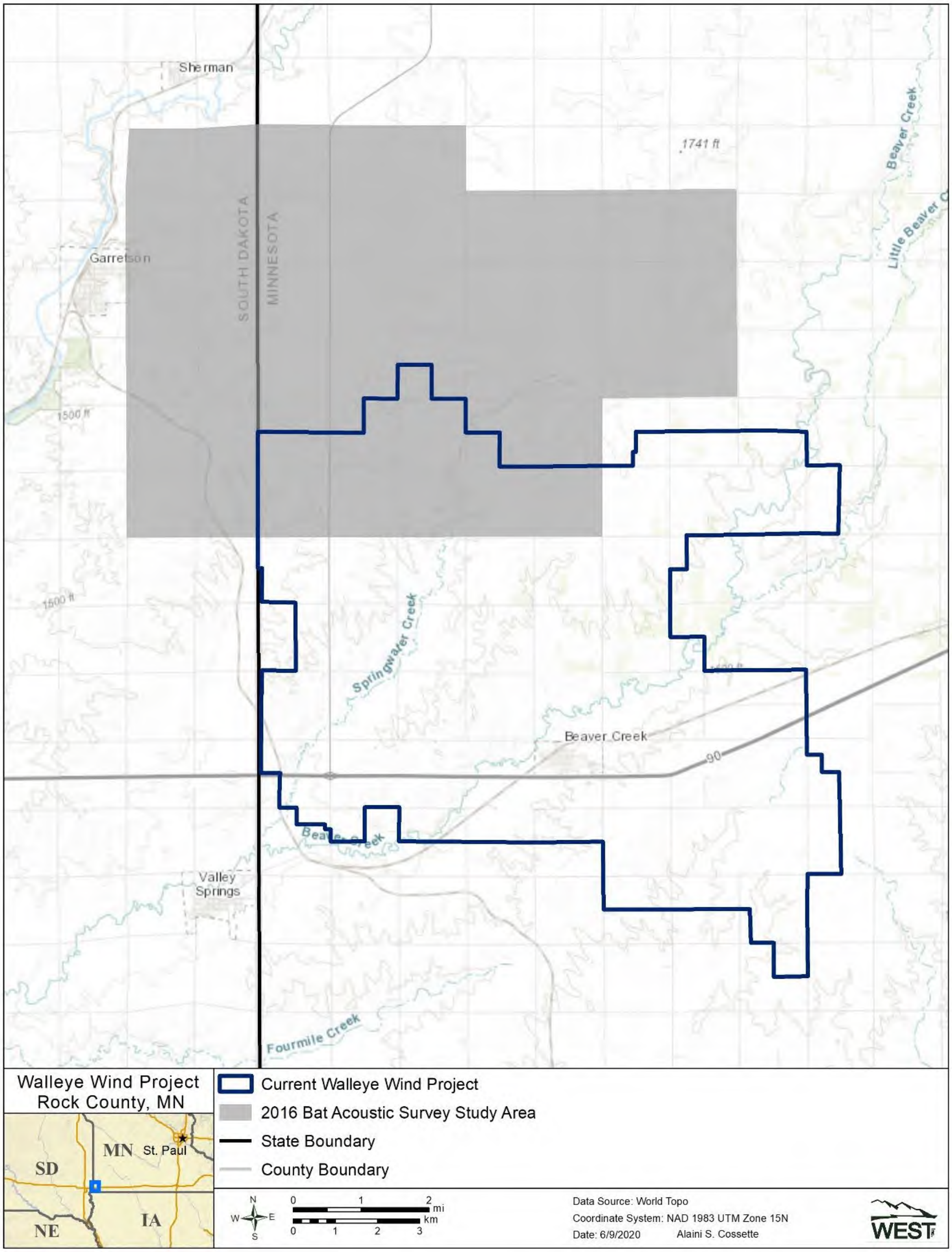

Figure 1. 2016 Bat Acoustic Survey study area in comparison to the current Walleye Wind Project, Rock County, Minnesota.

Bat Acoustic Survey
for the Walleye Wind Project
Rock County, Minnesota and Minnehaha County, South Dakota

Final Report

April 14 – November 3, 2016

Prepared for:

Renewable Energy Systems Americas, Inc.

12 South 6th Street, Suite 930
Minneapolis, MN 55402

Prepared by:

Larisa Bishop-Boros, Donald Solick, and Adam Kreger

Western EcoSystems Technology, Inc.
200 South Second Street
Laramie, WY 82070

February 2, 2017

EXECUTIVE SUMMARY

In April 2016, Western EcoSystems Technology, Inc. initiated a bat acoustic survey for the proposed Walleye Wind Project (Project) in Rock County, Minnesota, and in Minnehaha County, South Dakota. The bat acoustic survey conducted at the Project was designed to estimate levels of bat activity throughout the Project during the spring, summer, and fall.

Acoustic surveys were conducted between April 14 and November 3, 2016, at two stations located in cropland habitat representative of potential turbine locations, and at one station located in forested edge habitat that contained features attractive to bats (i.e., a bat feature station). AnaBat® SD2 detectors were placed approximately 1.5 m above ground level and were serviced every two weeks.

The AnaBat units placed in cropland habitat detected 1,128 bat passes on 310 detector-nights for a mean (± standard error) of 3.73 ± 0.45 bat passes per detector-night. Weekly activity was highest at the cropland stations from late July to early August, and peaking at 9.17 bat passes per detector-night. This timing coincides with the period of peak bat fatalities at other wind facilities. Approximately 77% of bat passes at cropland stations were classified as low-frequency (e.g., big brown bats, hoary bats, and silver-haired bats) and 23% of bat passes were classified as high-frequency (e.g., eastern red bats [*Lasiurus borealis*], evening bats, and little brown bats).

The bat feature station recorded 7,423 bat passes on 166 detector-nights for a mean of 44.72 ± 4.05 bat passes per detector-night. Activity at the bat feature station was highest in early August, and peaking at 152.29 bat passes per detector-night. Approximately 65% of bat passes were by low-frequency species. The high activity at this station was likely due to bats being attracted to forested habitat for foraging and roosting opportunities.

All eight bat species with potential to occur within the Project were identified at each of the three stations using the auto-classifier component of Kaleidoscope 3.1.7. The northern long-eared bat is the only protected bat species with potential to occur within the Project based on established bat species ranges. All of the potential northern long-eared bat calls identified by Kaleidoscope were determined to be false identifications after qualitative review by an experienced bat biologist, and no protected bat species calls were identified during this survey.

Bat activity was highest in the summer and fall among stations and peaked at cropland stations in early July. Activity during the standardized Fall Migration Period (FMP; defined here as July 30 – October 14) at cropland stations was 6.15 ± 0.78 bat passes per detector-night, which is within the range of other studies in the Midwest region that have reported pre-construction bat activity and post-construction fatality. Bat activity estimates at the cropland stations are comparable with data at other wind energy facilities that have recorded both pre-construction bat activity and post-construction bat fatality. Most facilities in the Midwest region have reported fewer than five bat fatalities/MW/year, and therefore it is possible that bat fatality rates at the

Walleye Project will be comparable (Appendix A). The results of the study indicate that these fatalities will likely occur mainly in the late summer and early fall, and mainly be composed of low-frequency species such as hoary bats and silver-haired bats. The pre-construction bat studies completed at Project will add to the growing body of research regarding the impacts of wind energy development on bats.

STUDY PARTICIPANTS

Western EcoSystems Technology

Adam Kreger	Project Manager
Donald Solick	Bat Biologist
Donald Solick	Data and Report Manager
Larisa Bishop-Boros	Bat Data Analyst/Statistical Analyst
Terri Harvey	Bat Data Analyst
Jeff Gruver	Bat Biologist
John Lombardi	Statistician
Adam Kreger	GIS Technician
J.R. Boehrs	GIS Technician
Eve Armour	Technical Editor
Carissa Goodman	Technical Editor
Rachel Pahlke	Field Technician
Margaret Neja	Field Technician

REPORT REFERENCE

Bishop-Boros, L., D. I. Solick, and A. Kreger. 2016. Bat Activity Studies for the Walleye Wind Project, Rock County, Minnesota and Minnehaha County, South Dakota. Final Report: April 14 – November 3, 2016. Prepared for Renewable Energy Systems Americas, Inc., Minneapolis, Minnesota. Prepared by Western EcoSystems Technology, Inc. (WEST), Laramie, Wyoming.

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INTRODUCTION

Renewable Energy Systems, Inc. (RES) is considering the development of a wind energy facility at the Walleye Wind Energy Project (Project) in Rock County, Minnesota, and in Minnehaha County, South Dakota. RES contracted Western EcoSystems Technology, Inc. (WEST) to complete a study of bat activity following the recommendations of the US Fish and Wildlife Service (USFWS) Land-based Wind Energy Guidelines (WEG; USFWS 2012) and Kunz et al. (2007b). WEST conducted acoustic monitoring surveys to estimate levels of bat activity throughout the Project during the spring, summer, and fall. The following report describes the results of acoustic monitoring surveys conducted at the Project between April 14 and November 3, 2016.

STUDY AREA

The boundary of the proposed Project encompasses 29,753 acres (120.4 square kilometers [km], 46.5 square miles [mi]) in Rock County, Minnesota, and in Minnehaha County, South Dakota (Figure 1). The Project falls within the Western Corn Belt Plains Ecoregion, which encompasses southern Minnesota (USEPA 2016). The Western Corn Belt Plains Ecoregion is composed of glaciated till plains and undulating loess plains. Much of the region was originally dominated by tall-grass prairie, riparian forest, oak-prairie savannas, and brushy and herbaceous wetlands. Today, most of the area has been cleared for highly productive farms producing corn (*Zea mays*), soybeans (*Glycine max*), and livestock. The Project is on the very southern edge of the part of the Prairie Coteau in Minnesota. The elevation of the Project ranges from approximately 445–527 meters (m; 1,460–1,729 feet [ft]). Topography of the Project is generally flat with some gently rolling hills.

The majority of the Project is used for cultivated crops (83.5%) with additional use of pasture and hay land (7.0%) or developed open space (5.1%). Herbaceous land composes 2.4% of the Project (Figure 1, Table 1). A few streams are present within the Project draining to Beaver Creek in the southeastern portions of the Project, Springwater and westerly to Split Rock Creek in the northern and western portions of the Project. Many smaller streams in this ecoregion have been tilled, ditched and tied into existing drainage systems that has caused a reduction in the amount of aquatic habitat. Wetlands and deciduous forest each comprise 0.7% of the Project and are largely situated as fringe wetlands along riparian corridors within the Project. The remaining land covers (Open Water, Barren Land, and Shrub/Scrub) comprise less than 0.5% of the Project (Figure 1, Table 1).

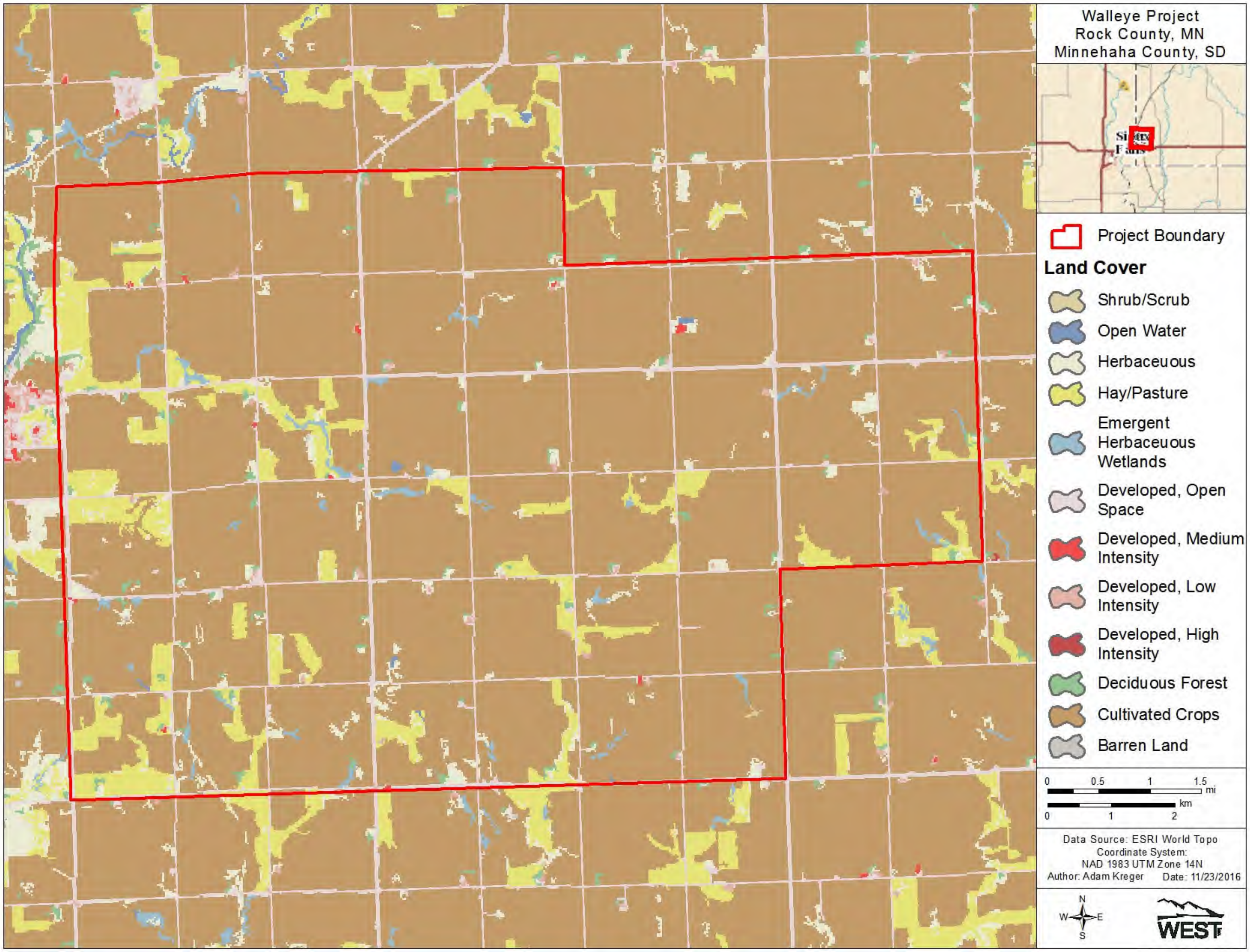

Figure 1. Land cover in the Walleye Wind Project (US Geological Survey National Land Cover Dataset [USGS NLCD] 2001).

Table 1. Land cover in the Walleye Wind Project according to the USGS NLCD (2001).

Land Cover	Acres	% Composition
Cultivated Crops	24,846.8	83.5
Hay/Pasture	2,075.1	7.0
Developed, Open Space	1,531.1	5.1
Herbaceous	719.8	2.4
Emergent Herbaceous Wetlands	215.6	0.7
Deciduous Forest	208.0	0.7
Developed, Low Intensity	98.4	0.3
Developed, Medium Intensity	20.2	0.1
Open Water	19.6	0.1
Barren Land	6.7	0.0
Shrub/Scrub	5.1	0.0
Developed, High Intensity	0.4	0.0
Total	**29,746.8**	**100**

Overview of Bat Diversity

Eight species of bats potentially occur at the Project and all eight species have been found as mortalities at wind energy facilities (Table 2). The northern long-eared bat (*Myotis septentrionalis*) is federally listed as threatened (USFWS 2016). The little brown bat (*Myotis lucifugus*), northern long-eared bat, tri-colored bat (*Perimyotis subflavus*), and big brown bat (*Eptesicus fuscus*) are state species of special concern in Minnesota (MNDNR 2013, Table 2). The northern long-eared bat and silver-haired bat (*Lasionycteris noctivagans*) are considered rare in South Dakota by the South Dakota Natural Heritage Program (SDGFP 2016; Table 2). The evening bat (*Nycticeius humeralis*) was not previously known to occur in Minnesota but was documented in July 2016 by the Minnesota Department of Natural Resources (MNDNR) in Arden Hills, northeast of the Project near Minneapolis, MN (MNDNR 2016). Evening bats have been regularly expanding their range including recent expansions within South Dakota, New York, Nebraska, Michigan, Kansas, and Texas (Mulnzer 2008). Recent records for evening bats show that they occur as far west as the Arizona and New Mexico border, and although there is potential for its presence in the general region, there is a low possibility of occurrence at the Project.

Table 2. Bat species with potential to occur within the Walleye Wind Project (IUCN 2016; USFWS 2016; MNDNR 2016) categorized by echolocation call frequency.

Common Name	Scientific Name
High-Frequency (> 30 kHz)	
eastern red bat[1,2]	*Lasiurus borealis*
evening bat[1,4,5]	*Nycticeius humeralis*
little brown bat[1,4]	*Myotis lucifugus*
northern long-eared bat[1,3,4]	*Myotis septentrionalis*
tri-colored bat[1,4]	*Perimyotis subflavus*
Low-Frequency (< 30 kHz)	
big brown bat[1,4]	*Eptesicus fuscus*
silver-haired bat[1,2]	*Lasionycteris noctivagans*
hoary bat[1,2]	*Lasiurus cinereus*

[1] species known to have been killed at wind energy facilities
[2] long-distance migrant
[3] federally threatened species (USFWS 2016)
[4] state species of special concern (MDNR 2013)
[5] state-listed as rare (SDGFP 2016, South Dakota Bat Working Group 2004)

White-Nose Syndrome

Bats that hibernate 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*) 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. By 2013, WNS had rapidly spread to over 115 caves and mines and it is now confirmed in 28 states and the causative fungus has been identified in four additional states. To date, the full WNS has spread north into five Canadian provinces, reaching as far south as Alabama and as far west as Washington (Heffernan 2016). WNS is the primary reason the USFWS recently listed the northern long-eared bat as threatened under the Endangered Species Act (USFWS 2015a), and is currently reviewing the status of the little brown bat. WNS has not been detected in South Dakota. In Minnesota, the causative fungus was discovered in 2013 at Mystery Cave State Park, approximately 215 mi (346 km) southeast of the Project in Fillmore County and in and Soudan Underground Mine in northeastern Minnesota's St. Louis County. The disease itself was confirmed in February 2016 in St. Louis County.

METHODS

Bat Acoustic Surveys

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

Survey Stations

Three AnaBat SD2 ultrasonic bat detectors (Titley™ Scientific, Australia) were used during the study. Two detectors were placed near ground level (approximately 1.5 m above ground level [AGL]) in cropland, which is the dominant land cover type (Table 1) and is representative of potential turbine locations (Figure 2). A third detector (station WE3) was placed approximately 1.5 m above ground level along forest edge habitat that contained features potentially attractive to bats for roosting, foraging, or drinking opportunities. This ‘bat feature’ station was selected to determine an upper level of bat activity for the Project, placing activity data from the other stations in better context. Data from the bat feature station were not used for making the final risk assessment.

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.

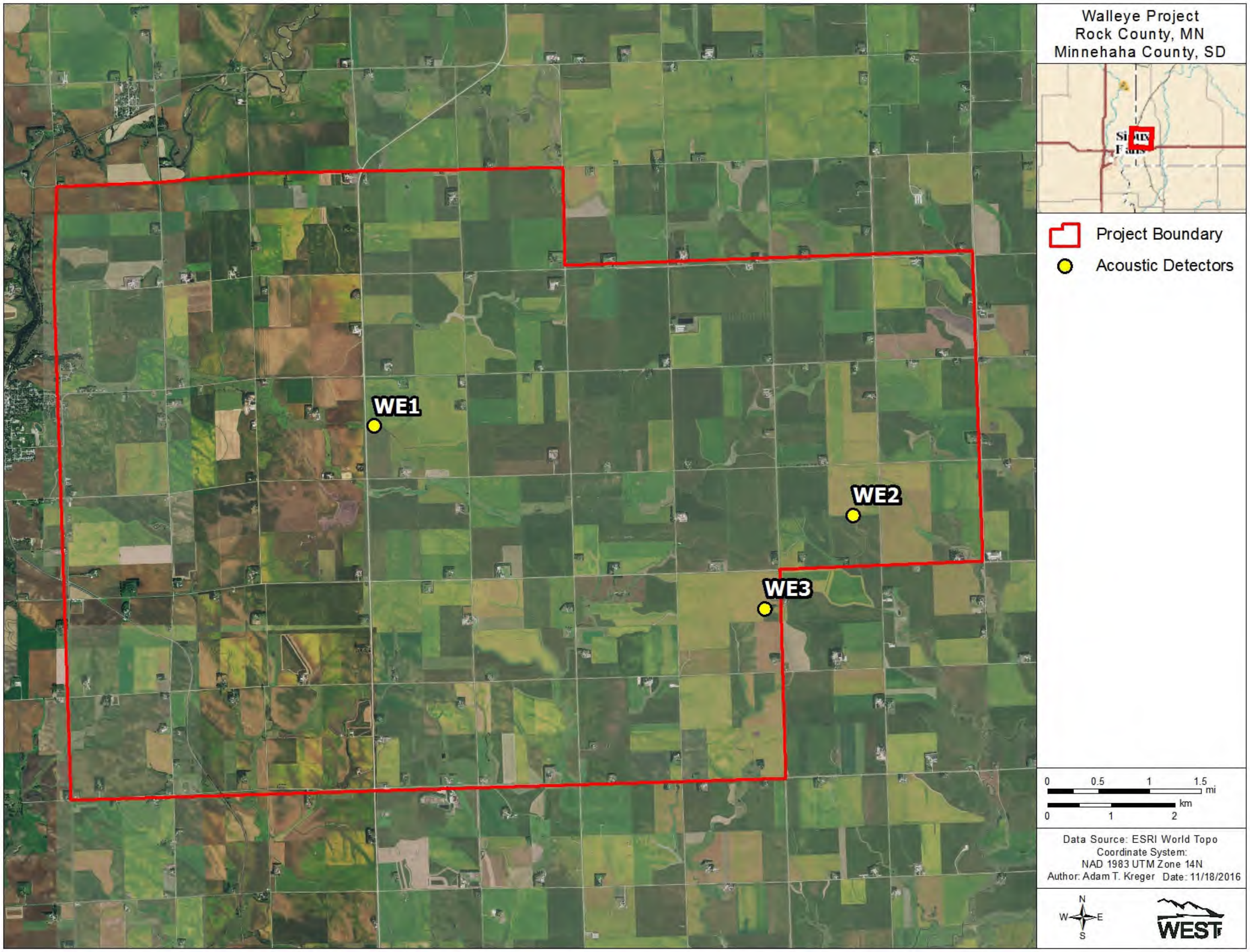

Figure 2. Location of AnaBat stations in the Walleye Wind Project.

Survey Schedule

Bats were surveyed in the Project from April 14 to November 3, 2016, and detectors were programmed to turn on approximately 30 minutes (min) before sunset and turn off approximately 30 min after sunrise each night. Mean bat activity was calculated for the full study period, as well as for a standardized Fall Migration Period (FMP), defined here as July 30 – October 14. The FMP was defined by WEST as a standard for comparison with activity from other wind energy facilities. During this time, bats begin moving toward wintering areas, and many species of bats initiate reproductive behaviors (Cryan 2008). This period of increased landscape-scale movement and reproductive behavior is often associated with increased levels of bat fatalities at operational wind energy facilities (Arnett et al. 2008; Arnett and Baerwald 2013).

Data Collection and Call Analysis

AnaBat detectors use a broadband high-frequency microphone to detect the echolocation calls of bats. Incoming echolocation calls are digitally processed and stored on a high capacity compact flash card. The resulting files can be viewed in appropriate software (e.g., Analook©) as digital sonograms that show changes in echolocation call frequency over time. Frequency versus time displays were used to separate bat calls from other types of ultrasonic noise (e.g., wind, insects, etc.) 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 minimum frequency. High frequency (HF) bats such as eastern red bats, tricolored bats, and *Myotis* species have minimum frequencies greater than 30 kilohertz (kHz). Low frequency (LF) bats such as big brown bats, silver-haired bats, and hoary bats (*Lasiurus cinereus*) typically emit echolocation calls with minimum frequencies below 30 kHz. HF and LF species that may occur in the study area are listed in Table 2.

Identification of calls was completed with the automated identification feature in program Kaleidoscope 3.1.7 (Wildlife Acoustics, Concord, Massachusetts) using the Bats of North America classifier 3.1.0. Kaleidoscope utilizes Hidden Markov Models and other statistical methods known for their application in temporal pattern recognition such as speech analysis, handwriting analysis, and DNA sequencing (Agranat 2012). Despite the capabilities of Kaleidoscope, many bat passes cannot be identified with certainty, either because only call fragments were recorded due to the distance between the bat and microphone or because many bat species produce similar calls with overlapping call characteristics that often cannot be distinguished. The Kaleidoscope output was used to generate a list of species that may have been present in the Project.

An experienced bat acoustic analyst qualitatively reviewed the echolocation calls of files identified by Kaleidoscope as northern long-eared bats through visual comparison of echolocation call metrics (e.g., minimum frequency, slope, duration) to reference calls of known bats (Yates and Muzika 2006).

Statistical Analysis

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

The period of peak sustained bat activity was defined as the 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.

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 publically 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 publically 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 three sampling locations for a total of 476 detector-nights between April 14 and November 3, 2016. AnaBat units were operating for 77.8% of the sampling period (Figure 3). The primary cause of lost data was due to technician error with detectors, corrupt cards, and low battery power. AnaBat units at cropland stations recorded 1,128 bat passes on 310 detector-nights for a mean (± standard error) of 3.73 ± 0.45 bat passes per detector-night (Table 3). In contrast, the AnaBat unit at the bat feature station recorded 7,423 bat passes on 166 detector-nights for a mean of 44.72 ± 4.05 bat passes per detector-night (Table 3).

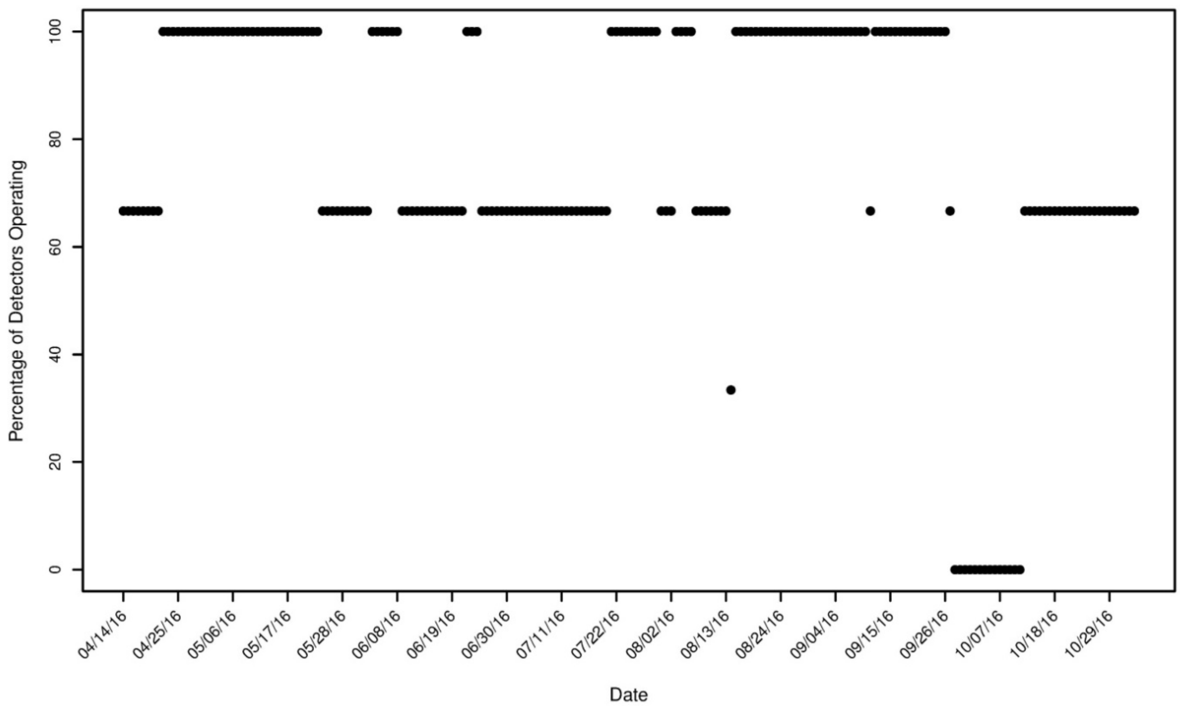

Figure 3. Operational status of bat detectors (n = 3) operating at the Walleye Wind Project during each night of the study period April 14 to November 3 2016.

Table 3. Results of acoustic bat surveys conducted at cropland and bat feature stations within the Walleye Wind Project from April 14 to November 3, 2016. Passes are separated by call frequency: high frequency (HF) and low frequency (LF).

Anabat Station	Habitat	Type	# of HF Bat Passes	# of LF Bat Passes	Total Bat Passes	Detector-Nights	Bat Passes/ Night***
WE1	cropland	fixed	162	642	804	147	5.47 ± 0.66
WE2	cropland	fixed	101	223	324	163	1.99 ± 0.34
WE3	forest edge	bat feature	2,693	4,730	7,423	166	44.72 ± 4.05
Total Cropland Stations			263	865	1,128	310	3.73 ± 0.45
Total Bat Feature Station			2,693	4,730	7,423	166	44.72 ± 4.05
Total			**2,956**	**5,595**	**8,551**	**476**	**17.39 ± 1.27**

*** ± bootstrapped standard error.

Spatial Variation

Bat activity in the Project was varied between the two cropland stations, ranging from 1.99 and 5.47 bat passes per detector-night (Table 3, Figure 4a). Bat activity at the bat feature station was much higher, averaging 44.72 bat passes per detector-night (Table 3, Figure 4b).

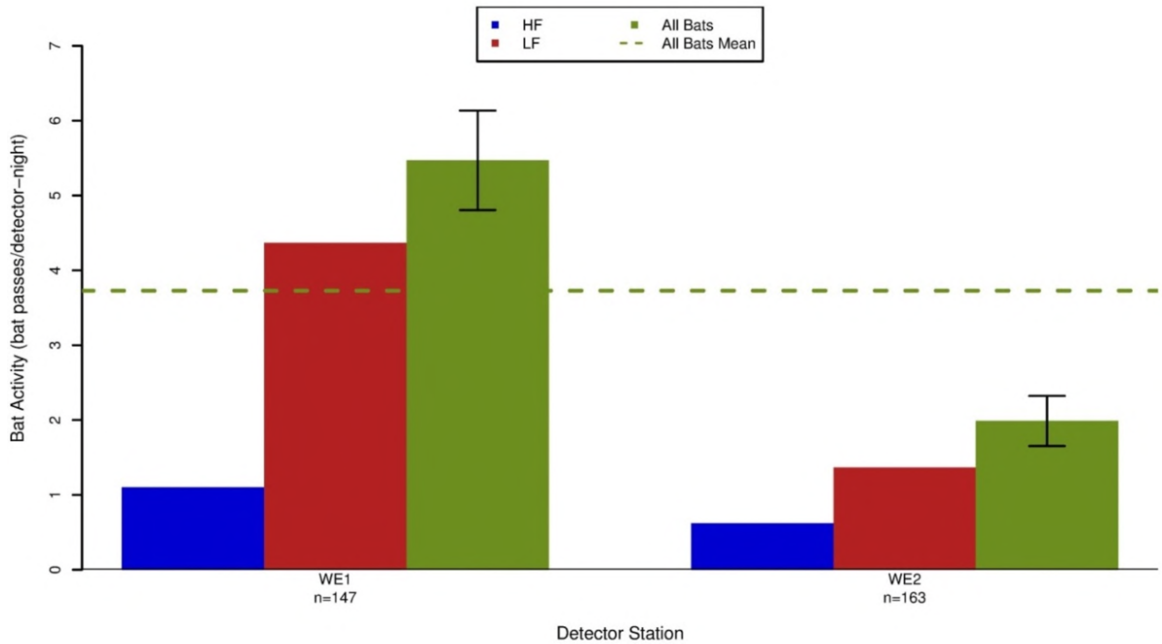

Figure 4a. Number of high-frequency (HF) and low-frequency (LF) bat passes per detector-night recorded at cropland stations in the Walleye Wind Project from April 14 to November 3, 2016. The bootstrapped standard errors are represented by the black error bars on the 'All Bats' columns.

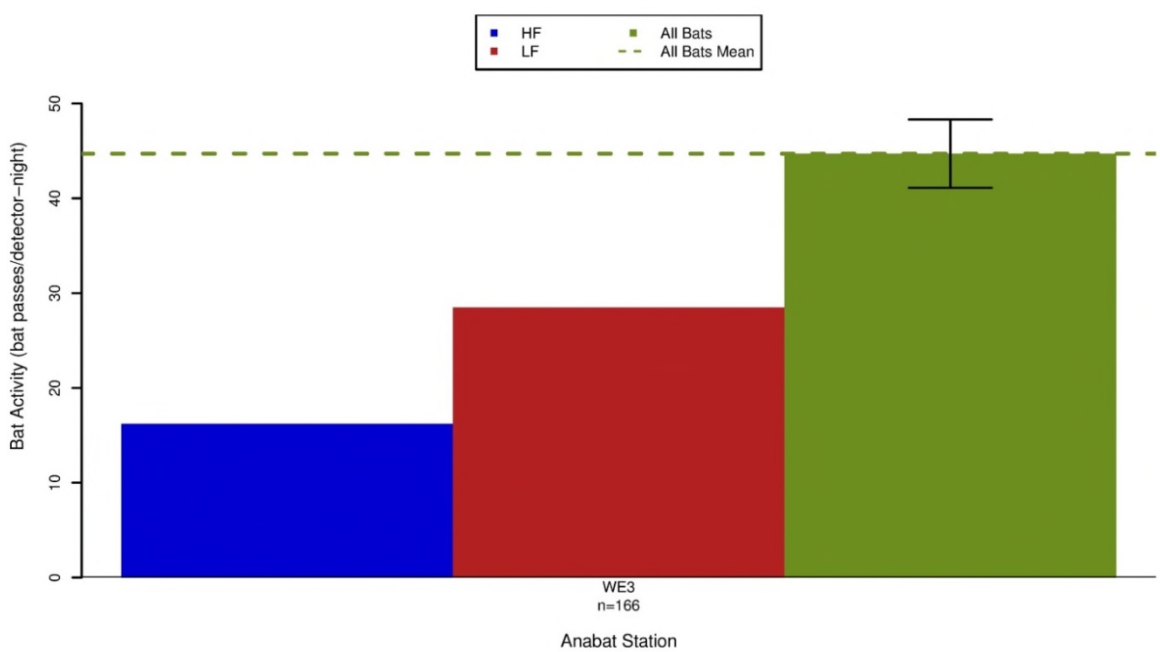

Figure 4b. Number of high-frequency (HF) and low-frequency (LF) bat passes per detector-night recorded at the bat feature station in the Walleye Wind Project from April 14 to November 3, 2016. The bootstrapped standard errors are represented by the black error bars on the 'All Bats' columns.

Temporal Variation

Weekly acoustic activity at cropland stations was relatively low throughout the spring, with an abrupt peak in activity from June 25 to July 1 (14.29 bat passes per detector-night) driven by LF bat activity (Table 4, Table 5a, Figure 6a). HF bat activity at cropland stations peaked later from August 16 to 22 (4.50 bat passes per detector-night; Table 5a). Bat activity at cropland stations during the FMP was 6.15 ± 0.78. Weekly activity at the bat feature station was low in the spring increasing during the early summer and peaking between August 5 and August 11 (152.29 bat passes per detector-night; Figure 6b, Table 5b). This overall bat peak coincided with the HF bat peak activity at the bat feature station. Low-frequency bat activity also peaked earlier at the bat feature station, from July 18 to 24 (77.14 bat passes per detector-night; Table 5b). Bat activity remained relatively high throughout September. No data were collected from September 27 through the end of the study period at bat feature station WE3 (Figure 3, Figure 6b).

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

Station	Call Frequency	Spring April 14 – May 31	Summer June 1 – Jul 31	Fall Aug 1 – Oct 27	Fall Migration Period Jul 30 – Oct 14
WE1	LF	0.16	6.89	4.67	6.39
	HF	0.12	1.29	1.43	1.96
	AB	0.28	8.18	6.1	8.35
WE2	LF	0.4	0.94	2.14	2.68
	HF	0.1	0.49	0.99	1.27
	AB	0.5	1.43	3.12	3.95
WE3	LF	11.88	31.2	39.6	39.39
	HF	1.6	12.44	32.58	32.54
	AB	13.48	43.64	72.18	71.93
Cropland Stations Total	LF	0.28 ± 0.07	3.92 ± 0.60	3.40 ± 0.57	4.53 ± 0.72
	HF	0.11 ± 0.04	0.89 ± 0.18	1.21 ± 0.21	1.62 ± 0.26
	AB	0.39 ± 0.09	4.80 ± 0.65	4.61 ± 0.64	6.15 ± 0.78
Bat Feature Station Total	LF	11.88 ± 2.35	31.20 ± 4.64	39.60 ± 4.08	39.39 ± 3.94
	HF	1.60 ± 0.37	12.44 ± 2.74	32.58 ± 4.79	32.54 ± 4.64
	AB	13.48 ± 2.46	43.64 ± 5.89	72.18 ± 6.99	71.93 ± 6.72
Overall	**LF**	**4.14 ± 0.77**	**13.01 ± 1.92**	**15.47 ± 1.31**	**16.15 ± 1.29**
	HF	**0.61 ± 0.15**	**4.74 ± 0.90**	**11.67 ± 1.55**	**11.93 ± 1.49**
	AB	**4.75 ± 0.81**	**17.75 ± 2.32**	**27.13 ± 2.27**	**28.08 ± 2.20**

Table 5a. Periods of peak activity for high frequency (HF), low frequency (LF), and all bats at cropland stations at the Walleye Wind Project for the study period April 14 to November 3, 2016.

Species Group	Start Date of Peak Activity	End Date of Peak Activity	Bat Passes per Detector-Night
HF	August 16	August 22	4.50
LF	June 25	July 1	14.29
All Bats	June 25	July 1	12.64

Table 5b. Periods of peak activity for high frequency (HF), low frequency (LF), and all bats at the bat feature station at the Walleye Wind Project for the study period April 14 to November 3, 2016.

Species Group	Start Date of Peak Activity	End Date of Peak Activity	Bat Passes per Detector-Night
HF	August 5	August 11	91.57
LF	July 18	July 24	77.14
All Bats	August 5	August 11	152.29

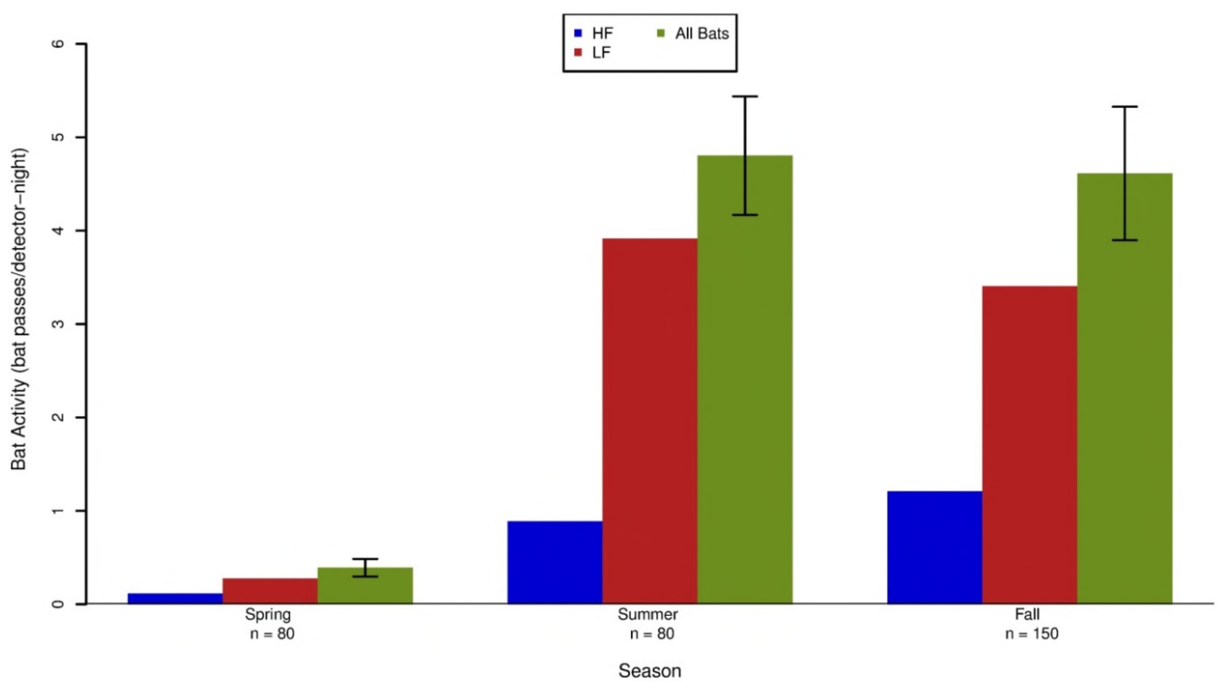

Figure 5a. Seasonal bat activity by high-frequency (HF), low-frequency (LF), and all bats at cropland stations at the Walleye Wind Energy Project from April 14 to October 27, 2016. The bootstrapped standard errors are represented on the 'All Bats' columns.

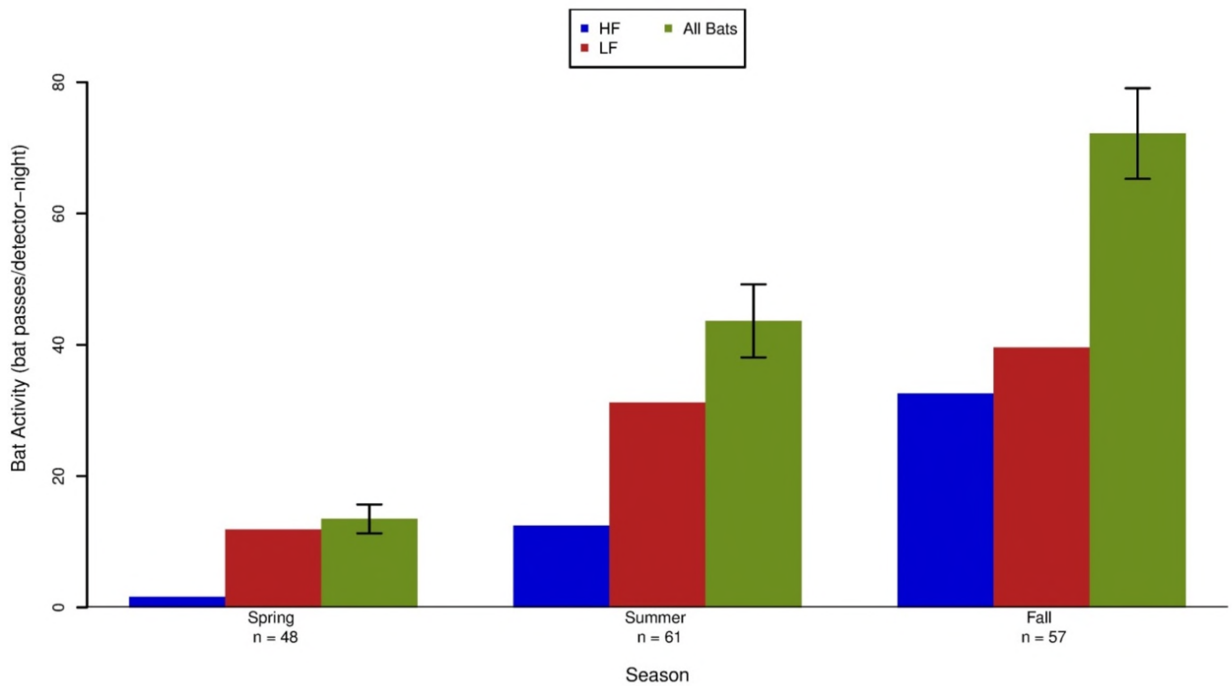

Figure 5b. Seasonal bat activity by high-frequency (HF), low-frequency (LF), and all bats at the bat feature station at the Walleye Wind Energy Project from April 14 to October 27, 2016. The bootstrapped standard errors are represented on the 'All Bats' columns

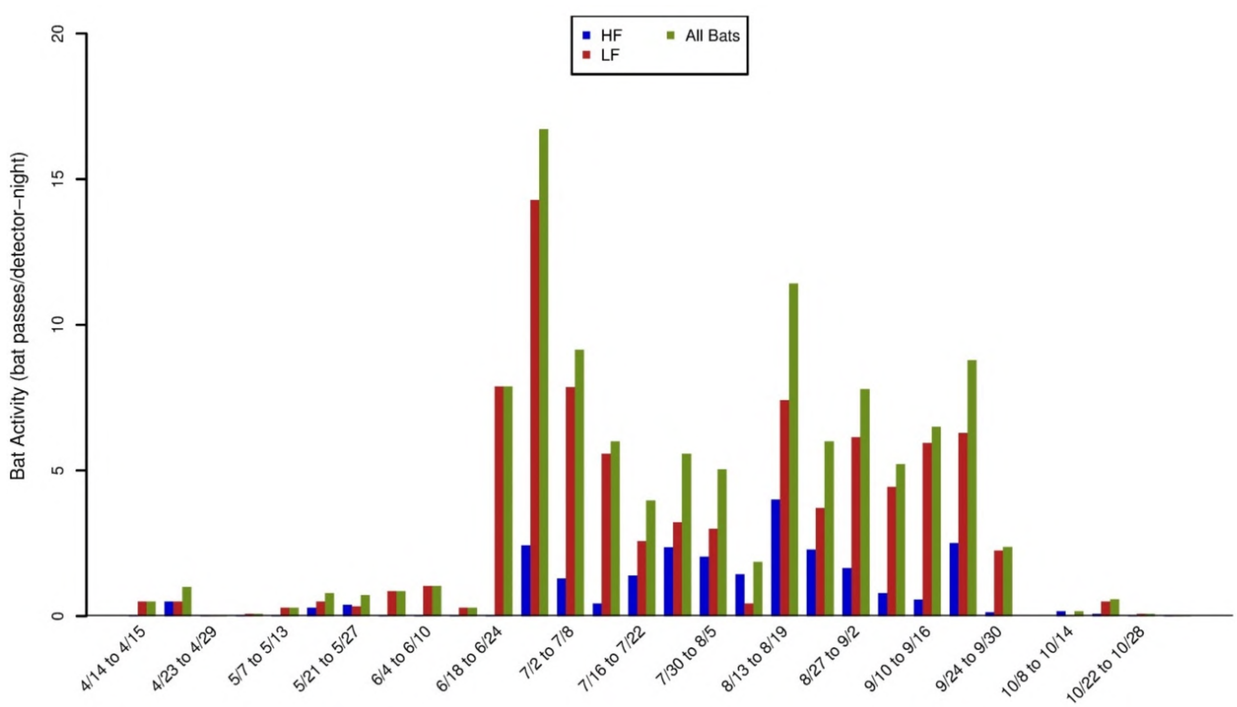

Figure 6a. Weekly patterns of bat activity by high-frequency (HF), low-frequency (LF), and all bats at cropland stations the Walleye Wind Project for the study period April 14 to November 3, 2016.

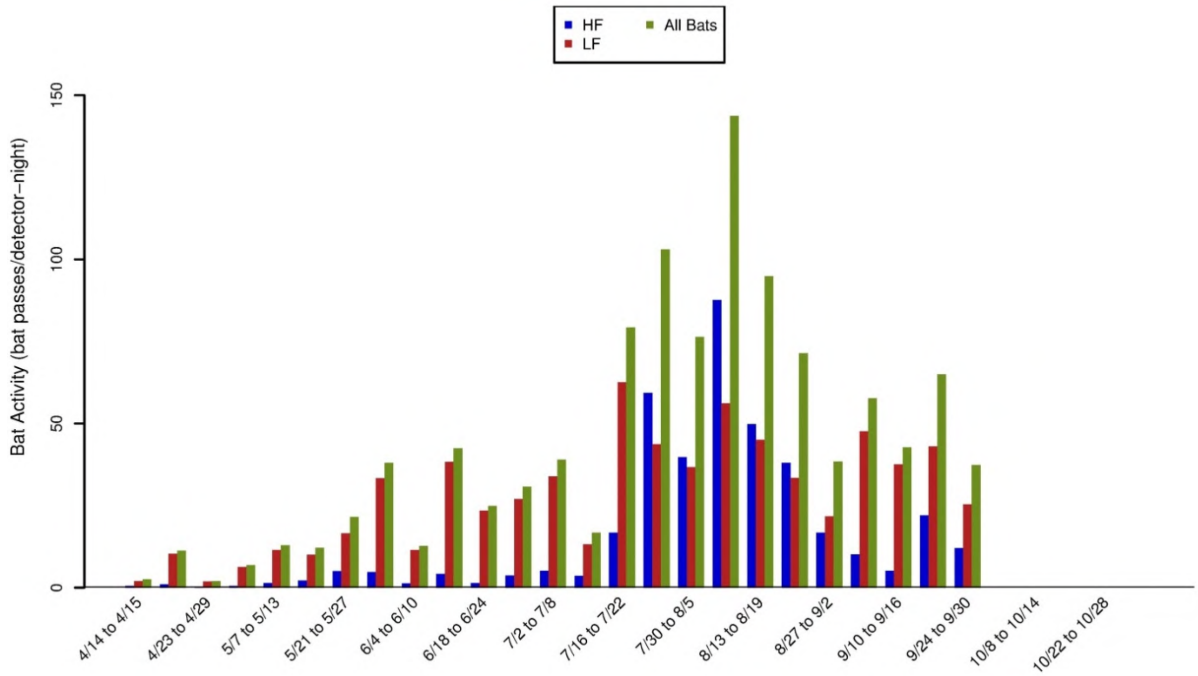

Figure 6b. Weekly patterns of bat activity by high-frequency (HF), low-frequency (LF), and all bats at the bat feature station at the Walleye Wind Project for the study period April 14 to November 3, 2016.

Species Composition

Low-frequency bats (LF; e.g., big brown bats, hoary bats, and silver-haired bats; Table 2) were the most commonly recorded species at both cropland (76.7%) and at bat feature (65.4%) stations (Table 3), suggesting that these species are relatively more abundant than high-frequency species in the Project. High-frequency bats (HF; e.g., tri-colored bats, eastern red bats, and *Myotis* species) composed 23.3% and 34.6% of bat passes recorded at cropland and bat feature stations, respectively (Table 2, Table 3).

All eight bat species with potential to occur within the Project were identified at each of the three stations using the auto-classifier component of Kaleidoscope 3.1.7 (Table 6). All of the potential northern long-eared bat calls identified by Kaleidoscope were determined to be false identifications after qualitative review by an experienced bat biologist. These passes are combined along with those by little brown bats as the *Myotis* group in Table 6. Hoary bats were the most commonly identified species by Kaleidoscope present on 71% of detector-nights. The other two LF species (big brown bats and silver-haired bats) were tied as the second most commonly identified species, detected on 56% of operational detector-nights. The *Myotis* group was the least commonly recorded species at all three stations (Table 6).

Table 6. The number (percent) of presence/absence dates for detector-nights with bat species present by station recorded by the detectors at Walleye Wind Project using Kaleidoscope 3.1.7

Common Name	WE1	WE2	WE3	Total
High-Frequency (> 30 kHz)				
eastern red bat	46 (31)	33 (20)	106 (64)	185 (39)
evening bat	26 (18)	20 (12)	80 (48)	126 (26)
Myotis species	4 (3)	2 (1)	30 (18)	36 (8)
tri-colored bat	5 (3)	3 (2)	33 (20)	41 (9)
Low-Frequency (< 30 kHz)				
big brown bat	74 (50)	48 (29)	146 (88)	268 (56)
hoary bat	120 (82)	113 (69)	103 (62)	336 (71)
silver-haired bat	67 (46)	53 (33)	147 (89)	267 (56)

DISCUSSION

Bat fatalities have been discovered at most wind energy facilities monitored in North America, ranging from 0.0 (Chatfield et al. 2014) to 40.2 bat fatalities/MW/year (Hein et al. 2013a; Appendix A). In 2012, an estimated 600,000 bats died as a result of interactions with wind turbines in the US (Hayes 2013). Proximate causes of bat fatalities are primarily due to collisions with moving turbine blades (Grodsky et al. 2011; Rollins et al. 2012) but to a limited extent may also be caused by barotrauma (Baerwald et al. 2008). The underlying reasons for why bats come near turbines are still largely unknown (Cryan and Barclay 2009). To date, post-construction monitoring studies of wind energy facilities show that 1) migratory tree-roosting species (e.g., eastern red bat, hoary bat, and silver-haired bat) compose approximately 78% of reported bat fatalities; 2) the majority of fatalities occur during the fall migration season (August and September); and 3) most fatalities occur on nights with relatively low wind speeds (e.g., less than 6.0 m per second [m/s; 19.7 feet per second (ft/s)]; Arnett et al. 2008; Arnett and Baerwald 2013; Arnett et al. 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 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. However, Baerwald and Barclay (2009) found a significant positive association between pass rates measured at 30 m/s (98 ft/s) AGL 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 therefore, that pre-construction acoustic data could not currently predict bat fatalities, but acknowledged that the data set was limited and additional data may indicate a stronger relationship. Therefore, the current approach to assessing the risk to bats requires a qualitative analysis of activity levels, spatial and temporal relationships, species composition, and comparison to regional fatality patterns.

Mean bat activity during the FMP at the Project cropland detectors (6.15 ± 0.78 bat passes per detector-night; Table 4) was lower than the North American median and within the range of the activities reported in studies available from the Midwest (Appendix A). Given that over two-thirds of bat fatality studies in the Midwest report fewer than five bat fatalities/MW/year (32 of 38 studies; Appendix A; Figure 7), 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. 2009a).

Bat activity was high at the bat feature station, likely because this station was located along forest edge habitat, which would have been attractive to bats for foraging and roosting opportunities. Forested habitat composes 0.7% of the Project (Table 1).

Approximately 76.7% of bat passes recorded in the cropland stations and 65.4% of passes at the bat feature station were emitted by LF bats, suggesting greater relative abundance of species such as big brown bats, silver-haired bats, and hoary bats (Table 3). These LF species may be more likely to become casualties because they typically fly at higher altitudes (see Norberg and Rayner 1987). Activity by HF bats composed 23.3% and 34.6% of bat passes recorded at cropland and bat feature stations. 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 2004b; Jain 2005; Brown and Hamilton 2006a; Gruver et al. 2009a). *Myotis* group bats were the least commonly detected bat species by Kaleidoscope at all three stations (Table 6). Given that hoary bats, eastern red bats, and silver-haired bats are also among the most common bat fatalities at many facilities (Arnett et al. 2008; Arnett and Baerwald 2013), it is expected that these three species would be the most common fatalities at the Project.

Bat activity at cropland stations was highest from late June to early July, while it was highest in early August at the bat feature station. 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. High mid-summer activity may reflect increased foraging by reproductive females during lactation (Kurta et al. 1989) and/or an increased number of foraging bats due to newly volant bat pups (young of the year) being added to the foraging population at this time.

The pre-construction bat studies completed at 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.

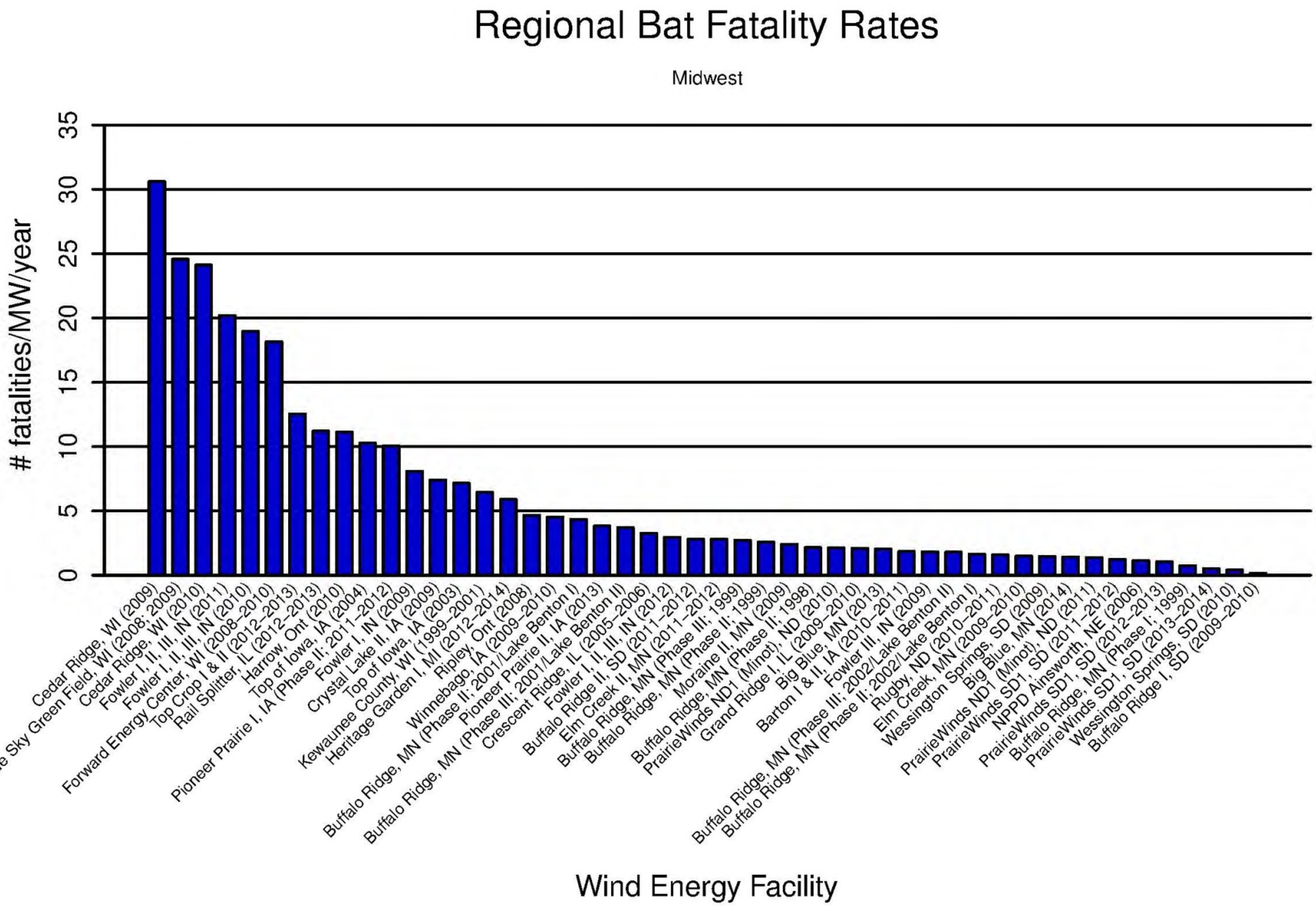

Figure 7. Fatality rates for bats (number of bats per MW per year) from publically available wind energy facilities in the Midwest region of North America.

Figure 7 (*continued*). Fatality rates for bats (number of bats per MW per year) from publically available wind energy facilities in the Midwest region of North America. Data from the following sources:

Facility	Activity Estimate	Fatality Estimate	Facility	Activity Estimate	Fatality Estimate
Cedar Ridge, WI (09)	BHE Environmental 2008	BHE Environmental 2010	Elm Creek II, MN (11-12)		Derby et al. 2012b
Blue Sky Green Field, WI (08; 09)	Gruver 2008	Gruver et al. 2009b	Buffalo Ridge, MN (Phase III; 99)		Johnson et al. 2000
Cedar Ridge, WI (10)	BHE Environmental 2008	BHE Environmental 2011	Buffalo Ridge, MN (Phase II; 99)		Johnson et al. 2000
Fowler I, II, III, IN (11)		Good et al. 2012	Moraine II, MN (09)		Derby et al. 2010d
Fowler I, II, III, IN (10)		Good et al. 2011	Buffalo Ridge, MN (Phase II; 98)		Johnson et al. 2000
Forward Energy Center, WI (08-10)	Watt and Drake 2011	Grodsky and Drake 2011	PrairieWinds ND1 (Minot), ND (10)		Derby et al. 2011c
Top Crop I & II, IL (12-13)		Good et al. 2013a	Grand Ridge I, IL (09-10)		Derby et al. 2010g
Rail Splitter, IL (12-13)		Good et al. 2013b	Big Blue, MN (13)		Fagen Engineering 2014
Harrow, Ont (10)		NRSI 2011	Barton I & II, IA (10-11)		Derby et al. 2011a
Top of Iowa, IA (04)	Jain 2005	Jain 2005	Fowler III, IN (09)		Johnson et al. 2010b
Pioneer Prairie I, IA (Phase II; 11-12)		Chodachek et al. 2012	Buffalo Ridge, MN (Phase III; 02/Lake Benton II)	Johnson et al. 2004	Johnson et al. 2004
Fowler I, IN (09)		Johnson et al. 2010a	Buffalo Ridge, MN (Phase II; 02/Lake Benton I)	Johnson et al. 2004	Johnson et al. 2004
Crystal Lake II, IA (09)		Derby et al. 2010a	Rugby, ND (10-11)		Derby et al. 2011b
Top of Iowa, IA (03)		Jain 2005	Elm Creek, MN (09-10)		Derby et al. 2010c
Kewaunee County, WI (99-01)		Howe et al. 2002	Wessington Springs, SD (09)		Derby et al. 2010f
Heritage Garden I, MI (2012-2014)		Kerlinger et al. 2014	Big Blue, MN (14)		Fagen Engineering 2015
Ripley, Ont (08)		Jacques Whitford 2009	PrairieWinds SD1 (Crow Lake), SD (11-12)		Derby et al. 2012d
Winnebago, IA (09-10)		Derby et al. 2010e	PrairieWinds SD1 (Crow Lake), SD (11-12)		Derby et al. 2012d
Buffalo Ridge, MN (Phase II; 01/Lake Benton I)	Johnson et al. 2004	Johnson et al. 2004	NPPD Ainsworth, NE (06)		Derby et al. 2007
Pioneer Prairie II, IA (13)		Chodachek et al. 2014	PrairieWinds SD1 (Crow Lake), SD (12-13)		Derby et al. 2013a
Buffalo Ridge, MN (Phase III; 01/Lake Benton II)	Johnson et al. 2004	Johnson et al. 2004	Buffalo Ridge, MN (Phase I; 99)		Johnson et al. 2000
Crescent Ridge, IL (05-06)		Kerlinger et al. 2007	PrairieWinds SD1, SD (13-14)		Derby et al. 2014
Fowler I, II, III, IN (12)		Good et al. 2013c	Wessington Springs, SD (10)		Derby et al. 2011d
Buffalo Ridge II, SD (11-12)		Derby et al. 2012a	Buffalo Ridge I, SD (09-10)		Derby et al. 2010b

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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. Bat activity presented as number of bat passes per detector night. Fatality estimate given as number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Bat Activity Estimate	Bat Activity Dates	Fatality Estimate	No. of Turbines	Total MW
Walleye, MN	**6.15**	7/30/16-11/3/16			
		Midwest			
Barton I & II, IA (2010-2011)	NA	NA	1.85	80	160
Big Blue, MN (2013)	NA	NA	2.04	18	36
Big Blue, MN (2014)	NA	NA	1.43	18	36
Blue Sky Green Field, WI (2008; 2009)	7.7[A]	7/24/07-10/29/07	24.57	88	145
Buffalo Ridge I, SD (2009-2010)	NA	NA	0.16	24	50.4
Buffalo Ridge II, SD (2011-2012)	1.75	7/1/08-10/14/08	2.81	105	210
Buffalo Ridge, MN (Phase I; 1999)	NA	NA	0.74	73	25
Buffalo Ridge, MN (Phase II; 1998)	NA	NA	2.16	143	107.25
Buffalo Ridge, MN (Phase II; 1999)	NA	NA	2.59	143	107.25
Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)	2.2[B]	6/15/01-9/15/01	4.35	143	107.25
Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)	1.9[B]	6/15/02-9/15/02	1.64	143	107.25
Buffalo Ridge, MN (Phase III; 1999)	NA	NA	2.72	138	103.5
Buffalo Ridge, MN (Phase III; 2001/Lake Benton II)	2.2[B]	6/15/01-9/15/01	3.71	138	103.5
Buffalo Ridge, MN (Phase III; 2002/Lake Benton II)	1.9[B]	6/15/02-9/15/02	1.81	138	103.5
Cedar Ridge, WI (2009)	9.97[A,B,C,D]	7/16/07-9/30/07	30.61	41	67.6
Cedar Ridge, WI (2010)	9.97[A,B,C,D]	7/16/07-9/30/07	24.12	41	68
Crescent Ridge, IL (2005-2006)	NA	NA	3.27	33	49.5
Crystal Lake II, IA (2009)	NA	NA	7.42	80	200
Elm Creek II, MN (2011-2012)	NA	NA	2.81	62	148.8
Elm Creek, MN (2009-2010)	NA	NA	1.49	67	100
Forward Energy Center, WI (2008-2010)	6.97	8/5/08-11/08/08	18.17	86	129
Fowler I, II, III, IN (2010)	NA	NA	18.96	355	600
Fowler I, II, III, IN (2011)	NA	NA	20.19	355	600
Fowler I, II, III, IN (2012)	NA	NA	2.96	355	600
Fowler I, IN (2009)	NA	NA	8.09	162	301
Fowler III, IN (2009)	NA	NA	1.84	60	99
Grand Ridge I, IL (2009-2010)	NA	NA	2.1	66	99
Harrow, Ont (2010)	NA	NA	11.13	24 (four 6-turb facilities)	39.6
Heritage Garden I, MI (2012-2014)	NA	NA	5.9	14	28
Kewaunee County, WI (1999-2001)	NA	NA	6.45	31	20.46
Moraine II, MN (2009)	NA	NA	2.42	33	49.5
NPPD Ainsworth, NE (2006)	NA	NA	1.16	36	20.5
Pioneer Prairie I, IA (Phase II; 2011-2012)	NA	NA	10.06	62	102.3
Pioneer Prairie II, IA (2013)	NA	NA	3.83	62	102.3
PrairieWinds ND1 (Minot), ND (2010)	NA	NA	2.13	80	115.5
PrairieWinds ND1 (Minot), ND (2011)	NA	NA	1.39	80	115.5

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

Wind Energy Facility	Bat Activity Estimate	Bat Activity Dates	Fatality Estimate	No. of Turbines	Total MW
PrairieWinds SD1, SD (2011-2012)	NA	NA	1.23	108	162
PrairieWinds SD1, SD (2012-2013)	NA	NA	1.05	108	162
PrairieWinds SD1, SD (2013-2014)	NA	NA	0.52	108	162
Rail Splitter, IL (2012-2013)	NA	NA	11.21	67	100.5
Ripley, Ont (2008)	NA	NA	4.67	38	76
Rugby, ND (2010-2011)	NA	NA	1.6	71	149
Top Crop I & II (2012-2013)	NA	NA	12.55	68 (phase I) 132 (phase (II)	300 (102 (phase I) 198 (phase II))
Top of Iowa, IA (2003)	NA	NA	7.16	89	80
Top of Iowa, IA (2004)	35.7	5/26/04-9/24/04	10.27	89	80
Wessington Springs, SD (2009)	NA	NA	1.48	34	51
Wessington Springs, SD (2010)	NA	NA	0.41	34	51
Winnebago, IA (2009-2010)	NA	NA	4.54	10	20
Southern Plains					
Barton Chapel, TX (2009-2010)	NA	NA	3.06	60	120
Big Smile, OK (2012-2013)	NA	NA	2.90	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	0.10	67	134
Rocky Mountains					
Summerview, Alb (2006; 2007)	7.65[B]	07/15/06-07-09/30/06-07	11.42	39	70.2
Summerview, Alb (2005-2006)	NA	NA	10.27	39	70.2
Judith Gap, MT (2006-2007)	NA	NA	8.93	90	135
Foote Creek Rim, WY (Phase I; 1999)	NA	NA	3.97	69	41.4
Judith Gap, MT (2009)	NA	NA	3.2	90	135
Milford I, UT (2010-2011)	NA	NA	2.05	58	145
Milford I & II, UT (2011-2012)	NA	NA	1.67	107	160.5 (58.5 I, 102 II)
Foote Creek Rim, WY (Phase I; 2001-2002)	2.2[B,C]	6/15/01-9/1/01	1.57	69	41.4
Foote Creek Rim, WY (Phase I; 2000)	2.2[B,C]	6/15/00-9/1/00	1.05	69	41.4
Southwestern					
Dry Lake I, AZ (2009-2010)	8.80	4/29/10-11/10/10	3.43	30	63
Dry Lake II, AZ (2011-2012)	11.50	5/11/11-10/26/11	1.66	31	65
California					
Alite, CA (2009-2010)	NA	NA	0.24	8	24
Alta VIII, CA (2012-2013)	NA	NA	0	50	150
Alta Wind I, CA (2011-2012)	4.42[E]	6/26/2009 - 10/31/2009	1.28	100	150
Alta Wind II-V, CA (2011-2012)	0.78	6/26/2009 - 10/31/2009	0.08	190	570

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

Wind Energy Facility	Bat Activity Estimate	Bat Activity Dates	Fatality Estimate	No. of Turbines	Total MW
Alta Wind I-V, CA (2013-2014)	NA	NA	0.2	290	720 (150 GE, 570 vestas)
Diablo Winds, CA (2005-2007)	NA	NA	0.82	31	20.46
Dillon, CA (2008-2009)	NA	NA	2.17	45	45
High Winds, CA (2003-2004)	NA	NA	2.51	90	162
High Winds, CA (2004-2005)	NA	NA	1.52	90	162
Montezuma I, CA (2011)	NA	NA	1.9	16	36.8
Montezuma I, CA (2012)	NA	NA	0.84	16	36.8
Montezuma II, CA (2012-2013)	NA	NA	0.91	34	78.2
Mustang Hills, CA (2012-2013)	NA	NA	0.1	50	150
Pinyon Pines I & II, CA (2013-2014)	NA	NA	0.04	100	NA
Shiloh I, CA (2006-2009)	NA	NA	3.92	100	150
Shiloh II, CA (2009-2010)	NA	NA	2.6	75	150
Shiloh II, CA (2010-2011)	NA	NA	3.8	75	150
Shiloh III, CA (2012-2013)	NA	NA	0.4	50	102.5
Solano III, CA (2012-2013)	NA	NA	0.31	55	128
Pacific Northwest					
Big Horn, WA (2006-2007)	NA	NA	1.9	133	199.5
Biglow Canyon, OR (Phase I; 2008)	NA	NA	1.99	76	125.4
Biglow Canyon, OR (Phase I; 2009)	NA	NA	0.58	76	125.4
Biglow Canyon, OR (Phase II; 2009-2010)	NA	NA	2.71	65	150
Biglow Canyon, OR (Phase II; 2010-2011)	NA	NA	0.57	65	150
Biglow Canyon, OR (Phase III; 2010-2011)	NA	NA	0.22	76	174.8
Combine Hills, OR (2011)	NA	NA	0.73	104	104
Combine Hills, OR (Phase I; 2004-2005)	NA	NA	1.88	41	41
Elkhorn, OR (2008)	NA	NA	1.26	61	101
Elkhorn, OR (2010)	NA	NA	2.14	61	101
Goodnoe, WA (2009-2010)	NA	NA	0.34	47	94
Harvest Wind, WA (2010-2012)	NA	NA	1.27	43	98.9
Hay Canyon, OR (2009-2010)	NA	NA	0.53	48	100.8
Hopkins Ridge, WA (2006)	NA	NA	0.63	83	150
Hopkins Ridge, WA (2008)	NA	NA	1.39	87	156.6
Kittitas Valley, WA (2011-2012)	NA	NA	0.12	48	100.8
Klondike II, OR (2005-2006)	NA	NA	0.41	50	75
Klondike III (Phase I), OR (2007-2009)	NA	NA	1.11	125	223.6
Klondike IIIa (Phase II), OR (2008-2010)	NA	NA	0.14	51	76.5
Klondike, OR (2002-2003)	NA	NA	0.77	16	24
Leaning Juniper, OR (2006-2008)	NA	NA	1.98	67	100.5
Linden Ranch, WA (2010-2011)	NA	NA	1.68	25	50
Marengo I, WA (2009-2010)	NA	NA	0.17	78	140.4
Marengo II, WA (2009-2010)	NA	NA	0.27	39	70.2
Nine Canyon, WA (2002-2003)	NA	NA	2.47	37	48.1

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

Wind Energy Facility	Bat Activity Estimate	Bat Activity Dates	Fatality Estimate	No. of Turbines	Total MW
Palouse Wind, WA (2012-2013)	NA	NA	4.23	58	104.4
Pebble Springs, OR (2009-2010)	NA	NA	1.55	47	98.7
Stateline, OR/WA (2001-2002)	NA	NA	1.09	454	299
Stateline, OR/WA (2003)	NA	NA	2.29	454	299
Stateline, OR/WA (2006)	NA	NA	0.95	454	299
Tuolumne (Windy Point I), WA (2009-2010)	NA	NA	0.94	62	136.6
Vansycle, OR (1999)	NA	NA	1.12	38	24.9
Vantage, WA (2010-2011)	NA	NA	0.4	60	90
White Creek, WA (2007-2011)	NA	NA	2.04	89	204.7
Wild Horse, WA (2007)	NA	NA	0.39	127	229
Windy Flats, WA (2010-2011)	NA	NA	0.41	114	262.2
Northeast					
Beech Ridge, WV (2012)	NA	NA	2.03	67	100.5
Beech Ridge, WV (2013)	NA	NA	0.58	67	100.5
Casselman Curtailment, PA (2008)	NA	NA	4.4	23	35.4
Casselman, PA (2008)	NA	NA	12.61	23	34.5
Casselman, PA (2009)	NA	NA	8.6	23	34.5
Cohocton/Dutch Hill, NY (2009)	NA	NA	8.62	50	125
Cohocton/Dutch Hills, NY (2010)	NA	NA	10.32	50	125
Criterion, MD (2011)	NA	NA	15.61	28	70
Criterion, MD (2012)	NA	NA	7.62	28	70
Criterion, MD (2013)	NA	NA	5.32	28	70
High Sheldon, NY (2010)	NA	NA	2.33	75	112.5
High Sheldon, NY (2011)	NA	NA	1.78	75	112.5
Kibby, ME (2011)	NA	NA	0.12	44	132
Lempster, NH (2009)	NA	NA	3.11	12	24
Lempster, NH (2010)	NA	NA	3.57	12	24
Locust Ridge, PA (Phase II; 2009)	NA	NA	14.11	51	102
Locust Ridge, PA (Phase II; 2010)	NA	NA	14.38	51	102
Maple Ridge, NY (2006)	NA	NA	11.21	120	198
Maple Ridge, NY (2007)	NA	NA	6.49	195	321.75
Maple Ridge, NY (2007-2008)	NA	NA	4.96	195	321.75
Maple Ridge, NY (2012)	NA	NA	7.3	195	321.75
Mars Hill, ME (2007)	NA	NA	2.91	28	42
Mars Hill, ME (2008)	NA	NA	0.45	28	42
Mount Storm, WV (2009)	30.09	7/15/09-10/7/09	17.53	132	264
Mount Storm, WV (2010)	36.67[F]	4/18/10-10/15/10	15.18	132	264
Mount Storm, WV (2011)	NA	NA	7.43	132	264
Mount Storm, WV (Fall 2008)	35.2	7/20/08-10/12/08	6.62	82	164
Mountaineer, WV (2003)	NA	NA	31.69	44	66
Munnsville, NY (2008)	NA	NA	1.93	23	34.5
Noble Altona, NY (2010)	NA	NA	4.34	65	97.5
Noble Bliss, NY (2008)	NA	NA	7.8	67	100
Noble Bliss, NY (2009)	NA	NA	3.85	67	100
Noble Chateaugay, NY (2010)	NA	NA	2.44	71	106.5
Noble Clinton, NY (2008)	2.1[D]	8/8/08-09/31/08	3.14	67	100
Noble Clinton, NY (2009)	1.9[D]	8/1/09-09/31/09	4.5	67	100
Noble Ellenburg, NY (2008)	NA	NA	3.46	54	80

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

Wind Energy Facility	Bat Activity Estimate	Bat Activity Dates	Fatality Estimate	No. of Turbines	Total MW
Noble Ellenburg, NY (2009)	16.1[D]	8/16/09-09/15/09	3.91	54	80
Noble Wethersfield, NY (2010)	NA	NA	16.3	84	126
Pinnacle, WV (2012)	NA	NA	40.2	23	55.2
Record Hill, ME (2012)	24.6	4/16/12-10/23/12	2.96	22	50.6
Record Hill, ME (2014)	NA	NA	0.55	22	50.6
Rollins, ME (2012)	NA	NA	0.18	40	60
Stetson Mountain I, ME (2009)	28.5; 0.3[G]	7/10/09-10/15/09	1.4	38	57
Stetson Mountain I, ME (2011)	NA	NA	0.28	38	57
Stetson Mountain I, ME (2013)	NA	NA	0.18	38	57
Stetson Mountain II, ME (2010)	NA	NA	1.65	17	25.5
Stetson Mountain II, ME (2012)	NA	NA	2.27	17	25.5
Wolfe Island, Ont (July-December 2009)	NA	NA	6.42	86	197.8
Wolfe Island, Ont (July-December 2010)	NA	NA	9.5	86	197.8
Wolfe Island, Ont (July-December 2011)	NA	NA	2.49	86	197.8
Southeast					
Buffalo Mountain, TN (2005)	NA	NA	39.70	18	28.98
Buffalo Mountain, TN (2000-2003)	23.70[C]	NA	31.54	3	1.98

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

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

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

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

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

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

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

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

Facility	Fatality Estimate	Facility	Fatality Estimate
Alite, CA (09-10)	Chatfield et al. 2010	Lempster, NH (09)	Tidhar et al. 2010
Alta Wind I, CA (11-12)	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)	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 2008
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 et al. 2009b	Moraine II, MN (09)	Derby et al. 2010d
Buffalo Gap I, TX (06)	Tierney 2007	Mount Storm, WV (Fall 08)	Young et al. 2009b
Buffalo Gap II, TX (07-08)	Tierney 2009	Mount Storm, WV (09)	Young et al. 2009a, 2010b
Buffalo Mountain, TN (00-03)	Nicholson et al. 2005	Mount Storm, WV (10)	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 2004a
Buffalo Ridge, MN (Phase II; 98)	Johnson et al. 2000	Munnsville, NY (08)	Stantec 2009b
Buffalo Ridge, MN (Phase II; 99)	Johnson et al. 2000	Mustang Hills, CA (12-13)	Chatfield and Bay 2014
Buffalo Ridge, MN (Phase II; 01/Lake Benton I)	Johnson et al. 2004	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 Chateaugay, NY (10)	Jain et al. 2011c
Buffalo Ridge I, SD (09-10)	Derby et al. 2010b	Noble Clinton, NY (08)	Jain et al. 2009c
Buffalo Ridge II, SD (11-12)	Derby et al. 2012a	Noble Clinton, NY (09)	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)	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 2010	NPPD Ainsworth, NE (06)	Derby et al. 2007
Cedar Ridge, WI (10)	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
Criterion, MD (13)	Young et al. 2014a	PrairieWinds SD1 (Crow Lake), SD (11-12)	Derby et al. 2012d
Crystal Lake II, IA (09)	Derby et al. 2010a	PrairieWinds SD1 (Crow Lake), SD (12-13)	Derby et al. 2013a
Diablo Winds, CA (05-07)	WEST 2006, 2008	PrairieWinds SD1, SD (13-14)	Derby et al. 2014
Dillon, CA (08-09)	Chatfield et al. 2009	Rail Splitter, IL (12-13)	Good et al. 2013b
Dry Lake I, AZ (09-10)	Thompson et al. 2011	Record Hill, ME (12)	Stantec 2013b
Dry Lake II, AZ (11-12)	Thompson and Bay 2012	Record Hill, ME (14)	Stantec 2015
Elkhorn, OR (08)	Jeffrey et a. 2009b	Red Hills, OK (12-13)	Derby et al. 2013c
Elkhorn, OR (10)	Enk et al. 2011b	Ripley, Ont (08)	Jacques Whitford 2009
Elm Creek, MN (09-10)	Derby et al. 2010c	Rollins, ME (12)	Stantec 2013c
Elm Creek II, MN (11-12)	Derby et al. 2012b	Rugby, ND (10-11)	Derby et al. 2011b
Foote Creek Rim, WY (Phase I; 99)	Young et al. 2003a	Shiloh I, CA (06-09)	Kerlinger et al. 2009
Foote Creek Rim, WY (Phase I; 00)	Young et al. 2003a, 2003b	Shiloh II, CA (09-10)	Kerlinger et al. 2010
Foote Creek Rim, WY (Phase I; 01-02)	Young et al. 2003a, 2003b	Shiloh II, CA (10-11)	Kerlinger et al. 2013a
Forward Energy Center, WI (08-10)	Grodsky and Drake 2011	Shiloh III, CA (12-13)	Kerlinger et al. 2013b
Fowler I, IN (09)	Johnson et al. 2010a	Solano III, CA (12-13)	AECOM 2013
Fowler III, IN (09)	Johnson et al. 2010b	Stateline, OR/WA (01-02)	Erickson et al. 2004
Fowler I, II, III, IN (10)	Good et al. 2011	Stateline, OR/WA (03)	Erickson et al. 2004
Fowler I, II, III, IN (11)	Good et al. 2012	Stateline, OR/WA (06)	Erickson et al. 2007
Fowler I, II, III, IN (12)	Good et al. 2013c	Stetson Mountain I, ME (09)	Stantec 2009c
Goodnoe, WA (09-10)	URS Corporation 2010a	Stetson Mountain I, ME (11)	Normandeau Associates 2011
Grand Ridge I, IL (09-10)	Derby et al. 2010g	Stetson Mountain I, ME (13)	Stantec 2014
Harrow, Ont (10)	NRSI 2011	Stetson Mountain II, ME (10)	Normandeau Associates 2010
Harvest Wind, WA (10-12)	Downes and Gritski 2012a	Stetson Mountain II, ME (12)	Stantec 2013d
Hay Canyon, OR (09-10)	Gritski and Kronner 2010a	Summerview, Alb (05-06)	Brown and Hamilton 2006b
Heritage Garden I, MI (2012-2014)	Kerlinger et al. 2014	Summerview, Alb (06; 07)	Baerwald 2008

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

Facility	Fatality Estimate	Facility	Fatality Estimate
High Sheldon, NY (10)	Tidhar et al. 2012a	Top Crop I & II, IL (12-13)	Good et al. 2013a
High Sheldon, NY (11)	Tidhar et al. 2012b	Top of Iowa, IA (03)	Jain 2005
High Winds, CA (03-04)	Kerlinger et al. 2006	Top of Iowa, IA (04)	Jain 2005
High Winds, CA (04-05)	Kerlinger et al. 2006	Tuolumne (Windy Point I), WA (09-10)	Enz and Bay 2010
Hopkins Ridge, WA (06)	Young et al. 2007	Vansycle, OR (99)	Erickson et al. 2000
Hopkins Ridge, WA (08)	Young et al. 2009c	Vantage, WA (10-11)	Ventus 2012
Judith Gap, MT (06-07)	TRC 2008	Wessington Springs, SD (09)	Derby et al. 2010f
Judith Gap, MT (09)	Poulton and Erickson 2010	Wessington Springs, SD (10)	Derby et al. 2011d
Kewaunee County, WI (99-01)	Howe et al. 2002	White Creek, WA (07-11)	Downes and Gritski 2012b
Kibby, ME (11)	Stantec 2012a	Wild Horse, WA (07)	Erickson et al. 2008
Kittitas Valley, WA (11-12)	Stantec Consulting Services 2012	Windy Flats, WA (10-11)	Enz et al. 2011
Klondike, OR (02-03)	Johnson et al. 2003	Winnebago, IA (09-10)	Derby et al. 2010e
Klondike II, OR (05-06)	NWC and WEST 2007	Wolfe Island, Ont (July-December 09)	Stantec Ltd. 2010b
Klondike III (Phase I), OR (07-09)	Gritski et al. 2010	Wolfe Island, Ont (July-December 10)	Stantec Ltd. 2011b
Klondike IIIa (Phase II), OR (08-10)	Gritski et al. 2011	Wolfe Island, Ont (July-December 11)	Stantec Ltd. 2012
Leaning Juniper, OR (06-08)	Gritski et al. 2008		

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 et al. 2012
Alta Wind I-V, CA (2013-2014)	0.2	NA	Chatfield et al. 2014
Alta Wind I, CA (2011-2012)	1.28	woodland, grassland, shrubland	Chatfield et al. 2012
Alta Wind II-V, CA (2011-2012)	0.08	desert scrub	Chatfield and Bay 2014
Barton Chapel, TX (2009-2010)	3.06	agriculture/forest	WEST 2011
Barton I & II, IA (2010-2011)	1.85	agriculture	Derby et al. 2011a
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. 2009b
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 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
Buffalo Ridge, MN (Phase I; 1996)	NA	agriculture	Johnson et al. 2000
Buffalo Ridge, MN (Phase I; 1997)	NA	agriculture	Johnson et al. 2000
Buffalo Ridge, MN (Phase I; 1998)	NA	agriculture	Johnson et al. 2000
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
Casselman Curtailment, PA (2008)	4.4	forest	Arnett et al. 2009b

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

Project	Bat Fatalities (bats/MW/year)	Predominant Habitat Type	Citation
Casselman, PA (2008)	12.61	forest	Arnett et al. 2010
Casselman, PA (2009)	8.6	forest, pasture, grassland	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 (2011)	0.73	grassland/shrub-steppe, agriculture	Enz et al. 2012
Combine Hills, OR (Phase I; 2004-2005)	1.88	agriculture/grassland	Young et al. 2006
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		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 II, MN (2011-2012)	2.81	agriculture, grassland	Derby et al. 2010c
Elm Creek, MN (2009-2010)	1.49	agriculture	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, 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 I, IN (2009)	8.09	agriculture	Johnson et al. 2010a
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
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

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

Project	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. 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 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
Klondike, OR (2002-2003)	0.77	agriculture/grassland	Johnson et al. 2003
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 (2007-2008)	4.96	agriculture/forested	Jain et al. 2009a
Maple Ridge, NY (2007)	6.49	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 2008
Mars Hill, ME (2008)	0.45	forest	Stantec 2009a
Milford I & II, UT (2011-2012)	1.67	desert shrub	Stantec 2012b
Milford I, UT (2010-2011)	2.05	desert shrub	Stantec 2011b
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 (2009)	17.53	forest	Young et al. 2009a, 2010b

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

Project	Bat Fatalities (bats/MW/year)	Predominant Habitat Type	Citation
Mount Storm, WV (2010)	15.18	forest	Young et al. 2010a, 2011b
Mount Storm, WV (2011)	7.43	forest	Young et al. 2011a, 2012b
Mount Storm, WV (Fall 2008)	6.62	forest	Young et al. 2009b
Mountaineer, WV (2003)	31.69	forest	Kerns and Kerlinger 2004a
Munnsville, NY (2008)	1.93	agriculture/forest	Stantec 2009b
Mustang Hills, CA (2012-2013)	0.1	Grasslands and Riparian	Chatfield and Bay 2014
Nine Canyon, WA (2002-2003)	2.47	agriculture/grassland	Erickson et al. 2003
Noble Altona, NY (2010)	4.34	forest	Jain et al. 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
Pine Tree, CA (2009-2010, 2011)	NA	grassland	BioResource Consultants 2012
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
Rugby, ND (2010-2011)	1.6	agriculture	Derby et al. 2011b

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

Project	Bat Fatalities (bats/MW/year)	Predominant Habitat Type	Citation
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 2013d
Summerview, Alb (2005-2006)	10.27	agriculture	Brown and Hamilton 2006b
Summerview, Alb (2006; 2007)	11.42	agriculture/grassland	Baerwald 2008
Top Crop I & II (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 VIII, CA (2012-2013)	50	150	90	12 plots (equivalent to 15 turbines)	240 x 240 m	1 year	Bi-weekly
Alta Wind I, CA (2011-2012)	100	150	80	25	120-m radius circle	12.5 months	Every two weeks
Alta Wind II-V, CA (2011-2012)	190	570	80	41	120-m radius circle	14.5 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	n/a	Monthly or bi-weekly
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 two days
Beech Ridge, WV (2013)	67	100.5	80	67	40-m radius	7.5 months	Every two days
Big Blue, MN (2013)	18	36	78 or 90 (according to Gamesa website)	18	200-m diameter	n/a	Weekly, monthly (Nov and Dec)
Big Blue, MN (2014)	18	36	78 or 90 (according to Gamesa website)	18	200-m diameter	n/a	Weekly, monthly (Nov and Dec)
Big Horn, WA (2006-2007)	133	199.5	80	133	180 m x 180 m	1 year	B-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 m x 100 m	20 months	Varies; see number turbines searched or page 44 of report
Buffalo Ridge, MN (Phase I; 1996)	73	25	36	21	126 m x 126 m	1 year	Bi-monthly (spring, summer, and fall)

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; 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 m 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 (2001-2002)	60	39.6	50	60	50-m radius	2 years	Weekly, bi-weekly
Castle River, Alb (2001-2002)	60	39.6	50	60	50-m radius	2 years	Weekly, bi-weekly

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	n/a	n/a	n/a	n/a	n/a	n/a
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)

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 m x 100 m)	1 year	20 searched every 28 days, 10 turbines every 7 days during migration)
Erie Shores, Ont (2006)	66	99	80	66	40-m radius	2 years	Weekly, bi-monthly, 2-3 times weekly (migration)
Foote Creek Rim, WY (Phase I; 1999)	69	41.4	40	69	126 m x 126 m	1 year	Monthly
Foote Creek Rim, WY (Phase I; 2000)	69	41.4	40	69	126 m x 126 m	1 year	Monthly
Foote Creek Rim, WY (Phase I; 2001-2002)	69	41.4	40	69	126 m x 126 m	1 year	Monthly
Forward Energy Center, WI (2008-2010)	86	129	80	29	160 m x 160 m	2 years	11 turbines daily, 9 every 3 days, 9 every 5 days
Fowler I, IN (2009)	162	301	78 (Vestas), 80 (Clipper)	25	160 m x 160 m	spring, summer, fall	weekly, bi-weekly
Fowler I, II, III, IN (2010)	355	600	Vestas = 80, Clipper = 80, GE = 80	36 turbines, 100 road and pads	80 m x 80 m for turbines ; 40-m radius for roads and pads	spring, fall	Daily, weekly
Fowler I, II, III, IN (2011)	355	600	Vestas = 80, Clipper = 80, GE = 80	177 road and pads (spring), 9 turbines & 168 roads and pads (fall)	turbines (80 m circular plot), roads and pads (out to 80 m)	spring, fall	Daily, weekly
Fowler I, II, III, IN (2012)	355	600	Vestas = 80, Clipper = 80, GE = 80	118 roads and pads	roads and pads (out to 80 m)	2.5 months	Weekly
Fowler III, IN (2009)	60	99	78	12	160 m x 160 m	10 weeks	Weekly, bi-weekly
Goodnoe, WA (2009-2010)	47	94	80	24	180 m x 180 m	1 year	14 days during migration periods, 28 days during non-migration periods
Grand Ridge I, IL (2009-2010)	66	99	80	30	160 m x 160 m	1 year	Weekly, monthly

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
Harrow, Ont (2010)	24 (four 6-turb facilities)	39.6	n/a	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 280 m x280 m	1 years	Weekly (spring, summer, and fall) and bi-weekly (winter)
High Winds, CA (2003-2004)	90	162	60	90	75-m radius	1 year	Bi-monthly
High Winds, CA (2004-2005)	90	162	60	90	75-m radius	1 year	Bi-monthly
Hopkins Ridge, WA (2006)	83	150	67	41	180 m x 180 m	1 year	Monthly, weekly (subset of 22 turbines spring and fall migration)
Hopkins Ridge, WA (2008)	87	156.6	67	41-43	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Jersey Atlantic, NJ (2008)	5	7.5	80	5	130 m x 120 m	9 months	Weekly
Judith Gap, MT (2006-2007)	90	135	80	20	190 m x 190 m	7 months	Monthly
Judith Gap, MT (2009)	90	135	80	30	100 m x 100 m	5 months	Bi-monthly
Kewaunee County, WI (1999-2001)	31	20.46	65	31	60 m x 60 m	2 years	Bi-weekly (spring, summer), daily (spring, fall migration), weekly (fall, winter)
Kibby, ME (2011)	44	132	124	22 turbines	75-m diameter circular plots	22 weeks	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

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
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 (2.3 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)
Lakefield Wind, MN (2012)	137	205.5	80	26	100 m x 100 m	7.5 months	3 times per week
Leaning Juniper, OR (2006-2008)	67	100.5	80	17	240 m x 240 m	2 years	Bi-monthly (spring, fall), monthly (winter, summer)
Lempster, NH (2009)	12	24	78	4	120 m x 130 m	6 months	Daily
Lempster, NH (2010)	12	24	78	12	120 m x 130 m	6 months	Weekly
Linden Ranch, WA (2010-2011)	25	50	80	25	110 m x 110 m	1 year	Bi-weekly(spring, fall), monthly (summer, winter)
Locust Ridge, PA (Phase II; 2009)	51	102	80	15	120 m x 126 m	6.5 months	Daily
Locust Ridge, PA (Phase II; 2010)	51	102	80	15	120 m x 126 m	6.5 months	Daily
Madison, NY (2001-2002)	7	11.55	67	7	60-m radius	1 year	Weekly (spring, fall), monthly (summer)
Maple Ridge, NY (2006)	120	198	80	50	130 m x 120 m	5 months	Daily (10 turbines), every 3 days (10 turbines), weekly (30 turbines)
Maple Ridge, NY (2007)	195	321.75	80	64	130 m x 120 m	7 months	Weekly
Maple Ridge, NY (2007-2008)	195	321.75	80	64	130 m x 120 m	7 months	Weekly
Maple Ridge, NY (2012)	195	321.75	80	105 (5 turbines, 100 roads/pads)	100 m x 100 m	3 months	Weekly
Marengo I, WA (2009-2010)	78	140.4	67	39	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Marengo II, WA (2009-2010)	39	70.2	67	20	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)

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
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	n/a	n/a	45	35 m 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 & II, UT (2011-2012)	107	160.5 (58.5 I, 102 II)	80	43	120 m x 120 m	n/a	Every 10.5 days
Milford I, UT (2010-2011)	58	145	80	24	120 m x 120 m	n/a	Weekly
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 (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
Mount Storm, WV (Fall 2008)	82	164	78	27	varied	3 months	Weekly (18 turbines), daily (9 turbines)
Mountaineer, WV (2003)	44	66	80	44	60-m radius	7 months	Weekly, monthly
Mountaineer, WV (2004)	44	66	80	44	130 m x 120 m	6 weeks	Daily, weekly
Munnsville, NY (2008)	23	34.5	69.5	12	120 m x 120 m	spring, summer, fall	Weekly

Appendix 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
Mustang Hills, CA (2012-2013)	50	150	90	13 plots (equivalent to 15 turbines)	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)
Nine Canyon II, WA (2004)	12	15.6	60	12	90 m x 90 m	3 months	Once every two weeks
Noble Altona, NY (2010)	65	97.5	80	22	120 m x 120 m	spring, summer, fall	Daily, weekly
Noble Altona, NY (2011)	65	97.5	80	22	120 m x 120 m	2 months	Daily
Noble Bliss, NY (2008)	67	100	80	23	120 m x 120 m	spring, summer, fall	Daily (8 turbines), 3-day (8 turbines), weekly (7 turbines)
Noble Bliss, NY (2009)	67	100	80	23	120 m x 120 m	spring, summer, fall	Weekly, 8 turbines searched daily from July 1 to August 15
Noble Bliss/Wethersfield, NY (2011)	151	226	80	48 (24 from each site:12 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
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

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
Oklahoma Wind Energy Center, OK (2004; 2005)	68	102	70	68	20-m radius	3 months (2 years)	Bi-monthly
Pacific, CA (2012-2013)	70	140	78.5	20	126-m radius	n/a	Twice weekly (fall), and biweekly
Palouse Wind, WA (2012-2013)	58	104.4	80, 90, or 105 M (according to the Vestas website)	19	120 m x 120 m	1 year	Monthly (winter) and Weekly (spring-fall)
Pebble Springs, OR (2009-2010)	47	98.7	79	20	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Pine Tree, CA (2009-2010, 2011)	90	135	65	40	100-m radius	1.5 year	Bi-weekly, weekly
Pinnacle, WV (2012)	23	55.2	80	11	126 m x 120 m	9 months	Weekly
Pinnacle Operational Mitigation Study (2012)	23	55.2	80	12	126 m x 120 m	2.5 months	Daily
Pinyon Pines I & II, CA (2013-2014)	100	n/a	90	25 plots (approx. 31 turbines)	240 m x 240 m	n/a	Bi-weekly
Pioneer Prairie II, IA (2013)	62	102.3	80	62	80 m x80 m (5 turbines), road and pad within 100 m of turbine (57 turbines)	n/a	Weekly
Pioneer Prairie I, IA (Phase II; 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 Trail, IL (2012-2013)	94	150.5	n/a	50	80 m x80 m	fall, spring	Weekly
Prairie Rose, MN (2014)	119	200	80	10	100 m x 100 m	6 months	Weekly
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)
PrairieWinds ND1 (Minot), ND (2010)	80	115.5	89	35	minimum of 100 m x 100 m	3 seasons	Bi-monthly

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
PrairieWinds ND1 (Minot), ND (2011)	80	115.5	80	35	minimum 100 m x 100 m	3 season	Twice monthly
PrairieWinds SD1, SD (2011-2012)	108	162	80	50	200 m x 200 m	1 year	Twice monthly (spring, summer, fall), monthly (winter)
Rail Splitter, IL (2012-2013)	67	100.5	80	34	60-m radius	1 year	Weekly (spring, summer, and fall) and bi-weekly (winter)
Record Hill, ME (2012)	22	50.6	80	22	126.5 m x 126.5 m	5 months	Three times every two weeks
Record Hill, ME (2014)	22	50.6	80	10	varied due to steep terrain and heavily vegetated areas	4.5 months	Daily for 5 days a week
Red Canyon, TX (2006-2007)	56	84	70	28	200 m x 200 m in fall and winter; 160 m x 160 m in spring and summer	1 year	Every 14 days in fall and winter; 7 days in spring, 3 days in summer
Red Hills, OK (2012-2013)	82	123	80	20 (plus one met tower)	100 m x 100 m	1 year	Weekly (spring, summer, fall), monthly (winter)
Ripley, Ont (2008)	38	76	64	38	80 m x 80 m	spring, fall	Twice weekly for odd turbines; weekly for even turbines.
Ripley, Ont (2008-2009)	38	76	64	38	80 m x 80 m	6 weeks	Twice weekly for odd turbines; weekly for even turbines.
Rollins, ME (2012)	40	60	80	20	varied; turbine laydown area and gravel access roads out to 60 m	6 months	Weekly
Roth Rock, MD (2011)	20	50	80	10	80m x 80 m	3 months	Daily
Rugby, ND (2010-2011)	71	149	78	32	200 m x 200 m	1 year	Weekly (spring, fall; migratory turbines), monthly (non-migratory turbines)
San Gorgonio, CA (1997-1998; 1999-2000)	3000	n/a	24.4-42.7		50-m radius	2 years	Quarterly
Searsburg, VT (1997)	11	7	65	11	20- to 55-m radius	spring, fall	Weekly (fall migration)
Sheffield, VT (2012)	16	40	80	8	126 m x 120 m	3 months	Daily
Sheffield Operational Mitigation Study (2012)	16	40	80	16	126 m x 120 m	4 months	Daily
High Sheldon, NY (2010)	75	112.5	80	25	115 m x 115 m	7 months	daily (8 turbines), weekly (17 turbines)

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
High Sheldon, NY (2011)	75	112.5	80	25	115 m x 115 m	7 months	Daily (8 turbines), weekly (17 turbines)
Shiloh I, CA (2006-2009)	100	150	65	100	105-m radius	3 years	Weekly
Shiloh II, CA (2009-2010)	75	150	80	25	100-m radius	1 year	Weekly
Shiloh II, CA (2010-2011)	75	150	80	25	100-m radius	1 year	Weekly
Shiloh III, CA (2012-2013)	50	102.5	78.5	25	100-m radius	n/a	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	n/a	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)	120 m x 120 m	6 months	Weekly, bi-weekly (November only)
Steel Winds I, NY (2007)	8	20	80	8	176 m x 176 m	6.5 months	Every 10 days (spring, fall) every 21 days (summer)
Stetson Mountain I, ME (2009)	38	57	80	19	76-m diameter	27 weeks (spring, summer, fall)	Weekly
Stetson Mountain I, ME (2011)	38	57	80	19	79.45 m x79.45 m	6 months	Weekly
Stetson Mountain I, ME (2013)	38	57	80	19	76-m diameter	6 months	Weekly
Stetson Mountain II, ME (2010)	17	25.5	80	17	74.5 m x 74.5 m	6 months	Weekly (3 turbines twice a week)
Stetson Mountain II, ME (2012)	17	25.5	80	17	laydown area and road up to 60 m	6 months	Weekly

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

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 (May-June 2009)	86	197.8	80	86	60-m radius	spring	43 twice weekly, 43 weekly
Wolfe Island, Ont (July-December 2009)	86	197.8	80	86	60-m radius	summer, fall	43 twice weekly, 43 weekly
Wolfe Island, Ont (January-June 2010)	86	197.8	80	86	60-m radius	6 months	43 twice weekly, 43 weekly
Wolfe Island, Ont (July-December 2010)	86	197.8	80	86	50-m radius	6 months	43 twice weekly, 43 weekly
Wolfe Island, Ont (January-June 2011)	86	197.8	80	86	50-m radius	6 months	43 twice weekly, 43 weekly
Wolfe Island, Ont (July-December 2011)	86	197.8	80	86	50-m radius	6 months	43 twice weekly, 43 weekly
Wolfe Island, Ont (January-June 2012)	86	197.8	n/a	86	50-m radius	n/a	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	Chatfield et al. 2010	Klondike II, OR	NWC and WEST 2007
Alta Wind I, CA (11)	Chatfield et al. 2012	Klondike III (Phase I), OR	Gritski et al. 2010
Alta Wind II-V, CA (11)	Chatfield et al. 2012	Klondike IIIa (Phase II), OR	Gritski et al. 2011
Barton I&II, IA	Derby et al. 2011a	Leaning Juniper, OR	Gritski et al. 2008
Barton Chapel, TX	WEST 2011	Lempster, NH (09)	Tidhar et al. 2010
Beech Ridge, WV	Tidhar et al. 2013b	Lempster, NH (10)	Tidhar et al. 2011
Big Horn, WA	Kronner et al. 2008	Linden Ranch, WA	Enz and Bay 2011
Big Smile, OK	Derby et al. 2013b	Locust Ridge, PA (Phase II; 09)	Arnett et al. 2011
Biglow Canyon, OR (Phase I; 08)	Jeffrey et al. 2009a	Locust Ridge, PA (Phase II; 10)	Arnett et al. 2011
Biglow Canyon, OR (Phase I; 09)	Enk et al. 2010	Madison, NY	Kerlinger 2002b
Biglow Canyon, OR (Phase II; 09/10)	Enk et al. 2011a	Maple Ridge, NY (06)	Jain et al. 2007
Biglow Canyon, OR (Phase II; 10/11)	Enk et al. 2012b	Maple Ridge, NY (07)	Jain et al. 2009a
Biglow Canyon, OR (Phase III; 10/11)	Enk et al. 2012a	Maple Ridge, NY (08)	Jain et al. 2009d
Blue Sky Green Field, WI	Gruver et al. 2009b	Marengo I, WA (09)	URS Corporation 2010b
Buena Vista, CA	Insignia Environmental 2009	Marengo II, WA (09)	URS Corporation 2010c
Buffalo Gap I, TX	Tierney 2007	Mars Hill, ME (07)	Stantec 2008
Buffalo Gap II, TX	Tierney 2009	Mars Hill, ME (08)	Stantec 2009a
Buffalo Mountain, TN (00-03)	Nicholson et al. 2005	McBride, Alb (04)	Brown and Hamilton 2004
Buffalo Mountain, TN (05)	Fiedler et al. 2007	Melancthon, Ont (Phase I)	Stantec Ltd. 2008
Buffalo Ridge, MN (94/95)	Osborn et al. 1996, 2000	Meyersdale, PA (04)	Arnett et al. 2005
Buffalo Ridge, MN (Phase I; 96)	Johnson et al. 2000	Moraine II, MN	Derby et al. 2010d
Buffalo Ridge, MN (Phase I; 97)	Johnson et al. 2000	Mount Storm, WV (Fall 08)	Young et al. 2009b
Buffalo Ridge, MN (Phase I; 98)	Johnson et al. 2000	Mount Storm, WV (09)	Young et al. 2009a, 2010b
Buffalo Ridge, MN (Phase I; 99)	Johnson et al. 2000	Mount Storm, WV (10)	Young et al. 2010a, 2011b
Buffalo Ridge, MN (Phase II;98)	Johnson et al. 2000	Mount Storm, WV (11)	Young et al. 2011a, 2012b
Buffalo Ridge, MN (Phase II; 99)	Johnson et al. 2000	Mountaineer, WV (03)	Kerns and Kerlinger 2004a
Buffalo Ridge, MN (Phase II; 01/Lake Benton I)	Johnson et al. 2004	Mountaineer, WV (04)	Arnett et al. 2005
Buffalo Ridge, MN (Phase II; 02/Lake Benton I)	Johnson et al. 2004	Munnsville, NY (08)	Stantec 2009b
Buffalo Ridge, MN (Phase III; 99)	Johnson et al. 2000	Nine Canyon, WA	Erickson et al. 2003
Buffalo Ridge, MN (Phase III; 01/Lake Benton II)	Johnson et al. 2004	Noble Altona, NY	Jain et al. 2011b
Buffalo Ridge, MN (Phase III; 02/Lake Benton II)	Johnson et al. 2004	Noble Bliss, NY (08)	Jain et al.2009e
Buffalo Ridge I, SD (10)	Derby et al. 2010b	Noble Bliss, NY (09)	Jain et al. 2010a
Buffalo Ridge II, SD (11)	Derby et al. 2012a	Noble Chateaugay, NY	Jain et al. 2011c
Casselman, PA (08)	Arnett et al. 2009b	Noble Clinton, NY (08)	Jain et al. 2009c
Casselman, PA (09)	Arnett et al. 2010	Noble Clinton, NY (09)	Jain et al. 2010b
Casselman Curtailment, PA (08)	Arnett et al. 2009a	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	Jain et al. 2011a
Cedar Ridge, WI (09)	BHE Environmental 2010	NPPD Ainsworth, NE	Derby et al. 2007
Cedar Ridge, WI (10)	BHE Environmental 2011	Oklahoma Wind Energy Center, OK	Piorkowski and O'Connell 2010
Cohocton/Dutch Hill, NY (09)	Stantec 2010	Pebble Springs, OR	Gritski and Kronner 2010b
Cohocton/Dutch Hills, NY (10)	Stantec 2011a	Pine Tree, CA	BioResource Consultants 2012
Combine Hills, OR	Young et al. 2006	Pioneer Prairie I, IA (Phase II)	Chodachek et al. 2012
Combine Hills, OR (11)	Enz et al. 2012	PrairieWinds ND1 (Minot), ND	Derby et al. 2011c
Condon, OR	Fishman Ecological Services 2003	PrairieWinds ND1 (Minot), ND (11)	Derby et al. 2012c
Crescent Ridge, IL	Kerlinger et al. 2007	PrairieWinds SD1, SD	Derby et al. 2012d
Criterion, MD (11)	Young et al. 2012a	Prince Wind Farm, Ont (06)	Natural Resource Solutions 2009
Criterion, MD (12)	Young et al. 2013	Prince Wind Farm, Ont (07)	Natural Resource Solutions 2009
Crystal Lake II, IA	Derby et al. 2010a	Prince Wind Farm, Ont (08)	Natural Resource Solutions 2009
Diablo Winds, CA	WEST 2006, 2008	Red Canyon, TX	Miller 2008
Dillon, CA	Chatfield et al. 2009	Red Hills, OK	Derby et al. 2013c
Dry Lake I, AZ	Thompson et al. 2011	Ripley, Ont (08)	Jacques Whitford 2009
Dry Lake II, AZ	Thompson and Bay 2012	Ripley, Ont (Fall 09)	Golder Associates 2010
Elkhorn, OR (08)	Jeffrey et a. 2009b	Rugby, ND	Derby et al. 2011b
Elkhorn, OR (10)	Enk et al. 2011b	San Gorgonio, CA	Anderson et al. 2005
Elm Creek, MN	Derby et al. 2010c	Searsburg, VT (07)	Kerlinger 2002a
Elm Creek II, MN	Derby et al. 2012b	Shiloh I, CA	Kerlinger et al. 2009
Erie Shores, Ont	James 2008	Shiloh II, CA	Kerlinger et al. 2010
Foote Creek Rim, WY (Phase I; 99)	Young et al. 2003a	SMUD Solano, CA	Erickson and Sharp 2005
Foote Creek Rim, WY (Phase I; 00)	Young et al. 2003a	Stateline, OR/WA (02)	Erickson et al. 2004
Foote Creek Rim, WY (Phase I; 01-02)	Young et al. 2003a	Stateline, OR/WA (03)	Erickson et al. 2004
Forward Energy Center, WI	Grodsky and Drake 2011	Stateline, OR/WA (06)	Erickson et al. 2007
Fowler I, IN (09)	Good et al. 2011	Stetson Mountain I, ME (09)	Stantec 2009c
Fowler I, II, III, IN (10)	Good et al. 2011	Stetson Mountain I, ME (11)	Normandeau Associates 2011
Fowler I, II, III, IN (11)	Good et al. 2012	Stetson Mountain II, ME (10)	Normandeau Associates 2010
Fowler I, II, III, IN (12)	Good et al. 2013c	Summerview, Alb (06)	Brown and Hamilton 2006b
Fowler III, IN (09)	Good et al. 2011	Summerview, Alb (08)	Baerwald 2008
Goodnoe, WA	URS Corporation 2010a	Tehachapi, CA	Anderson et al. 2004

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
Grand Ridge I, IL	Derby et al. 2010g	Top of Iowa, IA (03)	Jain 2005
Harrow, Ont (10)	Natural Resource Solutions 2011	Top of Iowa, IA (04)	Jain 2005
Harvest Wind, WA (10-12)	Downes and Gritski 2012a	Tuolumne (Windy Point I), WA	Enz and Bay 2010
Hay Canyon, OR	Gritski and Kronner 2010a	Vansycle, OR	Erickson et al. 2000
High Sheldon, NY (10)	Tidhar et al. 2012a	Vantage, WA	Ventus Environmental Solutions 2012
High Sheldon, NY (11)	Tidhar et al. 2012b	Wessington Springs, SD (09)	Brown et al. 2013
High Winds, CA (04)	Kerlinger et al. 2006	Wessington Springs, SD (10)	Derby et al. 2010f
High Winds, CA (05)	Kerlinger et al. 2006	White Creek, WA (07-11)	Downes and Gritski 2012b
Hopkins Ridge, WA (06)	Young et al. 2007	Wild Horse, WA	Erickson et al. 2008
Hopkins Ridge, WA (08)	Young et al. 2009c	Windy Flats, WA	Enz et al. 2011
Jersey Atlantic, NJ	NJAS 2008a, 2008b, 2009	Winnebago, IA	Derby et al. 2010e
Judith Gap, MT (06-07)	TRC 2008	Wolfe Island, Ont (May-June 09)	Stantec Ltd. 2010a
Judith Gap, MT (09)	Poulton and Erickson 2010	Wolfe Island, Ont (July-Dec 09)	Stantec Ltd. 2010b
Kewaunee County, WI	Howe et al. 2002	Wolfe Island, Ont (Jan-June 10)	Stantec Ltd. 2011a
Kibby, ME (11)	Stantec 2012a	Wolfe Island, Ont (July-Dec 10)	Stantec Ltd. 2011b
Kittitas Valley, WA (11-12)	Stantec Consulting 2012	Wolfe Island, Ont (Jan-June 11)	Stantec Ltd. 2011c
Klondike, OR	Johnson et al. 2003	Wolfe Island, Ont (July-Dec 11)	Stantec Ltd. 2012

ENVIRONMENTAL & STATISTICAL CONSULTANTS
7575 Golden Valley Road, Suite 300, Golden Valley, Minnesota 55427
Phone: 612.655.1726 ♦ www.west-inc.com

COVER MEMORANDUM

Date: June 10, 2020

To: Walleye Wind Project, LLC

From: Western EcoSystems Technology, Inc.

Subject: Walleye Wind Project – 2018 Bat Activity Survey Report Cover Memo

INTRODUCTION

Walleye Wind Project, LLC is developing the Walleye Wind Project (Project) in Rock County, Minnesota (Figure 1). The 2018 Bat Activity Survey Report attached to this memorandum was initially prepared for a study area that preceded the current Project. This report is provided due to the study area's proximity to and partial overlap with the current Project, as it provides information pertinent to Minnesota state agency review. The 2018 Bat Activity Survey study area and current Project are depicted in Figure 1, below.

Please also note that in the attached 2018 Bat Activity Survey Report, all references to "Project" and "Project area" refer to the area delineated by the 2018 Bat Activity Survey study area as shown on Figure 1.

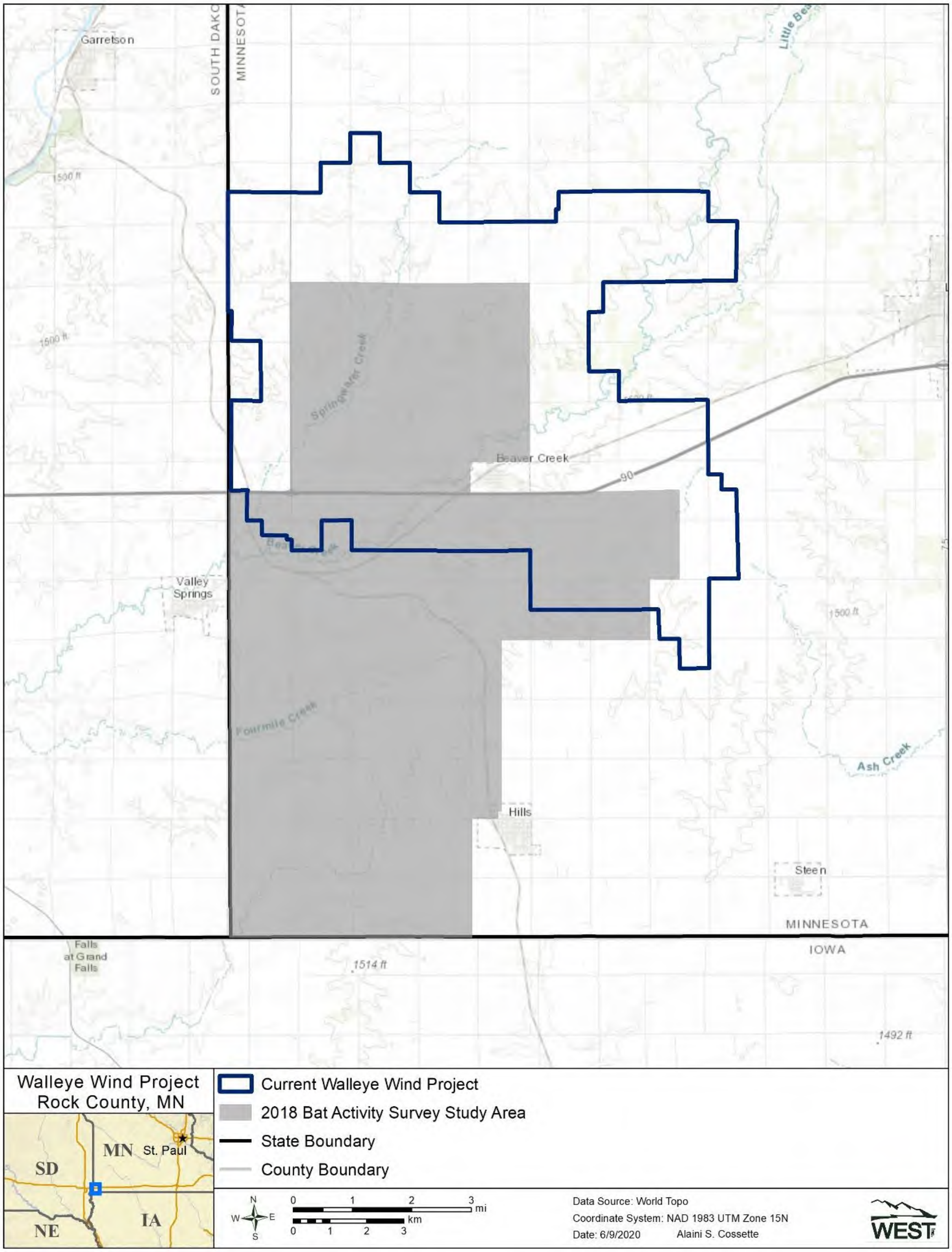

Figure 1. 2018 Bat Activity Survey study area in comparison to the current Walleye Wind Project, Rock County, Minnesota.

Bat Activity Surveys for the Walleye Wind Project Rock County, Minnesota

Final Report

June 28 – October 29, 2018

Prepared for:

Walleye Wind Project, LLC

330 2nd Avenue South, Suite 820
Minneapolis, Minnesota 55401

Prepared by:

Adam Kreger, Brenna Hyzy, Donald Solick

Western EcoSystems Technology, Inc.
7575 Golden Valley Road, Suite 300
Golden Valley, Minnesota 55427

March 2019

WEST Inc.

EXECUTIVE SUMMARY

In 2018, Western EcoSystems Technology, Inc. initiated a bat acoustic activity survey for the proposed Walleye Wind Project (Project) in Rock County, Minnesota. The bat acoustic survey was designed to estimate levels of bat activity throughout the Project area during the summer and fall.

Acoustic surveys were conducted from June 28 – October 29 at four monitoring stations within the Project area. Two AnaBat™ SD2 ultrasonic bat detectors were paired at one meteorological tower with one microphone placed near the ground at 5.0 feet (ft; 1.5 meters [m]) and the other placed within the rotor-swept zone at 148 ft (45 m). An additional detector was placed near the ground at another location. All three stations were located in cropland habitat, which is the dominant land cover type and, therefore, representative of future turbine placement (representative stations). A fourth detector was also designated as a ‘bat feature’ station and was located near the ground in forest edge habitat potentially attractive to bats.

All stations recorded a combined mean (± standard error) of 37.81 ± 3.53 bat passes per detector-night. Ground detectors in representative habitat recorded an average bat activity of 10.62 ± 0.90 bat passes per detector-night, and raised detectors recorded 13.91 ± 1.48 bat passes per detector-night. The bat feature station recorded 116.08 ± 14.21 bat passes per detector-night.

Bat activity at representative stations varied among the two seasons with lower activity in the fall and higher activity in summer. 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 middle of July. At representative stations, 11.2% of bat passes were classified as HF, and 88.7% of bat passes were classified as LF.

Bat activity recorded at the Project area at ground representative stations during the Fall Migration Period (11.20 ± 1.18 bat passes per detector-night) was higher than activity recorded at other facilities in the Midwest. The closest operating wind energy facility to the Project with public post-construction fatality data is the Prairie Rose Wind Farm, located approximately 9.2 miles (14.8 kilometers) to the north of the Project. Both projects are located in landscapes dominated by corn and soybean fields, with little topography and few woodlots. There are no documented pre-construction bat activity estimates from ground-based detectors at the Prairie Rose Wind Project. Bat casualty rates at Prairie Rose have been estimated at 0.41 bats/megawatt/study period for the spring and fall, and it is expected that fatality rates would be similar at the Project due to the close proximity and similarities in landscape features. However, the precise level of fatalities expected for the Project 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

Western EcoSystems Technology

Adam Kreger	Project Manager
Todd Mattson	Senior Review
Brenna Hyzy	Bat Biologist, Bat Data Labeler, Data Analyst
Donald Solick	Bat Biologist
Casi Lathan	Bat Activity Project Coordinator
Carmen Boyd	Project Tracking and Data Manager
Julie Bushey	Statistician
Wes Conway	GIS Technician
Brenna Hyzy	Report Writer
Linda Koepsell	Technical Editor
Aaorn Suehring	Field Supervisor
Ben Chistiansen	Field Technician
Ron Moore	Field Technician

REPORT REFERENCE

Kreger, A., B. Hyzy, and D. Solick. 2019. Bat Activity Surveys for the Walleye Wind Project, Rock County, Minnesota. Final Report: June 28 – October 29, 2018. Prepared for Walleye Wind Project, LLC. Prepared by Western EcoSystems Technology, Inc. (WEST), Golden Valley, Minnesota. January 23, 2019.

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INTRODUCTION

Resource Environmental Solutions, Inc. (RES) is considering the development of the Walleye Project (Project) in Rock County, Minnesota (Figure 1). RES contracted Western EcoSystems Technology, Inc. (WEST) to complete a bat activity surveys following the recommendations of the US Fish and Wildlife Service (USFWS) *Land-based Wind Energy Guidelines* (USFWS 2012a) and Kunz et al. (2007b). The objective of these surveys was to conduct acoustic monitoring surveys to estimate levels of bat activity throughout the Project area during summer and fall. This report describes the results of the acoustic monitoring surveys conducted within the Project area between June 28 and October 29, 2018. This report also presents existing information and results of bat monitoring surveys conducted at other wind facilities. When possible, comparisons with regional and local surveys were made to help assess risk to bats at the Project.

SURVEY AREA

The proposed 34,515-acre (13,967-hectare) Project is located in the bottom southwestern corner of Rock County, Minnesota (Figure 1). The Project area has elevations ranging from 1,325 – 1,601 feet (ft; 404 – 488 meters [m]). The Project is located in the Western Corn Belt Plains Ecoregion, which contains glaciated till plains and undulating loess plains (US Environmental Protection Agency 2017). Historically, much of the region was dominated by tallgrass prairie, riparian forest, oak-prairie savannas, and woody and herbaceous wetlands, but most of the area has been cleared for agricultural purposes. According to the National Land Cover Database (NLCD; US Geological Survey [USGS] NLCD 2011, Homer et al. 2015), the majority of the Project area is cultivated cropland (84.2%; Table 1; Figure 2). Less prominent land cover types include developed open space (6.3%) and hay/pasture (6.3%). The remaining land cover types are less than 2% of the Project area and include herbaceous grassland, deciduous forest, emergent herbaceous wetland, and open water. Deciduous forest provides potential habitat for several bat species, including the federally and state-threatened northern long-eared bat (*Myotis septentrionalis*; USFWS 2013).

Table 1. Land cover types present within the Walleye Wind Project in Rock County, Minnesota.

	Project Area	
Cover Type	**Acres**	**Percent**
Cultivated Crops	29,056.35	84.2
Hay/Pasture	2,179.39	6.3
Developed	2,176.74	6.3
Herbaceous (Grassland)	675.61	2.0
Deciduous Forest	217.59	0.6
Emergent Herbaceous Wetlands	161.95	0.5
Open Water	23.80	0.1
Barren Land	20.47	0.1
Shrub/Scrub	3.34	< 0.1
Total*	**34,515,24**	**100**

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

* Totals may not equal sum of values shown due to rounding.

Overview of Bat Diversity

Seven bat species potentially occur within the Project area (Table 2; International Union for Conservation of Nature 2017, USFWS 2017). The northern long-eared bat is federally listed as threatened (USFWS 2018). The tri-colored bat (*Perimyotis subflavus*) has been proposed for federal listing under the Endangered Species Act (Center for Biological Diversity and Defenders of Wildlife 2016). The USFWS announced on December 20, 2017, that listing may be warranted and initiated a 12-month status review.

Table 2. Bat species with potential to occur within the Walleye Wind Project, Rock County, Minnesota, categorized by echolocation call frequency.

Common Name	**Scientific Name**
High-Frequency (greater than or equal to 30)	
eastern red bat[1,2]	*Lasiurus borealis*
little brown bat[1]	*Myotis lucifugus*
northern long-eared bat[1,3]	*Myotis septentrionalis*
tri-colored bat[1]	*Perimyotis subflavus*
Low-Frequency (less than 30 kHz)	
big brown bat[1]	*Eptesicus fuscus*
silver-haired bat[1,2]	*Lasionycteris noctivagans*
hoary bat[1,2]	*Lasiurus cinereus*

[1] Species known to have been killed at wind energy facilities (American Wind Wildlife Institute 2018)

[2] Long-distance migrant

[3] Federally threatened species (US Fish and Wildlife Service 2018)

kHz = kilohertz

* Sources: (International Union for Conservation of Nature 2018, US Fish and Wildlife Service 2018)

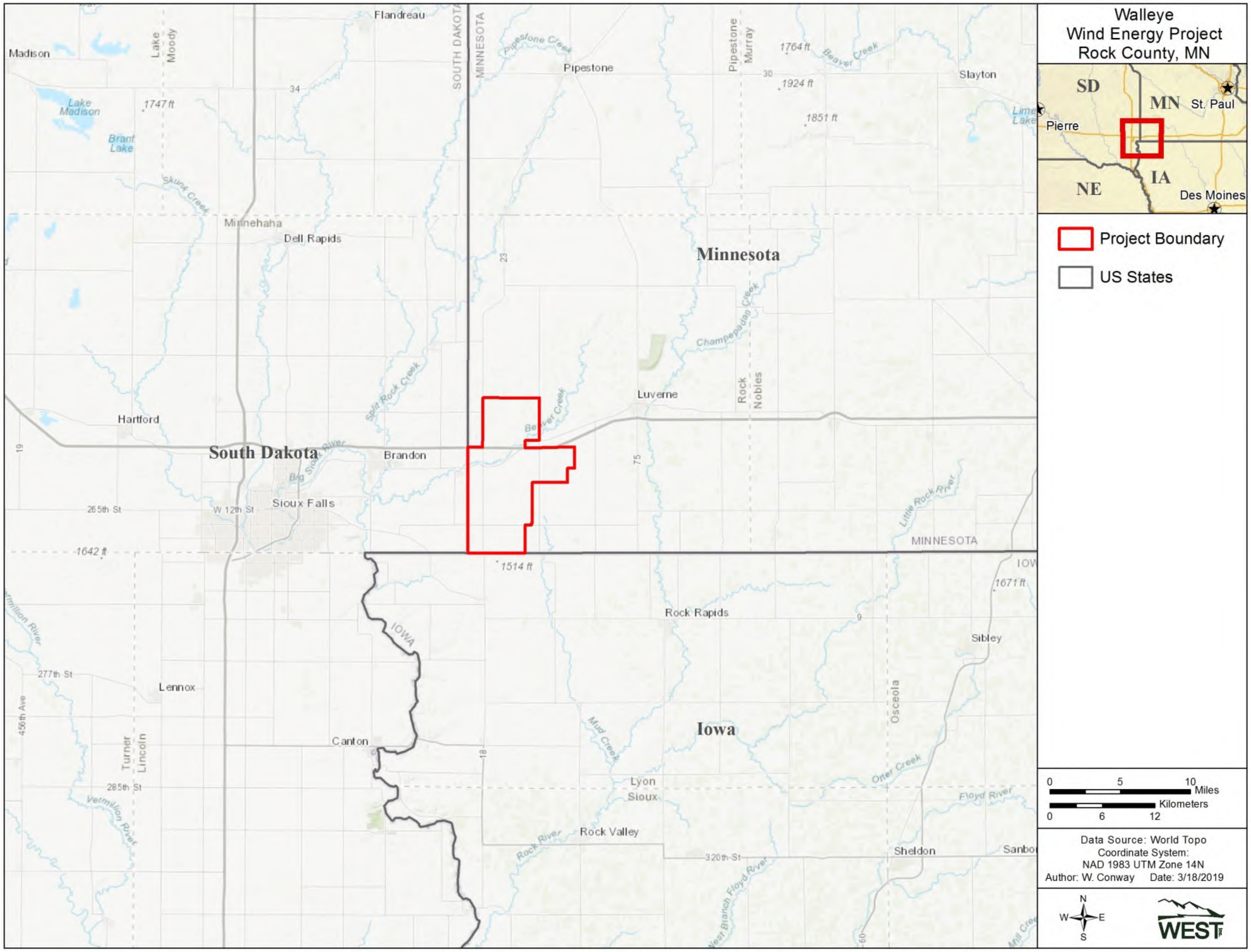

Figure 1. Location of the Walleye Wind Project, Rock County, Minnesota.

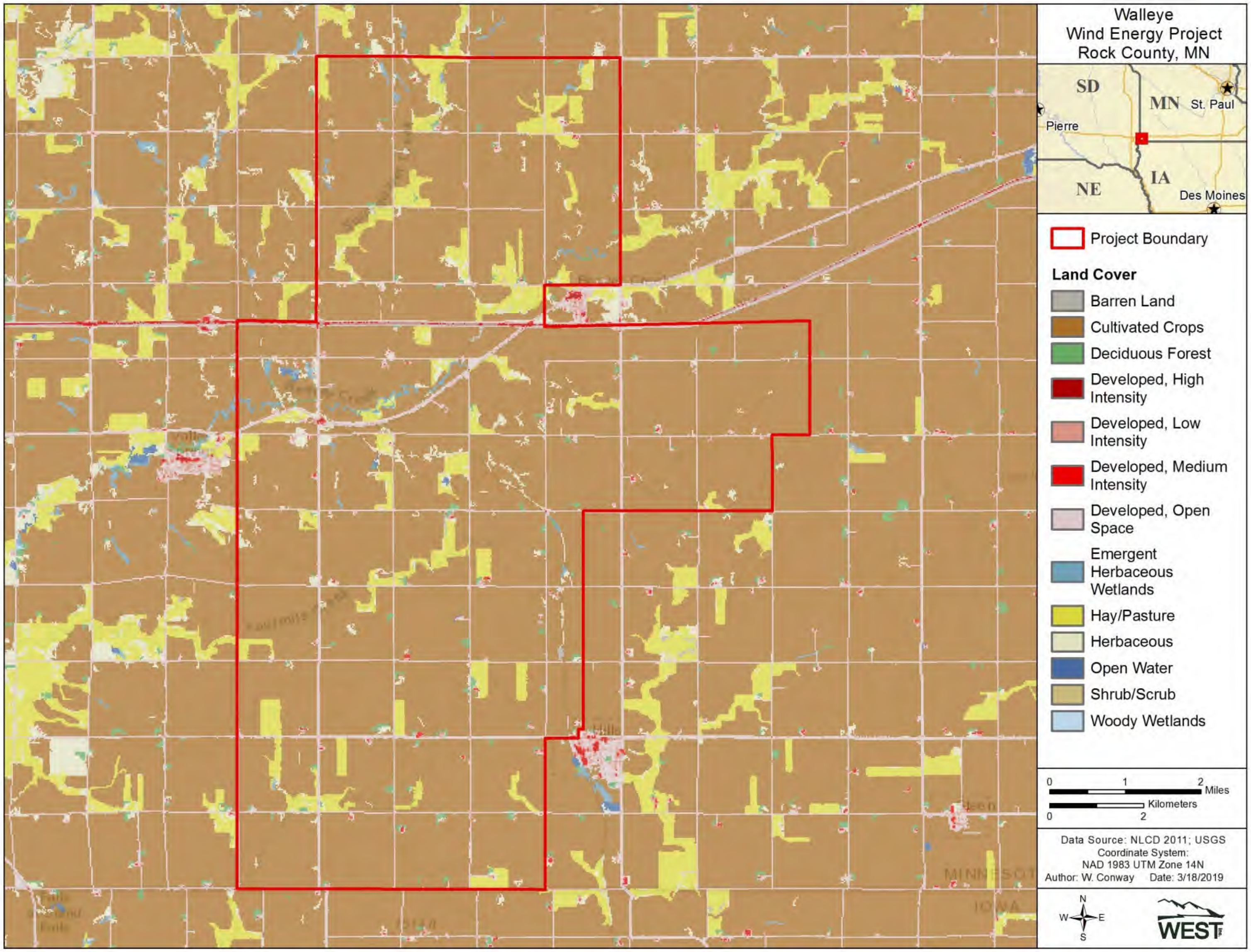

Figure 2. Land cover types and coverage within the Walleye Wind Project, Rock County, Minnesota (US Geological Survey National Land Cover Database 2011, Homer et al. 2015]).

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 from hibernation more frequently than normal, 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 suggest that by 2012 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). Recently, the causative fungus was identified in an additional three states: Wyoming, Kansas, and South Dakota. In Minnesota, the causative fungus was discovered in 2013 at Mystery Cave State Park, approximately 217 miles (mi; 349 kilometers [km]) west of the Project in Fillmore County, and in the Soudan Underground Mine in northeastern Minnesota's St. Louis County, approximately 440 mi (708 km) north of the Project. In 2018, WNS was confirmed in an additional two counties in Minnesota: Wabasha County and Winona County (White-Nose Syndrome.org 2018). The nearest county in Minnesota to confirm WNS is Hennepin County, 167 mi (269 km) to the northeast of the Project (White-Nose Syndrome.org 2018).

METHODS

Bat Activity Surveys

The bat activity acoustic surveys were conducted to estimate the level of bat activity throughout the Project area during June 28 – October 29, 2018.

Survey Stations

Four AnaBat™ SD2 ultrasonic bat detectors (Titley™ Scientific, Columbia, Missouri) were used during the surveys. One AnaBat™ detector was placed at ground level ('ground station'; approximately 5.0 feet [ft; 1.5 meters (m)] above ground level [AGL]) in cropland habitat that was representative of future turbine placement ('representative station'; station WE1g; Figure 3). A second detector was placed along forest edge habitat attractive to bats for foraging and commuting ('bat feature station' WE2g; Figure 3). An experienced bat biologist selected the location of the bat feature station. Monitoring at the bat feature station provides an upper threshold for bat activity in the Project area for comparison with representative stations.

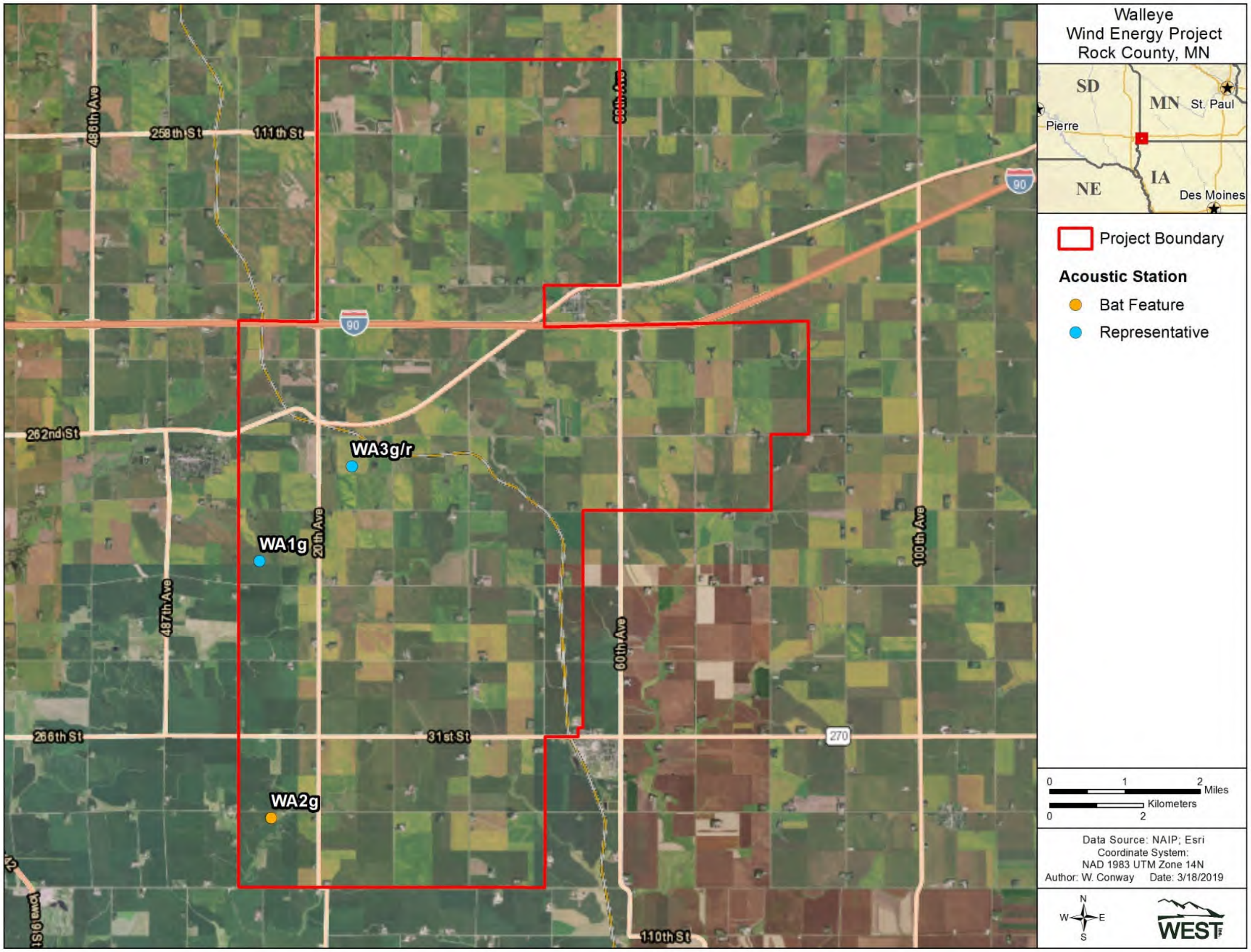

Figure 3. Location of bat stations within the Walleye Wind Project, Rock County, Minnesota.

Two AnaBat™ detectors were placed at a meteorological (met) tower in a representative station, with one microphone at ground level and another within the rotor-swept zone ('raised station'; approximately 148 ft [45 m] AGL; station WE3; Figure 3). Due to a delay in erecting the met tower, the paired detectors (WA3g and WA3t) did not become operational until July 21, 2018. 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).

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 polyvinyl chloride (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. The raised microphone was elevated to approximately 148 ft (45 m) on the met tower using a pulley system. Standard bat-hat weatherproof housing was modified to use a 45-degree angle PVC elbow and an audio cable connected the microphone to the AnaB AnaBat™ at inside the container at the base of the met tower.

Survey Schedule

Bat activity surveys were conducted from June 28 – October 29, 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 two survey periods: summer (June 28 – August 14) and fall (August 15 – October 29). 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, 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 kiloHertz (kHz). Low-frequency (LF) bats such as big brown bats (*Eptesicus fuscus*), silver-haired bats (*Lasionycteris noctivagans*), and hoary bats (*Lasiurus cinereus)* typically emit echolocation calls with minimum frequencies equal to or below 30 kHz. HF and LF species that may occur in the 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; 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™. Additionally, the calculation of bat passes per detector-night was based on the first and last call sequence positively identified during the study period. This removed the inclusion of operational days where no bat calls were recorded from the analysis.

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. Data from the bat feature station was excluded from temporal analysis because seasonal changes in activity at bat feature stations likely reflects changes in insect abundance or roosting behavior, whereas activity at representative stations reflects bats commuting through the Project area.

Risk Assessment

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

RESULTS

Bat Activity Surveys

Bat activity was monitored at four stations for a total of 440 detector-nights between June 28 and October 29, 2018. Detectors and microphones were operating for 97.7% of the sampling period for all stations (Figure 4).

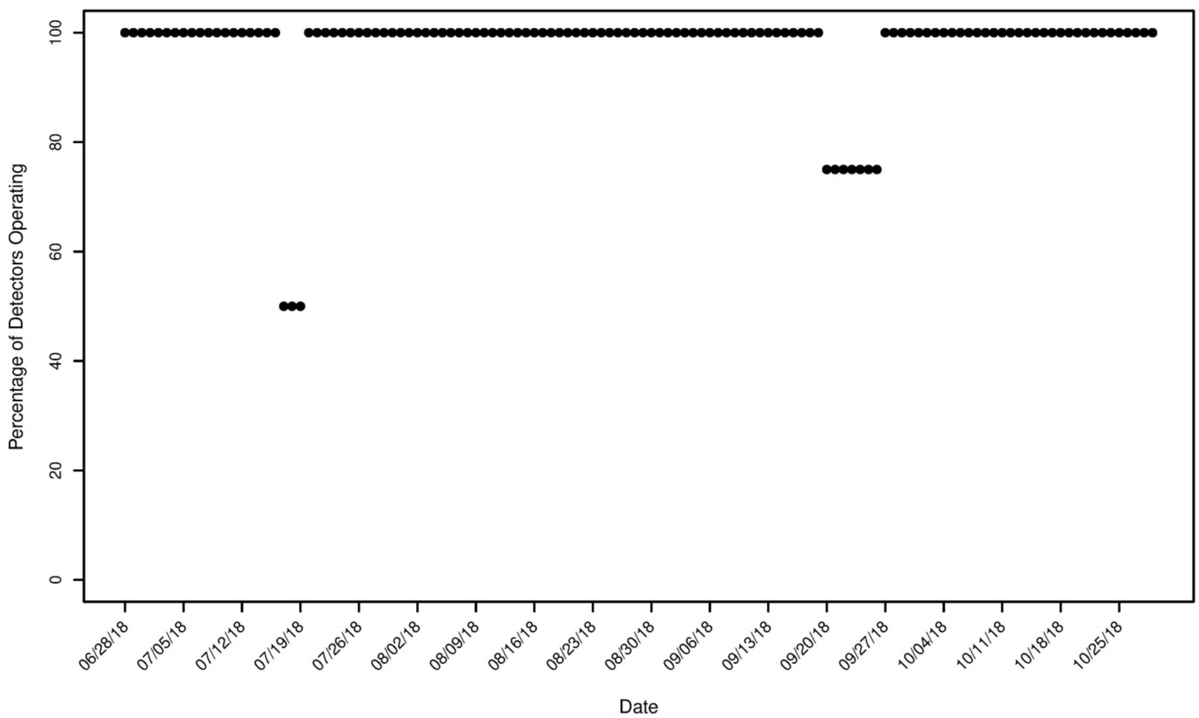

Figure 4. Operational status of all bat detectors and microphones (n=4) operating at the Walleye Wind Project, Rock County, Minnesota, during each night of the survey period June 28 – October 29, 2018.

Spatial Variation

Bat activity within the Project area varied among representative stations (Figure 5). Activity was consistently higher at the raised station (13.91 ± 1.55 bat passes per detector-night), compared to activity at ground stations (10.62 ± 0.90; Table 3). However, at the met tower paired station, activity was higher at the ground microphone (17.13 ± 1.80 bat passes per detector-night) than at the raised microphone (13.91 ± 1.55; Figure 6; Table 3). Among ground stations, station WA3g recorded the most bat passes per detector-night (17.13 ± 1.80), while station WA1g recorded the fewest (4.11 ± 0.46). Activity at the bat feature station was over ten times greater (116.08 ± 13.74 bat passes per detector-night) than activity at representative stations (11.72 ± 1.13; Table 3).

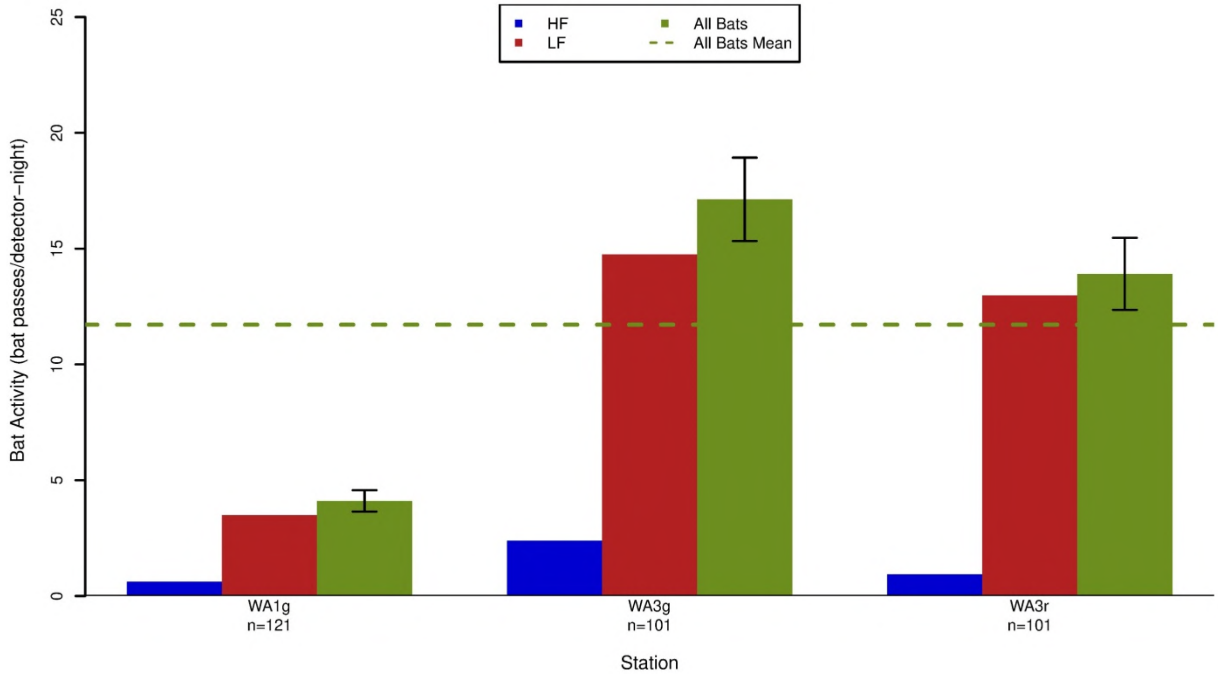

Figure 5. Number of high-frequency (HF) and low-frequency (LF) bat passes per detector-night recorded at stations within the Walleye Wind Project, Rock County, Minnesota, from June 28 – October 29, 2018. The bootstrapped standard errors are represented by the black error bars on the 'All Bats' columns.

Table 3. Results of bat activity surveys conducted at stations within the Walleye Wind Project, Rock County, Minnesota, from June 28 – October 29, 2018. Passes are separated by call frequency: high frequency and low frequency.

Station	Location	Type	Number of HF Bat Passes	Number of LF Bat Passes	Total Bat Passes	Detector-Nights	Bat Passes/Night[1]
WA1g	Ground	Representative	74	423	497	121	4.11 ± 0.47
WA2g	Ground	Bat Feature	5,435	8,146	13,581	117	116.08 ± 14.18
WA3g	Ground	Representative	241	1,489	1,730	101	17.13 ± 1.63
WA3r	Raised	Representative	94	1,311	1,405	101	13.91 ± 1.62
Total Representative Ground			315	1,912	2,227	222	10.62 ± 0.90
Total Representative Raised			94	1,311	1,405	101	13.91 ± 1.48
Total Representative			409	3,223	3,632	323	11.72 ± 1.13
Total Bat Feature			5,435	8,146	13,581	117	116.08 ± 14.21
Total			5,844	11,369	17,213	440	37.81 ± 3.53

[1]± bootstrapped standard error.

HF = high frequency; LF = low frequency

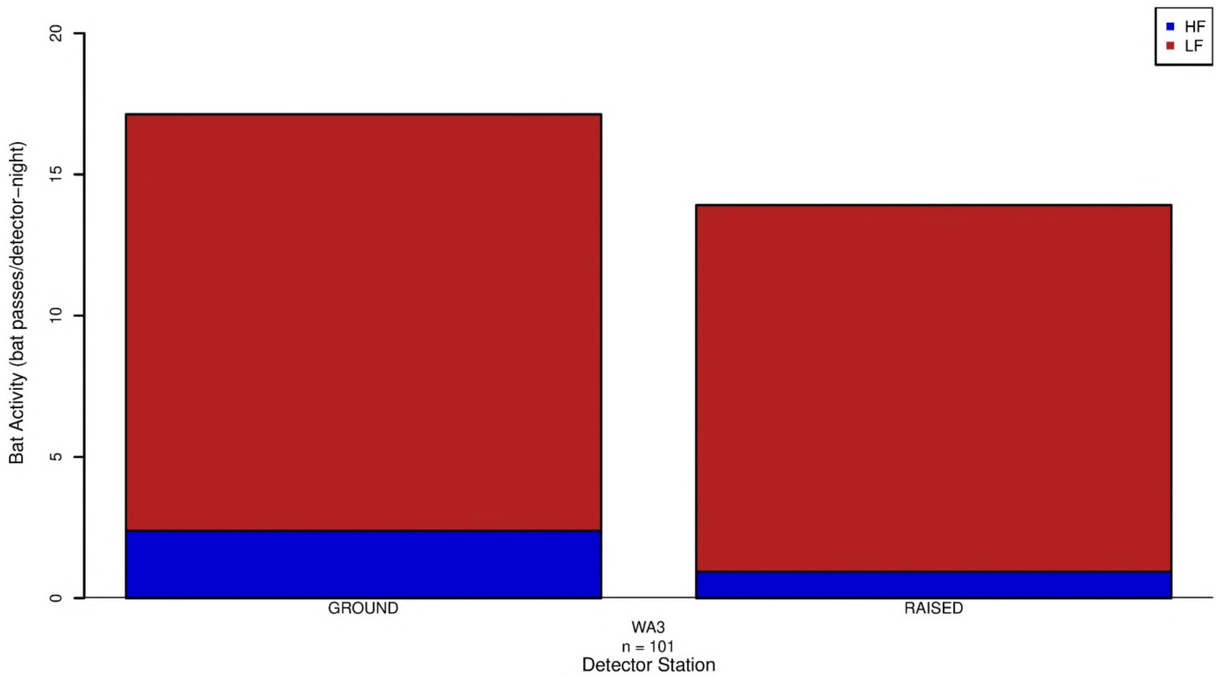

Figure 6. Number of high-frequency (HF) and low-frequency (LF) bat passes per detector-night recorded at paired stations within the Walleye Wind Project area, Rock County, Minnesota, from June 28 – October 29, 2018.

Temporal Variation

Bat activity at representative stations was relatively low in the fall and higher in summer (Table 4; Figure 7). Bat activity at ground representative stations was 11.20 during the FMP (Table 4). Weekly acoustic activity at representative stations was relatively low from June through early July (Figure 8), but increased sharply in mid-July and August, peaking from July 15 to July21 (33.0 bat passes per detector-night; Table 5; Figure 8). Overall bat activity gradually decreased for the remainder of the survey period (Figure 8). At paired stations, weekly activity was higher at ground microphones throughout most of the study period during nights that ground and raised microphones were both operating (Figure 9).

Table 4. The number of bat passes per detector-night recorded at representative stations within the Walleye Wind Project area, Rock County, Minnesota, during each season, separated by call frequency: low-frequency, high-frequency, and all bats.

Station	Call Frequency	Summer Jun 28 – Aug 14	Fall Aug 15 – Nov 5	Fall Migration Period Jul 30 – Oct 14
WA1g	LF	4.73	2.76	3.16
	HF	0.76	0.53	0.68
	AB	5.49	3.29	3.83
WA3g	LF	30.2	9.66	15.94
	HF	5.72	1.29	2.64
	AB	35.92	10.95	18.57
WA3r	LF	25.44	8.88	14.25
	HF	2.28	0.49	1.04
	AB	27.72	9.37	15.29
Ground Totals	**LF**	17.47 ± 1.73	6.21 ± 0.82	9.55 ± 1.03
	HF	3.24 ± 0.42	0.91 ± 0.15	1.66 ± 0.21
	AB	20.70 ± 2.04	7.12 ± 0.91	11.20 ± 1.18
Raised Totals	**LF**	25.44 ± 2.56	8.88 ± 1.56	14.25 ± 1.74
	HF	2.28 ± 0.54	0.49 ± 0.10	1.04 ± 0.22
	AB	27.72 ± 2.51	9.37 ± 1.62	15.29 ± 1.82
Overall	**LF**	20.12 ± 1.58	7.10 ± 1.09	11.11 ± 1.20
	HF	2.92 ± 0.41	0.77 ± 0.13	1.45 ± 0.18
	AB	23.04 ± 1.81	7.87 ± 1.18	12.56 ± 1.32

AB = all bats; HF = high frequency; LF = low frequency

Table 5. Periods of peak activity for high-frequency, low-frequency, and all bats at the Walleye Wind Project, Rock County, Minnesota from June 28 – October 29, 2018.

Species Group	Start Date of Peak Activity	End Date of Peak Activity	Bat Passes per Detector-Night
High Frequency	7/30/18	8/5/18	4.0
Low Frequency	7/15/18	7/21/18	30.4
All Bats	7/15/18	7/21/18	33.0

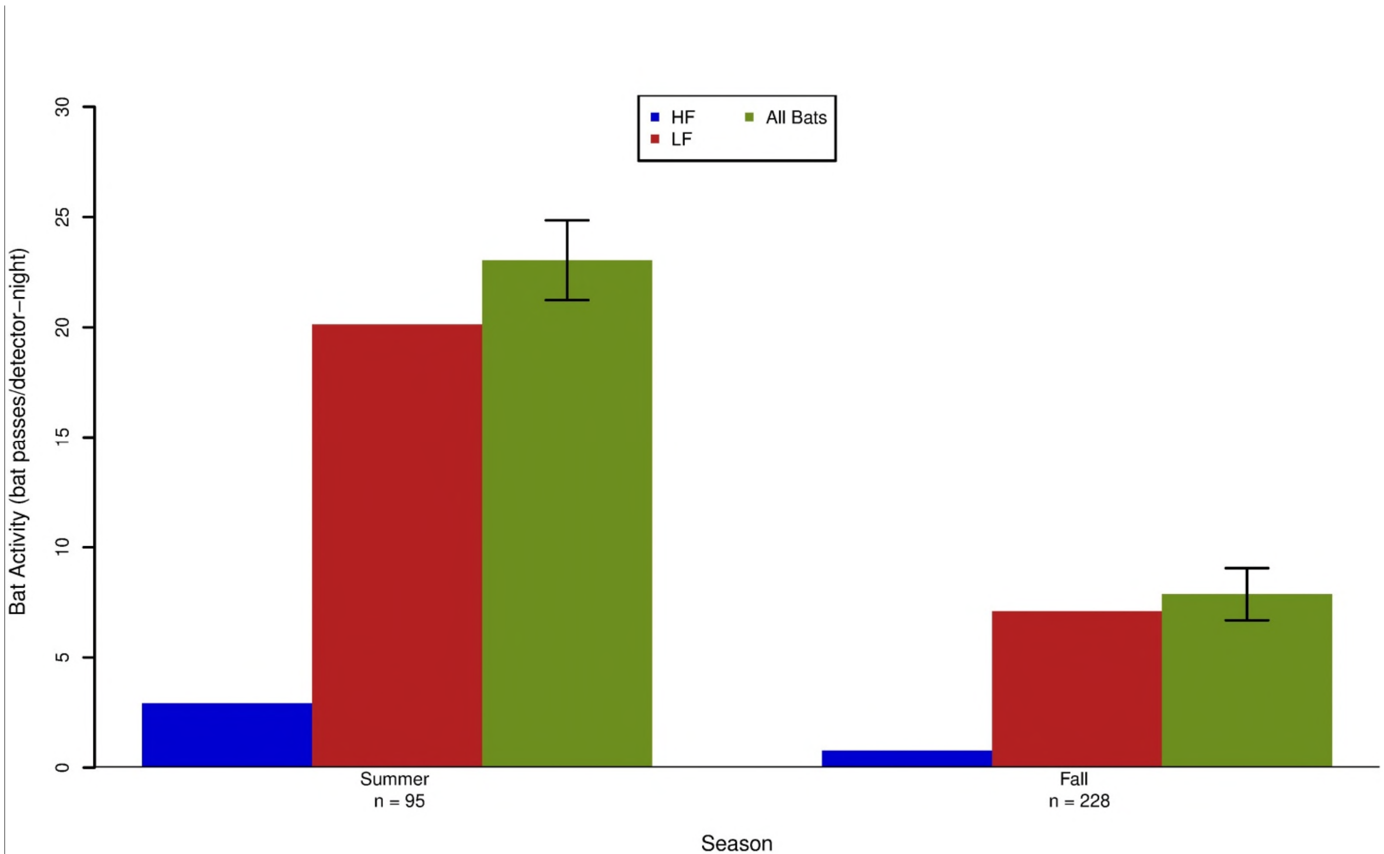

Figure 7. Seasonal bat activity by high-frequency (HF), low-frequency (LF), and all bats at the Walleye Wind Project, Rock County, Minnesota, from June 28 – October 29, 2018. The bootstrapped standard errors are represented on the 'All Bats' columns.

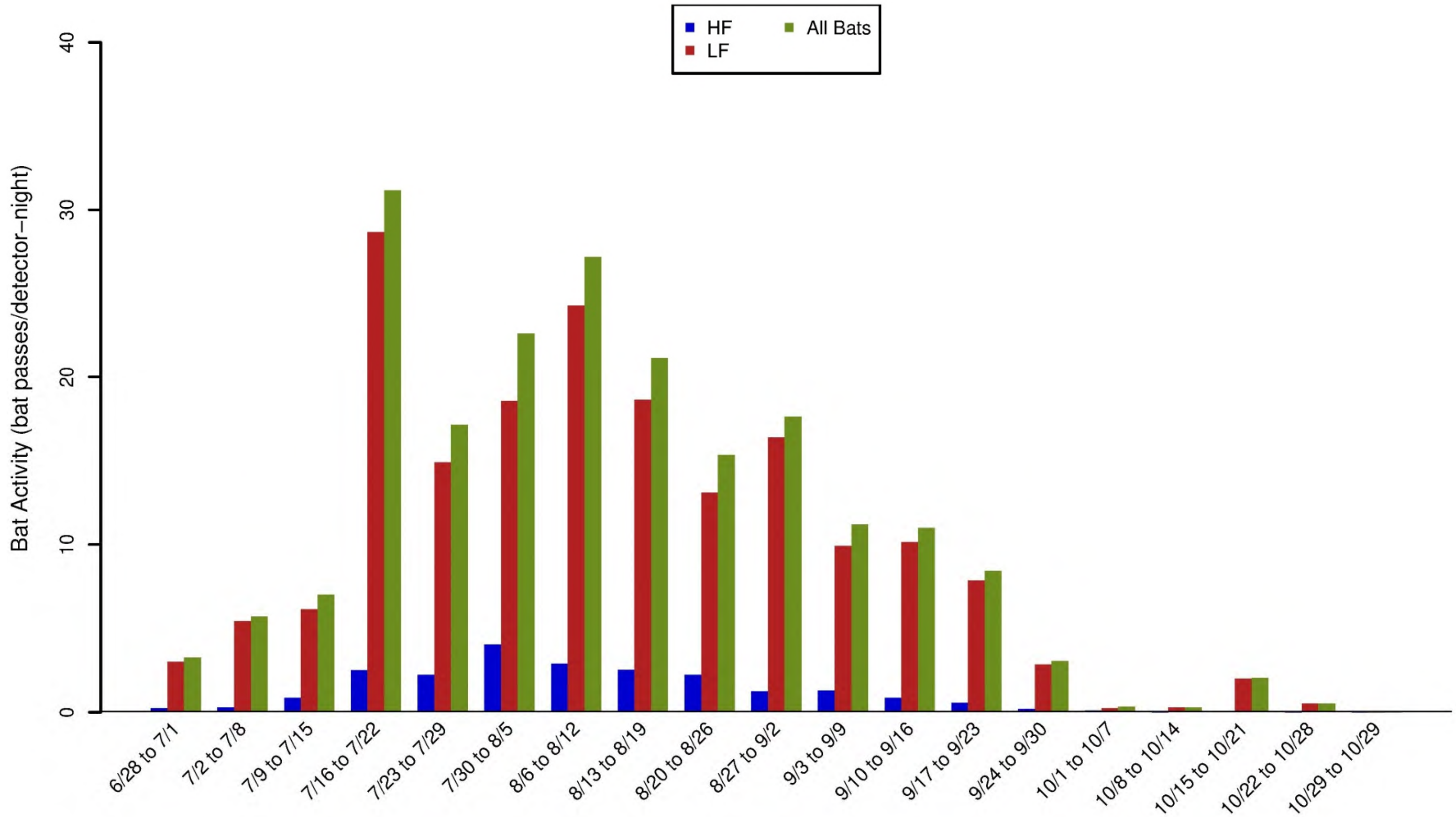

Figure 8. Weekly patterns of bat activity by high-frequency (HF), low-frequency (LF), and all bats at the Walleye Wind Project, Rock County, Minnesota, from June 28 – October 29, 2018.

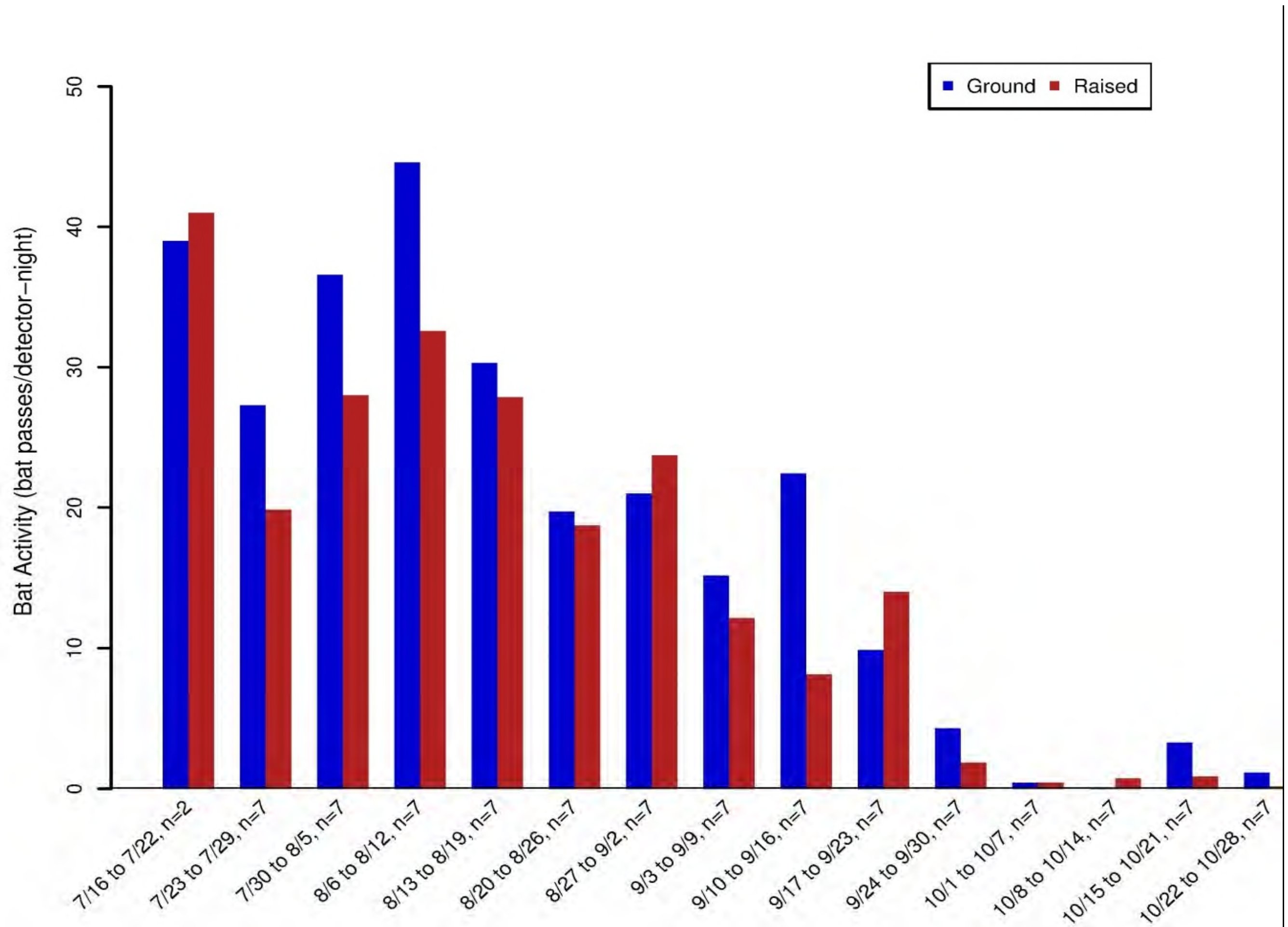

Figure 9. Weekly patterns of bat activity from July 16 – October 29, 2018 at ground and raised meteorological tower stations at the Walleye Wind Project, Rock County, Minnesota.

* Paired Met tower detectors became operational on July 21

Call Frequency Composition

Of the total bat passes recorded at all stations, 34.0% of bat passes were classified as HF(e.g., tri-colored bats, eastern red bats, and *Myotis* species), and 60.7% were classified as LF(e.g., big brown bats, hoary bats, and silver-haired bats; Tables 2 and 3; Figure 10). LF bats were most commonly recorded at representative ground stations (85.9%; Table 3), and were also the most commonly recorded species at raised stations (93.3%; Table 3). At bat feature stations, the majority of recorded calls were produced by LF bats (60.0%; Table 3).

DISCUSSION

Bat fatalities have been discovered at most wind energy facilities monitored in North America, with fatality estimates ranging from zero to 49.70 bat fatalities/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 reported fewer than five bat fatalities/MW/year, with a nationwide median of 2.66 bat fatalities/MW/year (AWWI 2018). In 2012, an estimated 600,000 bats died as a result of interactions with wind turbines in the US (Hayes 2013). Wind development may pose a threat to populations of migratory bats in particular. Projection models estimate that populations of hoary bats could decline as much as 90% in the next 50 years (Frick et al. 2017). Proximate causes of bat fatalities are primarily due to collisions with moving turbine blades (Grodsky et al. 2011, Rollins et al. 2012), but also, to a limited extent, by barotrauma (Baerwald et al. 2008e). 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., less than 20 ft/second [6.0 m/second]; Arnett et al. 2008, Arnett and Baerwald 2013, Arnett et al. 2013, AWWI 2018, Thompson et al. 2017).

Few studies of wind energy facilities are available that have recorded both bat activity and bat fatality rates (Appendix A). Hein et al. (2013a) compiled data from 12 wind projects that measured bat activity and fatality rates and found a non-significant ($p = 0.07$), positive correlation where low activity was generally associated with low fatalities and vice-versa. Researchers concluded 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. Complicating matters, recent evidence suggests the main species killed at wind turbines, hoary bats, often fly without echolocation (Corcoran and Weller 2018) and are therefore not recorded on ultrasonic detectors. However, Baerwald and Barclay (2009) found a significant positive association between pass rates measured at 98 ft (30 m) and fatality rates for hoary and silver-haired bats across five sites in southern Alberta. Yet, on a continental scale, a similar relationship has proven difficult to establish.

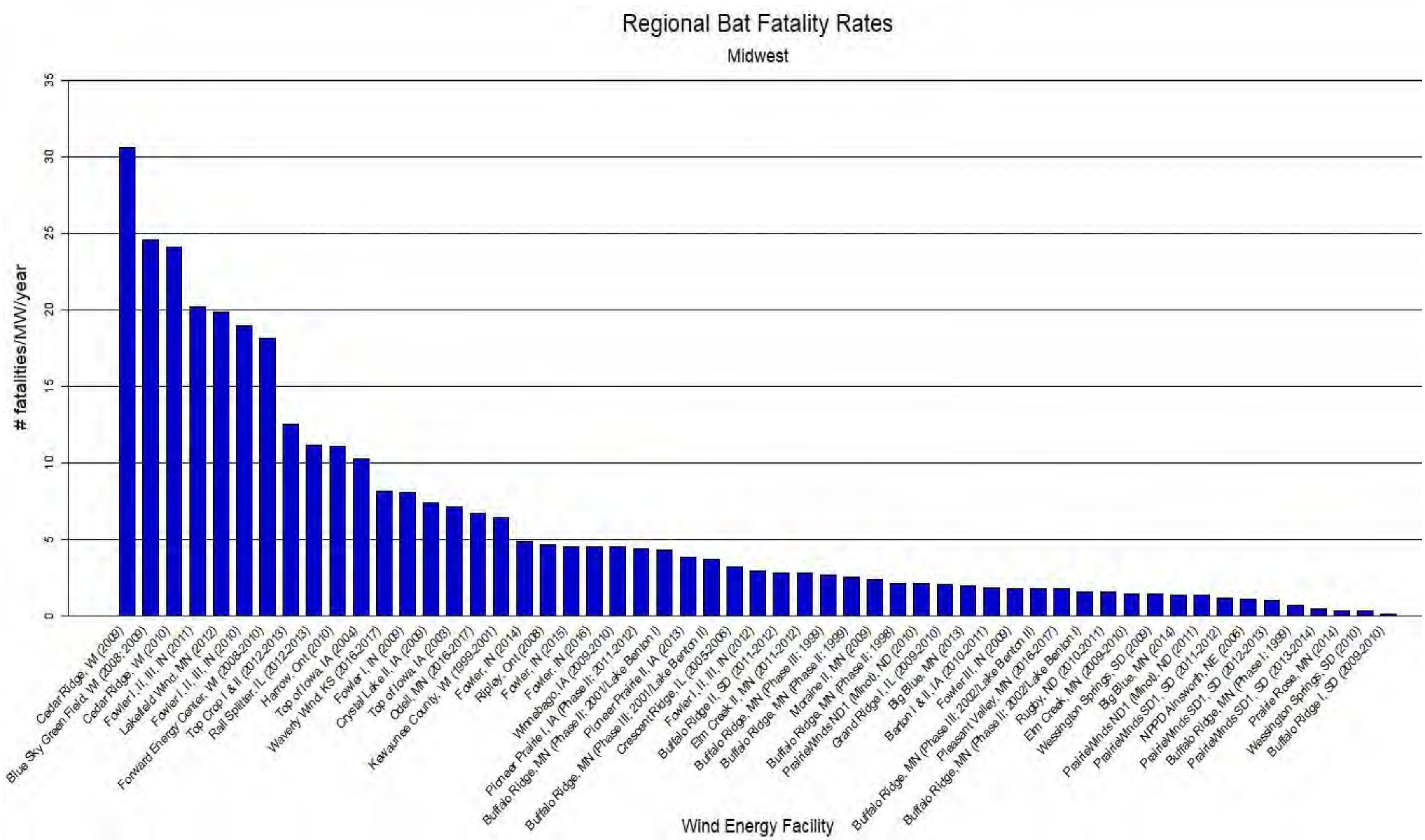

Figure 10. Fatality rates for bats (number of bats per megawatts per year) from publically available wind energy facilities in the Midwest region of North America (references provided in Appendix A).

A review of 40 US studies found that bat mortality might be inversely related to the percent grassland cover surrounding wind facilities (Thompson et al. 2017). That is, the more open the landscape, the less risk of turbine collisions by bats. However, exceptions to this pattern exist (e.g., Jain 2005, Arnett and Baerwald 2013) and it may not be applicable to all regions (Thompson et al. 2017). Bat activity in the rotor-swept zone is representative of bat exposure to turbines (Baerwald and Barclay 2009, Collins and Jones 2009, Roemer et al. 2017), but it is unclear how bat activity at raised stations might relate to bat fatality, or even if such a relationship exists.

Mean bat activity during the FMP at representative ground detectors (11.20 bat passes per detector-night; Table 4) was higher than the national median bat activity (7.68 bat passes per detector-night) and the activity for the majority of studies available from the Midwest (Appendix A).

Bat activity at representative stations varied among the two seasons with lower activity in the fall and higher activity in summer. At these stations, activity by LF (e.g., big brown bats, hoary bats, and silver-haired bats) and HF (e.g., eastern red bats and *Myotis* species) bats peaked during the middle of July. This timing is consistent with peak fatality periods for most wind energy facilities in the US (AWWI 2018), and suggests that bat fatalities at the Project will be highest during late summer.

At all stations, 34.0% of bat passes were classified as HF bats. 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. 2007a, Arnett et al. 2008, AWWI 2018), with a few notable exceptions (Kerns and Kerlinger 2004b, Jain 2005, Brown and Hamilton 2006, Gruver et al. 2009a).

Approximately 66.0% of bat passes were classified as LF at the Project. LF species may become casualties because they fly at higher altitudes, as demonstrated by their greater prevalence at raised detectors (Table 3; Figure 6). Given that hoary 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 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 10) and it is possible that similar fatality rates could be recorded at the Project, even though the pre-construction activity rate during the FMP is higher than average. The closest operating wind-energy facility to the Project with public post-construction fatality data is the Prairie Rose Wind Farm, located approximately 9.2 mi (14.8 km) to the north of the Project. Both projects are located in landscapes dominated by corn and soybean fields, with little topography and few woodlots. There are no documented pre-construction bat activity estimates from ground-based detectors at the Prairie Rose Wind Project. However, bat casualty rates at the Prairie Rose Wind Farm have been estimated at 0.41 bat/MW/study period for the spring and fall, and it is expected that fatality rates would be similar at the Project, due to the close proximity and similarities in landscape features. However, the precise level of fatalities expected for the Project 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.

In summary, while bat activity rates at the Project area are higher than other wind projects in the Midwest, the lack of relationship between pre-construction activity rates and post-construction fatality rates, coupled with the low fatality rates documented at the Prairie Rose Wind Farm 9.2 miles away, leads to the conclusion that bat fatality rates are expected to be similar to other projects in the region. Data suggest that most bat fatalities will occur during the summer and will primarily consist of LF bat species based on the timing of bat activity and the call frequency composition. The pre-construction bat studies completed at the Project area will add to the growing body of research regarding the impacts of wind energy development on bats.

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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. Bat activity presented as number of bat passes per detector night. Fatality estimate given as number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Bat Activity Estimate[A]	Bat Activity Dates	Fatality Estimate[B]	No. of Turbines	Total MW
Walleye, Minnesota	**11.20**	**7/31/18 – 10/14/18**			
		Midwest			
Barton I & II, IA (2010-2011)	NA	NA	1.85	80	160
Big Blue, MN (2013)	NA	NA	2.04	18	36
Big Blue, MN (2014)	NA	NA	1.43	18	36
Blue Sky Green Field, WI (2008; 2009)	7.7	7/24/07-10/29/07	24.57	88	145
Buffalo Ridge I, SD (2009-2010)	NA	NA	0.16	24	50.4
Buffalo Ridge II, SD (2011-2012)	NA	NA	2.81	105	210
Buffalo Ridge, MN (Phase I; 1999)	NA	NA	0.74	73	25
Buffalo Ridge, MN (Phase II; 1998)	NA	NA	2.16	143	107.25
Buffalo Ridge, MN (Phase II; 1999)	NA	NA	2.59	143	107.25
Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)	2.2	6/15/01-9/15/01	4.35	143	107.25
Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)	1.9	6/15/02-9/15/02	1.64	143	107.25
Buffalo Ridge, MN (Phase III; 1999)	NA	NA	2.72	138	103.5
Buffalo Ridge, MN (Phase III; 2001/Lake Benton II)	2.2	6/15/01-9/15/01	3.71	138	103.5
Buffalo Ridge, MN (Phase III; 2002/Lake Benton II)	1.9	6/15/02-9/15/02	1.81	138	103.5
Cedar Ridge, WI (2009)	9.97	7/16/07-9/30/07	30.61	41	67.6
Cedar Ridge, WI (2010)	9.97	7/16/07-9/30/07	24.12	41	68
Crescent Ridge, IL (2005-2006)	NA	NA	3.27	33	49.5
Crystal Lake II, IA (2009)	NA	NA	7.42	80	200
Elm Creek II, MN (2011-2012)	NA	NA	2.81	62	148.8
Elm Creek, MN (2009-2010)	NA	NA	1.49	67	100
Forward Energy Center, WI (2008-2010)	6.97	8/5/08-11/08/08	18.17	86	129
Fowler I, II, III, IN (2010)	NA	NA	18.96	355	600
Fowler I, II, III, IN (2011)	NA	NA	20.19	355	600
Fowler I, II, III, IN (2012)	NA	NA	2.96	355	600
Fowler I, IN (2009)	NA	NA	8.09	162	301
Fowler III, IN (2009)	NA	NA	1.84	60	99
Fowler, IN (2014)	NA	NA	4.86	355	600
Fowler, IN (2015)	NA	NA	4.54	420	NA
Fowler, IN (2016)	NA	NA	4.54	420	750
Grand Ridge I, IL (2009-2010)	NA	NA	2.1	66	99
Harrow, Ont (2010)	NA	NA	11.13	24 (four 6-turb facilities)	39.6
Kewaunee County, WI (1999-2001)	NA	NA	6.45	31	20.46
Lakefield Wind, MN (2012)	NA	NA	19.87	137	205.5
Moraine II, MN (2009)	NA	NA	2.42	33	49.5
NPPD Ainsworth, NE (2006)	NA	NA	1.16	36	20.5
Odell, MN (2016-2017)	NA	NA	6.74	100	200
Pioneer Prairie I, IA (Phase II; 2011-2012)	NA	NA	4.43	62	102.3
Pioneer Prairie II, IA (2013)	NA	NA	3.83	62	102.3
Pleasant Valley, MN (2016-2017)	NA	NA	1.8	100	200
Prairie Rose, MN (2014)	NA	NA	0.41	119	200

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

Wind Energy Facility	Bat Activity Estimate[A]	Bat Activity Dates	Fatality Estimate[B]	No. of Turbines	Total MW
PrairieWinds ND1 (Minot), ND (2010)	NA	NA	2.13	80	115.5
PrairieWinds ND1 (Minot), ND (2011)	NA	NA	1.39	80	115.5
PrairieWinds SD1, SD (2011-2012)	NA	NA	1.23	108	162
PrairieWinds SD1, SD (2012-2013)	NA	NA	1.05	108	162
PrairieWinds SD1, SD (2013-2014)	NA	NA	0.52	108	162
Rail Splitter, IL (2012-2013)	NA	NA	11.21	67	100.5
Ripley, Ont (2008)	NA	NA	4.67	38	76
Rugby, ND (2010-2011)	NA	NA	1.6	71	149
Top Crop I & II (2012-2013)	NA	NA	12.55	68(phase I) 132(phase (II)	300(102 (phase I) 198(phase II))
Top of Iowa, IA (2003)	NA	NA	7.16	89	80
Top of Iowa, IA (2004)	35.7	5/26/04-9/24/04	10.27	89	80
Waverly Wind, KS (2016-2017)	NA	NA	8.2	95	199
Wessington Springs, SD (2009)	NA	NA	1.48	34	51
Wessington Springs, SD (2010)	NA	NA	0.41	34	51
Winnebago, IA (2009-2010)	NA	NA	4.54	10	20
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
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 I, WY (1999)	NA	NA	3.97	69	41
Judith Gap, MT (2009)	NA	NA	3.2	90	135
Top of the World, WY (2010-2011)	NA	NA	2.74	110	200
Top of the World, WY (2011-2012)	NA	NA	2.43	110	200
Top of the World, WY (2012-2013)	NA	NA	2.34	110	200
Milford I, UT (2010-2011)	NA	NA	2.05	58	145
Milford I & II, UT (2011-2012)	NA	NA	1.67	107	160.5 (58.5 I, 102 II)
Foote Creek Rim I, WY (2001-2002)	NA	NA	1.57	69	41
Foote Creek Rim I, WY (2000)	NA	NA	1.05	69	41
Southwestern					
Spring Valley, NV (2012-2013)	NA	NA	3.73	66	152
Dry Lake I, AZ (2009-2010)	8.8	4/29/10-11/10/10	3.43	30	63
Dry Lake II, AZ (2011-2012)	11.5	5/11/11-10/26/11	1.66	31	65
California					
Alite, CA (2009-2010)	NA	NA	0.24	8	24
Alta I, CA (2013-2014)	NA	NA	0.36	290	720
Alta I, CA (2015-2016)	NA	NA	0.7	290	720
Alta II-V, CA (2013-2014)	NA	NA	0	290	720
Alta II-V, CA (2015-2016)	NA	NA	0	290	720

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

Wind Energy Facility	Bat Activity Estimate[A]	Bat Activity Dates	Fatality Estimate[B]	No. of Turbines	Total MW
Alta VIII, CA (2012-2013)	NA	NA	0	50	150
Alta VIII, CA (2014-2015)	NA	NA	0.17	100	300
Alta Wind I, CA (2011-2012)	4.42	6/26/2009 - 10/31/2009	1.28	100	150
Alta Wind II-V, CA (2011-2012)	0.78	6/26/2009 - 10/31/2009	0.08	190	570
Alta X, CA (2014-2015)	NA	NA	0.42	48	137
Alta X, CA (2015-2016)	NA	NA	0.8	48	137
Cameron Ridge/Section 15, CA (2014-2015)	NA	NA	0.15	34	102
Cameron Ridge/Section 15, CA (2015-2016)	NA	NA	0.19	34	102
Diablo Winds, CA (2005-2007)	NA	NA	0.82	31	20.46
Dillon, CA (2008-2009)	NA	NA	2.17	45	45
Hatchet Ridge, CA (2011)	NA	NA	2.23	44	101
Hatchet Ridge, CA (2012)	NA	NA	5.22	44	101
Hatchet Ridge, CA (2012-2013)	NA	NA	4.2	44	NA
High Winds, CA (2003-2004)	NA	NA	2.51	90	162
High Winds, CA (2004-2005)	NA	NA	1.52	90	162
Lower West, CA (2012-2013)	NA	NA	2.17	7	14
Lower West, CA (2014-2015)	NA	NA	1.13	7	14
Lower West, CA (2016-2017)	NA	NA	0	7	14
Montezuma I, CA (2011)	NA	NA	1.9	16	36.8
Montezuma I, CA (2012)	NA	NA	0.84	16	36.8
Montezuma II, CA (2012-2013)	NA	NA	0.91	34	78.2
Mustang Hills, CA (2012-2013)	NA	NA	0.1	50	150
Mustang Hills, CA (2014-2015)	NA	NA	0	100	300
Mustang Hills, CA (2016-2017)	NA	NA	0.33	100	300
Pacific Wind, CA (2014-2015)	NA	NA	0.21	70	144
Pacific Wind, CA (2015-2016)	NA	NA	0	70	144
Pinyon Pines I & II, CA (2013-2014)	NA	NA	0.04	100	NA
Pinyon Pines I & II, CA (2015-2016)	NA	NA	0.18	100	300
Rising Tree, CA (2017-2018)	NA	NA	0	60	198
Shiloh I, CA (2006-2009)	NA	NA	3.92	100	150
Shiloh II, CA (2009-2010)	NA	NA	2.6	75	150
Shiloh II, CA (2010-2011)	NA	NA	3.8	75	150
Shiloh II, CA (2011-2012)	NA	NA	3.4	75	150
Shiloh III, CA (2012-2013)	NA	NA	0.4	50	102.5
Solano III, CA (2012-2013)	NA	NA	0.31	55	128
Windstar, CA (2012-2013)	NA	NA	0	53	106
Pacific Northwest					
Big Horn, WA (2006-2007)	NA	NA	1.9	133	199.5
Biglow Canyon, OR (Phase I; 2008)	NA	NA	1.99	76	125.4
Biglow Canyon, OR (Phase I; 2009)	NA	NA	0.58	76	125.4
Biglow Canyon, OR (Phase II; 2009-2010)	NA	NA	2.71	65	150
Biglow Canyon, OR (Phase II; 2010-2011)	NA	NA	0.57	65	150

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

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)	NA	NA	0.22	76	174.8
Chopin, OR (2016-2017)	NA	NA	1.9	6	10
Combine Hills, OR (2011)	NA	NA	0.73	104	104
Combine Hills, OR (Phase I; 2004-2005)	NA	NA	1.88	41	41
Elkhorn, OR (2008)	NA	NA	1.26	61	101
Elkhorn, OR (2010)	NA	NA	2.14	61	101
Goodnoe, WA (2009-2010)	NA	NA	0.34	47	94
Harvest Wind, WA (2010-2012)	NA	NA	1.27	43	98.9
Hay Canyon, OR (2009-2010)	NA	NA	0.53	48	100.8
Hopkins Ridge, WA (2006)	NA	NA	0.63	83	150
Hopkins Ridge, WA (2008)	NA	NA	1.39	87	156.6
Kittitas Valley, WA (2011-2012)	NA	NA	0.12	48	100.8
Klondike II, OR (2005-2006)	NA	NA	0.41	50	75
Klondike III (Phase I), OR (2007-2009)	NA	NA	1.11	125	223.6
Klondike IIIa (Phase II), OR (2008-2010)	NA	NA	0.14	51	76.5
Klondike, OR (2002-2003)	NA	NA	0.77	16	24
Leaning Juniper, OR (2006-2008)	NA	NA	1.98	67	100.5
Linden Ranch, WA (2010-2011)	NA	NA	1.68	25	50
Marengo I, WA (2009-2010)	NA	NA	0.17	78	140.4
Marengo II, WA (2009-2010)	NA	NA	0.27	39	70.2
Nine Canyon, WA (2002-2003)	NA	NA	2.47	37	48.1
Palouse Wind, WA (2012-2013)	NA	NA	4.23	58	104.4
Pebble Springs, OR (2009-2010)	NA	NA	1.55	47	98.7
Stateline, OR/WA (2001-2002)	NA	NA	1.09	454	299
Stateline, OR/WA (2003)	NA	NA	2.29	454	299
Stateline, OR/WA (2006)	NA	NA	0.95	454	299
Tucannon River, WA (2015)	NA	NA	2.22	116	267
Tuolumne (Windy Point I), WA (2009-2010)	NA	NA	0.94	62	136.6
Vansycle, OR (1999)	NA	NA	1.12	38	24.9
Vantage, WA (2010-2011)	NA	NA	0.4	60	90
White Creek, WA (2007-2011)	NA	NA	2.04	89	204.7
Wild Horse, WA (2007)	NA	NA	0.39	127	229
Windy Flats, WA (2010-2011)	NA	NA	0.41	114	262.2
Northeast					
Beech Ridge, WV (2012)	NA	NA	2.03	67	100.5
Beech Ridge, WV (2013)	NA	NA	0.58	67	100.5
Bingham Wind Project, ME (2017)	NA	NA	0.23	56	185
Bull Hill, ME (2013)	NA	NA	1.62	19	34
Casselman Curtailment, PA (2008)	NA	NA	4.4	23	35.4
Casselman, PA (2008)	NA	NA	12.61	23	34.5
Casselman, PA (2009)	NA	NA	8.6	23	34.5
Cohocton/Dutch Hill, NY (2009)	NA	NA	8.62	50	125
Cohocton/Dutch Hill, NY (2013)	NA	NA	1.37	50	125
Cohocton/Dutch Hills, NY (2010)	NA	NA	10.32	50	125
Criterion, MD (2011)	NA	NA	15.61	28	70
Criterion, MD (2012)	NA	NA	7.62	28	70
Criterion, MD (2013)	NA	NA	5.32	28	70

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

Wind Energy Facility	Bat Activity Estimate[A]	Bat Activity Dates	Fatality Estimate[B]	No. of Turbines	Total MW
Groton, NH (2013)	NA	NA	1.31	24	48
Groton, NH (2014)	NA	NA	1.63	24	48
Groton, NH (2015)	NA	NA	1.74	24	48
Hancock, ME (2017)	NA	NA	0.3	17	51
High Sheldon, NY (2010)	NA	NA	2.33	75	112.5
High Sheldon, NY (2011)	NA	NA	1.78	75	112.5
Howard, NY (2012)	NA	NA	10	27	54
Howard, NY (2013)	NA	NA	2.13	27	54
Kibby, ME (2011)	NA	NA	0.12	44	132
Lempster, NH (2009)	NA	NA	3.11	12	24
Lempster, NH (2010)	NA	NA	3.57	12	24
Locust Ridge, PA (Phase II; 2009)	NA	NA	14.11	51	102
Locust Ridge, PA (Phase II; 2010)	NA	NA	14.38	51	102
Maple Ridge, NY (2006)	NA	NA	11.21	120	198
Maple Ridge, NY (2007)	NA	NA	6.49	195	321.75
Maple Ridge, NY (2007-2008)	NA	NA	4.96	195	321.75
Maple Ridge, NY (2012)	NA	NA	7.3	195	321.75
Mars Hill, ME (2007)	NA	NA	2.91	28	42
Mars Hill, ME (2008)	NA	NA	0.45	28	42
Mount Storm, WV (2009)	30.09	7/15/09-10/7/09	17.53	132	264
Mount Storm, WV (2010)	36.67	4/18/10-10/15/10	15.18	132	264
Mount Storm, WV (2011)	NA	NA	7.43	132	264
Mount Storm, WV (Fall 2008)	35.2	7/20/08-10/12/08	6.62	82	164
Mountaineer, WV (2003)	NA	NA	31.69	44	66
Munnsville, NY (2008)	NA	NA	1.93	23	34.5
Noble Altona, NY (2010)	NA	NA	4.34	65	97.5
Noble Bliss, NY (2008)	NA	NA	7.8	67	100
Noble Bliss, NY (2009)	NA	NA	3.85	67	100
Noble Chateaugay, NY (2010)	NA	NA	2.44	71	106.5
Noble Clinton, NY (2008)	2.1	8/8/08-09/31/08	3.14	67	100
Noble Clinton, NY (2009)	1.9	8/1/09-09/31/09	4.5	67	100
Noble Ellenburg, NY (2008)	NA	NA	3.46	54	80
Noble Ellenburg, NY (2009)	16.1	8/16/09-09/15/09	3.91	54	80
Noble Wethersfield, NY (2010)	NA	NA	16.3	84	126
Oakfield, ME (2017)	NA	NA	0.51	48	148
Pinnacle, WV (2012)	NA	NA	40.2	23	55.2
Record Hill, ME (2012)	24.6	4/16/12-10/23/12	2.96	22	50.6
Record Hill, ME (2014)	NA	NA	0.55	22	50.6
Record Hill, ME (2016)	NA	NA	1.25	22	51
Rollins, ME (2012)	NA	NA	0.18	40	60
Rollins, ME (2014)	NA	NA	0.33	40	60
Roth Rock, MD (2011)	NA	NA	6.24	20	50
Spruce Mountain Wind Project, ME (2014)	NA	NA	0.31	10	20
Steel Winds I & II, NY (2013)	NA	NA	6.14	14	35
Stetson II, ME (2014)	NA	NA	0.83	17	26
Stetson Mountain I, ME (2009)	28.5; 0.3	7/10/09-10/15/09	1.4	38	57
Stetson Mountain I, ME (2011)	NA	NA	0.28	38	57
Stetson Mountain I, ME (2013)	NA	NA	0.18	38	57

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

Wind Energy Facility	Bat Activity Estimate[A]	Bat Activity Dates	Fatality Estimate[B]	No. of Turbines	Total MW
Stetson Mountain II, ME (2010)	NA	NA	1.65	17	25.5
Stetson Mountain II, ME (2012)	NA	NA	2.27	17	25.5
Wolfe Island, Ont (July-December 2009)	NA	NA	6.42	86	197.8
Wolfe Island, Ont (July-December 2010)	NA	NA	9.5	86	197.8
Wolfe Island, Ont (July-December 2011)	NA	NA	2.49	86	197.8
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

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 activity and fatality data for bats. Data from the following sources:

Facility	Activity Citation	Fatality Citation	Facility	Activity Citation	Fatality Citation
Lake Benton II, MN (2018)	This study.				
Alite, CA (2009-2010)		Chatfield et al. 2010	Lempster, NH (2010)		Tidhar et al. 2011
Alta Wind I, CA (2011-2012)	Solick et al. 2010	Chatfield et al. 2012	Linden Ranch, WA (2010-2011)		Enz and Bay 2011
Alta Wind I, CA (2013-2014)		Chatfield et al. 2014	Locust Ridge, PA (Phase II; 2009)		Arnett et al. 2011
Alta I, CA (2015-2016)		Thompson et al. 2016a	Locust Ridge, PA (Phase II; 2010)		Arnett et al. 2011
Alta Wind II-V, CA (2011-2012)	Solick et al. 2010	Chatfield et al. 2012	Lower West, CA (2012-2013)		Levenstein and Bay 2013a
Alta II-V, CA (2013-2014)		Chatfield et al. 2014	Lower West, CA (2014-2015)		Levenstein and DiDonato 2015
Alta II-V, CA (2015-2016)		Thompson et al. 2016a	Lower West, CA (2016-2017)		WEST 2017b
Alta VIII, CA (2012-2013)		Chatfield and Bay 2014	Maple Ridge, NY (2006)		Jain et al. 2007
Alta VIII, CA (2014-2015)		Western EcoSystems Technology, Inc. (WEST) 2016c	Maple Ridge, NY (2007)		Jain et al. 2009a
Alta X, CA (2014-2015)		Chatfield et al. 2015	Maple Ridge, NY (2007-2008)		Jain et al. 2009b
Alta X, CA (2015-2016)		Thompson et al. 2016b	Maple Ridge, NY (2012)		Tidhar et al. 2013b
Barton I & II, IA (2010-2011)		Derby et al. 2011b	Marengo I, WA (2009-2010)		URS 2010b
Barton Chapel, TX (2009-2010)		WEST 2011	Marengo II, WA (2009-2010)		URS 2010c
Beech Ridge, WV (2012)		Tidhar et al. 2013a	Mars Hill, ME (2007)		Stantec 2008a
Beech Ridge, WV (2013)		Young et al. 2014a	Mars Hill, ME (2008)		Stantec 2009a
Big Blue, MN (2013)		Fagen Engineering 2014	Milford I, UT (2010-2011)		Stantec 2011b
Big Blue, MN (2014)		Fagen Engineering 2015	Milford I & II, UT (2011-2012)		Stantec 2012b
Big Horn, WA (2006-2007)		Kronner et al. 2008	Montezuma I, CA (2011)		ICF International 2012
Big Smile, OK (2012-2013)		Derby et al. 2013b	Montezuma I, CA (2012)		ICF International 2013
Biglow Canyon, OR (Phase I; 2008)		Jeffrey et al. 2009b	Montezuma II, CA (2012-2013)		Harvey & Associates 2013
Biglow Canyon, OR (Phase I; 2009)		Enk et al. 2010	Moraine II, MN (2009)		Derby et al. 2010f
Biglow Canyon, OR (Phase II; 2009-2010)		Enk et al. 2011b	Mount Storm, WV (Fall 2008)	Young et al. 2009c	Young et al. 2009c
Biglow Canyon, OR (Phase II; 2010-2011)		Enk et al. 2012b	Mount Storm, WV (2009)	Young et al. 2009a, 2010b	Young et al. 2009a, 2010b
Biglow Canyon, OR (Phase III; 2010-2011)		Enk et al. 2012a	Mount Storm, WV (2010)	Young et al. 2010a, 2011b	Young et al. 2010a, 2011b

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

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

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

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

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

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

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

Facility	Activity Citation	Fatality Citation	Facility	Activity Citation	Fatality Citation
Judith Gap, MT (2009)		Poulton and Erickson 2010	Waverly Wind, KS (2016-2017)		Tetra Tech 2017a
Kewaunee County, WI (1999-2001)		Howe et al. 2002	Wessington Springs, SD (2009)		Derby et al. 2010c
Kibby, ME (2011)		Stantec 2012a	Wessington Springs, SD (2010)		Derby et al. 2011a
Kittitas Valley, WA (2011-2012)		Stantec Consulting Services 2012	White Creek, WA (2007-2011)		Downes and Gritski 2012b
Klondike, OR (2002-2003)		Johnson et al. 2003	Wild Horse, WA (2007)		Erickson et al. 2008
Klondike II, OR (2005-2006)		Northwest Wildlife Consultants (NWC) and WEST 2007	Windstar, CA (2012-2013)		Levenstein and Bay 2013b
Klondike III (Phase I), OR (2007-2009)		Gritski et al. 2010	Windy Flats, WA (2010-2011)		Enz et al. 2011
Klondike IIIa (Phase II), OR (2008-2010)		Gritski et al. 2011	Winnebago, IA (2009-2010)		Derby et al. 2010g
Lakefield Wind, MN (2012)		Minnesota Public Utilities Commission 2012	Wolfe Island, Ont (July-December 2009)		Stantec Ltd. 2010
Leaning Juniper, OR (2006-2008)		Gritski et al. 2008	Wolfe Island, Ont (July-December 2010)		Stantec Ltd. 2011
Lempster, NH (2009)		Tidhar et al. 2010	Wolfe Island, Ont (July-December 2011)		Stantec Ltd. 2012

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 I, CA (2011-2012)	1.28	Woodland, grassland, shrubland	Chatfield et al. 2012
Alta I, CA (2013-2014)	0.36	Desert scrub, grassland	Chatfield et al. 2014
Alta I, CA (2015-2016)	0.7	Desert scrub, grassland	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	Desert scrub, grassland	Chatfield et al. 2014
Alta II-V, CA (2015-2016)	0	Desert scrub, grassland	Thompson et al. 2016a
Alta VIII, CA (2012-2013)	0	Grassland and riparian	Chatfield and Bay 2014
Alta VIII, CA (2014-2015)	0.17	NA	Western EcoSystems Technology, Inc. (WEST) 2016c
Alta X, CA (2014-2015)	0.42	Desert scrub, woodland	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)	4.35	Agriculture	Johnson et al. 2004
Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)	1.64	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, MN (Phase III; 1999)	2.72	Agriculture	Johnson et al. 2000
Buffalo Ridge, MN (Phase III; 2001/Lake Benton II)	3.71	Agriculture	Johnson et al. 2004
Buffalo Ridge, MN (Phase III; 2002/Lake Benton II)	1.81	Agriculture	Johnson et al. 2004
Buffalo Ridge I, SD (2009-2010)	0.16	Agriculture/grassland	Derby et al. 2010d
Buffalo Ridge II, SD (2011-2012)	2.81	Agriculture, grassland	Derby et al. 2012a
Bull Hill, ME (2013)	1.62	Forest	Stantec Consulting (Stantec) 2014a
Cameron Ridge/Section 15, CA (2014-2015)	0.15	Desert scrub	WEST 2016b
Cameron Ridge/Section 15, CA (2015-2016)	0.19	NA	Rintz and Thompson 2017
Casselman, PA (2008)	12.61	Forest	Arnett et al. 2009b
Casselman, PA (2009)	8.6	Forest, pasture, grassland	Arnett et al. 2010
Casselman Curtailment, PA (2008)	4.4	Forest	Arnett et al. 2009a
Cedar Ridge, WI (2009)	30.61	Agriculture	BHE Environmental 2010
Cedar Ridge, WI (2010)	24.12	Agriculture	BHE Environmental 2011
Chopin, OR (2016-2017)	1.9	Agriculture	Hallingstad and Riser-Espinoza 2017
Cohocton/Dutch Hill, NY (2009)	8.62	Agriculture/forest	Stantec 2010
Cohocton/Dutch Hills, NY (2010)	10.32	Agriculture/forest	Stantec 2011a
Cohocton/Dutch Hill, NY (2013)	1.37	Agriculture, forest	Stantec 2014b
Combine Hills, OR (Phase I; 2004-2005)	1.88	Agriculture/grassland	Young et al. 2006
Combine Hills, OR (2011)	0.73	Grassland/shrub-steppe, agriculture	Enz et al. 2012
Crescent Ridge, IL (2005-2006)	3.27	Agriculture	Kerlinger et al. 2007
Criterion, MD (2011)	15.61	Forest, agriculture	Young et al. 2012b
Criterion, MD (2012)	7.62	Forest, agriculture	Young et al. 2013
Criterion, MD (2013)	5.32	Forest, agriculture	Young et al. 2014b
Crystal Lake II, IA (2009)	7.42	Agriculture	Derby et al. 2010b
Diablo Winds, CA (2005-2007)	0.82	NA	WEST 2006, 2008
Dillon, CA (2008-2009)	2.17	Desert	Chatfield et al. 2009
Dry Lake I, AZ (2009-2010)	3.43	Desert grassland/forested	Thompson et al. 2011
Dry Lake II, AZ (2011-2012)	1.66	Desert grassland/forested	Thompson and Bay 2012
Elkhorn, OR (2008)	1.26	Shrub/scrub & agriculture	Jeffrey et a. 2009a
Elkhorn, OR (2010)	2.14	Shrub/scrub & agriculture	Enk et al. 2011a
Elm Creek, MN (2009-2010)	1.49	Agriculture	Derby et al. 2010e
Elm Creek II, MN (2011-2012)	2.81	Agriculture, grassland	Derby et al. 2012b
Foote Creek Rim I, WY (1999)	3.97	Grassland	Young et al. 2003a
Foote Creek Rim I, WY (2000)	1.05	Grassland	Young et al. 2003a
Foote Creek Rim I, WY (2001-2002)	1.57	Grassland	Young et al. 2003a
Forward Energy Center, WI (2008-2010)	18.17	Agriculture	Grodsky and Drake 2011

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

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

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

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

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

Project	Bat Fatalities (bats/MW/ year)	Predominant Habitat Type	Citation
Odell, MN (2016-2017)	6.74	Agriculture	Chodachek and Gustafson 2018
Pacific Wind, CA (2014-2015)	0.21	NA	WEST 2016a
Pacific Wind, CA (2015-2016)	0	NA	WEST 2017a
Palouse Wind, WA (2012-2013)	4.23	Agriculture and grasslands	Stantec 2013a
Pebble Springs, OR (2009-2010)	1.55	Grassland	Gritski and Kronner 2010b
Pinnacle, WV (2012)	40.2	Forest	Hein et al. 2013b
Pinyon Pines I & II, CA (2013-2014)	0.04	NA	Chatfield and Russo 2014
Pinyon Pines I & II, CA (2015-2016)	0.18	NA	Rintz and Starcevich 2016
Pioneer Prairie I, IA (Phase II; 2011-2012)	4.43	Agriculture, grassland	Chodachek et al. 2012
Pioneer Prairie II, IA (2013)	3.83	Agriculture	Chodachek et al. 2014
Pleasant Valley, MN (2016-2017)	1.8	NA	Tetra Tech 2017b
Prairie Rose, MN (2014)	0.41	Agriculture	Chodachek et al. 2015
PrairieWinds ND1 (Minot), ND (2010)	2.13	Agriculture	Derby et al. 2011d
PrairieWinds ND1 (Minot), ND (2011)	1.39	Agriculture, grassland	Derby et al. 2012d
PrairieWinds SD1, SD (2011-2012)	1.23	Grassland	Derby et al. 2012c
PrairieWinds SD1, SD (2012-2013)	1.05	Grassland	Derby et al. 2013a
PrairieWinds SD1, SD (2013-2014)	0.52	Grassland	Derby et al. 2014
Rail Splitter, IL (2012-2013)	11.21	Agriculture	Good et al. 2013b
Record Hill, ME (2012)	2.96	Forest	Stantec 2013b
Record Hill, ME (2014)	0.55	Forest	Stantec 2015b
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 2015c
Roth Rock, MD (2011)	6.24	Rocky	Atwell, LLC 2012
Rugby, ND (2010-2011)	1.6	Agriculture	Derby et al. 2011c
Shiloh I, CA (2006-2009)	3.92	Agriculture/grassland	Kerlinger et al. 2009
Shiloh II, CA (2009-2010)	2.6	Agriculture	Kerlinger et al. 2010, 2013a
Shiloh II, CA (2010-2011)	3.8	Agriculture	Kerlinger et al. 2013a
Shiloh II, CA (2011-2012)	3.4	Agriculture	Kerlinger et al. 2013a
Shiloh III, CA (2012-2013)	0.4	NA	Kerlinger et al. 2013b
Solano III, CA (2012-2013)	0.31	NA	AECOM 2013
Spring Valley, NV (2012-2013)	3.73	Grassland, shrub steppe	WEST 2014
Spruce Mountain Wind Project, ME (2014)	0.31	NA	Tetra Tech 2015
Stateline, OR/WA (2001-2002)	1.09	Agriculture/grassland	Erickson et al. 2004
Stateline, OR/WA (2003)	2.29	Agriculture/grassland	Erickson et al. 2004
Stateline, OR/WA (2006)	0.95	Agriculture/grassland	Erickson et al. 2007

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

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

Appendix A3. All post-construction monitoring studies, project characteristics, and select survey 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 I, CA (2011-2012)	100	150	80	25	120-m radius circle	12.5 months	Every two weeks
Alta I, CA (2013-2014)	290	720	80	NA	120-m radius circle	1 year	Monthly ; bi-monthly
Alta I, CA (2015-2016)	290	720	80	NA	120-m radius circle	1 year	Monthly; bi-monthly
Alta II-V, CA (2011-2012)	190	570	80	41	120-m radius circle	14.5 months	Every 2 weeks
Alta II-V, CA (2013-2014)	290	720	80	NA	120-m radius circle	1 year	Monthly ; bi-monthly
Alta II-V, CA (2015-2016)	290	720	80	NA	120-m radius circle	1 year	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 240 m	NA	Bi-monthly
Alta VIII, CA (2016-2017)	100	300	100	NA	240 m x 240 m	1 year	Bi-weekly
Alta X, CA (2014-2015)	48	137	100	NA	240 m x 240 m	1 year	Bi-monthly
Alta X, CA (2015-2016)	48	137	100	NA	240 m x 240 m	1 year	Bi-monthly
Barton Chapel, TX (2009-2010)	60	120	78	30	200 m x 200 m	1 year	10 turbines weekly, 20 monthly

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

Project Name	Total # of turbines	Total MW	Tower size (m)	Number turbines searched	Plot Size	Length of Study	Survey Frequency
Barton I & II, IA (2010-2011)	80	160	100	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	NA	Weekly, monthly (Nov. and Dec.)
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)

Appendix A3. All post-construction monitoring studies, project characteristics, and select survey 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 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	94	NA	Within 80m; 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)
Buffalo Ridge, MN (Phase II; 1999)	143	107.25	50	40	126 m x 126 m	1 year	Bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)	143	107.25	50	83	60 m x 60 m	Summer, fall	Bi-monthly
Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)	143	107.25	50	103	60 m x 60 m	Summer, fall	Bi-monthly

Appendix A3. All post-construction monitoring studies, project characteristics, and select survey 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 III; 1999)	138	103.5	50	30	126 m x 126 m	1 year	Bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase III; 2001/Lake Benton II)	138	103.5	50	83	60 m x 60 m	Summer, fall	Bi-monthly
Buffalo Ridge, MN (Phase III; 2002/Lake Benton II)	138	103.5	50	103	60 m x 60 m	Summer, fall	Bi-monthly
Buffalo Ridge I, SD (2009-2010)	24	50.4	79	24	200 m x 200 m	1 year	Weekly (migratory), monthly (non-migratory)
Buffalo Ridge II, SD (2011-2012)	105	210	78	65 (60 road and pad, 5 turbine plots)	100 m x 100 m	1 year	Weekly (spring, summer, fall), monthly (winter)
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	NA	62.5-m radius circle	1 year	Weekly
Cameron Ridge/Section 15, CA (2015-2016)	34	102	80	NA	125-m radius circle	NA	Weekly
Casselman Curtailment, PA (2008)	23	35.4	80	12 experimental; 10 control	126 m x 120 m	2.5 months	Daily
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
Cedar Ridge, WI (2010)	41	68	80	20	160 m x 160 m	1 year	5 turbines were surveyed daily, 15 turbines surveyed every 4 days in rotating groups each day. All 20 surveyed every three days during late fall

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

Project Name	Total # of turbines	Total MW	Tower size (m)	Number turbines searched	Plot Size	Length of Study	Survey Frequency
Chopin, OR (2016-2017)	6	10	NA	NA	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)
Cohocton/Dutch Hills, NY (2010)	50	125	80	17	120 m x 120 m	Spring, summer, fall	Daily, weekly
Cohocton/Dutch Hill, NY (2013)	50	125	80	NA	120 m x 120 m	Late summer, fall	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)

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

Project Name	Total # of turbines	Total MW	Tower size (m)	Number turbines searched	Plot Size	Length of Study	Survey Frequency
Dry Lake II, AZ (2011-2012)	31	65	78	31: 5 (full plot), 26 (road and pad)	160 m x 160 m	1 year	Twice weekly (spring, summer, fall), weekly (winter)
Elkhorn, OR (2008)	61	101	80	61	220 m x 220 m	1 year	Monthly
Elkhorn, OR (2010)	61	101	80	31	220 m x 220 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Elm Creek, MN (2009-2010)	67	100	80	29	200 m x 200 m	1 year	Weekly, monthly
Elm Creek II, MN (2011-2012)	62	148.8	80	30	200 m x 200 m (2 random migration search areas 100 m x 100 m)	1 year	20 searched every 28 days, 10 turbines every 7 days during migration)
Foote Creek Rim I, WY (1999)	69	41	60	NA	126 m x 126 m	26 months	Monthly
Foote Creek Rim I, WY (2000)	69	41	60	NA	126 m x 126 m	26 months	Monthly
Foote Creek Rim I, WY (2001-2002)	69	41	60	NA	126 m x 126 m	26 months	Monthly
Foote Creek Rim, WY (UV; 1999-2000)	105	67.95	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

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

Project Name	Total # of turbines	Total MW	Tower size (m)	Number turbines searched	Plot Size	Length of Study	Survey Frequency
Fowler I, II, III, IN (2011)	355	600	Vestas = 80, Clipper = 80, GE = 80	177 road and pads (spring), 9 turbines and 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	80	NA	Road/pad	3 months	Twice weekly
Fowler, IN (2015)	420	NA	80	NA	Road/pad	3 months	Weekly
Fowler, IN (2016)	420	750	80	NA	Road/pad (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	78	NA	60-m radius circle; road/pad	7 months	Weekly
Groton, NH (2014)	24	48	78	NA	60-m radius circle; road/pad	6 months	Weekly
Groton, NH (2015)	24	48	78	NA	60-m radius circle; road/pad	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-turb facilities)	39.6	NA	12 in July, 24 Aug-Oct	50-m radius from turbine base	4 months	Twice-weekly

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

Project Name	Total # of turbines	Total MW	Tower size (m)	Number turbines searched	Plot Size	Length of Study	Survey Frequency
Harvest Wind, WA (2010-2012)	43	98.9	80	32	180 m x 180 m and 240 m x 240 m	2 years	Twice a week, weekly and monthly
Hatchet Ridge, CA (2011)	44	101	80	NA	127 m x 127 m (bi-monthly), 190 m x 190 m (monthly)	NA	Half bi-monthly; half monthly
Hatchet Ridge, CA (2012)	44	101	80	NA	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	NA	80	NA	127 m x 127 m	1 year	Bi-weekly
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	NA	120 m x 120 m	7 months	Daily; weekly
Howard, NY (2013)	27	54	78.5	NA	120 m x 120 m	6 months	Daily; weekly

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

Project Name	Total # of turbines	Total MW	Tower size (m)	Number turbines searched	Plot Size	Length of Study	Survey Frequency
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, 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 (1.5 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)
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

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

Project Name	Total # of turbines	Total MW	Tower size (m)	Number turbines searched	Plot Size	Length of Study	Survey Frequency
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	NA	120-m radius circle	NA	Bi-monthly
Lower West, CA (2014-2015)	7	14	110.5	NA	120-m radius circle	NA	Bi-monthly
Lower West, CA (2016-2017)	7	14	110.5	NA	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 (2007-2008)	195	321.75	80	64	130 m x 120 m	7 months	Weekly
Maple Ridge, NY (2007)	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 survey methodology.

Project Name	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 x120 m	NA	Weekly
Milford I & II, UT (2011-2012)	107	160.5 (58.5 I, 102 II)	80	43	120 m x120 m	NA	Every 10.5 days
Montezuma I, CA (2011)	16	36.8	80	16	105-m radius	1 year	Weekly and bi-Weekly
Montezuma I, CA (2012)	16	36.8	80	16	105-m radius	1 year	Weekly and bi-Weekly
Montezuma II, CA (2012-2013)	34	78.2	80	17	105 m radius	1 year	Weekly
Moraine II, MN (2009)	33	49.5	82.5	30	200 m x 200 m	1 year	Weekly (migratory), monthly (non-migratory)
Mount Storm, WV (Fall 2008)	82	164	78	27	Varied	3 months	Weekly (18 turbines), daily (9 turbines)
Mount Storm, WV (2009)	132	264	78	44	Varied	4.5 months	Weekly (28 turbines), daily (16 turbines)
Mount Storm, WV (2010)	132	264	78	24	20 to 60 m from turbine	6 months	Daily
Mount Storm, WV (2011)	132	264	78	24	Varied	6 months	Daily
Mountaineer, WV (2003)	44	66	80	44	60-m radius	7 months	Weekly, monthly
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	NA	240 m x 240 m	Na	Bi-monthly

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

Project Name	Total # of turbines	Total MW	Tower size (m)	Number turbines searched	Plot Size	Length of Study	Survey Frequency
Mustang Hills, CA (2016-2017)	100	300	100	NA	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
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

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

Project Name	Total # of turbines	Total MW	Tower size (m)	Number turbines searched	Plot Size	Length of Study	Survey Frequency
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	NA	Within 80 m; within 140 m	7 months	Every other day
Odell, MN (2016-2017)	100	200	NA	NA	120 m x 120 m	1 year	Monthly; weekly
Pacific Wind, CA (2014-2015)	70	144	78.5	NA	126-m radius circle	NA	Weekly
Pacific Wind, CA (2015-2016)	70	144	78.5	NA	63-m radius circle	NA	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	NA	NA	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 120 m	9 months	Weekly
Pinyon Pines I & II, CA (2013-2014)	100	NA	90	25 plots (approx. 31 turbines)	240 m x240 m	NA	Bi-weekly
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 I, IA (Phase II; 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 2 weeks (summer), monthly (winter)

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

Project Name	Total # of turbines	Total MW	Tower size (m)	Number turbines searched	Plot Size	Length of Study	Survey Frequency
Pioneer Prairie II, IA (2013)	62	102.3	80	62	80 m x 80 m (5 turbines), road and pad within 100 m of turbine (57 turbines)	NA	Weekly
Pleasant Valley, MN (2016-2017)	100	200	95	NA	160m x 160m	NA	Weekly
Prairie Rose, MN (2014)	119	200	80	NA	100 m x 100 m (spring); road/pad (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 100 m	3 season	Twice monthly
PrairieWinds SD1, SD (2011-2012)	108	162	80	50	200 m x 200 m	1 year	Twice monthly (spring, summer, fall), monthly (winter)
PrairieWinds SD1, SD (2012-2013)	108	162	80	50	200 m x 200 m	1 year	Bi-weekly
PrairieWinds SD1, SD (2013-2014)	108	162	80	45	200 m x 200 m	1 year	Twice monthly (spring, summer, fall), monthly (winter)
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	3 times every 2 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 survey methodology.

Project Name	Total # of turbines	Total MW	Tower size (m)	Number turbines searched	Plot Size	Length of Study	Survey Frequency
Record Hill, ME (2016)	22	51	80	NA	42.5-m radius	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)
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	NA	280 m x 280 m	NA	Bi-monthly
Rising Tree, CA (2017-2018)	60	198	84	NA	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 60m	6 months	Weekly
Rollins, ME (2014)	40	60	NA	NA	60-m radius	6 months	Weekly
Roth Rock, MD (2011)	20	50	80	NA	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	NA	1 year	Weekly
Shiloh III, CA (2012-2013)	50	102.5	78.5	25	100-m radius	NA	Weekly
Solano III, CA (2012-2013)	55	128	80	19	100-m radius	NA	Bi-weekly

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

Project Name	Total # of turbines	Total MW	Tower size (m)	Number turbines searched	Plot Size	Length of Study	Survey Frequency
Spring Valley, NV (2012-2013)	66	152	80	NA	126 m x 126 m	14 months	Bi-weekly; daily
Spruce Mountain Wind Project, ME (2014)	10	20	78	NA	Road/pad	NA	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	NA	120 m x 120 m	5 months	Twice weekly
Stetson II, ME (2014)	17	26	NA	NA	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	79.45x79.45m	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)
Thunder Spirit, ND (2016-2017)	43	108	80	NA	160 m x 160 m; road/pad	10 months	Twice monthly

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

Project Name	Total # of turbines	Total MW	Tower size (m)	Number turbines searched	Plot Size	Length of Study	Survey Frequency
Top Crop I & II, IL (2012-2013)	68 (Phase I), 132 (Phase II)	300 (102 Phase I, 198 Phase II)	65 (Phase I) 80 (Phase II)	100	61-m radius	1 year	Weekly (spring, summer, and fall) and bi-weekly (winter)
Top of Iowa, IA (2003)	89	80	71.6	26	76 m x 76 m	Spring, summer, fall	Once every 2 to 3 days
Top of Iowa, IA (2004)	89	80	71.6	26	76 m x 76 m	Spring, summer, fall	Once every 2 to 3 days
Top of the World, WY (2010-2011)	110	200	80	NA	160 m x 160 m	1 year	Weekly; bi-monthly
Top of the World, WY (2011-2012)	110	200	80	NA	160 m x 160 m	1 year	Weekly; bi-monthly
Top of the World, WY (2012-2013)	110	200	80	NA	160 m x 160 m	1 year	Weekly; bi-monthly
Tucannon River, WA (2015)	116	267	80	NA	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	NA	160m x 160m; road/pad	1 year	Weekly, bi-weekly
Wessington Springs, SD (2009)	34	51	80	20	200 m x 200 m	Spring, summer, fall	Bi-monthly
Wessington Springs, SD (2010)	34	51	80	20	200 m x 200 m	8 months	Bi-weekly (spring, summer, fall)

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

Project Name	Total # of turbines	Total MW	Tower size (m)	Number turbines searched	Plot Size	Length of Study	Survey Frequency
White Creek, WA (2007-2011)	89	204.7	80	89	180 m x 180 m and 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)
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	50-m 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 (2009-2010)	Chatfield et al. 2010	Lempster, NH (2010)	Tidhar et al. 2011
Alta I, CA (2011-2012)	Chatfield et al. 2012	Linden Ranch, WA (2010-2011)	Enz and Bay 2011
Alta I, CA (2013-2014)	Chatfield et al. 2014	Locust Ridge, PA (Phase II; 2009)	Arnett et al. 2011
Alta I, CA (2015-2016)	Thompson et al. 2016a	Locust Ridge, PA (Phase II; 2010)	Arnett et al. 2011
Alta II-V, CA (2011-2012)	Chatfield et al. 2012	Lower West, CA (2012-2013)	Levenstein and Bay 2013a
Alta II-V, CA (2013-2014)	Chatfield et al. 2014	Lower West, CA (2014-2015)	Levenstein and DiDonato 2015
Alta II-V, CA (2015-2016)	Thompson et al. 2016a	Lower West, CA (2016-2017)	WEST 2017b
Alta VIII, CA (2012-2013)	Chatfield and Bay 2014	Maple Ridge, NY (2006)	Jain et al. 2007
Alta VIII, CA (2014-2015)	Western EcoSystems Technology, Inc. (WEST) 2016c	Maple Ridge, NY (2007)	Jain et al. 2009a
Alta VIII, CA (2016-2017)	WEST 2018	Maple Ridge, NY (2007-2008)	Jain et al. 2009b
Alta X, CA (2014-2015)	Chatfield et al. 2015	Maple Ridge, NY (2012)	Tidhar et al. 2013b
Alta X, CA (2015-2016)	Thompson et al. 2016b	Marengo I, WA (2009-2010)	URS 2010b
Barton I & II, IA (2010-2011)	Derby et al. 2011b	Marengo II, WA (2009-2010)	URS 2010c
Barton Chapel, TX (2009-2010)	WEST 2011	Mars Hill, ME (2007)	Stantec 2008a
Beech Ridge, WV (2012)	Tidhar et al. 2013a	Mars Hill, ME (2008)	Stantec 2009a
Beech Ridge, WV (2013)	Young et al. 2014a	Milford I, UT (2010-2011)	Stantec 2011b
Big Blue, MN (2013)	Fagen Engineering 2014	Milford I & II, UT (2011-2012)	Stantec 2012b
Big Blue, MN (2014)	Fagen Engineering 2015	Montezuma I, CA (2011)	ICF International 2012
Big Horn, WA (2006-2007)	Kronner et al. 2008	Montezuma I, CA (2012)	ICF International 2013
Big Smile, OK (2012-2013)	Derby et al. 2013b	Montezuma II, CA (2012-2013)	Harvey & Associates 2013
Biglow Canyon, OR (Phase I; 2008)	Jeffrey et al. 2009b	Moraine II, MN (2009)	Derby et al. 2010f
Biglow Canyon, OR (Phase I; 2009)	Enk et al. 2010	Mount Storm, WV (2008)	Young et al. 2009c
Biglow Canyon, OR (Phase II; 2009-2010)	Enk et al. 2011b	Mount Storm, WV (2009)	Young et al. 2009a, 2010b
Biglow Canyon, OR (Phase II; 2010-2011)	Enk et al. 2012b	Mount Storm, WV (2010)	Young et al. 2010a, 2011b
Biglow Canyon, OR (Phase III; 2010-2011)	Enk et al. 2012a	Mount Storm, WV (2011)	Young et al. 2011a, 2012a
Bingham Wind Project, ME (2017)	TRC 2017a	Mountaineer, WV (2003)	Kerns and Kerlinger 2004
Blue Sky Green Field, WI (2008; 2009)	Gruver 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	Mustang Hills, CA (2014-2015)	WEST 2016c
Buffalo Mountain, TN (2000-2003)	Nicholson et al. 2005	Mustang Hills, CA (2016-2017)	WEST 2018
Buffalo Mountain, TN (2005)	Fiedler et al. 2007	Nine Canyon, WA (2002-2003)	Erickson et al. 2003
Buffalo Ridge, MN (Phase I; 1996)	Johnson et al. 2000	Noble Altona, NY (2010)	Jain et al. 2011a
Buffalo Ridge, MN (Phase I; 1997)	Johnson et al. 2000	Noble Bliss, NY (2008)	Jain et al.2009c
Buffalo Ridge, MN (Phase I; 1998)	Johnson et al. 2000	Noble Bliss, NY (2009)	Jain et al. 2010c

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
Buffalo Ridge, MN (Phase I; 1999)	Johnson et al. 2000	Noble Chateaugay, NY (2010)	Jain et al. 2011b
Buffalo Ridge, MN (Phase II; 1998)	Johnson et al. 2000	Noble Clinton, NY (2008)	Jain et al. 2009d
Buffalo Ridge, MN (Phase II; 1999)	Johnson et al. 2000	Noble Clinton, NY (2009)	Jain et al. 2010a
Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)	Johnson et al. 2004	Noble Ellenburg, NY (2008)	Jain et al. 2009e
Buffalo Ridge, MN (Phase II; 2002/Lake Benton II)	Johnson et al. 2004	Noble Ellenburg, NY (2009)	Jain et al. 2010b
Buffalo Ridge, MN (Phase III; 1999)	Johnson et al. 2000	Noble Wethersfield, NY (2010)	Jain et al. 2011c
Buffalo Ridge, MN (Phase III; 2001/Lake Benton I)	Johnson et al. 2004	NPPD Ainsworth, NE (2006)	Derby et al. 2007
Buffalo Ridge, MN (Phase III; 2002/Lake Benton II)	Johnson et al. 2004	Oakfield, ME (2017)	TRC 2018
Buffalo Ridge I, SD (2009-2010)	Derby et al. 2010d	Odell, MN (2016-2017)	Chodachek and Gustafson 2018
Buffalo Ridge II, SD (2011-2012)	Derby et al. 2012a	Pacific Wind, CA (2014-2015)	WEST 2016a
Bull Hill, ME (2013)	Stantec 2014a	Pacific Wind, CA (2015-2016)	WEST 2017a
Cameron Ridge/Section 15, CA (2014-2015)	WEST 2016b	Palouse Wind, WA (2012-2013)	Stantec 2013a
Cameron Ridge/Section 15, CA (2015-2016)	Rintz and Thompson 2017	Passadumkeag, ME (2016)	Ritzert et al. 2017
Casselman, PA (2008)	Arnett et al. 2009b	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
Casselman Curtailment, PA (2008)	Arnett et al. 2009a	Pinnacle, WV (2012)	Hein et al. 2013b
Cedar Ridge, WI (2009)	BHE Environmental 2010	Pinyon Pines I & II, CA (2013-2014)	Chatfield and Russo 2014
Cedar Ridge, WI (2010)	BHE Environmental 2011	Pinyon Pines I & II, CA (2015-2016)	Rintz and Starcevich 2016
Chopin, OR (2016-2017)	Hallingstad and Riser-Espinoza 2017	Pinyon Pines I & II, CA (2017-2018)	Rintz and Pham 2018
Cohocton/Dutch Hill, NY (2009)	Stantec 2010	Pioneer Prairie II, IA (2011-2012)	Chodachek et al. 2012
Cohocton/Dutch Hill, NY (2013)	Stantec 2011a	Pioneer Prairie II, IA (2013)	Chodachek et al. 2014
Cohocton/Dutch Hills, NY (2010)	Stantec 2014b	Pleasant Valley, MN (2016-2017)	Tetra Tech 2017b
Combine Hills, OR (Phase I; 2004-2005)	Young et al. 2006	Prairie Rose, MN (2014)	Chodachek et al. 2015
Combine Hills, OR (2011)	Enz et al. 2012	PrairieWinds ND1 (Minot), ND (2010)	Derby et al. 2011d
Crescent Ridge, IL (2005-2006)	Kerlinger et al. 2007	PrairieWinds ND1 (Minot), ND (2011)	Derby et al. 2012d
Criterion, MD (2011)	Young et al. 2012b	PrairieWinds SD1, SD (2011-2012)	Derby et al. 2012c
Criterion, MD (2012)	Young et al. 2013	PrairieWinds SD1, SD (2012-2013)	Derby et al. 2013a
Criterion, MD (2013)	Young et al. 2014b	PrairieWinds SD1, SD (2013-2014)	Derby et al. 2014
Crystal Lake II, IA (2009)	Derby et al. 2010b	Rail Splitter, IL (2012-2013)	Good et al. 2013b
Diablo Winds, CA (2005-2007)	WEST 2006, 2008	Record Hill, ME (2012)	Stantec 2013b

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
Dillon, CA (2008-2009)	Chatfield et al. 2009	Record Hill, ME (2014)	Stantec 2015b
Dry Lake I, AZ (2009-2010)	Thompson et al. 2011	Record Hill, ME (2016)	Stantec 2017
Dry Lake II, AZ (2011-2012)	Thompson and Bay 2012	Red Hills, OK (2012-2013)	Derby et al. 2013c
Elkhorn, OR (2008)	Jeffrey et a. 2009a	Ripley, Ont (2008)	Jacques Whitford 2009
Elm Creek, MN (2009-2010)	Derby et al. 2010e	Rising Tree, CA (2017-2018)	Chatfield et al. 2018
Elm Creek II, MN (2011-2012)	Derby et al. 2012b	Rollins, ME (2012)	Stantec 2013c
Foote Creek Rim, WY (Phase I; 1999)	Young et al. 2003a	Rollins, ME (2014)	Stantec 2015c
Foote Creek Rim, WY (Phase I; 2000)	Young et al. 2003a	Roth Rock, MD (2011)	Atwell, LLC 2012
Foote Creek Rim, WY (Phase I; 2001-2002)	Young et al. 2003a	Rugby, ND (2010-2011)	Derby et al. 2011c
Foote Creek Rim, WY (UV study; 1999-2000)	Young et al. 2003b	Shiloh I, CA (2006-2009)	Kerlinger et al. 2009
Forward Energy Center, WI (2008-2010)	Grodsky and Drake 2011	Shiloh II, CA (2009-2010)	Kerlinger et al. 2010, 2013a
Fowler I, IN (2009)	Johnson et al. 2010a	Shiloh II, CA (2010-2011)	Kerlinger et al. 2013a
Fowler I, II, III, IN (2010)	Good et al. 2011	Shiloh II, CA (2011-2012)	Kerlinger et al. 2013a
Fowler I, II, III, IN (2011)	Good et al. 2012	Shiloh III, CA (2012-2013)	Kerlinger et al. 2013b
Fowler I, II, III, IN (2012)	Good et al. 2013a	Solano III, CA (2012-2013)	AECOM 2013
Fowler III, IN (2009)	Johnson et al. 2010b	Spring Valley, NV (2012-2013)	WEST 2014
Fowler, IN (2015)	Good et al. 2016	Stateline, OR/WA (2001-2002)	Erickson et al. 2004
Fowler, IN (2016)	Good et al. 2017	Stateline, OR/WA (2003)	Erickson et al. 2004
Goodnoe, WA (2009-2010)	URS Corporation (URS) 2010a	Stateline, OR/WA (2006)	Erickson et al. 2007
Grand Ridge I, IL (2009-2010)	Derby et al. 2010a	Steel Winds I & II, NY (2013)	Stantec 2014c
Groton, NH (2013)	Stantec and WEST 2014	Stetson II, ME (2014)	Stantec 2015d
Groton, NH (2014)	Stantec and WEST 2015a	Stetson Mountain I, ME (2009)	Stantec 2009c
Groton, NH (2015)	Stantec and WEST 2015b	Stetson Mountain I, ME (2011)	Normandeau Associates 2011
Hancock, ME (2017)	TRC 2017b	Stetson Mountain I, ME (2013)	Stantec 2014d
Harrow, Ont (2010)	Natural Resources Solutions Inc. 2011	Stetson Mountain II, ME (2010)	Normandeau Associates 2010
Harvest Wind, WA (2010-2012)	Downes and Gritski 2012a	Stetson Mountain II, ME (2012)	Stantec 2013d
Hatchet Ridge, CA (2011)	Tetra Tech 2013	Summerview, Alb (2005-2006)	Brown and Hamilton 2006b
Hatchet Ridge, CA (2012)	Tetra Tech 2013	Summerview, Alb (2006; 2007)	Baerwald 2008
Hatchet Ridge, CA (2012-2013)	Tetra Tech 2014	Thunder Spirit, ND (2016-2017)	Derby et al. 2018
Hay Canyon, OR (2009-2010)	Gritski and Kronner 2010a	Top Crop I & II (2012-2013)	Good et al. 2013c
High Sheldon, NY (2010)	Tidhar et al. 2012a	Top of Iowa, IA (2003)	Jain 2005
High Sheldon, NY (2011)	Tidhar et al. 2012b	Top of Iowa, IA (2004)	Jain 2005
High Winds, CA (2003-2004)	Kerlinger et al. 2006	Top of the World, WY (2010-2011)	Rintz and Bay 2012
High Winds, CA (2004-2005)	Kerlinger et al. 2006	Top of the World, WY (2011-2012)	Rintz and Bay 2013
Hopkins Ridge, WA (2006)	Young et al. 2007	Top of the World, WY (2012-2013)	Rintz and Bay 2014

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
Hopkins Ridge, WA (2008)	Young et al. 2009b	Tucannon River, WA (2015)	Hallingstad et al. 2016
Howard, NY (2012)	Tidhar et al. 2013c	Tuolumne (Windy Point I), WA (2009-2010)	Enz and Bay 2010
Howard, NY (2013)	Lukins et al. 2014	Vansycle, OR (1999)	Erickson et al. 2000
Judith Gap, MT (2006-2007)	TRC Environmental Corporation 2008	Vantage, WA (2010-2011)	Ventus Environmental Solutions 2012
Judith Gap, MT (2009)	Poulton and Erickson 2010	Waverly Wind, KS (2016-2017)	Tetra Tech 2017a
Kewaunee County, WI (1999-2001)	Howe et al. 2002	Wessington Springs, SD (2009)	Derby et al. 2010c
Kibby, ME (2011)	Stantec 2012a	Wessington Springs, SD (2010)	Derby et al. 2011a
Kittitas Valley, WA (2011-2012)	Stantec Consulting Services 2012	White Creek, WA (2007-2011)	Downes and Gritski 2012b
Klondike, OR (2002-2003)	Johnson et al. 2003	Wild Horse, WA (2007)	Erickson et al. 2008
Klondike II, OR (2005-2006)	Northwest Wildlife Consultants (NWC) and WEST 2007	Windstar, CA (2012-2013)	Levenstein and Bay 2013b
Klondike III (Phase I), OR (2007-2009)	Gritski et al. 2010	Windy Flats, WA (2010-2011)	Enz et al. 2011
Klondike IIIa (Phase II), OR (2008-2010)	Gritski et al. 2011	Winnebago, IA (2009-2010)	Derby et al. 2010g
Lakefield Wind, MN (2012)	Minnesota Public Utilities Commission 2012	Wolfe Island, Ont (July-December 2009)	Stantec Ltd. 2010
Laurel Mountain, WV (2014)	Stantec 2015a	Wolfe Island, Ont (July-December 2010)	Stantec Ltd. 2011
Leaning Juniper, OR (2006-2008)	Gritski et al. 2008	Wolfe Island, Ont (July-December 2011)	Stantec Ltd. 2012
Lempster, NH (2009)	Tidhar et al. 2010		

TECHNICAL MEMORANDUM

DATE: March 30, 2020

TO: Walleye Wind Project, LLC

FROM: Joyce Pickle, Jennifer Stucker, Kevin Murray, and Brenna Hyzy, Western EcoSystems Technology, Inc.

SUBJECT: Updated Results of Bat Acoustic Surveys at the Walleye Wind Study Area from June 28 – October 29, 2018.

INTRODUCTION

Walleye Wind Project, LLC (Walleye) is considering the development of the Walleye Wind Project (Project) in Rock County, Minnesota (Figure 1). In 2018, Western EcoSystems Technology, Inc. (WEST) completed a bat activity study following the recommendations of the US Fish and Wildlife Service's Land-based Wind Energy Guidelines and the Avian and Bat Survey Protocols for Large Wind Energy Conversion Systems in Minnesota (Mixon et al. 2014). The objective of this study was to conduct acoustic monitoring surveys to estimate levels of bat activity throughout the study area during the summer and fall. The previous analysis from 2018 did not include a species composition component or qualitative/manual review of any calls (Kreger et al. 2019). In 2020, Walleye requested WEST conduct a species composition analysis on the existing data collected in 2018 to determine whether any northern long-eared bats (*Myotis septentrionalis*; NLEB) were detected on the landscape during the time of the study. This report briefly summarizes the results of the acoustic surveys conducted within the study area between June 28 and October 29, 2018, and also describes the results of the species composition analysis.

It should be noted that the 2018 Bat Activity Survey Report (Kreger et al. 2019) was initially prepared for a study area that preceded the current Project. This updated analysis was conducted on the 2018 data due to the study area's proximity to and partial overlap with the current Project, as it provides information pertinent to Minnesota state agency review. The 2018 Bat Activity Survey study area and current Project are depicted in Figure 1, below.

Methods

Acoustic monitoring occurred at the study area from June 28 – October 29, 2018. Four AnaBat™ SD2 ultrasonic bat detectors (Titley™ Scientific, Columbia, Missouri) were used during the surveys. One AnaBat™ detector was placed at ground level (ground station; approximately 5.0 feet [ft; 1.5 meters (m)] above ground level [AGL]) in cropland habitat that was representative of future turbine placement (representative station; station WA1g; Figure 2). A second detector was placed along forest edge habitat considered attractive to bats for foraging and commuting (bat feature station; station WA2g; Figure 2). An experienced bat biologist selected the location of the bat feature station. Two additional AnaBat™ detectors were placed at a meteorological (MET) tower at a representative station, with one microphone at ground level and another within the rotor-swept zone (raised station; approximately 148 ft [45 m] AGL; station WA3; Figure 2). Mean bat activity was calculated for the spring, summer, and fall seasons, along with 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.

AnaBat™ detectors use a broadband high-frequency microphone to detect the echolocation calls of bats. To standardize acoustic sampling effort across the study area, AnaBat™ detectors were calibrated and sensitivity levels were set to six, a level that balanced the goal of recording bat calls against the need to reduce interference from other sources of ultrasonic noise. Incoming echolocation calls were digitally processed and stored on a high capacity compact flash card. The resulting files were 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) and to determine the call frequency category of the bat that generated the calls. For the original analysis conducted in 2018, echolocation calls were classified into two frequency categories; high frequency (HF; greater than 30 kilohertz [kHz]) and low frequency (LF; less than 30 kHz). Experienced bat biologists used the Analook software to determine the number of bat passes recorded by each detector, and to separate noise files from true bat calls.

For the updated species composition analysis conducted in 2020, the automated identification feature in program Kaleidoscope Pro 5.1.0 (Wildlife Acoustics, Concord, Massachusetts) using the Bats of North America classifier 5.1.0 at the "0" Balanced (neutral) sensitivity setting was then used to identify known bat calls to species. Species included in the model were big brown bats (*Eptesicus fuscus*), eastern red bats (*Lasiurus borealis*), hoary bats (*L. cinereus*), silver-haired bats (*Lasionycteris noctivagans*), little brown bats (*Myotis lucifugus*), NLEB, evening bats (*Nycticeius humeralis*), and tri-colored bats (*Perimyotis subflavus*). A qualified acoustic analyst (Dr. Kevin Murray) conducted a manual review of all calls identified as NLEB by Kaleidoscope Pro 5.1.0. Data on bat pass rates represent indices of bat activity and does not necessarily represent numbers of individuals.

Results

Spatial and Temporal Analysis Summary

Bat activity was monitored at four stations for 440 detector-nights between June 28 and October 29, 2018. All detectors and microphones were operating for 97.7% of the sampling period for all stations. Activity at representative stations was highest at the ground station at the MET tower, station WA3g (17.13 ± 1.63 bat passes per detector-night; Table 1), compared to activity at the raised station (13.91 ± 1.62; Table 1) and at the standalone representative ground station (4.11 ± 0.47; Table 1). However, when averaged across the study period, activity was slightly higher at the MET tower raised stations than at representative ground stations (Table 1). Activity at the bat feature station was over ten times greater (116.08 ± 14.21 bat passes per detector-night) than activity at representative stations (11.72 ± 1.13; Table 1).

As described in more detail in Kreger et al. (2019), overall bat activity at representative stations was relatively low in the fall (7.87 bat passes per detector-night) and higher in summer (23.04 bat passes per detector-night), and representative ground station activity was 11.20 bat passes per detector-night during the FMP (Table 2). Weekly acoustic activity at representative stations was relatively low from June through early July, but increased sharply in mid-July and August, peaking from July 15 to July 21 (33.0 bat passes per detector-night; Table 3). Overall bat activity gradually decreased for the remainder of the survey period.

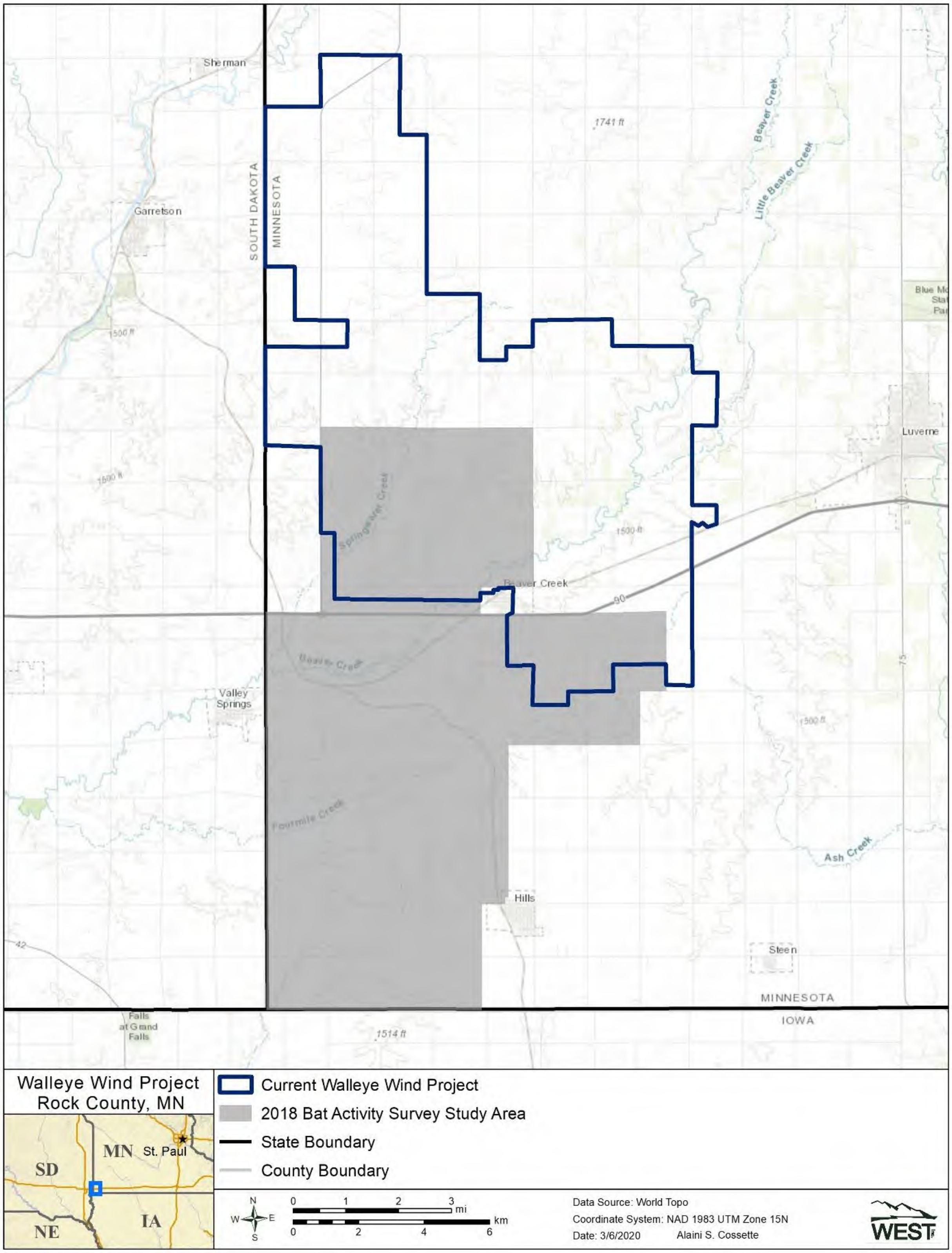

Figure 1. 2018 Bat Activity Survey Study Area in Comparison to the Current Walleye Wind Project, Rock County, Minnesota.

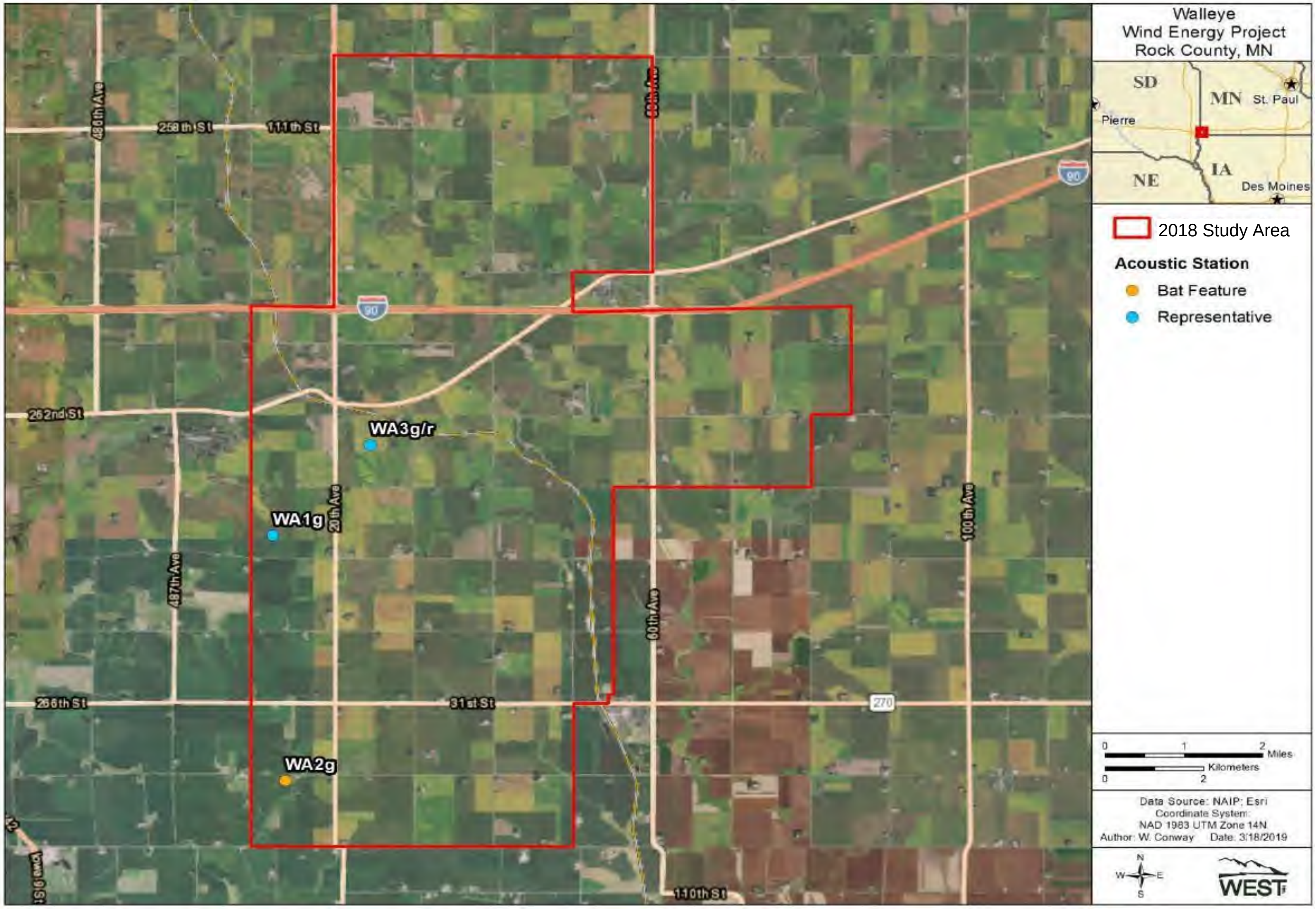

Figure 2. Location of 2018 acoustic stations within the Walleye Wind Study Area in Rock County, Minnesota.

Table 1. Results of bat activity surveys conducted at stations within the Walleye Wind study area, Rock County, Minnesota, from June 28 – October 29, 2018. Passes are separated by call frequency: high frequency (HF) and low frequency (LF).

Anabat Station	Location	Type	Number of HF Bat Passes	Number of LF Bat Passes	Total Bat Passes	Detector Nights	Bat Passes/ Night[1]
WA1g	Ground	Representative	74	423	497	121	4.11 ± 0.47
WA2g	Ground	Bat Feature	5,435	8,146	13,581	117	116.08 ± 14.18
WA3g	Ground	Representative	241	1,489	1,730	101	17.13 ± 1.63
WA3r	Raised	Representative	94	1,311	1,405	101	13.91 ± 1.62
Total Representative Ground (%)			**315 (14%)**	**1,912 (86%)**	**2,227**	**222**	**10.62 ± 0.90**
Total Representative Raised (%)			**94 (7%)**	**1,311 (93%)**	**1,405**	**101**	**13.91 ± 1.48**
Total Representative Stations (%)			**409 (11%)**	**3,223 (89%)**	**3,632**	**323**	**11.72 ± 1.13**
Total Bat Feature Stations (%)			**5,435 (40%)**	**8,146 (60%)**	**13,581**	**117**	**116.08 ± 14.21**
Total (%)			**5,844 (34%)**	**11,369 (66%)**	**17,213 (100%)**	**440**	**---**

[1]± bootstrapped standard error.

Table 2. The number of bat passes per detector-night recorded at representative stations within the Walleye Wind study area, Rock County, Minnesota, during each season, separated by call frequency: low frequency (LF), high frequency (HF), and all bats (AB).

Station	Call Frequency	Summer June 28 – August 14	Fall August 15 – November 5	Fall Migration Period July 30 – October 14
WA1g	LF	4.73	2.76	3.16
	HF	0.76	0.53	0.68
	AB	5.49	3.29	3.83
WA3g	LF	30.20	9.66	15.94
	HF	5.72	1.29	2.64
	AB	35.92	10.95	18.57
WA3r	LF	25.44	8.88	14.25
	HF	2.28	0.49	1.04
	AB	27.72	9.37	15.29
Ground Totals	**LF**	17.47 ± 1.73	6.21 ± 0.82	9.55 ± 1.03
	HF	3.24 ± 0.42	0.91 ± 0.15	1.66 ± 0.21
	AB	20.70 ± 2.04	7.12 ± 0.91	11.20 ± 1.18
Raised Totals	**LF**	25.44 ± 2.56	8.88 ± 1.56	14.25 ± 1.74
	HF	2.28 ± 0.54	0.49 ± 0.10	1.04 ± 0.22
	AB	27.72 ± 2.51	9.37 ± 1.62	15.29 ± 1.82
Overall	**LF**	**20.12 ± 1.58**	**7.10 ± 1.09**	**11.11 ± 1.20**
	HF	**2.92 ± 0.41**	**0.77 ± 0.13**	**1.45 ± 0.18**
	AB	**23.04 ± 1.81**	**7.87 ± 1.18**	**12.56 ± 1.32**

Table 3. Periods of peak activity for high-frequency, low-frequency, and all bats at the Walleye Wind study area, Rock County, Minnesota from June 28 – October 29, 2018.

Species Group	Start Date of Peak Activity	End Date of Peak Activity	Bat Passes per Detector-Night
High Frequency	7/30/18	8/5/18	4.0
Low Frequency	7/15/18	7/21/18	30.4
All Bats	7/15/18	7/21/18	33.0

Species Composition Analysis

Of the total bat passes recorded at all stations, 66% were classified as LF (e.g., big brown bats, hoary bats, and silver-haired bats), and 34% of bat passes were classified as HF (e.g., tri-colored bats, eastern red bats, and *Myotis* species; Table 1). LF bats were most commonly recorded at the raised station (93%; Table 1), and at all representative ground stations (86%; Table 1). At the bat feature station, the majority of recorded calls were also produced by LF bats (60%; Table 1).

Kaleidoscope Pro 5.1.0 identified bat calls for eight species that potentially occur within the study area (Table 4). Big brown bats and hoary bats were the main species detected, potentially present on 61% and 60% of the detector-nights, respectively, followed by silver-haired bats (51%) and eastern red bats (36%; Table 4). Kaleidoscope Pro 5.1.0 identified one potential NLEB call (Table 4) during the entire June 28 – October 29, 2018 study period. Dr. Kevin Murray qualitatively reviewed this call and identified it as a HF unknown. The call was a feeding buzz most likely emitted by an eastern red bat or evening bat and had no diagnostic features of a standard NLEB call. All the call files from the night of August 25, 2018, when the potential NLEB call was recorded, were also reviewed by Dr. Murray and no additional NLEB calls were observed. Therefore, no acoustic evidence of NLEB was observed during the 2018 surveys in the study area.

Table 4. The number of nights and percent of detector-nights (in parentheses) bat species were detected using Kaleidoscope Pro 5.1.0 by station (WA1, WA2, WA3) and microphone (g, r) at the Walleye Wind study area, Rock County, Minnesota from June 28 – October 29, 2018.

	Representative Stations			Bat Feature	
Common Name	**WA1g**	**WA3g**	**WA3r**	**WA2g**	**Total**
High-Frequency (Less than or equal to 30 kiloHertz [kHz])					
eastern red bat	20 (16)	46 (43)	25 (23)	70 (69)	161 (36)
evening bat	19 (15)	8 (7)	13 (12)	58 (57)	98 (22)
little brown bat	2 (2)	15 (14)	2 (2)	24 (24)	43 (10)
northern long-eared bat	0 (0)	0 (0)	0 (0)	**1 (1)**	1 (0)
tri-colored bat	3 (2)	3 (3)	1 (1)	28 (27)	35 (8)
Low-Frequency (Greater than 30 kHz)					
big brown bat	57 (46)	71 (66)	50 (46)	92 (90)	270 (61)
hoary bat	60 (48)	54 (50)	66 (61)	88 (86)	268 (60)
silver-haired bat	31 (25)	57 (53)	52 (48)	86 (84)	226 (51)

g = ground (339 detector nights); r = raised (101 detector nights); Total (440 detector nights).

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