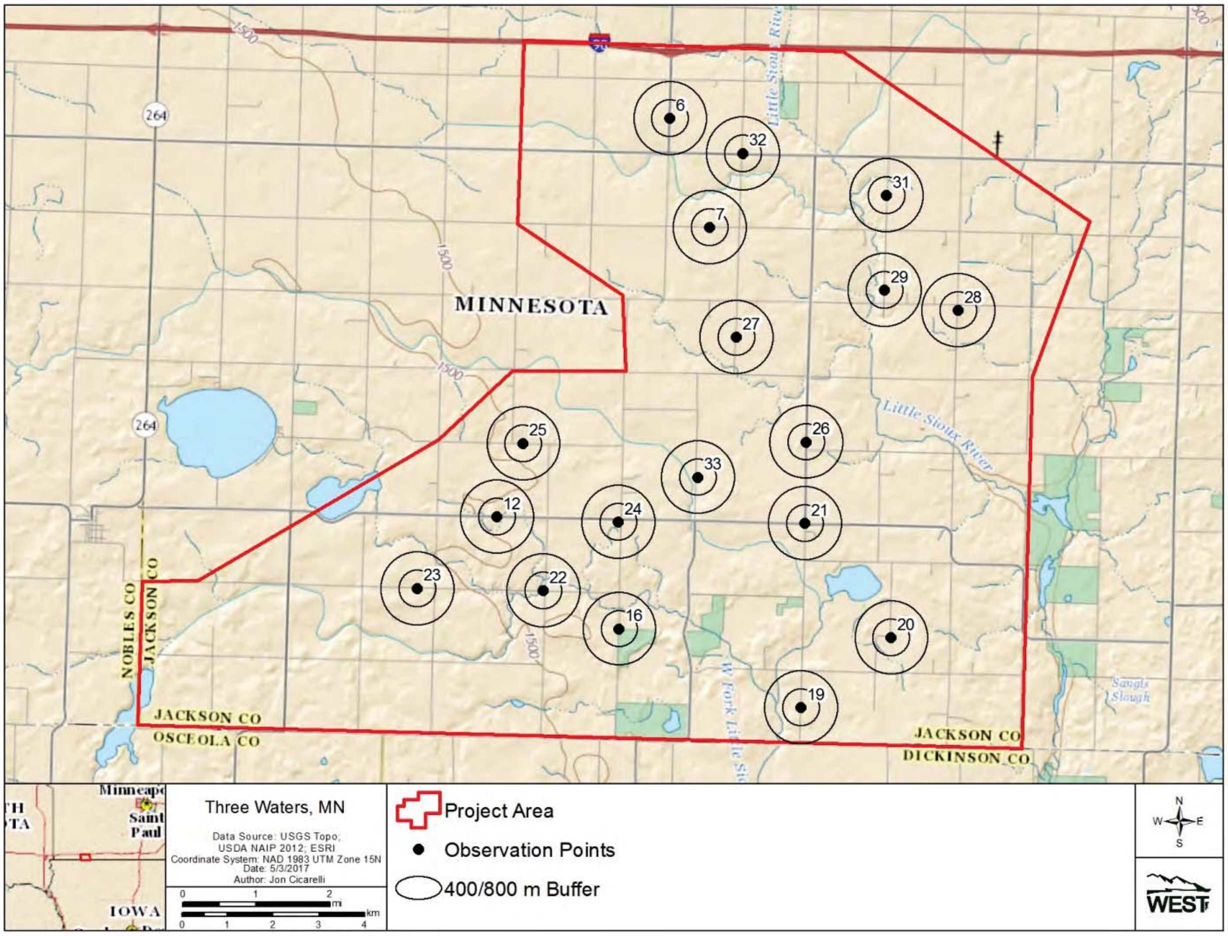

Figure 3. Fixed-point survey locations at the proposed Three Waters Wind Farm in Jackson County, Minnesota.

3.3 Eagle and Raptor Nest Survey

The objective of the eagle and raptor nest surveys is to identify nests within and surrounding the Project area. The ECPG suggests a survey area of 10 miles for golden eagle/bald eagle nest surveys in high eagle use areas or when little information on eagle nests in the area is available (Pagel et al. 2010, USFWS 2013).In addition, topographic and aerial maps will be examined to identify likely eagle nesting habitat (e.g., open lakes and rivers with large trees).

Eagle and raptor nest surveys will consist of aerial and ground surveys within ten miles of the Project boundary, beginning prior to leaf out in March 2017. An initial survey will be conducted from a helicopter, targeting likely eagle nesting habitat. To ensure complete coverage of the survey area, transects will be flown to search for potential nesting areas and locations that may need further investigation. Transects will be spaced no greater than one km apart (depending on land cover, topography, and visibility conditions). For all raptor/eagle nest structures detected, the biologist will record nest location coordinates, species present (if any), condition of the nest, presence of eggs or young (if present and visible), substrate of the nest (e.g., tree, power pole, rock outcrop), and aspect of the nest. For potential eagle nests, a follow-up visit will be conducted within 30 days of the initial aerial survey. The status of each nest will be determined as either: a) unoccupied, meaning a nest with no evidence of recent use or attendance by adult raptors; or b) occupied, indicating a nest with recent refurbishing (greenery, recent egg cup) or represented by at least one adult.

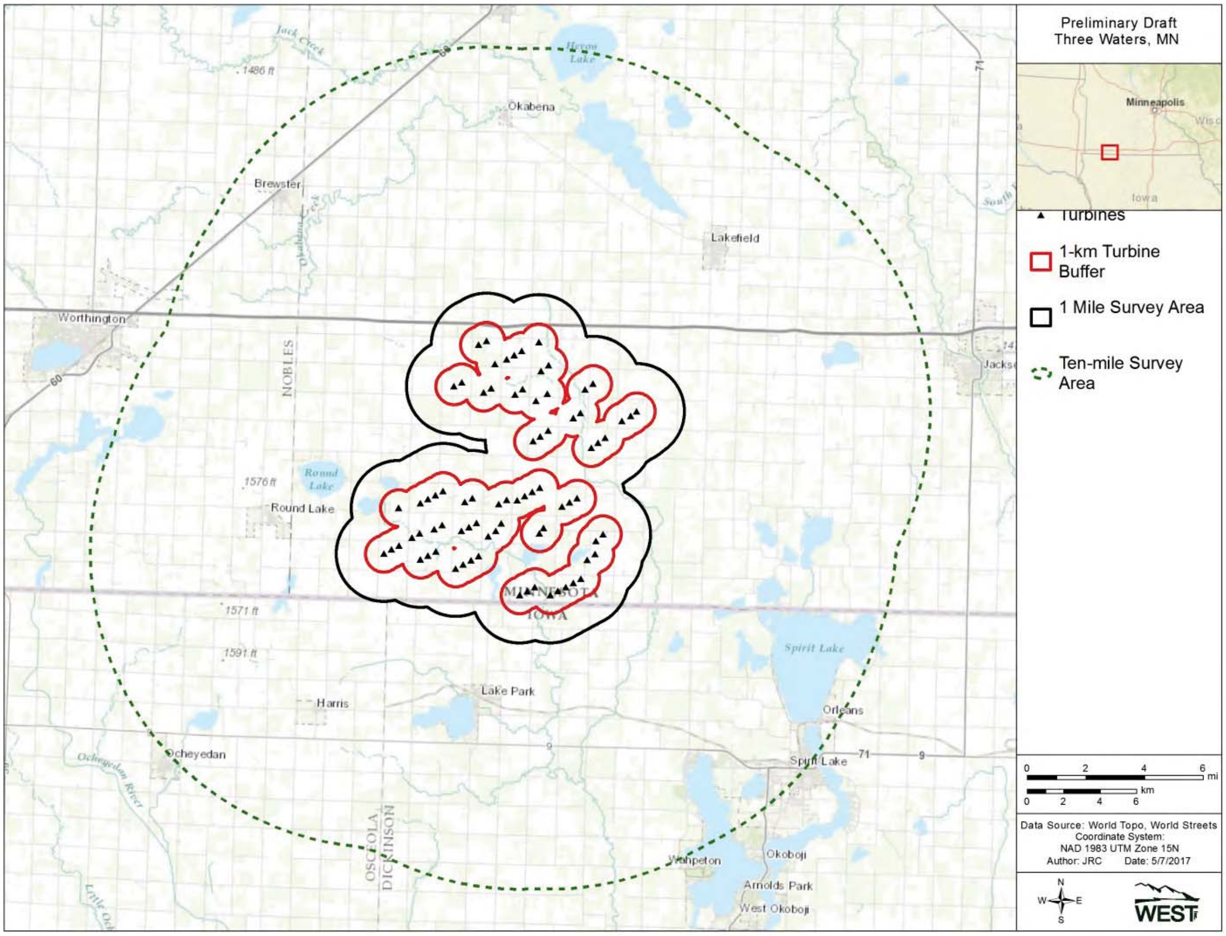

Figure 4. Proposed eagle and raptor nest survey buffers at the Three Waters Project area, in Jackson County, Minnesota.

3.4 Acoustic Surveys of Bat Activity

The objective of the acoustic bat surveys is to measure bat activity during the spring, summer, and fall seasons. Acoustic bat surveys will be conducted using AnaBat® SD1 (or equivalent) ultrasonic detectors (Titley Electronics Pty Ltd., NSW, Australia). These detectors use a broadband high-frequency microphone to detect and record the echolocation calls of foraging and commuting bats. Incoming echolocation calls are digitally processed by the detector and recorded by the internal Zero Crossing Analysis Interface Module (ZCAIM) for further processing and data storage. The ZCAIM produces a file that, when viewed in appropriate software, produces a digital "sonogram" of the echolocation calls showing change in frequency over time. During analysis, these frequency-versus-time displays can be useful for identifying the species of bat that generated the calls, and are used to separate bat calls from other types of ultrasonic noise (e.g., rain, insects, etc.).

Detectors will be placed approximately 1.5 m above ground level in suitable habitat within the Project area. Ground-based and raised detectors (45 m) will be paired at one meteorological tower within the Project and two ground-based locations. Acoustic sampling will occur continuously from July – November, 2017. Detectors will be serviced approximately once every other week during the study period to change batteries and data cards, as well as to check for disturbance and normal functioning.

Acoustic data will be analyzed to determine the number of recorded bat calls per detector per night. The total number of bat passes will be used as an index of bat use within the area. All data files collected at each station will be analyzed and bat calls will be separated from non-bat noise files. Bat calls will be identified to two frequency groups: 1) low frequency (LF; minimum frequency less than 30 kilohertz [kHz]), and 2) high frequency (HF; minimum frequency greater than 30 kHz). Bat calls will be further identified to species using methods outlined in the … (USFWS 2015).

3.5 Presence/Probable Absence Bat Surveys (if Necessary)

Presence/probable absence bat surveys will be conducted to determine the presence of northern long-eared bats (*Myotis septentrionalis*; NLEB) within the Project area. These surveys are broken into four phases: 1) desktop habitat assessment, 2) acoustic surveys, 3) follow-up mist-netting surveys, and 4) follow-up roost telemetry and emergence surveys.

3.5.1 Desktop Habitat Assessment

The desktop habitat assessment identified approximately 459.4 acres (1.9 km^2) of forest habitat within the Project area (Table 1). Based on a non-linear-calculation (i.e. 4 detector nights per 123 acres of suitable summer habitat), WEST proposes to survey 4 sites in the Project area in 2017. Survey sites will focus on areas of potential habitat for NLEB. WEST will provide the USFWS with proposed locations for acoustic surveys for site specific approval prior to initiating acoustic surveys.

3.5.2 Acoustic Surveys

Phase 2 presence/probable absence acoustic surveys will be used to determine presence of NLEB within the Project during summer. Surveys will be conducted using methods described in the *Northern Long-eared Bat Interim Conference and Planning Guidance* (USFWS 2014) and the *2017 Range-Wide Indiana Bat Summer Survey Guidelines* (USFWS 2017).

Acoustic surveys will be conducted at 4 sites within the Project area from May 15 – August 15, 2017. Survey sites will be placed in suitable habitat, such as forest-canopy openings, near water, wooded fence lines, blocks of recently logged forest with remnant potential roost trees, road and stream corridors with open canopy or closed canopy >10 meters high, and woodland edges. All acoustic survey sites will be positioned following USFWS bat survey protocols (USFWS 2016). To maximize the quality of recorded echolocation calls, detectors will be positioned at least 3 m above ground level at a microphone angle of 45° or greater (USFWS 2017).

Bats will be surveyed using Song Meter full spectrum ultrasonic detectors (SM2 or SM3; Wildlife Acoustics, Inc.; www.wildlifeacoustics.com). Acoustic monitoring will begin before sunset and continue for the entire night, for two consecutive nights. As recommended by the USFWS, four detector-nights per site will be completed by surveying two detector locations per site for two nights each. If weather conditions such as persistent rain (more than 30 minutes), strong sustained winds (greater than 9 miles per hour [mph] average for more than 2.5 hours), or cold temperatures (below 10°C [50°F] for more than 2.5 hours) occur during the first five hours of a survey night, then the site will be surveyed for an additional night (USFWS 2017), unless the target species are detected or number of bat passes/hour indicates that bat activity rates did not decrease due to inclement weather.

Bat calls will be identified using a quantitative identification program, such as Kaleidoscope Pro (Wildlife Acoustics, Inc., www.wildlifeacoustics.com). All calls identified as one of the target species will be examined and verified by a qualified biologist with extensive acoustic identification experience (Dr. Kevin L. Murray). In addition, all calls recorded on nights with probable NLEB detections will be reviewed when Maximum Likelihood Estimation (MLE) is significant. Call sequences will be reclassified if they are not characteristic of the target species, contain distinct calls produced by another species.

3.5.3 Follow-up Mist Netting Surveys

WEST proposes to conduct follow up mist-net surveys at sites where echolocation calls of, NLEB were identified and verified via qualitative identification. All mist-net surveys would follow current USFWS bat survey protocols (USFWS 2017). Mist-net surveys would be conducted near acoustic detection sites between May 15 and August 15, 2017. Mist-netting would begin at sunset and continue for at least five hours. Nets would be positioned perpendicularly across flight corridors, extending from the ground to the overhanging canopy. WEST would survey two to three mist-net locations per site. Disturbance in the form of noise, light, or movement will be minimized at all net locations. If target species are not captured and unsuitable weather conditions, such as persistent rain (more than 30 minutes), strong sustained winds (greater than 9 mph average for more than 2.5 hours), or cold temperatures (below 10°C [50°F] for more than 2.5 hours) impair survey effort during the first five hours of a survey night, then the site would be sampled for an additional night. All mist-net surveys would be performed by staff or subcontractors holding the proper state and federal permits. The USFWS White-Nose Syndrome (WNS) decontamination protocol would be followed for all mist-netting efforts to prevent cross contamination of captured bats with *Pseudogymnoascus destructans*, the fungus that causes WNS.

3.5.4 Follow-up Roost Telemetry and Emergence Surveys

If adult female or juveniles, NLEB of any sex are captured, telemetry surveys will be conducted to determine if these species have roost sites in or near the Project area. Up to two females or juveniles of each target species may be tracked for the Project. Adult males will not be tracked, and no other bat species will be tracked. Bats will be tracked to roost trees on leased lands

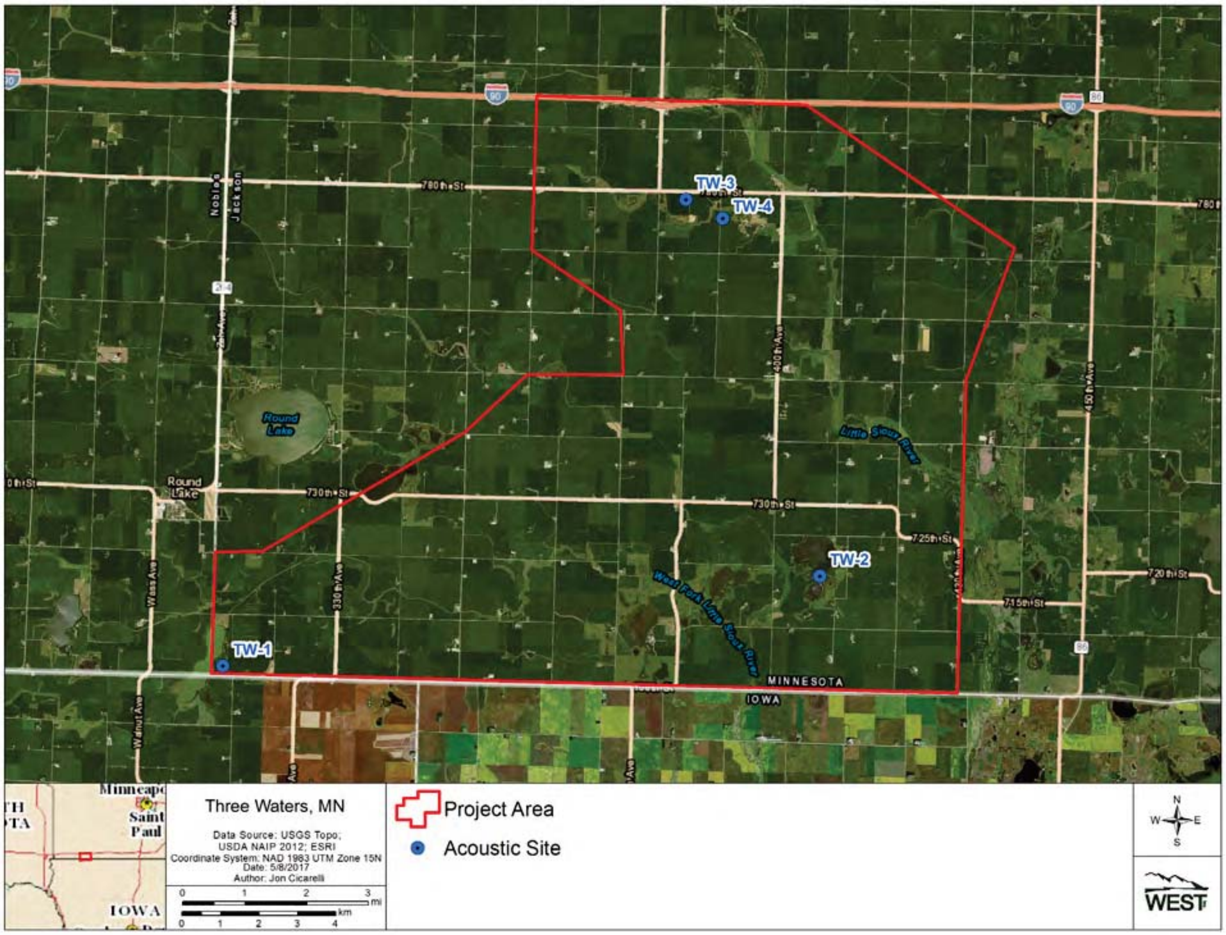

Figure 5. Proposed acoustic detector sites for NLEB presence/probable absence surveys at the Three Waters Project area, in Jackson County, Minnesota.

within the Project (when possible). If the bat is located outside the Project or on unleased lands, its day roost location will be triangulated from leased lands and public roads. Bats will be outfitted with a radio-transmitter (model no. LB-2X or similar; Holohil Systems Ltd., Ontario, Canada) and tracked for up to seven days, for a minimum of four hours per day, or until the transmitter signal is lost. Transmitter signals will be considered lost when no signal is detected for two days. For each roost tree, photographs, GPS coordinates, roost type (tree, building, etc.), tree species, tree type (live, snag), tree diameter at breast height (DBH), approximate roost height, and roost location (cavity, crevice, bark, etc.) will be recorded.

WEST will conduct emergence counts at all maternity roost trees following USFWS guidelines (USFWS 2017). Emergence surveys will begin 30 minutes before sunset and continue for at least 60 minutes after sunset or until it is too dark to continue surveys. Emergence surveys will not be conducted when: a) temperatures are below 50°F (10°C), b) precipitation (rain or fog) persists for more than 30 minutes, or c) average wind speed is > 9 mph (4 meters/second [m/sec]; 3 on Beaufort scale) and sustained for more than 30 minutes during the emergence count survey period. For each emergence survey, biologists will record the date, start and end time, roost name, number of bats exiting, and general weather conditions (e.g., temperature, precipitation, wind speed). Generally, two exit counts will be performed on documented roost trees to determine the number of bats in the roost and to confirm the specific roost type and location. However, if three or fewer bats exit the tree during the first emergence count, no second emergence count will be conducted.

3.6 Incidental Observations

Incidental observations of federally or state-listed species, other sensitive or unusual species, observed in the Project area will be recorded in a manner similar to avian use surveys, including observation number, date, time, species, number of individuals, distance from observer in meters, sex, age, habitat, and UTM coordinates.

3.7 Statistical Analysis of Baseline Data

3.7.1 Data Compilation and Storage

WEST will establish a database to store, retrieve, and organize field observations. Data from field forms will be keyed into electronic data files using a pre-defined format that should make subsequent data analysis straightforward. All field data forms, field notebooks, and electronic data files will be retained for ready reference.

3.7.2 Quality Assurance/Quality Control

WEST will ensure appropriate quality assurance/quality control (QA/QC) measures will be implemented at all stages of the study, including field data collection, data entry, data analysis, and report preparation. At the end of each survey day, each observer will be responsible for inspecting his or her data forms for completeness, accuracy, and legibility. Periodically, the study team leader will review data forms to insure completeness and legibility; any problems detected will be corrected. Any changes made to the data forms will be initialed and dated by the person making the change.

Data will be checked thoroughly for data entry errors. Any errors will be corrected by referencing the raw data forms and/or consulting with the observer(s) who collected the data. Any irregular codes detected, or any data suspected as questionable, will be discussed with the observer and study team leader. Any changes made to the raw data will be documented for future reference.

3.7.3 Survey Reports

Once the field data has been collected, WEST will prepare reports describing the surveys and their results.

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Aerial Raptor Nest Survey 2017

TECHNICAL MEMORANDUM

To: Three Waters Wind Farm, LLC

From: Tim Sichmeller, Western EcoSystems Technology, Inc. (WEST)

Subject: Aerial Nest Survey Results for the Three Waters Wind Farm

INTRODUCTION

Three Waters Wind Farm, LLC (Three Waters) is proposing to develop the Three Waters Wind Energy Project (Project) in Jackson County, Minnesota and Dickinson and Osceola counties, Iowa. In 2017, Three Waters contracted Western EcoSystems Technology, Inc. (WEST) to conduct an aerial raptor nest aerial survey to record eagle and other non-eagle raptor nests within the designated Raptor Nest Survey Area (within 1.6 kilometer [km; 1.0 miles {mi}] of proposed turbines locations; Figure 1) for all raptor nests, and an established buffer of proposed turbines (Eagle Nest Survey Area (16.1-km [10.0-mi] buffer of proposed turbines for eagle nests).

METHODS

Two rounds of helicopter surveys were conducted by a qualified WEST biologist during spring 2017 (Table 1). The first aerial survey round was conducted March 29 – April 1 with a follow-up survey conducted on May 3, 2017. Both survey rounds were scheduled to coincide with bald eagle (*Haliaeetus leucocephalus*) and other raptor nesting activity such as incubating eggs or tending young, based on chronology for nesting bald eagles in the region (see U.S. Fish and Wildlife Service's *National Bald Eagle Management Guidelines*, May 2007). During the first survey round, all stick nests within the Raptor Nest Survey Area and any eagle nests within the Eagle Nest Survey Area were recorded. During the second survey round, potential eagle nesting habitat within the Eagle Nest Survey Area was revisited to ensure that no nesting eagles were missed during the first survey round.

Table 1. Survey summary for aerial eagle nest surveys at the Three Waters Wind Farm, March 29 – May 3, 2017.

Round	Date(s)	Objectives
1	March 29 – April 1, 2017	• Record all stick nests within 1.6 km (1.0 mi) of proposed turbines (Raptor Nest Survey Area); • Record all eagle nests within 16.1 km (10.0 mi) of proposed turbines (Eagle Nest Survey Area).
2	May 3, 2017	• Revisit potential eagle nesting habitat within Eagle Nest Survey Area to exclude possibility of late-nesting eagles; • Revisit bald eagle winter roost location observed during first round.

Pre-flight planning included a review of topographic maps and aerial photographs, and the creation of Geographic Information Systems (GIS) route shapefiles to efficiently direct the pilot during surveys. North-south transects spaced approximately 0.4 km (0.25 mi) apart were flown within the entire Eagle Nest Survey Area.

When suitable bald eagle nesting habitat such as large trees near waterbodies were identified during a pass along a transect, 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 that showed characteristics of eagle nesting habitat. In some cases, multiple passes were needed to thoroughly cover potential nesting habitat.

Generally, the altitude of this survey was 46–61 meters (m; 150–200 feet [ft]) above ground level. Airspeed in suitable habitat was approximately 80 kilometers per hour (kph; 50 miles per hour [mph]). Nest evaluations were performed at lower speeds, or while the helicopter was hovering. GPS positions of all nests detected were recorded and datasheets were used to record nest attribute data including raptor species, nest type, nest status, nest condition, nest height, and substrate. Photographs of all recorded nests were taken.

WEST contracted Arkansas, LLC, to provide air support for the aerial survey. A Robinson R44 helicopter was used with the surveying biologist positioned in the front-left seat for optimized detection. A track log was recorded to ensure all areas were adequately covered. The survey was completed before deciduous tree leaf-out and therefore visibility and potential to detect nests was excellent, resulting in a high probability that the majority of medium to large size stick nests were recorded during this survey.

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 an individual was observed at the nest. Nests were not assigned a species when any stick nest was observed that did not have an occupant associated with it at the time of the survey. Assigning a species to a stick nest can be challenging when a species is not observed at the nest. As bald eagle nests are protected even when unoccupied, WEST used information on nest size, location on the landscape, the nest substrate, and location on the nest substrate to determine if a large unoccupied stick nest was consistent with the size and placement of an eagle nest. Bald eagle nests are typically placed near the tops of live trees in a main fork that can support the weight of the nest, and are typically a large open platform. Unknown raptor nests, including old nests or nests that could become suitable for raptors, were documented in order to ensure that future surveys include all potentially suitable nest sites.

Nest Type

Nest type describes the size and material used for nesting. General nest types include:

- Small Stick – roughly 20 to 25 centimeters (cm; 8 to 10 inches [in]) in diameter, bowl-shaped, comprised of small sticks, grasses, mud and other material, and typical of nests used by accipiter species.
- Medium Stick - typically 25 to 51 cm (10 to 20 in) in diameter, bowl-shaped, comprised of larger sticks, and typical of nests used by Buteo species (e.g. red-tailed hawk [*Buteo jamaicensis*]).
- Large Stick – typically greater than 51 cm (20 in) in diameter, large bowl or flat platform-shaped, comprised of intertwined large sticks from trees, shrubs or other scrub species, and typical of nests used by eagles or osprey (*Pandion haliaetus*).

Nest Condition

Nest condition was subjectively categorized using descriptions ranging from poor to excellent. Nests in poor to fair condition appear 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 may include manmade structures, such as power line poles, nest platforms, and dock hoists, and conifer and deciduous trees.

Nest Status

WEST categorizes basic nest use consistent with definitions from the USFWS Eagle Conservation Plan Guidance (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) 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;
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.

A nest that does not meet the above criteria for "occupied" was classified as "unoccupied". 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.

RESULTS

Twenty-seven stick nests were observed during aerial nest surveys, including 19 occupied nests, and 8 unoccupied nests (Table 2; Figure 2). Eleven of these nests exhibited the size or structural characteristics of a bald eagle nest. Four stick nests were recorded within the Study Area (Figure 1). Of these, two were occupied, while the remaining two nests within the Study Area were unoccupied stick nests of unknown species; however, none of the nests were within consistent size or shape of a bald eagle nest.

Of the remaining 23 stick nests, all were recorded outside of the Study Area but within the Eagle Nest Survey Area, including 8 active bald eagle, 7 red-tailed hawk (*Buteo jamaicensis*), and 3 great horned owl (*Bubo virginianus*; Figure 1) nests. One bald eagle nest was recorded as occupied and inactive, and two empty large stick nests of the size potentially used by bald eagles were recorded, but both were unoccupied. Five unoccupied nests of the size and shape used by non-eagle raptors were classified as unknown raptor nest because they could not be identified to species due to the absence of individuals at the nest. One unoccupied great blue heron (*Ardea herodias*) colony consisting of three nests was also recorded.

During the first aerial survey, two adult bald eagles and a single immature bald eagle, unassociated with any nests, were observed incidentally within the Eagle Nest Survey Area.

CONCLUSION

Twenty-seven nest structures were observed during the eagle and raptor nest surveys, of which 19 (70.4%) were occupied nests. There were eight occupied and active bald eagle nests, one occupied and inactive bald eagle nest, and two empty large stick nests of the size and shape used by bald eagles. All bald eagle nests were located outside of the proposed Project Area and 1-mile buffer, and almost all were located along the larger lakes in the southeast and northern sections of the 10-mile buffer area (Figure 1). Other occupied and active nests found included those of red-tailed hawks and great horned owls. Four nests were located within the Study Area, including two active red-tailed hawk nests and two inactive non-eagle raptor nests.

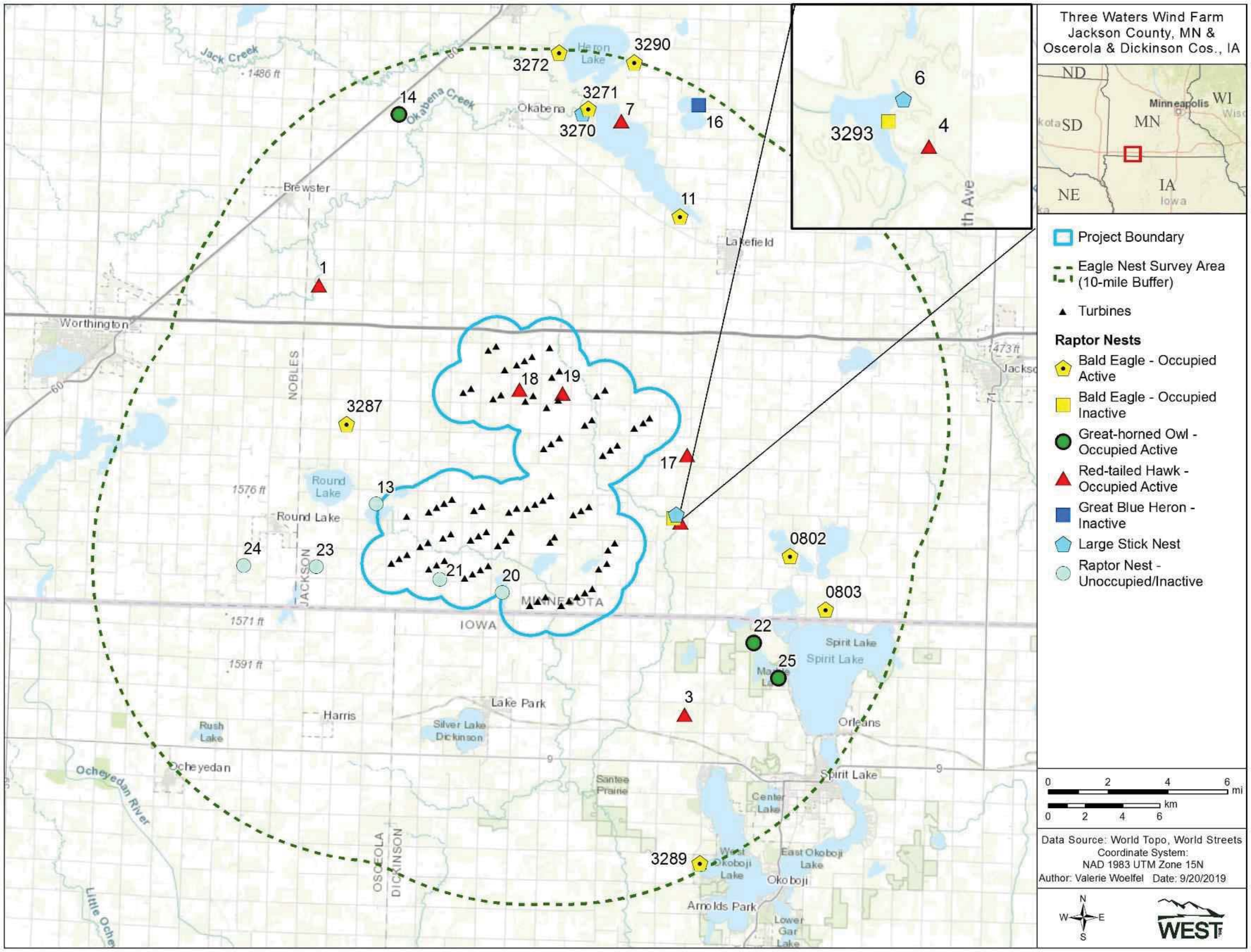

Figure 1. Three Waters Wind Farm 2017 aerial nest surveys location and results.

Table 1. Results of the 2017 raptor and eagle nest surveys at the Three Waters Wind Farm and 10-mile buffer.

Nest ID	Latitude	Longitude	Species	Status – Evidence	Condition
1	43.6566	-95.4450	Red-tailed hawk	Occupied – Adult Incubating	Fair
3289	43.3818	-95.1811	Bald eagle	Occupied – Adult Incubating	Good
3	43.4537	-95.1951	Red-tailed hawk	Occupied – Adult Incubating	Good
4	43.5465	-95.1996	Red-tailed hawk	Occupied – Adult Incubating	Good
3293	43.5493	-95.2037	Bald eagle	Occupied & Inactive	Fair
6	43.5504	-95.2027	Unknown raptor	Unoccupied – Large Stick Nest	Fair
7	43.7401	-95.2462	Red-tailed hawk	Occupied – Adult Incubating	Good
3272	43.7726	-95.2890	Bald eagle	Occupied – Adult Incubating	Good
3271	43.7435	-96.2721	Unknown raptor	Unoccupied – Large Stick Nest	Good
3270	43.7460	-95.2686	Bald eagle	Occupied – Adult Incubating	Good
1279	43.6961	-95.2075	Bald eagle	Occupied – Adult Incubating	Good
3287	43.5909	-95.4265	Bald eagle	Occupied – Adult Incubating	Good
13	43.5510	-95.4027	Unknown raptor	Unoccupied	Poor
14	43.7404	-95.3953	Great-horned owl	Occupied – Adult Incubating	Good
3290	43.7688	-95.2391	Bald eagle	Occupied – Adult Incubating	Good
16	43.7489	-95.1948	Great blue heron	Unoccupied	Fair
17	43.5794	-95.1975	Red-tailed hawk	Occupied – Adult Incubating	Good
3286	43.6082	-95.3111	Red-tailed hawk	Occupied - Adult Incubating	Good
19	43.6073	-95.2807	Red-tailed hawk	Occupied – Adult Incubating	Good
20	43.5103	-95.3173	Unknown raptor	Unoccupied	Poor
21	43.5158	-95.3589	Unknown raptor	Unoccupied	Fair
22	43.4893	-95.1491	Great-horned owl	Occupied – Adult Incubating	Good
23	43.5207	-95.4402	Unknown raptor	Unoccupied	Good
24	43.5202	-95.4899	Unknown raptor	Unoccupied	Good
25	43.4719	-95.1314	Great-horned owl	Occupied – Chick(S) Present	Good
0802	43.5319	-95.1265	Bald eagle	Occupied – Adult Incubating	Good
0803	43.5063	-95.2299	Bald eagle	Occupied – Adult Incubating	Good

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Appendix A. Photos of Eagle Nests Observed in 2017


Appendix A. Occupied bald eagle nest 2 recorded during aerial nest surveys at the Three Waters Wind Farm, 2017.

Appendix A. Unoccupied raptor nest 5 recorded during aerial nest surveys at the Three Waters Wind Farm, 2017.

Appendix A. Unoccupied raptor nest 6 recorded during aerial nest surveys at the Three Waters Wind Farm, 2017.

Appendix A. Occupied bald eagle nest 8 recorded during aerial nest surveys at the Three Waters Wind Farm, 2017.

Appendix A. Unoccupied raptor nest 9 recorded during aerial nest surveys at the Three Waters Wind Farm, 2017.

Appendix A. Occupied bald eagle nest 10 recorded during aerial nest surveys at the Three Waters Wind Farm, 2017.

Appendix A. Occupied bald eagle nest 11 recorded during aerial nest surveys at the Three Waters Wind Farm, 2017.

Appendix A. Occupied bald eagle nest 12 recorded during aerial nest surveys at the Three Waters Wind Farm, 2017.

Appendix A. Occupied bald eagle nest 15 recorded during aerial nest surveys at the Three Waters Wind Farm, 2017.

Appendix A. Occupied bald eagle nest 26 recorded during aerial nest surveys at the Three Waters Wind Farm, 2017.

Appendix A. Occupied bald eagle nest 27 recorded during aerial nest surveys at the Three Waters Wind Farm, 2017.

Aerial Raptor Nest Survey 2018

2018 Raptor Nest Survey Report

Three Waters Wind Farm

Jackson County, Minnesota

Dickinson and Osceola Counties, Iowa

Prepared for:

Three Waters Wind Farm, LLC

4865 Sterling Drive, Suite 200
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2018

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REPORT REFERENCE

Kreger, A., and T. Sichmeller 2018. 2018 Raptor Nest Survey Report for the Three Waters Wind Farm, Jackson County, Minnesota. April 9 – April 10, 2018. Prepared for Three Waters Wind Farm, LLC, Boulder, CO. Prepared by Western EcoSystems Technology, Inc. (WEST), Golden Valley, Minnesota. December 19, 2018.

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INTRODUCTION

Three Waters Wind Farm, LLC (Three Waters) is considering the development of a utility-scale wind energy project, the Three Waters Wind Farm (Project), in Jackson County, Minnesota and Dickinson and Osceola counties, Iowa. Three Waters requested Western EcoSystems Technology, Inc. (WEST) conduct an aerial raptor nest survey to record bald eagle (*Haliaeetus leucocephalus*) and other raptor nests in and near the Project. The 2018 survey was the second year of aerial nest surveys conducted for the Project. Nest surveys help in assessing potential effects of the Project on eagles and other raptors. The aerial 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 Project area encompasses approximately 23,832 hectares (ha; 58,890 acres [ac]) in Jackson County, Minnesota and Dickinson and Osceola counties, Iowa. The Project area is within the Des Moines Lobe Level IV Ecoregion and the Western Corn Belt Plains Level III Ecoregion (US Environmental Protection Agency 2017, Chapman et al. 2002). The Western Corn Belt Plains is over 75% cultivated cropland and much of the remainder is forage for livestock. Most of the Des Moines Lobe has been converted from wet prairie to agricultural land. The Project area includes portions of the Little Sioux River and the West Fork of the Little Sioux River, along with other small drainages. The Project area also overlaps with several small lakes and ponds, including Illinois Lake, Skunk Lake, Rush Lake, and Iowa Lake. Based on the US Geological Survey (USGS) National Land Cover Database (NLCD; USGS NLCD 2011), land cover within the Project area is primarily (89.9%) cultivated cropland, with small portions of emergent herbaceous wetlands (3.2%), developed, open space (3.1%), and herbaceous (1.4%), all other land cover types each cover less than 1% of the Project area.

METHODS

Aerial Raptor Nest Survey

Raptor surveys were conducted from a helicopter from April 9 – April 10, 2018, 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 ECPG (USFWS 2013) and the USFWS *Interim Golden Eagle Technical Guidance* (Pagel et al. 2010). An experienced raptor ecologist and a skilled helicopter pilot conducted the survey. Surveys from helicopters are generally limited to detecting large stick nests from tree-nesting raptor species such as eagles, buteos, 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 such as trees and transmission lines within and around the proposed Project, considering 1.0-mile (mi; 1.6-kilometer [km]) buffer for all raptor nests and a 10.0-mi (16.0-km) buffer for eagle nests (Figure 1). 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.

Disturbance to breeding raptors was minimized by maintaining the greatest possible distance at which the species could be identified, 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 Map 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. Raptor species, nest condition, nest substrate, and nest status were recorded at each nest location to the extent possible. The reported nest status reflects the most active status observed during both the aerial survey and follow-up status check.

On May 15, 2018, WEST conducted a follow-up aerial survey of bald eagle nests and potential bald eagle nests that were documented in the April survey to confirm species, occupancy and activity status. The follow-up nest checks occurred 33 to 35 days after the initial survey, following ECPG recommendations that eagle nest status be checked at least 30 days after the initial observation.

Terminology

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

Nest Identification (ID) – A unique nest ID number was assigned 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 were defined as any stick nest not having an occupant associated with it at the time of the survey. Many times, a nest becomes abandoned or is 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, were documented in order to populate a nest database to ensure future surveys include all potentially suitable nest sites. Unknown raptor species nests that appeared consistent in size and shape with bald eagle nests were classified as large stick nests.

Nest Type

Nest type describes the size and material used for nesting. General nest types include:

- Small Stick – roughly 20 to 25 centimeters (cm; 8 to 10 inches [in]) in diameter, bowl-shaped, comprised of small sticks, grasses, mud and other material, and typical of nests used by accipiter species.
- Medium Stick - typically 25 to 51 cm (10 to 20 in) in diameter, bowl-shaped, comprised of larger sticks, and typical of nests used by buteo species (e.g. red-tailed hawk [*Buteo jamaicensis*]).
- Large Stick – typically greater than 51 cm (20 in) in diameter, large bowl or flat platform-shaped, comprised of intertwined large sticks from trees, shrubs or other scrub species, and typical of nests used by eagles or osprey (*Pandion haliaetus*).

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 may require some repair or addition to use immediately. Nests in poor condition were sloughing or sagging heavily and required effort to restore for successful nesting.

Substrate –Substrates included manmade structures such as power lines, nest platforms, and dock hoists; and biological and physical structures including conifer and deciduous tree species.

Nest Status – Nest status was categorized using definitions originally proposed by Postupalsky (1974) and consistent with the USFWS 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) 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 observed. Occupied nests were classified as inactive if adults were not observed in a brooding position and no eggs or nestlings were present. Unoccupied nests were considered inactive by default.

RESULTS

Sixteen nests representing three identified species were detected during aerial surveys conducted April 9 – April 10, 2018 (Table 1). Eight occupied and active bald eagle nests, one occupied and inactive bald eagle nest, and two inactive nests of unidentified species that appeared consistent in size and shape with a bald eagle nest were documented. Additional raptor nests documented during the survey included two occupied active great horned owl (*Bubo virginianus*) nests and three occupied active red-tailed hawk (*Buteo jamaicensis)* nests.

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

Nest 3287 – This nest was located approximately 2.9 mi (4.6 km) west of the Project boundary. The nest was in good condition. One adult bald eagle was observed on the nest in an incubating position. The nest was therefore considered occupied and active in 2018 (Figure 1, Appendix A1). This nest was also occupied and active in 2017.

Nest 3291 – This nest was located approximately 4.6 mi (7.4 km) east of the Project boundary. The nest was in good condition. One adult bald eagle was observed on the nest in an incubating position. This nest was also active, with two adult bald eagles and one chick on the nest at the time of the status check survey in May. The nest was therefore considered occupied and active in 2018 (Figure 1, Appendix A2).

Nest 0802 – This nest was located approximately 4.9 mi (7.8 km) east of the Project boundary. The nest was in good condition. Two adult bald eagles were observed on the nest. One was in an incubating position and flushed to reveal three eggs. This nest was also active, with one adult and one chick on the nest at the time of the status check survey in May. The nest was therefore considered occupied and active in 2018 (Figure 1, Appendix A3). This nest was also occupied and active in 2017.

Nest 1279 – This nest was located approximately 5.2 mi (8.3 km) north of the Project boundary. The nest was in good condition. One adult bald eagle was observed on the nest in an incubating position. The nest was therefore considered occupied and active in 2018 (Figure 1, Appendix A4). This nest was also occupied and active in 2017.

Nest 3270 – This nest was located approximately 7.2 mi (11.5 km) north of the Project boundary. The nest was in good condition. One adult bald eagle was observed on the nest in an incubating position. The nest was therefore considered occupied and active in 2018 (Figure 1, Appendix A5). This nest was also occupied and active in 2017.

Nest 3289 – This nest was located approximately 8.8 mi (14.1 km) south of the Project boundary. The nest was in good condition. One adult bald eagle was observed on the nest in an incubating position and flushed revealing two eggs. The nest was therefore considered occupied and active in 2018 (Figure 1, Appendix A6). This nest was also occupied and active in 2017.

Nest 3272 – This nest was located approximately 8.9 mi (14.3 km) north of the Project boundary. The nest was in good condition. One adult bald eagle was observed on the nest in an incubating position. The nest was therefore considered occupied and active in 2018 (Figure 1, Appendix A7). This nest was also occupied and active in 2017.

Nest 3290 – This nest was located 8.9 mi (14.3 km) north of the Project boundary. The nest was in good condition. One adult bald eagle was observed on the nest in an incubating position. The nest was therefore considered occupied and active in 2018 (Figure 1, Appendix A8). This nest was also occupied and active in 2017.

Nest 3293 – This nest was located approximately 1.2 mi (1.9 km) east of the Project boundary. The nest was in good condition. Two adult bald eagles were observed perched near the nest. No bald eagles, eggs, or chicks were observed on the nest at the time of the nest status check survey in May. The nest is therefore considered occupied and inactive in 2018 (Figure 1, Appendix A9). This nest was also occupied and inactive in 2017.

Nest 3271 – This nest was located approximately 7.0 mi (1.9 km) north of the Project boundary. The nest was in fair condition. No bald eagles were seen at the nest, but it was consistent in size and shape with a bald eagle nest. The nest was inactive with no signs of recent use at the time of the status check survey in May. The nest was therefore considered inactive in 2018 (Figure 1, Appendix A10). This nest was also inactive in 2017.

Nest 3288 – This nest was located approximately 9.8 mi (15.6 km) west of the Project boundary. The nest was in good condition. No bald eagles were seen at the nest, but it was consistent in size and shape with a bald eagle nest. No bald eagles, eggs, or chicks were observed on the nest at the time of the nest status check survey in May. The nest was therefore considered an inactive nest of an unidentified species in 2018 (Figure 1, Appendix A11).

Nest 803 – This nest was located approximately 6.4 mi (10.3 km) east of the Project boundary. The nest was in good condition. This nest was documented as an active bald eagle nest in 2017. At the time of the survey there was one great-horned owl incubating on the nest. This nest was also active, with one adult great-horned owl and one chick on the nest at the time of the status check survey in May. The nest is therefore considered an active great-horned owl nest in 2018, but it is known to be a historic bald eagle nest (Figure 1, Appendix A12).

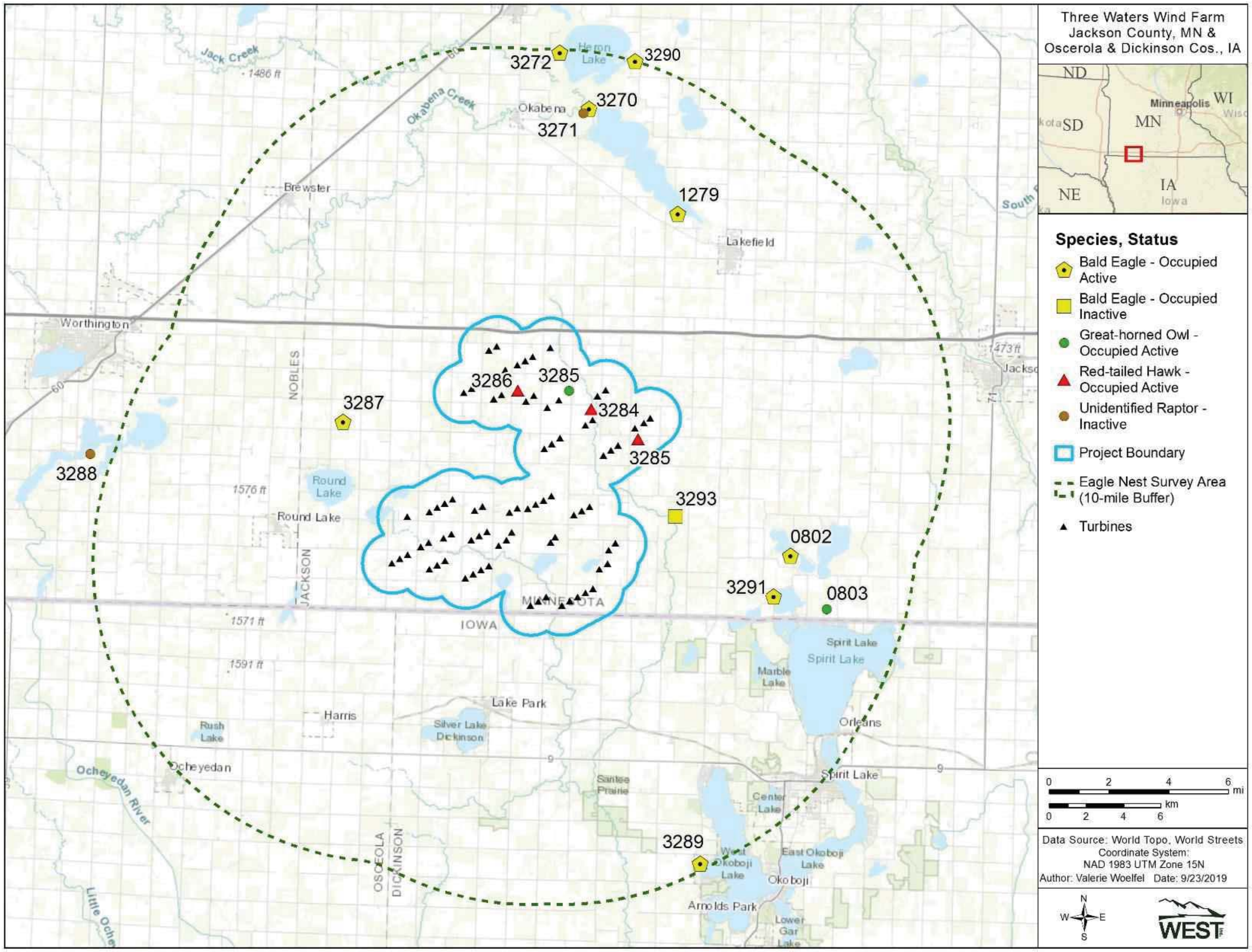

Figure 1. Nests documented April 9 – April 10, 2018 near the Three Waters Wind Farm in Jackson County, Minnesota, and Dickinson and Osceola counties, Iowa.

Table 1. Raptor nest ID, location, species, status, substrate, and condition of nests documented April 9 – April 10, 2018 near the Three Waters Wind Farm in Jackson County, Minnesota and Dickinson and Osceola counties, Iowa.

Nest ID	Latitude	Longitude	Species[1, 2]	Status at time of survey	Condition
3287	43.5909	-95.4265	BAEA	occupied active	good
3291	43.5120	-95.1369	BAEA	occupied active	good
0802	43.5319	-95.1265	BAEA	occupied active	good
1279	43.6961	-95.2075	BAEA	occupied active	good
3270	43.7460	-95.2686	BAEA	occupied active	good
3289	43.3818	-95.1811	BAEA	occupied active	good
3272	43.7726	-95.2890	BAEA	occupied active	good
3290	43.7688	-95.2391	BAEA	occupied active	good
3293	43.5493	-95.2037	BAEA	occupied inactive	fair
3271	43.7435	-95.2721	UNRA*	inactive	fair
3288	43.5715	-95.5935	UNRA*	inactive	good
0803	43.5063	-95.1015	GHOW*	occupied active	good
3285	43.6088	-95.2767	GHOW	occupied active	good
3286	43.6082	-95.3111	RTHA	occupied active	good
3283	43.5863	-95.2299	RTHA	occupied active	fair
3284	43.6008	-95.2616	RTHA	occupied active	fair

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Appendix A. Images of Active and Occupied Eagle Nests and Nests Consistent in Size and Shape with Eagle Nests Found April 9 – April 10, 2018 within the 10 mile Buffer of the Three Waters Wind Farm in Jackson County, Minnesota and Dickinson and Osceola counties, Iowa

Appendix A1. Nest 3287 was located approximately 2.9 mi (4.6 km) west of the Project boundary. The nest was in good condition. One adult bald eagle was observed on the nest in an incubating position. The nest was therefore considered occupied and active in 2018.

Appendix A2. Nest 3291 was located approximately 4.6 mi (7.4 km) east of the Project boundary. The nest was in good condition. One adult bald eagle was observed on the nest in an incubating position. The nest was therefore considered occupied and active in 2018.

Appendix A3. Nest 0802 was located approximately 4.9 mi (7.8 km) east of the Project boundary. The nest was in good condition. Two adult bald eagles were observed on the nest. One was in an incubating position and flushed to reveal three eggs. The nest was therefore considered occupied and active in 2018.

Appendix A4. Nest 1279 was located approximately 5.2 mi (8.3 km) north of the Project boundary. The nest was in good condition. One adult bald eagle was observed on the nest in an incubating position. The nest was therefore considered occupied and active in 2018.

Appendix A5. Nest 3270 was located approximately 7.2 mi (11.5 km) north of the Project boundary. The nest was in good condition. One adult bald eagle was observed on the nest in an incubating position. The nest was therefore considered occupied and active in 2018.

Appendix A6. Nest 3289 was located approximately 8.8 mi (14.1 km) south of the Project boundary. The nest was in good condition. One adult bald eagle was observed on the nest in an incubating position and flushed revealing two eggs. The nest was therefore considered occupied and active in 2018.

Appendix A7. Nest 3272 was located approximately 8.9 mi (14.3 km) north of the Project boundary. The nest was in good condition. One adult bald eagle was observed on the nest in an incubating position. The nest was therefore considered occupied and active in 2018.

Appendix A8. Nest 3290 was located 8.9mi (14.3 km) north of the Project boundary. The nest was in good condition. One adult bald eagle was observed on the nest in an incubating position. The nest was therefore considered occupied and active in 2018.

Appendix A9. Nest 3293 was located approximately 1.2 mi (1.9 km) east of the Project boundary. The nest was in good condition. Two adult bald eagles were observed perched near the nest. The nest was therefore considered occupied and inactive in 2018.

Appendix A10. Nest 3271 was located approximately 7.0 mi (1.9 km) north of the Project boundary. The nest was in fair condition. No bald eagles were seen at the nest, but it was consistent in size and shape with a bald eagle nest. The nest was therefore considered inactive in 2018.

Appendix A11. Nest 3288 was located approximately 9.6 miles (15.4 kilometers) north of the Project boundary. The nest was in good condition. No bald eagles were seen at the nest, but it is consistent in size and shape with a bald eagle nest. The nest was therefore considered inactive in 2018.

Appendix A12. Nest 803 was located approximately 6.4 mi (10.3 km) east of the Project boundary. The nest was in good condition. This nest was documented as an active bald eagle nest in 2017. At the time of the survey there was one great-horned owl incubating on the nest. The nest is therefore considered an active great-horned owl nest in 2018, but is a historic bald eagle nest.

Year 1 Avian Use Report 2017

Year 1 Avian Use Report

Three Waters Wind Farm

Jackson County, Minnesota
Osceola and Dickinson Counties, Iowa

Final Report

March 2017 – February 2018

Prepared for:

Three Waters Wind Farm, LLC

4865 Sterling Drive, Suite 200
Boulder, Colorado 80301

Prepared by:

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Western EcoSystems Technology, Inc.
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2018

WEST Inc.

EXECUTIVE SUMMARY

Three Waters Wind Farm, LLC (Three Waters) has proposed the development of the Three Waters Wind Farm (Project) in Jackson County, Minnesota, Osceola and Dickinson Counties, Iowa. Western EcoSystems Technology, Inc. (WEST) conducted a year of baseline avian use surveys for the proposed Project from March 2017 through February 2018. This report provides results of fixed-point avian use surveys, eagle use surveys, and incidental observations.

The Project area includes 23,832 hectares (58,890 acres) of mostly (89.9%) cultivated cropland. The Project includes portions of the Little Sioux River and the West Fork of the Little Sioux River, along with other small drainages, and several small lakes and ponds, including Illinois Lake, Skunk Lake, Rush Lake, and Iowa Lake.

Avian use surveys were designed to collect information that would help assess potential impacts, and identify methods of avoiding and/or mitigating impacts based on temporal and spatial use of the Project area by eagles and other birds. Eagle, large bird and small bird use surveys were conducted from March 2017 through February 2018, at 18 observation points established throughout the Project area. Two hundred sixteen 60-minute large bird surveys and 10-minute small bird surveys were completed during 12 visits.

Thirty-five unique large bird species and 45 small bird species were recorded. The most abundant large bird types recorded were waterfowl (1,769 observations) and gulls/terns (1,405 observations). One hundred four diurnal raptors were observed, with 56 of the observations recorded during fall including 2 bald eagles, which were observed in spring (6 observations) and winter (1 observation) as well as a single golden eagle observed during the spring. During spring, ring-billed gulls had the highest use of all large birds recorded. During summer and fall, Canada geese had the highest use of all large birds recorded. During winter, large corvids had the highest use of all large birds recorded. Overall, large bird use was highest in spring, followed by fall, summer, and winter.

During the 10-minute small bird surveys, 3,031 passerines were recorded. Overall, the most abundant small bird species recorded were unknown blackbirds, red-winged blackbird, Lapland longspur, and horned lark. Red-winged blackbirds had the highest use of small birds recorded in spring. Unknown blackbirds had the highest use of small birds recorded in summer and fall. Lapland longspurs had the highest use of small birds recorded during winter. Overall, small bird use was highest in fall, followed by winter, summer, and spring.

While no federally listed species were recorded during the fixed-point bird use surveys, several species of concern were recorded during surveys or as incidental observations recorded outside standardized survey intervals. Ten observations of bald eagle and one of golden eagle were recorded; both species are protected by the Bald and Golden Eagle Protection Act of 1940. In addition, Henslow's sparrow, a state-listed endangered species, was recorded. Several other

Minnesota Special Concern species and Species of Greatest Conservation Need were recorded, including relatively large numbers of Franklin's gull and American white pelican observations.

While the Project area is primarily cultivated cropland, it also includes wetland and herbaceous areas that could provide valuable habitat to waterbirds, waterfowl, eagles, and other bird types, especially during migration. Although limited, forested areas near wetland habitat could be attractive nesting sites for breeding raptors, including eagles. Data indicates relatively high use of the Project area during spring and fall migration, driven largely by waterfowl and gull/tern observations. Diurnal raptor observations were relatively high during spring (36 observations) and fall (56), and the surveys recorded observations of 12 species, with red-tailed hawk being most common species observed. Nine bald eagle observations were recorded, with six observations in spring, two observations in fall, and one observation in winter. One golden eagle was recorded during spring. Small bird use was highest during the fall, driven primarily by comparatively large numbers of blackbird observations.

STUDY PARTICIPANTS

Western EcoSystems Technology

Tim Sichmeller	Project Manager
Ryan McDonald	Field Coordinator
Guy DiDonato	Statistician
Carissa Goodman	Data Analyst
Carmen Boyd	Project Tracking & Data Manager
Jon Cicarelli	GIS Specialist
Katie Wynne	Technical Editing Coordinator
Andrea Palochak	Technical Editor
Kyle Mitchell	Field Technician
Patricia Zalabowski	Field Technician

REPORT REFERENCE

McDonald, R., and T. Sichmeller. 2018. Year 1 Avian Use Report for the Three Waters Wind Project, Jackson County, Minnesota and Osceola and Dickinson Counties, Iowa. Final Report: March 2017 – February 2018. Prepared for Three Waters Wind Farm, LLC, Boulder, Colorado. Prepared by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming. 2018.

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INTRODUCTION

In 2017, Three Waters Wind Farm, LLC (Three Waters) contracted Western EcoSystems Technology, Inc., (WEST) to conduct surveys and monitor wildlife resources for the potential Three Waters Wind Farm (Project) in southwestern Minnesota (Figure 1) to estimate the potential impacts of wind energy facility construction and operations on wildlife. This document provides results of fixed-point bird use surveys, eagle use surveys, and incidental observations. The study was designed to address questions posed under Tier 3 of the US Fish and Wildlife Service (USFWS) Land-Based Wind Energy Guidelines (USFWS 2012) and the USFWS Eagle Conservation Plan Guidance (ECPG; USFWS 2013) and the revised eagle permit rules published on December 16, 2016 (USFWS 2016).

The principal objectives of the study were to: 1) provide site-specific bird resource and use data that would be useful for evaluating potential impacts from developing the Project; 2) provide information that could be used for Project planning and design of the facility to minimize impacts to birds; 3) estimate temporal and spatial patterns of avian use within the Project area; and 4) collect data on eagle use in the area following the USFWS ECPG (USFWS 2013) and the revised eagle permit rule (USFWS 2016).

PROJECT AREA

The Project area encompasses approximately 23,832 hectares (ha; 58,890 acres [ac]) in Jackson County, Minnesota and Dickinson and Osceola counties, Iowa (Figure 1). The Project area is within the Des Moines Lobe Level IV Ecoregion and the Western Corn Belt Plains Level III Ecoregion. The Western Corn Belt Plains is over 75% cultivated cropland and much of the remainder is forage for livestock (US Environmental Protection Agency [USEPA] 2018). Most of the Des Moines Lobe has been converted from wet prairie to agricultural land (USEPA 2018). The Project area includes portions of the Little Sioux River and the West Fork of the Little Sioux River, along with other small drainages. The Project area also overlaps with several small lakes and ponds, including Illinois Lake, Skunk Lake, Rush Lake, and Iowa Lake (Figure 2). Based on the National Land Cover Database (NLCD; Yang et al., Multi-Resolution Land Characteristics 2019), land cover within the Project area is primarily (89.9%) cultivated cropland, with small portions of emergent herbaceous wetlands (3.2%), developed open space (3.1%), and herbaceous (1.4%) and other habitat types (Figure 3, Table 1).

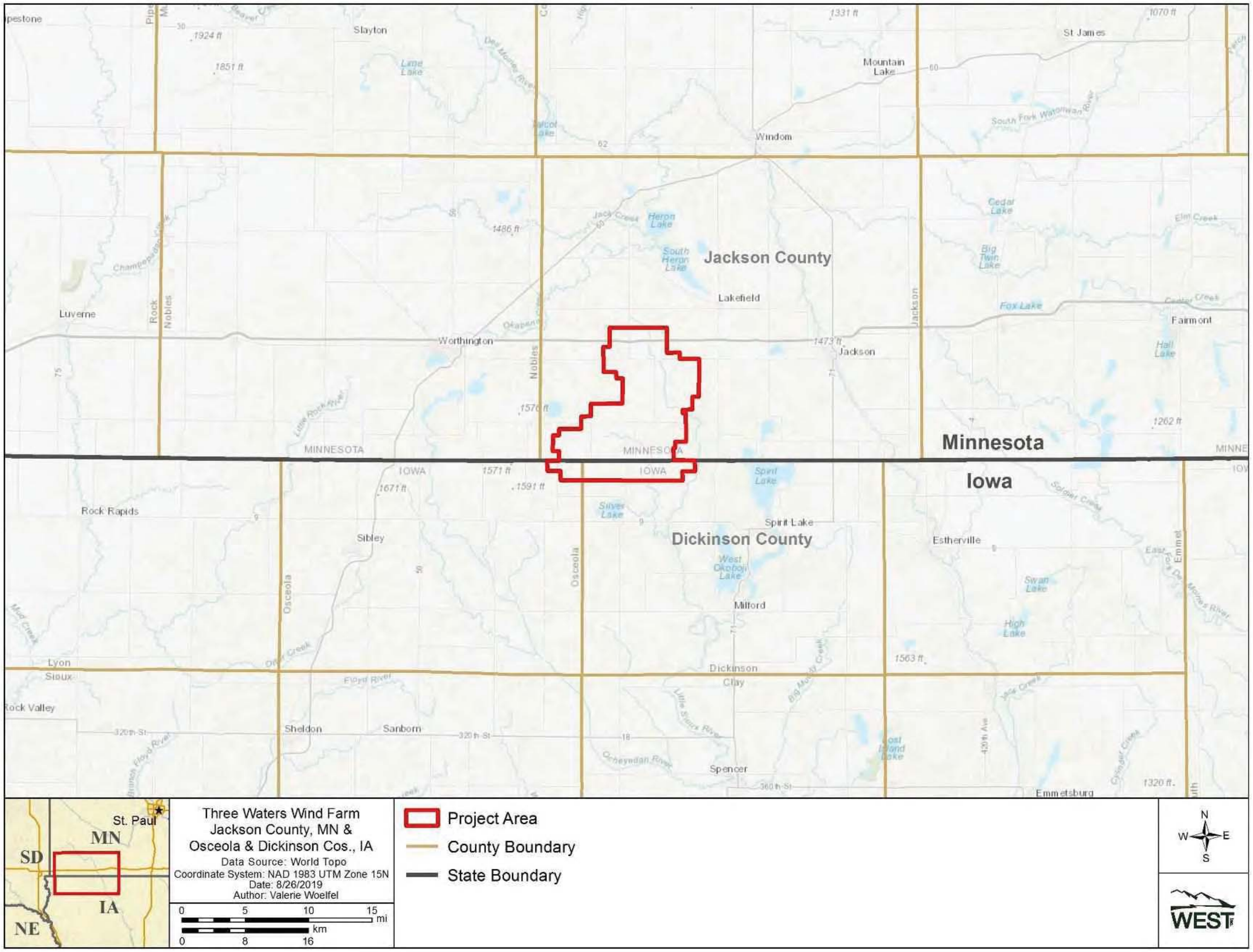

Figure 1. Location of the Three Waters Wind Farm in Jackson County, Minnesota and Osceola and Dickinson Counties, Iowa.

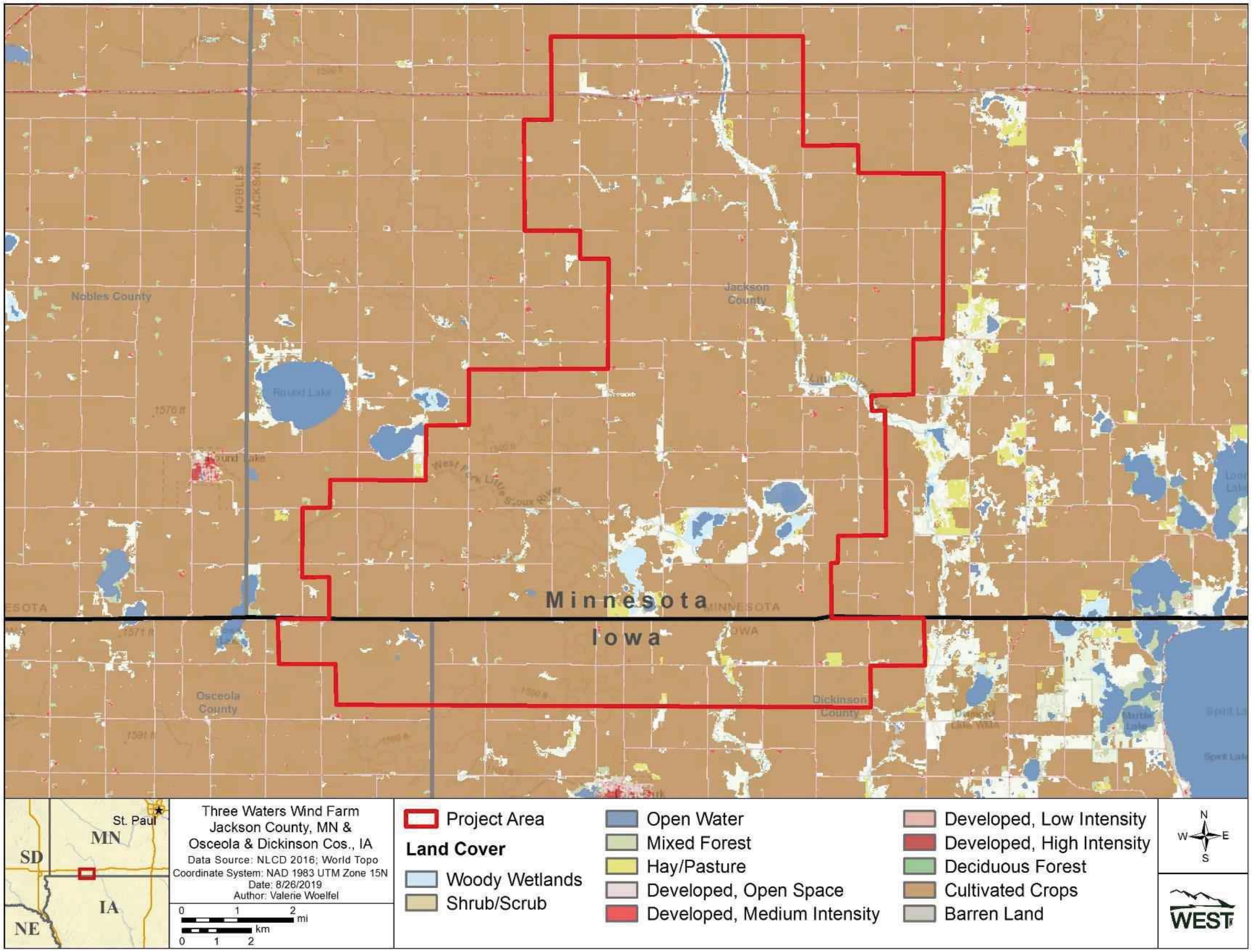

Figure 2. Land cover in the Three Waters Wind Farm (US Geological Survey National Land Cover Database 2011, Homer et al. 2015) in Jackson County, Minnesota and Osceola and Dickinson Counties, Iowa.

Table 1. Land cover types, coverage, and composition within the Three Waters Wind Farm in Jackson County, Minnesota and Osceola and Dickinson Counties, Iowa.

Habitat	Hectares	Acres	% Composition
Cultivated Crops	21,411.7	52,910.4	89.9
Emergent Herbaceous Wetlands	764.1	1,888.1	3.2
Developed, Open Space	735.9	1,818.5	3.1
Herbaceous	335.5	829.0	1.4
Open Water	160.8	397.3	0.7
Hay/Pasture	128.3	317.0	0.5
Developed, Low Intensity	119.7	295.9	0.5
Mixed Forest	107.2	264.8	0.5
Developed, Medium Intensity	33.9	83.9	0.1
Deciduous Forest	10.4	25.6	<0.1
Shrub/Scrub	9.5	23.6	<0.1
Barren Land	6.1	15.1	<0.1
Woody Wetlands	5.6	13.8	<0.1
Developed, High Intensity	2.7	6.7	<0.1
Total[1]	**23,832**	**58,890**	**100**

Data from the National Land Cover Database (Yang et al. 2018, Multi-Resolution Land Characteristics 2019).

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

METHODS

Pre-construction avian use surveys were conducted for the Project from March 2017 – February 2018, which included: 1) fixed-point large bird/eagle use surveys, 2) fixed-point small bird use surveys, and 3) incidental wildlife observations. Surveys were designed based on methods described by Reynolds et al. (1980) and recommendations in the ECPG (USFWS 2013) and in coordination with the Minnesota USFWS Ecological Services Field Office (Bloomington, MN).

Large Bird/Eagle Use Surveys

Eagle and large bird use surveys were conducted from March 2017 – February 2018. The objective of the eagle and large bird use surveys was to provide site-specific bird resource and use data that would be useful for evaluating potential impacts from developing the Project and estimate temporal and spatial patterns of large bird and eagle use within the Project area. Eagle data were collected following the USFWS *Eagle Conservation Plan Guidance* (ECPG; USFWS 2013) as well as new eagle permit rules published on December 16, 2016.

Survey Plots

Surveys consisted of eagle and other large bird counts within circular plots centered on an observation point. The maximum survey radius around each observation point was 800 meter (m; 2,625 feet [ft]) for inclusion in data analysis, though some observations farther than 800 m were recorded. For eagle use surveys, the ECPG recommends that at least 30% of the project footprint be covered by bird observation plots. Eighteen observation points were used in this study to meet the recommended 30% coverage of the Project area (USFWS 2013). Figures within this report represent updated boundaries in August 2019. A Geographic Information System (GIS) software specialist assigned survey locations in a spatially random design to maximize the spatial coverage of the Project area, ensure good visibility for the survey observers, and provide readily accessible survey point locations from public roads. Survey point locations were micro-sited by a WEST biologist prior to the first surveys to optimize viewshed, access, and safety.

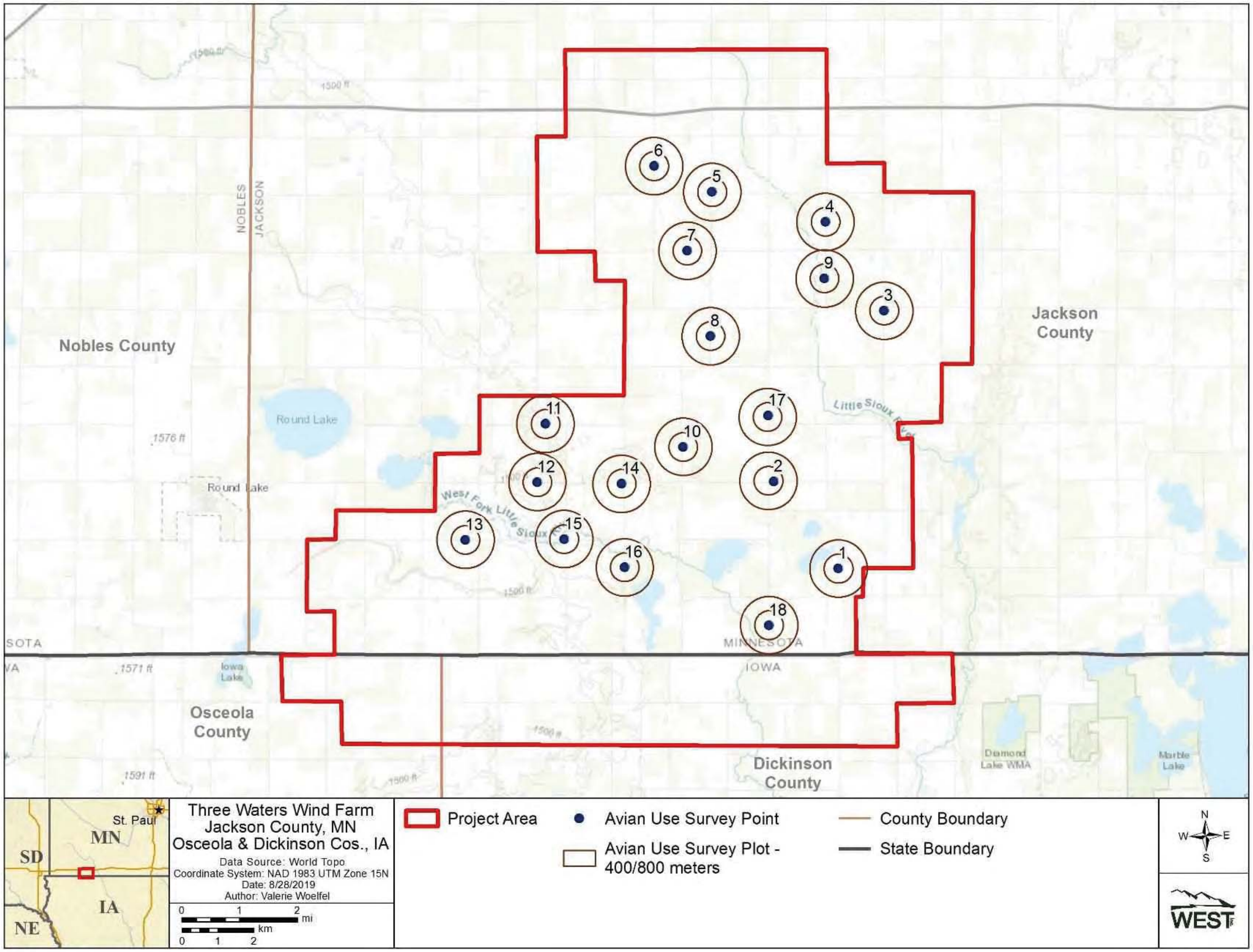

Figure 3. Survey points used during avian use surveys at the Three Waters Wind Farm, Jackson County, Minnesota and Osceola and Dickinson Counties, Iowa.

Observation Schedule

Surveys were conducted for one hour (60 minutes [min]) at each point once per month. Surveys were only conducted during daylight hours. Each month the survey order was varied so that each point was visited at multiple times of day during each season. Each survey day was initiated with a randomly selected survey location from available points remaining to be surveyed.

Survey Methods

Every eagle and other large bird observed during each survey was recorded, though for generating standardized fixed-point bird use estimates, only large birds detected within the 800 m radius plot during the 60 min survey were used to generate descriptive statistics. Observations of large birds beyond the 800 m radius were recorded, but were not included in statistical analyses. Large birds were defined as waterbirds, waterfowl, rails and coots, grebes and loons, gulls and terns, shorebirds, diurnal raptors, owls, vultures, upland game birds, doves and pigeons, large corvids (i.e., ravens, magpies, and crows), and goatsuckers.

Estimated distance to each eagle or other large bird observation was recorded to the nearest 5 m (16-ft). The date, start and end time of observation period, plot number, species or best possible identification, number of individuals, sex and age class, distance from plot center when first observed, closest distance, height above ground level (AGL), activity, and habitat were recorded. For eagles, flight height and behavior were recorded at one-minute intervals for as long as the eagle remained visible, based on the recommendations in the ECPG. Observations of eagles and other large birds outside of the 800 m observation plot may have been recorded, but data collected on these birds were analyzed separately from data collected on birds observed within the plot. Behavior categories included perched, soaring, flapping, flushed, circle soaring, hunting, gliding, and other. Any comments or unusual observations were noted, and weather information was recorded for each survey point including temperature, wind speed, wind direction and cloud cover. The proportion of the 800 m viewshed visible from each observation point was documented.

Flight paths and perch locations for eagles and other species of interest (raptors, waterbirds, sensitive species) were mapped on USGS topographic base maps. Landmarks shown on the map helped determine whether the bird was within the plot area. Flight paths and perch locations were digitized using GIS software so that bird movement patterns could be evaluated relative to topography, habitat, and other features. Small Bird Use Surveys

Small bird use surveys were conducted from March 2017 – February 2018. The objective of small bird use surveys was to provide a list of species for small birds recorded during the surveys and to document the relative abundance of species observed in the Project in order to provide data to estimate temporal and spatial use of the Project. The small bird use surveys consisted of small bird counts at the same 18 observation points used for eagle/large bird surveys (Figure 4). Small birds were defined as passerines (excluding large corvids), kingfishers, swifts and hummingbirds, woodpeckers, and cuckoos.

Small bird use surveys were conducted for 10 min preceding the large bird/eagle use surveys at each point. A 100-m (328-ft) plot radius was used for small bird surveys. Observations of small birds beyond the specified radius may have been recorded, but data collected on these birds were analyzed separately from data collected on birds observed within the plot. The estimated distance to each bird observed was recorded to the nearest five meters. The date, start and end time of the survey, and weather information was collected for each survey. For each observation, the biologist recorded: species (or best taxonomic identification), number of individuals, sex, age, distance from plot center when first observed, closest distance, flight height AGL, activity, and habitat.

Incidental Observations

Incidental wildlife observations provide records of sensitive species or noteworthy observations outside of the standardized surveys. Sensitive and unusual birds, mammals, reptiles, and amphibians were recorded in a similar fashion to standardized surveys. Sensitive species include federally and state-listed (endangered, threatened, or candidate) species and eagles, which are protected by the Bald and Golden Eagle Protection Act (1940). Data recorded for these species included: observation number, date, time, species, number of individuals, sex, age, distance from observer, activity, height AGL, and habitat. The location of sensitive species was recorded by Universal Transverse Mercator (UTM) coordinates using a hand-held Global Positioning System (GPS) unit.

Statistical Analysis

For analysis, a visit was defined as the required length of time, in days, to survey all of the plots once within the Project area. Visits were assigned according to the following criteria: 1) a single visit had to be completed in a single season; and 2) a visit could be spread across multiple dates, but a single date could not contain surveys from multiple visits. Under certain circumstances (such as extreme weather conditions), plots were not surveyed during some visits. Additionally for all analyses, seasons were categorized as spring (March 1 – May 31), summer (June 1 – August 31), fall (September 1 – November 30), and winter (December 1 – February 28). The statistician limited analyses to the maximum extent of data collection within the defined viewshed (i.e., 800 m for eagles and large birds and 100 m for small birds). Observations beyond the defined viewshed were also recorded, but were analyzed separately from data collected on birds observed within the defined viewsheds (Appendix A).

Quality Assurance and Quality Control

WEST implemented quality assurance and quality control (QA/QC) measures at all stages of the study, including in the field, during data entry and analysis, and report writing. Following surveys, field biologists were responsible for inspecting data forms for completeness, accuracy, and legibility. WEST data specialists identified potentially erroneous data using a series of database queries and discussed irregular codes or questionable data 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 corrections were made.

Data Compilation and Storage

A database was developed to store, organize, and retrieve survey data. Data were keyed into the electronic database using a pre-defined protocol to facilitate subsequent QA/QC and data analysis. All data forms, field notebooks (if provided), and electronic data files were retained for future reference.

Bird Diversity and Species Richness

Bird diversity was illustrated by the total number of unique species observed. Species lists (with the number of observations and groups) were generated by season and they included all observations of birds detected, regardless of their distance from the observer (Appendix A). In some cases, the number of observations may have included repeated sightings of an individual. For example, five observations of a species may represent five different birds, or one bird observed on five separate visits, or something in between.

Species richness by season was calculated by averaging the total number of species observed within each plot during a visit, then averaging across plots within each visit, followed by averaging across visits within the season. Overall species richness was calculated as a weighted average of seasonal values by the number of days in each season. Species diversity and richness were compared among seasons for fixed-point bird use surveys. Species diversity and richness were calculated separately for large birds and small birds.

Bird Use, Percent of Use, and Frequency of Occurrence

Use was defined as the number of birds per plot per survey. Large bird use included birds detected within the 800-m radius plots during the 60-min surveys. For small birds, use includes birds detected within the 100-m radius plots during the 10-min surveys. Mean bird use equals the average number of birds per plot per survey. Estimates of mean bird use were used to compare differences among bird types, seasons, survey points. Mean use by season was calculated by summing the total number of birds seen within each plot during a visit, then averaging across plots within each visit, followed by averaging across visits within the season. Overall mean use was calculated as a weighted average of seasonal values by the number of days in each season.

Percent of use equals the relative proportion of use attributed to a particular bird type or species. Frequency of occurrence represents the percent of surveys in which a particular bird type or species was observed. For example, flocks of waterfowl, waterbirds, and shorebirds can comprise several dozen, hundred, or 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. Therefore, exposure to facility infrastructure is more accurately assessed by evaluating both percent of use and frequency of occurrence.

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

Bird Flight Height and Behavior

Bird flight heights are important metrics to assess relative exposure. Flight height information was used to calculate the percentage of birds observed flying within the likely rotor-swept height (RSH) for turbines used at the Project, defined here as 25–150 m (82–492 ft) AGL. The initial flight height recorded was used to calculate mean flight height. The percentage of birds flying within the RSH was determined based on initial flight height and based on all flight heights estimated during the observation.

Bird Exposure Index

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

$$R = A*P_f*P_t$$

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

Spatial Use

Large bird flight paths were qualitatively compared to study area characteristics (e.g., topographic features). The objective of mapping observed large bird locations and flight paths was to identify features or habitats that may be particularly attractive within the Project area. This information can be useful in turbine layout design or micro-siting individual turbines to reduce risk to birds.

RESULTS

Eagle/Large Bird Use Surveys

Bird Diversity and Species Richness

Two-hundred sixteen eagle/large bird use surveys were conducted over 12 visits from March 2017 through February 2018 (Table 2). Thirty-five unique large bird species were recorded over the study period. On average, large bird species richness was highest in spring (2.11 species/800-m plot/60-min survey), followed by fall (1.67), summer (0.89), and winter (0.20; Table 2).

During the large bird use surveys, 3,850 large birds were observed in 357 groups (Appendix A1). The most abundant large bird types recorded were waterfowl (1,769 observations in 96 groups) and gulls/terns (1,405 observations in 37 groups; Appendix A1). The higher number of waterfowl observations were driven mostly by observations of unidentified ducks (826 observations in 14 groups), mallard (*Anas platyrhynchos*; 292 observations in 31 groups), and Canada goose (*Branta canadensis*; 440 observations in 33 groups), primarily in the spring and fall (Appendix A1). The higher number of gull/tern observations were driven mostly by observations of ring-billed gull (*Larus delawarensis*; 1,142 observations in 17 groups) and Franklin's gull (*Leucophaeus pipixcan*; 246 observations in 16 groups; Appendix A1). A total of 104 diurnal raptor observations were recorded, including 53 observations of red-tailed hawks (*Buteo jamaicensis*), 9 bald eagles (*Haliaeetus leucocephalus*), a single golden eagle (*Aquila chrysaetos*), and a single peregrine falcon (*Falco peregrinus*; Appendix A1).

Table 2. Summary of large bird species richness (species/800-meter plot/60-minute survey), and sample size by season and overall during the fixed-point bird use surveys at the Three Waters Wind Farm from March 2017 through February 2018.

Season	Visits	Surveys Conducted	Unique Species	Large Bird Species Richness
Spring	3	54	32	2.11
Summer	3	54	12	0.89
Fall	3	54	24	1.67
Winter	3	54	7	0.20
Overall	**12**	**216**	**35**	**1.22**

Bird Use, Percent of Use, and Frequency of Occurrence

Overall large bird use was highest during spring (38.31 birds/800-m plot/60-min survey) and fall (29.11) compared to summer (3.33) and winter (0.46; Table 3, Appendix B1). Large bird use in spring was primarily composed of waterfowl (44.9%) and gulls/terns (42.3%; Table 3). In summer, large bird use was primarily waterfowl (58.9%), followed by vultures (16.1%) and waterbirds (13.9%). In fall, large bird use was primarily waterfowl (46.3%) and gulls/terns (33.6%). In winter, large bird use was primarily large corvids (48.0%), followed by waterfowl (24.0%) and diurnal raptors (24.0%).

Waterbirds

Waterbird use (observations/800-m plot/60-min survey) was recorded during spring (3.65), summer (0.46), and fall (3.91; Table 3). Waterbirds accounted for 9.5% of large bird use during spring, 13.9% during summer, and 13.4% during fall. Waterbirds were observed during 24.1% of spring surveys, 18.5% of summer surveys, and 16.7% of fall surveys.

Waterfowl

Waterfowl use (observations/800-m plot/60-min survey) was recorded during spring (17.20), summer (1.96), fall (13.48), and winter (0.11; Table 3). Waterfowl accounted for 44.9% of large bird use during spring, 58.9% during summer, 46.3% during fall, and 24.0% during winter. Waterfowl were observed during 40.7% of spring surveys, 14.8% of summer surveys, 22.2% of fall surveys, and 1.9% of winter surveys.

Shorebirds

Shorebird use was only recorded in the spring (0.07 observation/800-m plot/60-min survey; Table 3). Shorebirds use in spring was relatively low, accounting for 0.2% of large bird use. Shorebirds were observed during 5.6% of spring surveys.

Gulls/Terns

Gull/tern use (observations/800-m plot/60-min survey) was recorded during spring (16.20), summer (0.04), and fall (9.78; Table 3). Gulls/terns accounted for 42.3% of large bird use during spring, 1.1% during summer, and 33.6% during fall. Gulls/terns were observed during 14.8% of spring surveys, 3.7% of summer surveys, and 24.1% of fall surveys.

Diurnal Raptors

Diurnal raptor use (observations/800-m plot/60-min survey) was recorded during spring (0.59), summer (0.11), fall (1.04), and winter (0.11; Table 3). Diurnal raptors accounted for 1.5% of large bird use during spring, 3.3% during summer, 3.6% during fall, and 24.0% during winter. Diurnal raptors were observed during 42.6% of spring surveys, 11.1% of summer surveys, 46.3% of fall surveys, and 9.3% of winter surveys. Eagle use was recorded during spring (0.06 observation/800-m plot/60-min survey), fall (0.04), and winter (0.02), but not during the summer.

Vultures

Vulture use (observations/800-m plot/60-min survey) was recorded during spring (0.13), summer (0.54), and fall (0.17; Table 3). Vultures accounted for 0.3% of large bird use during spring, 16.1% during summer, and 0.6% during fall. Vultures were observed during 13.0% of spring surveys, 24.1% of summer surveys, and 13.0% of fall surveys.

Upland Game Birds

Upland game bird use (observations/800-m plot/60-min survey) was recorded during spring (0.11), summer (0.11), fall (0.04), and winter (0.02; Table 3). Upland game birds accounted for 0.3% of large bird use during spring, 3.3% during summer, 0.1% during fall, and 4.0% during winter. Upland game birds were observed during 11.1% of spring surveys, 5.6% of summer surveys, 1.9% of fall surveys, and 1.9% of winter surveys.

Doves/Pigeons

Dove/pigeon use was only recorded in the spring (0.19 observation/800-m plot/60-min survey; Table 3). Dove/pigeon use in spring was relatively low, accounting for 0.5% of large bird use. Doves/pigeons were observed during 1.9% of spring surveys.

Large Corvids

Large corvid use (observations/800-m plot/60-min survey) was recorded during spring (0.17), summer (0.11), fall (0.70), and winter (0.22; Table 3). Large corvids accounted for 0.4% of large bird use during spring, 3.3% during summer, 2.4% during fall, and 48.0% during winter. Large corvids were observed during 9.3% of spring surveys, 3.7% of summer surveys, 14.8% of fall surveys, and 5.6% of winter surveys.

Table 3. Mean large bird use (number of birds/800-m plot/60-minute survey), percent of total use (%), and frequency of occurrence (%) for each large bird type by season during the 60-minute fixed-point eagle/large bird use surveys at the Three Waters Wind Farm from March 2017 through February 2018.

	Mean Use				% of Use				% Frequency			
Type	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
Waterbirds	3.65	0.46	3.91	0	9.5	13.9	13.4	0	24.1	18.5	16.7	0
Waterfowl	17.20	1.96	13.48	0.11	44.9	58.9	46.3	24.0	40.7	14.8	22.2	1.9
Shorebirds	0.07	0	0	0	0.2	0	0	0	5.6	0	0	0
Gulls/Terns	16.20	0.04	9.78	0	42.3	1.1	33.6	0	14.8	3.7	24.1	0
Diurnal Raptors	0.59	0.11	1.04	0.11	1.5	3.3	3.6	24.0	42.6	11.1	46.3	9.3
Accipiters	*0.07*	*0*	*0.09*	*0*	*0.2*	*0*	*0.3*	*0*	*7.4*	*0*	*9.3*	*0*
Buteos	*0.28*	*0.07*	*0.78*	*0.07*	*0.7*	*2.2*	*2.7*	*16.0*	*18.5*	*7.4*	*31.5*	*5.6*
Northern Harrier	*0.06*	*0*	*0.07*	*0*	*0.1*	*0*	*0.3*	*0*	*5.6*	*0*	*7.4*	*0*
Eagles	*0.06*	*0*	*0.04*	*0.02*	*0.1*	*0*	*0.1*	*4.0*	*5.6*	*0*	*3.7*	*1.9*
Falcons	*0.13*	*0.04*	*0.06*	*0.02*	*0.3*	*1.1*	*0.2*	*4.0*	*11.1*	*3.7*	*3.7*	*1.9*
Vultures	0.13	0.54	0.17	0	0.3	16.1	0.6	0	13.0	24.1	13.0	0
Upland Game Birds	0.11	0.11	0.04	0.02	0.3	3.3	0.1	4.0	11.1	5.6	1.9	1.9
Doves/Pigeons	0.19	0	0	0	0.5	0	0	0	1.9	0	0	0
Large Corvids	0.17	0.11	0.70	0.22	0.4	3.3	2.4	48.0	9.3	3.7	14.8	5.6
Overall[a]	**38.31**	**3.33**	**29.11**	**0.46**	**100**	**100**	**100**	**100**				

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

Eagle Minutes

Following the ECPG guidance for eagle use surveys, a total of 33 bald eagle minutes were documented during 216 hours of observation time, with 6 minutes recorded in the ZOR and the majority of the minutes documented in spring (Tables 4a and 4b). The majority of eagle minutes in the ZOR (defined as the number of minutes eagles are observed flying within 800 m of the observer and below 200 m AGL) were recorded during May (3 eagle minutes in ZOR), followed by February, April, and September 2017 (1 eagle minutes in ZOR each; Table 4a). Eagles were documented flying in the ZOR at seven observation Points: 1, 2, 4, 7, 9, 13, and 18 (Table 4c); point 9 had the highest number of minutes observed in the ZOR (4 minutes), followed by point 1 and 7 (1 minute each). Bald eagle minutes in the ZOR per minute of survey were highest during spring (0.0012), followed by fall and winter (0.0003); no eagle flight minutes were recorded in summer (Table 4b).

Table 4a. Bald eagle observations attributable to bald eagle minutes and bald eagle minutes by month during 60-minute eagle surveys conducted at the Three Waters Wind Farm from March 2017 – February 2018.

Month	Total Bald Eagles Observed	Total Minutes Observed	Total Minutes in Zone of Risk[1]
January	0	0	0
February	1	3	1
March	0	0	0
April	2	11	1
May	4	15	3
June	0	0	0
July	0	0	0
August	0	0	0
September	1	1	1
October	1	3	0
November	0	0	0
December	0	0	0
Total	**9**	**33**	**6**

[1]Zone of Risk is the defined as flying behavior below 200 meters (m; 656 feet [ft]) and within 800 m (2,625 ft) of the survey location.

Table 4b. Bald eagle minutes documented in the zone of risk during 60-minute eagle surveys conducted in the Three Waters Wind Farm from March 2017 – February 2018.

Season	Bald Eagle Minutes in Zone of Risk	Survey Effort (hours)	Survey Effort (minutes)	Eagle Flight Min per Min Survey
Spring (03/01 – 05/31)	4	54	3,240	0.0012
Summer (06/01 – 08/31)	0	54	3,240	0.0000
Fall (09/01 – 11/30)	1	54	3,240	0.0003
Winter (12/01 – 02/28)	1	54	3,240	0.0003
Total	**6**	**216**	**12,960**	**0.0018**

Table 4c. Bald eagle minutes by point during 60-minute eagle surveys conducted at the Three Waters Wind Farm from March 2017 – February 2018.

Point	Total Minutes Observed	Minutes Flying In Zone of Risk[1]
1	4	1
2	3	0
3	0	0
4	2	0
5	0	0
6	0	0
7	3	1
8	0	0
9	14	4
10	0	0
11	0	0
12	0	0
13	4	0
14	0	0
15	0	0
16	0	0
17	0	0
18	3	0
Total	**33**	**6**

[1]Zone of Risk is defined as below 200 meters (m; 656 feet [ft]) and within 800 m (2,625 ft) of the survey location.

Bird Flight Height and Behavior

Flight height characteristics, based on initial flight height observations, and estimated use were calculated for bird types and species (Tables 5 and 6; Appendix C1). During fixed-point large bird surveys, 328 groups of large birds were documented flying within the 800-m plot, totaling 3,813 observations. Overall, 19.2% of flying large birds were recorded within the RSH (i.e., 25–150 m AGL), 27.1% were below the RSH, and 53.7% were above the RSH (Table 5). Most flying diurnal raptors (51.6%) were recorded within the RSH, while 27.5% were below the RSH and 20.9% were above the RSH. Diurnal raptor subtypes that tended to fly within the RSH included accipiters (66.7%) and buteos (57.6%; Table 5). Of the 6 bald eagles observed flying, 33.3% were within the RSH, 50.0% were above the RSH, and 16.7% were below the RSH (Table 5).

Table 5 Flight height characteristics by bird type and raptor subtype during 60-minute fixed-point eagle/large bird use surveys at the Three Waters Wind Farm from March 2017 through February 2018.

Bird Type	# Groups Flying	# Obs Flying	Mean Flight Height (m)	% Obs Flying	% within Flight Height Categories		
					0–25 m	25–150 m[a]	> 150 m
Waterbirds	46	433	165.02	100	7.4	16.9	75.8
Waterfowl	92	1,758	69.03	99.4	23.0	14.7	62.3
Gulls/Terns	37	1,405	123.89	100	34.3	23.4	42.3
Diurnal Raptors	87	91	102.94	91.0	27.5	51.6	20.9
Accipiters	*9*	*9*	*40.67*	*100*	*33.3*	*66.7*	*0*
Buteos	*55*	*59*	*125.42*	*90.8*	*16.9*	*57.6*	*25.4*
Northern Harrier	*7*	*7*	*73.71*	*100*	*42.9*	*42.9*	*14.3*
Eagles	*6*	*6*	*171.17*	*100*	*16.7*	*33.3*	*50.0*
Falcons	*10*	*10*	*14.90*	*76.9*	*80.0*	*20.0*	*0*
Vultures	35	43	90.17	95.6	51.2	32.6	16.3
Upland Game Birds	6	8	4.33	53.3	100	0	0
Doves/Pigeons	1	10	20.00	100	100	0	0
Large Corvids	24	65	24.00	100	75.4	16.9	7.7
Large Birds Overall	**328**	**3,813**	**95.30**	**99.1**	**27.1**	**19.2**	**53.7**

[a] The likely "rotor-swept height" for potential collision with a turbine blade, or 25 to 150 m (82 to 492 ft) above ground level.

m= meter, Obs = observations

Bird Exposure Index

A relative exposure index based on initial flight height observations and the use estimate was calculated for each large bird species (Appendix C1). Table 6 displays all species that had exposure to the RSH. Due to relatively high use and number of observations within the RSH, ring-billed gull had the highest exposure index value (1.16), followed by mallard (0.70), and Canada goose (0.47; Table 6). Bald eagle had an exposure index value of less than 0.01, based on six groups observed flying.

Table 6. Relative exposure index and flight characteristics for large bird species[a] during 60-minute fixed-point eagle/large bird use surveys at the Three Waters Wind Farm from March 2017 through February 2018.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within RSH[b] Based on Initial Observations	Exposure Index	% Within RSH at Anytime
Large Bird Species						
ring-billed gull	17	5.32	100	21.9	1.16	62.5
mallard	31	1.35	100	52.1	0.70	61.0
Canada goose	29	2.04	97.5	23.8	0.47	28.9
Franklin's gull	16	1.14	100	32.1	0.36	56.5
American white pelican	21	0.67	100	44.8	0.30	44.8
red-tailed hawk	45	0.25	90.6	58.3	0.13	70.8
turkey vulture	35	0.21	95.6	32.6	0.07	62.8
American crow	24	0.30	100	16.9	0.05	43.1
great blue heron	13	0.08	100	35.3	0.03	41.2
sharp-shinned hawk	8	0.04	100	75.0	0.03	75.0
rough-legged hawk	6	0.03	85.7	100	0.03	100
northern harrier	7	0.03	100	42.9	0.01	42.9
unidentified duck	14	3.85	100	0.2	<0.01	88.9
double-crested cormorant	10	1.24	100	0.7	<0.01	1.1
bald eagle	6	0.03	100	33.3	<0.01	50.0
American kestrel	7	0.05	70.0	14.3	<0.01	42.9
northern shoveler	2	0.01	100	33.3	<0.01	100
snow goose	3	0.58	100	0.8	<0.01	0.8
peregrine falcon	1	<0.01	100	100	<0.01	100

a. Only includes species with actual exposure index values; see Appendix C1 for full listing.

b. The likely “rotor-swept height” (RSH) for potential collision with a turbine blade, or 25 to 150 meters (82 to 492 feet) above ground level.

Spatial Use

Large bird use was recorded at all 18 survey points (Appendix D1). Large bird use ranged from 2.00 to 66.67 observations/60-min survey, with highest use at Point 10 (Appendix D1). The high use observed at Point 10 was largely due to high waterfowl use observed in the spring and fall (Appendix D1).

Waterbird use was recorded at 15 of the 18 survey points (Appendix D1). Waterbird use at the 15 points ranged from 0.08 to 14.75 observations/800-m plot/60-min survey, with highest use at Point 16. Waterfowl use was recorded at 16 of the 18 survey points (Appendix D1). Waterfowl use at the 16 points ranged from 0.17 to 65.75 observations/800-m plot/60-min survey, with highest use at Point 10. Shorebird use was recorded at three of the 18 survey points (Appendix D1). Shorebird use at the three points ranged from 0.08 to 0.17 observations/800-m plot/60-min survey, with highest use at Point 8. Gulls/tern use was recorded at 13 of the 18 survey points (Appendix D1). Gull/tern use at the 13 points ranged from 0.08 to 37.83 observations/800-m plot/60-min survey, with higher use at Point 8 (37.83) and Point 9 (33.33). Vulture use was recorded at 17 survey points (Appendix D1). Vulture use at the 17 points ranged from 0.08 to 1.08 observations/800-m plot/60-min survey, with highest use at Point 16. Upland game bird use was recorded at four of the 18 survey points (Appendix D1). Upland game bird use at the four points ranged from 0.17 to

0.50 observations/800-m plot/60-min survey, with highest use at Point 16. Doves/pigeon use was only recorded at Point 2 (Appendix D1). Dove/pigeon use at this point was 0.83 observations/800-m plot/60-min survey. Large corvid use was recorded at 11 of the 18 survey points (Appendix D1). Large corvid use at the 11 points ranged from 0.08 to 2.33 observations/800-m plot/60-min survey, with highest use at Point 6.

Diurnal raptor use was recorded at 17 of the 18 survey points (Appendix D1). Diurnal raptor use at the 17 points ranged from 0.08 to 1.17 observations/800-m plot/60-min survey, with highest use at Point 14. Eagle use was recorded at five survey points, with highest use (0.17) at Point 9 (Figure 5, Appendix D1). Flight paths and perch locations of diurnal raptor species were digitized and mapped (Figure 6). While all species of diurnal raptors observed were recorded as flying or perched, flight paths indicated no obvious movement corridors or areas of concentration. The available data (from observations, survey data, and habitats) suggests that overall large bird use is distributed throughout the Project area, with variability in large bird use among survey points, but there is no indication that any portions of the study area receive disproportionately high large bird use. These results suggest (Figure 6, Appendix D1).

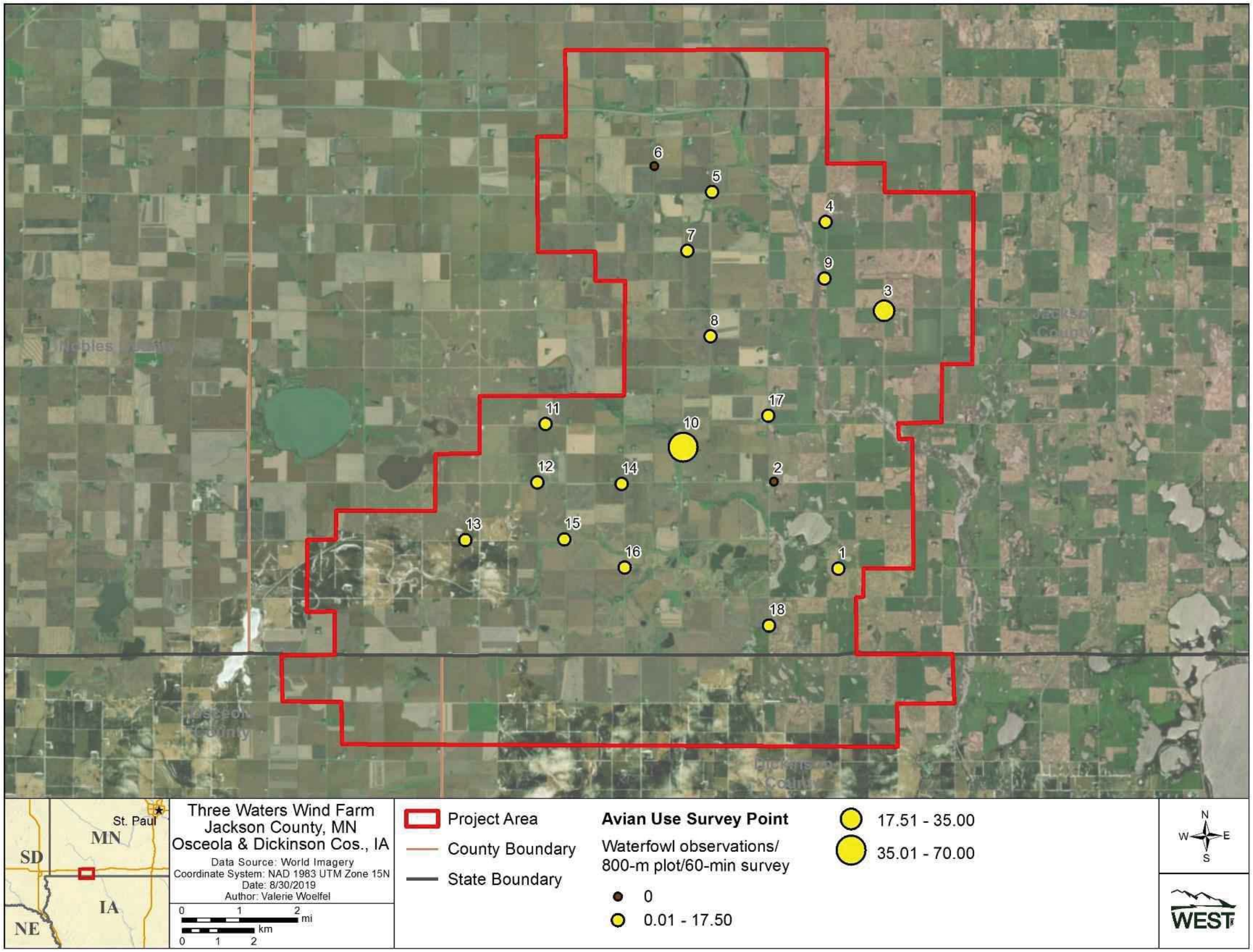

Figure 4a. Waterfowl use by observation point during 60-minute fixed-point eagle/large bird use surveys at the Three Waters Wind Farm from March 2017 through February 2018.

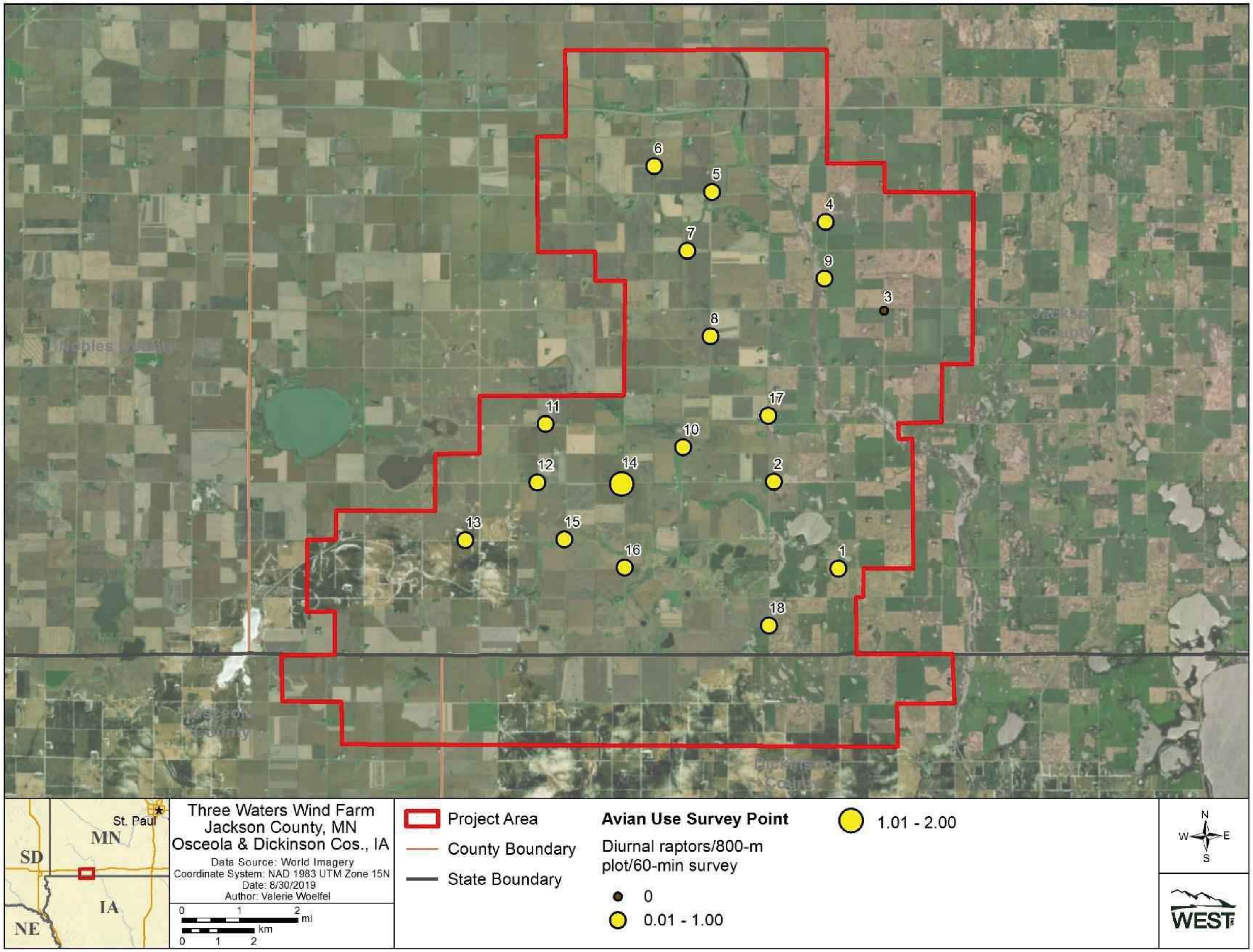

Figure 4b. Raptor use by observation point during 60-minute fixed-point eagle/large bird use surveys at the Three Waters Wind Farm from March 2017 through February 2018.

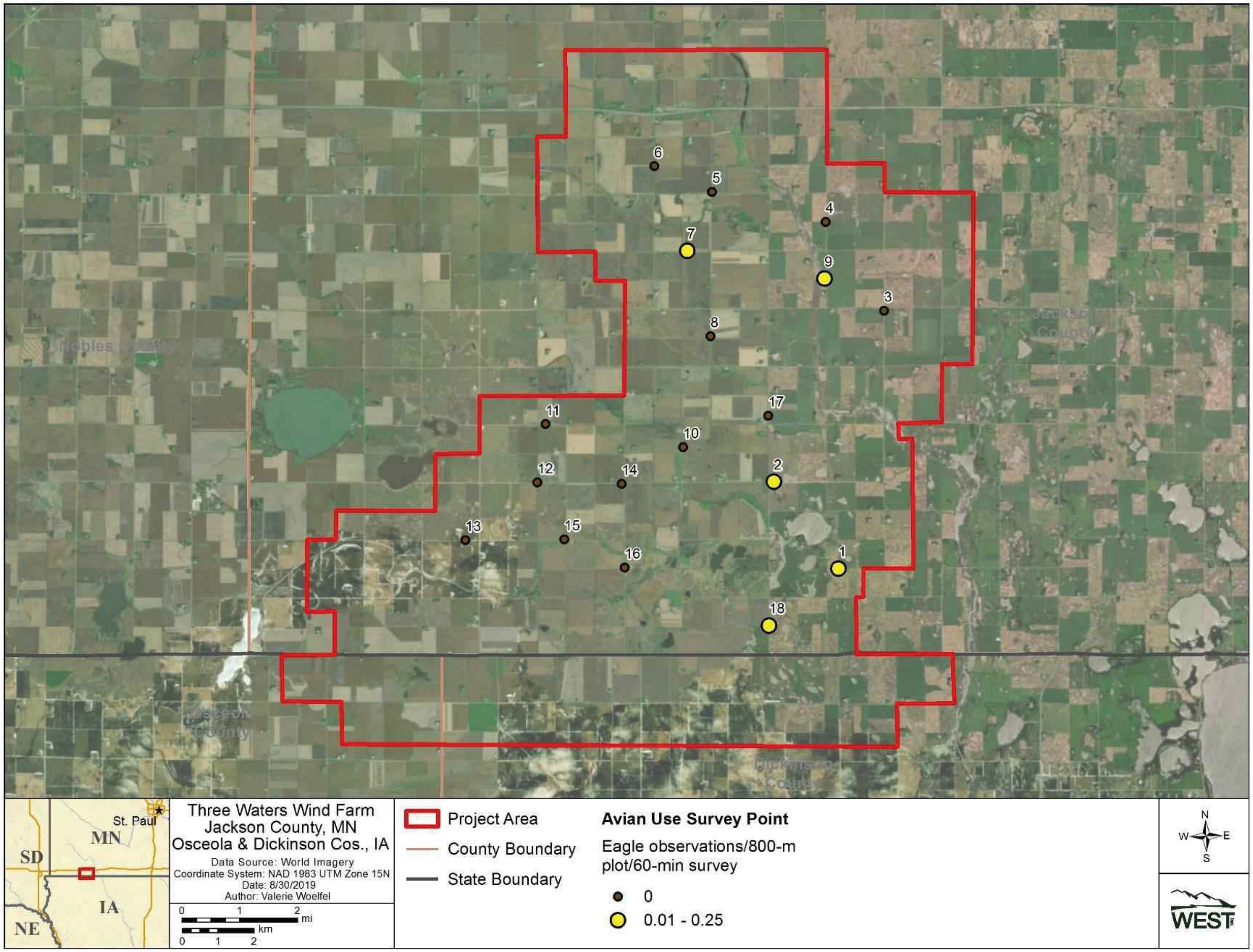

Figure 4c. Eagle use by observation point during 60-minute fixed-point eagle/large bird use surveys at the Three Waters Wind Farm from March 2017 through February 2018.

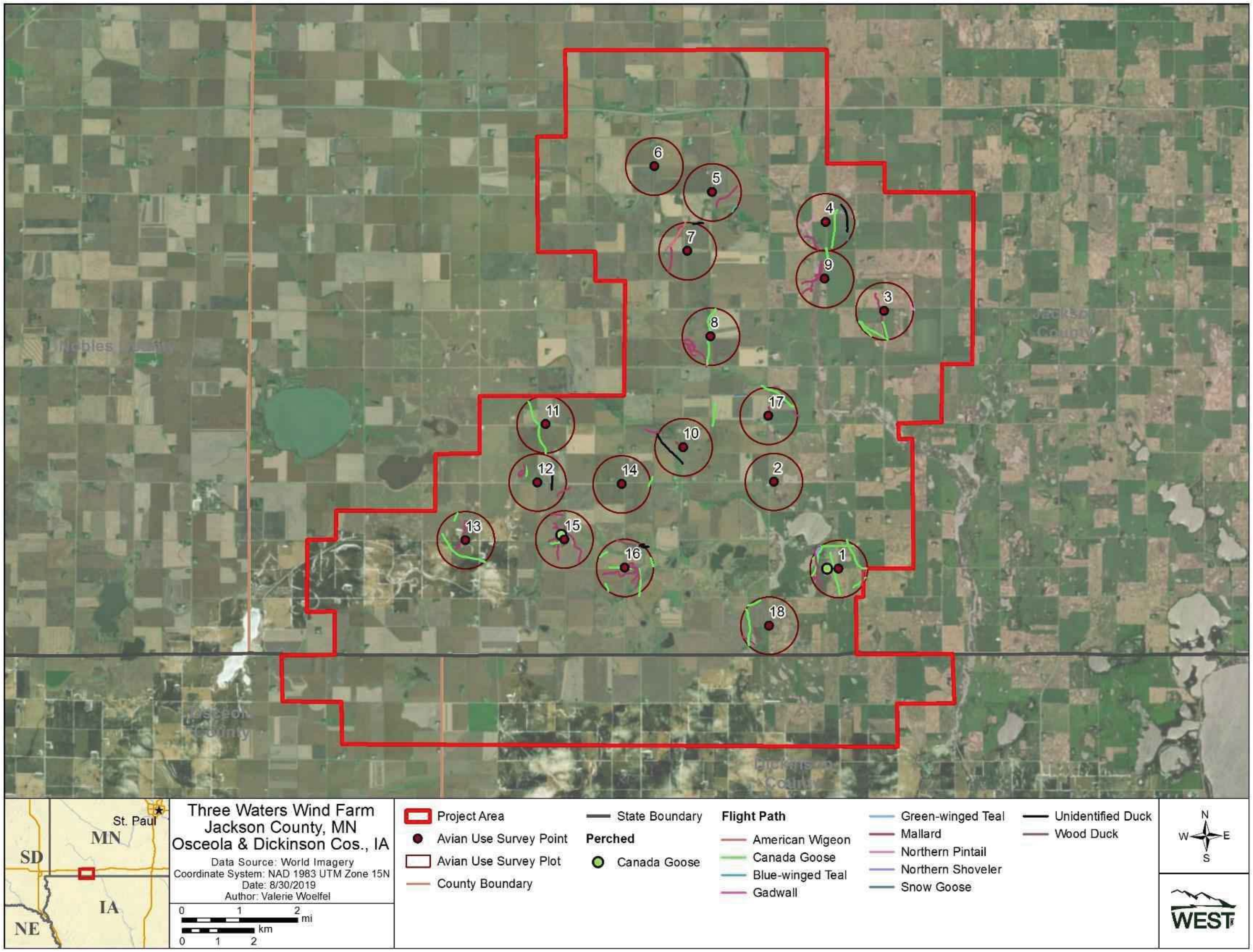

Figure 5a. Waterfowl flight paths recorded during 60-minute fixed-point eagle/large bird use surveys within the Three Waters Wind Farm from March 2017 through February 2018.

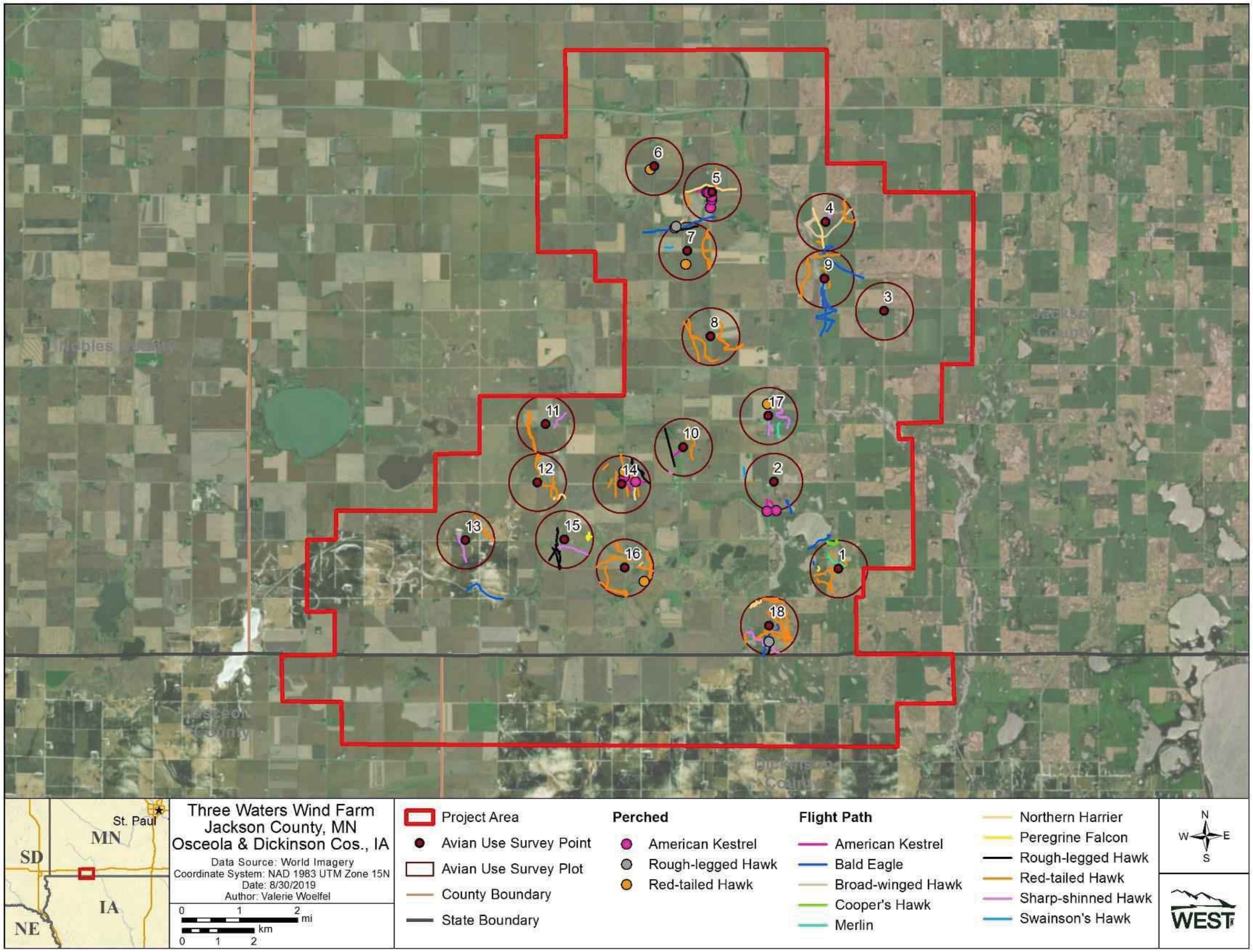

Figure 5b. Diurnal raptor flight paths recorded during 60-minute fixed-point eagle/large bird use surveys within the Three Waters Wind Farm from March 2017 through February 2018.

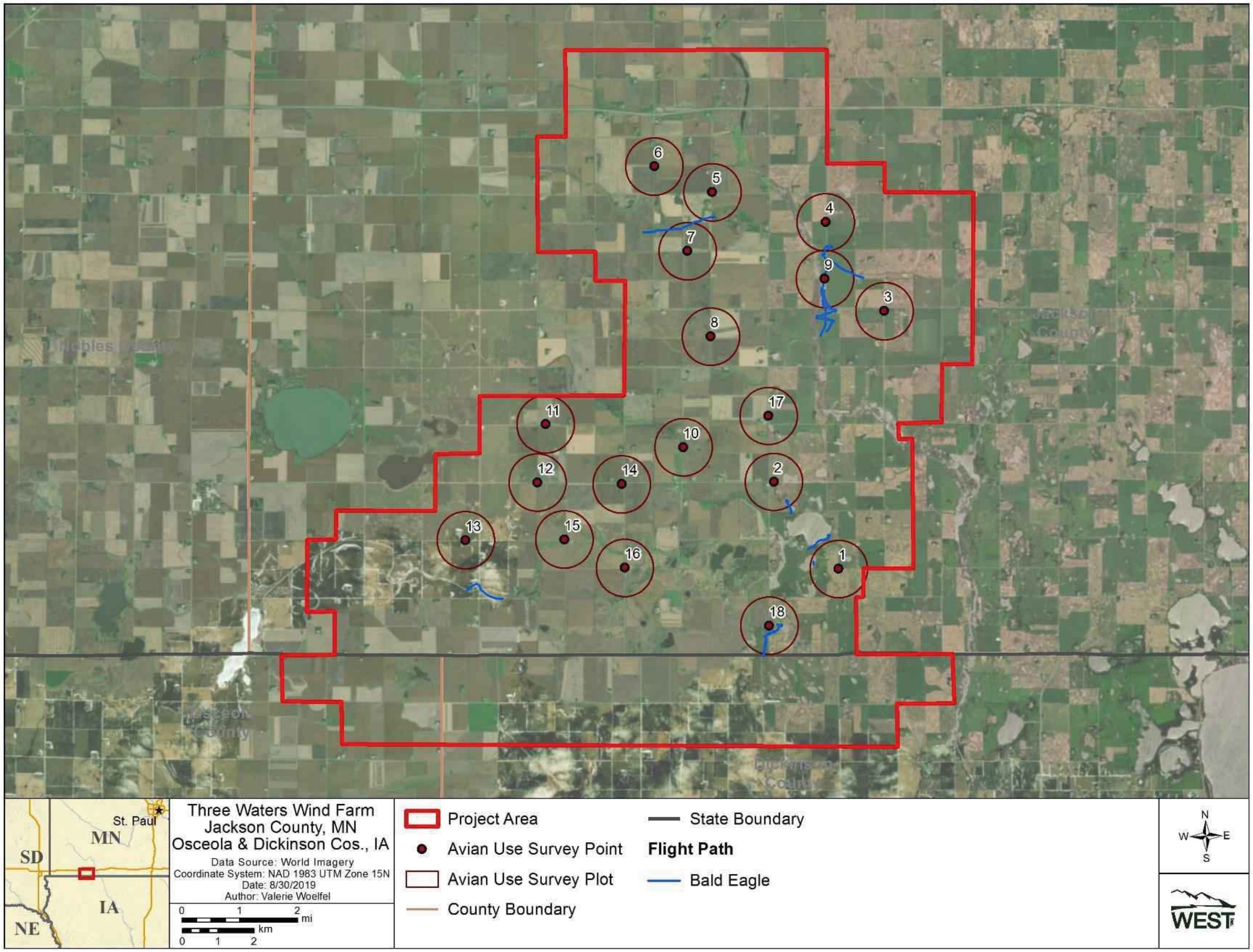

Figure 5c. Eagle flight paths recorded during 60-minute fixed-point eagle/large bird use surveys within the Three Waters Wind Farm from March 2017 through February 2018.

Small Bird Use Surveys

Bird Diversity and Species Richness

Forty-five small bird species were documented over the course of all fixed-point small bird use surveys (Table 7). A mean of 1.82 small bird species/100-m plot/10-min survey were recorded. The number of unique small bird species recorded was highest in summer (28), followed by spring (25), fall (25), and winter (6; Table 7). Small bird species richness (mean number of species/100-m plot/10-min survey) was highest during summer (3.35), followed by spring (2.31), fall (1.30), and winter (0.30; Table 7).

Table 7. Summary of small bird species richness (species/100-meter plot/10-minute survey), and sample size by season and overall during the fixed-point small bird use surveys at the Three Waters Wind Farm from March 2017 through February 2018.

Season	Number of Visits	# Surveys Conducted	# Unique Species	Small Bird Species Richness
Spring	3	54	25	2.31
Summer	3	54	28	3.35
Fall	3	54	25	1.30
Winter	3	54	6	0.30
Overall	**12**	**216**	**45**	**1.82**

Small bird surveys resulted in a total of 3,036 observations in 525 groups, with the greatest abundance of small birds recorded in the fall (Appendix A2). Most small bird observations were of unidentified blackbird (30.9%), red-winged blackbird (*Agelaius phoeniceus*; 23.5%), Lapland longspur (*Calcarius lapponicus*; 13.0%), and horned lark (*Eremophila alpestris*; 8.6%).

Bird Use, Percent of Use, and Frequency of Occurrence

Mean bird use, percent of use, and frequency of occurrence were calculated by season for all small bird types (Table 8) and species (Appendix B2). Small bird use consisted mostly of use by passerines, though use by swifts, woodpeckers, and kingfishers were also recorded. Overall, mean small bird use (birds/100-m plot/10-min survey) was highest in fall (29.78), followed by winter (11.11), summer (9.02), and spring (4.06; Table 7). Because small birds were documented within a 100-m viewshed during a 10-min observation period, descriptive statistics for small bird types are not directly comparable to large bird types.

In spring, small bird use consisted mostly of use by American robins (*Turdus migratorius*; 18.3%), brown-headed cowbirds (*Molothrus ater*; 17.4%), and red-winged blackbird (14.2%; Appendix B2). In summer, small bird use was primarily due to use by unidentified blackbird (18.5%), red-winged blackbird (18.3%), and barn swallow (*Hirundo rustica*; 11.9%; Appendix B2). In fall, small bird use was primarily unidentified blackbird (52.3%) and red-winged blackbird (29.5%; Appendix B2). In winter, small bird use was primarily due to use by Lapland longspur (65.8%) and horned lark (32.2%; Appendix B2).

Table 8. Mean small bird use (number of birds/100-m plot/10-minute survey), percent of total use (%), and frequency of occurrence (%) for each small bird type by season during the 10-minute fixed-point small bird use surveys at the Three Waters Wind Farm from March 2017 through February 2018.

	Mean Use				% of Use				% Frequency			
Type	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
Passerines	4.04	8.98	29.74	11.11	99.5	99.6	99.9	100	64.8	88.9	57.4	25.9
Swifts/Hummingbirds	0	0.04	0.02	0	0	0.4	<0.1	0	0	1.9	1.9	0
Woodpeckers	0	0	0.02	0	0	0	<0.1	0	0	0	1.9	0
Kingfishers	0.02	0	0	0	0.5	0	0	0	1.9	0	0	0
Overall[a]	**4.06**	**9.02**	**29.78**	**11.11**	**100**	**100**	**100**	**100**				

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

Bird Flight Height and Behavior

Flight height characteristics, based on initial flight height observations, and estimated use were calculated for small bird types and species (Table 9, Appendix C2). During fixed-point small bird surveys, 363 groups of small birds were documented flying within the 100-m plot, totaling 2,543 observations. Overall, 29.3% of flying small birds were recorded within the RSH (i.e., 25 – 150 m AGL), 69.1% were below the RSH, and 1.7% were above the RSH (Table 8). Most flying swifts (66.7%) were recorded within the RSH (Table 9).

Table 9. Flight height characteristics by bird type during 10-minute fixed-point small bird use surveys at the Three Waters Wind Farm from March 2017 through February 2018.

Bird Type	# Groups Flying	# Obs Flying	Mean Flight Height (m)	% Obs Flying	% within Flight Height Categories 0 - 25 m	25 - 150 m[a]	> 150 m
Passerines	360	2,539	18.09	87.3	69.2	29.2	1.6
Swifts/Hummingbirds	2	3	85.00	100	33.3	66.7	0
Woodpeckers	0	0	0	0	0	0	0
Kingfishers	1	1	180.00	100	0	0	100
Small Birds Overall[b]	**363**	**2,543**	**18.91**	**87.3**	**69.1**	**29.3**	**1.7**

[a] The likely "rotor-swept height" for potential collision with a turbine blade, or 25 to 150 m (82 to 492 ft) above ground level.

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

m=meters; Obs = observation

Bird Exposure Index

A relative exposure index based on initial flight height observations and the use estimate was calculated for each small bird species (Appendix C2). Lapland longspur had the highest exposure index value of all small bird species (1.60), followed by unidentified blackbird (0.59), snow bunting (*Plectrophenax nivalis*; 0.43), red-winged blackbird (0.28), and others (Table 10).

Table 10. Relative exposure index and flight characteristics for each small bird species during the 10-minute fixed-point small bird use surveys at the Three Waters Wind Farm from March 2017 through February 2018.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within RSH Based on Initial Observations	Exposure Index	% Within RSH at Anytime
Lapland longspur	2	1.80	89.9	98.6	1.60	98.6
unidentified blackbird	7	4.34	100	13.5	0.59	13.5
snow bunting	4	0.43	100	100	0.43	100
red-winged blackbird	61	2.75	96.6	10.4	0.28	16.0
tree swallow	17	0.26	98.2	87.5	0.23	87.5
horned lark	16	1.19	45.0	9.4	0.05	9.4
American robin	24	0.29	59.7	27.0	0.05	27.0
common grackle	59	0.42	95.6	10.3	0.04	13.8
barn swallow	44	0.36	100	10.3	0.04	15.4
American goldfinch	15	0.14	89.7	26.9	0.03	26.9
bobolink	4	0.04	62.5	80.0	0.02	80.0
cliff swallow	23	0.17	100	8.3	0.01	33.3
European starling	14	0.13	74.1	15.0	0.01	15.0
pine siskin	1	0.01	100	100	0.01	100
brown-headed cowbird	28	0.32	83.8	3.5	<0.01	3.5

Table 10. Relative exposure index and flight characteristics for each small bird species during the 10-minute fixed-point small bird use surveys at the Three Waters Wind Farm from March 2017 through February 2018.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within RSH Based on Initial Observations	Exposure Index	% Within RSH at Anytime
chimney swift	2	0.01	100	66.7	<0.01	100
palm warbler	2	<0.01	100	50.0	<0.01	50.0
eastern bluebird	1	<0.01	100	100	<0.01	100

[a.] Only includes species with actual exposure index values; see Appendix C2 for full listing.

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

Spatial Use

Small bird use was recorded at all 18 survey points, ranging from 1.67 to 62.17 birds/100-m plot/10-min survey (Appendix D2). Overall, small bird use was highest at Point 1 (62.17 birds/100-m plot/10-min survey) and Point 6 (46.25). Passerine use was reported at all points, ranging from 1.58 to 62.17, with the highest use reported at Point 1. All swift use was recorded at Point 2 (0.25 birds/100-m plot/10-min survey), all woodpecker use was recorded at Point 14 (0.08), and all kingfisher use was recorded at Point 15 (0.08; Appendix D2).

Sensitive Species Observations

While no federally listed species were recorded during the fixed-point bird use surveys, several species of concern were recorded during surveys or as incidental observations recorded outside standardized survey intervals (Table 11). Ten bald eagle observations and one golden eagle observation (*Aquila chrysaetos*) were recorded during Year 1 avian use surveys. In addition, the state-listed endangered Henslow's sparrow (*Ammodramus henslowii*) was recorded. Several other Minnesota Special Concern species and Species of Greatest Conservation Need were also recorded (Table 11), including larger numbers of observations of Franklin's gull and American white pelican (*Pelecanus erythrorhynchos*).

Table 11. Summary of sensitive species observed at the Three Waters Wind Farm during fixed-point use surveys (FP) and as incidental wildlife observations (Inc.) from March 2017 through February 2018.

			FP[a]		Inc.		Total	
Species	**Scientific Name**	**Status**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
American white pelican	*Pelecanus erythrorhynchos*	SGCN, SC	21	145	0	0	21	145
bald eagle	*Haliaeetus leucocephalus*	BGEPA, SGCN	9	9	1	1	10	10
black tern	*Chlidonias niger*	SGCN	1	12	0	0	1	12
bobolink	*Dolichonyx oryzivorus*	SGCN	7	8	0	0	7	8
dickcissel	*Spiza americana*	SGCN	12	12	0	0	12	12
eastern meadowlark	*Sturnella magna*	SGCN	1	1	0	0	1	1
field sparrow	*Spizella pusilla*	SGCN	1	1	0	0	1	1
Franklin's gull	*Leucophaeus pipixcan*	SGCN, SC	16	246	0	0	16	246
golden eagle	*Aquila chrysaetos*	BGEPA	1	1	0	0	1	1
Henslow's sparrow	*Ammodramus henslowii*	SE, SGCN	1	1	0	0	1	1
marsh wren	*Cistothorus palustris*	SGCN	2	2	0	0	2	2
northern harrier	*Circus cyaneus*	SGCN	7	7	2	2	9	9
northern pintail	*Anas acuta*	SGCN	3	58	0	0	3	58
peregrine falcon	*Falco peregrinus*	SGCN, SC	1	1	0	0	1	1
sedge wren	*Cistothorus platensis*	SGCN	5	5	0	0	5	5
semipalmated sandpiper	*Calidris pusilla*	SGCN	0	0	1	1	1	1
Swainson's hawk	*Buteo swainsoni*	SGCN	2	3	0	0	2	3
swamp sparrow	*Melospiza georgiana*	SGCN	2	2	0	0	2	2
upland sandpiper	*Bartramia longicauda*	SGCN	0	0	1	1	1	1
Total	**19 Species**		**92**	**514**	**5**	**5**	**97**	**519**

[a] FP data also shown in Appendix A1 (large birds) and Appendix B2 (small birds).

[b] BGEPA=Protected under the Bald and Golden Eagle Protection Act (1940); SE=State-listed as Endangered in Minnesota (Minnesota Department of Natural Resources [MDNR]); SC=State-listed as Special Concern in Minnesota (MDNR 2013); SGCN=Species of Greatest Conservation Need in Minnesota (MDNR 2006)

Incidental Observations

Four bird species were recorded as incidental observations outside of standard surveys (Table 12). These species were recorded outside of fixed-point surveys because they are listed as Species of Greatest Conservation Need (MDNR 2006).

Table 12. Incidental wildlife observed while conducting all surveys at the Three Waters Wind Farm from March 2017 through February 2018.

Species	Scientific Name	# grps	# obs
bald eagle	*Haliaeetus leucocephalus*	1	1
northern harrier	*Circus cyaneus*	2	2
semipalmated sandpiper	*Calidris pusilla*	1	1
upland sandpiper	*Bartramia longicauda*	1	1
Total		**5**	**5**

DISCUSSION

Potential Impacts

Wind energy facilities can impact wildlife resources both directly and indirectly. Direct impacts include fatalities from construction and operation of the wind energy facility, including collision mortality and habitat loss/fragmentation caused by infrastructure placement. Indirect impacts may include long-term changes in breeding potential, fecundity, and reproductive potential to individuals directly affected by facility operations.

Project construction could affect birds from direct noise (i.e., avoidance), habitat loss, or fatalities from construction equipment. However, potential mortality from construction equipment would be expected to be relatively low, as equipment used in wind energy facility construction generally moves at slow rates or is stationary for long periods (e.g., cranes). The highest risk of direct mortality to birds during construction is most likely the potential destruction of nests of ground- and shrub-nesting species during initial site clearing. Mortality or injury from collisions with wind turbines or guy wires of meteorological (met) towers during project operation are the most probable direct impact to birds from wind energy facilities.

Post-construction fatality monitoring results from other wind energy projects in the Midwest have shown varying levels of bird mortality (Appendix E1). The Wessington Springs facility in South Dakota had the highest estimated bird mortality rate in the Midwest (8.25 bird fatalities/MW/year; Derby et al. 2010).

Behavioral displacement (i.e., avoidance) may lead to decreased habitat suitability for local populations. Birds displaced by wind energy development may move to lower quality habitat with fewer disturbances, with an overall effect of reducing breeding success (USFWS 2012). Behavioral avoidance may render much larger areas unsuitable or less suitable for some wildlife species, depending on how far each species is displaced from wind energy facilities. Although habitat fragmentation would be a direct effect to area wildlife, other future indirect effects from fragmentation could include increased predation and intra- and inter-species competition, potentially impacting the survivorship and reproductive ability of birds in the vicinity of the wind energy facility. Some studies suggest displacement effects associated with wind energy may have a greater impact than collision mortality (Gill et al. 1996, Pearce-Higgins et al. 2012).

The greatest concern for indirect impact of wind energy facilities on wildlife resources is where these facilities have been constructed in native vegetation communities, such as grasslands or shrub steppe that provide comparatively rare, high-quality habitat for some bird species and species of concern (USFWS 2012). Most of the Project area is cultivated crops (21,411.7 ha [52,910.4 ac]), with an estimated 735.9 ha (1,818.5 ac) of developed open space, and 335.5 ha (829.0 ac) of herbaceous land cover (Table 1). Siting turbines and other infrastructure in cultivated areas and other non-native or previously disturbed landscapes would reduce the potential for habitat fragmentation and displacement of birds or other wildlife species.

Bird Types of Concern

Most of the bird species observed during this study are not of conservation concern and represent species relatively common for the region. The following section provides more information on groups of birds that have been documented as being at risk of impacts from wind projects in general and were observed at the Project relatively frequently.

Waterfowl

Waterfowl use at the Project varied seasonally, with greatest use observed in spring and fall (Appendix B1). Waterfowl use in spring was largely attributed to unidentified ducks. In fall, waterfowl use was primarily attributed to Canada geese, mallards, and snow geese. Based on available evidence, waterfowl do not seem especially vulnerable to turbine collisions. In an analysis of 116 studies of bird mortality at over 70 facilities, waterfowl made up 2.7% of 4,975 fatalities found (Erickson et al. 2014). In a database of 208 publicly available fatality studies, 207 waterfowl fatalities out of 7,993 total fatalities (2.6% of the total fatalities) were documented.

Diurnal Raptors

<u>Use Comparison</u>

Annual mean diurnal raptor use at the Project, standardized to 20-min survey periods for comparison (0.17 raptor/plot/20-min survey) was compared with 48 other wind energy facilities that implemented similar protocols and had data for at least three seasons (Figure 7). The annual mean diurnal raptor use at these wind energy facilities ranged from 2.34 to 0.06 raptors/800-m plot/20-min survey (Figure 7). Annual mean diurnal raptor use at the Project was relatively low, ranking 42nd out of the 49 wind energy facilities (Figure 7).

<u>Exposure Index Analysis</u>

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 at the highest exposure to risk of collisions. However, this index does not take into consideration bird behavior (e.g., foraging, courtship), flight speed, size, ability to detect and avoid turbines, and other factors that may vary among species and influence turbine collision risk. For these reasons, the exposure index is only a relative index of collision risk among species.

At the Three Waters Project, ring-billed gulls had the greatest exposure (1.16). The diurnal raptor species with the highest relative exposure index was red-tailed hawk (0.13). Other raptors with exposure indices above zero were sharp-shinned hawk (0.03), rough-legged hawk (0.03), northern harrier (0.01), bald eagle (<0.01), American kestrel (<0.01), and peregrine falcon (<0.01; Appendix C1). Based on the relative abundance of red-tailed hawk and a relatively higher exposure index than other raptor species during the studies at the Project, there is higher potential for red-tailed hawk fatalities, compared to other raptor species.

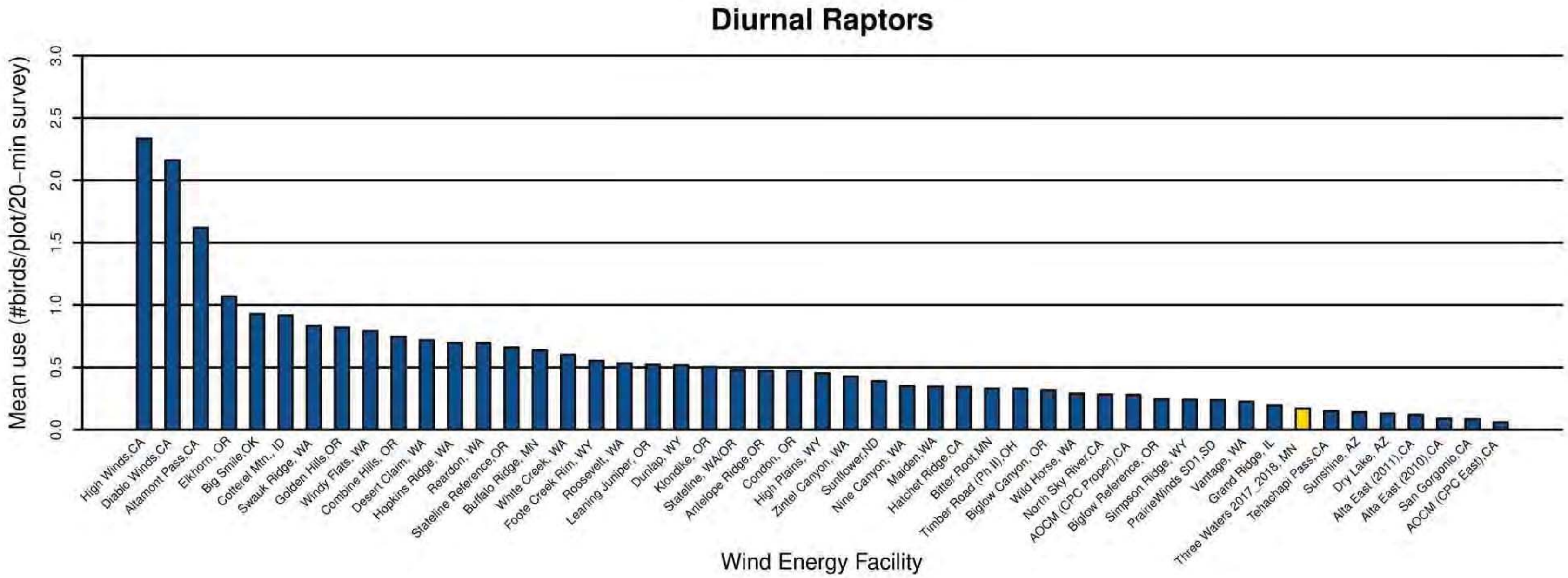

Figure 7. Comparison of estimated annual diurnal raptor use during fixed-point bird use surveys at the Three Waters Farm from March 2017 through February 2018 and diurnal raptor use at other US wind resource areas.

Data from the following sources:

Study and Location	Reference	Study and Location	Reference	Study and Location	Reference
Three Waters 2017_2018, MN, IA	This study.				
High Winds, CA	Kerlinger et al. 2005	Foote Creek Rim, WY	Johnson et al. 2000b	Wild Horse, WA	Erickson et al. 2003d
Diablo Winds, CA	WEST 2006	Roosevelt, WA	NWC and WEST 2004	North Sky River, CA	Erickson et al. 2011
Altamont Pass, CA	Orloff and Flannery 1992	Leaning Juniper, OR	Kronner et al. 2005	AOCM (CPC Proper), CA	Chatfield et al. 2010
Elkhorn, OR	WEST 2005a	Dunlap, WY	Johnson et al. 2009a	Biglow Reference, OR	WEST 2005c
Big Smile (Dempsey), OK	Derby et al. 2010c	Klondike, OR	Johnson et al. 2002	Simpson Ridge, WY	Johnson et al. 2000b
Cotterel Mtn., ID	BLM 2006	Stateline, WA/OR	Erickson et al. 2003b	Vantage, WA	Jeffrey et al. 2007
Swauk Ridge, WA	Erickson et al. 2003c	Antelope Ridge, OR	WEST 2009	Grand Ridge, IL	Derby et al. 2009
Golden Hills, OR	Jeffrey et al. 2008	Condon, OR	Erickson et al. 2002b	Tehachapi Pass, CA	Anderson et al. 2000, Erickson et al. 2002b
Windy Flats, WA	Johnson et al. 2007	High Plains, WY	Johnson et al. 2009b	Sunshine, AZ	WEST and the CPRS 2006
Combine Hills, OR	Young et al. 2003a	Zintel Canyon, WA	Erickson et al. 2002a, 2003a	Dry Lake, AZ	Young et al. 2007a
Desert Claim, WA	Young et al. 2003b	Nine Canyon, WA	Erickson et al. 2001a	Alta East (2011), CA	Chatfield et al. 2011

Hopkins Ridge, WA	Young et al. 2003c	Maiden, WA	Young et al. 2002	Alta East (2010), CA	Chatfield et al. 2011
Reardon, WA	WEST 2005b	Hatchet Ridge, CA	Young et al. 2007b	San Gorgonio, CA	Anderson et al. 2000, Erickson et al. 2002b
Stateline Reference, OR	URS et al. 2001	Bitter Root. MN	Derby and Dahl 2009	AOCM (CPC East), CA	Chatfield et al. 2010
Buffalo Ridge, MN	Johnson et al. 2000a	Timber Road (Phase II), OH	Good et al. 2010		
White Creek, WA	NWC and WEST 2005	Biglow Canyon, OR	WEST 2005c		

Fatality Studies

Diurnal raptor fatality estimates at 139 wind energy facilities across the US averaged 0.11 raptor fatalities/MW/year. In the Midwest, raptor fatality rates from 36 studies averaged 0.07 fatalities/MW/year (Appendix E). One comparison of 14 studies resulted in a combined raptor fatality rate of 0.04 fatalities/MW/year and reported that diurnal raptors and vultures accounted for 6% of fall bird fatalities (NRC 2007). In a review of 31 studies, Erickson et al. (2001) reported that 2.7% of carcasses found were diurnal raptors.

Use Versus Fatality Rates

Results from several studies suggest that mortality for some bird species is not necessarily related to abundance and can vary widely among facilities. For example, American kestrel (*Falco sparverius*) use at High Winds Energy Center in California was nearly seven times higher than that recorded at the Altamont Pass Wind Farm (Kerlinger et al. 2005), yet American kestrel mortality at Altamont was nearly seven times higher than at High Winds (Kerlinger et al. 2006, Altamont Pass Avian Monitoring Team 2008). Relatively few northern harrier fatalities have been reported in publicly available documents, despite the fact they are commonly observed during fixed-point bird counts at these facilities (Erickson et al. 2001a, Whitfield and Madders 2006, Smallwood and Karas 2009). Northern harriers typically fly close to the ground (MacWhirter and Bildstein 1996), with some studies reporting up to 97% of flights below 20 m (66 ft; Madders and Whitfield 2006); therefore, risk of collision with turbine blades is considered low for this species (Whitfield and Madders 2005, Madders and Whitfield 2006).

Comparable pre-construction raptor use and post-construction raptor mortality data are available for several studies at new-generation wind energy facilities, resulting in 34 pairs of raptor use with fatality data (see Appendix E2). Of these, 16 pairings were from studies at facilities classified as having relatively low raptor use (less than 0.5 raptor/800-m plot/20-min survey), 13 were classified as having low to moderate raptor use (between 0.5 and 1.0), and five were classified as having moderate or high raptor use (more than 1.0). Due to the relatively low sample size and other biological factors that can influence raptor fatality rates as discussed above, it is not known if the relationship between raptor use and fatality rates is a simple linear relationship. Additionally, mortality estimation for wind resource areas with moderate to high raptor use is subject to greater uncertainty due to a lack of available data, as few wind resource areas have had moderate or high pre-construction raptor use estimates. Variation in species composition is likely to influence overall raptor mortality; however, data are not available at this time to perform species-specific regression analyses.

WEST used the available data to assess risk to raptors by examining the mean and range of mortality for wind energy facilities. Because the proposed Project has relatively low raptor use, the Project is expected to result in low raptor fatality rates compared to other wind energy facilities (Appendix E2).

Migratory Behavior

Most diurnal raptor species in North America exhibit some degree of latitudinal or elevational migration during the spring and fall seasons (Bildstein 2006). Migrating raptors are known to concentrate along linear topographic features such as coastlines, rivers, and ridges, particularly where linear features are oriented within approximately 45 degrees of the optimal flight direction (Richardson 2000). Although the Project area does not include any prominent topographic features that would attract large concentrations of migratory raptors, use of the Project area by diurnal raptors was greatest during spring and fall indicating that the Project is within the migratory pathway of some diurnal raptors (Appendix B1).

Eagles

While bald eagles reside in Minnesota year-round, they are more abundant during migration and winter (eBird 2018). All bald eagles observations made during this study occurred during spring, fall, and winter, suggesting that the Project area is used mostly by non-resident bald eagles outside of the breeding season. Golden eagles are only observed in Minnesota at low rates during migration and winter (eBird 2018). The only golden eagle observed during this study was recorded during spring.

Passerines

Small-sized passerines composed about 62.5% of wind turbine fatalities in 116 studies included in a recent analysis (Erickson et al. 2014). A total of 3,110 fatalities represented by 156 species of small passerines were found during the studies. From this, it was estimated about 134,000 to 230,000 fatalities of small passerines occurred each year in the US and Canada combined, a rate of 2.10 to 3.35 small birds/MW of installed capacity. In comparison, researchers estimated that over six million passerines were killed annually from collisions with communication towers (passerines composed 97% of all fatalities; Longcore et al. 2012, Longcore and Smith 2013). However, population-level effects due to turbine collision fatalities have not been detected (Arnold and Zink 2011, Erickson et al. 2014). Specific to the Project, passerines would likely represent the majority of bird fatalities during project operation, given the results of avian surveys completed to date. However, no federally-listed species and only a single state listed observation were recorded in 225 surveys at the Project, and passerine fatalities at the Project would be expected to be spread out among multiple species (similar to what is observed at facilities throughout the US); therefore no regional or population-level effects are anticipated.

At the Combine Hills facility in Oregon, western meadowlark use of areas within 150 m (492 ft) of turbines was reduced by about 86%, compared to a 12.6% reduction in use of reference areas over the same time period (Young et al. 2006). Horned larks, however, showed significant increases in use of areas near turbines at both the Stateline and the Combine Hills facilities, possibly because the cleared turbine pads and access roads provided habitat preferred by this species. Leddy et al. (1999) surveyed bird densities in Conservation Reserve Program grasslands at the Buffalo Ridge wind energy facility in Minnesota and found the mean densities of 10 grassland bird species were four times higher in areas located 180 m (591 ft) from turbines than they were in grasslands closer to turbines. Johnson et al. (2000a) found reduced use of habitat within 100 m of turbines by seven of 22 grassland-breeding birds following construction of the

Buffalo Ridge facility in southwest Minnesota, and Osborn et al. (1998) reported birds at Buffalo Ridge avoided flying in areas with turbines. At a wind energy facility in Cooke County, Texas, no evidence of displacement by turbines was reported for four species of wintering grassland birds (eastern meadowlark, western meadowlark, Savannah sparrow, and Sprague's pipit [*Anthus spragueii*]). At the same time, significant evidence of displacement at distances up to 400 m (1,312 ft) was recorded for a fifth species, Le Conte's sparrow (*Ammodramus leconteii*; Stevens et al. 2013). Nest survival for red-winged blackbirds, a habitat generalist, was not affected by proximity to turbines in a controlled study in central Iowa (Gillespie and Dinsmore 2014).

Researchers concluded that nesting success for shrub-nesting birds, grassland-nesting birds, and the scissor-tailed flycatcher was not related to the distance of nests from wind turbines at a wind energy facility in Cooke County, Texas (Rubenstahl et al. 2012, Hatchett et al. 2013, Bennett et al. 2014, Hale et al. 2014). Study species included the white-eyed vireo (*Vireo griseus*), blue-gray gnatcatcher (*Polioptila caerulea*), northern cardinal (*Cardinalis cardinalis*), painted bunting (*Passerina ciris*), and lark sparrow (*Chondestes grammacus*), all which nest in shrubby habitats, as well as the prairie species dickcissel (*Spiza americana*) and grasshopper sparrow. Stevens et al. (2013) reported no evidence of displacement for three of four species of wintering grassland birds at the Cooke County facility, including Sprague's pipit, Savannah sparrow, and meadowlarks, while Le Conte's sparrow was significantly more likely to occur at distances of at least 200 m (656 ft) from turbines. However, no data were collected before the facility was constructed and the effect of vegetation characteristics, which may influence breeding densities, was not addressed.

CONCLUSIONS

These baseline (Tier 3) studies provided site-specific data that, when combined with available literature, allowed for a better-informed assessment of the risk of significant adverse impacts to species of concern at the Three Waters Wind Farm. Raptor use at the Project was within the range of use levels recorded at other wind energy facilities throughout the US. While a correlation between diurnal raptor use and mortality rates due to collision with wind turbines has not been observed in the region, diurnal raptor fatality rates will likely be within the range of fatality rates observed at other facilities where raptor use levels were low. Based on greater use during spring and fall, collision risk for diurnal raptors is likely highest during migration. To date, no relationships have been observed between overall use by other bird types and fatality rates of those bird types at wind energy facilities. However, the flight characteristics, breeding, and foraging habits of some species may result in increased exposure for these species in the Project area. Bald eagles were only recorded during spring, fall, and winter and risk to bald eagles is likely low-moderate overall. While one golden eagle was observed at the Project, risk to golden eagles is considered low and limited to rare individuals that may pass through the area during migration. A second year of eagle use surveys is being conducted and eagle risk will be further evaluated once that information is available.

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Appendix A. All Bird Types and Species Observed at the Three Waters Wind Farm during Fixed-Point Bird Use Surveys from March 2017 through February 2018

Appendix A1. Summary of individual and group observations by bird type and species for 60-minute fixed-point eagle/large bird use surveys[a] at the Three Waters Wind Farm [b] from March 2017 through February 2018.

		Spring		Summer		Fall		Winter		Total	
Type/Species	Scientific Name	# grps	# obs	# grps	# obs	# grps	# obs	# grps	# obs	# grps	# obs
Waterbirds		**21**	**197**	**15**	**25**	**10**	**211**	**0**	**0**	**46**	**433**
American white pelican	*Pelecanus erythrorhynchos*	11	85	5	12	5	48	0	0	21	145
double-crested cormorant	*Phalacrocorax auritus*	4	104	2	2	4	162	0	0	10	268
great blue heron	*Ardea herodias*	4	5	8	11	1	1	0	0	13	17
sandhill crane	*Antigone canadensis*	2	3	0	0	0	0	0	0	2	3
Waterfowl		**61**	**929**	**11**	**106**	**23**	**728**	**1**	**6**	**96**	**1,769**
American wigeon	*Anas americana*	1	4	0	0	1	7	0	0	2	11
blue-winged teal	*Anas discors*	1	1	0	0	0	0	0	0	1	1
Canada goose	*Branta canadensis*	14	34	6	92	12	308	1	6	33	440
gadwall	*Anas strepera*	1	3	0	0	0	0	0	0	1	3
green-winged teal	*Anas crecca*	1	1	0	0	0	0	0	0	1	1
mallard	*Anas platyrhynchos*	24	66	4	12	3	214	0	0	31	292
northern pintail	*Anas acuta*	1	1	0	0	2	57	0	0	3	58
northern shoveler	*Anas clypeata*	1	2	0	0	1	1	0	0	2	3
snow goose	*Chen caerulescens*	2	15	0	0	1	110	0	0	3	125
unidentified duck		11	795	1	2	2	29	0	0	14	826
wood duck	*Aix sponsa*	4	7	0	0	1	2	0	0	5	9
Shorebirds		**3**	**4**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**4**
killdeer	*Charadrius vociferus*	3	4	0	0	0	0	0	0	3	4
Gulls/Terns		**10**	**875**	**2**	**2**	**25**	**528**	**0**	**0**	**37**	**1,405**
black tern	*Chlidonias niger*	1	12	0	0	0	0	0	0	1	12
Franklin's gull	*Leucophaeus pipixcan*	0	0	1	1	15	245	0	0	16	246
herring gull	*Larus argentatus*	1	3	0	0	2	2	0	0	3	5
ring-billed gull	*Larus delawarensis*	8	860	1	1	8	281	0	0	17	1,142
Diurnal Raptors		**34**	**36**	**6**	**6**	**54**	**56**	**6**	**6**	**100**	**104**
Accipiters		*4*	*4*	*0*	*0*	*5*	*5*	*0*	*0*	*9*	*9*
Cooper's hawk	*Accipiter cooperii*	1	1	0	0	0	0	0	0	1	1
sharp-shinned hawk	*Accipiter striatus*	3	3	0	0	5	5	0	0	8	8
Buteos		*13*	*15*	*4*	*4*	*40*	*42*	*4*	*4*	*61*	*65*
broad-winged hawk	*Buteo platypterus*	2	2	0	0	0	0	0	0	2	2
red-tailed hawk	*Buteo jamaicensis*	10	11	4	4	35	37	1	1	50	53
rough-legged hawk	*Buteo lagopus*	0	0	0	0	4	4	3	3	7	7
Swainson's hawk	*Buteo swainsoni*	1	2	0	0	1	1	0	0	2	3

Appendix A1. Summary of individual and group observations by bird type and species for 60-minute fixed-point eagle/large bird use surveys[a] at the Three Waters Wind Farm [b] from March 2017 through February 2018.

		Spring		Summer		Fall		Winter		Total	
Type/Species	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Northern Harrier		*3*	*3*	*0*	*0*	*4*	*4*	*0*	*0*	*7*	*7*
northern harrier	*Circus cyaneus*	3	3	0	0	4	4	0	0	7	7
Eagles		*7*	*7*	*0*	*0*	*2*	*2*	*1*	*1*	*10*	*10*
bald eagle	*Haliaeetus leucocephalus*	6	6	0	0	2	2	1	1	9	9
golden eagle	*Aquila chrysaetos*	1	1	0	0	0	0	0	0	1	1
Falcons		*7*	*7*	*2*	*2*	*3*	*3*	*1*	*1*	*13*	*13*
American kestrel	*Falco sparverius*	6	6	2	2	2	2	0	0	10	10
merlin	*Falco columbarius*	1	1	0	0	0	0	1	1	2	2
peregrine falcon	*Falco peregrinus*	0	0	0	0	1	1	0	0	1	1
Vultures		**7**	**7**	**21**	**29**	**9**	**9**	**0**	**0**	**37**	**45**
turkey vulture	*Cathartes aura*	7	7	21	29	9	9	0	0	37	45
Upland Game Birds		**6**	**6**	**4**	**6**	**2**	**2**	**1**	**1**	**13**	**15**
ring-necked pheasant	*Phasianus colchicus*	6	6	4	6	2	2	1	1	13	15
Doves/Pigeons		**1**	**10**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**10**
rock pigeon	*Columba livia*	1	10	0	0	0	0	0	0	1	10
Large Corvids		**8**	**9**	**3**	**6**	**10**	**38**	**3**	**12**	**24**	**65**
American crow	*Corvus brachyrhynchos*	8	9	3	6	10	38	3	12	24	65
Overall	***NA***	**151**	**2073**	**62**	**180**	**133**	**1572**	**11**	**25**	**357**	**3,850**

[a] Data from all 18 avian use points included.

[b] Regardless of distance from observer.

grps = groups of observqations, obs = individual observations

Appendix A2. Summary of individuals and group observations by bird type and species for 10-minute fixed-point small bird use surveys[a] at the Three Waters Wind Farm [b] from March 2017 through February 2018.

		Spring		Summer		Fall		Winter		Total	
Type/Species	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Passerines		**169**	**340**	**247**	**485**	**86**	**1,606**	**19**	**600**	**521**	**3,031**
American goldfinch	*Spinus tristis*	3	4	11	18	4	7	0	0	18	29
American robin	*Turdus migratorius*	33	44	10	11	3	11	0	0	46	66
American tree sparrow	*Spizelloides arborea*	0	0	0	0	1	3	2	4	3	7
bank swallow	*Riparia riparia*	0	0	1	1	0	0	0	0	1	1
barn swallow	*Hirundo rustica*	7	8	33	58	4	12	0	0	44	78
blue jay	*Cyanocitta cristata*	1	2	0	0	0	0	0	0	1	2
bobolink	*Dolichonyx oryzivorus*	5	5	2	3	0	0	0	0	7	8
brown-headed cowbird	*Molothrus ater*	24	38	11	30	0	0	0	0	35	68
chipping sparrow	*Spizella passerina*	2	2	4	4	0	0	0	0	6	6
clay-colored sparrow	*Spizella pallida*	0	0	1	1	1	1	0	0	2	2
cliff swallow	*Petrochelidon pyrrhonota*	1	1	22	35	0	0	0	0	23	36
common grackle	*Quiscalus quiscula*	14	24	40	51	8	16	0	0	62	91
common yellowthroat	*Geothlypis trichas*	0	0	11	11	2	2	0	0	13	13
dark-eyed junco	*Junco hyemalis*	0	0	0	0	1	1	1	1	2	2
dickcissel	*Spiza americana*	0	0	12	12	0	0	0	0	12	12
eastern bluebird	*Sialia sialis*	0	0	0	0	1	1	0	0	1	1
eastern kingbird	*Tyrannus tyrannus*	2	2	1	2	0	0	0	0	3	4
eastern meadowlark	*Sturnella magna*	1	1	0	0	0	0	0	0	1	1
eastern phoebe	*Sayornis phoebe*	2	2	0	0	0	0	0	0	2	2
European starling	*Sturnus vulgaris*	5	6	6	14	4	7	0	0	15	27
field sparrow	*Spizella pusilla*	1	1	0	0	0	0	0	0	1	1
Henslow's sparrow	*Ammodramus henslowii*	0	0	0	0	1	1	0	0	1	1
horned lark	*Eremophila alpestris*	3	3	3	3	6	61	11	193	23	260
house finch	*Haemorhous mexicanus*	0	0	1	1	0	0	0	0	1	1
house sparrow	*Passer domesticus*	2	5	5	10	0	0	1	6	8	21
house wren	*Troglodytes aedon*	0	0	0	0	1	1	0	0	1	1
Lapland longspur	*Calcarius lapponicus*	0	0	0	0	0	0	3	395	3	395
marsh wren	*Cistothorus palustris*	0	0	2	2	0	0	0	0	2	2
palm warbler	*Setophaga palmarum*	1	1	0	0	1	1	0	0	2	2
pine siskin	*Spinus pinus*	0	0	0	0	1	3	0	0	1	3
red-winged blackbird	*Agelaius phoeniceus*	29	149	37	89	19	475	0	0	85	713
Savannah sparrow	*Passerculus sandwichensis*	4	5	1	1	3	15	0	0	8	21
sedge wren	*Cistothorus platensis*	0	0	5	5	0	0	0	0	5	5
snow bunting	*Plectrophenax nivalis*	0	0	0	0	3	93	1	1	4	94
song sparrow	*Melospiza melodia*	7	7	7	7	6	6	0	0	20	20

Appendix A2. Summary of individuals and group observations by bird type and species for 10-minute fixed-point small bird use surveys[a] at the Three Waters Wind Farm [b] from March 2017 through February 2018.

		Spring		Summer		Fall		Winter		Total	
Type/Species	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
swamp sparrow	*Melospiza georgiana*	0	0	2	2	0	0	0	0	2	2
tree swallow	*Tachycineta bicolor*	7	9	7	7	4	41	0	0	18	57
unidentified blackbird		1	7	1	90	5	841	0	0	7	938
unidentified meadowlark	*Sturnella* spp.	2	2	0	0	1	1	0	0	3	3
unidentified sparrow		0	0	1	1	2	2	0	0	3	3
unidentified swallow		0	0	1	1	0	0	0	0	1	1
unidentified warbler		1	1	0	0	0	0	0	0	1	1
vesper sparrow	*Pooecetes gramineus*	7	7	6	6	2	2	0	0	15	15
western meadowlark	*Sturnella neglecta*	2	2	0	0	1	1	0	0	3	3
yellow-headed blackbird	*Xanthocephalus xanthocephalus*	2	2	2	8	0	0	0	0	4	10
yellow-rumped warbler	*Setophaga coronata*	0	0	0	0	1	1	0	0	1	1
yellow warbler	*Setophaga petechia*	0	0	1	1	0	0	0	0	1	1
Swifts/Hummingbirds		**0**	**0**	**1**	**2**	**1**	**1**	**0**	**0**	**2**	**3**
chimney swift	*Chaetura pelagica*	0	0	1	2	1	1	0	0	2	3
Woodpeckers		**0**	**0**	**0**	**0**	**1**	**1**	**0**	**0**	**1**	**1**
northern flicker	*Colaptes auratus*	0	0	0	0	1	1	0	0	1	1
Kingfishers		**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**
belted kingfisher	*Megaceryle alcyon*	1	1	0	0	0	0	0	0	1	1
Overall		**170**	**341**	**248**	**487**	**88**	**1,608**	**19**	**600**	**525**	**3,036**

[a] Data from all 18 avian use points included.

[b] Regardless of distance from observer.

grps = groups of observqations, obs = individual observations

Appendix B. Mean Use, Percent of Use, and Frequency of Occurrence for Large Birds and Small Birds Observed at the Three Waters Wind Farm during Fixed-Point Bird Use Surveys from March 2017 through February 2018

Appendix B1. Mean large bird use (number of large birds/800-meter plot/60-minute survey), percent of total use (%), and frequency of occurrence (%) for each large bird type and species by season during the fixed-point eagle/large bird use surveys[a] at the Three Waters Wind Farm from March 2017 through February 2018.

	Mean Use				% of Use				% Frequency			
Type / Species	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter
Waterbirds	**3.65**	**0.46**	**3.91**	**0**	**9.5**	**13.9**	**13.4**	**0**	**24.1**	**18.5**	**16.7**	**0**
American white pelican	1.57	0.22	0.89	0	4.1	6.7	3.1	0	14.8	7.4	7.4	0
double-crested cormorant	1.93	0.04	3.00	0	5.0	1.1	10.3	0	7.4	3.7	7.4	0
great blue heron	0.09	0.20	0.02	0	0.2	6.1	<0.1	0	7.4	11.1	1.9	0
sandhill crane	0.06	0	0	0	0.1	0	0	0	3.7	0	0	0
Waterfowl	**17.20**	**1.96**	**13.48**	**0.11**	**44.9**	**58.9**	**46.3**	**24.0**	**40.7**	**14.8**	**22.2**	**1.9**
American wigeon	0.07	0	0.13	0	0.2	0	0.4	0	1.9	0	1.9	0
blue-winged teal	0.02	0	0	0	<0.1	0	0	0	1.9	0	0	0
Canada goose	0.63	1.70	5.70	0.11	1.6	51.1	19.6	24.0	18.5	9.3	16.7	1.9
gadwall	0.06	0	0	0	0.1	0	0	0	1.9	0	0	0
green-winged teal	0.02	0	0	0	<0.1	0	0	0	1.9	0	0	0
mallard	1.22	0.22	3.96	0	3.2	6.7	13.6	0	29.6	7.4	5.6	0
northern pintail	0.02	0	1.06	0	<0.1	0	3.6	0	1.9	0	3.7	0
northern shoveler	0.04	0	0.02	0	<0.1	0	<0.1	0	1.9	0	1.9	0
snow goose	0.28	0	2.04	0	0.7	0	7.0	0	3.7	0	1.9	0
unidentified duck	14.72	0.04	0.54	0	38.4	1.1	1.8	0	3.7	1.9	3.7	0
wood duck	0.13	0	0.04	0	0.3	0	0.1	0	5.6	0	1.9	0
Shorebirds	**0.07**	**0**	**0**	**0**	**0.2**	**0**	**0**	**0**	**5.6**	**0**	**0**	**0**
killdeer	0.07	0	0	0	0.2	0	0	0	5.6	0	0	0
Gulls/Terns	**16.20**	**0.04**	**9.78**	**0**	**42.3**	**1.1**	**33.6**	**0**	**14.8**	**3.7**	**24.1**	**0**
black tern	0.22	0	0	0	0.6	0	0	0	1.9	0	0	0
Franklin's gull	0	0.02	4.54	0	0	0.6	15.6	0	0	1.9	14.8	0
herring gull	0.06	0	0.04	0	0.1	0	0.1	0	1.9	0	3.7	0
ring-billed gull	15.93	0.02	5.20	0	41.6	0.6	17.9	0	13.0	1.9	9.3	0
Diurnal Raptors	**0.59**	**0.11**	**1.04**	**0.11**	**1.5**	**3.3**	**3.6**	**24.0**	**42.6**	**11.1**	**46.3**	**9.3**
Accipiters	*0.07*	*0*	*0.09*	*0*	*0.2*	*0*	*0.3*	*0*	*7.4*	*0*	*9.3*	*0*
Cooper's hawk	0.02	0	0	0	<0.1	0	0	0	1.9	0	0	0
sharp-shinned hawk	0.06	0	0.09	0	0.1	0	0.3	0	5.6	0	9.3	0
Buteos	*0.28*	*0.07*	*0.78*	*0.07*	*0.7*	*2.2*	*2.7*	*16.0*	*18.5*	*7.4*	*31.5*	*5.6*
broad-winged hawk	0.04	0	0	0	<0.1	0	0	0	3.7	0	0	0
red-tailed hawk	0.20	0.07	0.69	0.02	0.5	2.2	2.4	4.0	13.0	7.4	25.9	1.9
rough-legged hawk	0	0	0.07	0.06	0	0	0.3	12.0	0	0	3.7	5.6
Swainson's hawk	0.04	0	0.02	0	<0.1	0	<0.1	0	1.9	0	1.9	0

Appendix B1. Mean large bird use (number of large birds/800-meter plot/60-minute survey), percent of total use (%), and frequency of occurrence (%) for each large bird type and species by season during the fixed-point eagle/large bird use surveys[a] at the Three Waters Wind Farm from March 2017 through February 2018.

	Mean Use				% of Use				% Frequency			
Type / Species	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
Northern Harrier	*0.06*	*0*	*0.07*	*0*	*0.1*	*0*	*0.3*	*0*	*5.6*	*0*	*7.4*	*0*
northern harrier	0.06	0	0.07	0	0.1	0	0.3	0	5.6	0	7.4	0
Eagles	*0.06*	*0*	*0.04*	*0.02*	*0.1*	*0*	*0.1*	*4.0*	*5.6*	*0*	*3.7*	*1.9*
bald eagle	0.06	0	0.04	0.02	0.1	0	0.1	4.0	5.6	0	3.7	1.9
Falcons	*0.13*	*0.04*	*0.06*	*0.02*	*0.3*	*1.1*	*0.2*	*4.0*	*11.1*	*3.7*	*3.7*	*1.9*
American kestrel	0.11	0.04	0.04	0	0.3	1.1	0.1	0	9.3	3.7	1.9	0
merlin	0.02	0	0	0.02	<0.1	0	0	4.0	1.9	0	0	1.9
peregrine falcon	0	0	0.02	0	0	0	<0.1	0	0	0	1.9	0
Vultures	**0.13**	**0.54**	**0.17**	**0**	**0.3**	**16.1**	**0.6**	**0**	**13.0**	**24.1**	**13.0**	**0**
turkey vulture	0.13	0.54	0.17	0	0.3	16.1	0.6	0	13.0	24.1	13.0	0
Upland Game Birds	**0.11**	**0.11**	**0.04**	**0.02**	**0.3**	**3.3**	**0.1**	**4.0**	**11.1**	**5.6**	**1.9**	**1.9**
ring-necked pheasant	0.11	0.11	0.04	0.02	0.3	3.3	0.1	4.0	11.1	5.6	1.9	1.9
Doves/Pigeons	**0.19**	**0**	**0**	**0**	**0.5**	**0**	**0**	**0**	**1.9**	**0**	**0**	**0**
rock pigeon	0.19	0	0	0	0.5	0	0	0	1.9	0	0	0
Large Corvids	**0.17**	**0.11**	**0.70**	**0.22**	**0.4**	**3.3**	**2.4**	**48.0**	**9.3**	**3.7**	**14.8**	**5.6**
American crow	0.17	0.11	0.70	0.22	0.4	3.3	2.4	48.0	9.3	3.7	14.8	5.6
Overall[b]	**38.31**	**3.33**	**29.11**	**0.46**	**100**	**100**	**100**	**100**				

[a] Data included is from the 18 survey points that were surveyed multiple times.

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

Appendix B2. Mean small bird use (number of large birds/100-meter plot/10-minute survey), percent of total use (%), and frequency of occurrence (%) for each small bird type and species by season during the 10-minute fixed-point small bird use surveys at the Three Waters Wind Farm from March 2017 through February 2018.

	Mean Use				% of Use				% Frequency			
Type / Species	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter
Passerines	**4.04**	**8.98**	**29.74**	**11.11**	**99.5**	**99.6**	**99.9**	**100**	**64.8**	**88.9**	**57.4**	**25.9**
American goldfinch	0.07	0.33	0.13	0	1.8	3.7	0.4	0	5.6	14.8	7.4	0
American robin	0.74	0.20	0.20	0	18.3	2.3	0.7	0	35.2	14.8	5.6	0
American tree sparrow	0	0	0.06	0.07	0	0	0.2	0.7	0	0	1.9	3.7
bank swallow	0	0.02	0	0	0	0.2	0	0	0	1.9	0	0
barn swallow	0.15	1.07	0.22	0	3.7	11.9	0.7	0	13.0	40.7	5.6	0
blue jay	0.04	0	0	0	0.9	0	0	0	1.9	0	0	0
bobolink	0.09	0.06	0	0	2.3	0.6	0	0	7.4	3.7	0	0
brown-headed cowbird	0.70	0.56	0	0	17.4	6.2	0	0	31.5	18.5	0	0
chipping sparrow	0.04	0.07	0	0	0.9	0.8	0	0	3.7	7.4	0	0
clay-colored sparrow	0	0.02	0.02	0	0	0.2	<0.1	0	0	1.9	1.9	0
cliff swallow	0.02	0.65	0	0	0.5	7.2	0	0	1.9	25.9	0	0
common grackle	0.44	0.94	0.30	0	11.0	10.5	1.0	0	16.7	37.0	9.3	0
common yellowthroat	0	0.20	0.04	0	0	2.3	0.1	0	0	14.8	3.7	0
dark-eyed junco	0	0	0.02	0.02	0	0	<0.1	0.2	0	0	1.9	1.9
dickcissel	0	0.22	0	0	0	2.5	0	0	0	20.4	0	0
eastern bluebird	0	0	0.02	0	0	0	<0.1	0	0	0	1.9	0
eastern kingbird	0.04	0.04	0	0	0.9	0.4	0	0	3.7	1.9	0	0
eastern meadowlark	0.02	0	0	0	0.5	0	0	0	1.9	0	0	0
eastern phoebe	0.04	0	0	0	0.9	0	0	0	3.7	0	0	0
European starling	0.11	0.26	0.13	0	2.7	2.9	0.4	0	7.4	9.3	5.6	0
field sparrow	0.02	0	0	0	0.5	0	0	0	1.9	0	0	0
Henslow's sparrow	0	0	0.02	0	0	0	<0.1	0	0	0	1.9	0
horned lark	0.06	0.06	1.13	3.57	1.4	0.6	3.8	32.2	5.6	5.6	11.1	16.7
house finch	0	0.02	0	0	0	0.2	0	0	0	1.9	0	0
house sparrow	0.09	0.19	0	0.11	2.3	2.1	0	1.0	3.7	9.3	0	1.9
house wren	0	0	0.02	0	0	0	<0.1	0	0	0	1.9	0
Lapland longspur	0	0	0	7.31	0	0	0	65.8	0	0	0	3.7
marsh wren	0	0.04	0	0	0	0.4	0	0	0	3.7	0	0
palm warbler	0.02	0	0.02	0	0.5	0	<0.1	0	1.9	0	1.9	0
pine siskin	0	0	0.06	0	0	0	0.2	0	0	0	1.9	0
red-winged blackbird	0.57	1.65	8.80	0	14.2	18.3	29.5	0	25.9	40.7	24.1	0
Savannah sparrow	0.09	0.02	0.28	0	2.3	0.2	0.9	0	7.4	1.9	1.9	0

Appendix B2. Mean small bird use (number of large birds/100-meter plot/10-minute survey), percent of total use (%), and frequency of occurrence (%) for each small bird type and species by season during the 10-minute fixed-point small bird use surveys at the Three Waters Wind Farm from March 2017 through February 2018.

	Mean Use				% of Use				% Frequency			
Type / Species	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
sedge wren	0	0.09	0	0	0	1.0	0	0	0	7.4	0	0
snow bunting	0	0	1.72	0.02	0	0	5.8	0.2	0	0	3.7	1.9
song sparrow	0.13	0.13	0.11	0	3.2	1.4	0.4	0	11.1	11.1	9.3	0
swamp sparrow	0	0.04	0	0	0	0.4	0	0	0	3.7	0	0
tree swallow	0.17	0.13	0.76	0	4.1	1.4	2.5	0	13.0	13.0	3.7	0
unidentified blackbird	0.13	1.67	15.57	0	3.2	18.5	52.3	0	1.9	1.9	7.4	0
unidentified meadowlark	0.04	0	0.02	0	0.9	0	<0.1	0	3.7	0	1.9	0
unidentified sparrow	0	0.02	0.04	0	0	0.2	0.1	0	0	1.9	3.7	0
unidentified swallow	0	0.02	0	0	0	0.2	0	0	0	1.9	0	0
unidentified warbler	0.02	0	0	0	0.5	0	0	0	1.9	0	0	0
vesper sparrow	0.13	0.11	0.04	0	3.2	1.2	0.1	0	11.1	11.1	3.7	0
western meadowlark	0.04	0	0.02	0	0.9	0	<0.1	0	3.7	0	1.9	0
yellow-headed blackbird	0.04	0.15	0	0	0.9	1.6	0	0	3.7	3.7	0	0
yellow-rumped warbler	0	0	0.02	0	0	0	<0.1	0	0	0	1.9	0
yellow warbler	0	0.02	0	0	0	0.2	0	0	0	1.9	0	0
Swifts/Hummingbirds	**0**	**0.04**	**0.02**	**0**	**0**	**0.4**	**<0.1**	**0**	**0**	**1.9**	**1.9**	**0**
chimney swift	0	0.04	0.02	0	0	0.4	<0.1	0	0	1.9	1.9	0
Woodpeckers	**0**	**0**	**0.02**	**0**	**0**	**0**	**<0.1**	**0**	**0**	**0**	**1.9**	**0**
northern flicker	0	0	0.02	0	0	0	<0.1	0	0	0	1.9	0
Kingfishers	**0.02**	**0**	**0**	**0**	**0.5**	**0**	**0**	**0**	**1.9**	**0**	**0**	**0**
belted kingfisher	0.02	0	0	0	0.5	0	0	0	1.9	0	0	0
Overall[a]	**4.06**	**9.02**	**29.78**	**11.11**	**100**	**100**	**100**	**100**				

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

Appendix C. Species Exposure Indices for the Three Waters Wind Farm during Fixed-Point Bird Use Surveys from March 2017 through February 2018

Appendix C1. Relative exposure index and flight characteristics for each large bird species during the 60-minute fixed-point eagle/large bird use surveys at the Three Waters Wind Farm from March 2017 through February 2018.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within RSH Based on Initial Observation	Exposure Index	% Within RSH at Anytime
ring-billed gull	17	5.32	100	21.9	1.16	62.5
mallard	31	1.35	100	52.1	0.70	61.0
Canada goose	29	2.04	97.5	23.8	0.47	28.9
Franklin's gull	16	1.14	100	32.1	0.36	56.5
American white pelican	21	0.67	100	44.8	0.30	44.8
red-tailed hawk	45	0.25	90.6	58.3	0.13	70.8
turkey vulture	35	0.21	95.6	32.6	0.07	62.8
American crow	24	0.3	100	16.9	0.05	43.1
great blue heron	13	0.08	100	35.3	0.03	41.2
sharp-shinned hawk	8	0.04	100	75.0	0.03	75.0
rough-legged hawk	6	0.03	85.7	100	0.03	100
northern harrier	7	0.03	100	42.9	0.01	42.9
unidentified duck	14	3.85	100	0.2	<0.01	88.9
double-crested cormorant	10	1.24	100	0.7	<0.01	1.1
bald eagle	6	0.03	100	33.3	<0.01	50.0
American kestrel	7	0.05	70.0	14.3	<0.01	42.9
northern shoveler	2	0.01	100	33.3	<0.01	100
snow goose	3	0.58	100	0.8	<0.01	0.8
peregrine falcon	1	<0.01	100	100	<0.01	100
northern pintail	3	0.27	100	0	0	1.7
ring-necked pheasant	6	0.07	53.3	0	0	0
black tern	1	0.06	100	0	0	0
American wigeon	2	0.05	100	0	0	36.4
rock pigeon	1	0.05	100	0	0	100
wood duck	5	0.04	100	0	0	0
herring gull	3	0.02	100	0	0	0
killdeer	0	0.02	0	0	0	0
sandhill crane	2	0.01	100	0	0	0
gadwall	1	0.01	100	0	0	100
Swainson's hawk	2	0.01	100	0	0	0
broad-winged hawk	2	<0.01	100	0	0	0
merlin	2	<0.01	100	0	0	0

Appendix C1. Relative exposure index and flight characteristics for each large bird species during the 60-minute fixed-point eagle/large bird use surveys at the Three Waters Wind Farm from March 2017 through February 2018.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within RSH Based on Initial Observation	Exposure Index	% Within RSH at Anytime
green-winged teal	1	<0.01	100	0	0	0
Cooper's hawk	1	<0.01	100	0	0	100
blue-winged teal	1	<0.01	100	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.

Appendix C2. Relative exposure index and flight characteristics for each small bird species during the 10-minute fixed-point small bird use surveys at the Three Waters Wind Farm from March 2017 through February 2018.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within RSH Based on Initial Observation	Exposure Index	% Within RSH at Anytime
Lapland longspur	2	1.80	89.9	98.6	1.60	98.6
unidentified blackbird	7	4.34	100	13.5	0.59	13.5
snow bunting	4	0.43	100	100	0.43	100
red-winged blackbird	61	2.75	96.6	10.4	0.28	16.0
tree swallow	17	0.26	98.2	87.5	0.23	87.5
horned lark	16	1.19	45.0	9.4	0.05	9.4
American robin	24	0.29	59.7	27.0	0.05	27.0
common grackle	59	0.42	95.6	10.3	0.04	13.8
barn swallow	44	0.36	100	10.3	0.04	15.4
American goldfinch	15	0.14	89.7	26.9	0.03	26.9
bobolink	4	0.04	62.5	80.0	0.02	80.0
cliff swallow	23	0.17	100	8.3	0.01	33.3
European starling	14	0.13	74.1	15.0	0.01	15.0
pine siskin	1	0.01	100	100	0.01	100
brown-headed cowbird	28	0.32	83.8	3.5	<0.01	3.5
chimney swift	2	0.01	100	66.7	<0.01	100
palm warbler	2	<0.01	100	50.0	<0.01	50.0
eastern bluebird	1	<0.01	100	100	<0.01	100
house sparrow	5	0.10	57.1	0	0	0
Savannah sparrow	3	0.10	14.3	0	0	0
song sparrow	4	0.09	20.0	0	0	0
vesper sparrow	4	0.07	26.7	0	0	0
common yellowthroat	3	0.06	23.1	0	0	0
dickcissel	3	0.06	25.0	0	0	0
yellow-headed blackbird	2	0.05	80.0	0	0	0
American tree sparrow	0	0.03	0	0	0	0
chipping sparrow	1	0.03	16.7	0	0	0
sedge wren	1	0.02	20.0	0	0	0
eastern kingbird	2	0.02	50.0	0	0	0
western meadowlark	0	0.01	0	0	0	0
unidentified meadowlark	1	0.01	33.3	0	0	0
unidentified sparrow	2	0.01	66.7	0	0	0
swamp sparrow	1	<0.01	50.0	0	0	0
marsh wren	0	<0.01	0	0	0	0
eastern phoebe	1	<0.01	50.0	0	0	0

Appendix C2. Relative exposure index and flight characteristics for each small bird species during the 10-minute fixed-point small bird use surveys at the Three Waters Wind Farm from March 2017 through February 2018.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within RSH Based on Initial Observation	Exposure Index	% Within RSH at Anytime
blue jay	1	<0.01	100	0	0	0
clay-colored sparrow	0	<0.01	0	0	0	0
dark-eyed junco	0	<0.01	0	0	0	0
yellow warbler	0	<0.01	0	0	0	0
unidentified warbler	1	<0.01	100	0	0	0
unidentified swallow	1	<0.01	100	0	0	0
house finch	0	<0.01	0	0	0	0
field sparrow	1	<0.01	100	0	0	0
eastern meadowlark	1	<0.01	100	0	0	0
belted kingfisher	1	<0.01	100	0	0	0
bank swallow	0	<0.01	0	0	0	0
yellow-rumped warbler	0	<0.01	0	0	0	0
northern flicker	0	<0.01	0	0	0	0
house wren	0	<0.01	0	0	0	0
Henslow's sparrow	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 (AGL).

Appendix D. Mean Use by Point for All Birds, Major Bird Types, and Diurnal Raptor Subtypes at the Three Waters Wind Farm during Fixed-Point Bird Use Surveys from March 2017 through February 2018

Appendix D1. Mean use (number of birds/60-minute survey) by point for all large bird types and diurnal raptor subtypes observed at the Three Waters Wind Farm during fixed-point eagle/large bird use surveys from March 2017 through February 2018.

	Survey Point																	
Bird Type	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
Waterbirds	2.17	3.50	0	0.08	1.83	0	0.08	0.33	0.33	0.08	0	0.58	0.17	2.83	7.83	14.75	0.33	1.17
Waterfowl	6.08	0	29.42	12.25	0.17	0	8.50	2.42	1.00	65.75	1.83	2.42	0.33	0.92	2.50	10.92	2.08	0.83
Shorebirds	0	0.08	0	0	0	0	0.08	0.17	0	0	0	0	0	0	0	0	0	0
Gulls/Terns	1.75	1.00	0.08	11.67	0.08	0	0	37.83	33.33	0	0.08	0	1.08	2.50	0	1.92	14.75	11.00
Diurnal Raptors	0.58	0.50	0	0.42	0.50	0.08	0.67	0.25	0.50	0.42	0.17	0.25	0.17	1.17	0.42	1.00	0.33	0.92
Accipiters	*0.08*	*0*	*0*	*0.08*	*0*	*0*	*0*	*0*	*0*	*0.08*	*0.08*	*0*	*0.08*	*0*	*0.08*	*0*	*0.17*	*0.08*
Buteos	*0.25*	*0.25*	*0*	*0.25*	*0.25*	*0.08*	*0.50*	*0.25*	*0.33*	*0.17*	*0.08*	*0.17*	*0.08*	*0.83*	*0.25*	*0.92*	*0.08*	*0.67*
Northern Harrier	*0.08*	*0*	*0*	*0.08*	*0.08*	*0*	*0.08*	*0*	*0*	*0*	*0*	*0.08*	*0*	*0.08*	*0*	*0*	*0*	*0.08*
Eagles	*0.08*	*0.08*	*0*	*0*	*0*	*0*	*0.08*	*0*	*0.17*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0.08*
Falcons	*0.08*	*0.17*	*0*	*0*	*0.17*	*0*	*0*	*0*	*0*	*0.17*	*0*	*0*	*0*	*0.25*	*0.08*	*0.08*	*0.08*	*0*
Vultures	0.42	0.17	0.17	0.17	0.17	0.08	0.17	0.17	0.17	0.17	0	0.08	0.17	0.08	0.17	1.08	0.25	0.08
Upland Game Birds	0	0	0	0	0	0	0	0	0.17	0.25	0	0	0	0	0.50	0.33	0	0
Doves/Pigeons	0	0.83	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Large Corvids	0.67	0	0	0.67	0.17	2.33	0.25	0.25	0	0	0	0.42	0.08	0.42	0.08	0.08	0	0
All Large Birds[a]	**11.67**	**6.08**	**29.67**	**25.25**	**2.92**	**2.50**	**9.75**	**41.42**	**35.50**	**66.67**	**2.08**	**3.75**	**2.00**	**7.92**	**11.50**	**30.08**	**17.75**	**14.00**

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

Appendix D2. Mean use (number of birds/10-minute survey) by point for all small bird types observed at the Three Waters Wind Project during fixed-point small bird use surveys from March 2017 through February 2018.

	Survey Point																	
Bird Type	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
Passerines	62.17	5.25	3.33	10.75	2.75	46.25	4.83	3.75	4.92	3.00	11.92	17.08	25.50	1.58	15.08	9.67	11.17	3.42
Swifts/Hummingbirds	0	0.25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Woodpeckers	0	0	0	0	0	0	0	0	0	0	0	0	0	0.08	0	0	0	0
Kingfishers	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.08	0	0	0
All Small Birds[a]	**62.17**	**5.50**	**3.33**	**10.75**	**2.75**	**46.25**	**4.83**	**3.75**	**4.92**	**3.00**	**11.92**	**17.08**	**25.50**	**1.67**	**15.17**	**9.67**	**11.17**	**3.42**

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

Appendix E. Regional Fatality Table Summaries

Appendix E1. Wind energy facilities in the Midwest with publicly available and comparable fatality data for all bird species.

Wind Energy Facility	Fatality Estimate[a]	No. of Turbines	Total MW	Reference
Midwest				
Wessington Springs, SD (2009)	8.25	34	51	Derby et al. 2010a
Blue Sky Green Field, WI (2008; 2009)	7.17	88	145	Gruver et al. 2009
Cedar Ridge, WI (2009)	6.55	41	67.6	BHE Environmental 2010
Buffalo Ridge, MN (Phase III; 1999)	5.93	138	103.5	Johnson et al. 2000
Moraine II, MN (2009)	5.59	33	49.5	Derby et al. 2010b
Barton I & II, IA (2010-2011)	5.5	80	160	Derby et al. 2011a
Buffalo Ridge I, SD (2009-2010)	5.06	24	50.4	Derby et al. 2010c
Buffalo Ridge, MN (Phase I; 1996)	4.14	73	25	Johnson et al. 2000
Winnebago, IA (2009-2010)	3.88	10	20	Derby et al. 2010d
Rugby, ND (2010-2011)	3.82	71	149	Derby et al. 2011b
Cedar Ridge, WI (2010)	3.72	41	68	BHE Environmental 2011
Elm Creek II, MN (2011-2012)	3.64	62	148.8	Derby et al. 2012a
Buffalo Ridge, MN (Phase II; 1999)	3.57	143	107.25	Johnson et al. 2000
Buffalo Ridge, MN (Phase I; 1998)	3.14	73	25	Johnson et al. 2000
Ripley, Ont (2008)	3.09	38	76	Jacques Whitford 2009
Fowler I, IN (2009)	2.83	162	301	Johnson et al. 2010
Buffalo Ridge, MN (Phase I; 1997)	2.51	73	25	Johnson et al. 2000
Buffalo Ridge, MN (Phase II; 1998)	2.47	143	107.25	Johnson et al. 2000
PrairieWinds SD1, SD (2012-2013)	2.01	108	162	Derby et al. 2013
Buffalo Ridge II, SD (2011-2012)	1.99	105	210	Derby et al. 2012b
Kewaunee County, WI (1999-2001)	1.95	31	20.46	Howe et al. 2002
PrairieWinds SD1, SD (2013-2014)	1.66	108	162	Derby et al. 2014
NPPD Ainsworth, NE (2006)	1.63	36	20.5	Derby et al. 2007
PrairieWinds ND1 (Minot), ND (2011)	1.56	80	115.5	Derby et al. 2012c
Elm Creek, MN (2009-2010)	1.55	67	100	Derby et al. 2010e
PrairieWinds ND1 (Minot), ND (2010)	1.48	80	115.5	Derby et al. 2011c
Buffalo Ridge, MN (Phase I; 1999)	1.43	73	25	Johnson et al. 2000
PrairieWinds SD1, SD (2011-2012)	1.41	108	162	Derby et al. 2012d
Top Crop I & II (2012-2013)	1.35	68 (phase I) 132 (phase (II)	300 (102 (phase I) 198 (phase II))	Good et al 2013a
Heritage Garden I, MI (2012-2014)	1.3	14	28	Kerlinger et al. 2014
Wessington Springs, SD (2010)	0.89	34	51	Derby et al. 2011d
Rail Splitter, IL (2012-2013)	0.84	67	100.5	Good et al 2013b
Top of Iowa, IA (2004)	0.81	89	80	Jain 2005
Big Blue, MN (2013)	0.6	18	36	Fagen Engineering 2014
Grand Ridge I, IL (2009-2010)	0.48	66	99	Derby et al. 2010f
Top of Iowa, IA (2003)	0.42	89	80	Jain 2005

Appendix E1. Wind energy facilities in the Midwest with publicly available and comparable fatality data for all bird species.

Wind Energy Facility	Fatality Estimate[a]	No. of Turbines	Total MW	Reference
Big Blue, MN (2014)	0.37	18	36	Fagen Engineering 2015
Pioneer Prairie II, IA (2011-2012)	0.27	62	102.3	Chodachek et al. 2012

[a.] number of bird fatalities/MW/year

Appendix E2. Wind energy facilities in the Midwest with publicly available and comparable fatality data for diurnal raptors.

Wind Energy Facility	Fatality Estimate[a]	No. of Turbines	Total MW	Reference
Midwest				
Buffalo Ridge, MN (Phase I; 1999)	NA	0.47	73	Johnson et al. 2000
Moraine II, MN (2009)	NA	0.37	33	Derby et al. 2010b
Winnebago, IA (2009-2010)	NA	0.27	10	Derby et al. 2010d
Buffalo Ridge I, SD (2009-2010)	NA	0.2	24	Derby et al. 2010c
Cedar Ridge, WI (2009)	NA	0.18	41	BHE Environmental 2010
PrairieWinds SD1, SD (2013-2014)	NA	0.17	108	Derby et al. 2014
Top of Iowa, IA (2004)	NA	0.17	89	Jain 2005
Cedar Ridge, WI (2010)	NA	0.13	41	BHE Environmental 2011
Ripley, Ont (2008)	NA	0.1	38	Jacques Whitford 2009
Wessington Springs, SD (2010)	0.232	0.07	34	Derby et al. 2011d
Rugby, ND (2010-2011)	NA	0.06	71	Derby et al. 2011b
NPPD Ainsworth, NE (2006)	NA	0.06	36	Derby et al. 2007
Wessington Springs, SD (2009)	0.232	0.06	34	Derby et al. 2008, Derby et al. 2010a
PrairieWinds ND1 (Minot), ND (2011)	NA	0.05	80	Derby et al. 2012c
PrairieWinds ND1 (Minot), ND (2010)	NA	0.05	80	Derby et al. 2011c
PrairieWinds SD1, SD (2012-2013)	NA	0.03	108	Derby et al. 2013
Elm Creek, MN (2009-2010)	NA	0	67	Derby et al. 2010e
Rail Splitter, IL (2012-2013)	NA	0	67	Good et al 2013b
Pioneer Prairie II, IA (2011-2012)	NA	0	62	Chodachek et al. 2012
Buffalo Ridge, MN (Phase III; 1999)	NA	0	138	Johnson et al. 2000
Buffalo Ridge, MN (Phase II; 1998)	NA	0	143	Johnson et al. 2000
Buffalo Ridge, MN (Phase II; 1999)	NA	0	143	Johnson et al. 2000
Blue Sky Green Field, WI (2008; 2009)	NA	0	88	Gruver et al. 2009
Elm Creek II, MN (2011-2012)	NA	0	62	Derby et al. 2012a
Barton I & II, IA (2010-2011)	NA	0	80	Derby et al. 2011a
PrairieWinds SD1, SD (2011-2012)	NA	0	108	Derby et al. 2012d
Kewaunee County, WI (1999-2001)	NA	0	31	Howe et al. 2002
Buffalo Ridge II, SD (2011-2012)	NA	0	105	Derby et al. 2012b
Buffalo Ridge, MN (Phase I; 1996)	NA	0	73	Johnson et al. 2000
Buffalo Ridge, MN (Phase I; 1997)	NA	0	73	Johnson et al. 2000
Buffalo Ridge, MN (Phase I; 1998)	NA	0	73	Johnson et al. 2000
Fowler I, IN (2009)	NA	0	162	Johnson et al. 2010
Big Blue, MN (2013)	NA	0	18	Fagen Engineering 2014
Big Blue, MN (2014)	NA	0	18	Fagen Engineering 2015
Top of Iowa, IA (2003)	NA	0	89	Jain 2005
Grand Ridge I, IL (2009-2010)	0.195	0	66	Derby et al. 2010f

Appendix E2. Wind energy facilities in the Midwest with publicly available and comparable fatality data for diurnal raptors.

Wind Energy Facility	Fatality Estimate[a]	No. of Turbines	Total MW	Reference
Buffalo Ridge, MN (Phase I; 1999)	NA	0.47	73	Johnson et al. 2000
Moraine II, MN (2009)	NA	0.37	33	Derby et al. 2009, Derby et al. 2010b

[a.] number of bird fatalities/MW/year

Year 2 Avian Use Report 2018

Year 2 Avian Use Report

Three Waters Wind Farm

Jackson County, Minnesota

Osceola and Dickinson Counties, Iowa

March 2018 – February 2019

Prepared for:

Three Waters Wind Farm, LLC

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EXECUTIVE SUMMARY

Three Waters Wind Farm, LLC, has proposed the development of the Three Waters Wind Farm (Project) in Jackson County, Minnesota and Osceola and Dickinson Counties, Iowa. As part of the development process, Western EcoSystems Technology, Inc. conducted a second year of avian use surveys for the Project from March 2018 through February 2019. The results of these surveys highlight potential risks posed by the Project to birds within the Project area and may help with development of measures to avoid or minimize risk to birds during construction and operation of the Project.

Surveys were conducted once per month from March 3, 2018, through February 27, 2019, at 18 survey points within the Project area. Two hundred fourteen 60-minute (min) large bird surveys and separate 10-min small bird surveys were completed. Fifty-four large bird species and 35 small bird species were recorded. The most abundant large bird types recorded were waterfowl (10,078 observations) and gulls/terns (1,307 observations). During spring, summer, and winter, Canada goose had the highest use of all large birds recorded. During fall, Franklin's gull had the highest use of all large bird recorded. Overall, large bird use was highest in spring, followed by fall, summer, and winter. Most small bird observations were passerines (1,714 observations), largely represented by horned larks during spring, common grackles during summer, red-winged blackbirds during fall, and house sparrows during winter.

While no federally listed species were recorded during the bird use surveys, two state-listed threatened species and several species of concern were recorded. In addition, the state-listed threatened peregrine falcon was observed and the state-listed threatened trumpeter swan was observed incidentally within the Project. Several other Minnesota special concern species and species of greatest conservation need were recorded, including large numbers of American white pelican and Franklin's gull observations. Two hundred fifty-three observations of diurnal raptors were recorded during surveys, composed of 13 identified species. Diurnal raptor observations were highest during spring and fall. Red-tailed hawk was the most frequently recorded diurnal raptor species during the study. Fifty-four observations of bald eagle were documented, during which 196 eagle minutes were recorded. Of the 196 eagle minutes, 63 minutes were recorded in the Zone of Risk (ZOR), with most eagle minutes in the ZOR recorded during fall.

While the Project area is primarily cultivated cropland, it also includes wetland and herbaceous areas that could provide valuable habitat to waterbirds, waterfowl, eagles, and other bird types, especially during migration. The study results show higher use of the Project area by large birds during spring and fall migration, driven largely by waterfowl and gull/tern observations. Overall, the results of this study do not suggest high risk to any particular species of concern, although some there may be some risk to bald eagles and waterfowl, particularly during migration.

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INTRODUCTION

Three Waters Wind Farm, LLC (Three Waters) has proposed the development of the Three Waters Wind Farm (Project) in Jackson County, Minnesota and Dickinson and Osceola counties, Iowa (Figure 1). In order to evaluate the potential impacts associated with the development and operation of the Project on local bird populations, Three Waters contracted Western EcoSystems Technology, Inc. (WEST) to conduct a second year of avian use surveys from March 2018 through February 2019. This document provides full detail on the methods and results of the year-long avian use survey effort. It also documents conclusions about the Project's potential risk to bird populations as informed by the results of this study, comparative empirical data from other wind energy facilities, and a review of relevant technical and scientific wind-wildlife literature.

All surveys conducted during this study were designed to address questions posed under Tier 3 of the US Fish and Wildlife Service (USFWS) *Land-Based Wind Energy Guidelines* (USFWS 2012). Avian use survey protocols followed guidance provided in the USFWS *Eagle Conservation Plan Guidance* (ECPG; USFWS 2013) and the revised Eagle Permit Rule, published on December 16, 2016 (USFWS 2016).

The principal objectives of the study were to: 1) provide site-specific avian use data that could help evaluate potential impacts from development and operation of the Project; 2) provide information that could be used to inform Project planning and design of the facility to minimize impacts to birds; 3) estimate temporal and spatial patterns of avian use within the Project area; and 4) collect data on eagle use in the Project area following the USFWS ECPG (USFWS 2013) and the revised Eagle Permit Rule (USFWS 2016).

PROJECT AREA

The Project area encompasses approximately 23,832 hectares (ha; 58,890 acres [ac]) in Jackson County, Minnesota and Osceola and Dickinson Counties, Iowa (Figure 1). The Project area is within the Des Moines Lobe Level IV Ecoregion and the Western Corn Belt Plains Level III Ecoregion. The Western Corn Belt Plains is over 75% cultivated cropland and much of the remainder is forage for livestock (US Environmental Protection Agency [USEPA] 2013). Most of the Des Moines Lobe has been converted from wet prairie to agricultural land (USEPA 2018). The Project area includes portions of the Little Sioux River and the West Fork of the Little Sioux River, along with other small drainages (Figure 2). The Project area also overlaps with several small lakes and ponds, including Illinois Lake, Skunk Lake, Rush Lake, and Iowa Lake (Figure 2). Based on the National Land Cover Database (NLCD; Yang et al., Multi-Resolution Land Characteristics 2019), land cover within the Project area is primarily (89.9%) cultivated cropland, with small portions of emergent herbaceous wetlands (3.2%), developed open space (3.1%), and herbaceous (1.4%) and other habitat types (Figure 3, Table 1).

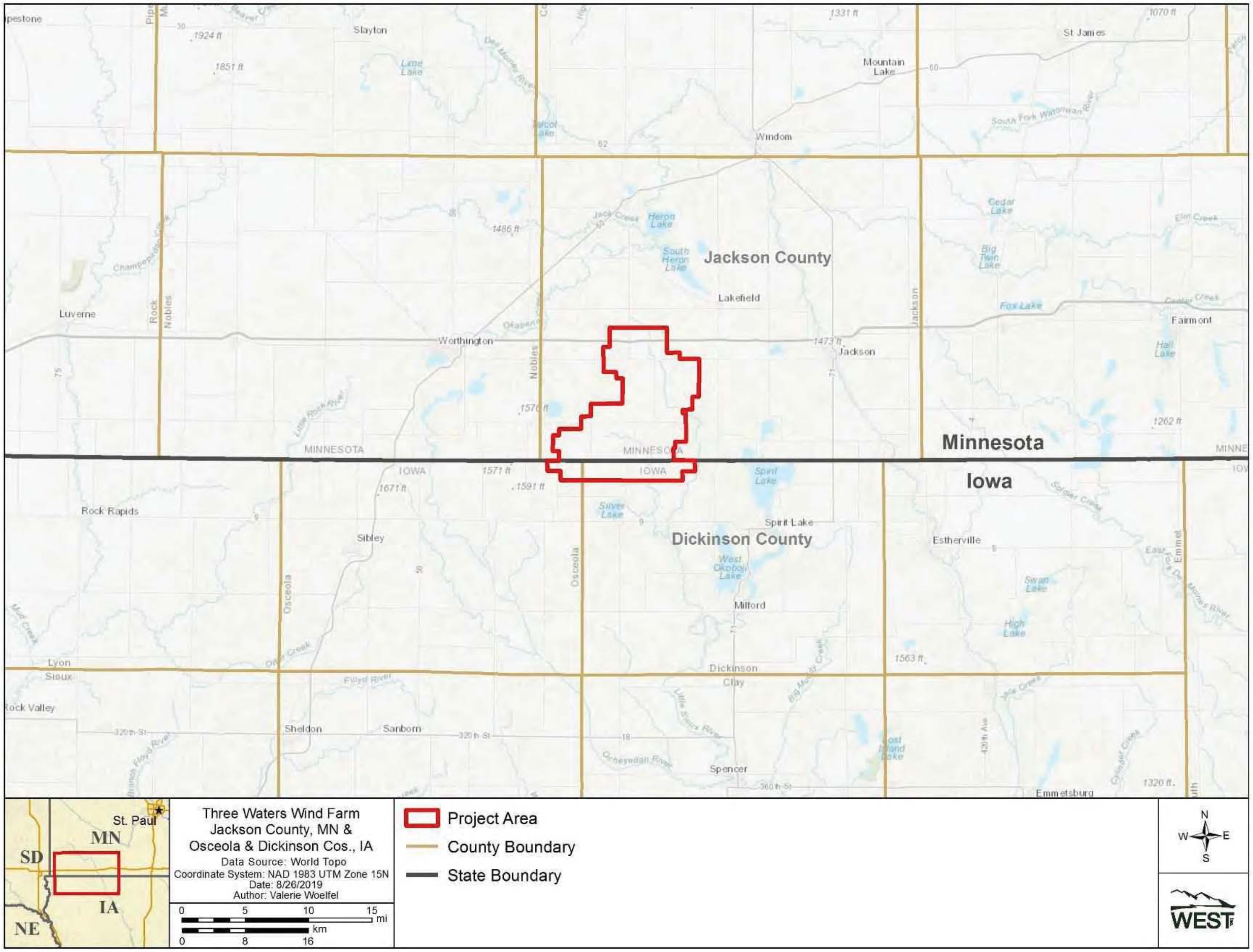

Figure 1. Location of the Three Waters Wind Farm in Jackson County, Minnesota and Dickinson and Osceola counties, Iowa.

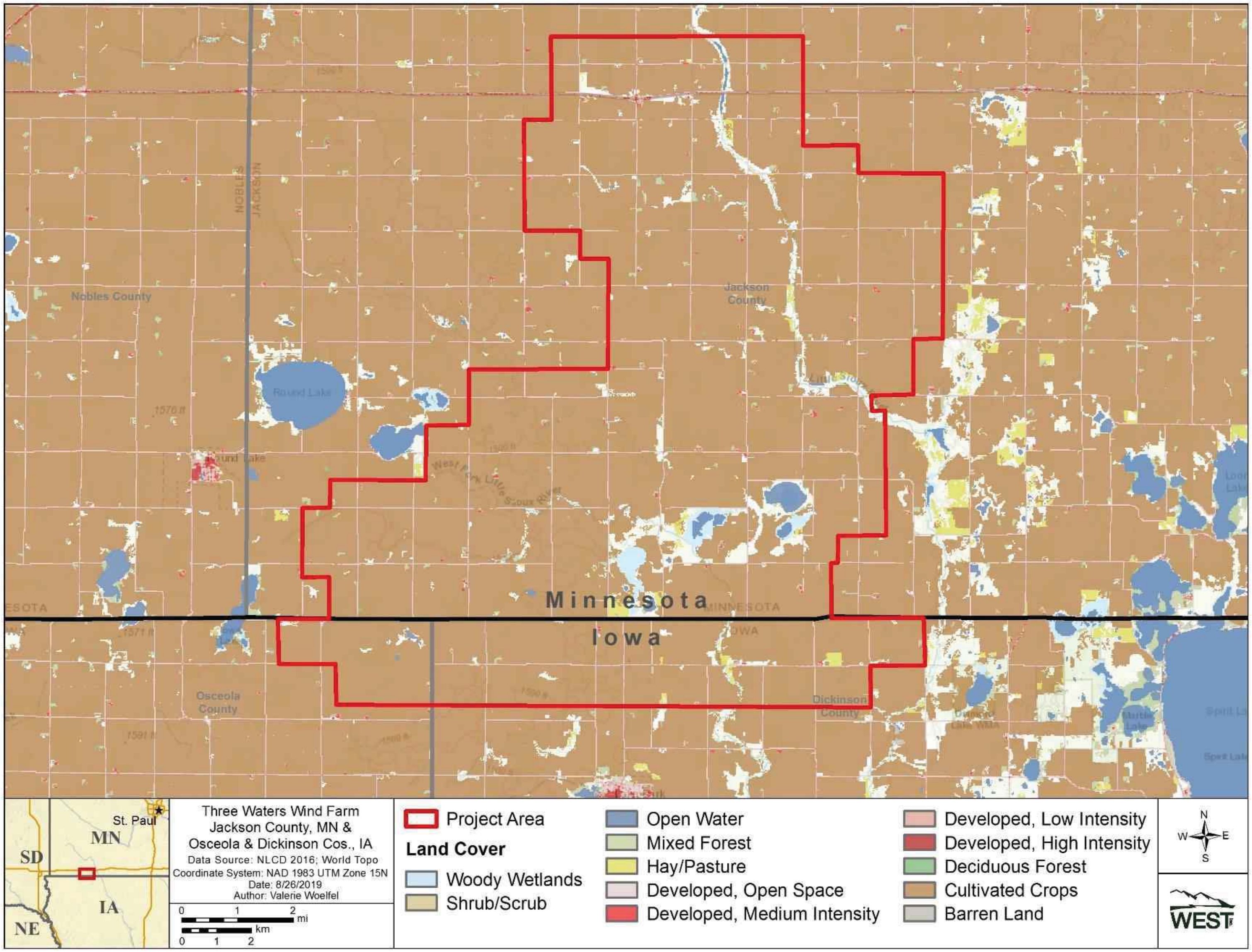

Figure 2. Land cover in the Three Waters Wind Farm in Jackson County, Minnesota and Dickinson and Osceola counties, Iowa.

Table 1. Land cover types, coverage, and composition within the Three Waters Wind Farm in Jackson County, Minnesota and Dickinson and Osceola counties, Iowa.

Habitat	Hectares	Acres	% Composition
Cultivated Crops	21,411.7	52,910.4	89.9
Emergent Herbaceous Wetlands	764.1	1,888.1	3.2
Developed, Open Space	735.9	1,818.5	3.1
Herbaceous	335.5	829.0	1.4
Open Water	160.8	397.3	0.7
Hay/Pasture	128.3	317.0	0.5
Developed, Low Intensity	119.7	295.9	0.5
Mixed Forest	107.2	264.8	0.5
Developed, Medium Intensity	33.9	83.9	0.1
Deciduous Forest	10.4	25.6	<0.1
Shrub/Scrub	9.5	23.6	<0.1
Barren Land	6.1	15.1	<0.1
Woody Wetlands	5.6	13.8	<0.1
Developed, High Intensity	2.7	6.7	<0.1
Total[1]	**23,832**	**58,890**	**100**

Data from the National Land Cover Database (Yang et al. 2018, Multi-Resolution Land Characteristics 2019).

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

METHODS

Avian use surveys were designed based on methods described by Reynolds et al. (1980) and recommendations in the ECPG (USFWS 2013) and in coordination with the Minnesota USFWS Ecological Services Field Office (Bloomington, MN).

Eagle/Large Bird Use Surveys

The objective of the eagle/large bird surveys was to estimate the seasonal and spatial use of the Project by eagles and other large birds (e.g., waterfowl, waterbirds, and diurnal raptors) over a year-long study period.

Survey Plots

Surveys consisted of eagle and other large bird counts within circular survey plots centered on a survey point. Each survey plot included an 800-meter (m; 2,625-feet [ft]; survey plot). To achieve 30% spatial coverage of the Project area as recommended in the ECPG (USFWS 2013), 18 survey points were established (Figure 4). Figures within this report represent updated boundaries in August 2019.A Geographic Information System (GIS) software specialist assigned survey point locations in a spatially random design to maximize the spatial coverage of the Project area, ensure good visibility for the observers, and provide readily accessible survey point locations from public roads. Survey point locations were micro-sited by a WEST biologist prior to the first surveys to optimize viewshed, access, and safety.

Observation Schedule

Each survey point was surveyed once per month, resulting in 12 surveys per point during the study period. Each eagle/large bird use survey was conducted for 60 minutes (min) immediately following the 10-min small bird use survey. Surveys were only conducted during daylight hours.

Each month the survey order was varied so each point was visited at different times of day during each season. Each survey day began at a randomly selected survey location.

Survey Methods

All eagle and other large birds observed within the 800-m survey radius during each survey were recorded. For each observation, the initial distance and closest distance from the observer to the bird was estimated using aerial maps and landmarks. The date, start and end time, plot number, species or best taxonomic identification, number of individuals, sex and age class, height above ground level (AGL), activity, and habitat were recorded. For eagles, flight height and behavior were recorded at 1-min intervals for as long as the eagle remained visible, based on USFWS ECPG recommendations. Behavior categories included perched, soaring, flapping, flushed, circle soaring, hunting, gliding, and other. Any comments or unusual observations were noted, and weather information, including temperature, wind speed, wind direction and cloud cover, was recorded for each survey. Flight paths and perch locations for eagles and other large birds were drawn on USGS topographic base maps and digitized using GIS software so bird movement patterns could be evaluated relative to topography, habitat, or other features.

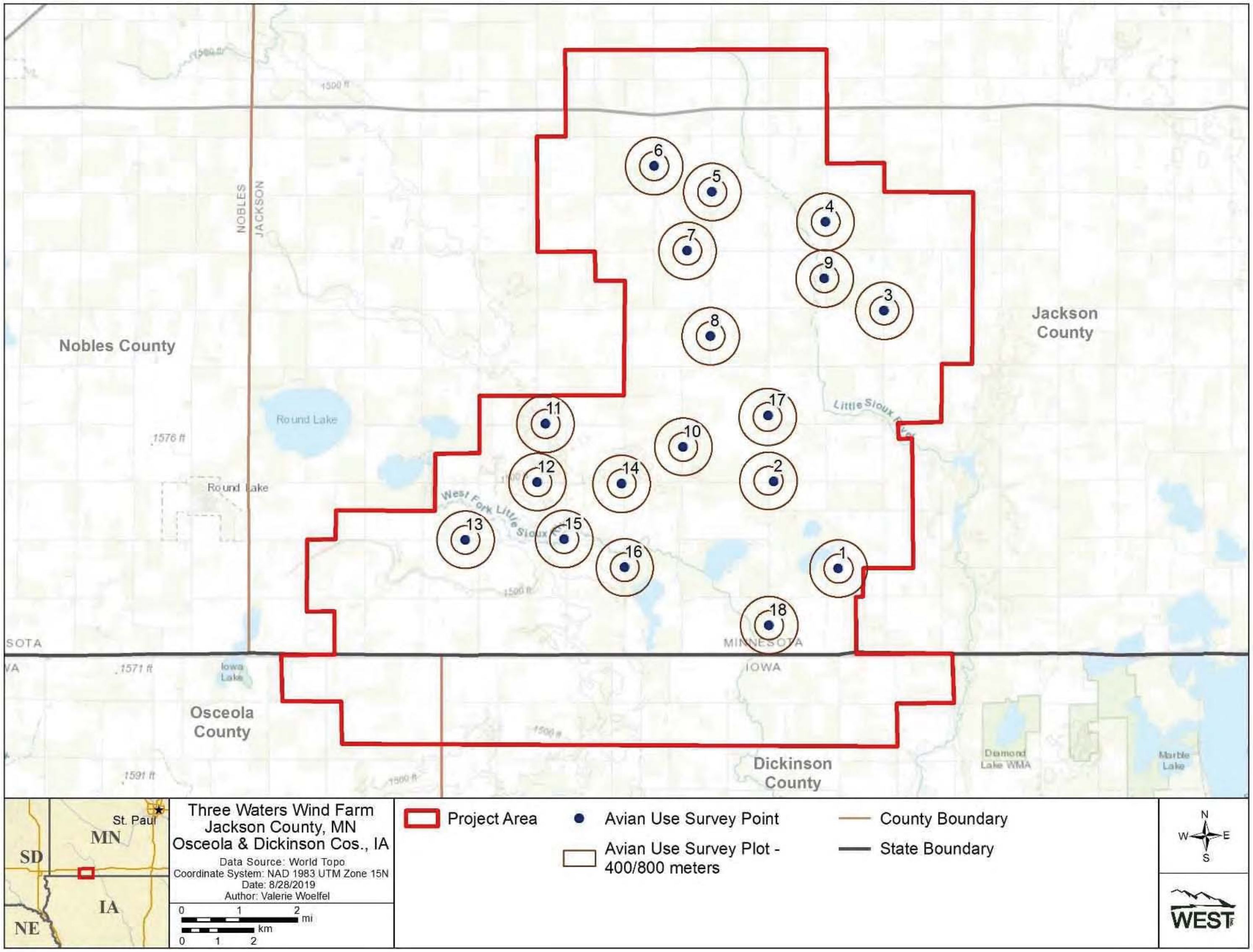

Figure 3. Avian use survey points at the Three Waters Wind Farm in Jackson County, Minnesota and Dickinson and Osceola counties, Iowa.

Small Bird Use Surveys

Small bird use surveys were conducted in conjunction with eagle/large bird surveys from March 2018 through February 2019. The objective of small bird use surveys was to document seasonal species diversity and relative abundance in the Project in order to estimate temporal and spatial use of the Project by small birds (e.g., passerines [excluding large corvids], kingfishers, swifts and hummingbirds, woodpeckers, and cuckoos). The small bird use surveys were conducted at the same 18 survey points used for eagles and other large birds (Figure 4). Small bird use surveys were conducted for 10 min in duration immediately prior to the eagle/large bird use surveys at each point. A 100-m (328-ft) survey radius was used for small bird survey plots. The distance to each bird observed was recorded and estimated to the nearest 5-m. The date, start and end time of the survey, and weather information was collected for each survey. For each observation, the biologist recorded: species (or best taxonomic identification), number of individuals, sex, age, distance from plot center when first observed, closest distance, flight height AGL, activity, and habitat.

Incidental Observations

Incidental wildlife observations provide records of sensitive species or noteworthy observations outside of the standardized surveys. Sensitive and unusual birds, mammals, reptiles, and amphibians were recorded in a similar fashion to standardized surveys. Sensitive species include federally and state-listed (endangered, threatened, or candidate) species and eagles, which are protected by the Bald and Golden Eagle Protection Act (BGEPA 1940). Data recorded for these species included: observation number, date, time, species, number of individuals, sex, age, distance from observer, activity, height AGL, and habitat. The location of sensitive species was recorded by Universal Transverse Mercator coordinates using a hand-held Global Positioning System unit. Incidental wildlife observations were recorded for any sensitive or unusual species observed within the Project area outside of standardized survey times.

Statistical Analysis

For analysis, a visit was defined as the number of days needed to complete one round of surveys at all survey points within the Project. Visits were held to the following criteria: 1) each visit had to be completed in a single season; and 2) a visit could be spread across multiple dates, but a single date could not contain surveys from multiple visits. Additionally, for all analyses, seasons were categorized as spring (March 1 – May 31), summer (June 1 – August 31), fall (September 1 – November 30), and winter (December 1 – February 28). Analyses were limited to observations within f data collection within the defined viewshed (i.e., 800 m for eagle and large birds and 100 m for small birds). Observations beyond the defined survey radius for small and large birds may have been recorded, but were not included in analyses (Appendix A).

Quality Assurance and Quality Control

WEST implemented quality assurance and quality control (QA/QC) measures at all stages of the study, including in the field, during data entry and analysis, and report writing. Following surveys, field biologists were responsible for inspecting data forms for completeness, accuracy, and legibility. WEST data specialists identified potentially erroneous data using a series of database queries and discussed irregular codes or questionable data 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 corrections were made.

Data Compilation and Storage

A database was developed to store, organize, and retrieve survey data. Data were keyed into the electronic database using a pre-defined protocol to facilitate subsequent QA/QC and data analysis. All data forms, field notebooks (if provided), and electronic data files were retained for future reference.

Bird Diversity and Species Richness

Bird diversity was illustrated by the total number of species observed. Species lists (with the number of observations and groups) were generated by season and included all observations of birds detected, regardless of their distance from the observer (Appendix A). In some cases, the number of observations may have included repeated sightings of an individual. For example, five observations of a species may represent five different birds or one bird observed on five separate visits, or something in between.

Species richness by season was calculated by averaging the total number of species observed within each plot during a visit, then averaging across plots within each visit, followed by averaging across visits within the season. Overall species richness was calculated as a weighted average of seasonal values by the number of days in each season. Species diversity and richness were compared among seasons for bird use surveys and calculated separately for large and small birds.

Bird Use, Percent of Use, and Frequency of Occurrence

Use was defined as the number of birds per plot per survey. For large birds, use includes birds detected within the 800-m radius plots during the 60-min surveys. For small birds, use includes birds detected within the 100-m radius plots during the 10-min surveys. Mean bird use equals the average number of birds per plot per survey. Estimates of mean bird use were used to compare differences among bird types, seasons, survey points. Mean use by season was calculated by summing the total number of birds seen within each plot during a visit, then averaging across plots within each visit, followed by averaging across visits within the season. Overall mean use was calculated as a weighted average of seasonal values by the number of days in each season.

Percent of use equals the relative proportion of use attributed to a particular bird type or species. Frequency of occurrence represents the percent of surveys in which a particular bird type or species was observed. For example, flocks of waterfowl, waterbirds, and shorebirds can compose several dozen, hundred, or 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 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 this species may be affected by the facility. Therefore, exposure to facility infrastructure is more accurately assessed by evaluating both percent of use and frequency of occurrence.

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

Bird Flight Height and Behavior

Bird flight heights are important metrics to assess relative exposure. Flight height information was used to calculate the percentage of birds observed flying within the likely rotor-swept height (RSH) for turbines used at the Project, defined here as 25–150 m (82–492 ft) AGL. The initial flight height recorded was used to calculate mean flight height. The percentage of birds flying within the RSH was determined based on initial flight height and based on all flight heights estimated during the observation.

Bird Exposure Index

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

$$R = A*P_f*P_t$$

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

Spatial Use

Large bird flight paths were qualitatively compared to Project area habitat and landscape characteristics (e.g., land cover and topographic features). The objective of mapping observed large bird locations and flight paths was to identify features or habitats that may be particularly attractive within the study area. This information can be useful in turbine layout design or micro-siting individual turbines to reduce risk to birds.

RESULTS

Eagle/Large Bird Use Surveys

Bird Diversity and Species Richness

Two-hundred fourteen eagle/large bird use surveys were conducted over 12 visits from March 3, 2018 through February 27, 2019 (Table 2). Fifty-six large bird species were recorded over the study period. Overall, large bird species richness was highest in spring (4.24 species/800-m plot/60-min survey), followed by summer (2.17), fall (1.48), and winter (0.38; Table 2).

During the eagle/large bird use surveys, 13,869 large birds were observed within 1,049 groups (Appendix A1). The most abundant large bird types recorded were waterfowl (10,078 observations in 272 groups), gulls/terns (1,307 observations in 47 groups), and waterbirds (1,116 observations in 97 groups; Appendix A1). Twenty species of waterfowl, three species of gulls/terns, and four species of waterbirds were identified during eagle/large bird surveys (Appendix A1). Canada goose (*Branta canadensis*) was the most frequently recorded large bird species (4,079 observations), followed by greater white-fronted goose (*Anser albifrons*; 2,197 observations), and American white pelican (*Pelecanus erythrorhynchos*; 986 observations). Thirteen diurnal raptor species were identified during standardized surveys and the most abundant diurnal raptor species recorded was red-tailed hawk (*Buteo jamaicensis*; 83 observations), followed by bald eagle (*Haliaeetus leucocephalus*; 54 observations), northern harrier (*Circus hudsonius*; 32 observations), sharp-shinned hawk (*Accipiter striatus*; 14 observations), and American kestrel (*Falco sparverius*; 13 observations; Appendix A1). Twenty-six observations within 24 groups of unidentified raptor species were also recorded during the study period (Appendix A1). The remainder of diurnal raptor species recorded during the study period had eight or fewer observations (Appendix A1).

Table 2. Summary of large bird species richness (species/800-meter plot/60-minute survey), and sample size by season and overall during eagle/large bird use surveys conducted from March 3, 2018 – February 27, 2019, at the Three Waters Wind Farm in Jackson County, Minnesota and Dickinson and Osceola counties, Iowa.

Season	Visits	Surveys Conducted	Species Richness	Index to Species Richness Large Birds
Spring	3	54	50	4.24
Summer	3	54	15	2.17
Fall	3	54	26	1.48
Winter	3	52	7	0.38
Overall	**12**	**214**	**56**	**2.08**

Bird Use, Percent of Use, and Frequency of Occurrence

Overall large bird use was highest during spring (139.59 birds/800-m plot/60-min survey), followed by fall (46.04), summer (8.11), and winter (3.55; Table 3, Appendix B1). In each season, large bird use was predominantly influenced by waterfowl activity. The second year of surveys were similar to large bird use recorded during Year 1. Waterfowl use was highest across all seasons except during winter and spring and fall were the highest use seasons (38.31 birds/800-m plot/60-min survey), followed by fall (29.11), summer (3.33), and winter (0.46).

Loons/Grebes

Loons/grebes use (observations/800-m plot/60-min survey) was recorded in relatively low levels during spring (0.06) and fall (0.09); no loons/grebes use was recorded during summer or winter (Table 3, Appendix B1). Loons/grebes accounted for less than 0.1% of large bird use during the spring and 0.2% during the fall. Loons/grebes were observed during 3.7% of spring and fall surveys (Table 3, Appendix B1).

Waterbirds

Waterbird use (observations/800-m plot/60-min survey) was recorded during spring (3.69), summer (0.52), and fall (3.20); no waterbird use was recorded in winter (Table 3, Appendix B1). Waterbirds accounted for 2.6% of large bird use during the spring, 6.6% during the summer, and 7.0% during the fall. Waterbirds were observed during 18.5% of spring surveys, 20.4% of summer surveys, and 7.4% of fall surveys (Table 3, Appendix B1). American white pelicans accounted for most waterbird use, particularly in spring and fall (Appendix B1).

Waterfowl

Waterfowl use (observations/800-m plot/60-min survey) was recorded during each season, with the highest use recorded in spring (129.94), followed by fall (19.93), summer (2.59), and winter (1.41; Table 3, Appendix B1). Waterfowl accounted for 93.1% of large bird use during the spring, 32.0% during the summer, 43.3% during the fall, and 39.7% during the winter. Waterfowl were observed during 61.1% of spring surveys, 14.8% of summer surveys, 13.0% of fall surveys, and 1.9% of winter surveys (Table 3, Appendix B1).

Shorebirds

Shorebird use (observation/800-m plot/60-min survey) was recorded during spring (2.07), summer (1.46), fall (0.20), and no use recorded during winter (Table 3, Appendix B1). Shorebirds use was relatively low, accounting for 1.5% of large bird use during the spring, 18.0% during the summer, and 0.4% during the fall. Shorebirds were observed during 18.5% of spring surveys, 68.5% of summer surveys, and 7.4% of fall surveys (Table 3, Appendix B1).

Gulls/Terns

Gulls/terns use (observation/800-m plot/60-min survey) was recorded relatively high during the fall (19.65) compared to spring (0.52) and summer (0.76); no use was recorded during winter (Table 3, Appendix B1). Gulls/terns accounted for 0.4% of large bird use during the spring, 9.4% during the summer, and 42.7% during the fall. Gulls/terns were observed during 24.1% of spring surveys, 3.7% of summer surveys, and 18.5% of fall surveys (Table 3, Appendix B1).

Rails/Coots

Rails/coots use (observations/800-m plot/60-min survey) was only recorded during spring (0.04; Table 3, Appendix B1). Rails/coots accounted for less than 0.1% of large bird use during spring and were observed during 1.9% of spring surveys (Table 3, Appendix B1).

Diurnal Raptors

Diurnal raptor use (observations/800-m plot/60-min survey) was recorded during each season, with the highest use recorded in spring (1.87), followed by fall (0.63), summer (0.15), and winter (0.12; Table 3, Appendix B1). Diurnal raptors accounted for 1.3% of large bird use during spring, 1.8% during summer, 1.4% during fall, and 3.3% during winter. Diurnal raptors were observed during 50.0% of spring surveys, 7.4% of summer surveys, 37.0% of fall surveys, and 11.6% of winter surveys (Table 3, Appendix B1).

Red-tailed hawk had the highest use observed for diurnal raptors during the spring (0.67 observation/800-m plot/60-min survey), and were observed during 20.4% of spring surveys (Appendix B1). American kestrel had the highest use observed for diurnal raptors during the fall (0.17), and were observed during 11.1% of fall surveys (Appendix B1). Bald eagle had the highest use observed for diurnal raptors in summer and winter (0.09 and 0.06 each); and were observed during 1.9% of summer and 6.0% of winter surveys, respectively (Appendix B1). Eagle use (observations/800-m plot/60-min survey) was recorded during each season, with the highest eagle use recorded during spring and fall (0.15), followed by summer (0.09), and winter (0.06; Table 3, Appendix B1).

Owls

Owl use (observations/800-m plot/60-min survey) was only recorded during spring (0.02; Table 3, Appendix B1). Owls accounted for less than 0.1% of large bird use during spring and were observed during 1.9% of spring surveys (Table 3, Appendix B1).

Vultures

Vulture use (observation/800-m plot/60-min survey) was recorded during spring (0.28), summer (0.17), fall (0.15), and no use recorded during winter (Table 3, Appendix B1). Vulture use was relatively low, accounting for 0.2% of large bird use during the spring, 2.1% during the summer, and 0.3% during the fall. Vultures were observed during 14.8% of spring surveys, 11.1% of summer surveys, and 7.4% of fall surveys (Table 3, Appendix B1).

Upland Game Birds

Upland game bird use (observations/800-m plot/60-min survey) was recorded during spring (0.74), summer (0.41), fall (0.04), and winter (0.96; Table 3, Appendix B1). Upland game birds accounted for 0.5% of large bird use during spring, 5.0% during summer, less than 0.1% during fall, and 27.0% during winter. Upland game birds were observed during 18.5% of spring surveys, 25.9% of summer surveys, 3.7% of fall surveys, and 6.0% of winter surveys (Table 3, Appendix B1).

Doves/Pigeons

Dove/pigeon use (observations/800-m plot/60-min survey) was recorded during spring (0.284), summer (2.02), fall (1.87), and winter (0.96; Table 3, Appendix B1). Doves/pigeons accounted for 0.2% of large bird use during spring, 24.9% during summer, 4.1% during fall, and 27.0% during winter. Doves/pigeons were observed during 9.3% of spring surveys, 50.0% of summer surveys, 16.7% of fall surveys, and 15.3% of winter surveys (Table 3, Appendix B1).

Large Corvids

Large corvid use (observations/800-m plot/60-min survey) was recorded during spring (0.07), summer (2.02), fall (1.87), and winter (0.96; Table 3, Appendix B1). Large corvids accounted for 0.2% of large bird use during spring, 24.9% during summer, 4.1% during fall, and 27.0% during winter. Large corvids were observed during 9.3% of spring surveys, 50.0% of summer surveys, 16.7% of fall surveys, and 15.3% of winter surveys (Table 3, Appendix B1).

<u>Goatsuckers</u>

Goatsucker use (observations/800-m plot/60-min survey) was only recorded during spring (0.02; Table 3, Appendix B1). Goatsuckers accounted for 0.5% of large bird use during spring and were observed during 18.5% of spring surveys (Table 3, Appendix B1).

Eagle Minutes

One hundred ninety-six bald eagle minutes were recorded during 54 bald eagle observations documented during 214 ECPG-level survey hours (Tables 4a and 4b). Of the 196 eagle minutes, 63 minutes were recorded in the ZOR (Tables 4a and 4b). Most eagle minutes in the ZOR were recorded during the fall (September – November), however the highest number of minutes in the ZOR were recorded during August (15 eagle minutes in ZOR), followed by September (10 eagle minutes in ZOR), and March (9 eagle minutes in ZOR; Tables 4a and 4b). Bald eagle minutes in the ZOR per 60-min survey were highest during fall (0.4259), followed by spring (0.3148), summer (0.2778), and winter (0.1538; Table 4b). Eagles were documented flying in the ZOR at eight of the 18 survey points (Table 4c). Point 1 had the highest number of minutes observed in the ZOR (25 minutes), followed by Point 14 (11 minutes), and Point 5 (nine minutes; Table 4c).

A larger number of bald eagle observations were recorded during Year 2 (54 observations) than Year 1 (9 observations), with a higher number of eagle minutes recorded in the ZOR during Year 2 than in Year 1 (e.g., 6 minutes in Year 1 and 63 minutes in Year 2). Most Year 1 eagle observations and associated minutes were recorded during the May, while eagle observations and flight minutes during Year 2 were primarily from the fall (September – November).

Table 3. Mean large bird use (number of birds/800-m plot/60-minute survey), percent of total use (%), and frequency of occurrence (%) for each large bird type and raptor subtype by season during fixed-point eagle/large bird use surveys conducted from March 3, 2018 – February 27, 2019, at the Three Waters Wind Farm in Jackson County, Minnesota and Dickinson and Osceola counties, Iowa.

	Mean Use				% of Use				% Frequency			
Type	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
Loons/Grebes	0.06	0	0.09	0	<0.1	0	0.2	0	3.7	0	3.7	0
Waterbirds	3.69	0.54	3.20	0	2.6	6.6	7.0	0	18.5	20.4	7.4	0
Waterfowl	129.94	2.59	19.93	1.41	93.1	32.0	43.3	39.7	61.1	14.8	13.0	1.9
Shorebirds	2.07	1.46	0.20	0	1.5	18.0	0.4	0	18.5	68.5	7.4	0
Gulls/Terns	0.52	0.76	19.65	0	0.4	9.4	42.7	0	24.1	3.7	18.5	0
Rails/Coots	0.04	0	0	0	<0.1	0	0	0	1.9	0	0	0
Diurnal Raptors	**1.87**	**0.15**	**0.63**	**0.12**	**1.3**	**1.8**	**1.4**	**3.3**	**50.0**	**7.4**	**37.0**	**11.6**
Accipiters	*0.33*	*0*	*0.02*	*0*	*0.2*	*0*	*<0.1*	*0*	*22.2*	*0*	*1.9*	*0*
Buteos	*0.83*	*0.06*	*0.13*	*0.04*	*0.6*	*0.7*	*0.3*	*1.0*	*27.8*	*5.6*	*11.1*	*3.7*
Northern Harrier	*0.39*	*0*	*0.13*	*0.02*	*0.3*	*0*	*0.3*	*0.5*	*18.5*	*0*	*9.3*	*1.9*
Eagles	*0.15*	*0.09*	*0.15*	*0.06*	*0.1*	*1.1*	*0.3*	*1.7*	*11.1*	*1.9*	*9.3*	*6.0*
Falcons	*0.13*	*0*	*0.20*	*0*	*<0.1*	*0*	*0.4*	*0*	*9.3*	*0*	*14.8*	*0*
Osprey	*0.04*	*0*	*0*	*0*	*<0.1*	*0*	*0*	*0*	*3.7*	*0*	*0*	*0*
Owls	0.02	0	0	0	<0.1	0	0	0	1.9	0	0	0
Vultures	0.28	0.17	0.15	0	0.2	2.1	0.3	0	14.8	11.1	7.4	0
Upland Game Birds	0.74	0.41	0.04	0.96	0.5	5.0	<0.1	27.0	18.5	25.9	3.7	6.0
Doves/Pigeons	0.28	2.02	1.87	0.96	0.2	24.9	4.1	27.0	9.3	50.0	16.7	15.3
Large Corvids	0.07	0.02	0.28	0.11	<0.1	0.2	0.6	3.1	3.7	1.9	11.1	3.7
Goatsuckers	0.02	0	0	0	<0.1	0	0	0	1.9	0	0	0
Large Birds Overall[a]	**139.59**	**8.11**	**46.04**	**3.55**	**100**	**100**	**100**	**100**				

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

Table 4a. Bald eagle observations attributable to bald eagle minutes and bald eagle minutes by month during eagle/large bird use surveys conducted from March 3, 2018 – February 27, 2019 at the Three Waters Wind Farm in Jackson County, Minnesota and Dickinson and Osceola counties, Iowa.

Month	Total Bald Eagles Observed	Total Minutes Observed	Total Minutes in Zone of Risk[1]
March 2018	8	23	9
April 2018	5	65	8
May 2018	2	0	0
June 2018	1	0	0
July 2018	2	0	0
August 2018	5	38	15
September 2018	12	25	10
October 2018	11	17	8
November 2018	3	12	5
December 2018	0	0	0
January 2019	3	3	2
February 2019	2	13	6
Total	**54**	**196**	**63**

[1]Zone of Risk is the defined as flying behavior below 200 meters (m; 656 feet [ft]) and within 800 m (2,625 ft) of the survey location.

Table 4b. Bald eagle minutes documented in the zone of risk during fixed-point eagle/large bird use surveys conducted from March 3, 2018 – February 27, 2019, at the Three Waters Wind Farm in Jackson County, Minnesota and Dickinson and Osceola counties, Iowa.

Season	Bald Eagle Minutes in Zone of Risk	Survey Effort (hours)	Survey Effort (minutes)	Eagle Flight Minute per Minute Survey
Spring (03/01 – 05/31)	17	54	3,240	0.3148
Summer (06/01 – 08/31)	15	54	3,240	0.2778
Fall (09/01 – 11/30)	23	54	3,240	0.4259
Winter (12/01 – 02/28)	8	52	3,120	0.1538
Total	**63**	**214**	**12,840**	**0.2944**

Table 4c. Bald eagle minutes by point during fixed-point eagle/large bird use surveys conducted from March 3, 2018 – February 27, 2019, at the Three Waters Wind Farm in Jackson County, Minnesota and Dickinson and Osceola counties, Iowa.

Point	Total Minutes Observed	Minutes Flying In Zone of Risk[1]
1	63	25
2	17	7
3	0	0
4	0	0
5	69	9
6	0	0
7	9	5
8	2	2
9	0	0
10	0	0
11	10	2
12	0	0
13	3	2
14	23	11
15	0	0
16	0	0
17	0	0
18	0	0
Total	**196**	**63**

[1]Zone of Risk is defined as below 200 meters (m; 656 feet [ft]) and within 800 m (2,625 ft) of the survey location.

Bird Flight Height and Behavior

Flight height characteristics were calculated for bird types and species, based on initial flight heights and estimated use (Table 5). During eagle/large bird use surveys, 9,621 observations in 544 groups of large birds were documented flying within the 800-m plots. Overall, 54.0% of flying large birds were recorded within the RSH (i.e., 25–150 m AGL), 38.0% were above the RSH, and 8.0% were below the RSH (Table 5). Most flying diurnal raptors were recorded either below RSH (34.3%) or above RSH (24.1%), while 41.6% were within the RSH. Of the 24 bald eagles observed flying, 79.2% were within the RSH, while 12.5% were above RSH and 8.3% were below the RSH (Table 5).

Bird Exposure Index

A relative exposure index was calculated for each bird species based on initial flight heights observations and use estimates (Table 6, Appendix C1). Canada goose had the highest exposure index value (9.64), followed by greater white-fronted goose (6.23), Franklin's gull (*Leucophaeus pipixcan* [3.32]), and snow goose (*Chen caerulescens* [2.32; Table 6]). The remaining species with recorded flying observations had exposure indices of 0.71 or lower. Bald eagles had an exposure index value of 0.09 (Table 6).

Table 5 Flight height characteristics by bird type and raptor subtype during eagle/large bird use surveys conducted from March 3, 2018 – February 27, 2019, at the Three Waters Wind Farm in Jackson County, Minnesota and Dickinson and Osceola counties, Iowa.

Bird Type	# Groups Flying	# Obs Flying	Mean Flight Height (m)	% Obs Flying	% within Flight Height Categories 0–25 m	25–150 m[a]	> 150 m
Loons/Grebes	2	5	69.00	62.5	60.0	40.0	0
Waterbirds	36	399	91.53	99.5	40.4	21.3	38.3
Waterfowl	210	7,677	119.90	92.4	4.3	53.4	42.3
Shorebirds	43	91	9.30	45.0	93.4	6.6	0
Gulls/Terns	38	1,130	104.03	100	1.9	78.8	19.4
Rails/Coots	0	0	NA	0	NA	NA	NA
Diurnal Raptors	**133**	**137**	**99.96**	**91.9**	**34.3**	**41.6**	**24.1**
Accipiters	*19*	*19*	*113.11*	*100*	*42.1*	*21.1*	*36.8*
Buteos	*47*	*51*	*136.57*	*89.5*	*15.7*	*51.0*	*33.3*
Northern Harrier	*29*	*29*	*61.41*	*100*	*62.1*	*24.1*	*13.8*
Eagles	*24*	*24*	*95.42*	*100*	*8.3*	*79.2*	*12.5*
Falcons	*12*	*12*	*22.17*	*66.7*	*91.7*	*0*	*8.3*
Osprey	*2*	*2*	*195.00*	*100*	*0*	*50.0*	*50.0*
Owls	1	1	3.00	100	100	0	0
Vultures	24	31	80.12	96.9	9.7	77.4	12.9
Upland Game Birds	8	23	1.38	20.7	100	0	0
Doves/Pigeons	40	108	11.93	39.4	80.6	19.4	0
Large Corvids	8	18	14.50	69.2	72.2	27.8	0
Goatsuckers	1	1	80.00	100	0	100	0
Large Birds Overall	**544**	**9,621**	**89.84**	**90.4**	**8.0**	**54.0**	**38.0**

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

Obs=observations; m = meters.

Table 6. Relative exposure index and flight characteristics for large bird species[a] during eagle/large bird use surveys conducted from March 3, 2018 – February 27, 2019, at the Three Waters Wind Farm in Jackson County, Minnesota and Dickinson and Osceola counties, Iowa.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within RSH[b] Based on Initial Observations	Exposure Index	% Within RSH at Anytime
Canada goose	76	17.55	85.2	64.4	9.64	78.1
greater white-fronted goose	12	10.25	100	60.7	6.23	70.9
Franklin’s gull	15	3.41	100	97.4	3.32	97.4
snow goose	14	4.28	100	54.1	2.32	54.1
mallard	48	3.06	91.9	25.4	0.71	26.9
unidentified gull	3	0.53	100	100	0.53	100
American white pelican	9	1.62	100	16.0	0.26	41.3
herring gull	6	0.23	100	90.0	0.21	96.0
red-tailed hawk	38	0.22	87.5	57.1	0.11	59.5
turkey vulture	24	0.15	96.9	77.4	0.11	80.6
bald eagle	24	0.11	100	79.2	0.09	87.5
double-crested cormorant	6	0.13	100	66.7	0.08	66.7
rock pigeon	11	0.95	31.4	26.6	0.08	28.1
ring-billed gull	14	1.05	100	4.8	0.05	93.0
great blue heron	20	0.10	100	45.5	0.05	59.1

Table 6. Relative exposure index and flight characteristics for large bird species[a] during eagle/large bird use surveys conducted from March 3, 2018 – February 27, 2019, at the Three Waters Wind Farm in Jackson County, Minnesota and Dickinson and Osceola counties, Iowa.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within RSH[b] Based on Initial Observations	Exposure Index	% Within RSH at Anytime
gadwall	7	0.07	100	50.0	0.04	81.2
wood duck	3	0.06	53.8	100	0.03	100
northern harrier	29	0.13	100	24.1	0.03	27.6
green-winged teal	4	0.06	100	46.2	0.03	46.2
northern pintail	5	0.28	100	10.0	0.03	10.0
blue-winged teal	2	0.08	52.9	55.6	0.02	55.6
American crow	8	0.12	69.2	27.8	0.02	38.9
sharp-shinned hawk	14	0.07	100	28.6	0.02	28.6
American wigeon	6	0.06	100	33.3	0.02	58.3
killdeer	39	0.48	46.2	8.3	0.02	20.8
mourning dove	29	0.33	62.9	9.1	0.02	9.1
common merganser	4	0.07	100	18.8	0.01	18.8
unidentified duck	12	1.21	100	1.2	0.01	1.5
redhead	2	0.05	100	20.0	<0.01	20.0
rough-legged hawk	8	0.04	100	25.0	<0.01	25.0
unidentified shorebird	2	<0.01	100	100	<0.01	100
common loon	1	<0.01	100	100	<0.01	100
northern shoveler	3	0.05	54.5	33.3	<0.01	33.3
cackling goose	3	1.40	100	0.7	<0.01	100
common nighthawk	1	<0.01	100	100	<0.01	100
osprey	2	<0.01	100	50.0	<0.01	50.0
Ross' goose	1	<0.01	100	100	<0.01	100
unidentified scaup	1	<0.01	100	100	<0.01	100
great egret	1	<0.01	100	100	<0.01	100
ring-necked pheasant	7	0.53	19.3	0	0	0
gray partridge	1	<0.01	100	0	0	0
short-eared owl	1	<0.01	100	0	0	0
American kestrel	7	0.06	53.8	0	0	0
peregrine falcon	1	<0.01	100	0	0	100
merlin	4	0.02	100	0	0	0
Swainson's hawk	1	<0.01	100	0	0	0
unidentified accipiter	1	<0.01	100	0	0	0
northern goshawk	1	<0.01	100	0	0	0
Cooper's hawk	3	0.01	100	0	0	0
upland sandpiper	1	0.03	16.7	0	0	0
unidentified plover	1	0.42	44.4	0	0	0
bufflehead	1	0.03	100	0	0	0
ring-necked duck	2	0.01	100	0	0	0
lesser scaup	4	0.12	100	0	0	0
western grebe	1	0.01	100	0	0	0

[a] Only includes species with actual exposure index values; see Appendix C for full listing.

[b] The likely "rotor-swept height" (RSH) for potential collision with a turbine blade, or 25−150 m (82−492 ft) above ground level.

Spatial Use

Large birds were observed at all 18 survey points (Figure 5a, Appendix D1). Large bird use by point ranged from 1.45−170.25 observations/60-min survey, with highest use at Point 4 (Figure 5a, Appendix D1). The high use observed at Point 4 was largely due to high waterfowl use (167.67 observations/60-min survey; Appendix D1).

Diurnal raptors were observed at all 18 survey points (Figure 5b, Appendix D1). Diurnal raptor use ranged from 0.17−1.58 observations/60-min survey, with higher use at Points 7 and 16 (1.58; Figure 5b, Appendix D1). Bald eagles were observed at eight of the 18 survey points, with highest use at Point 1 (0.67), followed by Point 2 (0.33), Point 14 (0.33), and Point 5 (0.25; Figure 5c). Flight paths of diurnal raptors, including bald eagles, were digitized and mapped (Figure 6). Flight paths of diurnal raptors indicated no obvious movement corridors or areas of concentration. Survey results suggests overall large bird use is distributed throughout the Project area, with variability in large bird use among survey points (Appendix D1). The higher concentration of eagle flight paths recorded at Point 1 was associated with Skunk Lake, located in the southeastern portion of the Project area (Figure 6). The remaining recorded bald eagle flight paths appear to be generally evenly spread through the Project boundary.

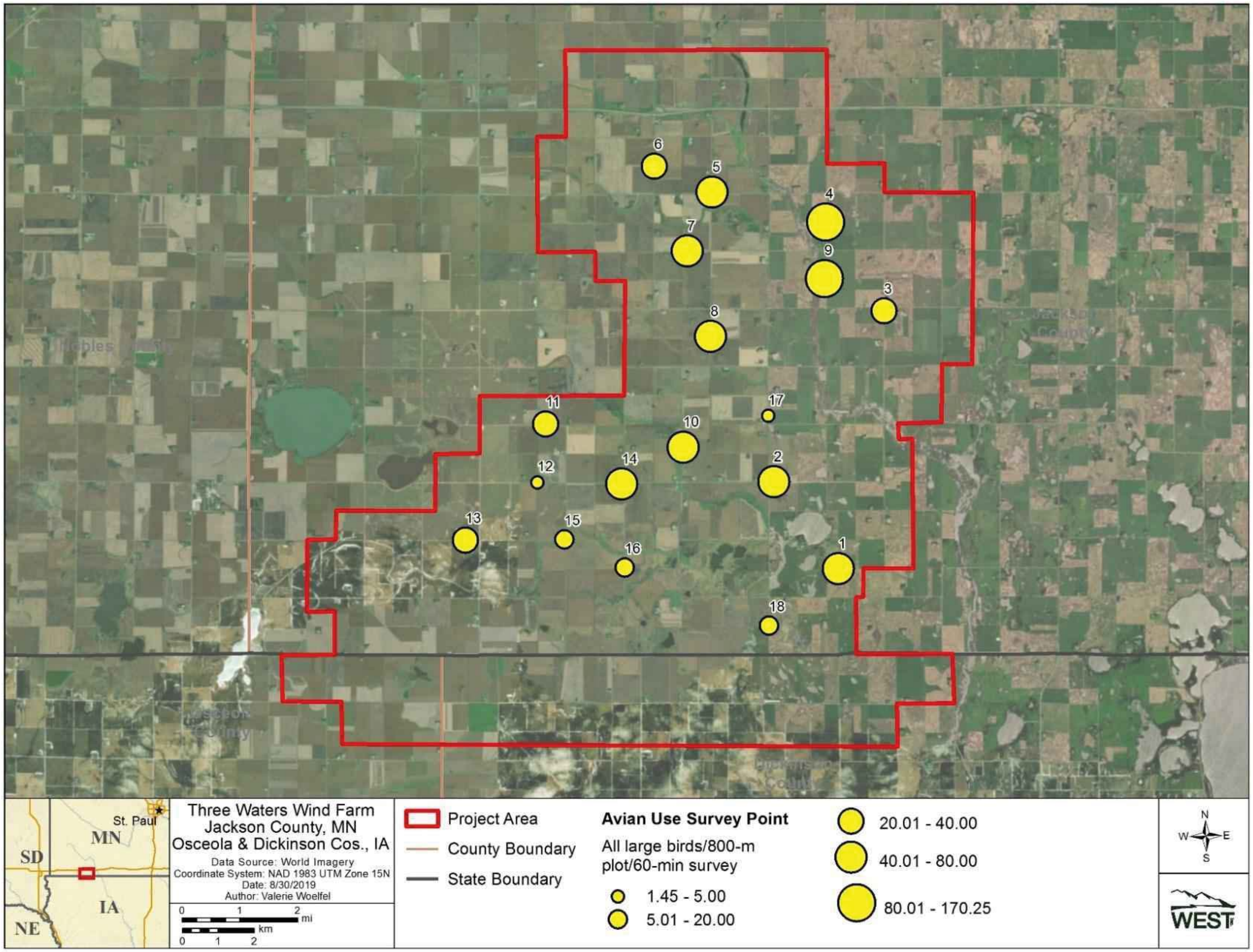

Figure 4a. Large bird use by observation point during eagle/large bird use surveys conducted from March 3, 2018 – February 27, 2019 at the Three Waters Wind Farm in Jackson County, Minnesota and Dickinson and Osceola counties, Iowa.

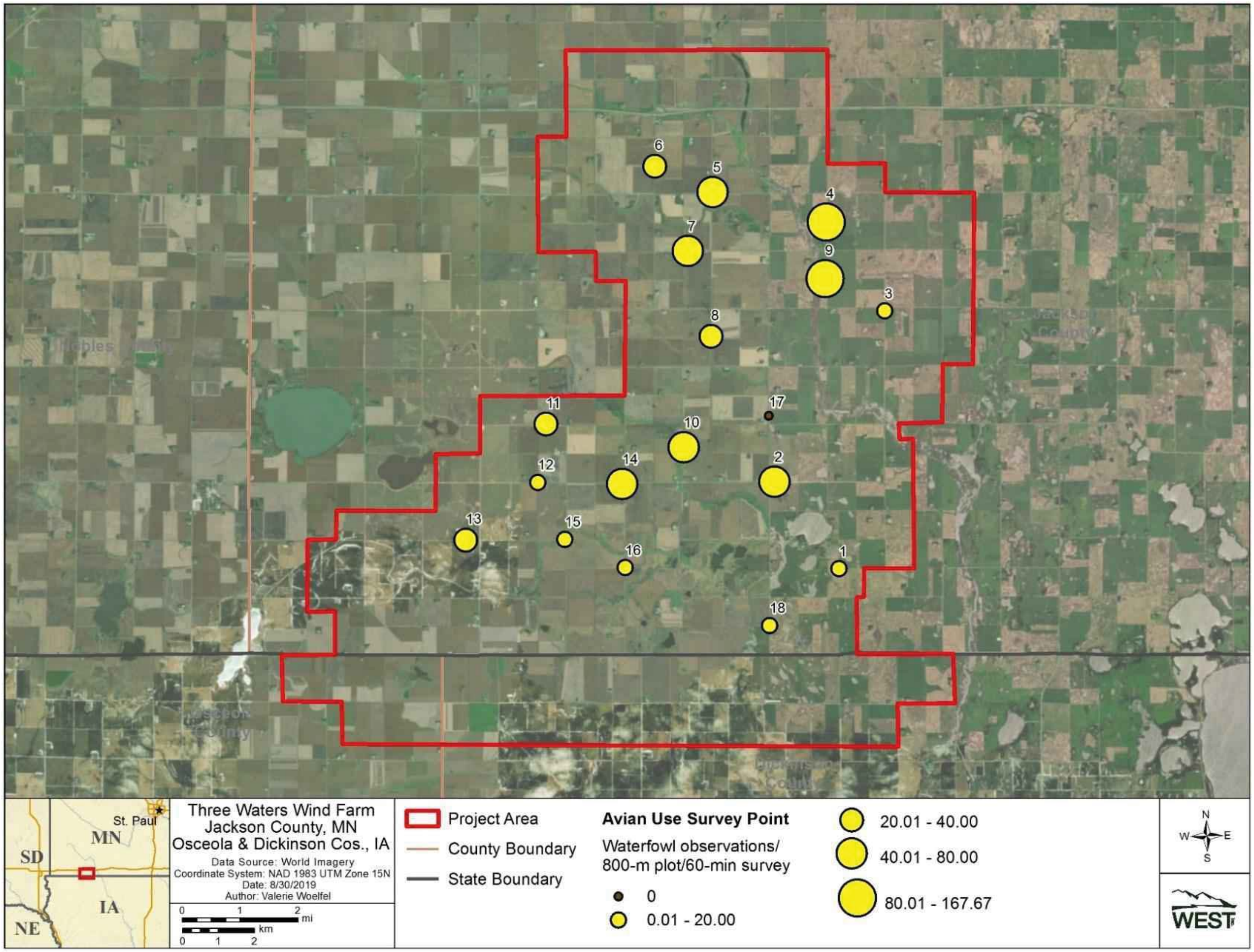

Figure 4b. Waterfowl use by observation point during eagle/large bird use surveys conducted from March 3, 2018 – February 27, 2019 at the Three Waters Wind Farm in Jackson County, Minnesota and Dickinson and Osceola counties, Iowa.

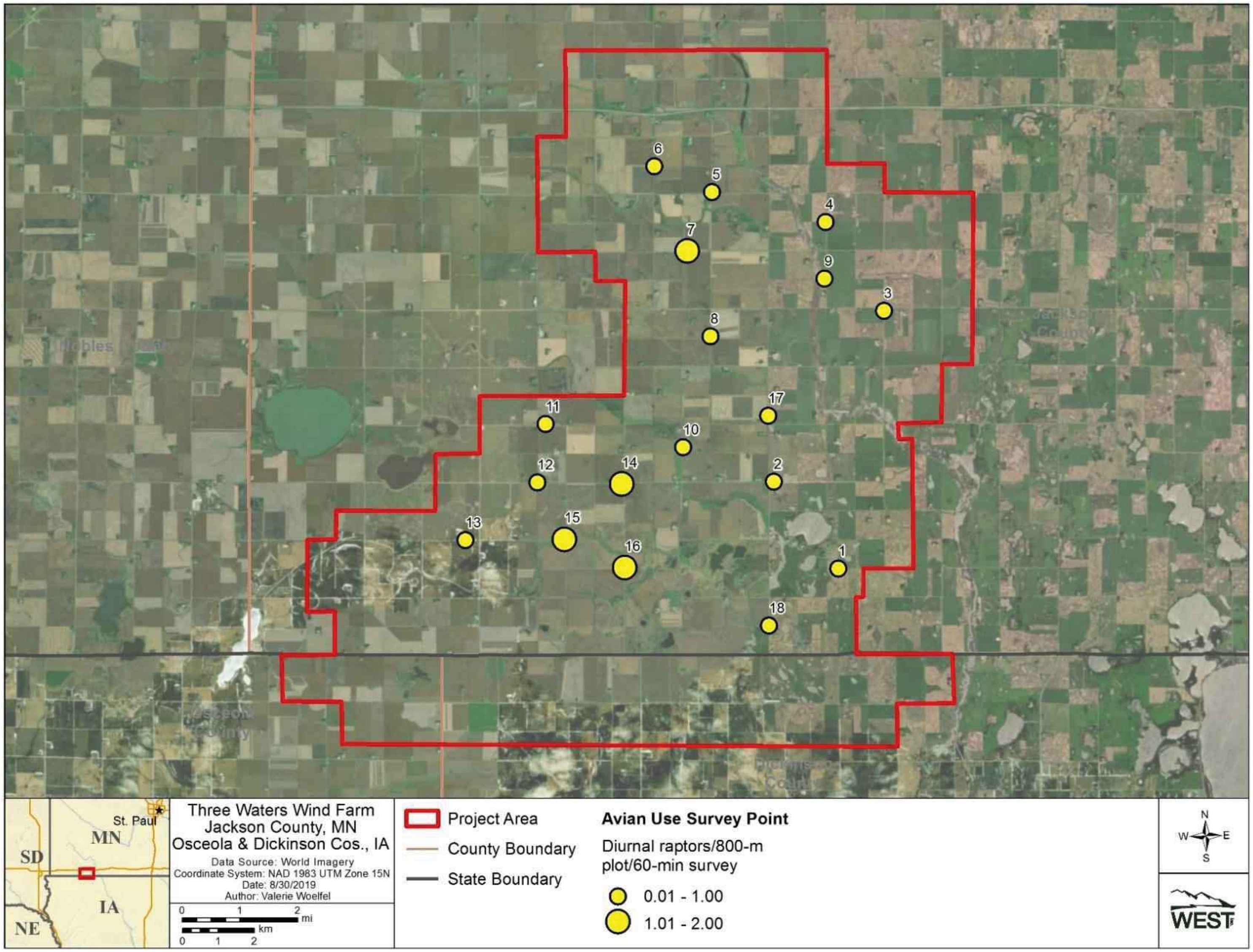

Figure 4c. Diurnal raptor use by observation point during eagle/large bird use surveys conducted from March 3, 2018 – February 27, 2019 at the Three Waters Wind Farm in Jackson County, Minnesota and Dickinson and Osceola counties, Iowa.

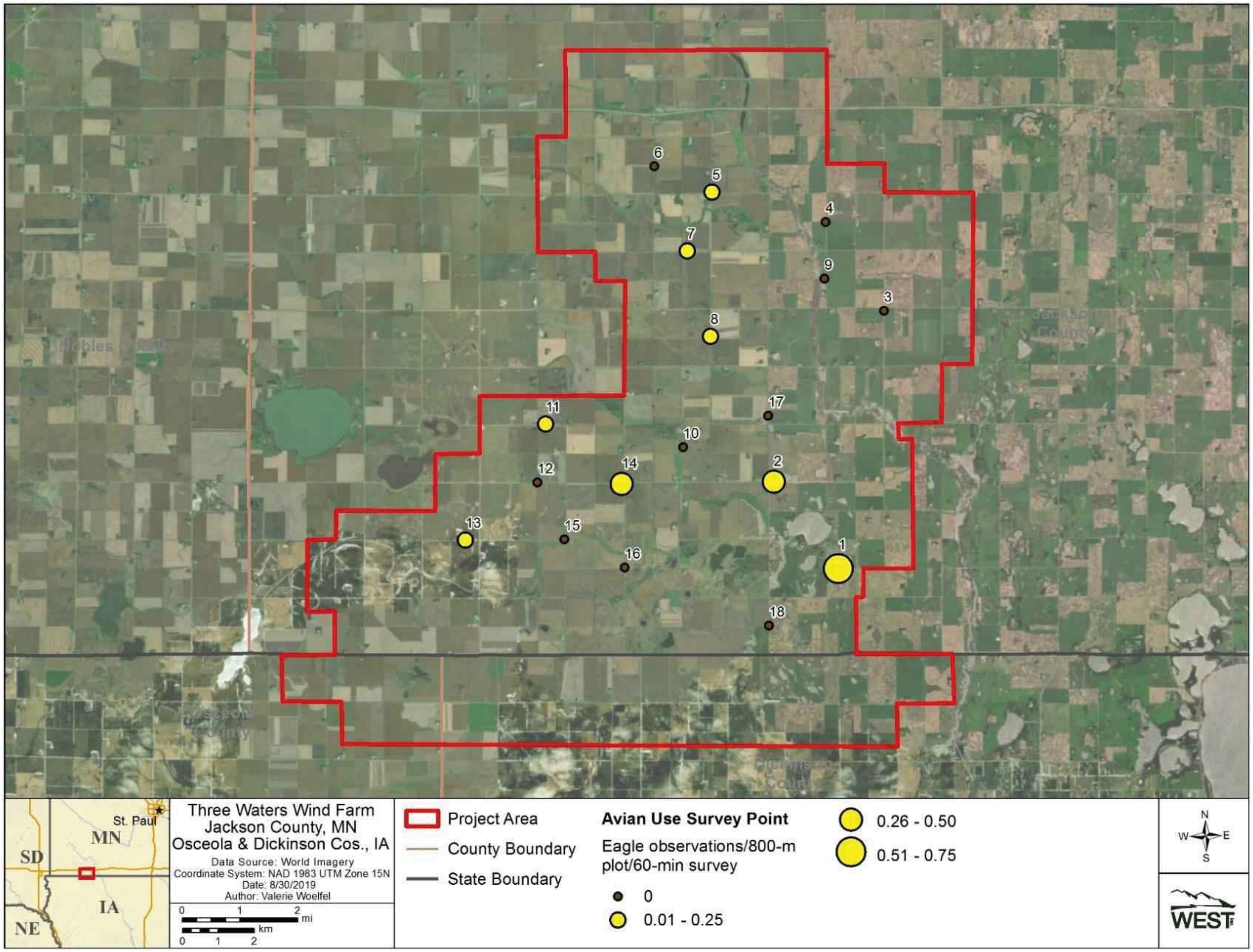

Figure 4d. Bald eagle use by observation point during eagle/large bird use surveys conducted from March 3, 2018 – February 27, 2019 at the Three Waters Wind Farm in Jackson County, Minnesota and Dickinson and Osceola counties, Iowa.

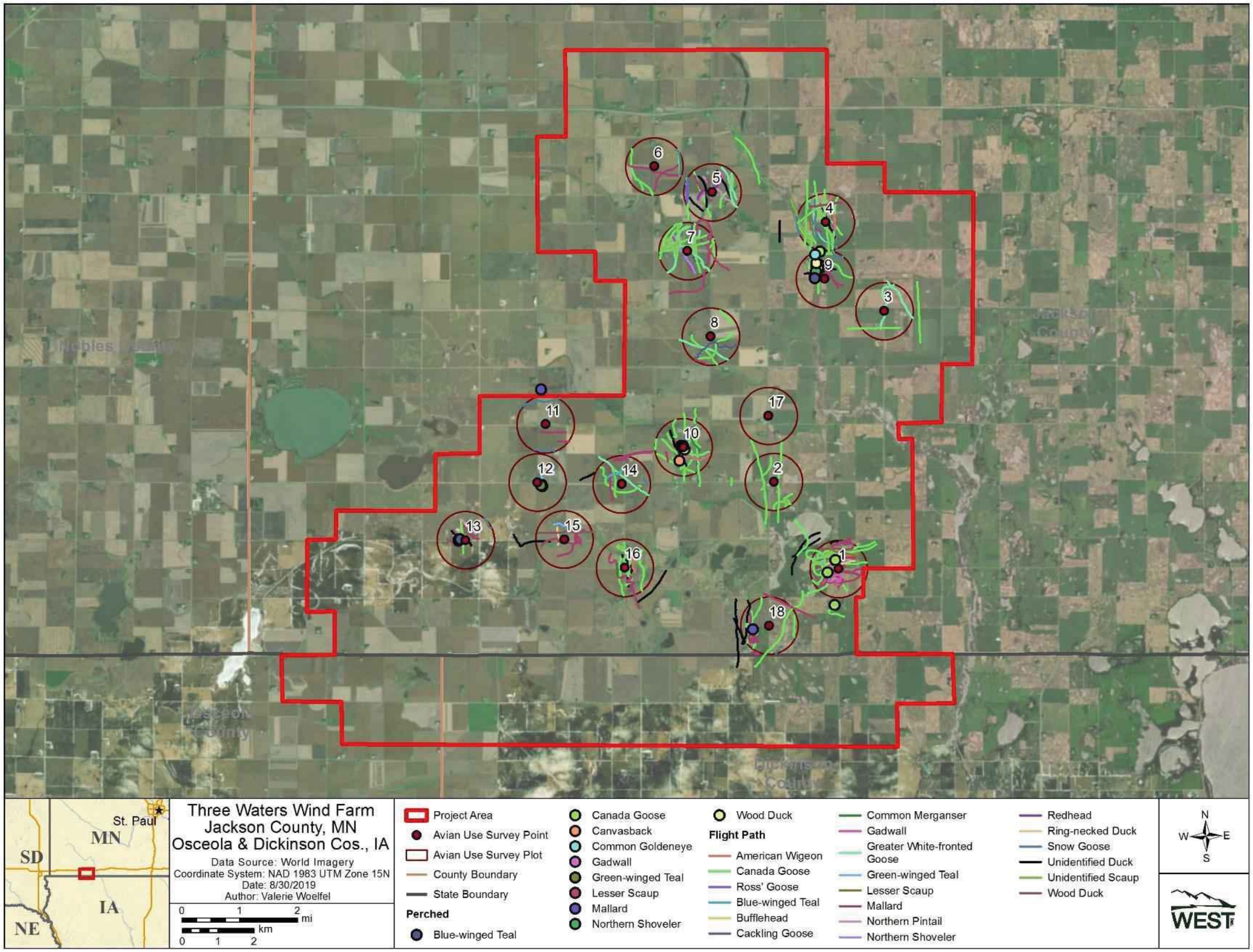

Figure 5a. Waterfowl flight paths recorded during eagle/large bird use surveys conducted from March 3, 2018 – February 27, 2019 at the Three Waters Wind Farm in Jackson County, Minnesota and Dickinson and Osceola counties, Iowa.

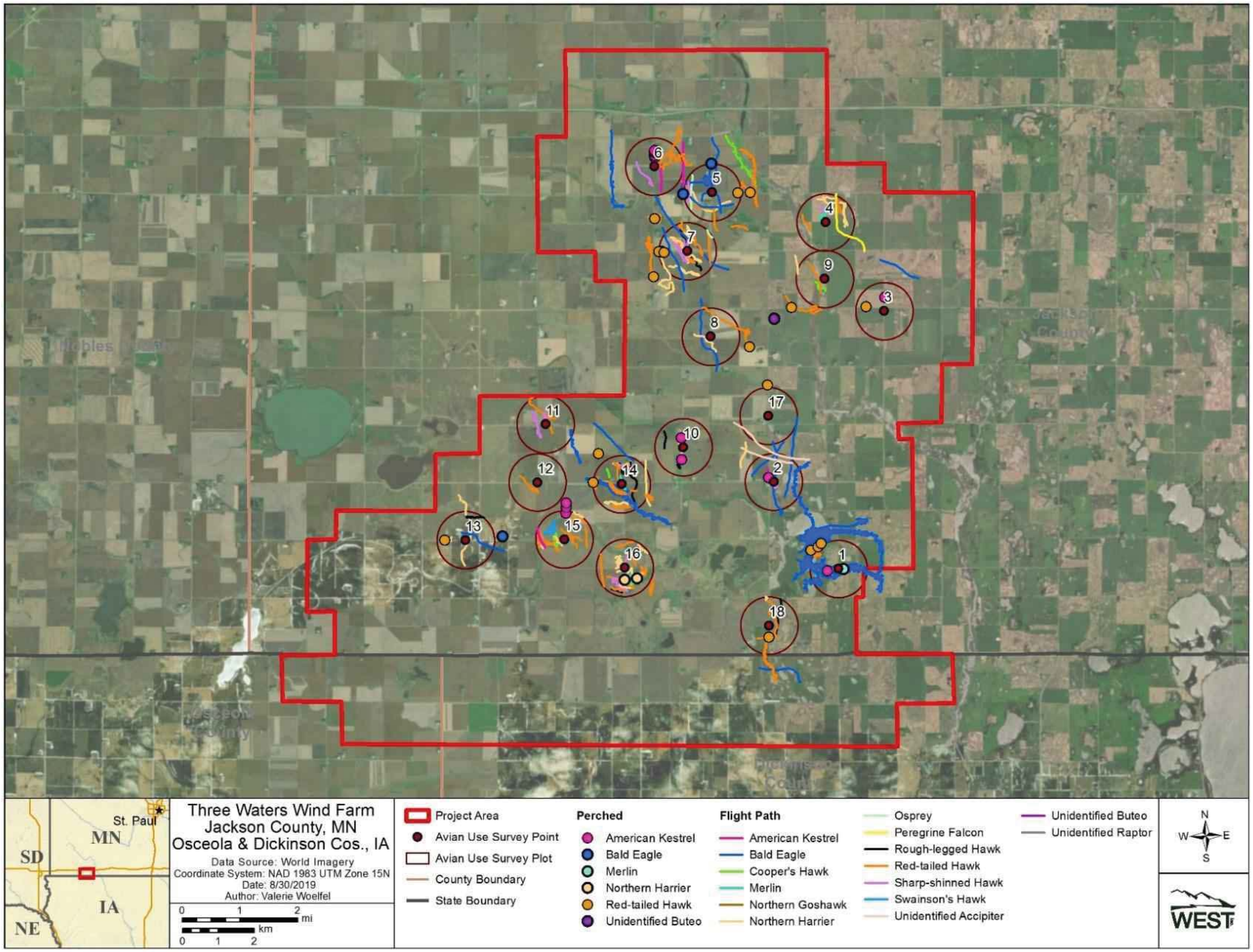

Figure 5b. Diurnal raptor flight paths recorded during eagle/large bird use surveys conducted from March 3, 2018 – February 27, 2019 at the Three Waters Wind Farm in Jackson County, Minnesota and Dickinson and Osceola counties, Iowa.

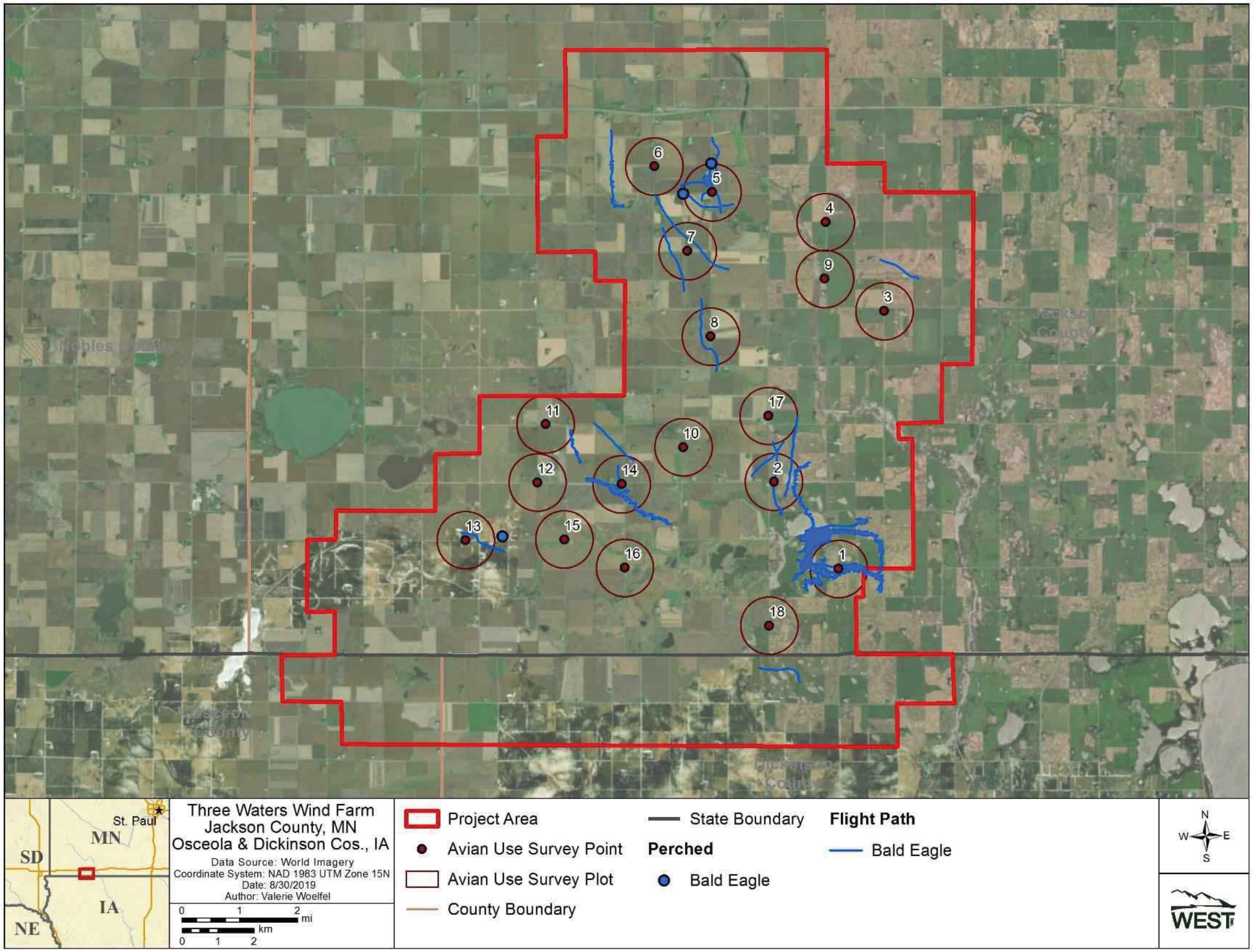

Figure 5c. Bald eagle flight paths recorded during eagle/large bird use surveys conducted from March 3, 2018 − February 27, 2019 at the Three Waters Wind Farm in Jackson County, Minnesota and Dickinson and Osceola counties, Iowa.

Small Bird Use Surveys

Bird Diversity and Species Richness

Thirty-six small bird species were documented during small bird use surveys (Table 7). A mean of 1.48 small bird species/100-m plot/10-min survey were recorded. The number of small bird species recorded was highest in spring (27), followed by summer (22), fall (14), and winter (four; Table 7). Small bird species richness (mean number of species/100-m plot/10-min survey) was highest during summer (3.11), followed by spring (1.94), fall (0.69), and winter (0.15; Table 7). In comparison, Year 1 small bird species richness range from 0.30 species/100-m/10-min survey in the winter to 3.35 species/100-m/10-min survey in the summer.

Table 7. Summary of small bird species richness (species/100-meter plot/10-minute survey), and sample size by season and overall during small bird use surveys conducted from March 3, 2018 – February 27, 2019, at the Three Waters Wind Farm in Jackson County, Minnesota and Dickinson and Osceola counties, Iowa.

Season	Number of Visits	# Surveys Conducted	# Species	Small Bird Species Richness
Spring	3	54	27	1.94
Summer	3	54	22	3.11
Fall	3	54	14	0.69
Winter	3	52	4	0.15
Overall	**12**	**214**	**36**	**1.48**

Small bird surveys resulted in a total of 1,714 observations in 644 groups, with the greatest abundance of small birds recorded in the spring (Appendix A2). Most small bird observations were of horned lark (*Eremophila alpestris*; 401 observations), red-winged blackbird (*Agelaius phoeniceus*; 398 observations), and common grackle (*Quiscalus quiscula*; 236 observations; Appendix A2). One hundred fifty-five observations of unidentified blackbirds were also recorded during small bird surveys.

Bird Use, Percent of Use, and Frequency of Occurrence

Mean bird use, percent of use, and frequency of occurrence were calculated by season for all small bird types (Table 8) and species (Appendix B2). Small bird use consisted mostly of use by passerines, though use by swifts/hummingbirds and woodpeckers were also recorded. Overall, mean small bird use (birds/100-m plot/10-min survey) was highest in spring (17.54), followed by summer (8.63), fall (4.15), and winter (1.03; Table 7). Small bird use recorded during Year 1 was also attributed to primarily passerine species and was highest during the fall (29.74 birds/100-m plot/10-min survey), but was lowest during the spring (4.04).

Horned lark represented the highest percentage of small bird use in spring (37.9%), common grackle had the highest percentage of small bird use (32.8%) during summer, red-winged blackbird had the highest percentage of small bird use (50.4%) during fall, and house sparrow had the highest percentage of small bird use in winter (62.9%; Appendix B2). Because small birds were documented within a 100-m viewshed during a 10-min observation period, descriptive statistics for small bird types are not directly comparable to large bird types.

Table 8. Mean small bird use (number of birds/100-meter plot/10-minute survey), percent of total use (%), and frequency of occurrence (%) for each small bird type by season recorded during small bird use surveys conducted from March 3, 2018 – February 27, 2019, at the Three Waters Wind Farm in Jackson County, Minnesota and Dickinson and Osceola counties, Iowa.

	Mean Use				% of Use				% Frequency			
Type	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
Passerines	17.54	8.61	4.07	1.03	99.8	99.8	98.2	100	59.3	96.3	50.0	11.3
Swifts/Hummingbirds	0	0.02	0	0	0	0.2	0	0	0	1.9	0	0
Woodpeckers	0.04	0	0.07	0	0.2	0	1.8	0	1.9	0	3.7	0
Overall[a]	**17.57**	**8.63**	**4.15**	**1.03**	**100**	**100**	**100**	**100**				

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

Bird Flight Height and Behavior

Flight height characteristics, based on initial flight height observations, and estimated use were calculated for small bird types and species (Table 9, Appendix C2). During small bird surveys, 428 groups of small birds were documented flying within the 100-m plot, totaling 1,397 observations. Most flying observations were passerine species (1,390 observations), with only six observations of woodpeckers and one observation of swift/hummingbird. Overall, 15.9% of flying small birds were recorded within the RSH (i.e., 25-150 m AGL), 52.5% were below the RSH, and 31.6% were above the RSH (Table 9).

Table 9. Flight height characteristics by bird type during small bird use surveys conducted from March 3, 2018 – February 27, 2019, at the Three Waters Wind Farm in Jackson County, Minnesota and Dickinson and Osceola counties, Iowa.

Bird Type	# Groups Flying	# Obs Flying	Mean Flight Height (m)	% Obs Flying	% within Flight Height Categories		
					0-25 m	25-150 m[a]	>150 m
Passerines	423	1,390	11.91	82.4	52.4	15.8	31.7
Swifts/Hummingbirds	1	1	3.00	100	100	0	0
Woodpeckers	4	6	23.75	100	66.7	33.3	0
Small Birds Overall[b]	**428**	**1,397**	**12.00**	**82.5**	**52.5**	**15.9**	**31.6**

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

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

m=meters; Obs = observation

Bird Exposure Index

A relative exposure index based on initial flight height observations and the use estimate was calculated for each small bird species (Appendix C2). Horned lark had the highest exposure index value of all small bird species (0.59), followed by unidentified blackbird (0.14; Table 10). The remaining small bird species with recorded flying observations had exposure indices of 0.07 or lower.

Table 10. Relative exposure index and flight characteristics for each small bird species[a] during small bird use surveys conducted from March 3, 2018 – February 27, 2019, at the Three Waters Wind Farm in Jackson County, Minnesota and Dickinson and Osceola counties, Iowa.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within RSH[b] Based on Initial Observations	Exposure Index	% Within RSH at Anytime
horned lark	10	1.87	95.3	33.2	0.59	33.2
unidentified blackbird	3	0.72	100	19.4	0.14	19.4
common grackle	112	1.07	81.2	8.1	0.07	8.1
European starling	2	0.10	100	54.5	0.06	54.5
cliff swallow	20	0.18	100	26.3	0.05	44.7
American robin	25	0.27	76.3	20.0	0.04	20.0
unidentified passerine	12	0.24	54.9	21.4	0.03	28.6
red-winged blackbird	109	1.85	89.4	1.4	0.02	1.4
rusty blackbird	2	0.02	80.0	75.0	0.01	75.0
northern flicker	4	0.03	100	33.3	<0.01	33.3
barn swallow	33	0.24	98.1	2.0	<0.01	9.8
unidentified sparrow	21	0.16	74.3	3.8	<0.01	3.8
tree swallow	3	0.01	100	33.3	<0.01	33.3
ruby-throated hummingbird	1	<0.01	100	0	0	0
cedar waxwing	1	0.01	100	0	0	0
yellow warbler	1	<0.01	100	0	0	0
common yellowthroat	6	0.11	37.5	0	0	0
unidentified warbler	1	0.01	100	0	0	100
bank swallow	1	<0.01	100	0	0	0
purple martin	1	<0.01	100	0	0	0
vesper sparrow	2	0.04	25.0	0	0	0
house sparrow	4	0.19	16.7	0	0	0
song sparrow	1	0.06	7.7	0	0	0
eastern kingbird	1	<0.01	100	0	0	0
American goldfinch	10	0.12	50.0	0	0	0
yellow-headed blackbird	2	0.01	100	0	0	0
brown-headed cowbird	37	0.32	66.2	0	0	2.2
bobolink	3	0.02	60.0	0	0	0

a. Only includes species with actual exposure index values; see Appendix C2 for full listing.

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

Spatial Use

Small bird use was recorded at all 18 survey points, ranging from 1.58 to 39.00 birds/100-m plot/10-min survey (Appendix D2). Overall, small bird use was highest at Point 5 (39.00 birds/100-m plot/10-min survey). Points 1 and 6 had higher recorded small bird use during the Year 1 study (62.17 and 46.25 observations/100-m/10-min survey, respectively)Woodpecker use was recorded at three of the 11 survey points in low levels, ranging from 0.08−0.25 (Appendix D2). All swift/hummingbird use was recorded at Point 16 (0.08; Appendix D2).

Sensitive Species Observations

While no federally listed species were recorded during the bird use surveys, two state-listed threatened species and several species of concern were recorded during surveys or as incidental observations documented outside standardized surveys (Table 11). Fifty-seven bald eagle observations were recorded during the survey period. In addition, the state-listed threatened peregrine falcon (*Falco peregrinus*) was observed during surveys and the state-listed threatened trumpeter swan (*Cygnus buccinator*) was observed incidentally within the Project. Several other Minnesota special concern species and species of greatest conservation need were also recorded (Table 11), including observations of large numbers of American white pelican and Franklin's gull. Three of these sensitive species (bald eagle, golden eagle, and Henslow's sparrow) were also recorded during surveys and/or incidentally during Year 1 (Table 11).

Table 11. Summary of sensitive species observed during bird use surveys (BUS) and as incidental wildlife observations (Inc.) from March 3, 2018 – February 27, 2019 at the Three Waters Wind Farm in Jackson County, Minnesota and Dickinson and Osceola counties, Iowa.

			BUS[a]		Inc.		Total	
Species	**Scientific Name**	**Status**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
American white pelican	*Pelecanus erythrorhynchos*	SC; SGCN	45	986	6	20	51	1,006
bald eagle	*Haliaeetus leucocephalus*	BGEPA	54	54	3	3	57	57
common loon	*Gavia immer*	SGCN	1	2	0	0	1	2
common nighthawk	*Chordeiles minor*	SGCN	1	1	0	0	1	1
Franklin's gull	*Leucophaeus pipixcan*	SC; SGCN	16	747	0	0	16	747
lesser scaup	*Aythya affinis*	SGCN	4	26	0	0	4	26
northern goshawk	*Accipiter gentilis*	SGCN	1	1	0	0	1	1
northern harrier	*Circus hudsonius*	SGCN	32	32	2	2	34	34
northern pintail	*Anas acuta*	SGCN	5	60	0	0	5	60
peregrine falcon	*Falco peregrinus*	SC; SGCN	1	1	0	0	1	1
short-eared owl	*Asio flammeus*	SC; SGCN	1	1	0	0	1	1
Swainson's hawk	*Buteo swainsoni*	SGCN	1	1	0	0	1	1
trumpeter swan	*Cygnus buccinator*	SC; SGCN	0	0	1	2	1	2
upland sandpiper	*Bartramia longicauda*	SGCN	7	7	0	0	7	7
Virginia rail	*Rallus limicola*	SGCN	1	1	0	0	1	1
western grebe	*Aechmophorus occidentalis*	SGCN	1	3	0	0	1	3
Large Birds Overall	***16 Species***		**171**	**1,923**	**12**	**27**	**183**	**1,950**
grasshopper sparrow	*Ammodramus savannarum*	SGCN	4	4	0	0	4	4
marsh wren	*Cistothorus palustris*	SGCN	3	3	0	0	3	3
sedge wren	*Cistothorus platensis*	SGCN	4	4	0	0	4	4
bobolink	*Dolichonyx oryzivorus*	SGCN	6	6	0	0	6	6
rusty blackbird	*Euphagus carolinus*	SGCN	3	5	0	0	3	5
swamp sparrow	*Melospiza georgiana*	SGCN	5	5	0	0	5	5
dickcissel	*Spiza americana*	SGCN	8	8	0	0	8	8
Small Birds Overall	***7 Species***		**33**	**35**	**0**	**0**	**33**	**35**

[a] FP data also shown in Appendix A1 (large birds) and Appendix B2 (small birds).

[b] BGEPA=Protected under the Bald and Golden Eagle Protection Act (1940); SC=State-listed as Special Concern in Minnesota (Minnesota Department of Natural Resources [MDNR] 2006); SGCN=Species of Greatest Conservation Need in Minnesota (MDNR 2006); ST=State-listed as Threatened in Minnesota (MDNR 2006).

Incidental Observations

Four bird species were recorded as incidental observations including American white pelican, bald eagle, northern harrier, and trumpeter swan (Table 12). These species are listed as species of greatest conservation need (MDNR 2006), or are protected by BGEPA.

Table 12. Incidental wildlife observed outside of standardized survey times conducted from March 3, 2018 – February 27, 2019 at the Three Waters Wind Farm in Jackson County, Minnesota and Dickinson and Osceola counties, Iowa.

Species	Scientific Name	# groups	# observations
American white pelican	*Pelecanus erythrorhynchos*	6	20
bald eagle	*Haliaeetus leucocephalus*	3	3
northern harrier	*Circus hudsonius*	2	2
trumpeter swan	*Cygnus buccinator*	1	2
Total	***4 species***	**12**	**27**

DISCUSSION

Potential Impacts

Wind energy facilities can have direct and indirect impacts on birds. Direct impacts include fatalities from construction and operation of the wind energy facility, including collision mortality and habitat loss/fragmentation caused by infrastructure placement. Indirect impacts may include long-term changes in breeding potential, fecundity, and reproductive potential to individuals directly affected by facility operations.

Project construction could affect birds from direct noise (i.e., avoidance), habitat loss, or fatalities from construction equipment. However, potential mortality from construction equipment would be expected to be relatively low, as equipment used in wind energy facility construction generally moves at slow rates or is stationary for long periods (e.g., cranes). The highest risk of direct mortality to birds during construction is most likely the potential destruction of nests of ground- and shrub-nesting species during initial site clearing. Mortality or injury from collisions with wind turbines or guy wires of meteorological towers during project operation are the most probable direct impact to birds from wind energy facilities.

Post-construction fatality monitoring results from other wind energy projects in the Midwest have shown varying levels of bird mortality (Appendix E1). The Wessington Springs facility in South Dakota had the highest estimated bird mortality rate of publically available studies in the Midwest (8.25 bird fatalities/megawatt (MW)/year; Derby et al. 2010c).

Behavioral displacement (i.e., avoidance) may lead to decreased habitat suitability for local populations. Birds displaced by wind energy development may move to lower quality habitat with fewer disturbances, with an overall effect of reducing breeding success (USFWS 2012). Behavioral avoidance may render much larger areas unsuitable or less suitable for some wildlife species, depending on how far each species is displaced from wind energy facilities. Although habitat fragmentation would be a direct effect to area wildlife, other future indirect effects from fragmentation could include increased predation and intra- and inter-species competition, potentially impacting the survivorship and reproductive ability of birds in the vicinity of the wind energy facility. Some studies suggest displacement effects associated with wind energy may have a greater impact than collision mortality (Gill et al. 1996, Pearce-Higgins et al. 2012).

The greatest concern for indirect impact of wind energy facilities on wildlife resources is where these facilities have been constructed in native vegetation communities, such as grasslands or shrub steppe that provide comparatively rare, high-quality habitat for some bird species and species of concern (USFWS 2012). Most of the Project area is cultivated crops (21,411.7 ha [52,910.4 ac]), with an estimated 735.9 ha (1,818.5 ac) of developed open space, and 335.5 ha (829.0 ac) of herbaceous land cover (Table 1). Siting turbines and other infrastructure in cultivated areas and other non-native or previously disturbed landscapes would reduce the potential for habitat fragmentation and displacement of birds or other wildlife species.

Bird Types of Concern

Most of the bird species observed during this study are not of conservation concern and represent species relatively common for the region. The following section provides more information on groups of birds that have been documented as being at risk of impacts from wind projects in general and were observed at the Project relatively frequently.

Waterbirds

Waterbird use varied seasonally, with highest use observed during spring and fall (Appendix B1). In both seasons, waterbird use was largely attributed to American white pelicans. Two large groups of American white pelicans contributed to higher waterbird use at Point 3 (Appendix D1). Potential impacts to American white pelicans in the Project area would be limited largely to the migration seasons. Other waterbird species observed, including great blue heron, double-crested cormorants (*Phalacrocorax auritus*), and great egrets, were relatively less abundant (Appendix A1).

Waterfowl

Waterfowl use at the Project varied seasonally, with greatest use observed in spring (Appendix B1). Waterfowl use in spring was largely attributed to Canada geese, greater white-fronted geese, and snow geese. Canada geese use composed most waterfowl use through all other seasons. Based on available evidence, waterfowl do not seem especially vulnerable to turbine collisions. In an analysis of 116 studies of bird mortality at over 70 facilities, waterfowl made up 2.7% of 4,975 fatalities found (Erickson et al. 2014a). In a database of 208 publicly available fatality studies, 207 waterfowl fatalities out of 7,993 total fatalities (2.6% of the total fatalities) were documented.

Diurnal Raptors

Use Comparison

Annual mean diurnal raptor use at the Project, standardized to 20-min survey periods for comparison (0.31 raptor/plot/20-min survey) was compared with 48 other wind energy facilities that implemented similar protocols and had data for at least three seasons (Figure 7). The annual mean diurnal raptor use at these wind energy facilities ranged from 2.34 to 0.06 raptors/800-m plot/20-min survey (Figure 7). Annual mean diurnal raptor use at the Project was relatively low, ranking 42nd out of the 49 wind energy facilities during the Year 1 study and ranking lower at 33rd during the Year 2 study (Figure 7).

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 at the highest exposure to risk of collisions. However, this index does not take into consideration bird behavior (e.g., foraging, courtship), flight speed, size, ability to detect and avoid turbines, and other factors that may vary among species and influence turbine collision risk. For these reasons, the exposure index is only a relative index of collision risk among species.

At the Project, Canada goose had the greatest exposure (9.64). The diurnal raptor species with the highest relative exposure index was red-tailed hawk (0.11). Other raptors with exposure indices above zero were bald eagle (0.09), northern harrier (0.03), sharp-shinned hawk (0.02), rough-legged hawk (*Buteo lagopus*, <0.01), and osprey (*Pandion haliaetus*, <0.01; Appendix C1). Based on the relative abundance of red-tailed hawk and a relatively higher exposure index than other raptor species during the studies at the Project, there is higher potential for red-tailed hawk fatalities, compared to other raptor species.

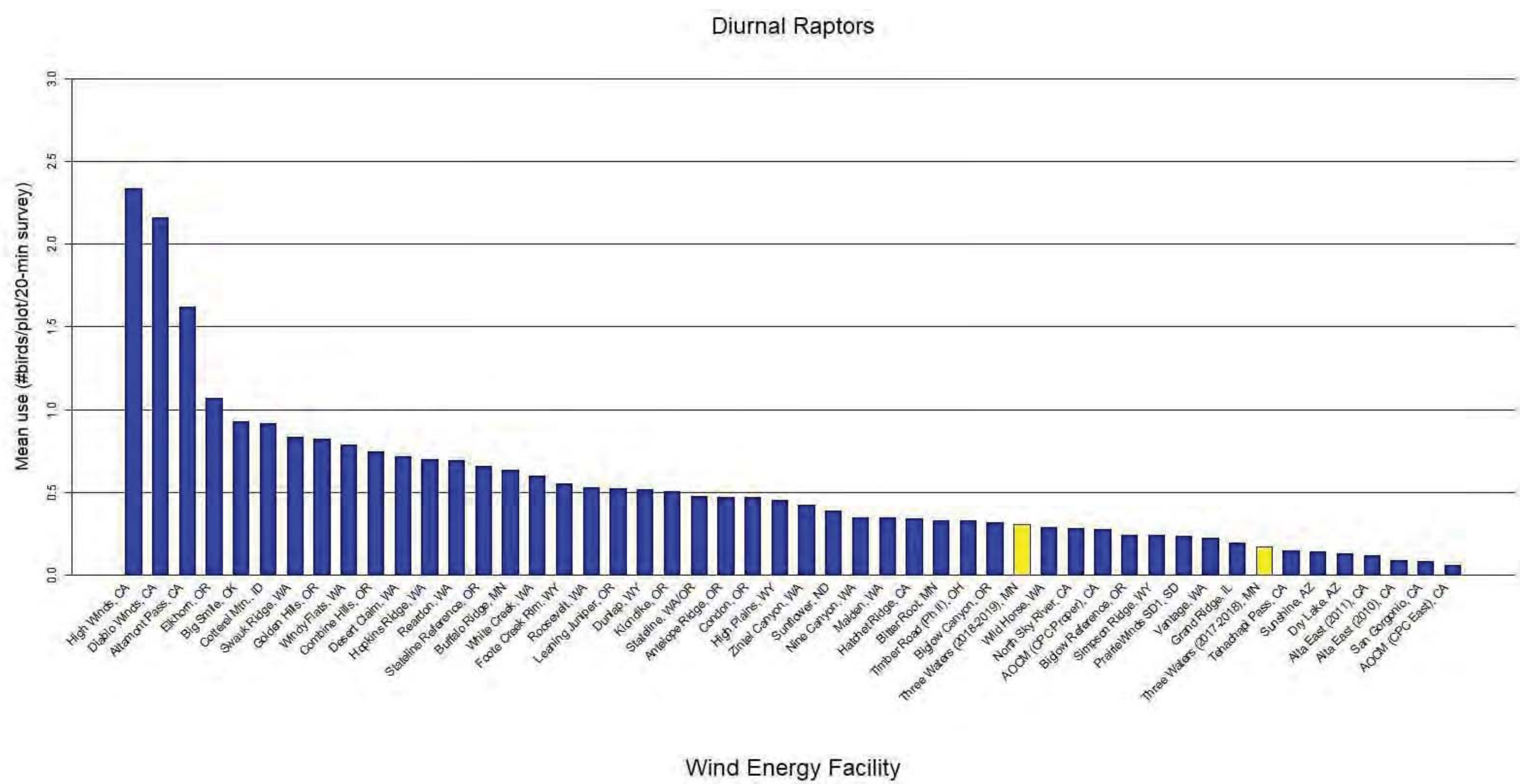

Figure 6. Estimated annual diurnal raptor use during eagle/large bird use surveys conducted from March 2017 − February 2019 at the Three Waters Wind Farm compared to diurnal raptor use at other U.S. wind energy facilities.

Figure 7 (*continued*). Comparison of estimated annual diurnal raptor use during eagle/large bird use surveys conducted from March 2017 – February 2019 at the Three Waters Wind Farm and estimated diurnal raptor use at other U.S. wind energy facilities. Data from the following sources:

Study and Location	Reference	Study and Location	Reference
Three Waters 2018_2019, MN, IA	This study.		
High Winds, CA	Kerlinger et al. 2005	High Plains, WY	Johnson et al. 2009b
Diablo Winds, CA	WEST 2006	Zintel Canyon, WA	Erickson et al. 2002a, 2003a
Altamont Pass, CA	Orloff and Flannery 1992	Sunflower, ND	Derby and Thorn 2014
Elkhorn, OR	WEST 2005a	Nine Canyon, WA	Erickson et al. 2001a
Big Smile (Dempsey), OK	Derby et al. 2010b	Maiden, WA	Young et al. 2002
Cotterel Mtn., ID	BLM 2006	Hatchet Ridge, CA	Young et al. 2007b
Swauk Ridge, WA	Erickson et al. 2003c	Bitter Root. MN	Derby and Dahl 2009
Golden Hills, OR	Jeffrey et al. 2008	Timber Road (Phase II), OH	Good et al. 2010
Windy Flats, WA	Johnson et al. 2007	Biglow Canyon, OR	WEST 2005c
Combine Hills, OR	Young et al. 2003a	Wild Horse, WA	Erickson et al. 2003d
Desert Claim, WA	Young et al. 2003b	North Sky River, CA	Erickson et al. 2011
Hopkins Ridge, WA	Young et al. 2003c	AOCM (CPC Proper), CA	Chatfield et al. 2010
Reardon, WA	WEST 2005b	Biglow Reference, OR	WEST 2005c
Stateline Reference, OR	URS et al. 2001	Simpson Ridge, WY	Johnson et al. 2000c
Buffalo Ridge, MN	Johnson et al. 2000b	PrairieWinds, SD1, SD	Derby and Thorn 2014
White Creek, WA	NWC and WEST 2005	Vantage, WA	Jeffrey et al. 2007
Foote Creek Rim, WY	Johnson et al. 2000c	Grand Ridge, IL	Derby et al. 2009
Roosevelt, WA	NWC and WEST 2004	Tehachapi Pass, CA	Anderson et al. 2000, Erickson et al. 2002b
Leaning Juniper, OR	Kronner et al. 2005	Sunshine, AZ	WEST and the CPRS 2006
Dunlap, WY	Johnson et al. 2009a	Dry Lake, AZ	Young et al. 2007a
Klondike, OR	Johnson et al. 2002	Alta East (2011), CA	Chatfield et al. 2011
Stateline, WA/OR	Erickson et al. 2003b	Alta East (2010), CA	Chatfield et al. 2011
Antelope Ridge, OR	WEST 2009	San Gorgonio, CA	Anderson et al. 2000, Erickson et al. 2002b
Condon, OR	Erickson et al. 2002b	AOCM (CPC East), CA	Chatfield et al. 2010

Fatality Studies

Diurnal raptor fatality estimates at 139 wind energy facilities across the US averaged 0.11 raptor fatalities/MW/year. In the Midwest, raptor fatality rates from 36 studies averaged 0.07 fatalities/MW/year (Appendix E). One comparison of 14 studies resulted in a combined raptor fatality rate of 0.04 fatalities/MW/year and reported that diurnal raptors and vultures accounted for 6% of fall bird fatalities (NRC 2007). In a review of 31 studies, Erickson et al. (2001b) reported that 2.7% of carcasses found were diurnal raptors.

Use Versus Fatality Rates

Results from several studies suggest that mortality for some bird species is not necessarily related to abundance and can vary widely among facilities. For example, American kestrel use at High Winds Energy Center in California was nearly seven times higher than that recorded at the Altamont Pass Wind Farm (Kerlinger et al. 2005), yet American kestrel mortality at Altamont was nearly seven times higher than at High Winds (Kerlinger et al. 2006, Altamont Pass Avian Monitoring Team 2008). Relatively few northern harrier fatalities have been reported in publicly available documents, despite the fact they are commonly observed during bird counts at these facilities (Erickson et al. 2001b, Whitfield and Madders 2006, Smallwood and Karas 2009). Northern harriers typically fly close to the ground (MacWhirter and Bildstein 1996), with some studies reporting up to 97% of flights below 20 m (66 ft; Madders and Whitfield 2006); therefore, risk of collision with turbine blades is considered low for this species (Whitfield and Madders 2005, Madders and Whitfield 2006).

Comparable pre-construction raptor use and post-construction raptor mortality data are available for several studies at new-generation wind energy facilities, resulting in 34 pairs of raptor use with fatality data (see Appendix E2). Of these, 16 pairings were from studies at facilities classified as having relatively low raptor use (less than 0.50 raptor/800-m plot/20-min survey), 13 were classified as having low to moderate raptor use (between 0.50 and 1.00), and five were classified as having moderate or high raptor use (more than 1.00). Due to the relatively low sample size and other biological factors that can influence raptor fatality rates as discussed above, it is not known if the relationship between raptor use and fatality rates is a simple linear relationship. Additionally, true mortality estimates from wind facilities with moderate to high raptor use are unknown due to a lack of available data from wind facilities that have had moderate or high pre-construction raptor use estimates. Variation in species composition is likely to influence overall raptor mortality; however, data are not available at this time to perform species-specific regression analyses. Because the proposed Project has relatively low raptor use, the Project is expected to result in low raptor fatality rates compared to other wind energy facilities (Appendix E2).

<u>Migratory Behavior</u>

Most diurnal raptor species in North America exhibit some degree of latitudinal or altitudinal migration during the spring and fall seasons (Bildstein 2006). Migrating raptors are known to concentrate along linear topographic features such as coastlines, rivers, and ridges, particularly where linear features are oriented within approximately 45 degrees of the optimal flight direction (Richardson 2000). Although the Project area does not include any prominent topographic features that would attract large concentrations of migratory raptors, use of the Project area by diurnal raptors was greatest during spring and fall indicating that the Project is within the migratory pathway of some diurnal raptors (Appendix B1).

<u>Eagles</u>

While bald eagles reside in Minnesota year-round, they are more abundant during migration and winter (eBird 2018). Bald eagles were recorded during all seasons, however most observations occurred during the spring and fall. Data from this study suggesting that the Project area is used mostly by non-resident bald eagles outside of the breeding season, though breeding bald eagles also occur in the region. Golden eagles (*Aquila chrysaetos*) are only observed in Minnesota at low rates during migration and winter (eBird 2018), and only a single golden eagle was observed during Year 1 surveys, while no golden eagles were observed during Year 2 surveys or incidentally within the Project.

Passerines

Small-sized passerines composed about 62.5% of wind turbine fatalities in 116 studies included in a recent analysis (Erickson et al. 2014b). A total of 3,110 fatalities represented by 156 species of small passerines were found during the studies. From this, it was estimated about 134,000 to 230,000 fatalities of small passerines occurred each year in the US and Canada combined, a rate of 2.10 to 3.35 small birds/MW of installed capacity. In comparison, researchers estimated that over six million passerines were killed annually from collisions with communication towers (passerines composed 97% of all fatalities; Longcore et al. 2012, Longcore and Smith 2013). However, population-level effects due to turbine collision fatalities have not been detected (Arnold and Zink 2011, Erickson et al. 2014b). Specific to the Project, passerines would likely represent the majority of bird fatalities during Project operation, given the results of avian surveys completed to date; however, no federally or state-listed small bird species were recorded in 214 surveys at the Project, and passerine fatalities at the Project would be expected to be spread out among multiple species (similar to what is observed at facilities throughout the US); therefore, no regional or population-level effects are anticipated.

At the Combine Hills facility in Oregon, western meadowlark use of areas within 150 m (492 ft) of turbines was reduced by about 86%, compared to a 12.6% reduction in use of reference areas over the same time period (Young et al. 2006). Horned larks, however, showed significant increases in use of areas near turbines at both the Stateline and the Combine Hills facilities, possibly because the cleared turbine pads and access roads provided habitat preferred by this species. Leddy et al. (1999) surveyed bird densities in Conservation Reserve Program grasslands at the Buffalo Ridge wind energy facility in Minnesota and found the mean densities of 10 grassland bird species were four times higher in areas located 180 m (591 ft) from turbines than they were in grasslands closer to turbines. Johnson et al. (2000a) found reduced use of habitat within 100 m of turbines by seven of 22 grassland-breeding birds following construction of the Buffalo Ridge facility in southwest Minnesota, and Osborn et al. (1998) reported birds at Buffalo Ridge avoided flying in areas with turbines. At a wind energy facility in Cooke County, Texas, no evidence of displacement by turbines was reported for four species of wintering grassland birds (eastern meadowlark [*Sturnella magna*], western meadowlark [*Sturnella neglecta*], Savannah sparrow [*Passerculus sandwichensis*], and Sprague's pipit [*Anthus spragueii*]). At the same time, significant evidence of displacement at distances up to 400 m (1,312 ft) was recorded for a fifth species, Le Conte's sparrow (*Ammodramus leconteii*; Stevens et al. 2013). Nest survival for red-winged blackbirds, a habitat generalist, was not affected by proximity to turbines in a controlled study in central Iowa (Gillespie and Dinsmore 2014).

Researchers concluded that nesting success for shrub-nesting birds, grassland-nesting birds, and the scissor-tailed flycatcher (*Tyrannus forficatus*) was not related to the distance of nests from wind turbines at a wind energy facility in Cooke County, Texas (Rubenstahl et al. 2012, Hatchett et al. 2013, Bennett et al. 2014, Hale et al. 2014). Study species included the white-eyed vireo (*Vireo griseus*), blue-gray gnatcatcher (*Polioptila caerulea*), northern cardinal (*Cardinalis cardinalis*), painted bunting (*Passerina ciris*), and lark sparrow (*Chondestes grammacus*), all which nest in shrubby habitats, as well as the prairie species dickcissel (*Spiza americana*) and grasshopper sparrow (*Ammodramus savannarum*). Stevens et al. (2013) reported no evidence of displacement for three of four species of wintering grassland birds at the Cooke County facility, including Sprague's pipit, Savannah sparrow, and meadowlarks, while Le Conte's sparrow was significantly more likely to occur at distances of at least 200 m (656 ft) from turbines. However, no data were collected before the facility was constructed and the effect of vegetation characteristics, which may influence breeding densities, was not addressed.

CONCLUSIONS

These baseline (Tier 3) studies provided site-specific data that, when combined with available literature, allowed for a better-informed assessment of the risk of significant adverse impacts to species of concern at the Project. Raptor use at the Project was within the lower range of use levels recorded at other wind energy facilities throughout the U.S. While a correlation between diurnal raptor use and mortality rates due to collision with wind turbines has not been observed in the region, diurnal raptor fatality rates will likely be within the range of fatality rates observed at other facilities where raptor use levels were low. Based on greater use during spring and fall, collision risk for diurnal raptors is likely highest during migration. To date, no relationships have been observed between overall use by other bird types and fatality rates of those bird types at wind energy facilities. However, the flight characteristics, breeding, and foraging habits of some species may result in increased exposure for these species in the Project area. Bald eagles were recorded during spring, fall, and winter in Year 1 studies, while during Year 2 studies, bald eagles were recorded in all seasons, with most observations recorded ruing the fall and spring, but were also recorded in lower levels during the Year 1 studies. Relative risk to bald eagles is, therefore, likely highest during the spring, fall, and winter, with low to minimal risk during the summer. While one golden eagle was observed at the Project during Year 1 studies, no additional golden eagles were observed during Year 2, risk to golden eagles is considered low and limited to rare individuals that may pass through the area during migration.

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Appendix A. All Bird Types and Species Observed at the Three Waters Wind Farm during Avian Use Surveys from March 3, 2018 – February 27, 2019

Appendix A1. Summary of individuals and group observations by bird type and species recorded during eagle/large bird use surveys conducted from March 3, 2018 – February 27, 2019 at the Three Waters Wind Farm[a] in Jackson County, Minnesota and Dickinson and Osceola counties, Iowa.

		Spring		Summer		Fall		Winter		Total	
Type/Species	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Loons/Grebes		**2**	**3**	**0**	**0**	**2**	**5**	**0**	**0**	**4**	**8**
western grebe	*Aechmophorus occidentalis*	0	0	0	0	1	3	0	0	1	3
common loon	*Gavia immer*	1	2	0	0	0	0	0	0	1	2
pied-billed grebe	*Podilymbus podiceps*	1	1	0	0	1	2	0	0	2	3
Waterbirds		**15**	**200**	**58**	**306**	**24**	**610**	**0**	**0**	**97**	**1,116**
great egret	*Ardea alba*	0	0	1	1	3	4	0	0	4	5
great blue heron	*Ardea herodias*	4	5	27	30	5	5	0	0	36	40
American white pelican	*Pelecanus erythrorhynchos*	5	168	26	250	14	568	0	0	45	986
double-crested cormorant	*Phalacrocorax auritus*	6	27	2	2	1	18	0	0	9	47
unidentified waterbird		0	0	2	23	1	15	0	0	3	38
Waterfowl		**206**	**7,041**	**20**	**166**	**40**	**2,639**	**6**	**232**	**272**	**10,078**
wood duck	*Aix sponsa*	5	13	0	0	0	0	0	0	5	13
northern pintail	*Anas acuta*	5	60	0	0	0	0	0	0	5	60
American wigeon	*Anas americana*	6	12	0	0	0	0	0	0	6	12
northern shoveler	*Anas clypeata*	3	6	0	0	1	5	0	0	4	11
green-winged teal	*Anas crecca*	4	13	0	0	0	0	0	0	4	13
blue-winged teal	*Anas discors*	4	12	1	1	1	4	0	0	6	17
mallard	*Anas platyrhynchos*	42	517	13	18	4	130	0	0	59	665
gadwall	*Anas strepera*	7	16	0	0	0	0	0	0	7	16
greater white-fronted goose	*Anser albifrons*	12	2,197	0	0	0	0	0	0	12	2,197
lesser scaup	*Aythya affinis*	4	26	0	0	0	0	0	0	4	26
redhead	*Aythya americana*	2	10	0	0	0	0	0	0	2	10
ring-necked duck	*Aythya collaris*	2	3	0	0	0	0	0	0	2	3
unidentified scaup	*Aythya spp*	1	1	0	0	0	0	0	0	1	1
canvasback	*Aythya valisineria*	1	2	0	0	0	0	0	0	1	2
Canada goose	*Branta canadensis*	70	2,933	4	138	16	920	3	88	93	4,079
cackling goose	*Branta hutchinsii*	2	3	0	0	1	300	0	0	3	303
bufflehead	*Bucephala albeola*	1	6	0	0	0	0	0	0	1	6
common goldeneye	*Bucephala clangula*	1	1	0	0	0	0	0	0	1	1
snow goose	*Chen caerulescens*	14	916	0	0	0	0	0	0	14	916
Ross' goose	*Chen rossii*	1	1	0	0	0	0	0	0	1	1
common merganser	*Mergus merganser*	4	16	0	0	0	0	0	0	4	16
unidentified duck		15	277	2	9	11	430	1	6	29	722
unidentified goose		0	0	0	0	3	350	0	0	3	350

Appendix A1. Summary of individuals and group observations by bird type and species recorded during eagle/large bird use surveys conducted from March 3, 2018 – February 27, 2019 at the Three Waters Wind Farm[a] in Jackson County, Minnesota and Dickinson and Osceola counties, Iowa.

Type/Species	Scientific Name	Spring # grps	Spring # obs	Summer # grps	Summer # obs	Fall # grps	Fall # obs	Winter # grps	Winter # obs	Total # grps	Total # obs
unidentified waterfowl		0	0	0	0	3	500	2	138	5	638
Shorebirds		**26**	**119**	**74**	**86**	**6**	**11**	**0**	**0**	**106**	**216**
upland sandpiper	*Bartramia longicauda*	1	1	6	6	0	0	0	0	7	7
killdeer	*Charadrius vociferus*	21	22	67	79	6	11	0	0	94	112
unidentified plover		2	90	0	0	0	0	0	0	2	90
unidentified shorebird		2	6	1	1	0	0	0	0	3	7
Gulls/Terns		**14**	**28**	**7**	**127**	**26**	**1,152**	**0**	**0**	**47**	**1,307**
herring gull	*Larus argentatus*	1	1	2	40	3	9	0	0	6	50
ring-billed gull	*Larus delawarensis*	13	27	0	0	1	200	0	0	14	227
Franklin's gull	*Leucophaeus pipixcan*	0	0	0	0	16	747	0	0	16	747
unidentified gull		0	0	5	87	6	196	0	0	11	283
Rails/Coots		**2**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**2**
sora	*Porzana carolina*	1	1	0	0	0	0	0	0	1	1
Virginia rail	*Rallus limicola*	1	1	0	0	0	0	0	0	1	1
Diurnal Raptors		**112**	**118**	**30**	**30**	**87**	**92**	**13**	**13**	**242**	**253**
Accipiters		*19*	*19*	*0*	*0*	*2*	*2*	*0*	*0*	*21*	*21*
Cooper's hawk	*Accipiter cooperii*	4	4	0	0	0	0	0	0	4	4
northern goshawk	*Accipiter gentilis*	1	1	0	0	0	0	0	0	1	1
unidentified accipiter	*Accipiter spp*	0	0	0	0	2	2	0	0	2	2
sharp-shinned hawk	*Accipiter striatus*	14	14	0	0	0	0	0	0	14	14
Buteos		*48*	*54*	*15*	*15*	*22*	*24*	*7*	*7*	*92*	*100*
red-tailed hawk	*Buteo jamaicensis*	37	43	15	15	18	18	7	7	77	83
rough-legged hawk	*Buteo lagopus*	8	8	0	0	0	0	0	0	8	8
broad-winged hawk	*Buteo platypterus*	0	0	0	0	2	4	0	0	2	4
unidentified buteo	*Buteo spp*	2	2	0	0	2	2	0	0	4	4
Swainson's hawk	*Buteo swainsoni*	1	1	0	0	0	0	0	0	1	1
Northern Harrier		*21*	*21*	*2*	*2*	*8*	*8*	*1*	*1*	*32*	*32*
northern harrier	*Circus hudsonius*	21	21	2	2	8	8	1	1	32	32
Eagles		*15*	*15*	*8*	*8*	*26*	*26*	*5*	*5*	*54*	*54*
bald eagle	*Haliaeetus leucocephalus*	15	15	8	8	26	26	5	5	54	54
Falcons		*7*	*7*	*0*	*0*	*10*	*11*	*0*	*0*	*17*	*18*
merlin	*Falco columbarius*	3	3	0	0	1	1	0	0	4	4
peregrine falcon	*Falco peregrinus*	0	0	0	0	1	1	0	0	1	1
American kestrel	*Falco sparverius*	4	4	0	0	8	9	0	0	12	13
Osprey		*2*	*2*	*0*	*0*	*0*	*0*	*0*	*0*	*2*	*2*

Appendix A1. Summary of individuals and group observations by bird type and species recorded during eagle/large bird use surveys conducted from March 3, 2018 – February 27, 2019 at the Three Waters Wind Farm[a] in Jackson County, Minnesota and Dickinson and Osceola counties, Iowa.

Type/Species	Scientific Name	Spring		Summer		Fall		Winter		Total	
		# grps	# obs	# grps	# obs	# grps	# obs	# grps	# obs	# grps	# obs
osprey	*Pandion haliaetus*	2	2	0	0	0	0	0	0	2	2
Other Raptors		*0*	*0*	*5*	*5*	*19*	*21*	*0*	*0*	*24*	*26*
unidentified raptor		0	0	5	5	19	21	0	0	24	26
Owls		**1**	**1**	**0**	**0**	**0**	**0**	**1**	**1**	**2**	**2**
short-eared owl	*Asio flammeus*	1	1	0	0	0	0	0	0	1	1
great horned owl	*Bubo virginianus*	0	0	0	0	0	0	1	1	1	1
Vultures		**19**	**26**	**40**	**46**	**17**	**25**	**0**	**0**	**76**	**97**
turkey vulture	*Cathartes aura*	19	26	40	46	17	25	0	0	76	97
Upland Game Birds		**29**	**40**	**21**	**22**	**2**	**2**	**6**	**47**	**58**	**111**
gray partridge	*Perdix perdix*	1	2	0	0	0	0	0	0	1	2
ring-necked pheasant	*Phasianus colchicus*	28	38	21	22	2	2	6	47	57	109
Doves/Pigeons		**12**	**29**	**53**	**146**	**16**	**132**	**22**	**256**	**103**	**563**
rock pigeon	*Columba livia*	4	16	13	92	8	122	22	256	47	486
mourning dove	*Zenaida macroura*	8	13	40	54	8	10	0	0	56	77
Large Corvids		**5**	**6**	**7**	**13**	**17**	**73**	**10**	**23**	**39**	**115**
American crow	*Corvus brachyrhynchos*	5	6	7	13	17	73	10	23	39	115
Goatsuckers		**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**
common nighthawk	*Chordeiles minor*	1	1	0	0	0	0	0	0	1	1
Overall		**444**	**7,614**	**310**	**942**	**237**	**4,741**	**58**	**572**	**1,049**	**13,869**

[a] Regardless of distance from observer.

grps = groups of observations, obs = individual observations

Appendix A2. Summary of individuals and group observations by bird type and species recorded during small bird use surveys conducted from March 3, 2018 – February 27, 2019 at the Three Waters Wind Farm[a] in Jackson County, Minnesota and Dickinson and Osceola counties, Iowa.

		Spring		Summer		Fall		Winter		Total	
Type/Species	Scientific Name	# grps	# obs	# grps	# obs	# grps	# obs	# grps	# obs	# grps	# obs
Passerines		**213**	**947**	**346**	**475**	**68**	**225**	**12**	**60**	**639**	**1,707**
unidentified passerine		3	3	13	15	18	32	1	1	35	51
Blackbirds/Orioles		*132*	*492*	*184*	*276*	*20*	*126*	*2*	*4*	*338*	*898*
red-winged blackbird	*Agelaius phoeniceus*	53	209	67	73	11	113	1	3	132	398
bobolink	*Dolichonyx oryzivorus*	5	5	1	1	0	0	0	0	6	6
rusty blackbird	*Euphagus carolinus*	2	4	0	0	0	0	1	1	3	5
Brewer's blackbird	*Euphagus cyanocephalus*	1	1	0	0	0	0	0	0	1	1
brown-headed cowbird	*Molothrus ater*	22	31	28	37	0	0	0	0	50	68
common grackle	*Quiscalus quiscula*	43	64	83	159	9	13	0	0	135	236
western meadowlark	*Sturnella neglecta*	1	1	3	3	0	0	0	0	4	4
European starling	*Sturnus vulgaris*	2	22	0	0	0	0	0	0	2	22
yellow-headed blackbird	*Xanthocephalus xanthocephalus*	0	0	2	3	0	0	0	0	2	3
unidentified blackbird		3	155	0	0	0	0	0	0	3	155
Finches/Crossbills		*8*	*9*	*14*	*16*	*1*	*1*	*0*	*0*	*23*	*26*
American goldfinch	*Spinus tristis*	8	9	14	16	1	1	0	0	23	26
Flycatchers		*2*	*3*	*0*	*0*	*0*	*0*	*0*	*0*	*2*	*3*
eastern kingbird	*Tyrannus tyrannus*	1	2	0	0	0	0	0	0	1	2
unidentified flycatcher		1	1	0	0	0	0	0	0	1	1
Grassland/Sparrows		*30*	*378*	*60*	*63*	*12*	*35*	*9*	*55*	*111*	*531*
grasshopper sparrow	*Ammodramus savannarum*	0	0	4	4	0	0	0	0	4	4
horned lark	*Eremophila alpestris*	12	360	9	9	2	23	3	9	26	401
swamp sparrow	*Melospiza georgiana*	1	1	4	4	0	0	0	0	5	5
song sparrow	*Melospiza melodia*	5	5	7	7	1	1	0	0	13	13
house sparrow	*Passer domesticus*	0	0	2	3	2	4	2	35	6	42
savannah sparrow	*Passerculus sandwichensis*	2	2	0	0	0	0	0	0	2	2
vesper sparrow	*Pooecetes gramineus*	2	2	5	5	1	1	0	0	8	8
dickcissel	*Spiza americana*	0	0	8	8	0	0	0	0	8	8
chipping sparrow	*Spizella passerina*	1	1	6	6	0	0	0	0	7	7
unidentified sparrow		7	7	15	17	6	6	4	11	32	41
Mimids		*0*	*0*	*0*	*0*	*1*	*1*	*0*	*0*	*1*	*1*
gray catbird	*Dumetella carolinensis*	0	0	0	0	1	1	0	0	1	1
Swallows		*11*	*16*	*40*	*67*	*8*	*12*	*0*	*0*	*59*	*95*
barn swallow	*Hirundo rustica*	7	12	24	35	3	5	0	0	34	52
cliff swallow	*Petrochelidon pyrrhonota*	1	1	16	32	3	5	0	0	20	38
purple martin	*Progne subis*	1	1	0	0	0	0	0	0	1	1

Appendix A2. Summary of individuals and group observations by bird type and species recorded during small bird use surveys conducted from March 3, 2018 – February 27, 2019 at the Three Waters Wind Farm[a] in Jackson County, Minnesota and Dickinson and Osceola counties, Iowa.

		Spring		Summer		Fall		Winter		Total	
Type/Species	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
bank swallow	*Riparia riparia*	1	1	0	0	0	0	0	0	1	1
tree swallow	*Tachycineta bicolor*	1	1	0	0	2	2	0	0	3	3
Thrushes		*17*	*33*	*15*	*15*	*6*	*11*	*0*	*0*	*38*	*59*
American robin	*Turdus migratorius*	17	33	15	15	6	11	0	0	38	59
Warblers		*8*	*11*	*14*	*15*	*1*	*3*	*0*	*0*	*23*	*29*
common yellowthroat	*Geothlypis trichas*	6	9	14	15	0	0	0	0	20	24
northern waterthrush	*Parkesia noveboracensis*	1	1	0	0	0	0	0	0	1	1
yellow warbler	*Setophaga petechia*	1	1	0	0	0	0	0	0	1	1
unidentified warbler		0	0	0	0	1	3	0	0	1	3
Waxwings		*0*	*0*	*1*	*3*	*0*	*0*	*0*	*0*	*1*	*3*
cedar waxwing	*Bombycilla cedrorum*	0	0	1	3	0	0	0	0	1	3
Wrens		*2*	*2*	*5*	*5*	*0*	*0*	*0*	*0*	*7*	*7*
marsh wren	*Cistothorus palustris*	2	2	1	1	0	0	0	0	3	3
sedge wren	*Cistothorus platensis*	0	0	4	4	0	0	0	0	4	4
Corvids		*0*	*0*	*0*	*0*	*1*	*4*	*0*	*0*	*1*	*4*
blue jay	*Cyanocitta cristata*	0	0	0	0	1	4	0	0	1	4
Swifts/Hummingbirds		**0**	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**1**	**1**
ruby-throated hummingbird	*Archilochus colubris*	0	0	1	1	0	0	0	0	1	1
Woodpeckers		**1**	**2**	**0**	**0**	**3**	**4**	**0**	**0**	**4**	**6**
northern flicker	*Colaptes auratus*	1	2	0	0	3	4	0	0	4	6
Overall		**214**	**949**	**347**	**476**	**71**	**229**	**12**	**60**	**644**	**1,714**

[a] Regardless of distance from observer.

grps = groups of observqations, obs = individual observations

Appendix B. Mean Use, Percent of Use, and Frequency of Occurrence for Large Birds and Small Birds Observed during Avian Use Surveys at the Three Waters Wind Farm from March 3, 2018 – February 27, 2019

Appendix B1. Mean large bird use (number of large birds/800-meter plot/60-minute survey), percent of total use (%), and frequency of occurrence (%) for each large bird type and species by season recorded during eagle/large bird use surveys conducted from March 3, 2018 – February 27, 2019 at the Three Waters Wind Farm in Jackson County, Minnesota and Dickinson and Osceola counties, Iowa.

	Mean Use				% of Use				% Frequency			
Type / Species	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
Loons/Grebes	**0.06**	**0**	**0.09**	**0**	**<0.1**	**0**	**0.2**	**0**	**3.7**	**0**	**3.7**	**0**
western grebe	0	0	0.06	0	0	0	0.1	0	0	0	1.9	0
common loon	0.04	0	0	0	<0.1	0	0	0	1.9	0	0	0
pied-billed grebe	0.02	0	0.04	0	<0.1	0	<0.1	0	1.9	0	1.9	0
Waterbirds	**3.69**	**0.54**	**3.20**	**0**	**2.6**	**6.6**	**7.0**	**0**	**18.5**	**20.4**	**7.4**	**0**
great egret	0	0	0.02	0	0	0	<0.1	0	0	0	1.9	0
great blue heron	0.07	0.30	0.04	0	<0.1	3.7	<0.1	0	5.6	16.7	3.7	0
American white pelican	3.11	0.20	3.15	0	2.2	2.5	6.8	0	7.4	3.7	1.9	0
double-crested cormorant	0.50	0	0	0	0.4	0	0	0	11.1	0	0	0
unidentified waterbird	0	0.04	0	0	0	0.5	0	0	0	1.9	0	0
Waterfowl	**129.94**	**2.59**	**19.93**	**1.41**	**93.1**	**32.0**	**43.3**	**39.7**	**61.1**	**14.8**	**13.0**	**1.9**
wood duck	0.24	0	0	0	0.2	0	0	0	7.4	0	0	0
northern pintail	1.11	0	0	0	0.8	0	0	0	7.4	0	0	0
American wigeon	0.22	0	0	0	0.2	0	0	0	9.3	0	0	0
northern shoveler	0.11	0	0.09	0	<0.1	0	0.2	0	5.6	0	1.9	0
green-winged teal	0.24	0	0	0	0.2	0	0	0	7.4	0	0	0
blue-winged teal	0.22	0.02	0.07	0	0.2	0.2	0.2	0	7.4	1.9	1.9	0
Mallard	9.57	0.20	2.37	0	6.9	2.5	5.1	0	33.3	11.1	3.7	0
Gadwall	0.30	0	0	0	0.2	0	0	0	9.3	0	0	0
greater white-fronted goose	40.69	0	0	0	29.1	0	0	0	13.0	0	0	0
lesser scaup	0.48	0	0	0	0.3	0	0	0	5.6	0	0	0
Redhead	0.19	0	0	0	0.1	0	0	0	3.7	0	0	0
ring-necked duck	0.06	0	0	0	<0.1	0	0	0	3.7	0	0	0
unidentified scaup	0.02	0	0	0	<0.1	0	0	0	1.9	0	0	0
Canvasback	0.04	0	0	0	<0.1	0	0	0	1.9	0	0	0
Canada goose	54.22	2.37	11.80	1.41	38.8	29.2	25.6	39.7	40.7	1.9	13.0	1.9
cackling goose	0.06	0	5.56	0	<0.1	0	12.1	0	3.7	0	1.9	0
Bufflehead	0.11	0	0	0	<0.1	0	0	0	1.9	0	0	0
common goldeneye	0.02	0	0	0	<0.1	0	0	0	1.9	0	0	0
snow goose	16.96	0	0	0	12.2	0	0	0	18.5	0	0	0
Ross' goose	0.02	0	0	0	<0.1	0	0	0	1.9	0	0	0
common merganser	0.30	0	0	0	0.2	0	0	0	5.6	0	0	0
unidentified duck	4.78	0	0.04	0	3.4	0	<0.1	0	16.7	0	1.9	0
Shorebirds	**2.07**	**1.46**	**0.20**	**0**	**1.5**	**18.0**	**0.4**	**0**	**18.5**	**68.5**	**7.4**	**0**

Appendix B1. Mean large bird use (number of large birds/800-meter plot/60-minute survey), percent of total use (%), and frequency of occurrence (%) for each large bird type and species by season recorded during eagle/large bird use surveys conducted from March 3, 2018 – February 27, 2019 at the Three Waters Wind Farm in Jackson County, Minnesota and Dickinson and Osceola counties, Iowa.

	Mean Use				% of Use				% Frequency			
Type / Species	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
upland sandpiper	0.02	0.09	0	0	<0.1	1.1	0	0	1.9	5.6	0	0
Killdeer	0.37	1.35	0.20	0	0.3	16.7	0.4	0	18.5	66.7	7.4	0
unidentified plover	1.67	0	0	0	1.2	0	0	0	1.9	0	0	0
unidentified shorebird	0.02	0.02	0	0	<0.1	0.2	0	0	1.9	1.9	0	0
Gulls/Terns	**0.52**	**0.76**	**19.65**	**0**	**0.4**	**9.4**	**42.7**	**0**	**24.1**	**3.7**	**18.5**	**0**
herring gull	0.02	0.74	0.17	0	<0.1	9.1	0.4	0	1.9	1.9	3.7	0
ring-billed gull	0.50	0	3.70	0	0.4	0	8.0	0	24.1	0	1.9	0
Franklin's gull	0	0	13.69	0	0	0	29.7	0	0	0	14.8	0
unidentified gull	0	0.02	2.09	0	0	0.2	4.5	0	0	1.9	1.9	0
Rails/Coots	**0.04**	**0**	**0**	**0**	**<0.1**	**0**	**0**	**0**	**1.9**	**0**	**0**	**0**
Sora	0.02	0	0	0	<0.1	0	0	0	1.9	0	0	0
Virginia rail	0.02	0	0	0	<0.1	0	0	0	1.9	0	0	0
Diurnal Raptors	**1.87**	**0.15**	**0.63**	**0.12**	**1.3**	**1.8**	**1.4**	**3.3**	**50.0**	**7.4**	**37.0**	**11.6**
Accipiters	*0.33*	*0*	*0.02*	*0*	*0.2*	*0*	*<0.1*	*0*	*22.2*	*0*	*1.9*	*0*
Cooper's hawk	0.06	0	0	0	<0.1	0	0	0	5.6	0	0	0
northern goshawk	0.02	0	0	0	<0.1	0	0	0	1.9	0	0	0
unidentified accipiter	0	0	0.02	0	0	0	<0.1	0	0	0	1.9	0
sharp-shinned hawk	0.26	0	0	0	0.2	0	0	0	16.7	0	0	0
Buteos	*0.83*	*0.06*	*0.13*	*0.04*	*0.6*	*0.7*	*0.3*	*1.0*	*27.8*	*5.6*	*11.1*	*3.7*
red-tailed hawk	0.67	0.06	0.13	0.04	0.5	0.7	0.3	1.0	20.4	5.6	11.1	3.7
rough-legged hawk	0.15	0	0	0	0.1	0	0	0	11.1	0	0	0
Swainson's hawk	0.02	0	0	0	<0.1	0	0	0	1.9	0	0	0
Northern Harrier	*0.39*	*0*	*0.13*	*0.02*	*0.3*	*0*	*0.3*	*0.5*	*18.5*	*0*	*9.3*	*1.9*
northern harrier	0.39	0	0.13	0.02	0.3	0	0.3	0.5	18.5	0	9.3	1.9
Eagles	*0.15*	*0.09*	*0.15*	*0.06*	*0.1*	*1.1*	*0.3*	*1.7*	*11.1*	*1.9*	*9.3*	*6.0*
bald eagle	0.15	0.09	0.15	0.06	0.1	1.1	0.3	1.7	11.1	1.9	9.3	6.0
Falcons	*0.13*	*0*	*0.20*	*0*	*<0.1*	*0*	*0.4*	*0*	*9.3*	*0*	*14.8*	*0*
Merlin	0.06	0	0.02	0	<0.1	0	<0.1	0	5.6	0	1.9	0
peregrine falcon	0	0	0.02	0	0	0	<0.1	0	0	0	1.9	0
American kestrel	0.07	0	0.17	0	<0.1	0	0.4	0	7.4	0	11.1	0
Osprey	*0.04*	*0*	*0*	*0*	*<0.1*	*0*	*0*	*0*	*3.7*	*0*	*0*	*0*
Osprey	0.04	0	0	0	<0.1	0	0	0	3.7	0	0	0
Owls	**0.02**	**0**	**0**	**0**	**<0.1**	**0**	**0**	**0**	**1.9**	**0**	**0**	**0**
short-eared owl	0.02	0	0	0	<0.1	0	0	0	1.9	0	0	0

Appendix B1. Mean large bird use (number of large birds/800-meter plot/60-minute survey), percent of total use (%), and frequency of occurrence (%) for each large bird type and species by season recorded during eagle/large bird use surveys conducted from March 3, 2018 – February 27, 2019 at the Three Waters Wind Farm in Jackson County, Minnesota and Dickinson and Osceola counties, Iowa.

	Mean Use				% of Use				% Frequency			
Type / Species	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter
Vultures	**0.28**	**0.17**	**0.15**	**0**	**0.2**	**2.1**	**0.3**	**0**	**14.8**	**11.1**	**7.4**	**0**
turkey vulture	0.28	0.17	0.15	0	0.2	2.1	0.3	0	14.8	11.1	7.4	0
Upland Game Birds	**0.74**	**0.41**	**0.04**	**0.96**	**0.5**	**5.0**	**<0.1**	**27.0**	**18.5**	**25.9**	**3.7**	**6.0**
gray partridge	0.04	0	0	0	<0.1	0	0	0	1.9	0	0	0
ring-necked pheasant	0.70	0.41	0.04	0.96	0.5	5.0	<0.1	27.0	16.7	25.9	3.7	6.0
Doves/Pigeons	**0.28**	**2.02**	**1.87**	**0.96**	**0.2**	**24.9**	**4.1**	**27.0**	**9.3**	**50.0**	**16.7**	**15.3**
rock pigeon	0.04	1.11	1.72	0.96	<0.1	13.7	3.7	27.0	1.9	13.0	7.4	15.3
mourning dove	0.24	0.91	0.15	0	0.2	11.2	0.3	0	7.4	46.3	9.3	0
Large Corvids	**0.07**	**0.02**	**0.28**	**0.11**	**<0.1**	**0.2**	**0.6**	**3.1**	**3.7**	**1.9**	**11.1**	**3.7**
American crow	0.07	0.02	0.28	0.11	<0.1	0.2	0.6	3.1	3.7	1.9	11.1	3.7
Goatsuckers	**0.02**	**0**	**0**	**0**	**<0.1**	**0**	**0**	**0**	**1.9**	**0**	**0**	**0**
common nighthawk	0.02	0	0	0	<0.1	0	0	0	1.9	0	0	0
Overall[a]	**139.59**	**8.11**	**46.04**	**3.55**	**100**	**100**	**100**	**100**				

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

Appendix B2. Mean large bird use (number of large 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 small bird use surveys conducted from March 3, 2018 – February 27, 2019 at the Three Waters Wind Farm in Jackson County, Minnesota and Dickinson and Osceola counties, Iowa.

	Mean Use				% of Use				% Frequency			
Type / Species	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
Passerines	**17.54**	**8.61**	**4.07**	**1.03**	**99.8**	**99.8**	**98.2**	**100**	**59.3**	**96.3**	**50.0**	**11.3**
unidentified passerine	0.06	0.28	0.59	0.02	0.3	3.2	14.3	1.8	3.7	14.8	25.9	1.9
Blackbirds/Orioles	*9.11*	*4.98*	*2.31*	*0.07*	*51.8*	*57.7*	*55.8*	*7.2*	*48.1*	*68.5*	*13.0*	*1.9*
red-winged blackbird	3.87	1.35	2.09	0.06	22.0	15.7	50.4	5.4	27.8	38.9	5.6	1.9
Bobolink	0.09	0	0	0	0.5	0	0	0	3.7	0	0	0
rusty blackbird	0.07	0	0	0.02	0.4	0	0	1.8	3.7	0	0	1.9
Brewer's blackbird	0.02	0	0	0	0.1	0	0	0	1.9	0	0	0
brown-headed cowbird	0.57	0.69	0	0	3.3	7.9	0	0	27.8	38.9	0	0
common grackle	1.19	2.83	0.22	0	6.7	32.8	5.4	0	22.2	38.9	11.1	0
western meadowlark	0.02	0.06	0	0	0.1	0.6	0	0	1.9	5.6	0	0
European starling	0.41	0	0	0	2.3	0	0	0	3.7	0	0	0
yellow-headed blackbird	0	0.06	0	0	0	0.6	0	0	0	3.7	0	0
unidentified blackbird	2.87	0	0	0	16.3	0	0	0	5.6	0	0	0
Finches/Crossbills	*0.17*	*0.30*	*0.02*	*0*	*0.9*	*3.4*	*0.4*	*0*	*7.4*	*22.2*	*1.9*	*0*
American goldfinch	0.17	0.30	0.02	0	0.9	3.4	0.4	0	7.4	22.2	1.9	0
Flycatchers	*0.06*	*0*	*0*	*0*	*0.3*	*0*	*0*	*0*	*3.7*	*0*	*0*	*0*
eastern kingbird	0.04	0	0	0	0.2	0	0	0	1.9	0	0	0
unidentified flycatcher	0.02	0	0	0	0.1	0	0	0	1.9	0	0	0
Grassland/Sparrows	*7.00*	*1.11*	*0.65*	*0.94*	*39.8*	*12.9*	*15.6*	*91.0*	*37.0*	*53.7*	*16.7*	*9.5*
grasshopper sparrow	0	0.07	0	0	0	0.9	0	0	0	5.6	0	0
horned lark	6.67	0.17	0.43	0.18	37.9	1.9	10.3	17.3	18.5	13.0	3.7	5.8
swamp sparrow	0.02	0.07	0	0	0.1	0.9	0	0	1.9	5.6	0	0
song sparrow	0.09	0.13	0.02	0	0.5	1.5	0.4	0	7.4	13.0	1.9	0
house sparrow	0	0.06	0.07	0.65	0	0.6	1.8	62.9	0	1.9	1.9	1.9
savannah sparrow	0.04	0	0	0	0.2	0	0	0	3.7	0	0	0
vesper sparrow	0.04	0.09	0.02	0	0.2	1.1	0.4	0	3.7	7.4	1.9	0
Dickcissel	0	0.11	0	0	0	1.3	0	0	0	7.4	0	0
chipping sparrow	0.02	0.11	0	0	0.1	1.3	0	0	1.9	11.1	0	0
unidentified sparrow	0.13	0.30	0.11	0.11	0.7	3.4	2.7	10.8	11.1	22.2	9.3	1.9
Mimids	*0*	*0*	*0.02*	*0*	*0*	*0*	*0.4*	*0*	*0*	*0*	*1.9*	*0*
gray catbird	0	0	0.02	0	0	0	0.4	0	0	0	1.9	0
Swallows	*0.30*	*1.24*	*0.22*	*0*	*1.7*	*14.4*	*5.4*	*0*	*16.7*	*40.7*	*9.3*	*0*

Appendix B2. Mean large bird use (number of large 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 small bird use surveys conducted from March 3, 2018 – February 27, 2019 at the Three Waters Wind Farm in Jackson County, Minnesota and Dickinson and Osceola counties, Iowa.

	Mean Use				% of Use				% Frequency			
Type / Species	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
barn swallow	0.22	0.65	0.09	0	1.3	7.5	2.2	0	13.0	27.8	1.9	0
cliff swallow	0.02	0.59	0.09	0	0.1	6.9	2.2	0	1.9	18.5	5.6	0
purple martin	0.02	0	0	0	0.1	0	0	0	1.9	0	0	0
bank swallow	0.02	0	0	0	0.1	0	0	0	1.9	0	0	0
tree swallow	0.02	0	0.04	0	0.1	0	0.9	0	1.9	0	1.9	0
Thrushes	*0.61*	*0.28*	*0.20*	*0*	*3.5*	*3.2*	*4.9*	*0*	*20.4*	*20.4*	*5.6*	*0*
American robin	0.61	0.28	0.20	0	3.5	3.2	4.9	0	20.4	20.4	5.6	0
Warblers	*0.20*	*0.28*	*0.06*	*0*	*1.2*	*3.2*	*1.3*	*0*	*1.9*	*16.7*	*1.9*	*0*
common yellowthroat	0.17	0.28	0	0	0.9	3.2	0	0	1.9	16.7	0	0
northern waterthrush	0.02	0	0	0	0.1	0	0	0	1.9	0	0	0
yellow warbler	0.02	0	0	0	0.1	0	0	0	1.9	0	0	0
unidentified warbler	0	0	0.06	0	0	0	1.3	0	0	0	1.9	0
Waxwings	*0*	*0.06*	*0*	*0*	*0*	*0.6*	*0*	*0*	*0*	*1.9*	*0*	*0*
cedar waxwing	0	0.06	0	0	0	0.6	0	0	0	1.9	0	0
Wrens	*0.04*	*0.09*	*0*	*0*	*0.2*	*1.1*	*0*	*0*	*1.9*	*5.6*	*0*	*0*
marsh wren	0.04	0.02	0	0	0.2	0.2	0	0	1.9	1.9	0	0
sedge wren	0	0.07	0	0	0	0.9	0	0	0	3.7	0	0
Swifts/Hummingbirds	**0**	**0.02**	**0**	**0**	**0**	**0.2**	**0**	**0**	**0**	**1.9**	**0**	**0**
ruby-throated hummingbird	0	0.02	0	0	0	0.2	0	0	0	1.9	0	0
Woodpeckers	**0.04**	**0**	**0.07**	**0**	**0.2**	**0**	**1.8**	**0**	**1.9**	**0**	**3.7**	**0**
northern flicker	0.04	0	0.07	0	0.2	0	1.8	0	1.9	0	3.7	0
Overall[a]	**17.57**	**8.63**	**4.15**	**1.03**	**100**	**100**	**100**	**100**				

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

Appendix C. Species Exposure Indices for the Three Waters Wind Farm during Bird Use Surveys from March 2017 – February 2018

Appendix C1. Relative exposure index and flight characteristics for each large bird species recorded during eagle/large bird use surveys conducted from March 3, 2018 – February 27, 2019 at the Three Waters Wind Farm in Jackson County, Minnesota and Dickinson and Osceola counties, Iowa.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within RSH Based on Initial Observation	Exposure Index	% Within RSH at Anytime
Canada goose	76	17.55	85.2	64.4	9.64	78.1
greater white-fronted goose	12	10.25	100	60.7	6.23	70.9
Franklin's gull	15	3.41	100	97.4	3.32	97.4
snow goose	14	4.28	100	54.1	2.32	54.1
mallard	48	3.06	91.9	25.4	0.71	26.9
unidentified gull	3	0.53	100	100	0.53	100
American white pelican	9	1.62	100	16.0	0.26	41.3
herring gull	6	0.23	100	90.0	0.21	96.0
red-tailed hawk	38	0.22	87.5	57.1	0.11	59.5
turkey vulture	24	0.15	96.9	77.4	0.11	80.6
bald eagle	24	0.11	100	79.2	0.09	87.5
double-crested cormorant	6	0.13	100	66.7	0.08	66.7
rock pigeon	11	0.95	31.4	26.6	0.08	28.1
ring-billed gull	14	1.05	100	4.8	0.05	93.0
great blue heron	20	0.10	100	45.5	0.05	59.1
gadwall	7	0.07	100	50.0	0.04	81.2
wood duck	3	0.06	53.8	100	0.03	100
northern harrier	29	0.13	100	24.1	0.03	27.6
green-winged teal	4	0.06	100	46.2	0.03	46.2
northern pintail	5	0.28	100	10.0	0.03	10.0
blue-winged teal	2	0.08	52.9	55.6	0.02	55.6
American crow	8	0.12	69.2	27.8	0.02	38.9
sharp-shinned hawk	14	0.07	100	28.6	0.02	28.6
American wigeon	6	0.06	100	33.3	0.02	58.3
killdeer	39	0.48	46.2	8.3	0.02	20.8
mourning dove	29	0.33	62.9	9.1	0.02	9.1
common merganser	4	0.07	100	18.8	0.01	18.8
unidentified duck	12	1.21	100	1.2	0.01	1.5
redhead	2	0.05	100	20.0	<0.01	20.0
rough-legged hawk	8	0.04	100	25.0	<0.01	25.0
unidentified shorebird	2	<0.01	100	100	<0.01	100
common loon	1	<0.01	100	100	<0.01	100
northern shoveler	3	0.05	54.5	33.3	<0.01	33.3
cackling goose	3	1.40	100	0.7	<0.01	100
common nighthawk	1	<0.01	100	100	<0.01	100

Appendix C1. Relative exposure index and flight characteristics for each large bird species recorded during eagle/large bird use surveys conducted from March 3, 2018 – February 27, 2019 at the Three Waters Wind Farm in Jackson County, Minnesota and Dickinson and Osceola counties, Iowa.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within RSH Based on Initial Observation	Exposure Index	% Within RSH at Anytime
osprey	2	<0.01	100	50.0	<0.01	50.0
Ross' goose	1	<0.01	100	100	<0.01	100
unidentified scaup	1	<0.01	100	100	<0.01	100
great egret	1	<0.01	100	100	<0.01	100
ring-necked pheasant	7	0.53	19.3	0	0	0
gray partridge	1	<0.01	100	0	0	0
short-eared owl	1	<0.01	100	0	0	0
American kestrel	7	0.06	53.8	0	0	0
peregrine falcon	1	<0.01	100	0	0	100
merlin	4	0.02	100	0	0	0
Swainson's hawk	1	<0.01	100	0	0	0
unidentified accipiter	1	<0.01	100	0	0	0
northern goshawk	1	<0.01	100	0	0	0
Cooper's hawk	3	0.01	100	0	0	0
upland sandpiper	1	0.03	16.7	0	0	0
unidentified plover	1	0.42	44.4	0	0	0
bufflehead	1	0.03	100	0	0	0
ring-necked duck	2	0.01	100	0	0	0
lesser scaup	4	0.12	100	0	0	0
western grebe	1	0.01	100	0	0	0
Virginia rail	0	<0.01	0	-	-	-
sora	0	<0.01	0	-	-	-
common goldeneye	0	<0.01	0	-	-	-
canvasback	0	<0.01	0	-	-	-
unidentified waterbird	0	<0.01	0	-	-	-
pied-billed grebe	0	0.01	0	-	-	-

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

Appendix C2. Relative exposure index and flight characteristics for each small bird species recorded during small bird use surveys conducted from March 3, 2018 – February 27, 2019 at the Three Waters Wind Farm in Jackson County, Minnesota and Dickinson and Osceola counties, Iowa.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within RSH Based on Initial Observation	Exposure Index	% Within RSH at Anytime
horned lark	10	1.87	95.3	33.2	0.59	33.2
unidentified blackbird	3	0.72	100	19.4	0.14	19.4
common grackle	112	1.07	81.2	8.1	0.07	8.1
European starling	2	0.10	100	54.5	0.06	54.5
cliff swallow	20	0.18	100	26.3	0.05	44.7
American robin	25	0.27	76.3	20.0	0.04	20.0
unidentified passerine	12	0.24	54.9	21.4	0.03	28.6
red-winged blackbird	109	1.85	89.4	1.4	0.02	1.4
rusty blackbird	2	0.02	80.0	75.0	0.01	75.0
northern flicker	4	0.03	100	33.3	<0.01	33.3
barn swallow	33	0.24	98.1	2.0	<0.01	9.8
unidentified sparrow	21	0.16	74.3	3.8	<0.01	3.8
tree swallow	3	0.01	100	33.3	<0.01	33.3
ruby-throated hummingbird	1	<0.01	100	0	0	0
cedar waxwing	1	0.01	100	0	0	0
yellow warbler	1	<0.01	100	0	0	0
common yellowthroat	6	0.11	37.5	0	0	0
unidentified warbler	1	0.01	100	0	0	100
bank swallow	1	<0.01	100	0	0	0
purple martin	1	<0.01	100	0	0	0
vesper sparrow	2	0.04	25.0	0	0	0
house sparrow	4	0.19	16.7	0	0	0
song sparrow	1	0.06	7.7	0	0	0
eastern kingbird	1	<0.01	100	0	0	0
American goldfinch	10	0.12	50.0	0	0	0
yellow-headed blackbird	2	0.01	100	0	0	0
brown-headed cowbird	37	0.32	66.2	0	0	2.2
bobolink	3	0.02	60.0	0	0	0
sedge wren	0	0.02	0	-	-	-
marsh wren	0	0.01	0	-	-	-
northern waterthrush	0	<0.01	0	-	-	-
gray catbird	0	<0.01	0	-	-	-
chipping sparrow	0	0.03	0	-	-	-
dickcissel	0	0.03	0	-	-	-
savannah sparrow	0	<0.01	0	-	-	-

Appendix C2. Relative exposure index and flight characteristics for each small bird species recorded during small bird use surveys conducted from March 3, 2018 – February 27, 2019 at the Three Waters Wind Farm in Jackson County, Minnesota and Dickinson and Osceola counties, Iowa.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within RSH Based on Initial Observation	Exposure Index	% Within RSH at Anytime
swamp sparrow	0	0.02	0	-	-	-
grasshopper sparrow	0	0.02	0	-	-	-
unidentified flycatcher	0	<0.01	0	-	-	-
western meadowlark	0	0.02	0	-	-	-
Brewer's blackbird	0	<0.01	0	-	-	-

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

Appendix D. Mean Use by Point for All Birds, Major Bird Types, and Diurnal Raptor Subtypes at the Three Waters Wind Farm from March 3, 2018 – February 27, 2019

Appendix D1. Mean use (observations/60-minute survey) by point for all birds, major bird types, and diurnal raptor subtypes recorded during eagle/large bird use surveys conducted from March 3, 2018 – February 27, 2019 at the Three Waters Wind Farm in Jackson County, Minnesota and Dickinson and Osceola counties, Iowa.

	Survey Point																	
Bird Type	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
Loons/Grebes	0	0	0	0	0	0.18	0	0	0.25	0.17	0	0	0	0	0	0.08	0	0
Waterbirds	1.00	5.25	14.17	0.25	0	0.09	0	0	0	0.25	1.42	0.50	0.08	7.42	0.83	1.42	0	0.75
Waterfowl	14.50	41.83	6.92	167.67	57.00	31.18	46.83	25.42	135.33	49.17	21.92	0.42	31.58	41.58	2.92	6.17	0	14.58
Shorebirds	0.42	0.17	0.83	0.42	0.17	0.55	0.42	0.17	0.58	1.33	0.83	0.42	0.58	0.42	8.75	0.25	0.27	0.33
Gulls/Terns	53.83	0.25	0.25	0.25	0.08	0.82	17.67	16.67	0	0	2.08	0.33	0	0.08	0.08	1.58	0	0.25
Rails/Coots	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.17	0	0
Diurnal Raptors	**0.92**	**0.50**	**0.25**	**0.67**	**0.67**	**0.36**	**1.58**	**0.25**	**0.25**	**0.58**	**0.50**	**0.17**	**0.42**	**1.92**	**1.33**	**1.58**	**0.09**	**0.42**
Accipiters	*0*	*0.08*	*0.08*	*0.08*	*0.08*	*0.09*	*0.25*	*0*	*0.08*	*0.08*	*0.17*	*0*	*0*	*0.17*	*0.08*	*0.25*	*0.09*	*0*
Buteos	*0.08*	*0*	*0.08*	*0.17*	*0.17*	*0.09*	*0.58*	*0.08*	*0.08*	*0.17*	*0.25*	*0.17*	*0.17*	*0.92*	*0.75*	*0.67*	*0*	*0.33*
Northern Harrier	*0*	*0*	*0*	*0.25*	*0.08*	*0*	*0.50*	*0.08*	*0.08*	*0.08*	*0*	*0*	*0.17*	*0.33*	*0.25*	*0.50*	*0*	*0.08*
Eagles	*0.67*	*0.33*	*0*	*0*	*0.25*	*0*	*0.17*	*0.08*	*0*	*0*	*0.08*	*0*	*0.08*	*0.33*	*0*	*0*	*0*	*0*
Falcons	*0.17*	*0.08*	*0.08*	*0.17*	*0*	*0.18*	*0*	*0*	*0*	*0.25*	*0*	*0*	*0*	*0.17*	*0.25*	*0.17*	*0*	*0*
Osprey	*0*	*0*	*0*	*0*	*0.08*	*0*	*0.08*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Owls	0	0	0	0	0	0	0	0.08	0	0	0	0	0	0	0	0	0	0
Vultures	0.33	0.17	0	0.42	0	0.09	0	0.08	0.17	0.33	0.17	0	0.42	0.08	0.08	0.25	0.09	0
Upland Game Birds	0.50	0	0.08	0.17	0.42	0.18	0.08	0.08	0.58	0.92	0	0.17	0	0	0.67	5.33	0	0.08
Doves/Pigeons	0.58	0.42	0.92	0.33	0.25	0.82	0	0.67	0.17	1.42	0.67	0.42	1.58	13.33	0.17	0.42	0.73	0.08
Large Corvids	0.08	0	0	0.08	1.00	0.09	0	0.42	0	0	0	0	0	0	0.25	0	0.27	0
Goatsuckers	0	0	0.08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
All Large Birds[a]	**72.17**	**48.58**	**23.50**	**170.25**	**59.58**	**34.36**	**66.58**	**43.83**	**137.33**	**54.17**	**27.58**	**2.42**	**34.67**	**64.83**	**15.08**	**17.25**	**1.45**	**16.50**

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

Appendix D2. Mean use (observations/10-minute survey) by point for all birds and major bird types recorded during fixed-point small bird use surveys conducted from March 3, 2018 – February 27, 2019 at the Three Waters Wind Farm in Jackson County, Minnesota and Dickinson and Osceola counties, Iowa.

	Survey Point																	
Bird Type	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
Passerines	6.08	6.58	3.75	3.42	38.75	15.82	3.17	3.92	9.33	9.08	2.67	4.00	9.42	1.67	3.17	17.08	2.64	1.58
Swifts/Hummingbirds	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.08	0	0
Woodpeckers	0	0	0	0	0.25	0.18	0	0	0.08	0	0	0	0	0	0	0	0	0
All Small Birds[a]	**6.08**	**6.58**	**3.75**	**3.42**	**39.00**	**16.00**	**3.17**	**3.92**	**9.42**	**9.08**	**2.67**	**4.00**	**9.42**	**1.67**	**3.17**	**17.17**	**2.64**	**1.58**

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

Appendix E. Regional Fatality Table Summaries

Appendix E1. Wind energy facilities in the Midwest with publicly available and comparable fatality data for all bird species.

Wind Energy Facility	Fatality Estimate[a]	No. of Turbines	Total Megawatts	Reference
Midwest				
Wessington Springs, SD (2009)	8.25	34	51	Derby et al. 2010c
Blue Sky Green Field, WI (2008; 2009)	7.17	88	145	Gruver et al. 2009
Cedar Ridge, WI (2009)	6.55	41	67.6	BHE Environ-mental 2010
Buffalo Ridge, MN (Phase III; 1999)	5.93	138	103.5	Johnson et al. 2000b
Moraine II, MN (2009)	5.59	33	49.5	Derby et al. 2010f
Barton I & II, IA (2010-2011)	5.5	80	160	Derby et al. 2011b
Buffalo Ridge I, SD (2009-2010)	5.06	24	50.4	Derby et al. 2010d
Buffalo Ridge, MN (Phase I; 1996)	4.14	73	25	Johnson et al. 2000b
Winnebago, IA (2009-2010)	3.88	10	20	Derby et al. 2010g
Rugby, ND (2010-2011)	3.82	71	149	Derby et al. 2011c
Cedar Ridge, WI (2010)	3.72	41	68	BHE Environ-mental 2011
Elm Creek II, MN (2011-2012)	3.64	62	148.8	Derby et al. 2012b
Buffalo Ridge, MN (Phase II; 1999)	3.57	143	107.25	Johnson et al. 2000b
Buffalo Ridge, MN (Phase I; 1998)	3.14	73	25	Johnson et al. 2000b
Ripley, Ont (2008)	3.09	38	76	Jacques Whitford 2009
Fowler I, IN (2009)	2.83	162	301	Johnson et al. 2010
Buffalo Ridge, MN (Phase I; 1997)	2.51	73	25	Johnson et al. 2000b
Buffalo Ridge, MN (Phase II; 1998)	2.47	143	107.25	Johnson et al. 2000b
PrairieWinds SD1, SD (2012-2013)	2.01	108	162	Derby et al. 2013
Buffalo Ridge II, SD (2011-2012)	1.99	105	210	Derby et al. 2012a
Kewaunee County, WI (1999-2001)	1.95	31	20.46	Howe et al. 2002
PrairieWinds SD1, SD (2013-2014)	1.66	108	162	Derby et al. 2014
NPPD Ainsworth, NE (2006)	1.63	36	20.5	Derby et al. 2007
PrairieWinds ND1 (Minot), ND (2011)	1.56	80	115.5	Derby et al. 2012d
Elm Creek, MN (2009-2010)	1.55	67	100	Derby et al. 2010e
PrairieWinds ND1 (Minot), ND (2010)	1.48	80	115.5	Derby et al. 2011d
Buffalo Ridge, MN (Phase I; 1999)	1.43	73	25	Johnson et al. 2000b
PrairieWinds SD1, SD (2011-2012)	1.41	108	162	Derby et al. 2012c
Top Crop I & II (2012-2013)	1.35	68 (phase I) 132 (phase (II)	300 (102 (phase I) 198 (phase II))	Good et al. 2013b
Heritage Garden I, MI (2012-2014)	1.3	14	28	Kerlinger et al. 2014
Wessington Springs, SD (2010)	0.89	34	51	Derby et al. 2011a
Rail Splitter, IL (2012-2013)	0.84	67	100.5	Good et al. 2013a
Top of Iowa, IA (2004)	0.81	89	80	Jain 2005
Big Blue, MN (2013)	0.6	18	36	Fagen Engineering 2014
Grand Ridge I, IL (2009-2010)	0.48	66	99	Derby et al. 2010a
Top of Iowa, IA (2003)	0.42	89	80	Jain 2005
Big Blue, MN (2014)	0.37	18	36	Fagen Engineering 2015
Pioneer Prairie II, IA (2011-2012)	0.27	62	102.3	Chodachek et al. 2012

[a] number of bird fatalities/megawatt/year

Appendix E2. Wind energy facilities in the Midwest with publicly available and comparable fatality data for diurnal raptors.

Wind Energy Facility	Fatality Estimate[a]	No. of Turbines	Total Megawatts	Reference
		Midwest		
Buffalo Ridge, MN (Phase I; 1999)	NA	0.47	73	Johnson et al. 2000b
Moraine II, MN (2009)	NA	0.37	33	Derby et al. 2010f
Winnebago, IA (2009-2010)	NA	0.27	10	Derby et al. 2010g
Buffalo Ridge I, SD (2009-2010)	NA	0.2	24	Derby et al. 2010d
Cedar Ridge, WI (2009)	NA	0.18	41	BHE Environ-mental 2010
PrairieWinds SD1, SD (2013-2014)	NA	0.17	108	Derby et al. 2014
Top of Iowa, IA (2004)	NA	0.17	89	Jain 2005
Cedar Ridge, WI (2010)	NA	0.13	41	BHE Environ-mental 2011
Ripley, Ont (2008)	NA	0.1	38	Jacques Whitford 2009
Wessington Springs, SD (2010)	0.232	0.07	34	Derby et al. 2011a
Rugby, ND (2010-2011)	NA	0.06	71	Derby et al. 2011c
NPPD Ainsworth, NE (2006)	NA	0.06	36	Derby et al. 2007
Wessington Springs, SD (2009)	0.232	0.06	34	Derby et al. 2010c
PrairieWinds ND1 (Minot), ND (2011)	NA	0.05	80	Derby et al. 2012d
PrairieWinds ND1 (Minot), ND (2010)	NA	0.05	80	Derby et al. 2011d
PrairieWinds SD1, SD (2012-2013)	NA	0.03	108	Derby et al. 2013
Elm Creek, MN (2009-2010)	NA	0	67	Derby et al. 2010e
Rail Splitter, IL (2012-2013)	NA	0	67	Good et al. 2013a
Pioneer Prairie II, IA (2011-2012)	NA	0	62	Chodachek et al. 2012
Buffalo Ridge, MN (Phase III; 1999)	NA	0	138	Johnson et al. 2000b
Buffalo Ridge, MN (Phase II; 1998)	NA	0	143	Johnson et al. 2000b
Buffalo Ridge, MN (Phase II; 1999)	NA	0	143	Johnson et al. 2000b
Blue Sky Green Field, WI (2008; 2009)	NA	0	88	Gruver et al. 2009
Elm Creek II, MN (2011-2012)	NA	0	62	Derby et al. 2012b
Barton I & II, IA (2010-2011)	NA	0	80	Derby et al. 2011b
PrairieWinds SD1, SD (2011-2012)	NA	0	108	Derby et al. 2012c
Kewaunee County, WI (1999-2001)	NA	0	31	Howe et al. 2002
Buffalo Ridge II, SD (2011-2012)	NA	0	105	Derby et al. 2012a
Buffalo Ridge, MN (Phase I; 1996)	NA	0	73	Johnson et al. 2000b
Buffalo Ridge, MN (Phase I; 1997)	NA	0	73	Johnson et al. 2000b
Buffalo Ridge, MN (Phase I; 1998)	NA	0	73	Johnson et al. 2000b
Fowler I, IN (2009)	NA	0	162	Johnson et al. 2010
Big Blue, MN (2013)	NA	0	18	Fagen Engineering 2014
Big Blue, MN (2014)	NA	0	18	Fagen Engineering 2015
Top of Iowa, IA (2003)	NA	0	89	Jain 2005
Grand Ridge I, IL (2009-2010)	0.195	0	66	Derby et al. 2010a
Buffalo Ridge, MN (Phase I; 1999)	NA	0.47	73	Johnson et al. 2000b
Moraine II, MN (2009)	NA	0.37	33	Derby et al. 2010f

[a] number of bird fatalities/megawatt/year

Bat Acoustic Activity Studies 2017

Bat Acoustic Activity Studies for the Three Waters Wind Farm Jackson County, Minnesota, and Osceola and Dickinson Counties Iowa

Final Report

July 6 – November 16, 2017

Prepared for:

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2018

EXECUTIVE SUMMARY

In July 2017, Western EcoSystems Technology, Inc. initiated a bat acoustic survey for the proposed Three Waters Wind Farm (Project) in Jackson County, Minnesota. The bat acoustic survey conducted at the Project was designed to estimate levels of bat activity throughout the Project during the summer and fall.

Acoustic surveys were conducted from July 6 to November 11, 2017, using four AnaBat® SD2 (AnaBat) detectors. One detector was placed at a fixed station while the other two detectors were moved among four temporary stations every two weeks. All stations were located near the ground (1.5 m) in cultivated croplands and were representative of future turbine placement

Overall, the AnaBat units recorded 997 bat passes on 276 detector-nights for a mean (± standard error) of 3.62 ± 0.6 bat passes per detector-night. Activity ranged between 0.81 – 0.98 bat passes per detector-night at stations TW2t, TW4t, and TW5t to 11.74 bat passes per detector-night at station. Approximately 69% of bat passes were classified as low-frequency (LF; e.g., big brown bats, hoary bats, and silver-haired bats), and 31% of bat passes were classified as high-frequency (HF; e.g., eastern red bats and *Myotis* species). Hoary bats, eastern red bats, and silver-haired bats are the main casualties at other North American wind energy facilities, and it is expected these species will be the main potential bat fatalities at the Project.

Bat activity was highest during the fall, peaking from August 6 to 12 (13.80 bat passes per detector-night). This timing of high bat activity corresponds with the period of peak bat fatality at most wind-energy facilities, and suggests most bat fatalities at the Project will occur during the late summer/early fall. The bat pass rate for the fixed ground detector during the standardized Fall Migration Period was 4.72 ± 0.55 bat passes per detector-night. This activity rate was lower than the national median (7.7 bat passes per detector-night), and lower than most of the public studies from Midwest regions that have measured preconstruction bat activity and post-construction bat fatality. Mean activity was also lower than bat pass rates reported at the nearby Lakefield Wind Project in 2011 and in 2012. Post-construction monitoring of Lakefield in 2012 and in 2014 found estimated bat fatality rates of 19.87 and 20.19 bats/MW, respectively. Hoary bats, eastern red bats, and silver-haired bats were the main species found as fatalities, and most bat fatalities occurred between mid-July and mid-September. Given the proximity of Lakefield to the Project, it is expected that the Project will experience similar patterns in bat fatality, and that the bat fatality rate will likely be less than 20 bats/MW/year.

STUDY PARTICIPANTS

Tim Sichmeller	Project Manager
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Larisa Bishop-Boros	Bat Data Analyst
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REPORT REFERENCE

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INTRODUCTION

Three Waters Wind Farm, LLC (Three Waters) contracted Western EcoSystems Technology, Inc., (WEST) to conduct surveys and monitor wildlife resources for the potential Three Waters Wind Farm (Project) in southwestern Minnesota and northwestern Iowa (Figure 1) to estimate the potential impacts of wind energy facility construction and operations on wildlife. This document provides results of a study of bat activity following the recommendations of the U.S. Fish and Wildlife Service (USFWS) Land-based Wind Energy Guidelines (WEG; USFWS 2012), Kunz et al. (2007a), and following the Minnesota Department of Natural Resources (MN-DNR) Avian and Bat Survey Protocols for Large Wind Energy Conversion Systems in Minnesota (Mixon et al. 2014). WEST conducted acoustic monitoring surveys to estimate levels of bat activity throughout the Project during the summer and fall.

The following report describes the results of acoustic monitoring surveys conducted at the Project between July 6 and November 16, 2017.

PROJECT AREA

The proposed Project is located at the Minnesota-Iowa border in Jackson County, Minnesota, and Osceola and Dickinson counties, Iowa, between the towns of Jackson and Worthington (Figure 1). The Project area encompasses approximately 23,843.1 hectares (58,917.6 acres; Figure 2). The Project area is within the Des Moines Lobe Level IV Ecoregion and the Western Corn Belt Plains Level III Ecoregion. The Western Corn Belt Plains is over 75% cultivated cropland and much of the remainder is forage for livestock. Most of the Des Moines Lobe has been converted from wet prairie to agricultural land. The Project area includes portions of the Little Sioux River and the West Fork of the Little Sioux River, along with other small drainages (Figure 2). The Project area also overlaps with several small lakes and ponds, including Illinois Lake, Skunk Lake, Rush Lake, and Iowa Lake (Figure 2). Based on the National Land Cover Database (NLCD; US Geological Survey NLCD 2011, Homer et al. 2015), land cover within the Project area is primarily (89.8%) cultivated cropland, with small portions of emergent herbaceous wetlands (3.2%); developed open space (3.1%); herbaceous (1.4%); open water (0.7%); hay pasture (0.5%), and other habitat types (Figure 2, Table 1).

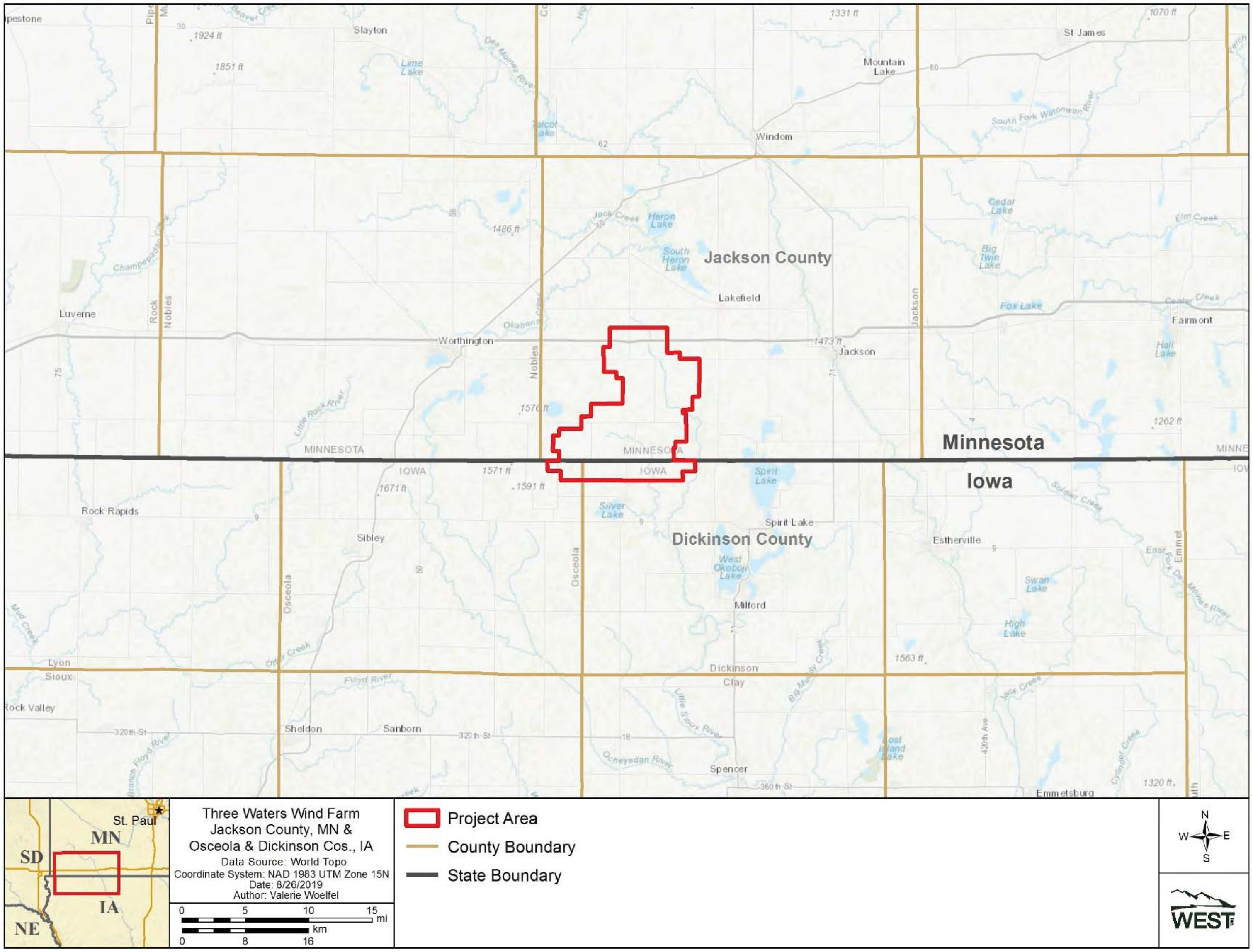

Figure 1. Topographic map showing the location of the Three Waters Wind Farm, Jackson County, Minnesota, and Osceola and Dickinson counties, Iowa.

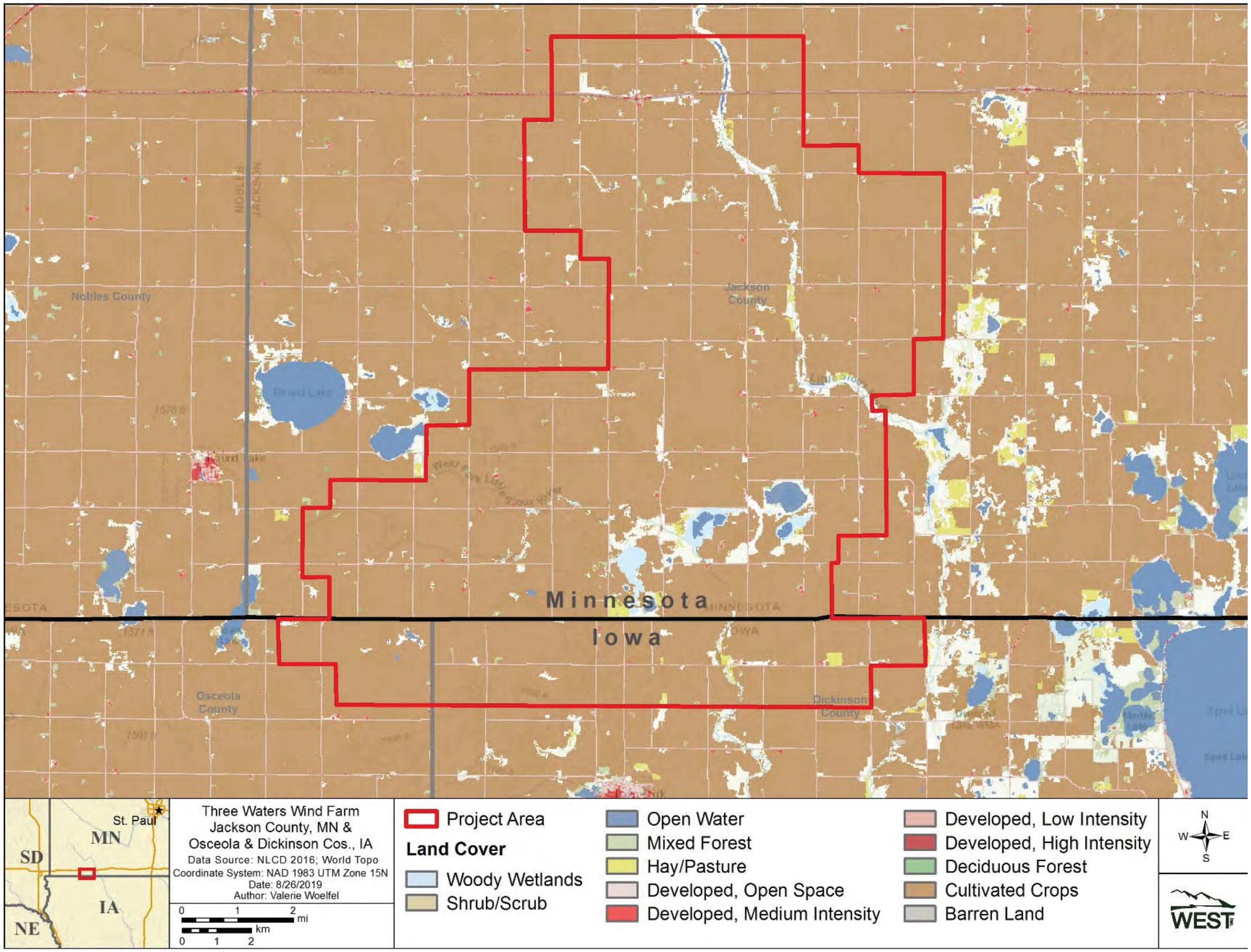

Figure 2. Land cover in the Three Waters Wind Farm, Jackson County, Minnesota, and Osceola and Dickinson counties, Iowa (Yang et al. 2018, Multi-Resolution Land Characteristics 2019).

Table 1. Land cover types, coverage, and composition within the Three Waters Wind Farm in Jackson County, Minnesota, and Osceola and Dickinson counties, Iowa.

Habitat	Hectares	Acres	% Composition
Cultivated Crops	21,419.0	52,927.5	89.8
Emergent Herbaceous Wetlands	764.2	1,888.3	3.2
Developed, Open Space	739.7	1,827.9	3.1
Herbaceous	335.7	829.5	1.4
Open Water	160.8	397.2	0.7
Hay/Pasture	128.6	317.7	0.5
Developed, Low Intensity	119.8	296.0	0.5
Mixed Forest	107.2	264.8	0.4
Developed, Medium Intensity	33.9	83.9	0.1
Deciduous Forest	10.4	25.6	<0.1
Shrub/Scrub	9.5	23.6	<0.1
Barren Land	6.1	15.1	<0.1
Woody Wetlands	5.6	13.8	<0.1
Developed, High Intensity	2.7	6.7	<0.1
Total[1]	**23,843.1**	**58,917.6**	**100**

Data from the National Land Cover Database (Yang et al. 2018, Multi-Resolution Land Characteristics 2019).

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

Overview of Bat Diversity

There are seven species of bats are found in Minnesota (Table 2). Those species include: the big brown bat (*Eptesicus fuscus*), silver-haired bat (*Lasionycteris noctivagans*), eastern red bat (*Lasiurus borealis*), hoary bat (*Lasiurus cinereus*), little brown bat (*M. lucifugus*), NLEB, and tri-colored bat (*Perimyotis subflavus*) all of which have been found as fatalities at wind energy facilities (Table 2). Of the seven species with the potential to occur in Minnesota, one (NLEB) is federally listed as threatened under the Endangered Species Act [ESA].

Table 2. Bat species with potential to occur within the Three Waters Wind Farm, categorized by echolocation call frequency.

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

[1] Species known to have been killed at wind energy facilities;

[2] federally threatened;

[3] species of special concern in Minnesota (Minnesota Department of Natural Resources 2013); and

[4] long-distance migrant

kHz = kilohertz

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 and by 2013 had rapidly spread to over 115 caves and mines and is now confirmed in 31 states and the causative fungus has been identified in an additional two states (Mississippi and Texas). To date, the full WNS has spread north into five Canadian provinces, and reaches as far south as Alabama and as far west as Washington (Heffernan, 2016). It is estimated that between 5.7 and 6.7 million bats have died as a result of WNS by 2012 (UMWS 2012). WNS is the primary reason the USFWS listed the northern long-eared bat as threatened in 2015 under the Endangered Species Act (USFWS 2015) and is the reason the little brown bat has been petitioned for listing as well. The fungus was first detected in Minnesota during the winter of 2014-2015. The closest confirmed occurrence of WNS to the Project is in Webster County, Iowa, approximately 97 mi (156 km) to the southeast of the Project.

METHODS

Bat Acoustic Surveys

The bat activity acoustic surveys were conducted to estimate the level of bat activity throughout the Project area during July 6 to November 11, 2017.

Survey Stations

AnaBat SD2 ultrasonic bat detectors (AnaBat; Titley™ Scientific, Columbia, Missouri) were used during the study. A single detector was placed near a proposed meteorological (met) tower, at ground level (ground station; station TW1g; approximately 1.5 meters (m; 5.0 feet [ft] above ground level [AGL]; Figure 3). Microphones at ground stations likely detect a more complete sample of the bat species present within the Project area (Kunz et al. 2007b; Collins and Jones 2009; Müeller et al. 2013; Roemer et al. 2017). The met tower station was located in cultivated crops, which are the dominant land cover type (Table 1) and is representative of potential turbine locations (representative stations).

Two more detectors were moved between four temporary stations (stations TW2t – TW5t; Figure 4) every two weeks to increase spatial coverage at the Project. These stations were placed near variable habitat types within the Project, near crops, near wetlands, and near deciduous forest habitat that may have the potential to attract foraging bats (bat feature stations; Figure 4). An experienced bat biologist selected the location of the bat feature stations. Monitoring at the bat feature stations provides an upper threshold for bat activity in the Project area for comparison with representative stations.

Each AnaBat unit was placed 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 polyvinyl chloride (PVC) tube, and holes were drilled in the PVC tube to allow water to drain.

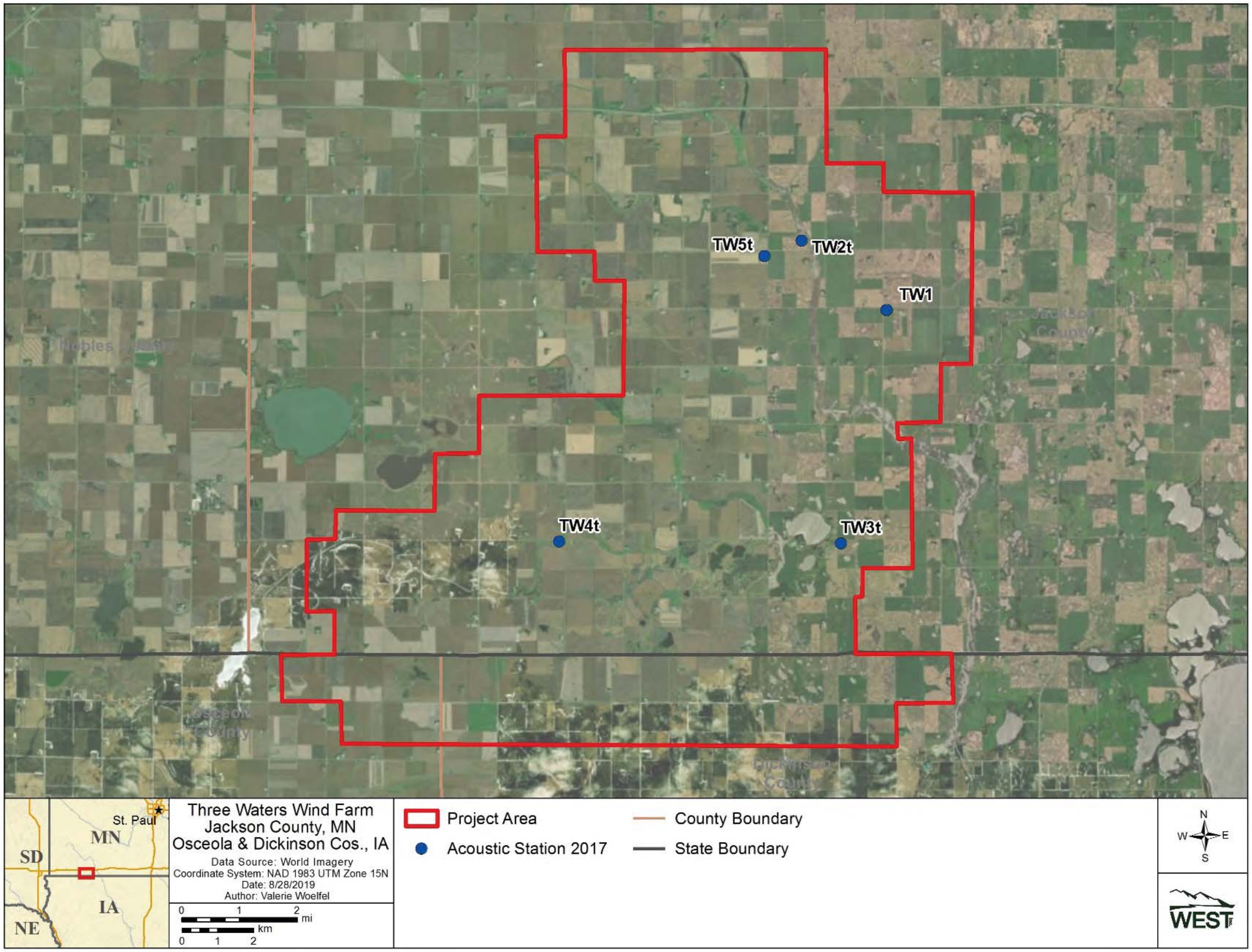

Figure 3. Location of bat monitoring stations in the Three Waters Wind Farm.

Survey Schedule

Bats were surveyed in the Project from July 6 to November 11, 2017, and detectors were programmed to turn on approximately 30 minutes (min) before sunset and turn off approximately 30 min after sunrise each night. To highlight seasonal activity patterns, the study was divided into two survey periods: summer (July 6 – August 15), and fall (August 16 – November 11). Mean bat activity was also calculated for a standardized Fall Migration Period (FMP), defined here as July 30 – October 14. The FMP was defined by WEST as a standard for comparison with activity from other wind energy facilities. During this time bats begin moving toward wintering areas, and many species of bats initiate reproductive behaviors (Cryan 2008). This period of increased landscape-scale movement and reproductive behavior is often associated with increased levels of bat fatalities at operational wind energy facilities (Arnett et al. 2008; Arnett and Baerwald 2013).

Data Collection and Call Analysis

AnaBat detectors use a broadband high-frequency microphone to detect the echolocation calls of bats. Incoming echolocation calls are digitally processed and stored on a high capacity, compact flash card. The resulting files can be viewed in appropriate software (e.g., Analook©) 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 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 (*Lasiurus borealis*) and *Myotis* species, have minimum frequencies greater than 30 kilohertz (kHz). Low-frequency (LF) bats, such as big brown bats, silver-haired bats (*Lasionycteris noctivagans*), and hoary bats (*L. 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

Statistical Analysis

The standard metric used for measuring bat activity is the number of bat passes per detector-night, and this metric was used as an index of bat activity in the Project area. A bat pass was defined as a sequence of at least two echolocation calls (pulses) produced by an individual bat with no pause between calls of more than one second (Fenton 1980). A detector-night was defined as one detector operating for one entire night. The terms bat pass and bat call are used interchangeably. Bat passes per detector-night 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. 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 7-day period with the highest average bat activity. If multiple 7-day periods equaled the peak sustained bat activity rate, all dates in these 7-day periods were reported. This and all multi-detector averages in this report were calculated as an unweighted average of total activity at each detector. Temporary stations were not sampled on a continuous basis throughout the survey period and were, therefore, excluded from temporal analyses. Data from the bat feature stations were also 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.

RESULTS

Bat Acoustic Surveys

Bat activity was monitored at five sampling locations for a total of 276 detector-nights between July 6 and November 11, 2017. AnaBat units were operating for 71.3% of the sampling period (Figure 4). Equipment malfunctions were the primary cause of lost data. Overall, the average bat pass rate was 3.62 ± 0.6 bat passes per detector-night (Table 3).

Spatial Variation

Bat activity in the Project was relatively low, and the average bat pass rates were nearly identical between the fixed station (3.72 bat passes per detector-night) and the temporary stations (3.59 bat passes per detector-night; Table 3). However, bat activity varied among the temporary stations, ranging from approximately 0.81 – 0.98 bat passes per detector-night at stations TW2t, TW4t, and TW5t to 11.74 bat passes per detector-night at station TW3t (Figure 5; Table 3).

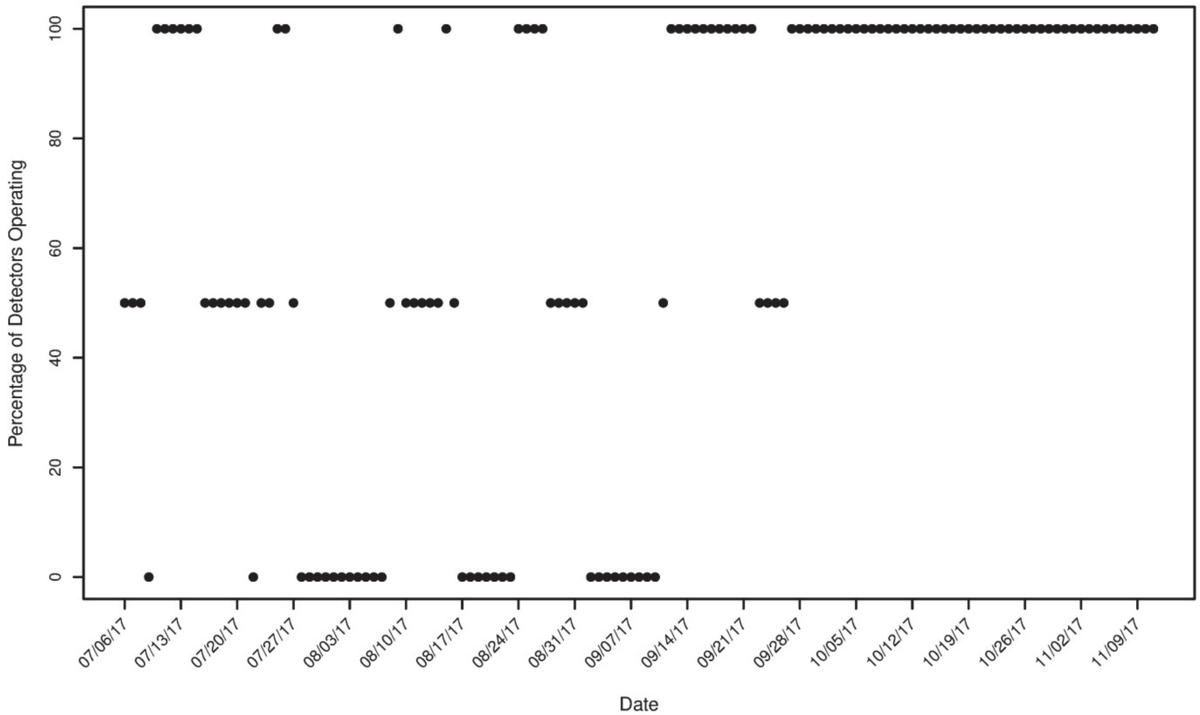

Figure 4. Operational status of bat detectors (n = 5) operating at the Three Waters Wind Farm during each night of the survey period July 6 – November 11, 2017.

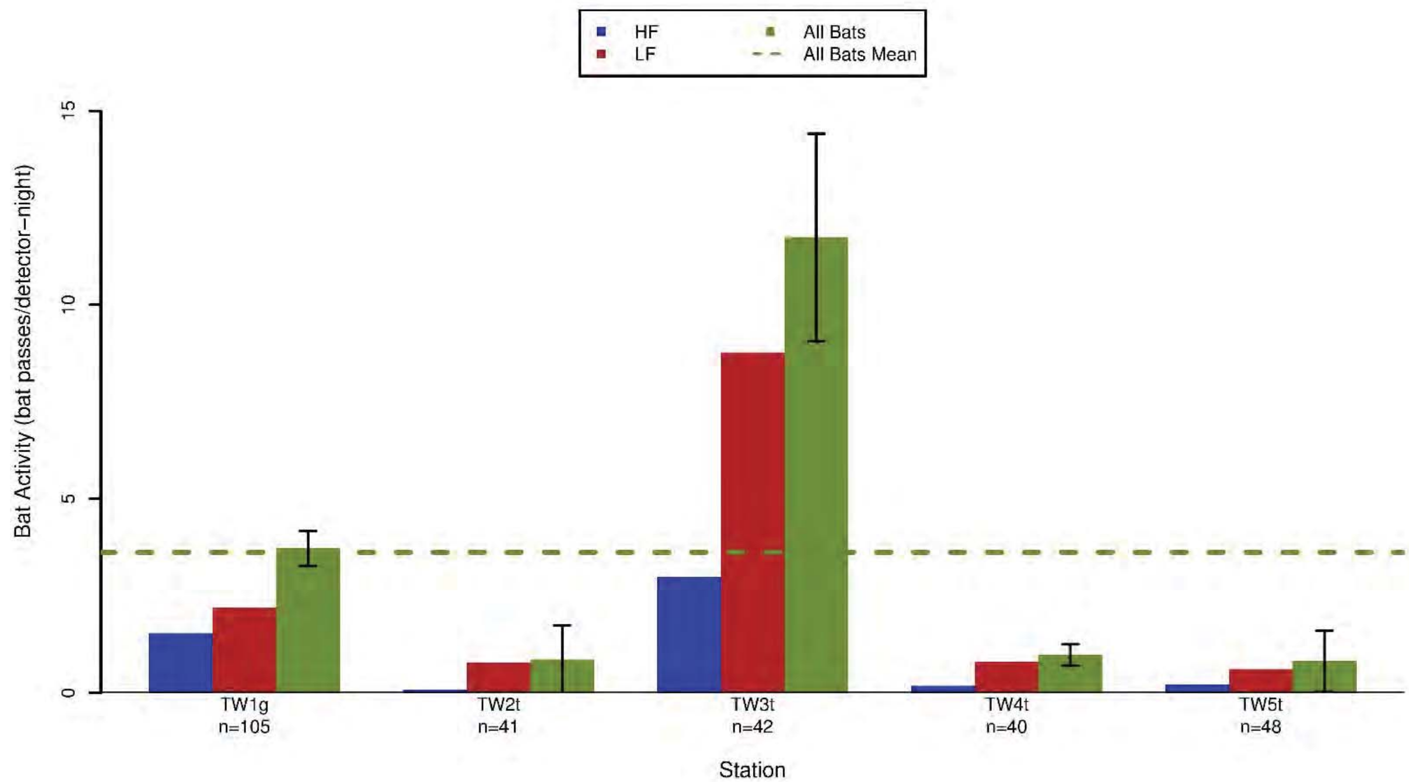

Figure 5. Number of high-frequency (HF) and low-frequency (LF) bat passes per detector-night recorded at detectors in the Three Waters Wind Farm, July 6 – November 11, 2017. The bootstrapped standard errors are represented by the black error bars on the 'All Bats' columns.

Table 3. Results of acoustic bat surveys conducted at the Three Waters Wind Farm July 6 – November 11, 2017. Passes are separated by call frequency: high-frequency and low-frequency.

Anabat Station	Location	Type	Bat Passes High-Frequency	Bat Passes Low-Frequency	Bat Passes Total	Detector- Nights	Mean Bat Passes/Night (± Standard Error)*
TW1g	ground	fixed; representative	161	230	391	105	3.72±0.45
TW2t	ground	temporary; bat feature	3	32	35	41	0.85±0.85
TW3t	ground	temporary; representative	125	368	493	42	11.74±2.41
TW4t	ground	temporary; representative	7	32	39	40	0.98±0.31
TW5t	ground	temporary; bat feature	10	29	39	48	0.81±0.91
Total Ground Fixed			**161**	**230**	**391**	**105**	**3.72±0.39**
Total Ground Temporary			**145**	**461**	**606**	**171**	**3.59±0.69**
Total			**306**	**691**	**997**	**276**	**3.62±0.60**

* ± bootstrapped standard error.

Temporal Variation

Bat activity at the fixed stations higher in the summer (7.13 bat passes per detector-night) than during the fall (2.3 bat passes per detector-night; Table 4, Figure 7). The bat pass rate for the fixed ground detector during the standardized FMP was 4.72 ± 0.55 bat passes per detector-night (Table 4). Weekly acoustic activity at the fixed station increased through July and August (Figure 6), peaking between August 6 and 12 (13.8 bat passes per detector-night; Table 5). Weekly activity then decreased through mid-October, was nearly absent for the remainder of the study period (Figure 7).

Table 4. The number of bat passes per detector-night recorded at the fixed AnaBat station in the Three Waters Wind Farm during each season in 2017, separated by call frequency: high-frequency (HF), low-frequency (LF), and all bats (AB).

Station	Call Frequency	Summer May 15 – August 15	Fall August 16 – October 15	Fall Migration Period July 30 – October 14
	LF	4.13	1.38	2.73
TW1g	HF	3	0.92	1.98
	AB	7.13	2.3	4.72
	LF	**4.13±0.74**	**1.38±0.31**	**2.73±0.45**
Overall	**HF**	**3.00±0.48**	**0.92±0.15**	**1.98±0.26**
	AB	**7.13±0.95**	**2.30±0.38**	**4.72±0.55**

Table 5. Periods of peak activity for low-frequency (LF) and all bats at representative stations within the Three Waters Wind Farm July 6 – November 11, 2017.

Species Group	Start Date of Peak Activity	End Date of Peak Activity	Bat Passes per Detector-Night
HF	August 6	August 12	5.8
LF	August 6	August 12	8.0
All Bats	August 6	August 12	13.8

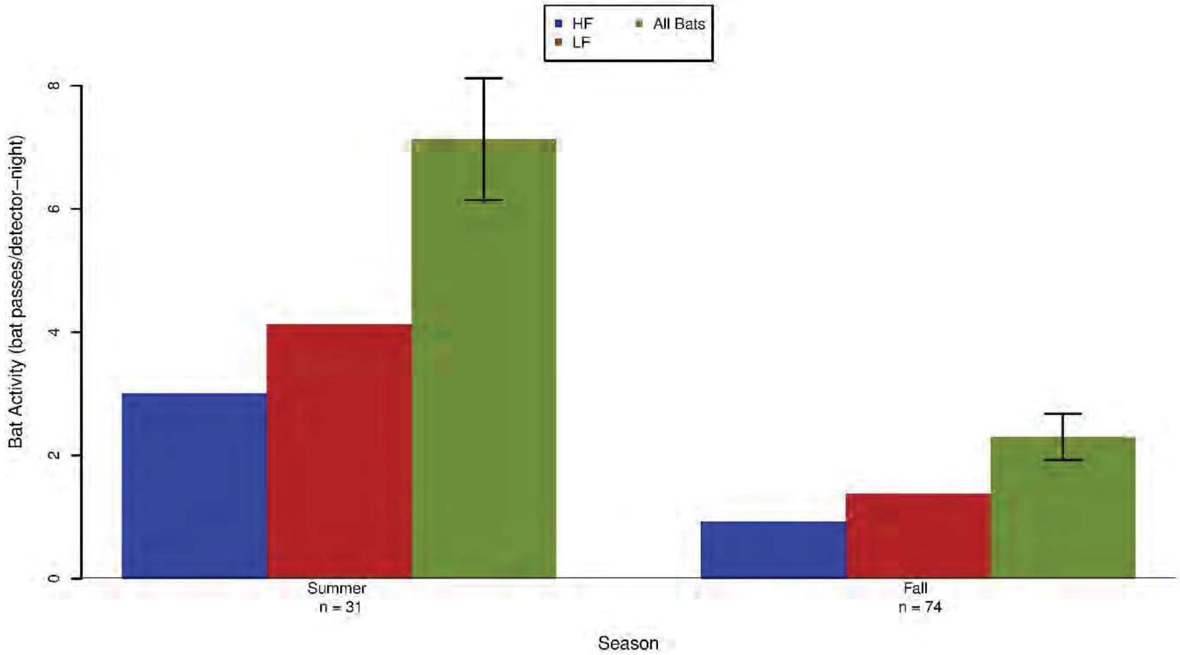

Figure 6. Mean seasonal bat activity by frequency for representative acoustic monitoring stations at the Three Waters Wind Farm, July 6 – November 11, 2017. The bootstrapped standard errors are represented on the 'All Bats' columns. HF = high-frequency; LF = low-frequency.

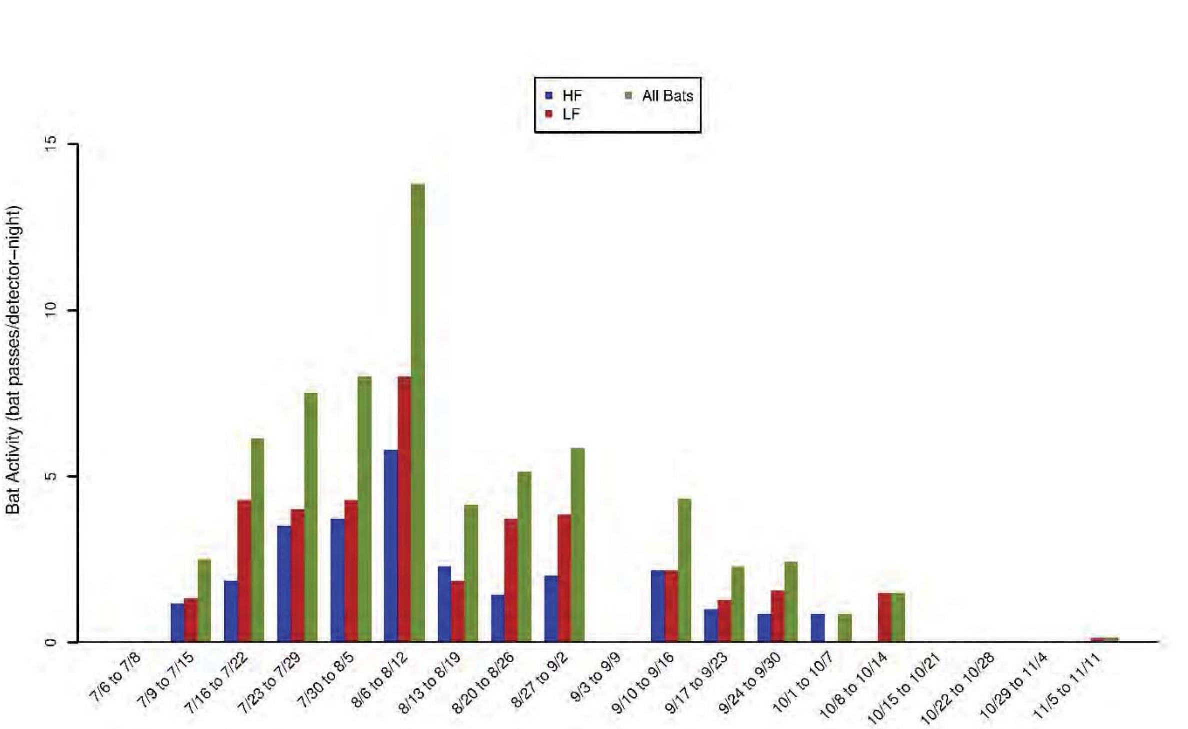

Figure 7. Weekly patterns of bat activity (bat passes) by high-frequency (HF), low-frequency (LF), and All bats at representative monitoring stations within the Three Waters Wind Farm, July 6 – November 11, 2017.

Species Composition

At all stations, 69.3% of bat passes were classified as LF (e.g., big brown bats, hoary bats, and silver-haired bats), and 30.7% of bat passes were classified as HF (e.g., eastern red bats and *Myotis* species; Tables 2 and 3). These proportions were similar among both fixed and temporary stations (Table 3). LF bat activity was greater than HF activity at all stations (Figure 5), during both seasons (Table 4; Figure 6), and during most of the weeks of the study period (Figure 7).

DISCUSSION

Bat fatalities have been discovered at most wind energy facilities monitored in North America, ranging from 0 (Tierney 2007) to 40.20 bat fatalities/MW/year (Fiedler et al. 2007; Appendix A). In 2012, an estimated 600,000 bats died as a result of interactions with wind turbines in the U.S. (Hayes 2013). Proximate causes of bat fatalities are primarily due to collisions with moving turbine blades (Grodsky et al. 2011; Rollins et al. 2012) but to a limited extent may also be caused by barotrauma (Baerwald et al. 2008). The underlying reasons for why bats come near turbines are still largely unknown (Cryan and Barclay 2009). To date, post-construction monitoring studies of wind energy facilities show that a) migratory tree-roosting species (e.g., eastern red bat [*Lasiurus borealis*], hoary bat [*Lasiurus cinereus*], and silver-haired bat [*Lasionycteris noctivagans*]) compose approximately 78% of reported bat fatalities; b) the majority of fatalities occur during the fall migration season (August and September); and c) most fatalities occur on nights with relatively low wind speeds (e.g., < 6.0 m/s; Arnett et al. 2008; Arnett and Baerwald 2013; Arnett et al. 2013).

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, though Baerwald and Barclay (2009) found a significant positive association between pass rates measured at 30 m and fatality rates for hoary and silver-haired bats across 5 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. (2013) 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 fixed ground detector (4.72 bat passes per detector-night; Table 4) was lower than the national median (7.7) and the majority of studies available from the Midwest region (Appendix A). Mean bat activity at the Project was also lower than activity recorded at the Lakefield Wind Project, located 5.3 miles to the northeast (Minnesota Public Utilities Commission (MPUC) 2012). At Lakefield, bat activity was surveyed from April 1 to October 31 in 2011 using ground and raised AnaBat detectors at two met towers. One of the ground detectors recorded 10.40 bat passes per detector-night, and the other recorded 13.08 bat passes per detector-night. In 2012, bat activity was monitored concurrently with post-construction monitoring from March 31 to October 31, and the bat pass rates at ground detectors were 7.94 and 14.77 bat passes per detector-night. In both years, peak bat activity occurred between mi-July and early September, and LF bats were the main species recorded, consistent with this study. Post-construction monitoring at Lakefield in 2012 and in 2014 determined estimated bat fatality rates of 19.87 and 20.19 bats/MW, respectively, with peak bat mortality for hoary, eastern red, and silver-haired bats occurring between mid-July and mid-September in both years (Westwood Professional Services (Westwood) 2013, 2015). Given the proximity of the Project to Lakefield, it is likely similar patterns in fatality could be recorded at the Project. Due to the lower bat activity rates at the Project, the bat fatality rates are likely to be less than 20 bats/MW/year.

Activity was highest at temporary station TW3t, recording 11.74 bat passes per detector-night. It is unclear why activity was so high at this station. The detector was located in cropland and grassland habitat, with no obvious features (e.g., water, trees) that would concentrate bat activity. The other temporary stations recorded approximately 0.8 bats per detector-night, and are likely more representative of bat activity at the Project.

Approximately 69% of bat passes recorded in the Project were emitted by LF bats, suggesting greater relative abundance of species such as big brown bats, silver-haired bats, and hoary bats (Table 3). LF species may become casualties because they fly at higher altitudes, as demonstrated by their greater prevalence at raised detectors (Table 3; Figure 6). Activity by HF bat species composed 31% of bat passes recorded at stations in the Project. Eastern red bats are usually the most common HF species found during carcass searches (Arnett et al. 2008; Arnett and Baerwald 2013). *Myotis* species are recorded less commonly than other species in the rotor-swept zone or as fatalities at most post-construction studies of wind energy facilities (Kunz et al. 2007b; Arnett et al. 2008), with a few notable exceptions (Kerns and Kerlinger 2004; Jain 2005; Brown and Hamilton 2006; Gruver et al. 2009). Given that hoary bats, eastern red bats, and silver-haired bats are among the most common bat fatalities at many facilities (Arnett et al. 2008; Arnett and Baerwald 2013), it is expected that these three species would be the most common fatalities at the Project.

Overall bat activity peaked during mid-August. This timing is consistent with peak fatality periods for most wind energy facilities in the U.S., and suggests that bat fatalities at the Project will be highest during late summer to early fall and may consist largely of migrating individuals.