Avian Use Surveys for the Merricourt Wind Energy Project McIntosh and Dickey Counties, North Dakota

Final Report

May 2016 – April 2017

Prepared for:

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EXECUTIVE SUMMARY

EDF Renewable Energy contracted Western EcoSystems Technology, Inc. (WEST) to conduct surveys and monitor wildlife resources in the Merricourt Wind Energy Project (Project) The Project, currently about 5,320 hectares (13,146 acres), is located in southeast North Dakota in eastern McIntosh and western Dickey Counties.

The principal objectives of the study were to: 1) provide site-specific bird use data; and 2) provide information that could be used for planning and design of the Project to minimize impacts to birds. Additional objectives were to document use of the Project area by threatened, endangered, and sensitive avian species and eagles.

Seven 800-m (2,625-ft) radius circular plots were selected to conduct fixed-point avian use surveys within the Project area based on the initial Project boundary. Avian use surveys were conducted from May 9, 2016 to April 28, 2017. Each point was surveyed for 60 minutes; all birds observed during the first 20 minutes of each survey were recorded; only eagles, other raptors, and sensitive species were recorded during the remaining 40 minutes. Each plot was surveyed approximately twice per month. Observations of large birds beyond the 800-meter (2,625-foot) radius were recorded, but were not included in statistical analyses. For small birds, observations beyond the 100-meter (328-foot) radius were excluded.

Sixty-one unique species were observed during avian use surveys. Bird diversity was highest during the summer (45 species). A mean of 1.08 large bird species/800-meter plot/20-minute survey and 1.44 small bird species/100-meter plot/20-minute survey was recorded. Large bird species richness was higher during the spring (1.90 species/800-meter plot/20-minute survey). Small bird species richness was higher during the summer (2.76 species/100-meter plot/20-minute survey).

A total of 3,632 birds were observed within 510 separate groups during avian use surveys. Waterfowl and passerines observations contributed about a third each to the total. Snow geese were the most recorded waterfowl species while snow buntings had the highest number of passerine observations. The highest overall large bird use occurred during spring (11.45 birds/800-meter plot/20-minute survey), followed by fall (10.83), winter (9.16), and summer (4.71). Small bird use was highest in spring also (24.38 birds/100-meter plot/20-minute survey), followed by winter (8.76), summer (7.36), and fall (5.2).

Twenty-five diurnal raptors were recorded within the Project area, representing three unique species. Diurnal raptor use was highest during fall (0.26 birds/800-meter plot/20-minute survey), followed by summer (0.24). Spring use was 0.12 birds/800-meter plot/20-minute survey with winter having the lowest use (0.02; Table 3). The majority of use during fall was by red-tailed hawks (0.11 birds/800-meter plot/20-minute survey) and unidentified hawks/raptors (0.11 birds/800-meter plot/20-minute survey). Most of the summer use (0.14 birds/800-meter plot/20-minute survey) was also by red-tailed hawks and all of the winter use (0.02 birds/800-meter

plot/20-minute survey) was by this species. Spring diurnal raptor use was exclusively by norther harriers. No eagles were observed during scheduled avian use surveys.

Overall mean diurnal raptor use was 0.15 raptors/800-meter plot/20-minute survey, which is considered to be low, compared to publicly available data from other facilities in the central and western US that implemented similar protocols and had data for three or four seasons.

Results of post-construction raptor fatality monitoring in the Midwest ranged from zero to 0.47 raptor fatalities per megawatt per year. Raptor mortality at the Project would likely be within this range and potentially similar to those rates observed at other wind projects in North Dakota and South Dakota (zero to 0.2 raptor fatalities/megawatt/year).

The Project is not within a known raptor migration corridor, and there are no features unique to the Project area, compared to surrounding area, that would appear to attract large numbers of diurnal raptors. Site-specific and regional data suggest there is some potential for raptor mortality, but these potential impacts to individuals are unlikely to cause significant adverse impacts to raptor populations. Likewise, there is some potential for other impacts, such as habitat loss and displacement of individuals, but the resources available in the Project area are widely available at the local landscape level. Therefore, any diurnal raptor habitat loss and displacement attributable to the Project is unlikely to result in significant adverse impacts to raptor populations.

Fourteen sensitive species were recorded during avian use surveys and incidentally. None of those were federally endangered, threatened, candidate, or proposed species. One bald and one golden eagle were observed incidentally. Four Level I state species of conservation priority (Franklin's gull, grasshopper sparrow, Swainson's hawk, and Wilson's phalarope) were recorded during surveys conducted at the Project.

STUDY PARTICIPANTS

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REPORT REFERENCE

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INTRODUCTION

EDF Renewable Energy (EDF RE) contracted with Western EcoSystems Technology, Inc. (WEST) to conduct surveys and monitor wildlife resources at the Merricourt Wind Energy Project (Project). The methods for this study were consistent with the US Fish and Wildlife Service's (USFWS) *Eagle Conservation Plan Guidance* (ECPG), *Module 1 – Land-Based Wind Energy* (USFWS 2013) and *Final Land-Based Wind Energy Guidelines* (USFWS 2012).

The principal objectives of the study were to: 1) provide site-specific bird use data; and 2) provide information that could be used for planning and design of the Project to minimize impacts to birds. Additional objectives were to document use of the Project area by threatened, endangered, and sensitive avian species and eagles. The following report describes the results of the avian use study conducted in the Project area from May 9, 2016 – April 28, 2017.

STUDY AREA

The approximately 5,319.5-hectares (ha; 13,144.8-acres [ac]) Project is located in McIntosh and Dickey counties, approximately 17.7 kilometers (km; 11.0 miles [mi]) south of the Town of Kulm (Figure 1), in southeast North Dakota. Topography within the Project area is relatively flat to gently rolling, with elevation ranging from 588.7 to 687.7 meters (m; 1,931.5 to 2,256.3 feet [ft]).

According to the US Geological Survey (USGS) National Land Cover Database (NLCD; USGS NLCD 2011, Homer et al. 2015), the majority (56.5%) of land cover within the Project area is grassland (including pasture/hay lands) and cultivated crops (29.6%). Another 9.3% of the Project area is water/wetlands. Developed (2.9%), shrub/Scrub (1.5%), barren lands (0.1%) and forest (0.1%), cover a small percentage of the Project area (Table 1, Figure 2).

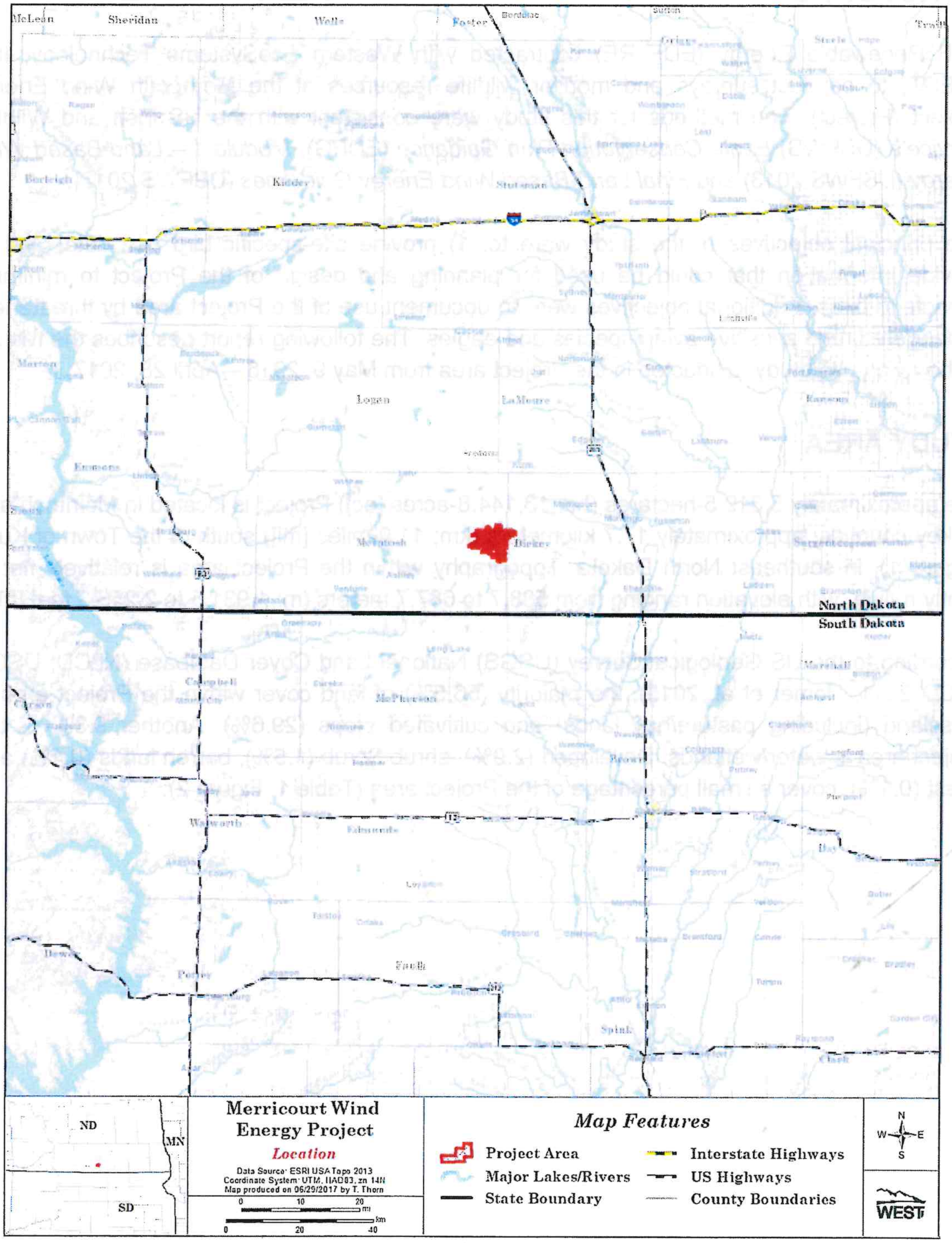

Figure 1. Location of the Merricourt Wind Energy Project in McIntosh and Dickey counties, North Dakota.

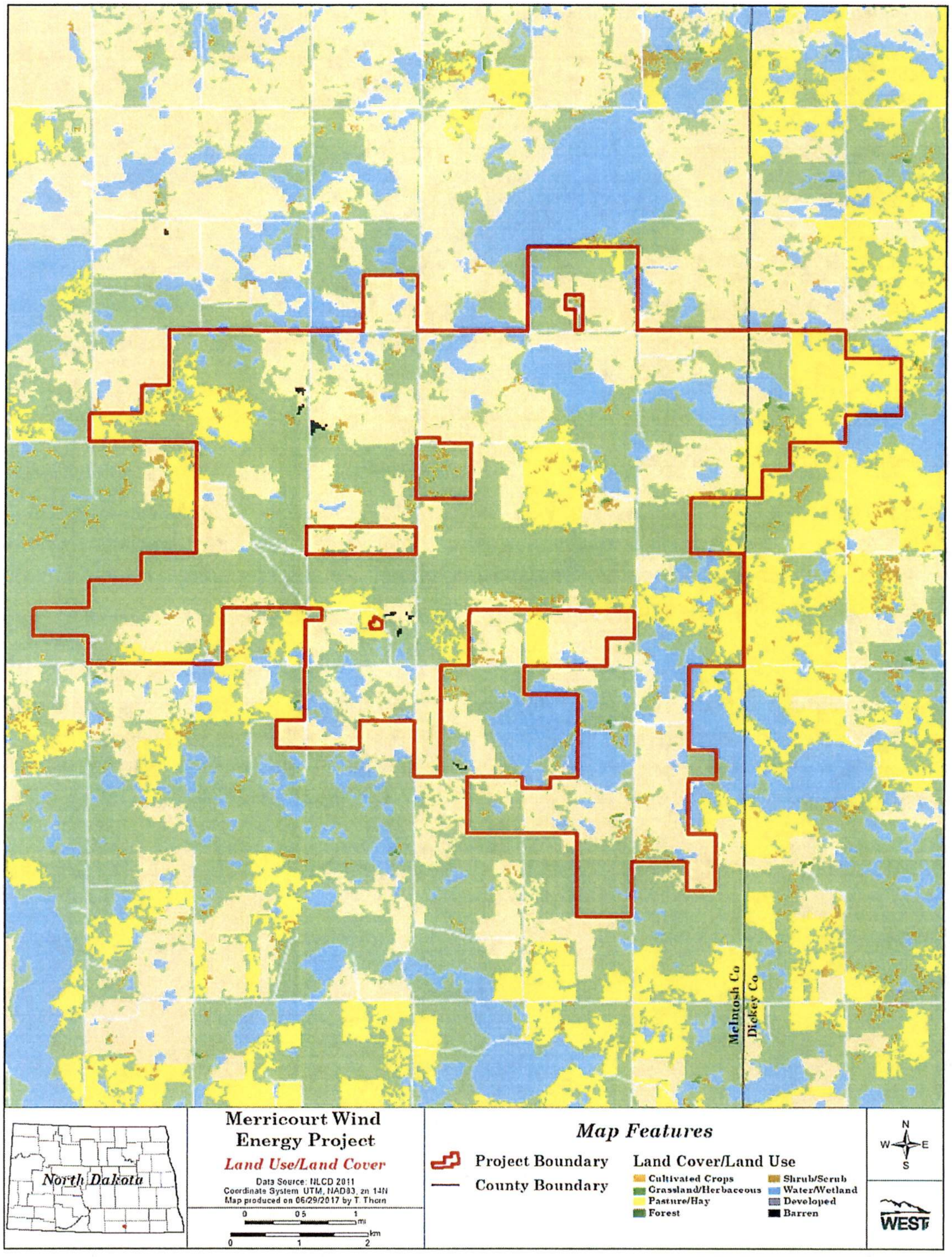

Figure 2. National Land Cover Database land cover types within and adjacent to the Merricourt Wind Energy Project in McIntosh and Dickey counties, North Dakota (USGS NLCD 2011, Homer et al. 2015).

Table 1. Condensed National Land Cover Database land cover types within the Merricourt Wind Energy Project in McIntosh and Dickey counties, North Dakota.

Cover Type[a]	Acres	% Composition
Grassland	7,422.2	56.5
Cultivated Crops	3,888.4	29.6
Water/Wetlands	1,229.4	9.3
Developed	374.9	2.9
Shrub/Scrub	201.9	1.5
Barren Land	15.8	0.1
Forest	12.2	0.1
Total	**13,144.8**	**100**

Data Sources: USGS NLCD 2011, Homer et al. 2015
[a] Related types condensed into broader categories

METHODS

Fixed-Point Avian Use Surveys

The objective of the avian use survey was to estimate the seasonal and spatial use of the Project area by birds, particularly diurnal raptors (defined here as kites, accipiters, buteos, harriers, eagles, falcons, and osprey [*Pandion haliaetus*]). Avian use surveys (variable circular plots) were conducted using methods described by Reynolds et al. (1980).

Survey Plots

Seven avian survey points consisting of 800-m (2,625-ft) radius circular plots were selected to achieve relatively even coverage of the Project area. These points were established based on the Project boundary at the beginning of the avian use study, which differs slightly from the current boundary (Figure 3).

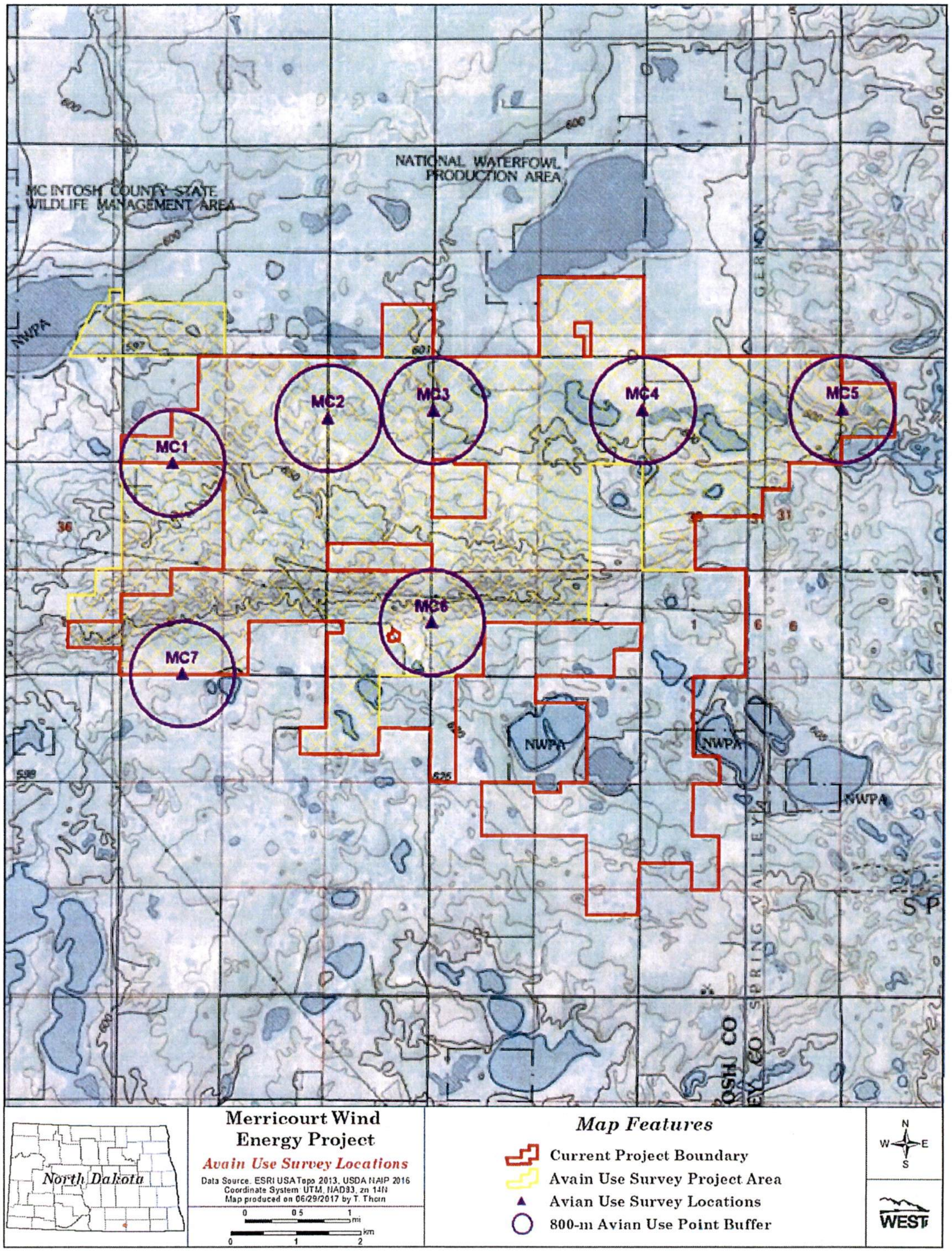

Figure 3. Location of the avian use survey points and survey plots within the Merricourt Wind Energy Project in McIntosh and Dickey counties, North Dakota, where surveys were conducted from May 9, 2016 - April 28, 2017.

Survey Methods

Avian use surveys were conducted for 60 minutes (min), with all small and large birds recorded for the first 20 min, then only eagles, species of concern, and other raptors being recorded for the remaining 40 min of each 60 min survey (small birds within 100 m [328 ft], large birds within 800 m [2,625 ft]). All large and small birds seen during each survey were recorded using a unique observation number. In some cases, observations may represent repeated sightings of the same individual. Observations of large birds outside the 800-m (2,625-ft) plot were recorded and were included in the development of species composition, relative abundance, and species diversity metrics, but were not included in analyses of avian use and flight heights. Large bird types included waterbirds, waterfowl, shorebirds, rails and coots, grebes and loons, gulls and terns, diurnal raptors, owls, vultures, upland game birds, doves/pigeons, some cuckoos, large corvids (e.g., ravens, magpies, and crows), and goatsuckers. Small birds included passerines (excluding large corvids), most cuckoos, swifts and hummingbirds, woodpeckers, and kingfishers.

The following information was recorded during each bird use survey: date, start and end time, and weather information (i.e., temperature, wind speed, wind direction, precipitation, and cloud cover). The following data were recorded for each observation:

- Observation Number
- Species (or best possible identification)
- Number of individuals
- Sex/Age class (to the extent possible)
- Distance from plot center when first observed
- Closest distance observed
- Flight height above ground level (AGL)
- Flight direction
- Activity (flying compared to perched)

Approximate flight height, flight direction, and distance from plot center at first observation were recorded to the nearest 5-m (16-ft) interval; the approximate lowest and highest heights were also recorded.

For bald eagle (*Haliaeetus leucocephalus*) or golden eagle (*Aquila chrysaetos*) observations, flight height, distance, and activity (i.e., flying or perched) were recorded during each one-min interval, per the ECPG. The perch locations and flight paths of eagles were mapped to qualitatively assess areas of eagle use within the Project area.

Incidental Wildlife Observations

Incidental observations provide records of wildlife seen outside of the standardized surveys. Biologists recorded endangered and threatened species, species of concern, and rare or unusual species. Incidental observations and locations were recorded in a similar fashion to standardized surveys, where the date, time, observation number, species, number of individuals, sex/age class, distance from observer, activity, and flight height AGL (for bird species) were recorded.

Observation Schedule

Each survey point was surveyed approximately twice per month. Surveys were carried out during daylight hours and, to the extent practical, each point was surveyed roughly the same number of times during the study period. Some surveys may have been missed or delayed due to adverse weather (e.g., snow, fog or rain) or access issues (e.g., road conditions, weather). Survey seasons were defined as spring (March 1 to May 31), summer (June 1 to August 31), fall (September 1 to November 15), and winter (November 16 to February 28).

Data Analysis

Fixed-Point Avian Use Surveys

The calculations and analyses described in this section were conducted for observations recorded during the first 20-min of surveys.

<u>Species Composition, Diversity, and Richness</u>

Bird species composition (lists of species and bird types observed during the surveys), diversity (total number of unique species observed within each season) and richness (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), were generated by season and included all observations of birds detected, regardless of their distance from the observer.

<u>Bird Use, Percent of Use, and Frequency of Occurrence</u>

For comparison with other studies, large bird use was calculated as the number of birds per 800-m (2,625-ft) plot per 20-min survey and small bird use was calculated as number of birds per 100-m (328-ft) plot per 20-min survey. For analysis purposes, a visit was defined as the required length of time, in days, to survey all of the plots once within the Project area (see Statistical Analysis Section). Bird use by season was calculated by first summing the number of birds seen within each plot during a visit, then by averaging across all plots within each visit, and finally by averaging across all visits within the season. Overall bird use was calculated as a weighted average of seasonal values by the number of calendar days in each season (as defined by the season dates). Percent of use was calculated as the proportion of large or small bird use that was attributable to a particular bird type or species, and frequency of occurrence was calculated as the percent of surveys in which a particular bird type or species was observed.

<u>Flight Height</u>

Flight height data were used to estimate bird use within a rotor-swept height (RSH) range of 25 to 150 m (82 to 492 ft) AGL. The groups' (a single bird or a flock of two or more) flight heights when first observed were used to calculate the percentage of the different groups flying at different height categories: below the RSH (zero to 25 m [zero to 82 ft] AGL), at RSH (25 to 150 m [82 to 492 ft] AGL), and greater than the RSH (more than 150 m [492 ft] AGL).

<u>Bird Exposure Index</u>

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

$$R = A*Pf*Pt$$

where A equals mean relative use for species *i* (large bird observations within 800 m [2,625 ft] and small bird observations within 100 m [328 ft] of the observer) averaged across all surveys, Pf equals the proportion of all observations of species *i* where activity was recorded as flying (an index to the approximate percentage of time species *i* spends flying during the daylight period), and Pt equals the proportion of all initial flight height observations of species *i* within the likely RSH. The exposure index does not account for other possible collision risk factors, such as foraging or courtship behavior.

<u>Spatial Use</u>

Spatial use was evaluated by comparing large bird and small bird use among survey plots for each species and bird type. In addition, eagle flight paths were mapped to qualitatively identify areas of concentrated use and/or consistent flight patterns.

<u>Statistical Analysis</u>

Visits were assigned according to the following criteria: 1) a single visit had to be completed in a single season; and 2) a visit could be spread across multiple dates, but a single date could not contain surveys from multiple visits. Under certain circumstances, such as extreme weather conditions, plots were not surveyed during some visits. In these cases, a visit might not have constituted a survey of all plots.

RESULTS

Fixed-Point Avian Use Surveys

A total of 175 60-min fixed-point avian use surveys were conducted during 25 visits conducted within the Project area from May 9, 2016 to April 28, 2017 (Table 2). Sixty-one unique species were recorded during the first 20-min; a total of 63 unique species were recorded during the 60-min surveys (Appendix A). This section includes the results for the first 20-min of avian use surveys.

Species Composition, Diversity and Richness

A total of 3,632 birds were observed within 510 separate groups (defined as one or more individuals) during the first 20-min of avian use surveys (Appendix A). Waterfowl and passerines contributed about a third each to the total observations. Snow geese (*Chen caerulescens;* 500 observations) and snow buntings (*Plectrophenax nivalis;* 233 observations) were the most recorded waterfowl and passerine species, respectively. Twenty-five diurnal raptor observations within 20 groups and three unique species were recorded within the Project area during avian use surveys (Appendix A). Red-tailed hawk (*Buteo jamaicensis*) was the most recorded diurnal raptor specie with 11 observations within eight groups.

Species diversity was highest during the summer (45 species), followed closely by spring (40), then fall (22), and winter (5; Table 2). Mean species richness (mean number of species per plot per survey) of 1.08 large bird species/800-m plot/20-min survey and 1.44 small bird species/100-m plot/20-min survey were recorded. Large bird species richness was higher during the spring (1.90 species/800-m plot/20-min survey), summer (1.50) and fall (0.97), compared to the winter (0.07). Small bird species richness was higher during the summer (2.76 species/100-m plot/20-min survey) and spring (2.12) compared to the fall (0.54) and winter (0.35; Table 2).

Table 2. Summary of species richness (species/plot[a]/20-minute survey), diversity (number of unique species), and sample size (number of visits and surveys conducted) by season and overall during the fixed-point bird use surveys conducted at the Merricourt Wind Energy Project in McIntosh and Dickey counties, North Dakota, from May 9, 2016 – April 28, 2017.

Season	Number of Visits	# Surveys Conducted	# Unique Species	Species Richness	
				Large Birds	Small Birds
Spring	6	42	40	1.90	2.12
Summer	6	42	45	1.50	2.76
Fall	5	35	22	0.97	0.54
Winter	8	56	5	0.07	0.35
Overall	**25**	**175**	**61**	**1.08**	**1.44**

[a] 800-meter (m; 2,625-foot [ft]) radius plot for large birds and 100-m (328-ft) radius plot for small birds.

Use, Percent of Use, and Frequency of Occurrence

Mean use, percent of use, and frequency of occurrence were calculated by season for all bird types (Table 3) and species (Appendix B) observed during the first 20-min of surveys. The highest overall large bird use occurred during spring (11.45 birds/800 m plot/20-min survey), fall (10.83), and winter (9.16), compared to summer (4.71). Small bird use was highest in spring (24.38 birds/100-m plot/20-min survey), compared to all other seasons (8.76 in winter, 7.36 in summer, and 5.2 in fall; Table 3).

Waterbirds

Waterbird use was highest during the spring (2.62 birds/800-m plot/20-min survey), followed by summer and fall (0.33 and 0.23, respectively); no waterbird use was recorded during the winter (Table3). American white pelican (*Pelecanus erythrorhynchos*) accounted for the majority of the summer observations while double crested cormorants (*Phalacrocorax auritus*) accounted for the majority of the summer and all of the fall observations (Appendix B). Great egret (*Ardea* *alba*) was only recorded during spring surveys; no whooping cranes (*Grus americana*) were observed during bird use surveys conducted in the Project area while Sandhill cranes (*Grus canadensis*) were observed during the 60-min surveys (Appendix A). Sandhill cranes were not included in the analysis because they were recorded outside the 20-min observation period.

Waterfowl

Waterfowl accounted for the majority of overall large bird use during all seasons (Table 3). Canada geese (*Branta canadensis*) and lesser scaup (*Aythya affinis*) were the most observed waterfowl species during spring, blue-winged teal (*Anas discors*) was the most recorded waterfowl species in summer, Canada goose was again the most observed waterfowl species in the fall, while snow goose was the highest recorded species in winter (Appendix B). Waterfowl accounted for over 99.8% of all large bird use in winter, 89.4% of fall use, 60.1% of summer use, and 55.3% of spring use (Table 3). Waterfowl were observed more frequently during the spring (54.8%), fall (31.4%), and summer (23.8%), compared to winter (3.6%; Table 3).

Shorebirds

Shorebird use was recorded in spring, summer, and fall, ranging from 0.55 to 0.69 birds/800-m plot/20-min survey (Table 3). Killdeer (*Charadrius vociferous*) composed the majority of use across seasons (Appendix B). Shorebirds accounted for 11.6% use in summer, followed by spring (6.0 %), and fall (5.5%). Shorebirds were observed more frequently during the spring (45.2%) and summer (35.7%) compared to the fall. No shorebirds were observed during winter surveys and no piping plovers (*Charadrius melodus*) were observed during year-round surveys conducted in the Project area (Appendix A).

Passerines

Passerine use was highest during the summer (7.33 birds/100-m plot/20-min survey), spring (7.26), and winter (6.46), compared to fall (2.34; Table 3). Red-winged blackbirds (*Agelaius phoeniceus*) had the highest passerine use by any one species during the summer (1.38 birds/100-m plot/20-min survey) and spring (3.17 birds/100-m plot/20-min survey). Barn swallows (*Hirundo rustica*) had the highest passerine use (1.49) of species observed in fall; snow buntings had the highest use in winter (4.16; Appendix B). Passerines accounted for 99.7% of small bird use in summer, 73.8% in winter, 45.1% in fall, and 29.8% in spring. Unidentified birds made up the remaining small bird use (Table 3). Passerines were observed during 95.2% of the surveys during summer, 83.3% during spring, 42.9% of surveys in fall, and in 25.0% of winter surveys (Table 3).

Diurnal Raptors

Diurnal raptor use was highest during fall (0.26 birds/800-m plot/20-min survey), followed closely by summer (0.24). Spring use was 0.12 birds/800-m plot/20-min survey while winter had the lowest use (0.02; Table 3). Red-tailed hawk was the most observed species in fall 0.11 birds/800-m plot/20-min survey) and summer (0.14 birds/800-m plot/20-min survey) and was the only diurnal raptor species recorded in winter (0.02 birds/800-m plot/20-min survey). Spring diurnal raptor use was exclusively by northern harriers (*Circus cyaneus*; Appendix B). Diurnal raptors accounted for 5.1% or less of the overall large bird use during any season. Diurnal raptors were observed during 20.0% of fall surveys compared to 16.7% of summer and 11.9% of spring surveys; diurnal raptors were observed in only 1.8% of winter surveys (Table 3). No eagles were observed during avian use surveys for the 20- or 60-min periods conducted at the Project.

Table 3. Mean bird use (species/plot[a]/20-minute survey), percent of use (%), and frequency of occurrence (%) for each bird type and species by season during the fixed-point bird use surveys conducted at the Merricourt Wind Energy Project in McIntosh and Dickey counties, North Dakota, from May 9, 2016 – April 28, 2017.

	Mean Use				% of Use				% Frequency			
Type / Species	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter
Waterbirds	**2.62**	**0.33**	**0.23**	**0**	**22.9**	**7.1**	**2.1**	**0**	**9.5**	**14.3**	**5.7**	**0**
Waterfowl	**6.33**	**2.83**	**9.69**	**9.14**	**55.3**	**60.1**	**89.4**	**99.8**	**54.8**	**23.8**	**31.4**	**3.6**
Shorebirds	**0.69**	**0.55**	**0.60**	**0**	**6.0**	**11.6**	**5.5**	**0**	**45.2**	**35.7**	**5.7**	**0**
Gulls/Terns	**1.40**	**0.21**	**0**	**0**	**12.3**	**4.5**	**0**	**0**	**16.7**	**9.5**	**0**	**0**
Rails/Coots	**0.07**	**0**	**0**	**0**	**0.6**	**0**	**0**	**0**	**2.4**	**0**	**0**	**0**
Diurnal Raptors	**0.12**	**0.24**	**0.26**	**0.02**	**1.0**	**5.1**	**2.4**	**0.2**	**11.9**	**16.7**	**20.0**	**1.8**
Buteos	*0*	*0.17*	*0.11*	*0.02*	*0*	*3.5*	*1.1*	*0.2*	*0*	*11.9*	*8.6*	*1.8*
Northern Harrier	*0.12*	*0.05*	*0.03*	*0*	*1.0*	*1.0*	*0.3*	*0*	*11.9*	*2.4*	*2.9*	*0*
Other Raptors	*0*	*0.02*	*0.11*	*0*	*0*	*0.5*	*1.1*	*0*	*0*	*2.4*	*8.6*	*0*
Upland Game Birds	0.12	0.21	0.03	0	1.0	4.5	0.3	0	11.9	16.7	2.9	0
Doves/Pigeons	0.07	0.33	0.03	0	0.6	7.1	0.3	0	4.8	19.0	2.9	0
Large Corvids	0.02	0	0	0	0.2	0	0	0	2.4	0	0	0
Large Bird Overall	**11.45**	**4.71**	**10.83**	**9.16**	**100**	**100**	**100**	**100**				
Passerines	7.26	7.33	2.34	6.46	29.8	99.7	45.1	73.8	83.3	95.2	42.9	25.0
Unidentified Birds	17.12	0.02	2.86	2.29	70.2	0.3	54.9	26.2	16.7	2.4	11.4	9.5
Small Bird Overall	**24.38**	**7.36**	**5.20**	**8.76**	**100**	**100**	**100**	**100**				

[a] 800-meter (m; 2,625-foot [ft]) radius plot for large birds and 100-m (328-ft) radius plot for small birds.

Flight Height Characteristics

A total of 102 groups of large birds were observed flying within the 800-m (2,625 ft) plot, totaling 923 individual observations, while 132 groups of small birds were observed flying within a 100-m (328-ft) plot, totaling 1,620 individual observations (Table 4; see Appendix C for full list of species). Overall, 65.4% of flying large birds and 0.1% of flying small birds were recorded within the RSH (25 to 150 m [82 to 492 ft] AGL). Large bird types that were most often recorded in the RSH were waterfowl (80.4%; Table 4) and diurnal raptors (38.1%), with the buteo subgroup having the highest (75.0%) percentage of diurnal raptors flying within the RSH. The majority of gulls/terns were recorded flying above the RSH, most of all other bird types were observed flying below RSH (Table 4).

Table 4. Flight height characteristics by bird type[a] and diurnal raptor subtype during the first 20-minutes of fixed-point bird use surveys conducted at the Merricourt Wind Energy Project in McIntosh and Dickey counties, North Dakota, from May 9, 2016 – April 28, 2017.

Bird Type	# Groups Flying	# Obs. Flying	Mean Flight Height (m)	% Obs. Flying	% Within Flight Height Categories: 0 - 25 m	25 - 150 m[b]	> 150 m
Waterbirds	**16**	**111**	**33.19**	**84.1**	**91.0**	**5.4**	**3.6**
Waterfowl	**43**	**724**	**24.56**	**58.6**	**19.1**	**80.4**	**0.6**
Shorebirds	**8**	**10**	**2.50**	**13.7**	**100**	**0**	**0**
Gulls/Terns	**11**	**46**	**58.55**	**67.6**	**17.4**	**17.4**	**65.2**
Rails/Coots	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Diurnal Raptors	**17**	**21**	**100.29**	**84.0**	**42.9**	**38.1**	**19.0**
Buteos	*6*	*8*	*155.00*	*66.7*	*12.5*	*75.0*	*12.5*
Northern Harrier	*7*	*8*	*7.86*	*100*	*87.5*	*12.5*	*0*
Other Raptors	*4*	*5*	*180.00*	*100*	*20.0*	*20.0*	*60.0*
Upland Game Birds	0	0	0	0	0	0	0
Doves/Pigeons	6	10	3.17	55.6	100	0	0
Large Corvids	1	1	4.00	100	100	0	0
Large Birds Overall	**102**	**923**	**39.01**	**58.8**	**30.0**	**65.4**	**4.6**
Passerines	119	688	3.76	65.1	99.7	0.3	0
Unidentified Birds	13	932	4.77	98.4	100	0	0
Small Birds Overall	**132**	**1,620**	**3.86**	**80.8**	**99.9**	**0.1**	**0**

Obs. = Observations

[a] 800-meter (m; 2,625-foot [ft]) radius plot for large birds and 100-m (328-ft) radius plot for small birds

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

Bird Exposure Index

A relative exposure index, based on initial flight height observations and relative abundance (defined as the use estimate), was calculated for each bird species (Appendix C). Those species that flew within the RSH are listed in Table 5.

Snow goose was the specie with the highest exposure index (2.59), compared to an exposure index of less than 0.4 for all other large bird species. Three of the top five large birds with an exposure index greater than zero were waterfowl species (Table 5).

All raptor species had an exposure index of 0.04 or less with the red-tailed hawks having the highest index. Both northern harriers and unidentified hawks had exposure indexes of less than 0.01. Based on observations within 100 m (328 ft), the small bird species with the highest exposure indexes (less than 0.01) were red-winged blackbird and common grackle (*Quiscalus quiscula*; Table 5).

Table 5. Relative exposure index and flight characteristics for bird species[a] observed during the first 20-minutes of fixed-point avian use surveys conducted at the Merricourt Wind Energy Project in McIntosh and Dickey counties, North Dakota, from May 9, 2016 – April 28, 2017.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying Within RSH[b] based on Initial Observation	Exposure Index	% Within RSH at Anytime
Large Bird Species[c]						
snow goose	1	2.59	100	100	2.59	100
Canada goose	15	1.55	55.9	41.1	0.36	41.1
unidentified duck	15	1.45	21.3	19.2	0.06	19.2
Franklin's gull	2	0.05	88.9	75.0	0.04	75.0
red-tailed hawk	6	0.06	72.7	75.0	0.04	87.5
mallard	4	0.20	24.2	62.5	0.03	62.5
tundra swan	1	0.02	100	100	0.02	100
double-crested cormorant	8	0.17	92.9	11.5	0.02	11.5
American white pelican	7	0.61	81.6	3.6	0.02	35.7
American wigeon	1	0.01	100	100	0.01	100
unidentified gull	8	0.34	63.8	5.4	0.01	5.4
unidentified hawk	3	0.02	100	33.3	<0.01	66.7
northern pintail	1	0.04	14.3	100	<0.01	100
northern harrier	7	0.05	100	12.5	<0.01	12.5
Small Bird Species[c]						
red-winged blackbird	18	1.14	47.1	1.1	<0.01	1.1
common grackle	18	0.30	48.0	4.2	<0.01	4.2

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

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

[c.] 800-m (2,625-ft) radius plot for large birds and 100-m (328-ft) radius plot for small birds

Spatial Use

Large bird use ranged from 0.84 to 34.58 birds/20-min survey, (Appendix D), being highest at Point 4 (Figure 4a). The high mean use estimate for Point 4 was largely due to waterfowl use (31.71 birds/800-m plot/20-min survey; Appendix D). Waterfowl use at other points ranged from 0.36 to 8.88 (Figure 4b; Appendix D). Diurnal raptor use was highest at Point 5 (0.29 birds/800-m plot/20-min survey), and ranged from zero at Point 3, to 0.20 at Point 1 (Figure 4c; Appendix D). No eagles were recorded during scheduled avian use surveys conducted at the Project. Small bird use was highest at Point 5 (34.33 birds/100-m plot/20-min survey) and ranged from 2.68 to 22.68 at other points (Figure 4d; Appendix D).

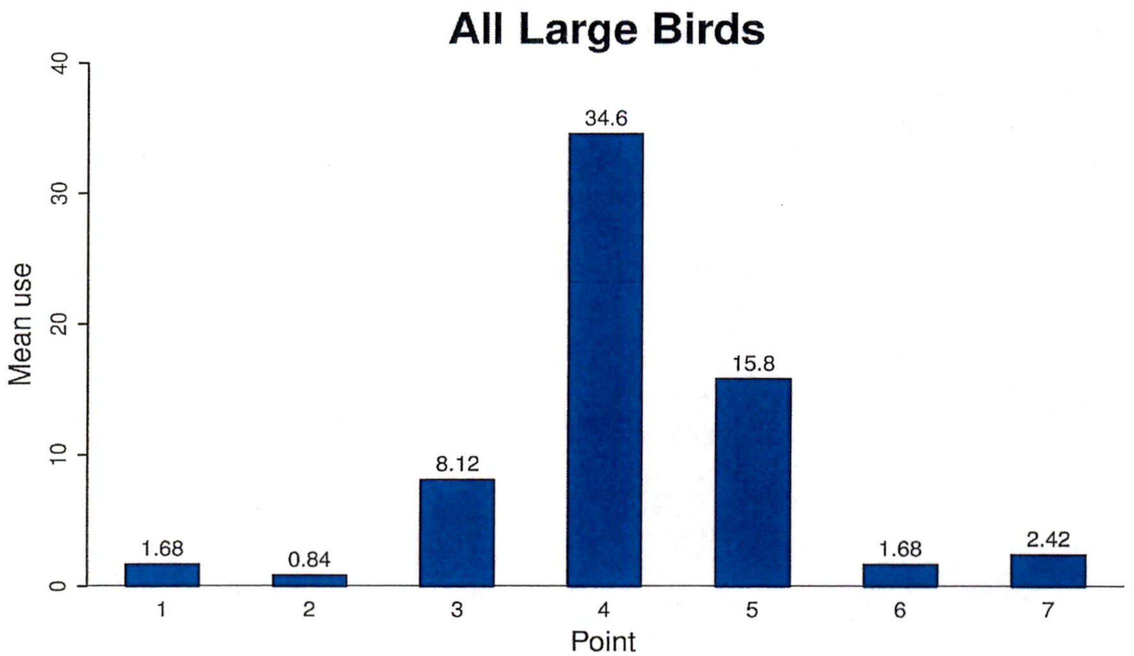

Figure 4a. Mean large bird use (number of birds/800-meter plot/20-minute survey) by survey point recorded during avian use surveys conducted at the Merricourt Wind Energy Project in McIntosh and Dickey counties, North Dakota, from May 9, 2016 – April 28, 2017.

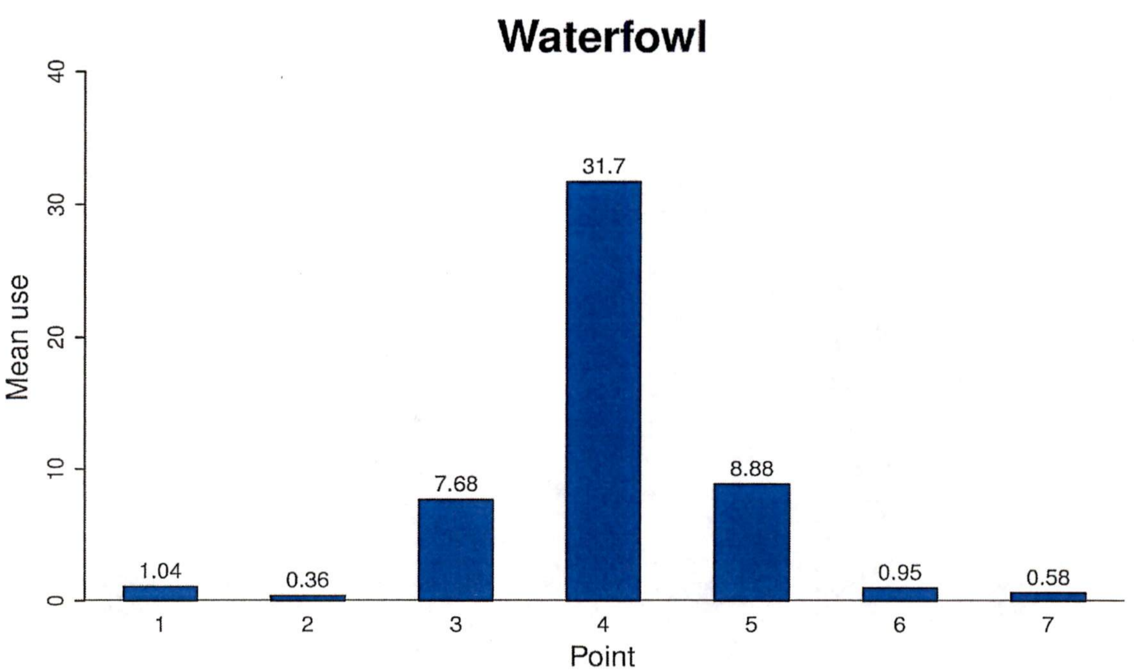

Figure 4b. Mean waterfowl use (number of birds/800-meter plot/20-minute survey) by survey point recorded during avian use surveys conducted at the Merricourt Wind Energy Project in McIntosh and Dickey counties, North Dakota, from May 9, 2016 – April 28, 2017.

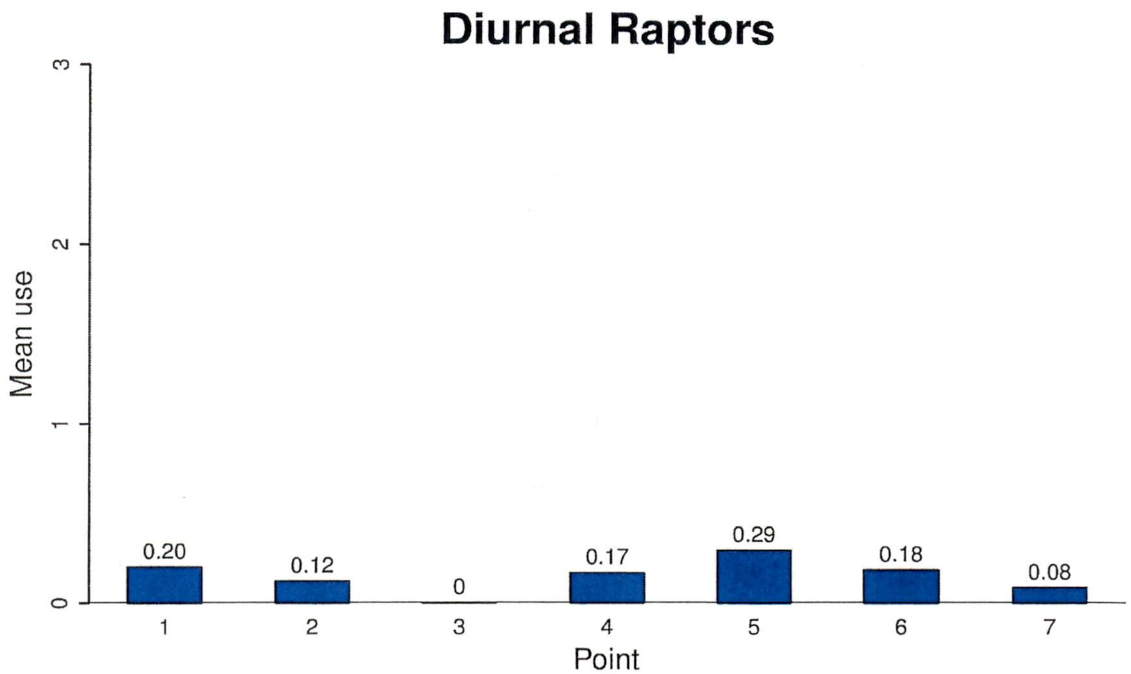

Figure 4c. Mean diurnal raptor use (number of birds/800-meter plot/20-minute survey) by survey point recorded during avian use surveys conducted at the Merricourt Wind Energy Project in McIntosh and Dickey counties, North Dakota, from May 9, 2016 – April 28, 2017.

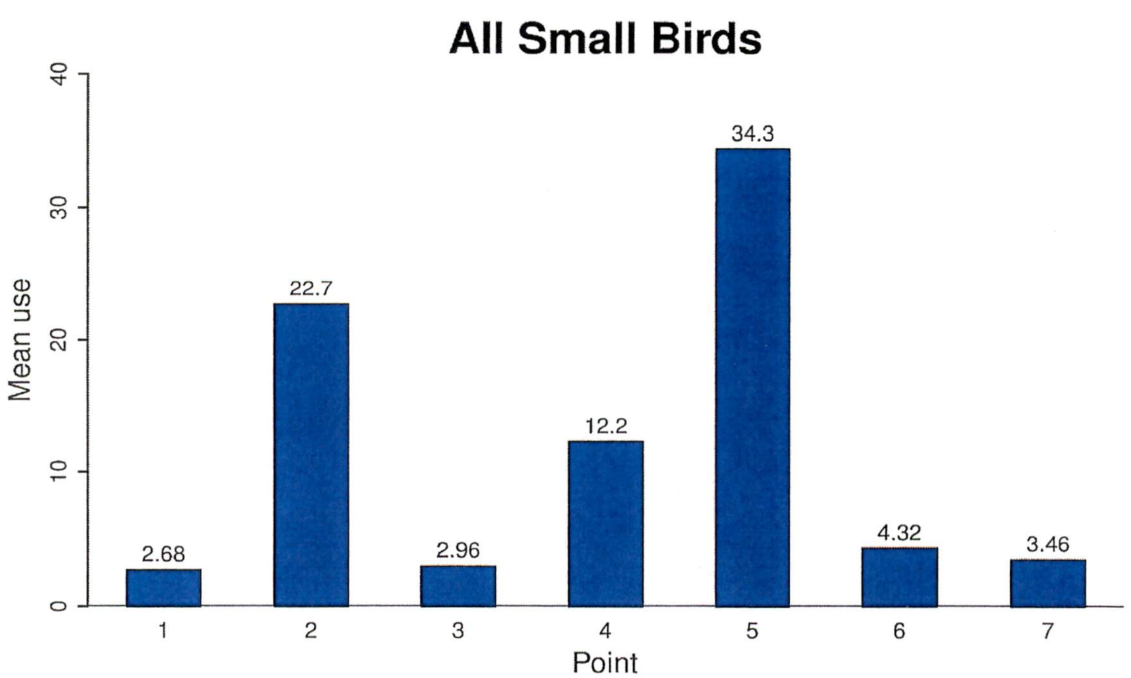

Figure 4d. Mean small bird use (number of birds/100-meter plot/20-minute survey) by survey point recorded during avian use surveys conducted at the Merricourt Wind Energy Project in McIntosh and Dickey counties, North Dakota, from May 9, 2016 – April 28, 2017.

Incidental Observations

Five identified and one unidentified bird species were observed incidentally at the Project, totaling 12 observations within six separate groups, with the majority of incidental observations corresponding to American white pelican. The snowy egret (*Egretta thula*) and golden and bald eagles were only observed incidentally (Table 6).

Table 6. Incidental wildlife observed outside of the standardized avian use) surveys conducted at the Merricourt Wind Energy Project in McIntosh and Dickey counties, North Dakota, from May 9, 2016 – April 28, 2017.

Species	Scientific Name	# Groups	# Observations
American white pelican	*Pelecanus erythrorhynchos*	1	7
bald eagle	*Haliaeetus leucocephalus*	1	1
golden eagle	*Aquila chrysaetos*	1	1
red-tailed hawk	*Buteo jamaicensis*	1	1
snowy egret	*Egretta thula*	1	1
unidentified hawk		1	1
Total		**6**	**12**

Sensitive Species Observations

No federally listed species were observed incidentally or during scheduled avian use surveys conducted at the Project (Table 7). The state of North Dakota does not designate species as endangered or threatened but uses a three level system to categorize species of conservation priority based on their conservation need (Dyke et al. 2015). There were four Level I (LI) species recorded in nine groups totaling 18 individuals with Franklin's gulls (*Leucophaeus pipixcan*) making up half of the observations (nine individuals). Ten Level II (LII) conservation priority species, including bald and golden eagles were recorded in 55 groups totaling 326 individuals (Table 7). Eagles are legally protected under the Bald and Golden Eagle Protection Act (1940), while the others, as well as eagles, are protected under the Migratory Bird Treaty Act (1918). American white pelican and lesser scaup made up the bulk of the LII species observations (Table 7). No Level III species were observed.

Table 7. Summary of sensitive species observed during the first 20-minutes of fixed-point bird use surveys (FP) and incidentally (Inc.) at the Merricourt Wind Energy Project in McIntosh and Dickey counties, North Dakota, from May 9, 2016 – April 28 2017.

			FP		Inc.		Total	
Species	**Scientific Name**	**Status[a]**	**# Groups**	**# Obs.**	**# Groups**	**# Obs.**	**# Groups**	**# Obs.**
Franklin's gull	*Leucophaeus pipixcan*	LI	3	9	0	0	3	9
grasshopper sparrow	*Ammodramus savannarum*	LI	4	7	0	0	4	7
Swainson's hawk	*Buteo swainsoni*	LI	1	1	0	0	1	1
Wilson's phalarope	*Phalaropus tricolor*	LI	1	1	0	0	1	1
American white pelican	*Pelecanus erythrorhynchos*	LII	17	204	1	7	18	211
bald eagle	*Haliaeetus leucocephalus*	LII, BGEPA	0	0	1	1	1	1
bobolink	*Dolichonyx oryzivorus*	LII	4	7	0	0	4	7
dickcissel	*Spiza americana*	LII	3	3	0	0	3	3
golden eagle	*Aquila chrysaetos*	LII, BGEPA	0	0	1	1	1	1
lesser scaup	*Aythya affinis*	LII	3	70	0	0	3	70
northern harrier	*Circus cyaneus*	LII	13	14	0	0	13	14
northern pintail	*Anas acuta*	LII	5	9	0	0	5	9
upland sandpiper	*Bartramia longicauda*	LII	9	9	0	0	9	9
willet	*Tringa semipalmata*	LII	1	1	0	0	1	1
Total	**14 species**		**64**	**335**	**3**	**9**	**67**	**344**

Obs. = Observations

[a] LI = Level I State Species of Conservation Priority; LII = Level II State Species of Conservation Priority North Dakota (Dyke et al. 2015); BGEPA = Bald and Golden Eagle Protection Act (BGEPA 1940)

DISCUSSION

Exposure to facility infrastructure is more accurately assessed by evaluating both percent of use (i.e., how much a species uses an area) and frequency of occurrence (i.e., how often use occurs). For example, flocks of waterfowl, waterbirds, and shorebirds can be comprised of several hundred, thousand, or tens of thousands of individual birds, which would result in a very high percentage of use. However, examining the percent of use alone would not account for the acute exposure to the facility associated with a small number of very large flocks (low frequency of occurrence). A high percentage of use may indicate that a species has higher exposure relative to other species, but when the frequency of occurrence is low, 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, increasing the likelihood that this species may be negatively affected by the facility.

Potential Impacts

Wind energy facilities can directly or indirectly impact wildlife resources. It is well-known that wind energy facilities have the potential to generate direct adverse impacts on wildlife, particularly when flying animals experience fatal collisions or near-collisions with wind turbines (National Academy of Sciences [NAS] 2007, Strickland et al. 2011). Indirect impacts on wildlife can occur through the alteration of habitats and/or behavioral changes that can carry fitness consequences (NAS 2007). One such impact is termed "displacement," which occurs when a wildlife species avoids occupying areas where wind turbines have been installed (Strickland et al. 2011).

Habitat-related indirect impacts can be long-term or temporary and can result from loss of habitat and fragmentation from installation of wind energy facility infrastructure (i.e., turbines, access roads, maintenance buildings, substations and overhead transmission lines). Approximately 56% of the Project area is covered by grasslands, resulting in potential for indirect impacts to be of concern; siting facilities on agricultural land would reduce the potential for displacement of species of fragmentation concern.

Post-construction fatality monitoring reports from the Midwest show varying levels of bird mortality across the region (Figure 5). In 2009, the Wessington Springs facility in South Dakota had the highest estimated bird mortality rate in the Midwest with 8.25 fatalities/megawatt (MW)/year (Derby et al. 2010f; Figure 5); however estimated bird mortality at this same facility in 2010 was only 0.89 fatalities/MW/year (Derby et al. 2011d). The Pioneer Prairie II facility had the lowest estimated bird mortality rate with 0.27 fatalities/MW/year (Chodachek et al. 2012; Figure 5). In North Dakota, the Rugby facility had an estimated bird mortality rate of 3.82 fatalities/MW/year (Derby et al. 2011b; Appendix E) and the Prairie Winds facility had estimated mortality rates of 1.56 (Derby et al. 2012c) and 1.48 (Derby et al. 2011c; Appendix E). It is likely that direct impacts from the Project would be similar to other regional projects given the mix of tilled agriculture, grasslands, and wetlands are similar to other regional projects.

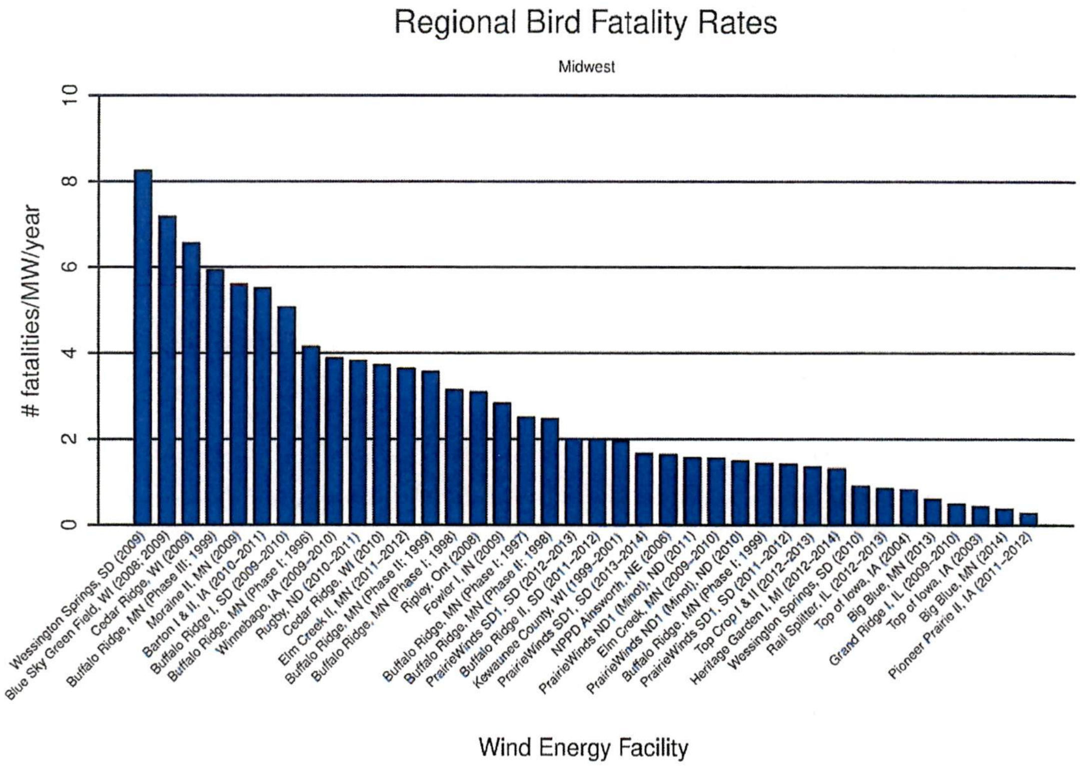

Figure 5. Fatality rates for all birds (number of fatalities per megawatt per year) reported in publically available studies conducted at wind energy facilities in Midwest North America.

Data from the following sources:

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

Bird Types of Concern

While the focus of this study was mainly to document large bird use with an emphasis on eagles and diurnal raptors; the majority of all bird observations during this study were waterfowl or passerine species, followed by far by waterbird and shorebird species. The most common waterfowl species were snow and Canada geese while the most common passerine species were red-winged blackbird and snow bunting. Relatively few (25 observations) diurnal raptors were observed during standardized surveys and only two were recorded incidentally. The most common diurnal raptor species was red-tailed hawk, documented both incidentally and during scheduled surveys. No bald or golden eagles were document during scheduled avian use surveys and only one of each was recorded incidentally. No whooping cranes or piping plovers were observed during surveys conducted in the Project. These five bird types are discussed in more detail below.

Waterbirds

Limited information exists on wind turbine collision risk of waterbirds because of limited experience with coastal wind facilities, particularly in the US (Kingsley and Whittam 2007, NAS 2007). Most, but not all, bird collision studies at land-based and non-coastal wind facilities to date have reported low rates of waterbird collisions (Kingsley and Whittam 2007).

Waterbirds were commonly observed within the Project area and could be impacted by Project development to some extent. However, the majority of the waterbird observations were recorded below RSH, indicating a low risk for collision. Sandhill cranes, observed during surveys, and whooping cranes tend to migrate together frequently flying at altitudes between 150 and 1,830 m (492.12 and 6,003.94 ft) AGL (Tacha et al. 1992, Stehn 2007), above the RSH. Collision with turbines could occur during take-off/landing, but low use by this species and no use by whooping crane suggest that risk is relatively low for cranes. There have been no recorded instances of whooping cranes being killed or injured by wind turbines (NWCC 2004); however, one sandhill crane (*Grus canadensis*) was reported killed at the Altamont wind energy facility in California (Smallwood and Karas 2009). It is unclear if this fatality was a result of turbine collision or collision with a power line. Additionally, two sandhill cranes struck turbines during a study of wintering cranes in Texas (Navarrete and Griffis 2011a). Thus, it appears that cranes are not particularly susceptible to collision with wind turbines given that hundreds of thousands of sandhill cranes migrate biannually through the Great Plains region with no documented fatalities as a result of collision with wind turbines during migration.

Besides direct mortality, concern has also been raised regarding potential displacement impacts that wind facilities may have on whooping cranes. To date, very few studies with quantitative data have become publicly available to help address displacement impacts on whooping cranes or sandhill cranes. Navarrete and Griffis (2011b) suggested that the mean density of sandhill cranes wintering in the high plains of Texas increased with increasing distance from studied wind facilities.

Waterfowl

Based on available evidence, waterfowl species 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 study at the Tatanka Wind Farm, located approximately 11.3 km (seven mi) south-southeast of the Project, researchers monitored 77 female mallards (*Anas platyrhynchos*) and 88 female blue-winged teal with radio collars and reported that only one of 46 fatalities among these was due to collision with a wind turbine. The authors stated that they observed no evidence that wind turbines directly reduced the survival of these breeding waterfowl (Gue et al. 2013).

Studies of the displacement effects of wind energy development on waterfowl show mixed results. Based on a review of several reports of waterfowl displacement, measured displacement of waterfowl from wind turbines has varied greatly, ranging from zero to more than 850 m (zero to 2,789 ft; Johnson et al. 2000a; Larsen and Madsen 2000; Hotker et al. 2006; Derby et al. 2009; Madsen et al. 2009; Larsen and Guillemette 2007; Stantec Consulting Ltd. 2011a, 2011b, 2011c). In the Prairie Pothole region of the Dakotas, researchers reported that breeding pairs of five species of dabbling ducks continued to use wetlands near turbines but at reduced densities compared to nearby reference sites (Loesch et al. 2013). Although the authors noted the limited geographic and temporal extent of their study (two facilities surveyed over three springs) prevented them from drawing broad conclusions about the effects of wind energy development on breeding ducks, they stated that wind energy should be considered an additional anthropogenic stressor for breeding waterfowl.

Waterfowl were commonly observed within the Project and could be impacted by Project development to some extent. Direct impacts should be similarly low to other local and regional Project. The presence of similar habitat surrounding the Project area suggests displacement of these species into surrounding habitats may limit potential for population-level effects.

Shorebirds

Although little is known regarding their potential to strike moving blades or stationary structures, based on mortality studies, shorebirds do not seem to be at great risk of colliding with wind turbines or communication towers (USFWS 2011). Public data collected to date at wind energy facilities in North America support that conclusion. Erickson et al. (2001a) summarized all publicly available avian fatality data from nine wind energy facilities located throughout the US, including the older facilities in California (e.g., Altamont Pass, Tehachapi, San Gorgonio). Based on this analysis, only one shorebird fatality (0.1%) occurred among the 1,036 documented fatalities. More recently, several regional summaries of avian fatalities at wind energy facilities have found that shorebirds are rarely killed by turbine strikes at modern wind energy facilities. Johnson and Stephens (2011) summarized avian mortality data from fatality monitoring studies conducted at 21 modern wind energy facilities in western North America and found that shorebirds accounted for only three of 1,247 documented fatalities (0.2%). An evaluation of avian fatalities documented at wind energy facilities in the Columbia Plateau Ecoregion of eastern Washington and Oregon found that only two of 1,183 documented bird fatalities (0.2%) were shorebirds (Johnson and Erickson 2011). Mortality of shorebirds appears to be slightly higher in the Midwest; in a database maintained by WEST that contains avian fatality data from all publicly available monitoring studies of modern wind energy projects throughout North America, shorebirds comprised 5.2% of bird fatalities collected during 32 fatality monitoring studies at wind energy projects located in the Midwest, compared to 1.7% of bird fatalities collected nationally (WEST, Inc. unpublished database; March 2016)

Only 10 unique shorebird species out of the approximately 50 shorebird species that regularly occur in North America have been found as turbine fatalities throughout North America (Bay et al. 2010). Species of shorebirds documented as wind turbine fatalities in the Midwest in the WEST database include killdeer, upland sandpiper (*Bartramia longicauda*), and unidentified shorebird. These data suggest that migrating shorebirds are not particularly susceptible to turbine collision and that risk to shorebirds in the Project area will be similar to other regional projects.

Diurnal Raptors

Use Comparison

Diurnal raptors occur in most areas with the potential for wind energy development (National Research Council 2007). Annual mean diurnal raptor use at the Project was 0.15 raptors/800-m plot/20-min survey, with highest use in fall, likely due to migrating raptors. Mean raptor use was compared with 46 other wind energy facilities that implemented similar protocols and had data for three or four seasons. A relative ranking of annual mean raptor use was developed based on the results from these studies as low (zero to 0.5 raptors/800-m plot/20-min survey), low to moderate (0.5 to 1.0), moderate (1.0 to 2.0), high (2.0 to 3.0), and very high (more than 3.0). Under this ranking, annual mean diurnal raptor use at the Project is considered to be low; ranking 41 compared to the 46 other wind energy facilities (Figure 6).

Exposure Index Analysis

Due to the low number of diurnal raptor groups recorded and the percentage of those observations flying with RHS, only two species, red-tailed hawk and northern harrier, had exposure indexes greater than zero (0.04 and less than 0.01, respectively), suggesting that these species could be slightly more susceptible to turbine collision than other diurnal raptor species.

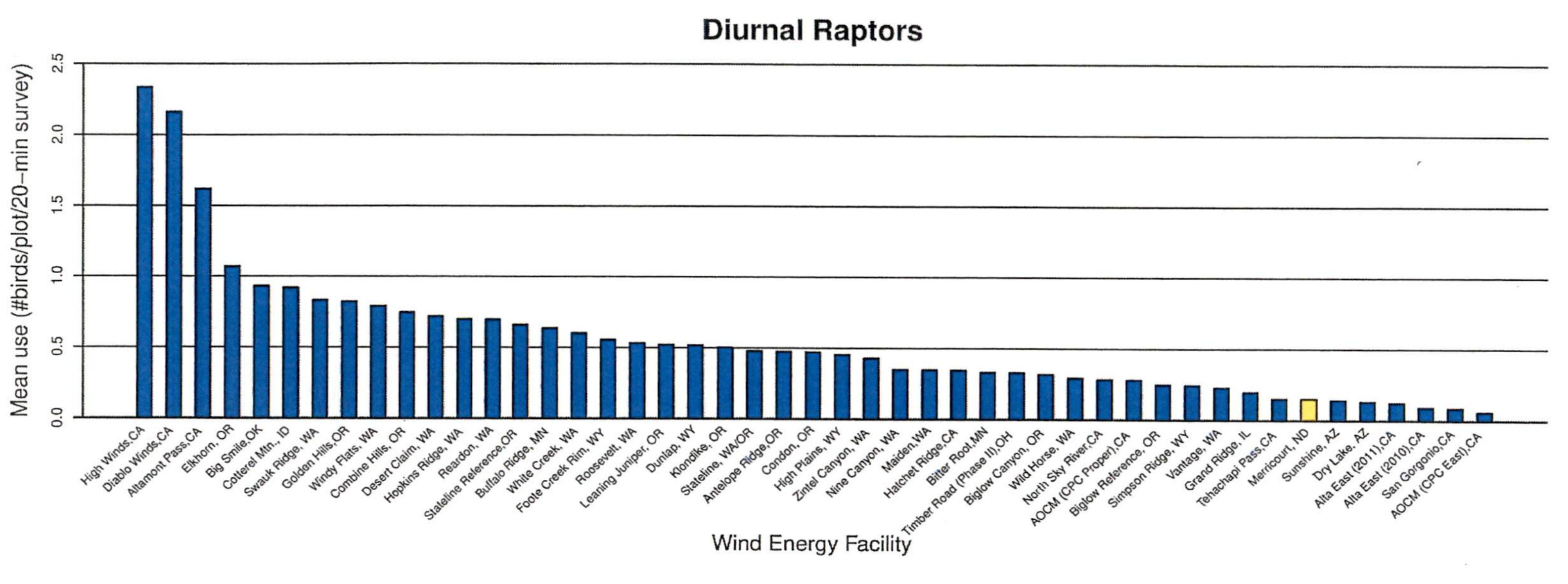

Figure 6. Comparison of estimated annual diurnal raptor use during fixed-point bird use surveys conducted at the Merricourt Wind Energy Project in McIntosh and Dickey counties, from May 9, 2016 to April 28, 2017 and diurnal raptor use at other US wind energy facilities with three or four seasons of raptor use data.

Data from the following sources:

Study and Location	Reference	Study and Location	Reference	Study and Location	Reference
Merricourt, ND	**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. 2010a	Klondike, OR	Johnson et al. 2002	Simpson Ridge, WY	Johnson et al. 2000b
Cotterel Mtn., ID	BLM 2006	Stateline, WA/OR	Erickson et al. 2003a	Vantage, WA	Jeffrey et al. 2007
Swauk Ridge, WA	Erickson et al. 2003b	Antelope Ridge, OR	WEST 2009	Grand Ridge, IL	Derby et al. 2009
Golden Hills, OR	Jeffrey et al. 2008	Condon, OR	Erickson et al. 2002b	Tehachapi Pass, CA	Anderson et al. 2000, Erickson et al. 2002b
Windy Flats, WA	Johnson et al. 2007	High Plains, WY	Johnson et al. 2009b	Sunshine, AZ	WEST and the CPRS 2006
Combine Hills, OR	Young et al. 2003c	Zintel Canyon, WA	Erickson et al. 2002a, 2003c	Dry Lake, AZ	Young et al. 2007b
Desert Claim, WA	Young et al. 2003b	Nine Canyon, WA	Erickson et al. 2001b	Alta East (2011), CA	Chatfield et al. 2011
Hopkins Ridge, WA	Young et al. 2003a	Maiden, WA	Young et al. 2002	Alta East (2010), CA	Chatfield et al. 2011
Reardon, WA	WEST 2005b	Hatchet Ridge, CA	Young et al. 2007a	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

A summary of diurnal raptor fatalities recorded at 36 Midwestern wind energy facilities (Appendix E) showed 55 raptor fatalities representing seven identified and one unidentified species. Red-tailed hawks accounted for 69.1% of the raptor fatalities (Table 8); this species was the most commonly observed diurnal raptor during surveys conducted at the Project. The second most common diurnal raptor species recorded at the Project, northern harrier, was not found as a fatality at any of the 36 facilities. Based on use at the Project and regional fatality studies, some limited, non-population level impacts to red-tailed hawks and other raptors may occur at the Project.

Table 8. Raptor fatalities, by species, recorded at new-generation wind energy facilities in Midwest North America.

Species	Scientific Name	Number of Raptor Fatalities[a]	Percent Composition of Raptor Fatalities
red-tailed hawk	*Buteo jamaicensis*	38	69.1
American kestrel	*Falco sparverius*	5	9.1
sharp-shinned hawk	*Accipiter striatus*	4	7.3
rough-legged hawk	*Buteo lagopus*	3	5.5
Cooper's hawk	*Accipiter cooperii*	2	3.6
Merlin	*Falco columbarius*	1	1.8
Swainson's hawk	*Buteo swainsoni*	1	1.8
unidentified raptor		1	1.8
Total		**55**	**100**

[a] Number of raptor fatalities are unadjusted, raw counts.

Passerines

Overall, passerine species observed during surveys were common species typical of agricultural landscapes in the Midwest. Although the majority of passerine observations were recorded below the likely RSH of proposed turbines during surveys, diurnal surveys may not always be good predictors of post-construction bird fatality rates since many passerine species are nocturnal migrants.

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 these studies. From this it was estimated that 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. The highest effect for individual species was for black-throated blue warbler (*Setophaga caerulescens*) and tree swallow (*Tachycineta bicolor*), both with an estimated 0.043% of their respective continental populations suffering mortality each year from collisions with wind turbines. Values for other species ranged from 0.008 to 0.038%. In comparison, Longcore et al. (2012, 2013) estimated that over six million (97% of all fatalities) passerines were killed annually from collisions with communication towers, and annual mortality for individual species ranged from 1.2% to 9.0% of their estimated total populations for the 20 species most affected (Longcore et al. 2012, 2013). Considering other larger sources of bird mortality and the results of Erickson et al. (2014b) cumulative analysis, passerine fatality rates at the Project are not likely to have significant adverse impacts on passerine populations.

Sensitive Species

Fourteen sensitive species (LI and LII state species of conservation priority, including eagles) were recorded within the Project area incidentally or during scheduled avian use surveys (see Sensitive Species Observations Section). LI state species of conservation priority and eagles are discussed in more detail below.

Franklin's Gull

Franklin's gulls were observed nine times in three groups (Table 7), with observations recorded in spring and summer. The Franklin's gull is a common to abundant summer resident of North Dakota (Dyke et al. 2015). The gull is a colonial breeder that nests in prairie wetland complexes. During non-breeding seasons, Franklin's gulls utilize prairie wetlands and lakes, feeding both over water and in agriculture fields (Dyke et al. 2015). Although 75.0% all of the Franklin's gulls observed flying were within the RSH, the lack of use of the Project by this species may offset risks to the population.

Grasshopper Sparrow

Seven grasshopper sparrows (*Ammodramus savannarum*) were observed within four groups at the Project (Table 7). This species prefers larger areas of intermediate height grasslands with some litter, bare areas, and little woody vegetation (Dyke et al. 2015). Displacement may be a higher risk factor to grasshopper sparrows than direct collision mortality. Placing turbines and facility infrastructure to minimize grassland fragmentation could reduce impacts to this species.

Swainson's Hawk

There was one Swainson's hawk observed during this study. Due to this apparent lack of use of the Project area by this species and its lower risk of turbine collisions, there should not be significant adverse population-level impacts from development of the Project.

Wilson's Phalarope

One Wilson's phalarope (*Phalaropus tricolor*) was observed during avian use surveys at the Project and was not recorded flying within RSH (Table 7; Appendix C). Again, with the overall lack of use of the Project and lower risk of turbine collisions, population risks should not be significant. Impacts to this species could be lowered further by placing turbines away from potential habitat such as shallow wetlands surrounded by grasslands.

Eagles

No eagles were observed in the Project area during scheduled avian use surveys while one bald and one golden eagle were recorded incidentally during winter. No eagle nests were observed during the raptor nest survey conducted by WEST in 2016 for the Project area (boundary as of July 2016) and 16.1-km (10-mi) buffer (WEST 2016). Results from the avian use surveys and raptor nest survey indicate that eagle use of the Project area and surrounding areas is minimal. Furthermore, the Project area does not include large rivers, lakes, or wetland systems that might provide substantial foraging opportunities to bald eagles, while golden eagle use within the Project area is likely largely limited to rare winter/migrating individuals.

CONCLUSIONS

Tier 3 studies are used to address questions regarding impacts that could not be sufficiently addressed using available literature (i.e., during Tier 1 and Tier 2 desktop analyses). These studies provide additional data that, when combined with available literature reviewed in previous tiers, allow for a better-informed assessment of the risk of significant adverse impacts to species of concern within a project area. Raptor use at the Project was generally low compared to other wind energy facilities throughout the US. Although few published studies that correlate raptor use and mortality rates are available from the Midwest, raptor use at the Project was low compared to other regional facilities. Diurnal raptor fatality rates are expected to be within the range of fatality rates observed at other facilities where raptor use levels are relatively low.

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 behavior, and foraging habits of some species may result in increased exposure and higher risk. Furthermore, the impacts to nocturnal migrants (e.g., passerines) were not addressed during surveys conducted at the Project. To date, overall fatality rates for birds (including nocturnal migrants) at wind energy facilities have been consistently low in the Midwest. Overall bird fatality estimates from 38 studies conducted at Midwest wind energy facilities ranged from 0.27 to 8.25 fatalities/MW/year (Appendix E). As more research is conducted at facilities in the Midwest, more information regarding the potential direct impacts of wind energy facilities to bird species will be obtained. Some species may be displaced by turbines placed in grasslands and near wetlands.

Eagle use at the Project was only documented incidentally on two separate dates in the winter, likely attributable to migrating and wintering bald and golden eagles in the region. No bald eagles were detected during the summer, which may be a result of limited nesting, roosting, and foraging habitat within the Project area. Potential impacts to eagles should be minimal.

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Appendix A. All Bird Types, Raptor Subtypes, and Species Observed during Avian Use Surveys Conducted at the Merricourt Wind Energy Project in McIntosh and Dickey Counties, North Dakota, from May 9, 2016 – April 28, 2017

Appendix A1. Summary of individuals and group observations[a] by bird type and species recorded during the first 20-minutes of avian use surveys conducted at the Merricourt Wind Energy Project in McIntosh and Dickey counties, North Dakota, from May 9, 2016 - April 28, 2017.

Type/Species	Scientific Name	Spring # Grps.	Spring # Obs.	Summer # Grps.	Summer # Obs.	Fall # Grps.	Fall # Obs.	Winter # Grps.	Winter # Obs.	Total # Grps.	Total # Obs.
Waterbirds		**9**	**110**	**6**	**14**	**3**	**8**	**0**	**0**	**18**	**132**
American white pelican	*Pelecanus erythrorhynchos*	6	98	2	5	0	0	0	0	8	103
double-crested cormorant	*Phalacrocorax auritus*	2	11	4	9	3	8	0	0	9	28
great egret	*Ardea alba*	1	1	0	0	0	0	0	0	1	1
Waterfowl		**39**	**266**	**15**	**119**	**26**	**339**	**3**	**512**	**83**	**1,236**
American wigeon	*Anas americana*	0	0	1	2	0	0	0	0	1	2
blue-winged teal	*Anas discors*	4	10	1	60	1	11	0	0	6	81
bufflehead	*Bucephala albeola*	0	0	0	0	1	7	0	0	1	7
Canada goose	*Branta canadensis*	11	73	2	28	8	153	1	7	22	261
lesser scaup	*Aythya affinis*	3	70	0	0	0	0	0	0	3	70
mallard	*Anas platyrhynchos*	6	21	2	4	2	8	0	0	10	33
northern pintail	*Anas acuta*	1	4	2	3	0	0	0	0	3	7
northern shoveler	*Anas clypeata*	1	2	0	0	1	2	0	0	2	4
redhead	*Aythya americana*	2	10	0	0	0	0	0	0	2	10
ruddy duck	*Oxyura jamaicensis*	1	2	0	0	1	10	0	0	2	12
snow goose	*Chen caerulescens*	0	0	0	0	0	0	1	500	1	500
tundra swan	*Cygnus columbianus*	0	0	0	0	1	4	0	0	1	4
unidentified duck		10	74	6	21	11	144	1	5	28	244
unidentified teal	*Anas spp*	0	0	1	1	0	0	0	0	1	1
Shorebirds		**24**	**29**	**18**	**23**	**2**	**21**	**0**	**0**	**44**	**73**
Baird's sandpiper	*Calidris bairdii*	1	1	0	0	0	0	0	0	1	1
killdeer	*Charadrius vociferus*	21	26	16	21	1	1	0	0	38	48
unidentified shorebird		0	0	0	0	1	20	0	0	1	20
upland sandpiper	*Bartramia longicauda*	2	2	1	1	0	0	0	0	3	3
Wilson's phalarope	*Phalaropus tricolor*	0	0	1	1	0	0	0	0	1	1
Gulls/Terns		**10**	**59**	**4**	**9**	**0**	**0**	**0**	**0**	**14**	**68**
Franklin's gull	*Leucophaeus pipixcan*	2	3	1	6	0	0	0	0	3	9
ring-billed gull	*Larus delawarensis*	0	0	1	1	0	0	0	0	1	1
unidentified gull		8	56	2	2	0	0	0	0	10	58
Rails/Coots		**1**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**3**
American coot	*Fulica americana*	1	3	0	0	0	0	0	0	1	3
Diurnal Raptors		**5**	**5**	**7**	**10**	**7**	**9**	**1**	**1**	**20**	**25**
Buteos		*0*	*0*	*5*	*7*	*3*	*4*	*1*	*1*	*9*	*12*
red-tailed hawk	*Buteo jamaicensis*	0	0	4	6	3	4	1	1	8	11

Appendix A1. Summary of individuals and group observations[a] by bird type and species recorded during the first 20-minutes of avian use surveys conducted at the Merricourt Wind Energy Project in McIntosh and Dickey counties, North Dakota, from May 9, 2016 - April 28, 2017.

		Spring		Summer		Fall		Winter		Total	
Type/Species	**Scientific Name**	**# Grps.**	**# Obs.**	**# Grps.**	**# Obs.**	**# Grps.**	**# Obs.**	**# Grps.**	**# Obs.**	**# Grps.**	**# Obs.**
Swainson's hawk	*Buteo swainsoni*	0	0	1	1	0	0	0	0	1	1
Northern Harrier		*5*	*5*	*1*	*2*	*1*	*1*	*0*	*0*	*7*	*8*
northern harrier	*Circus cyaneus*	5	5	1	2	1	1	0	0	7	8
Other Raptors		*0*	*0*	*1*	*1*	*3*	*4*	*0*	*0*	*4*	*5*
unidentified hawk		0	0	1	1	2	2	0	0	3	3
unidentified raptor		0	0	0	0	1	2	0	0	1	2
Upland Game Birds		**5**	**5**	**8**	**9**	**1**	**1**	**0**	**0**	**14**	**15**
ring-necked pheasant	*Phasianus colchicus*	5	5	8	9	1	1	0	0	14	15
Doves/Pigeons		**2**	**3**	**9**	**14**	**1**	**1**	**0**	**0**	**12**	**18**
mourning dove	*Zenaida macroura*	2	3	9	14	1	1	0	0	12	18
Large Corvids		**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**
American crow	*Corvus brachyrhynchos*	1	1	0	0	0	0	0	0	1	1
Passerines		**104**	**339**	**142**	**330**	**17**	**83**	**21**	**362**	**284**	**1,114**
American goldfinch	*Spinus tristis*	0	0	3	5	0	0	0	0	3	5
American robin	*Turdus migratorius*	2	2	4	4	0	0	0	0	6	6
American tree sparrow	*Spizella arborea*	1	4	0	0	0	0	0	0	1	4
barn swallow	*Hirundo rustica*	5	10	18	52	7	52	0	0	30	114
bobolink	*Dolichonyx oryzivorus*	1	3	3	4	0	0	0	0	4	7
brown-headed cowbird	*Molothrus ater*	5	13	20	59	0	0	0	0	25	72
common grackle	*Quiscalus quiscula*	15	60	9	14	0	0	0	0	24	74
dickcissel	*Spiza americana*	0	0	3	3	0	0	0	0	3	3
eastern kingbird	*Tyrannus tyrannus*	3	4	16	25	0	0	0	0	19	29
European starling	*Sturnus vulgaris*	0	0	1	2	0	0	0	0	1	2
grasshopper sparrow	*Ammodramus savannarum*	2	4	2	3	0	0	0	0	4	7
horned lark	*Eremophila alpestris*	4	12	6	17	7	28	15	129	32	186
house sparrow	*Passer domesticus*	0	0	2	2	0	0	0	0	2	2
northern rough-winged swallow	*Stelgidopteryx serripennis*	0	0	2	5	0	0	0	0	2	5
orchard oriole	*Icterus spurius*	0	0	1	1	0	0	0	0	1	1
red-winged blackbird	*Agelaius phoeniceus*	22	135	20	65	0	0	0	0	42	200
snow bunting	*Plectrophenax nivalis*	0	0	0	0	0	0	6	233	6	233
song sparrow	*Melospiza melodia*	1	1	0	0	0	0	0	0	1	1
tree swallow	*Tachycineta bicolor*	1	2	3	16	0	0	0	0	4	18
unidentified passerine		2	12	0	0	0	0	0	0	2	12

Appendix A1. Summary of individuals and group observations[a] by bird type and species recorded during the first 20-minutes of avian use surveys conducted at the Merricourt Wind Energy Project in McIntosh and Dickey counties, North Dakota, from May 9, 2016 - April 28, 2017.

		Spring		Summer		Fall		Winter		Total	
Type/Species	**Scientific Name**	**# Grps.**	**# Obs.**	**# Grps.**	**# Obs.**	**# Grps.**	**# Obs.**	**# Grps.**	**# Obs.**	**# Grps.**	**# Obs.**
unidentified sparrow		1	2	2	4	1	1	0	0	4	7
western kingbird	*Tyrannus verticalis*	4	6	6	6	0	0	0	0	10	12
western meadowlark	*Sturnella neglecta*	35	69	15	25	2	2	0	0	52	96
yellow-headed blackbird	*Xanthocephalus xanthocephalus*	0	0	6	18	0	0	0	0	6	18
Unidentified Birds		**7**	**719**	**1**	**1**	**5**	**100**	**6**	**127**	**19**	**947**
unidentified bird (small)		7	719	1	1	5	100	6	127	19	947
Overall	***61***	**207**	**1,539**	**210**	**529**	**62**	**562**	**31**	**1,002**	**510**	**3,632**

[a] Regardless of distance from observer
Grps. = Groups, Obs. = Observations

Appendix A2. Summary of individuals and group observations[a] by bird type and species recorded during the 60-minute avian use surveys conducted at the Merricourt Wind Energy Project in McIntosh and Dickey counties, North Dakota, from May 9, 2016 - April 28, 2017.

		Spring		Summer		Fall		Winter		Total	
Type/Species	Scientific Name	# Grps.	# Obs.	# Grps.	# Obs.	# Grps.	# Obs.	# Grps.	# Obs.	# Grps.	# Obs.
Waterbirds		**19**	**243**	**20**	**34**	**7**	**133**	**0**	**0**	**46**	**410**
American white pelican	*Pelecanus erythrorhynchos*	12	194	5	10	0	0	0	0	17	204
cattle egret	*Bubulcus ibis*	0	0	1	2	0	0	0	0	1	2
double-crested cormorant	*Phalacrocorax auritus*	5	18	12	19	4	108	0	0	21	145
great blue heron	*Ardea herodias*	0	0	1	2	1	1	0	0	2	3
great egret	*Ardea alba*	1	1	0	0	0	0	0	0	1	1
sandhill crane	*Grus canadensis*	1	30	0	0	2	24	0	0	3	54
unidentified egret	*NA*	0	0	1	1	0	0	0	0	1	1
Waterfowl		**93**	**910**	**24**	**159**	**39**	**1946**	**3**	**512**	**159**	**3527**
American wigeon	*Anas americana*	0	0	1	2	0	0	0	0	1	2
blue-winged teal	*Anas discors*	7	17	3	70	2	86	0	0	12	173
Bufflehead	*Bucephala albeola*	0	0	0	0	1	7	0	0	1	7
Canada goose	*Branta canadensis*	33	182	2	28	9	203	1	7	45	420
Canvasback	*Aythya valisineria*	0	0	1	1	0	0	0	0	1	1
Gadwall	*Anas strepera*	0	0	1	2	0	0	0	0	1	2
greater white-fronted goose	*Anser albifrons*	0	0	0	0	1	5	0	0	1	5
lesser scaup	*Aythya affinis*	4	73	1	2	0	0	0	0	5	75
mallard	*Anas platyrhynchos*	12	36	2	4	2	8	0	0	16	48
northern pintail	*Anas acuta*	2	5	3	4	0	0	0	0	5	9
northern shoveler	*Anas clypeata*	3	6	0	0	2	15	0	0	5	21
redhead	*Aythya americana*	2	10	0	0	0	0	0	0	2	10
ruddy duck	*Oxyura jamaicensis*	2	8	0	0	1	10	0	0	3	18
snow goose	*Chen caerulescens*	7	418	0	0	4	1430	1	500	12	2348
tundra swan	*Cygnus columbianus*	0	0	0	0	1	4	0	0	1	4
unidentified duck	*NA*	21	155	9	45	16	178	1	5	47	383
unidentified teal	*Anas spp*	0	0	1	1	0	0	0	0	1	1
Shorebirds		**25**	**30**	**26**	**31**	**2**	**21**	**0**	**0**	**53**	**82**
American avocet	*Recurvirostra americana*	1	1	0	0	0	0	0	0	1	1
Baird's sandpiper	*Calidris bairdii*	1	1	0	0	0	0	0	0	1	1
killdeer	*Charadrius vociferus*	21	26	17	22	1	1	0	0	39	49
unidentified shorebird	*NA*	0	0	0	0	1	20	0	0	1	20
upland sandpiper	*Bartramia longicauda*	2	2	7	7	0	0	0	0	9	9
willet	*Tringa semipalmata*	0	0	1	1	0	0	0	0	1	1
Wilson's phalarope	*Phalaropus tricolor*	0	0	1	1	0	0	0	0	1	1

Appendix A2. Summary of individuals and group observations[a] by bird type and species recorded during the 60-minute avian use surveys conducted at the Merricourt Wind Energy Project in McIntosh and Dickey counties, North Dakota, from May 9, 2016 - April 28, 2017.

		Spring		Summer		Fall		Winter		Total	
Type/Species	Scientific Name	# Grps.	# Obs.	# Grps.	# Obs.	# Grps.	# Obs.	# Grps.	# Obs.	# Grps.	# Obs.
Gulls/Terns		**14**	**65**	**9**	**23**	**1**	**2**	**0**	**0**	**24**	**90**
black tern	*Chlidonias niger*	0	0	1	1	0	0	0	0	1	1
Franklin's gull	*Leucophaeus pipixcan*	3	4	1	6	0	0	0	0	4	10
ring-billed gull	*Larus delawarensis*	0	0	2	2	0	0	0	0	2	2
unidentified gull	*NA*	11	61	5	14	1	2	0	0	17	77
Rails/Coots		**2**	**4**	**1**	**1**	**0**	**0**	**0**	**0**	**3**	**5**
American coot	*Fulica americana*	1	3	0	0	0	0	0	0	1	3
sora	*Porzana carolina*	1	1	1	1	0	0	0	0	2	2
Diurnal Raptors		**9**	**9**	**15**	**18**	**17**	**20**	**1**	**1**	**42**	**48**
Buteos		*1*	*1*	*7*	*9*	*7*	*8*	*1*	*1*	*16*	*19*
red-tailed hawk	*Buteo jamaicensis*	1	1	5	7	4	5	1	1	11	14
Swainson's hawk	*Buteo swainsoni*	0	0	2	2	3	3	0	0	5	5
Northern Harrier		*7*	*7*	*3*	*4*	*3*	*3*	*0*	*0*	*13*	*14*
northern harrier	*Circus cyaneus*	7	7	3	4	3	3	0	0	13	14
Other Raptors		*1*	*1*	*5*	*5*	*7*	*9*	*0*	*0*	*13*	*15*
unidentified hawk	*NA*	1	1	5	5	6	7	0	0	12	13
unidentified raptor	*NA*	0	0	0	0	1	2	0	0	1	2
Vultures		**1**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**2**	**2**
turkey vulture	*Cathartes aura*	1	1	1	1	0	0	0	0	2	2
Upland Game Birds		**6**	**6**	**8**	**9**	**1**	**1**	**0**	**0**	**15**	**16**
ring-necked pheasant	*Phasianus colchicus*	6	6	8	9	1	1	0	0	15	16
Doves/Pigeons		**5**	**13**	**9**	**14**	**1**	**1**	**0**	**0**	**15**	**28**
mourning dove	*Zenaida macroura*	5	13	9	14	1	1	0	0	15	28
Large Corvids		1	1	0	0	0	0	0	0	1	1
American crow	*Corvus brachyrhynchos*	1	1	0	0	0	0	0	0	1	1
Passerines		**111**	**351**	**142**	**330**	**17**	**83**	**21**	**362**	**291**	**1126**
American goldfinch	*Spinus tristis*	0	0	3	5	0	0	0	0	3	5
American robin	*Turdus migratorius*	2	2	4	4	0	0	0	0	6	6
American tree sparrow	*Spizella arborea*	1	4	0	0	0	0	0	0	1	4
barn swallow	*Hirundo rustica*	5	10	18	52	7	52	0	0	30	114
bobolink	*Dolichonyx oryzivorus*	1	3	3	4	0	0	0	0	4	7
brown-headed cowbird	*Molothrus ater*	6	17	20	59	0	0	0	0	26	76
common grackle	*Quiscalus quiscula*	17	64	9	14	0	0	0	0	26	78
dickcissel	*Spiza americana*	0	0	3	3	0	0	0	0	3	3

Appendix A2. Summary of individuals and group observations[a] by bird type and species recorded during the 60-minute avian use surveys conducted at the Merricourt Wind Energy Project in McIntosh and Dickey counties, North Dakota, from May 9, 2016 - April 28, 2017.

		Spring		Summer		Fall		Winter		Total	
Type/Species	**Scientific Name**	**# Grps.**	**# Obs.**	**# Grps.**	**# Obs.**	**# Grps.**	**# Obs.**	**# Grps.**	**# Obs.**	**# Grps.**	**# Obs.**
eastern kingbird	*Tyrannus tyrannus*	3	4	16	25	0	0	0	0	19	29
European starling	*Sturnus vulgaris*	0	0	1	2	0	0	0	0	1	2
grasshopper sparrow	*Ammodramus savannarum*	2	4	2	3	0	0	0	0	4	7
horned lark	*Eremophila alpestris*	4	12	6	17	7	28	15	129	32	186
house sparrow	*Passer domesticus*	0	0	2	2	0	0	0	0	2	2
northern rough-winged swallow	*Stelgidopteryx serripennis*	0	0	2	5	0	0	0	0	2	5
orchard oriole	*Icterus spurius*	0	0	1	1	0	0	0	0	1	1
red-winged blackbird	*Agelaius phoeniceus*	23	136	20	65	0	0	0	0	43	201
snow bunting	*Plectrophenax nivalis*	0	0	0	0	0	0	6	233	6	233
song sparrow	*Melospiza melodia*	1	1	0	0	0	0	0	0	1	1
tree swallow	*Tachycineta bicolor*	1	2	3	16	0	0	0	0	4	18
unidentified passerine	*NA*	2	12	0	0	0	0	0	0	2	12
unidentified sparrow	*NA*	1	2	2	4	1	1	0	0	4	7
western kingbird	*Tyrannus verticalis*	4	6	6	6	0	0	0	0	10	12
western meadowlark	*Sturnella neglecta*	38	72	15	25	2	2	0	0	55	99
yellow-headed blackbird	*Xanthocephalus xanthocephalus*	0	0	6	18	0	0	0	0	6	18
Unidentified Birds		**7**	**719**	**1**	**1**	**5**	**100**	**6**	**127**	**19**	**947**
unidentified bird (small)	*NA*	7	719	1	1	5	100	6	127	19	947
Overall	***63***	**293**	**2352**	**256**	**621**	**90**	**2307**	**31**	**1002**	**670**	**6282**

[a] Regardless of distance from observer

Grps. = Groups, Obs. = Observations

Appendix B. Mean Use, Percent of Use, and Frequency of Occurrence by Season for Large and Small Birds Observed during Avian Use Surveys Conducted at the Merricourt Wind Energy Project in McIntosh and Dickey Counties, North Dakota, from May 9, 2016 – April 28, 2017

Appendix B1. Mean large bird use (number of large birds/800-meter plot/20-minute survey), percent of use (%), and frequency of occurrence (%) by season for each large bird type and species observed during avian use surveys conducted at the Merricourt Wind Energy Project in McIntosh and Dickey counties, North Dakota, from May 9, 2016 - April 28, 2017.

	Mean Use				% of Use				% Frequency			
Type/Species	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
Waterbirds	**2.62**	**0.33**	**0.23**	**0**	**22.9**	**7.1**	**2.1**	**0**	**9.5**	**14.3**	**5.7**	**0**
American white pelican	2.33	0.12	0	0	20.4	2.5	0	0	4.8	4.8	0	0
double-crested cormorant	0.26	0.21	0.23	0	2.3	4.5	2.1	0	4.8	9.5	5.7	0
great egret	0.02	0	0	0	0.2	0	0	0	2.4	0	0	0
Waterfowl	**6.33**	**2.83**	**9.69**	**9.14**	**55.3**	**60.1**	**89.4**	**99.8**	**54.8**	**23.8**	**31.4**	**3.6**
American wigeon	0	0.05	0	0	0	1.0	0	0	0	2.4	0	0
blue-winged teal	0.24	1.43	0.31	0	2.1	30.3	2.9	0	2.4	2.4	2.9	0
bufflehead	0	0	0.20	0	0	0	1.8	0	0	0	2.9	0
Canada goose	1.74	0.67	4.37	0.12	15.2	14.1	40.4	1.4	21.4	2.4	17.1	1.8
lesser scaup	1.67	0	0	0	14.6	0	0	0	7.1	0	0	0
mallard	0.50	0.10	0.23	0	4.4	2.0	2.1	0	11.9	4.8	5.7	0
northern pintail	0.10	0.07	0	0	0.8	1.5	0	0	2.4	4.8	0	0
northern shoveler	0.05	0	0.06	0	0.4	0	0.5	0	2.4	0	2.9	0
redhead	0.24	0	0	0	2.1	0	0	0	4.8	0	0	0
ruddy duck	0.05	0	0.29	0	0.4	0	2.6	0	2.4	0	2.9	0
snow goose	0	0	0	8.93	0	0	0	97.5	0	0	0	1.8
tundra swan	0	0	0.11	0	0	0	1.1	0	0	0	2.9	0
unidentified duck	1.76	0.50	4.11	0.09	15.4	10.6	38.0	1.0	21.4	14.3	22.9	1.8
unidentified teal	0	0.02	0	0	0	0.5	0	0	0	2.4	0	0
Shorebirds	**0.69**	**0.55**	**0.60**	**0**	**6.0**	**11.6**	**5.5**	**0**	**45.2**	**35.7**	**5.7**	**0**
Baird's sandpiper	0.02	0	0	0	0.2	0	0	0	2.4	0	0	0
killdeer	0.62	0.50	0.03	0	5.4	10.6	0.3	0	45.2	35.7	2.9	0
unidentified shorebird	0	0	0.57	0	0	0	5.3	0	0	0	2.9	0
upland sandpiper	0.05	0.02	0	0	0.4	0.5	0	0	4.8	2.4	0	0
Wilson's phalarope	0	0.02	0	0	0	0.5	0	0	0	2.4	0	0
Gulls/Terns	**1.40**	**0.21**	**0**	**0**	**12.3**	**4.5**	**0**	**0**	**16.7**	**9.5**	**0**	**0**
Franklin's gull	0.07	0.14	0	0	0.6	3.0	0	0	4.8	2.4	0	0
ring-billed gull	0	0.02	0	0	0	0.5	0	0	0	2.4	0	0
unidentified gull	1.33	0.05	0	0	11.6	1.0	0	0	11.9	4.8	0	0
Rails/Coots	**0.07**	**0**	**0**	**0**	**0.6**	**0**	**0**	**0**	**2.4**	**0**	**0**	**0**
American coot	0.07	0	0	0	0.6	0	0	0	2.4	0	0	0
Diurnal Raptors	**0.12**	**0.24**	**0.26**	**0.02**	**1.0**	**5.1**	**2.4**	**0.2**	**11.9**	**16.7**	**20.0**	**1.8**
Buteos	*0*	*0.17*	*0.11*	*0.02*	*0*	*3.5*	*1.1*	*0.2*	*0*	*11.9*	*8.6*	*1.8*
red-tailed hawk	0	0.14	0.11	0.02	0	3.0	1.1	0.2	0	9.5	8.6	1.8
Swainson's hawk	0	0.02	0	0	0	0.5	0	0	0	2.4	0	0

Appendix B1. Mean large bird use (number of large birds/800-meter plot/20-minute survey), percent of use (%), and frequency of occurrence (%) by season for each large bird type and species observed during avian use surveys conducted at the Merricourt Wind Energy Project in McIntosh and Dickey counties, North Dakota, from May 9, 2016 - April 28, 2017.

	Mean Use				% of Use				% Frequency			
Type/Species	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
Northern Harrier	*0.12*	*0.05*	*0.03*	*0*	*1.0*	*1.0*	*0.3*	*0*	*11.9*	*2.4*	*2.9*	*0*
northern harrier	0.12	0.05	0.03	0	1.0	1.0	0.3	0	11.9	2.4	2.9	0
Other Raptors	*0*	*0.02*	*0.11*	*0*	*0*	*0.5*	*1.1*	*0*	*0*	*2.4*	*8.6*	*0*
unidentified hawk	0	0.02	0.06	0	0	0.5	0.5	0	0	2.4	5.7	0
unidentified raptor	0	0	0.06	0	0	0	0.5	0	0	0	2.9	0
Upland Game Birds	**0.12**	**0.21**	**0.03**	**0**	**1.0**	**4.5**	**0.3**	**0**	**11.9**	**16.7**	**2.9**	**0**
ring-necked pheasant	0.12	0.21	0.03	0	1.0	4.5	0.3	0	11.9	16.7	2.9	0
Doves/Pigeons	**0.07**	**0.33**	**0.03**	**0**	**0.6**	**7.1**	**0.3**	**0**	**4.8**	**19.0**	**2.9**	**0**
mourning dove	0.07	0.33	0.03	0	0.6	7.1	0.3	0	4.8	19.0	2.9	0
Large Corvids	**0.02**	**0**	**0**	**0**	**0.2**	**0**	**0**	**0**	**2.4**	**0**	**0**	**0**
American crow	0.02	0	0	0	0.2	0	0	0	2.4	0	0	0
Overall	**11.45**	**4.71**	**10.83**	**9.16**	**100**	**100**	**100**	**100**				

Appendix B2. Mean small bird use (number of small birds/100-meter plot/20-minute survey), percent of total use (%), and frequency of occurrence (%)by season for each small bird type and species during avian use surveys conducted at the Merricourt Wind Energy Project in McIntosh and Dickey counties, North Dakota, from May 9, 2016 - April 28, 2017.

	Mean Use				% of Use				% Frequency			
Type / Species	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter
Passerines	**7.26**	**7.33**	**2.34**	**6.46**	**29.8**	**99.7**	**45.1**	**73.8**	**83.3**	**95.2**	**42.9**	**25.0**
American goldfinch	0	0.12	0	0	0	1.6	0	0	0	7.1	0	0
American robin	0.05	0.10	0	0	0.2	1.3	0	0	4.8	9.5	0	0
American tree sparrow	0.10	0	0	0	0.4	0	0	0	2.4	0	0	0
barn swallow	0.24	1.14	1.49	0	1.0	15.5	28.6	0	11.9	38.1	17.1	0
bobolink	0.07	0.10	0	0	0.3	1.3	0	0	2.4	7.1	0	0
brown-headed cowbird	0.31	1.26	0	0	1.3	17.2	0	0	9.5	31.0	0	0
common grackle	0.90	0.29	0	0	3.7	3.9	0	0	28.6	14.3	0	0
dickcissel	0	0.07	0	0	0	1.0	0	0	0	4.8	0	0
eastern kingbird	0.10	0.55	0	0	0.4	7.4	0	0	7.1	33.3	0	0
European starling	0	0.05	0	0	0	0.6	0	0	0	2.4	0	0
grasshopper sparrow	0.10	0.07	0	0	0.4	1.0	0	0	4.8	4.8	0	0
horned lark	0.29	0.40	0.80	2.30	1.2	5.5	15.4	26.3	9.5	14.3	20.0	19.6
house sparrow	0	0.05	0	0	0	0.6	0	0	0	4.8	0	0
northern rough-winged swallow	0	0.12	0	0	0	1.6	0	0	0	4.8	0	0
orchard oriole	0	0.02	0	0	0	0.3	0	0	0	2.4	0	0
red-winged blackbird	3.17	1.38	0	0	13	18.8	0	0	35.7	23.8	0	0
snow bunting	0	0	0	4.16	0	0	0	47.5	0	0	0	5.4
song sparrow	0.02	0	0	0	<0.1	0	0	0	2.4	0	0	0
tree swallow	0.05	0.38	0	0	0.2	5.2	0	0	2.4	7.1	0	0
unidentified passerine	0.12	0	0	0	0.5	0	0	0	2.4	0	0	0
unidentified sparrow	0.05	0.10	0.03	0	0.2	1.3	0.5	0	2.4	4.8	2.9	0
western kingbird	0.10	0.14	0	0	0.4	1.9	0	0	4.8	11.9	0	0
western meadowlark	1.62	0.60	0.03	0	6.6	8.1	0.5	0	64.3	35.7	2.9	0
yellow-headed blackbird	0	0.40	0	0	0	5.5	0	0	0	11.9	0	0
Unidentified Birds	**17.12**	**0.02**	**2.86**	**2.29**	**70.2**	**0.3**	**54.9**	**26.2**	**16.7**	**2.4**	**11.4**	**9.5**
unidentified bird (small)	17.12	0.02	2.86	2.29	70.2	0.3	54.9	26.2	16.7	2.4	11.4	9.5
Overall	**24.38**	**7.36**	**5.20**	**8.76**	**100**	**100**	**100**	**100**				

Appendix C. Species Exposure Indices and Flight Characteristics for Large and Small Birds during Avian Use Surveys Conducted at the Merricourt Wind Energy Project in McIntosh and Dickey Counties, North Dakota, from May 9, 2016 – April 28, 2017

Appendix C1. Relative exposure index and flight characteristics for each large bird species during the avian use surveys conducted at the Merricourt Wind Energy Project in McIntosh and Dickey counties, North Dakota, from May 9, 2016 - April 28, 2017.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within RSH Based on Initial Observation	Exposure Index	% Within RSH at Anytime
snow goose	1	2.59	100	100	2.59	100
Canada goose	15	1.55	55.9	41.1	0.36	41.1
unidentified duck	15	1.45	21.3	19.2	0.06	19.2
Franklin's gull	2	0.05	88.9	75.0	0.04	75.0
red-tailed hawk	6	0.06	72.7	75.0	0.04	87.5
mallard	4	0.20	24.2	62.5	0.03	62.5
tundra swan	1	0.02	100	100	0.02	100
double-crested cormorant	8	0.17	92.9	11.5	0.02	11.5
American white pelican	7	0.61	81.6	3.6	0.02	35.7
American wigeon	1	0.01	100	100	0.01	100
unidentified gull	8	0.34	63.8	5.4	0.01	5.4
unidentified hawk	3	0.02	100	33.3	<0.01	66.7
northern pintail	1	0.04	14.3	100	<0.01	100
northern harrier	7	0.05	100	12.5	<0.01	12.5
blue-winged teal	4	0.48	12.3	0	0	0
lesser scaup	0	0.42	0	0	0	0
killdeer	7	0.29	18.8	0	0	0
unidentified shorebird	0	0.12	0	0	0	0
mourning dove	6	0.11	55.6	0	0	0
ring-necked pheasant	0	0.09	0	0	0	0
ruddy duck	0	0.07	0	0	0	0
redhead	0	0.06	0	0	0	0
bufflehead	0	0.04	0	0	0	0
northern shoveler	0	0.02	0	0	0	0
upland sandpiper	0	0.02	0	0	0	0
American coot	0	0.02	0	0	0	0
unidentified raptor	1	0.01	100	0	0	0
Wilson's phalarope	1	<0.01	100	0	0	0
unidentified teal	1	<0.01	100	0	0	0
Swainson's hawk	0	<0.01	0	0	0	0
ring-billed gull	1	<0.01	100	0	0	0
great egret	1	<0.01	100	0	0	0
Baird's sandpiper	0	<0.01	0	0	0	0
American crow	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 avian use surveys conducted at the Merricourt Wind Energy Project in McIntosh and Dickey counties, North Dakota, from May 9, 2016 - April 28, 2017.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within RSH based on initial observation	Exposure Index	% Within RSH at anytime
red-winged blackbird	18	1.14	47.1	1.1	<0.01	1.1
common grackle	18	0.30	48.0	4.2	<0.01	4.2
unidentified bird (small)	13	5.53	98.4	0	0	0
snow bunting	6	1.21	100	0	0	0
horned lark	11	1.01	73.1	0	0	0
barn swallow	23	0.66	84.5	0	0	0
western meadowlark	1	0.56	2.1	0	0	0
brown-headed cowbird	17	0.40	75.8	0	0	0
eastern kingbird	3	0.16	18.5	0	0	0
tree swallow	4	0.11	100	0	0	0
yellow-headed blackbird	4	0.10	76.5	0	0	0
western kingbird	6	0.06	70.0	0	0	0
unidentified sparrow	2	0.04	71.4	0	0	0
bobolink	1	0.04	14.3	0	0	0
grasshopper sparrow	1	0.04	14.3	0	0	0
American robin	0	0.04	0	0	0	0
northern rough-winged swallow	1	0.03	60.0	0	0	0
American goldfinch	2	0.03	40.0	0	0	0
unidentified passerine	1	0.03	100	0	0	0
American tree sparrow	0	0.02	0	0	0	0
dickcissel	0	0.02	0	0	0	0
house sparrow	0	0.01	0	0	0	0
European starling	0	0.01	0	0	0	0
orchard oriole	0	<0.01	0	0	0	0
song 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.

Appendix D. Mean Use by Point for All Birds, Major Bird Types, and Diurnal Raptor Subtypes during Fixed-Point Bird Use Surveys Conducted at the Merricourt Wind Energy Project in McIntosh and Dickey Counties, North Dakota, from May 9, 2016 - April 28, 2017

Appendix D. Mean use (number of birds/plot/20-minute survey) by point for all birds[a], major bird types, and diurnal raptor subtypes observed during avian use surveys conducted at the Merricourt Wind Energy Project in McIntosh and Dickey counties, North Dakota, from May 9, 2016 - April 28, 2017.

	Survey Point						
Bird Type	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Waterbirds	0	0	0	0.92	4.42	0	0.17
Waterfowl	1.04	0.36	7.68	31.71	8.88	0.95	0.58
Shorebirds	0.28	0.24	0.28	0.75	1.04	0.14	0.29
Gulls/Terns	0	0.04	0.04	0.50	0.92	0.09	1.25
Rails/Coots	0	0	0	0.12	0	0	0
Diurnal Raptors	0.20	0.12	0	0.17	0.29	0.18	0.08
Buteos	*0.16*	*0.04*	*0*	*0.04*	*0.17*	*0.09*	*0*
Northern Harrier	*0.04*	*0.04*	*0*	*0.12*	*0.08*	*0*	*0.04*
Other Raptors	*0*	*0.04*	*0*	*0*	*0.04*	*0.09*	*0.04*
Upland Game Birds	0.08	0.08	0.08	0.21	0	0.18	0
Doves/Pigeons	0.08	0	0.04	0.21	0.25	0.14	0.04
Large Corvids	0	0	0	0	0.04	0	0
All Large Birds	**1.68**	**0.84**	**8.12**	**34.58**	**15.83**	**1.68**	**2.42**
Passerines	2.20	17.96	2.52	8.67	4.50	4.18	3.42
Unidentified Birds	0.48	4.72	0.44	3.58	29.83	0.14	0.04
All Small Birds	**2.68**	**22.68**	**2.96**	**12.25**	**34.33**	**4.32**	**3.46**

[a.] 800-meter (m; 2,625-foot [ft]) radius plot for large birds, 100-m (328-ft) radius plot for small birds.

Appendix E. Midwestern North America Fatality Summary Tables

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

Wind Energy Facility	Fatality Estimate[a]	No. of Turbines	Total MW
	Midwest		
Wessington Springs, SD (2009)	8.25	34	51
Blue Sky Green Field, WI (2008; 2009)	7.17	88	145
Cedar Ridge, WI (2009)	6.55	41	67.6
Buffalo Ridge, MN (Phase III; 1999)	5.93	138	103.5
Moraine II, MN (2009)	5.59	33	49.5
Barton I & II, IA (2010-2011)	5.50	80	160
Buffalo Ridge I, SD (2009-2010)	5.06	24	50.4
Buffalo Ridge, MN (Phase I; 1996)	4.14	73	25
Winnebago, IA (2009-2010)	3.88	10	20
Rugby, ND (2010-2011)	3.82	71	149
Cedar Ridge, WI (2010)	3.72	41	68
Elm Creek II, MN (2011-2012)	3.64	62	148.8
Buffalo Ridge, MN (Phase II; 1999)	3.57	143	107.25
Buffalo Ridge, MN (Phase I; 1998)	3.14	73	25
Ripley, Ont (2008)	3.09	38	76
Fowler I, IN (2009)	2.83	162	301
Buffalo Ridge, MN (Phase I; 1997)	2.51	73	25
Buffalo Ridge, MN (Phase II; 1998)	2.47	143	107.25
PrairieWinds SD1, SD (2012-2013)	2.01	108	162
Buffalo Ridge II, SD (2011-2012)	1.99	105	210
Kewaunee County, WI (1999-2001)	1.95	31	20.46
PrairieWinds SD1, SD (2013-2014)	1.66	108	162
NPPD Ainsworth, NE (2006)	1.63	36	20.5
PrairieWinds ND1 (Minot), ND (2011)	1.56	80	115.5
Elm Creek, MN (2009-2010)	1.55	67	100
PrairieWinds ND1 (Minot), ND (2010)	1.48	80	115.5
Buffalo Ridge, MN (Phase I; 1999)	1.43	73	25
PrairieWinds SD1, SD (2011-2012)	1.41	108	162
Top Crop I & II, IL (2012-2013)	1.35	68 (Phase I) 132 (Phase II)	300 (102 Phase I, 198 Phase II)
Heritage Garden I, MI (2012-2014)	1.30	14	28
Wessington Springs, SD (2010)	0.89	34	51
Rail Splitter, IL (2012-2013)	0.84	67	100.5
Top of Iowa, IA (2004)	0.81	89	80
Big Blue, MN (2013)	0.6	18	36
Grand Ridge, IL (2009-2010)	0.48	66	99
Top of Iowa, IA (2003)	0.42	89	80
Big Blue, MN (2014)	0.37	18	36
Pioneer Prairie I, IA (Phase II; 2011-2012)	0.27	62	102.3

[a] = Number of bird fatalities/megawatt/year

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

Data from the following sources:

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

Appendix E2. Wind energy facilities in Midwestern North America with publicly-available and comparable use and fatality data for raptors.

Wind Energy Facility	Use Estimate[a]	Raptor Fatality Estimate[b]	No. of Turbines	Total MW
Merricourt, ND (This Study)	**0.15**			
Buffalo Ridge, MN (Phase I; 1999)	NA	0.47	73	25
Moraine II, MN (2009)	NA	0.37	33	49.5
Winnebago, IA (2009-2010)	NA	0.27	10	20
Buffalo Ridge I, SD (2009-2010)	NA	0.2	24	50.4
Cedar Ridge, WI (2009)	NA	0.18	41	67.6
PrairieWinds SD1, SD (2013-2014)	NA	0.17	108	162
Top of Iowa, IA (2004)	NA	0.17	89	80
Cedar Ridge, WI (2010)	NA	0.13	41	68
Ripley, Ont (2008)	NA	0.10	38	76
Wessington Springs, SD (2010)	0.232	0.07	34	51
Rugby, ND (2010-2011)	NA	0.06	71	149
NPPD Ainsworth, NE (2006)	NA	0.06	36	20.5
Wessington Springs, SD (2009)	0.232	0.06	34	51
PrairieWinds ND1 (Minot), ND (2011)	NA	0.05	80	115.5
PrairieWinds ND1 (Minot), ND (2010)	NA	0.05	80	115.5
PrairieWinds SD1, SD (2012-2013)	NA	0.03	108	162
Elm Creek, MN (2009-2010)	NA	0	67	100
Rail Splitter, IL (2012-2013)	NA	0	67	100.5
Pioneer Prairie I, IA (Phase II; 2011-2012)	NA	0	62	102.3
Buffalo Ridge, MN (Phase III; 1999)	NA	0	138	103.5
Buffalo Ridge, MN (Phase II; 1998)	NA	0	143	107.25
Buffalo Ridge, MN (Phase II; 1999)	NA	0	143	107.25
Blue Sky Green Field, WI (2008; 2009)	NA	0	88	145
Elm Creek II, MN (2011-2012)	NA	0	62	148.8
Barton I & II, IA (2010-2011)	NA	0	80	160
PrairieWinds SD1, SD (2011-2012)	NA	0	108	162
Kewaunee County, WI (1999-2001)	NA	0	31	20.46
Buffalo Ridge II, SD (2011-2012)	NA	0	105	210
Buffalo Ridge, MN (Phase I; 1996)	NA	0	73	25
Buffalo Ridge, MN (Phase I; 1997)	NA	0	73	25
Buffalo Ridge, MN (Phase I; 1998)	NA	0	73	25
Fowler I, IN (2009)	NA	0	162	301
Big Blue, MN (2013)	NA	0	18	36
Big Blue, MN (2014)	NA	0	18	36
Top of Iowa, IA (2003)	NA	0	89	80
Grand Ridge, IL (2009-2010)	0.19	0	66	99

[a] = Number of raptors/plot/20-minute survey
[b] = Number of fatalities/megawatt/year

Appendix E2. Wind energy facilities in Midwestern North America with publicly-available and comparable use and fatality data for raptors.

Data from the following sources:

Wind Energy Facility	Use Estimate	Fatality Estimate
Merricourt, ND	**This study.**	
Barton I & II, IA (10-11)		Derby et al. 2011a
Big Blue, MN (13)		Fagen Engineering 2014
Big Blue, MN (14)		Fagen Engineering 2015
Blue Sky Green Field, WI (08; 09)		Gruver et al. 2009
Buffalo Ridge, MN (Phase I; 96)		Johnson et al. 2000a
Buffalo Ridge, MN (Phase I; 97)		Johnson et al. 2000a
Buffalo Ridge, MN (Phase I; 98)		Johnson et al. 2000a
Buffalo Ridge, MN (Phase I; 99)		Johnson et al. 2000a
Buffalo Ridge, MN (Phase II; 98)		Johnson et al. 2000a
Buffalo Ridge, MN (Phase II; 99)		Johnson et al. 2000a
Buffalo Ridge, MN (Phase III; 99)		Johnson et al. 2000a
Buffalo Ridge I, SD (09-10)		Derby et al. 2010b
Buffalo Ridge II, SD (11-12)		Derby et al. 2012a
Cedar Ridge, WI (09)		BHE Environmental 2010
Cedar Ridge, WI (10)		BHE Environmental 2011
Elm Creek, MN (09-10)		Derby et al. 2010c
Elm Creek II, MN (11-12)		Derby et al. 2012b
Fowler I, IN (09)		Johnson et al. 2010
Grand Ridge, IL (09-10)	Derby et al. 2009	Derby et al. 2010g
Kewaunee County, WI (99-01)		Howe et al. 2002
Moraine II, MN (09)		Derby et al. 2010d
NPPD Ainsworth, NE (06)		Derby et al. 2007
Pioneer Prairie I, IA (Phase II; 11-12)		Chodachek et al. 2012
PrairieWinds ND1 (Minot), ND (10)		Derby et al. 2011c
PrairieWinds ND1 (Minot), ND (11)		Derby et al. 2012c
PrairieWinds SD1 (Crow Lake), SD (11-12)		Derby et al. 2012d
PrairieWinds SD1 (Crow Lake), SD (12-13)		Derby et al. 2013
PrairieWinds SD1, SD (13-14)		Derby et al. 2014
Rail Splitter, IL (12-13)		Good et al. 2013b
Ripley, Ont (08)		Jacques Whitford 2009
Rugby, ND (10-11)		Derby et al. 2011b
Top of Iowa, IA (03)		Jain 2005
Top of Iowa, IA (04)		Jain 2005
Wessington Springs, SD (09)	Derby et al. 2008	Derby et al. 2010f
Wessington Springs, SD (10)	Derby et al. 2008	Derby et al. 2011d
Winnebago, IA (09-10)		Derby et al. 2010e