

**Bird and Bat Conservation Strategy
Thunder Spirit Wind Resource Area**

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1.0 INTRODUCTION

1.1 Purpose

The primary purposes of this Bird and Bat Conservation Strategy (BBCS) are to: 1) summarize the baseline avian and bat studies conducted within the proposed Thunder Spirit Wind Resource Area (TSWRA); 2) identify measures to avoid and minimize risks through site planning, best management practices (BMP's), and conservation measures, and; 3) describe the adaptive management, monitoring, and reporting requirements for the proposed project. This plan describes the measures that would be implemented prior to, during, and following construction to avoid and minimize impacts to birds and bats and allow for development and operation of the proposed wind energy facility in an environmentally responsible and practicable manner. This BBCS was prepared in accordance with the US Fish and Wildlife Service (USFWS) Land-based Wind Energy Guidelines (USFWS 2012) and the USFWS Eagle Conservation Plan Guidance (USFWS 2013). An eagle management plan has also been developed for the TSWRA and is included in Appendix A.

1.2 Background

In May 2007, Global Winds Harvest, through Two Creeks Wind LLC, contracted Western EcoSystems Technology, Inc. (WEST) to conduct baseline wildlife surveys at their proposed Two Creeks Wind Facility. In 2011, Global Winds Harvest changed the project name to the Thunder Spirit Wind Resource Area (TSWRA) and slightly modified the project boundary. At the same time, corporate management of the project was transferred to the Thunder Spirit Wind LLC (Thunder Spirit), an affiliate of Wind Works Power Corp. Thunder Spirit contracted WEST to conduct a second year of baseline wildlife surveys, which included avian and eagle use surveys, raptor nest surveys, sharp-tailed grouse lek surveys, acoustic bat surveys, a whooping crane habitat analysis, and vegetation community mapping. In 2013, Thunder Spirit contracted WEST to conduct an aerial golden eagle nest survey of the TSWRA and a 10 mile buffer as well as additional observational studies focused primarily on golden eagles.

1.3 Facility Description

Thunder Spirit is a wind powered electrical generating facility that is being constructed in Adams County, ND, approximately 5 miles northeast of Hettinger, N.D (Figure 1). Although the Project is permitted for, and has a valid interconnection agreement for, a maximum nameplate capacity of 150MW, a first phase of the project will be built with a nameplate capacity of 107.5MW. This first phase will consist of 43 Nordex wind turbine generators, each of 2.5MW capacity, with 80m steel tubular towers and 100m diameter rotors. Additional facilities will include access roads, electrical collection systems and cabling, a collector substation, a construction laydown area, and an approximately 0.85 mi overhead radial transmission line. The Project's two principal permits are a Wind Energy Facility Siting Permit from Adams County, granted on 9 September 2013, and a Certificate of Siting Compatibility from the North Dakota Public Service Commission, granted on 9 October 2013. Construction of the facility began in December 2013 and the Project is expected to go online in December 2015.

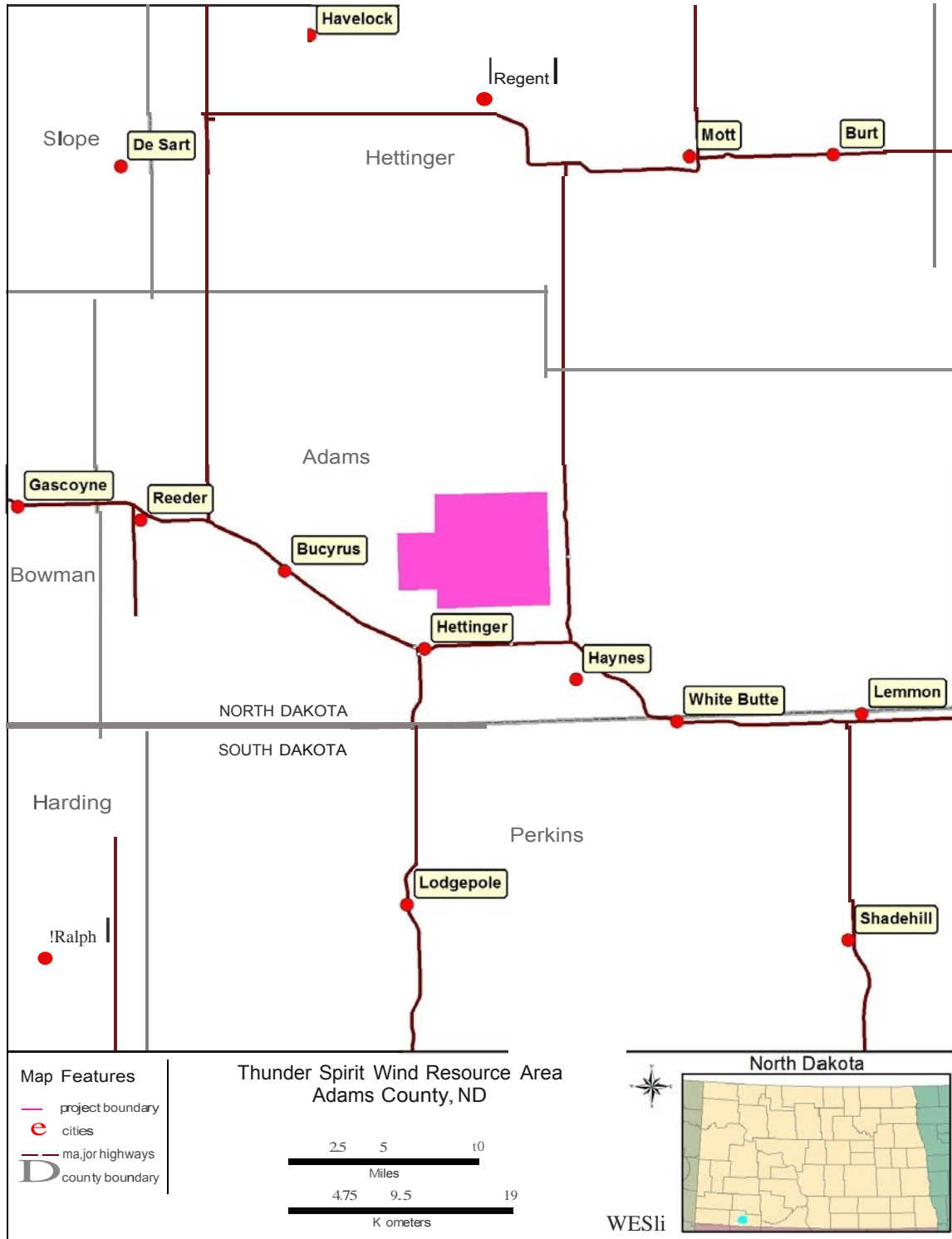


Figure 1. Location of the Thunder Spirit Wind Resource Area in Adams County, North Dakota

1.4 Key Avian and Bat Laws, Regulations, Authorizations

The project is subject to all relevant federal, state, and local statutes, and regulations. The key federal, state, and local agency approvals, reviews, and permitting requirements for avian and bat species that are anticipated to be needed are presented in Table 1.

Table 1. Key Avian and Bat Laws, Regulations, and Authorizations.

Authorization	Agency Authority	Statutory Reference
<i>Federal</i>		
Endangered Species Act Compliance	U.S. Fish and Wildlife Service (USFWS)	Endangered Species Act (PL 93-205, as amended by PL 100-478 [16 USC 1531 <i>et seq.</i>]); 50 Code of Federal Regulations (CFR) 402
Migratory Bird Treaty Act	USFWS	16 USC 703–711; 50 CFR 21 Subchapter B
Bald and Golden Eagle Protection Act	USFWS	16 USC 668–668(d)

The regulatory framework for protecting birds includes the Endangered Species Act of 1973, as amended (ESA 1973), the Migratory Bird Treaty Act (MBTA 1918), and the Bald and Golden Eagle Protection Act (BGEPA) of 1940. The MBTA prohibits the take of migratory birds and does not include provisions for allowing unauthorized take. This project affords substantial design measures to avoid and minimize the likelihood of take, but if take occurs, it will be reported to the US Fish and Wildlife Service (USFWS). Additionally, this BBCS has been developed to meet USFWS requirements for addressing the ESA, MBTA, and BGEPA. Both the BGEPA and the MBTA prohibit take as defined as pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, destroy, molest, disturb, or otherwise harm eagles, their nests, or their eggs. Under the BGEPA, “disturb” means to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available: 1) injury to an eagle; 2) decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior; or 3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior. However, on September 11, 2009 (*Federal Register*, 50 Code of Federal Regulations [CFR] 13 and 22), the USFWS set in place rules establishing two new permit types: 1) take of bald and golden eagles that is associated with, but not the purpose of, the activity; and 2) purposeful take of eagle nests that pose a threat to human or eagle safety.

1.5 Policy and Commitment to Environmental Protection

Thunder Spirit Wind is proud of its environmental commitment and continually seeks new ways to provide electricity with the least possible impact on the environment. It is Thunder Spirit Wind’s corporate policy to conduct its business in an environmentally sustainable and responsible manner while providing affordable and reliable electricity to customers. Thunder Spirit Wind is committed to siting, designing, constructing and operating its wind and transmission facilities in a way that minimizes adverse environmental impacts consistent with state and federal regulations. The Thunder Spirit Wind Project has been designed to minimize potential impacts on birds, bats and other wildlife and their habitats.

2.0 EXISTING CONDITIONS

2.1 Environmental Setting

The TSWRA falls entirely within the USFWS Mountain-Prairie Region (Region 6) as well as the Badlands and Prairies Bird Conservation Region (BCR 17). The site is generally situated north of US Highway 12 and west of State Highway 8, about six miles north of the South Dakota border.

The general boundary of the TSWRA encompasses about 9,310 hectares (ha; 23,006 acres [ac]). The landscape within the TSWRA is rolling to flat with several low buttes and ridges found within the project boundary. The area is a mixed landscape of grassland (about 53%) and agricultural areas (about 46%), including small areas of rural homes, shrubs and trees, and other developed areas. Elevation ranges from 779 to 902 feet (ft; 237.4 to 274.9 meters [m]) above sea level. There are about 210.4 ha (520 ac) of wetlands in 97 basins, excluding streams; about 96% of those wetlands are freshwater emergent wetlands (USFWS NWI 2011). Most of the historical short-grass prairie has been converted to agricultural use with crop production and livestock grazing the primary practices.

2.1.1 *Special-status Species*

North Dakota utilizes several levels of protection and/or designations for special-status wildlife species, with the top tier being an official listing or proposed listing under the federal ESA, followed by federal candidate species for possible listing. The USFWS has also developed a Birds of Conservation Concern (BCC) list for each Bird Conservation Region. Birds included in the BCC lists are deemed priorities for conservation actions (USFWS 2008). The North Dakota Game and Fish Department (NDGFD) also maintain a list of 100 Species of Conservation Priority that includes several designations. A Level 1 Species of Conservation Priority is considered a species of greatest conservation concern, either due to declining population status or at risk range-wide with North Dakota constituting the core of the species breeding range. A Level 2 Species of Conservation Priority is considered a species of moderate conservation concern, or of high concern but with suitable outside source funding for conservation efforts. A Level 3 Species of Conservation Priority is considered a species having a moderate level of conservation priority but believed to be peripheral or non-breeding in North Dakota. No levels of the Species of Conservation Priority List are specifically protected under the NDGFD code. A list of federally- and NDGFD-listed species is provided in Appendix B. The majority of federal or NDGFD-listed species are unlikely to occur within the TSWRA due to lack of suitable habitats.

2.2 Monitoring and Surveying to Date

In response to concerns about impacts to wildlife resulting from the development of the TSWRA, a variety of field studies and literature reviews were initiated. Field studies consisted of avian and bat surveys, which are summarized below in Table 2. The field studies were conducted by

WEST biologists. The baseline studies are summarized below and final reports have been included in Appendix C

Table 2. Monitoring and Surveying Efforts.

Study	Taxa	Survey Dates
Avian Point Count Surveys (WEST 2008, 2013a)	All Birds	June 2007 - October 2007; April 2011 – March 2012
Raptor Nest Surveys (WEST 2013b)	All Raptors	March – April 2010
Eagle Nest Surveys (WEST, unpub. data)	Eagles	May 2013
AnaBat Acoustic Surveys (WEST 2008, 2013a)	Bats	July – October 2007; May – October 2011
Lek Surveys (2013b)	Sharp-tailed Grouse	April and May 2011

2.2.1 Avian Point Count Surveys

2.2.1.1 Methods

The objective of the avian point count surveys was to estimate the seasonal and spatial use of the TWWRA by birds, particularly raptors. Avian use surveys followed the methods described by Reynolds et al. (Reynolds et al. 1980). In 2007, fixed-point avian use surveys were conducted at the TWWRA approximately every other week during the summer season (June 5, 2007 through August 10, 2007) and weekly during the fall season (August 24, 2007 through October 29, 2007). In 2011-2012, each Point was surveyed approximately every two weeks in fall (September 1 to November 15) and spring (March 15 to May 31) with even numbered points surveyed one week and odd numbered points the next week, and once per month during summer (June 1 to August 31) and winter (November 16 to March 14). Surveys were carried out during daylight hours, and survey periods varied to approximately cover all daylight hours during a season. Twenty survey plots were established throughout the TSWRA in 2007 (Figure 2a) and 25 survey plots were established in 2011-2012 (Figure 2b). Each survey plot was a 2,625-ft (800-m) radius circle centered on the point. To the extent practical, each plot was surveyed about the same number of times. However, the schedule varied in response to adverse weather conditions (e.g., fog, rain, heavy snow), which caused delays and/or missed surveys. A total of 615 20-min fixed point surveys were conducted during the baseline studies resulting in a total of 205 hours of survey effort. The species, number of individuals, sex and age class (if possible), flight height, flight direction, distance from observer, and behavior (e.g., directional flight, perched, flapping flight, soaring, etc.) were recorded for each observation. Observations of large birds beyond the 800-m radius were recorded, but were not included in the statistical analyses; for small birds, observations beyond the 100-m (328-ft) radius were excluded from analysis. Locations of raptors, other large birds, and species of concern observed during fixed-point surveys were recorded on field maps.

Incidental wildlife observations were recorded while conducting fixed-point surveys, moving between fixed-point locations, and traveling in the TSWRA. All raptors, unusual or unique birds,

and sensitive bird species were documented. All mammals, reptiles, and amphibians were also recorded. The observation number, date, time, species, number of individuals, sex/age class, distance from observer, activity, height above ground (for bird species), and habitat were recorded. The location of sensitive species was recorded.

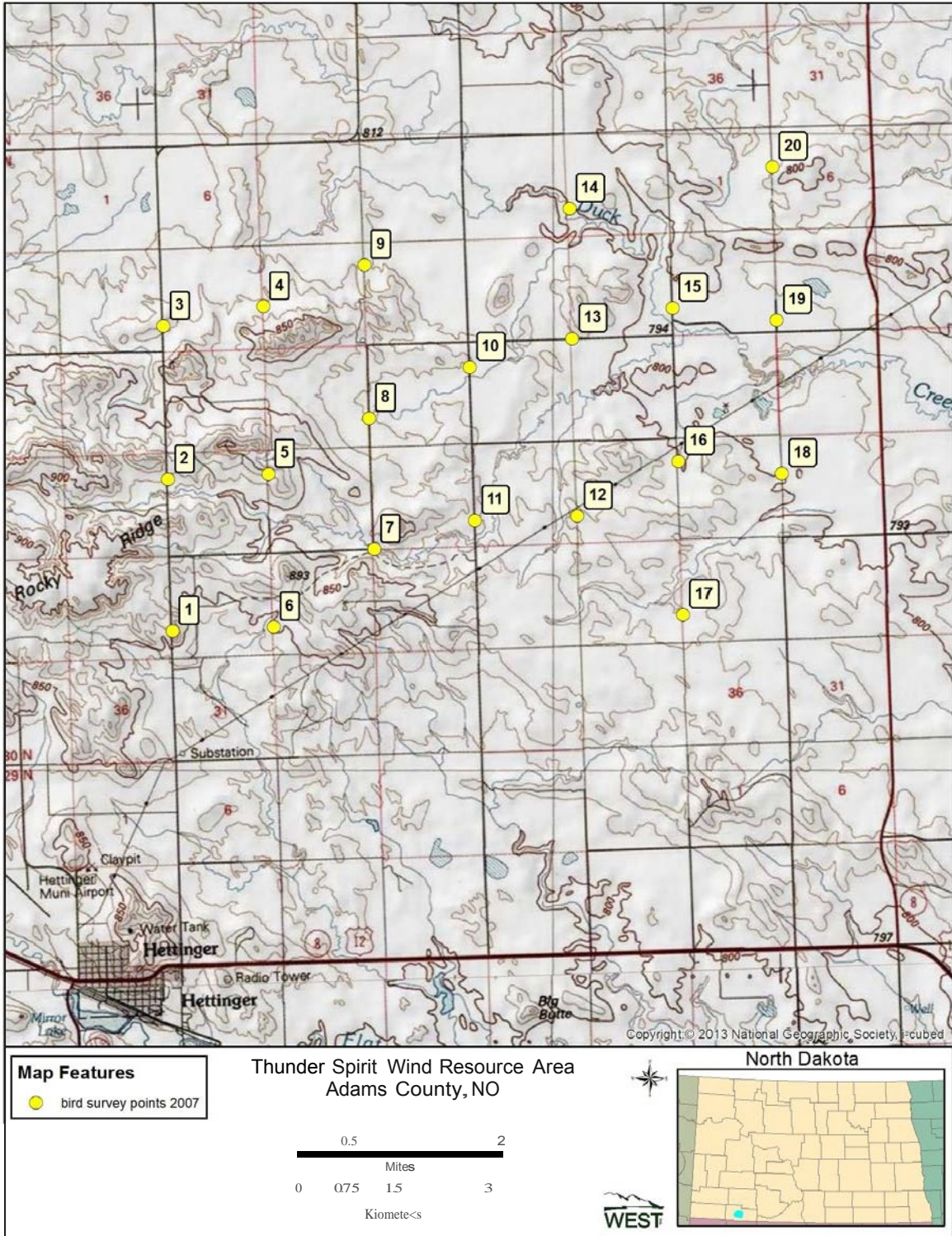


Figure 2a Fixed-point bird survey point locations used in 2007 at the Thunder Spirit Wind Resource Area (previously known as the Two Creeks Wind Resource Area).

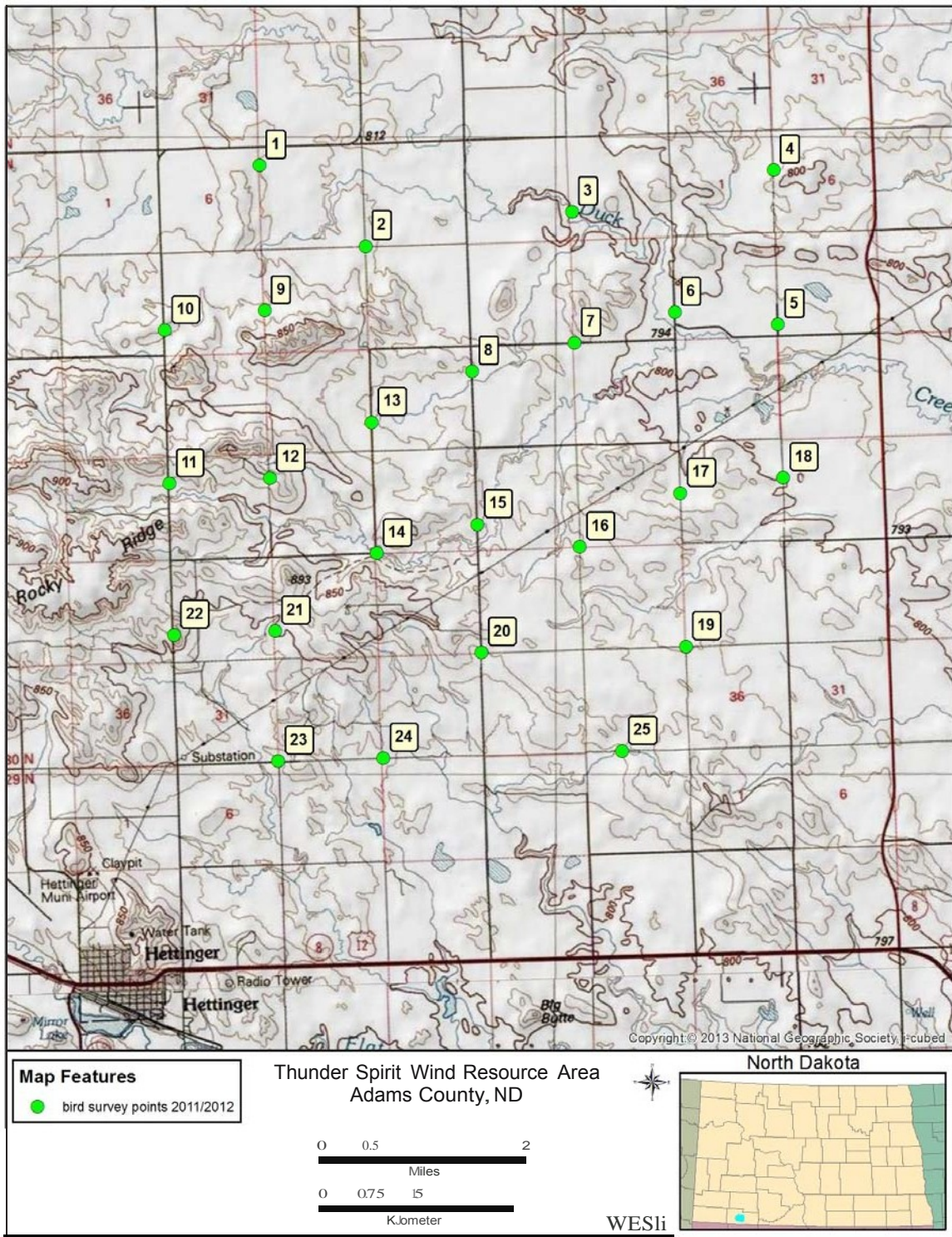


Figure 2b. Fixed-point bird survey point locations in 2011/2012 at the Thunder Spirit Wind Resource Area

2.2.1.2. Results

A total of 82 species and 5,199 individual bird observations were recorded during the fixed-point avian use surveys (Appendix C). Sandhill crane (*Grus canadensis*), horned lark (*Eremophila alpestris*), and western meadowlark (*Sturnella neglecta*) were the most abundant species observed during the study, composing 49% of total individual observations.

During the 2007 studies, overall all bird use was estimated to be 7.05 birds/plot/20-minute survey during the summer and fall seasons. In 2011-2012, overall large bird use was considerably higher in the spring season (17.93 birds/plot/20-min survey), compared to summer (2.27), fall (1.43) and winter (1.78). Higher use in the spring was largely due to sandhill crane observations. Small bird use was highest during winter (5.99) followed by summer (4.49), fall (3.30), and spring (2.84).

Raptors were observed throughout the fixed-point bird use studies. A total of 366 raptor observations (7.0% of the all observations) were detected during the studies. Observations varied seasonally from a low of 21 raptor observations in winter to a high of 165 raptor observations in fall. The most frequently observed raptors were northern harrier (*Circus cyaneus*), Swainson's hawk (*Buteo swainsoni*), and red-tailed hawk (*Buteo jamaicensis*); these species constituted 87% of the raptors observed. The rough-legged hawk (*Buteo lagopus*), golden eagle (*Aquila chrysaetos*), short-eared owl (*Asio flammeus*), prairie falcon (*Falco mexicanus*), peregrine falcon (*Falco peregrinus*), American kestrel (*Falco sparverius*), snowy owl (*Bubo scandiacus*), bald eagle (*Haliaeetus leucocephalus*), ferruginous hawk (*Buteo regalis*), turkey vulture (*Cathartes aura*), and unidentified raptors made up the remaining observations.

Twenty-one special-status species were observed during fixed-point use studies at the TSWRA, and another three special-status species were observed incidentally (Table 3). Both bald and golden eagles were observed and are protected under the BGEPA. In addition, a federal-candidate species (Sprague's pipit [*Anthus spragueii*]) for listing under the ESA was observed. The sharp-tailed grouse is a species of concern. Most of the special status species (18 of 24) are listed as Birds of Conservation Concern for the Badlands and Prairies Bird Conservation Region (USFWS 2008; Table 3). All 24 special-status species documented within the TSWRA are listed under the North Dakota Species of Conservation Priority list (NDFGD 2004). More than 100 observations were recorded for four of the special-status species during fixed-point avian use surveys and incidentally: northern harrier, Swainson's hawk, northern pintail (*Anas acuta*), and sharp-tailed grouse (Table 3; Appendix C).

2.2.1.3 Conclusions

Passerines were the most abundant bird type observed during fixed-point bird use surveys followed by waterbirds (due to 4 groups of 1,125 observations of sandhill cranes) observed during the spring season. Based on the data collected during this study, raptor and all bird use of the TSWRA is generally lower than most wind resource areas evaluated throughout the western and Midwestern US using similar methods (Appendix C). Further, the data collected

during the fixed-point avian use surveys suggest that the TSWRA is not within a major migratory pathway, although birds undoubtedly migrate through the area.

Raptor observations account for 7.0% of birds recorded during the survey period. The highest number of raptor observations occurred in the fall, which likely resulted from the passage and/or arrival of migrants. The majority of these sightings were common Great Plains species, including northern harrier, Swainson's hawk, red-tailed hawk, and rough-legged hawk. Seven golden eagles, four short-eared owls, and two ferruginous hawks were also documented during fixed-point avian use surveys. Other raptor observations included a single individual of each of the three species (American kestrel, bald eagle, peregrine falcon, snowy owl, and turkey vulture).

No federally listed threatened or endangered species were observed within the TSWRA. Bald and golden eagles protected under the BGEPA were document within the TSWRA as was the Sprague's pipit (federal candidate species under ESA).

Table 3. Summary of special-status species observed at the Thunder Spirit Wind Resource Area during fixed-point bird use surveys and as incidental wildlife observations from June 5 – October 29, 2007, and April 6, 2011 -- March 13, 2012.

Common Name	Scientific Name	Status	Fixed-point		Incidental Observations		Total	
			Group s	Individual s	Group s	Individual s	Group s	Individual s
northern harrier	<i>Circus cyaneus</i>	Level 2	135	153	24	28	159	181
Swainson's hawk	<i>Buteo swainsoni</i>	Level 1	57	110	32	60	89	170
northern pintail	<i>Anas acuta</i>	Level 2	16	41	1	100	17	141
sharp-tailed grouse	<i>Tympanuchus phasianellus</i>	SOC, Level 2	7	11	15	105	22	116
lark bunting	<i>Calamospiza melanocorys</i>	Level 1	34	90	0	0	34	90
bobolink	<i>Dolichonyx oryzivorus</i>	Level 2	37	56	0	0	37	56
redhead	<i>Aythya americana</i>	Level 2	0	0	1	50	1	50
grasshopper sparrow	<i>Ammodramus savannarum</i>	BCC, Level 1	21	23	0	0	21	23
loggerhead shrike	<i>Lanius ludovicianus</i>	BCC, Level 2	9	10	6	6	15	16
chestnut-collared longspur	<i>Calcarius ornatus</i>	BCC, Level 1 EA, BCC, Level 2	10	15	0	0	10	15
golden eagle	<i>Aquila chrysaetos</i>	2	7	7	1	1	8	8
marbled godwit	<i>Limosa fedoa</i>	BCC, Level 1	4	6	2	2	6	8
upland sandpiper	<i>Bartramia longicauda</i>	BCC, Level 1	5	5	2	2	7	7
short-eared owl	<i>Asio flammeus</i>	BCC, Level 2	3	4	2	2	5	6
ferruginous hawk	<i>Buteo regalis</i>	BCC, Level 1	1	1	2	2	3	3
prairie falcon	<i>Falco mexicanus</i>	BCC, Level 2	2	2	1	1	3	3
red-headed woodpecker	<i>Melanerpes erythrocephalus</i>	BCC, Level 2 FC, BCC, Level 1	2	3	0	0	2	3
Sprague's pipit	<i>Anthus spragueii</i>	1	1	1	1	2	2	3
burrowing owl	<i>Athene cunicularia</i> <i>Catoptrophorus</i>	BCC, Level 2	0	0	2	2	2	2
willet	<i>semipalmatus</i>	Level 1	1	1	1	1	2	2
American bittern	<i>Botaurus lentiginosus</i>	BCC, Level 1	0	0	1	1	1	1
Baird's sparrow	<i>Ammodramus bairdii</i>	BCC, Level 1	1	1	0	0	1	1
bald eagle	<i>Haliaeetus leucocephalus</i>	BCC, EA, Level	1	1	0	0	1	1

peregrine falcon	<i>Falco peregrinus</i>	2 BCC, Level 3	1	1	0	0	1	1
Total	24 species		355	542	94	365	449	907

FC = federal candidate species (USFWS 2011, 2012e)

BCC = USFWS Birds of Conservation Concern for BCR 17 (USFWS 2008)

ND Level 1, Level 2, Level 3 = North Dakota Species of Conservation Priority (NDGFD 2004)

EA = Bald and Golden Eagle Protection Act (BGEPA 1940)

2.2.2 Raptor and Eagle Nest Surveys

2.2.2.1 Methods

The objective of the raptor nest surveys was to locate and record potential raptor nests that may be subject to disturbance and/or displacement effects by wind-energy facility construction and/or operation as well as to identify the locations of raptor nests that could be used in planning the facility. Surveys were focused on large, stick nest structures, and did not include searches for cavity nests or nests on the ground.

WEST conducted surveys of raptor and golden eagle nest sites in two separate studies at the TSWRA. In spring 2011, two survey methods were used to document potential raptor nests within and adjacent to the TSWRA. Suitable habitat (large trees, power poles, rocky outcroppings) within a 16.1 kilometer (km; 10 mi) buffer surrounding the project boundary was surveyed by fixed-winged aircraft to document large nest structures indicative of eagle nests. Buffer size was determined in accordance with the guidance provided in the USFWS Inventory and Monitoring Protocols (USFWS 2010b). The second survey technique employed in 2011 was ground-based, completed by having a field biologist record potential raptor nests while conducting weekly avian Point Counts during leaf-off conditions within and immediately adjacent to the TSWRA. An additional nest survey was conducted in 2013 that focused the search exclusively on suitable eagle nest substrates within a 16.1 km (10 mi) buffer. For this effort, a helicopter was used due to the higher nest detection rates compared to fixed-wing aircraft. Finally, WEST performed database reviews of known eagle nest locations within 10 miles of the project in both 2011 and 2013.

Potential raptor nests were recorded on aerial photo maps or hand-held global positioning system (GPS) units and digitized with geographic information system (GIS) software. Other information recorded included nest status, nest height, and nest material.

2.2.2.2 Results

Two active raptor nests were recorded during aerial and ground surveys in 2011 (Figure 3a), neither of which were occupied by eagles. Nest TS-RN1 was located within the TSWRA and was occupied by a great horned owl (*Bubo virginianus*; Figure 3a). An active Swainson's hawk nest (TS-RN2) was located approximately 1.2 km (0.75 mi) outside of the eastern project boundary (Figure 3a). No other potential raptor nest structures were observed during aerial or ground surveys. A database query identified a historic golden eagle nest approximately 5 miles west of the project boundary, but the nest was not detected during surveys.

In 2013, six active raptor nests were identified during the aerial surveys (Figure 3b). An active great-horned owl nest and an active red-tailed hawk nest were located just outside the project boundary. One active golden eagle nest was located just outside of the southern project boundary. An active bald eagle nest was located near the edge of the 10-mile buffer to the south of the TSWRA (Figure 3b). The historical golden eagle nest located approximately 5 miles west of the project boundary was identified as inactive.

2.2.2.3 Conclusions

Based on both ground and aerial surveys, it does not appear that the TSWRA and surrounding area has high raptor nesting density. Both native and planted grassland habitat is present in and around the TSWRA and could provide suitable nesting habitat for the ground nesting northern harrier and burrowing owl. Additional discussion of the TSWRA's potential impacts on bald and golden eagles is provided in the Eagle Management Plan included in Appendix A.

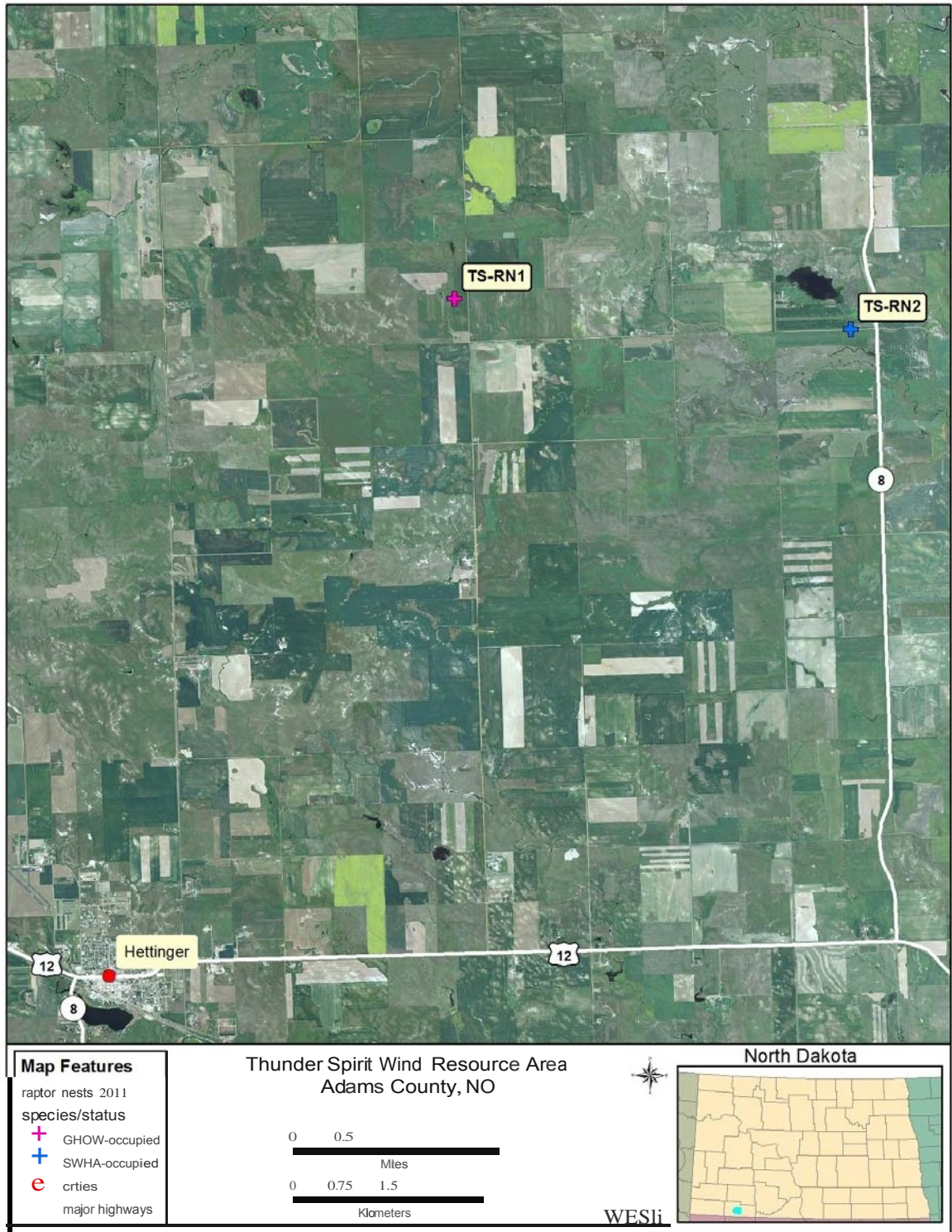


Figure 3a. Raptor nest locations at the Thunder Spirit Wind Resource Area during spring 2011.

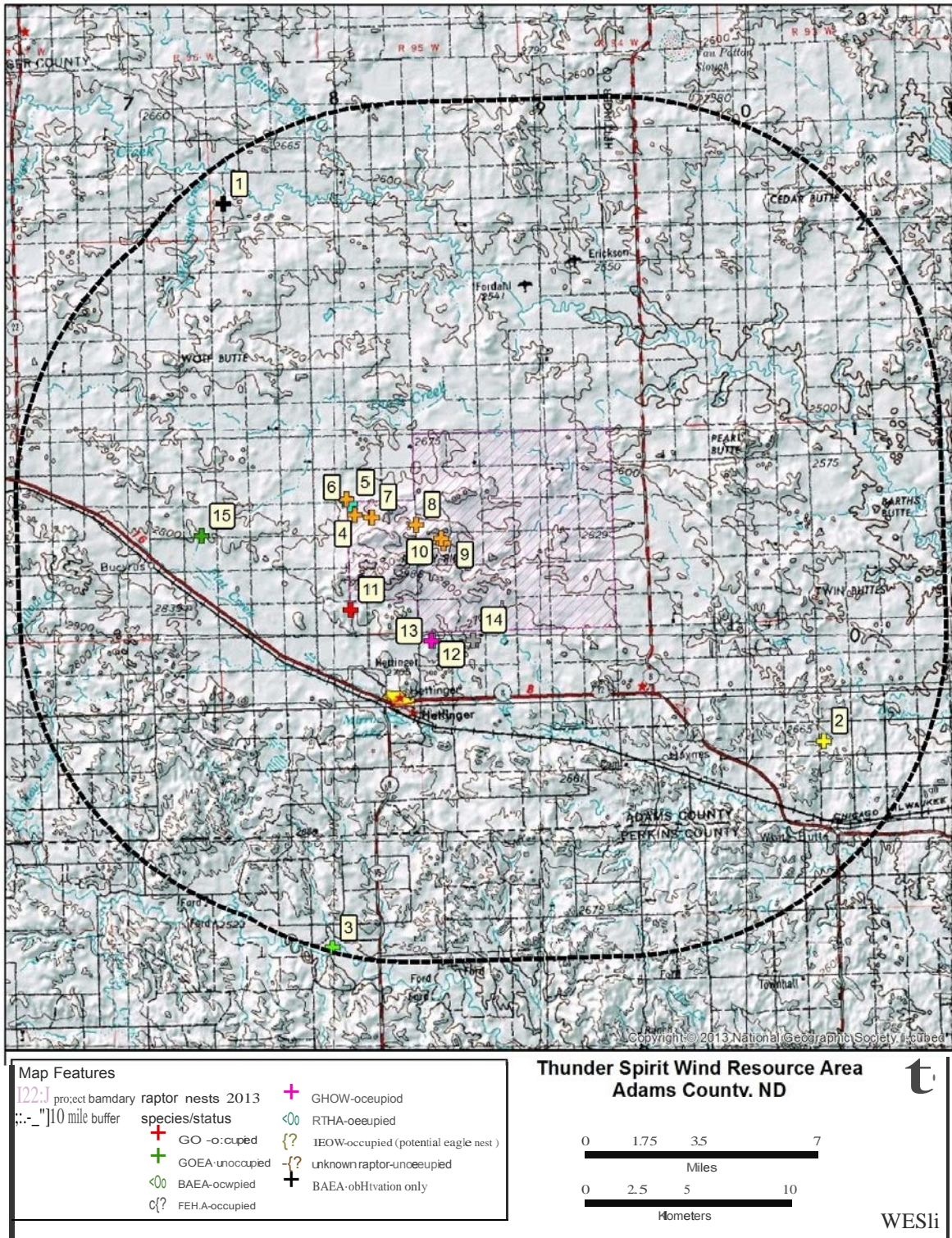


Figure 3b. Raptor nest locations at the Thunder Spirit Wind Resource Area during spring 2013.

2.2.3 Lek Surveys

2.2.3.1 Methods

The objective of the aerial sharp-tailed grouse lek survey was to determine the approximate location of sharp-tailed grouse leks and provide a general sense of sharp-tailed grouse use within and immediately adjacent to the TSWRA during the normal lekking period (early April through mid-May).

Survey methodology was similar to that used for greater prairie chickens (*Tympanuchus cupido*) in Oklahoma (Martin and Knopf 1981). North/south running transects started 800 meters (m; 0.5 miles [mi]) outside the east/west project boundary and were placed at approximate 400 m (0.25 mi) intervals, covering the entire TSWRA (Figure 4). Each transect was approximately 11.3 km (7 mi) long and extended 800 m (0.5 mi) beyond the north/south boundary. Each transect was flown by fixed-winged aircraft at an approximate height of 30 to 46 m (100 – 150 feet [ft]) during three separate survey periods. Surveys began approximately one half hour before sunrise. The location of any suspected sharp-tailed grouse lek was recorded with a GPS unit. The number and activity of birds at each location was also recorded.

2.2.3.1 Results

Approximately 327.1 km (203.3 mi) of transects were surveyed during each of three time periods (April 27 & 28, May 3, and May 5). One confirmed (birds observed in courtship behavior at the same location during more than one survey) lek, three probable (birds observed in courtship behavior during only one survey) leks, and one possible (birds observed in the same general location during more than one survey but showing little or no courtship behavior) lek were identified (Table 4; Figure 4). Confirmed lek TS-GR1 was located within the project boundary in planted grassland habitat (Figure 4). Two of the three probable leks were located in native prairie habitat outside of the project boundary, while the third was within the boundary in alfalfa hay cropland (Figure 4). The one possible lek, TS-GR4, was located in an unknown grassland habitat type, inside the project boundary (Figure 4).

Observation TS-GR4 was considered a possible lek location even though no courtship behavior was observed because of 1) the habitat in which the birds were observed in, and 2) the reluctance of the birds to leave the area. All other sharp-tailed grouse observation locations had males displaying during one or more survey periods.

Table 4. Summary of aerial sharp-tailed grouse surveys conducted during spring 2011 at the Thunder Spirit Wind Resource Area.

Survey Period	Date First Observed	Observation ID	Highest Total	Number Displaying	Lek
1	4/28/2011	TS-GR1	7	7	confirmed
	4/28/2011	TS-GR2	18	+/-13	probable
2	5/3/2011	TS-GR3	6	4	probable
	5/3/2011	TS-GR4	4	0	possible
3	5/5/2011	TS-GR5	17	+/-13	probable

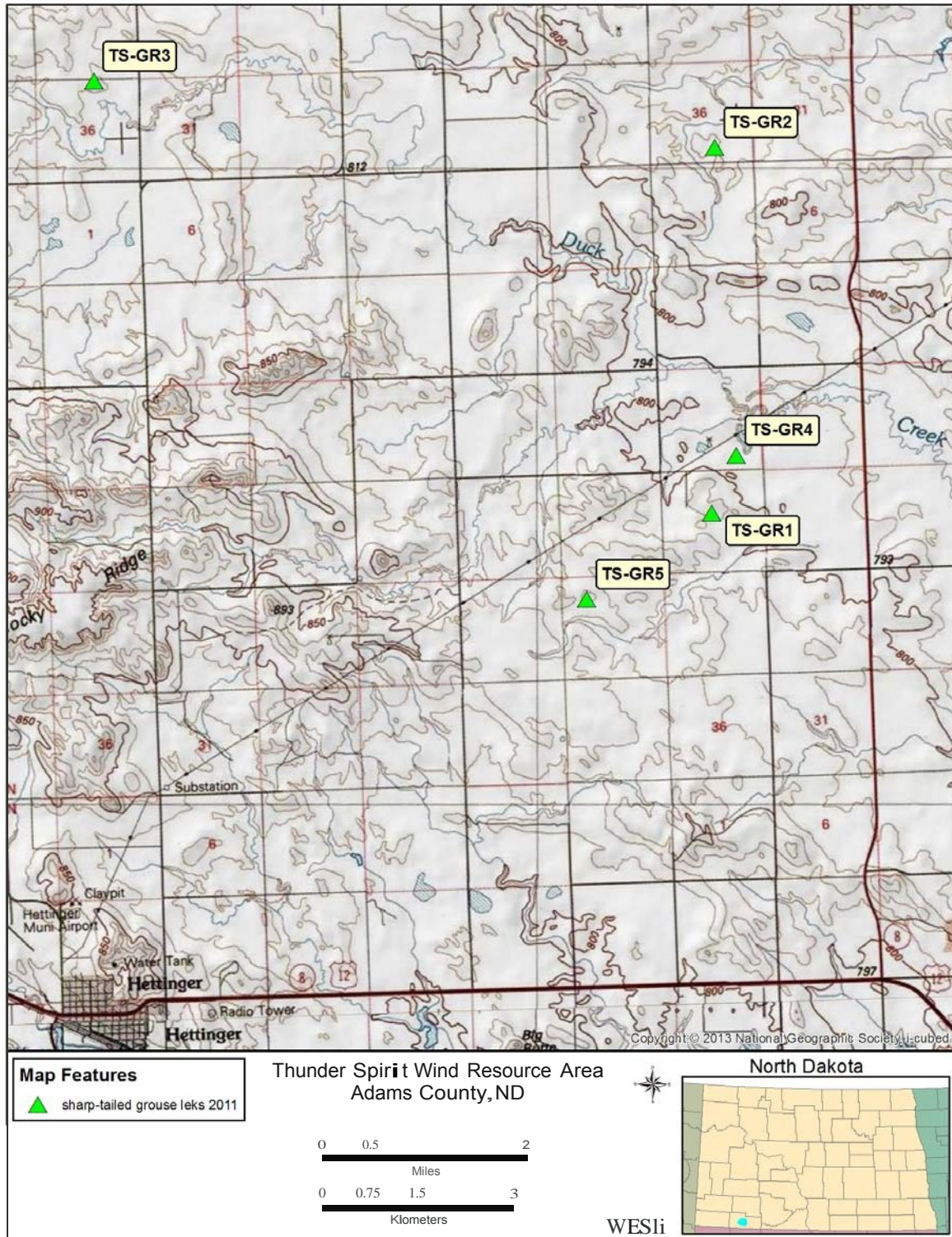


Figure 4. Sharp-tailed grouse observations at the Thunder Spirit Wind Resource Area during spring 2011.

2.2.3.3 Conclusions

Sharp-tailed grouse were observed lekking within the TSWRA during the baseline studies and sharp-tailed grouse may utilize grassland habitats within the TSWRA during the breeding season as well as other times of the year. The start of aerial surveys was delayed due to persistent snow cover across the project area and the availability of survey aircraft. Aircraft availability also caused all three surveys to be conducted within a nine day period in late April/early May. This time frame, however, likely fell during peak sharp-tailed grouse lekking activity within this part of their range (SDGFP undated). Also, the TSWRA and 0.8 km (0.5 mi) buffer were completely surveyed during each survey period. Therefore, it is likely the majority of leks used in 2011 within and immediately adjacent to the project were detected.

2.2.4 Bat Surveys

2.2.4.1 Methods

The objectives of the bat acoustic surveys were to: 1) estimate levels of bat activity throughout the TSWRA during summer reproduction and fall migration; 2) characterize patterns of temporal variation in levels of bat activity; and 3) assess the potential risk wind energy development poses to bats flying 30 to 80 m (98 to 262 ft) above ground level (AGL), within the approximate height of turbine blades (2011 survey only, see below).

Bats were surveyed at the TSWRA using AnaBat[®] II (AnaBat) ultrasonic detectors coupled with Zero Crossing Analysis Interface Modules (ZCAIM; Titley Electronics Pty Ltd., New South Wales, Australia). Two detectors were placed at fixed locations (Figure 5a) from July 23, 2007 to October 15, 2007. The 2011 bat acoustic survey was conducted from May 25 to October 20, 2011. Four AnaBat detectors were used during the 2011 study: two were paired at one meteorological (met) tower, with one detector at ground level (approximately one m AGL) and another within the rotor-swept height (approximately 50 m [164 ft] AGL; Figure 5b); the other two detectors were placed at ground stations in short grass habitats near agricultural fields.

For each detector location, bat passes were sorted into two groups based on their minimum frequency; this grouping corresponded roughly to the bat species groups of interest. For example, most species of *Myotis* bats, as well as eastern red bats, echolocate at frequencies greater than 30 kilohertz (kHz; High Frequency [HF]), whereas species such as the big brown bat (*Eptesicus fuscus*), silver-haired bat (*Lasionycteris noctivagans*), and hoary bat typically emit echolocation calls below 30 kHz (Low Frequency [LF]). To establish which species may have produced passes in each category, a list of species expected to occur in the study area was compiled from range maps (Table 5; Harvey et al. 1999, BCI 2011). There are three Level III Species of Conservation Priority (NDGFD 2004) known to occur in North Dakota (Table 5).

Table 5. Bat species with potential to occur in North Dakota (Harvey et al. 1999, Bat Conservation International 2012), categorized by echolocation call frequency.

Common Name	Scientific Name
High-frequency (> 30 kHz)	
eastern red bat ^{1,2}	<i>Lasiurus borealis</i>
little brown bat ¹	<i>Myotis lucifugus</i>
long-legged bat ^{1,3}	<i>Myotis volans</i>
northern long-eared bat ^{1,4}	<i>Myotis septentrionalis</i>
western long-eared bat ^{1,3}	<i>Myotis evotis</i>
western small-footed bat ³	<i>Myotis ciliolabrum</i>
Low-frequency (< 30 kHz)	
big brown bat ¹	<i>Eptesicus fuscus</i>
hoary bat ^{1,2}	<i>Lasiurus cinereus</i>
silver-haired bat ^{1,2}	<i>Lasionycteris noctivagans</i>
Townsend's big-eared bat	<i>Corynorhinus townsendii</i>

¹ species known to have been killed at wind energy facilities; species found as fatalities reported by Kunz et al. 2007b

² long-distance migrant

³ Level III Species of Conservation Priority (NDGFD 2004))

⁴Listed as Threatened

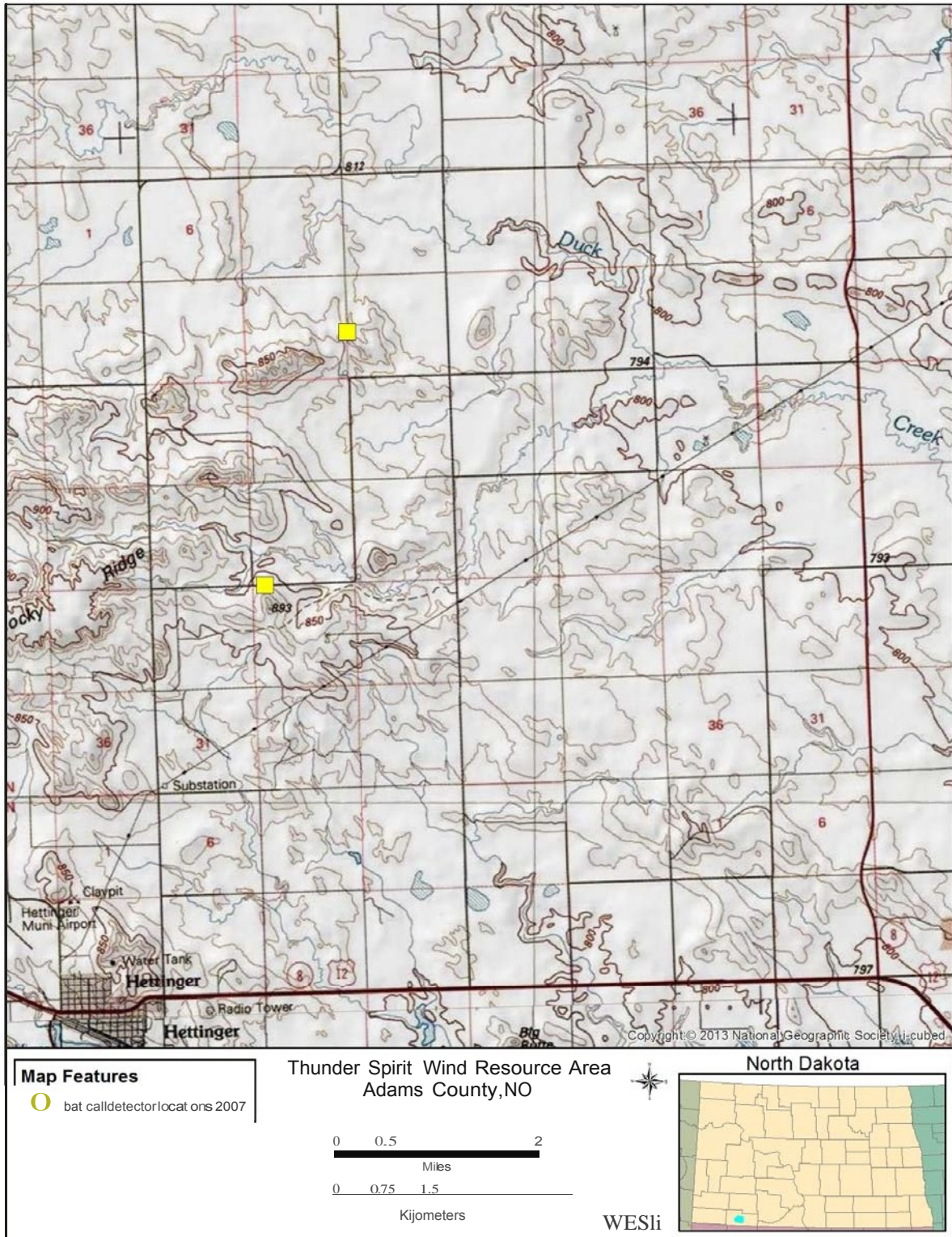


Figure Sa. Bat call detector locations at the Thunder Spirit Wind Resource Area in 2007.

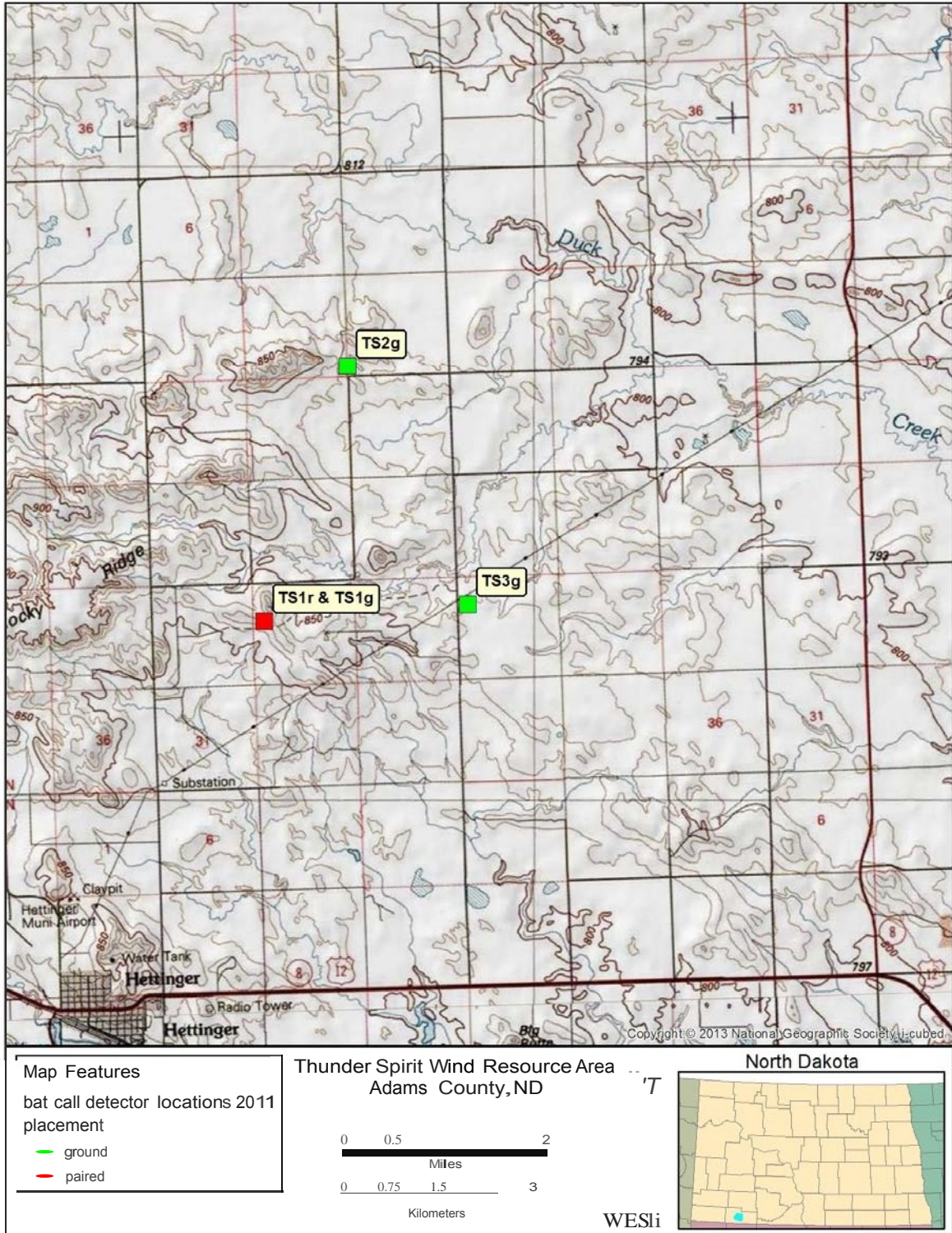


Figure 5b. Bat call detector locations at the Thunder Spirit Wind Resource Area in 2011.

2.2.4.2 Results

2007 Surveys

During 2007 surveys, a total of 126 bat calls were recorded during 112 bat detector nights (Table 6a). Fifty-eight of the calls were more than 35 kHz in frequency (e.g., little brown bat [*Myotis lucifugus*], eastern red bat [*Lasiurus borealis*]), while the remaining 68 were less than 35 kHz (e.g., big brown bat [*Eptesicus fuscus*], silver-haired bat [*Lasionycteris noctivagans*], hoary bat [*Lasiurus cinereus*]) (Table 6a). Noise was recorded on many nights throughout the sample period, which may have interfered with detection of bats. Furthermore, AnaBats failed sporadically during the sampling period. The north unit failed to capture data to any great degree during the last two weeks of the study and the south unit failed to record data during a two and a half week period, from August 6-23.

Bat activity was similar between the ground AnaBat units in the north end (1.0 passes per detector-night) and south (1.26 passes per detector-night). More low-frequency calls than high-frequency calls were detected at the south location. This was reversed at the north location with more high-frequency calls being detected.

The earliest call detected occurred on July 23 and the latest was detected on September 29. Calls were fairly regular, between 1 and 7 per night with most nights having 2-4 calls from July 23 and September 6. After early September the calls drop off dramatically. This time period would correspond to the summer breeding and fall bat migration periods.

Table 6a. Summary of the results of the acoustic bat surveys conducted at the Thunder Spirit Wind Resource Area, May 23 – September 22, 2007.

Detector Location	# of High Frequency Bat Passes	# of Low Frequency Bat Passes	Total Bat Passes	Detector-Nights	Bat Passes/Detector-Night
2024 (south)	25	42	67	53	1.26
2037 (north)	33	26	59	59	1.00
Total	58	68	126	112	1.13

2011 Surveys

In 2011, 406 bat passes were recorded during the survey period; overall bat activity was 0.78 ± 0.08 bat passes per detector-night (Table 6b). AnaBats at ground stations (TS1g, TS2g, and TS3g) recorded 364 bat passes on 374 detector-nights for a mean (\pm standard error) of 0.92 ± 0.09 bat passes per detector-night, while the raised station (TS1r) recorded 42 bat passes on 115 detector nights for a mean of 0.37 ± 0.08 per detector-night (Table 6b).

Bat activity in the TSWRA was higher at the ground stations (0.92 ± 0.09) than at the raised station (0.37 ± 0.08 ; Table 6b). Among ground stations, TS3g recorded the fewest bat passes per detector-night (0.65 ± 0.12), while TS1g recorded the most (1.44 ± 0.19), but all were

consistently low. Activity at TS2g (0.67 ± 0.09) was very similar to TS3g. The raised detector recorded the fewest bat passes of all AnaBats (0.37 ± 0.08 ; Table 6b).

Overall bat activity was higher during the fall, averaging 1.13 bat passes per detector-night compared to 0.62 in summer. Generally, bat activity was very low until mid-July, higher during the period from July 23 to September 2, and lower again for the rest of the monitoring period (Figure 6). The week of highest overall bat activity was the week of July 27 to August 2 (2.61 passes per detector-night; Figure 6).

Bat activity at ground stations was lower in the summer (0.73 bat passes per detector-night) and higher in fall (1.30). Weekly bat activity at ground stations was generally low from late May to late July, higher in late July, August, and early September, and lower for the rest of the monitoring period (Figure 7).

The raised station also had lower bat activity in the summer (0.28 bat passes per detector-night) and higher bat activity in the fall (0.61; Figure 7). Weekly bat activity at the raised station was first recorded in early July, was somewhat higher in August and September, and then ceased in mid-September (Figure 7).

Table 6b. Number of bat passes by frequency (high-frequency [HF], low-frequency [LF]), species, and all bats; detector-nights; and bat passes per detector-night at ground and raised stations at the Thunder Spirit Wind Resource Area from May 25 to October 20, 2011.

Detector Location	Location	# of HF Bat Passes	# of LF Bat Passes	Total Bat Passes	Detector- Nights	Bat Passes/ Night[*]
TS1g	ground	147	68	215	149	1.44±0.19
TS1r	raised	12	30	42	115	0.37±0.08
TS2g	ground	56	36	92	137	0.67±0.09
TS3g	ground	40	17	57	88	0.65±0.12
Total Ground		243	121	364	374	0.92±0.09
Total Raised		12	30	42	115	0.37±0.08
Overall		255	151	406	489	0.78±0.08

^{*} ± bootstrapped standard error.

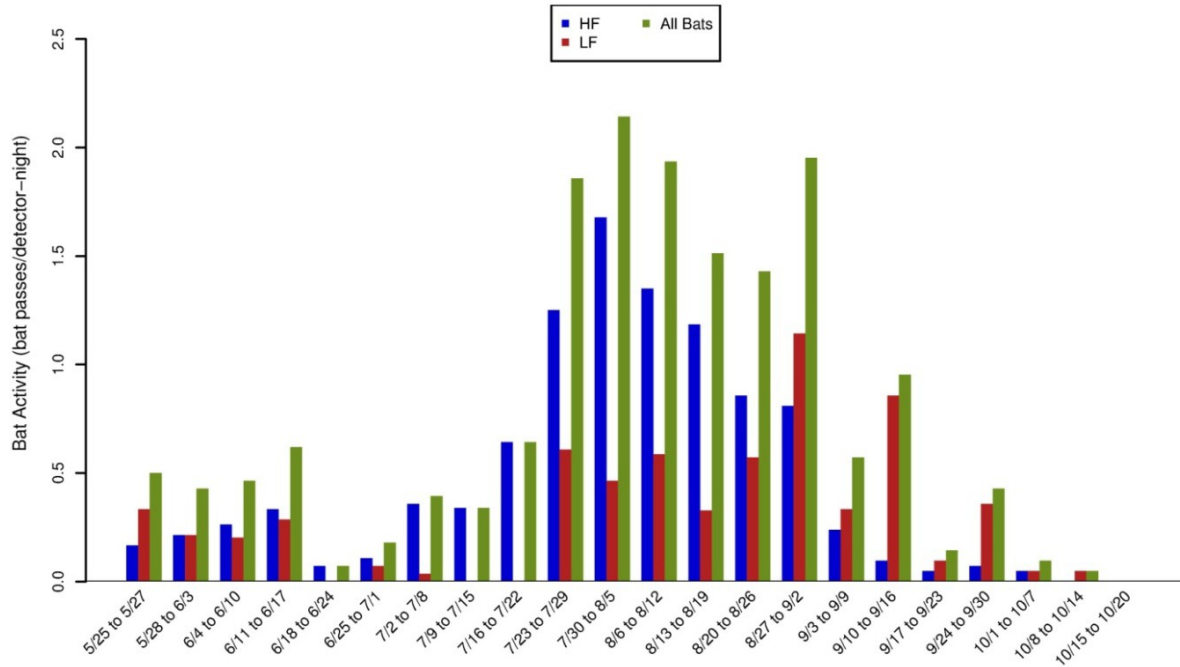


Figure 6. Weekly bat activity (bat passes per detector-night) by high-frequency (HF), low-frequency (LF), and all bats at the Thunder Spirit Wind Resource Area for the period May 25 to October 20, 2011.

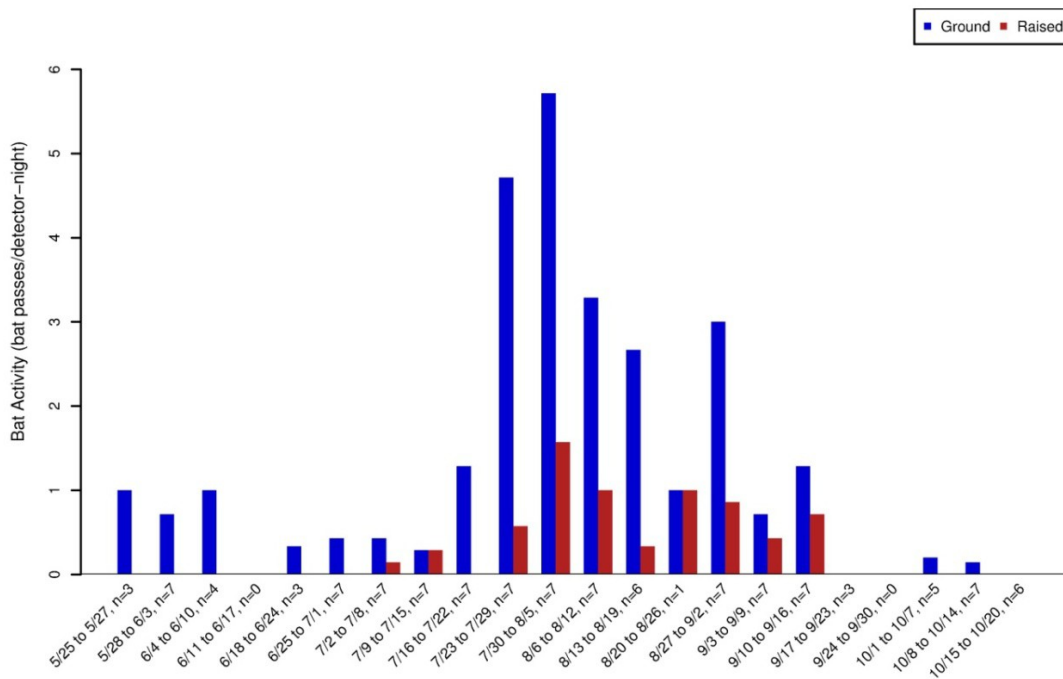


Figure 7. Weekly bat activity (bat passes per detector-night) at ground and raised stations at the Thunder Spirit Wind Resource Area from May 25 to October 20, 2011.

2.2.4.3 Conclusions

Bat activity within the TSWRA (mean = 1.13 bat passes per detector-night in 2007 and 0.78 passes/night in 2011) was comparable to that observed at facilities in Minnesota and Wyoming, where bat collision mortality was low. These activity rates were much lower than activity recorded at sites in West Virginia and Tennessee, where bat mortality rates were high. Thus, based on the presumed relationship between pre-construction bat activity and post-construction fatalities (Hein et al. 2013), and assuming that this relationship extends to the Midwest, we expect bat mortality rates at the TSWRA to be similar to the 2.2 bat fatalities/turbine/year reported at the Buffalo Ridge, Minnesota, wind-energy facility, but much lower than the 20.8 fatalities/turbine/year reported at the Buffalo Mountain, Tennessee, facility.

Acoustic bat surveys were used to distinguish high-frequency from low-frequency species. During 2007 at the TSWRA, 46.0% of all bat passes were high-frequency and 54% were low-frequency calls, suggesting only slightly higher relative abundance of species such as hoary bats, silver-haired bats, and big brown bats. However, in 2011, approximately 62.8% of passes recorded at the detector stations were high-frequency calls, suggesting higher relative abundance of species such as eastern red bats and little brown bats.

In both years, the highest number of bat passes was recorded during late summer and early fall. This likely corresponds with the migration period in which bats may be moving through the area (Fleming and Eby 2005). Most bat fatality studies at wind energy facilities in the US have shown a peak in fatality rates in August and September (the fall migration period) and generally lower fatality rate earlier in the summer and very low fatality rate during the spring (Johnson 2005, Arnett et al. 2008). While the survey effort varied among the different studies, a general association between the timing of increased bat call rates and timing of fatality rates was suggested in the studies that combine activity and fatality surveys, with both call rates and fatalities peaking during the fall migration period. Based on the available data, it is expected that bat fatalities at the TSWRA, which are expected to be low overall, will be highest in late summer to early fall.

The TSWRA is not located near any large, known bat colonies or other features that are likely to attract large numbers of bats. The TSWRA does not contain topographic features that may funnel migrating bats, and is lacking large tracts of forest cover, unlike high-mortality sites in the eastern US. However, the relatively large numbers of bat fatalities reported in northern Iowa (Jain 2005) and southwestern Alberta (Baerwald 2006) indicate that an open landscape is no guarantee of low mortality. Based on species composition and timing, we expect the majority of bat mortalities to be individuals migrating through the area.

3.0 ASSESSMENT OF RISK TO BIRDS AND BATS

3.1 Direct Impacts to Birds and Bats

3.1.1 *Raptors*

Three approaches are used to describe and estimate risk to all raptors: 1) a comparison of annual use relative to other facilities in the US, 2) an estimate of fatality rates based on other publicly available studies for which both raptor use and raptor fatality rates are available, and 3) an estimate of risk based on fatality rates estimated for other wind energy facilities in the region.

Combined mean diurnal raptor use (number of raptor observations from the Avian Point Count Surveys divided by the total observation hours standardized to 20-minutes; excluding turkey vulture) recorded at the TSWRA during the 2011/2012 baseline study was compared with 44 other wind energy facilities that implemented similar protocols and had data for three or four seasons. The mean annual raptor use at these other wind energy facilities ranged from 0.06 raptors/20-min survey to 2.34 raptors/20-min survey. Mean diurnal raptor use at the TSWRA excluding turkey vulture (adjusted for 20-min surveys; 0.68 raptors/plot/20-min survey) was considered to be low to moderate, ranking 14th compared to the 44 other wind energy facilities (Figure 8).

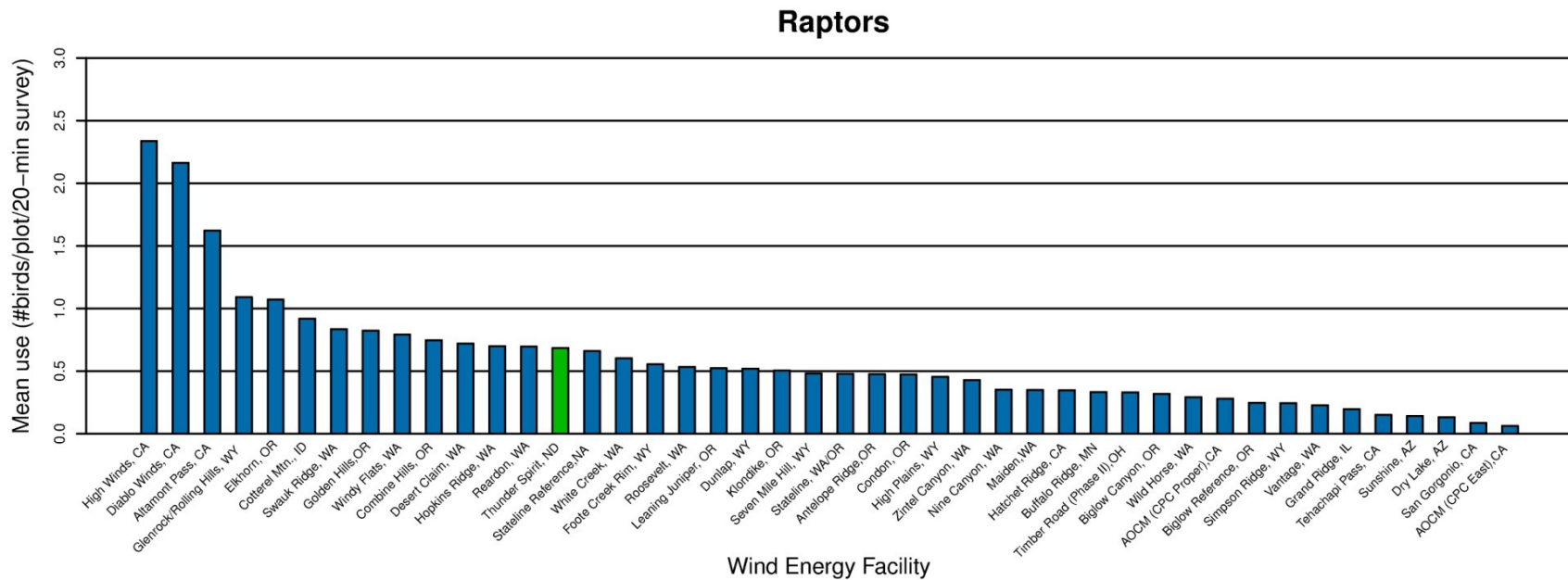


Figure 8. Comparison of the 2011/2012 annual raptor use (birds/plot/20-min survey) between the Thunder Spirit Wind Resource Area and other US wind energy facilities.

Data from the following sources:

Study and Location	Reference	Study and Location	Reference	Study and Location	Reference
Thunder Spirit, ND	This study.				
High Winds, CA	Kerlinger et al. 2005	Footo Creek Rim, WY	Johnson et al. 2000b	Timber Road (Phase II), OH	Good et al. 2010
Diablo Winds, CA	WEST 2006	Roosevelt, WA	NWC and WEST 2004	Biglow Canyon, OR	WEST 2005c
Altamont Pass, CA	Orloff and Flannery 1992	Leaning Juniper, OR	Kronner et al. 2005	Wild Horse, WA	Erickson et al. 2003d
Glenrock/Rolling Hills, WY	Johnson et al. 2008a	Dunlap, WY	Johnson et al. 2009a	AOCM (CPC Proper), CA	Chatfield et al. 2010a
Elkhorn, OR	WEST 2005a	Klondike, OR	Johnson et al. 2002a	Biglow Reference, OR	WEST 2005c
Cotterel Mtn., ID	BLM 2006	Seven Mile Hill, WY	Johnson et al. 2008b	Simpson Ridge, WY	Johnson et al. 2000b
Swauk Ridge, WA	Erickson et al. 2003c	Stateline, WA/OR	Erickson et al. 2003b	Vantage, WA	WEST 2007

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Golden Hills, OR	Jeffrey et al. 2008	Antelope Ridge, OR	WEST 2009	Grand Ridge, IL	Derby et al. 2009
Windy Flats, WA	Johnson et al. 2007	Condon, OR	Erickson et al. 2002b	Tehachapi Pass, CA	Anderson et al. 2000, Erickson et al. 2002b
Combine Hills, OR	Young et al. 2003c	High Plains, WY	Johnson et al. 2009b	Sunshine, AZ	WEST and the CPRS 2006
Desert Claim, WA	Young et al. 2003d	Zintel Canyon, WA	Erickson et al. 2002a, 2003a	Dry Lake, AZ	Young et al. 2007a
Hopkin's Ridge, WA	Young et al. 2003e	Nine Canyon, WA	Erickson et al. 2001a	San Geronio, CA	Anderson et al. 2000, Erickson et al. 2002b
Reardon, WA	WEST 2005b	Maiden, WA	Young et al. 2002	AOCM (CPC East), CA	Chatfield et al. 2010a
Stateline Reference	URS et al. 2001	Hatchet Ridge, CA	Young et al. 2007b		
White Creek, WA	NWC and WEST 2005	Buffalo Ridge, MN	Johnson et al. 2000a		

Based on raptor use (excluding turkey vulture) at the project (approximately 0.68/20-min survey), the estimated raptor mortality rate might be expected to be within the range of fatality rates observed at existing facilities where similar raptor use has been recorded. Table 7 lists publicly available studies with both raptor use estimates and estimated raptor mortality in the U.S.

Table 7. Publicly available studies with both raptor use estimates and estimated raptor mortality in the U.S.

Project Name	State	Overall Use (birds/800m/20-min survey)	Overall Fatality (Birds/MW/year)
Bighorn	WA	0.51	0.11
Biglow Canyon	WA	0.32	0.06
Buffalo Ridge	MN	0.33	0.03
Combine Hills	OR	0.75	0.03
Diablo Winds	CA	2.16	0.87
Dry Lake	AZ	0.13	0.00
Elkhorn	OR	1.07	0.06
Foote Creek Rim	WY	0.55	0.04
Grand Ridge	IL	0.20	0.00
High Winds	CA	2.34	0.39
Hopkins Ridge	WA	0.70	0.14
Klondike	OR	0.50	0.00
Klondike II	OR	0.50	0.11
Leaning Juniper	OR	0.52	0.21
Nine Canyon	WA	0.35	0.03
Shiloh I	CA	2.94	0.42
Shiloh II	CA	3.47	0.12
Stateline	OR	0.48	0.09
Tuolumne	WA	0.77	0.29
Vansycle	OR	0.66	0.00
Wessington Springs	SD	0.23	0.06
Wild Horse	WA	0.29	0.09
Zintel Canyon	WA	0.43	0.05

Estimated raptor fatality rates were available from 31 publicly available studies at wind energy facilities in Midwest. Raptor fatality estimates in this region ranged from 0.47 raptor fatalities/MW/year at the Buffalo Ridge I facility in Minnesota to zero raptor fatalities/MW/study period at several facilities (Table 8). Raptor use estimates were only available for three of the facilities: Wessington Springs, SD, had a use estimate of 0.23 raptors/20-min survey, Grand Ridge, IL, had an estimate of 0.20 raptors/20-min survey, and Buffalo Ridge, MN had an estimate of 0.33 raptors/20-min survey. The associated fatality rates for these three projects were 0.06, 0.0, and 0.03 raptor fatalities/MW/year, respectively.

Table 8. Midwest Raptor Fatality Rates (fatalities/MW/Year) from Publicly Available Studies.

Project Name	State	Fatality Rate (MW/Year)	Reference
Barton I and II	IA	0	Derby et al. 2011
BSGF	WI	0	Gruver et al. 2009
Buffalo Ridge (Phase I; 1996)	MN	0	Johnson et al. 2000
Buffalo Ridge (Phase I; 1997)	MN	0	Johnson et al. 2000
Buffalo Ridge (Phase I; 1998)	MN	0	Johnson et al. 2000
Buffalo Ridge (Phase I; 1999)	MN	0.047	Johnson et al. 2000
Buffalo Ridge (Phase II; 1998)	MN	0	Johnson et al. 2000
Buffalo Ridge (Phase II; 1999)	MN	0	Johnson et al. 2000
Buffalo Ridge (Phase III; 1999)	MN	0	Johnson et al. 2000
Buffalo Ridge I (2010)	SD	0.2	Derby et al. 2010
Buffalo Ridge II (2011)	SD	0	Derby et al. 2012
Cedar Ridge (2009)	WI	0.18	BHE Environmental 2010
Cedar Ridge (2010)	WI	0.13	BHE Environmental 2011
Elm Creek	MN	0	Derby et al. 2010
Elm Creek II	MN	0	Derby et al. 2012
Fowler I (2009)	IN	0	Good et al. 2011
Grand Ridge I	IL	0	Derby et al. 2010
Kewaunee County	WI	0	Howe et al. 2002
Moraine II	MN	0.37	Derby et al. 2010
NPPD Ainsworth	NE	0.06	Derby et al. 2007
Pioneer Prairie I (Phase II)	IA	0	Chodachek et al. 2012
PrairieWinds ND1 (Minot) 2010	ND	0.05	Derby et al. 2011
PrairieWinds ND1 (Minot) 2011	ND	0.05	Derby et al. 2012
PrairieWinds SD1 (Crow Lake)	SD	0	Derby et al. 2012
Ripley (2008)	Ontario	0.1	Jacques Whitford 2009
Rugby	ND	0.06	Derby et al. 2011
Top of Iowa 2003	IA	0	Jain 2005
Top of Iowa 2004	IA	0.17	Jain 2005
Wessington Springs (2009)	SD	0.06	Derby et al. 2010
Wessington Springs (2010)	SD	0.07	Derby et al. 2011
Winnebago	IA	0.27	Derby et al. 2010

3.1.2 Non-raptor Bird Species

Estimated bird fatality rates were available for 32 studies at wind energy facilities in the Midwest. Bird fatality estimates in this region ranged from 0.27 fatalities/MW/study period at the Pioneer Prairie I facility to 8.25 fatalities/MW/study period during year one of study at the Wessington Springs wind energy facility. Fatality rates at the TSWRA site are expected to be within the range of fatality rates observed at other Midwest wind energy facilities and based on habitat similarities, fatality rates could be similar to rates observed at the Rugby Wind Project and PrairieWinds ND1 Project (Table 9).

Table 9. Midwest Bird Fatality Rates (fatalities/MW/Year) from Publicly Available Studies.

Project Name	State	Fatality Rate (MW/Year)	Reference
Barton I and II	IA	5.5	Derby et al. 2011
BSGF	WI	7.17	Gruver et al. 2009
Buffalo Ridge (Phase I; 1996)	MN	4.14	Johnson et al. 2000
Buffalo Ridge (Phase I; 1997)	MN	2.51	Johnson et al. 2000
Buffalo Ridge (Phase I; 1998)	MN	3.14	Johnson et al. 2000
Buffalo Ridge (Phase I; 1999)	MN	1.43	Johnson et al. 2000
Buffalo Ridge (Phase II; 1998)	MN	2.47	Johnson et al. 2000
Buffalo Ridge (Phase II; 1999)	MN	3.57	Johnson et al. 2000
Buffalo Ridge (Phase III; 1999)	MN	5.93	Johnson et al. 2000
Buffalo Ridge I (2010)	SD	5.06	Derby et al. 2010
Buffalo Ridge II (2011)	SD	1.99	Derby et al. 2012
Cedar Ridge (2009)	WI	6.55	BHE Environmental 2010
Cedar Ridge (2010)	WI	3.72	BHE Environmental 2011
Elm Creek	MN	1.55	Derby et al. 2010
Elm Creek II	MN	3.64	Derby et al. 2012
Fowler I (2009)	IN	2.83	Good et al. 2011
Grand Ridge I	IL	0.48	Derby et al. 2010
Kewaunee County	WI	1.95	Howe et al. 2002
Moraine II	MN	5.59	Derby et al. 2010
NPPD Ainsworth	NE	1.63	Derby et al. 2007
Pioneer Prairie I (Phase II)	IA	0.27	Chodachek et al. 2012
PrairieWinds ND1 (Minot) 2010	ND	1.48	Derby et al. 2011
PrairieWinds ND1 (Minot) 2011	ND	1.56	Derby et al. 2012
PrairieWinds SD1 (Crow Lake)	SD	1.41	Derby et al. 2012
Ripley (2008)	Ontario	3.09	Jacques Whitford 2009
Rugby	ND	3.82	Derby et al. 2011
Top of Iowa 2003	IA	0.42	Jain 2005
Top of Iowa 2004	IA	0.81	Jain 2005
Wessington Springs (2009)	SD	8.25	Derby et al. 2010
Wessington Springs (2010)	SD	0.89	Derby et al. 2011
Winnebago	IA	3.88	Derby et al. 2010
Barton I and II	IA	5.5	Derby et al. 2011

Approximately 94% of all passerine groups observed during point counts were outside the RSA. However, some detection bias exists for lower flying birds. There is some potential for all recorded species to fly within the RSA. Given that the site does not appear to be part of a major migratory movement corridor and the bird abundance is relatively low, overall collision risk for

diurnally active avian species is not expected to be relatively high. Based on data from other fatality studies, nocturnal migrating passerines and resident passerines are the most common fatalities, and are the most common bird groups from surveys. It is possible that nocturnal species such as owls, nightjars, etc., and species that migrate at night (most passerines) may be at a greater risk of collision. Many of the migratory species were detected in relatively low numbers, which indicates this is not a major migration corridor for passerines.

3.1.3 Bats

Assessing the potential impacts of wind energy development to bats at the TSWRA is complicated by our current lack of understanding of why bats collide with wind turbines (Kunz et al 2007b), combined with the inherent difficulties of monitoring elusive, night-flying animals (O'Shea et al. 2003). To date, monitoring studies of wind energy projects suggest that: a) migratory tree-roosting species (eastern red, hoary, and silver-haired bats) comprise almost 75% of reported bats killed (Johnson 2005, Kunz et al. 2007b); b) the majority of collisions occur during the post-breeding or fall migration season (roughly August and September; Gruver 2002; Johnson et al. 2003a); and c) the highest reported fatalities occur at wind facilities located along forested ridge tops in the eastern US (Kunz et al. 2007b) and regions of the Midwest report relatively high fatalities as well (Jain 2005; Baerwald 2006; Hein et al. 2013).

Currently, it remains unclear whether pre-construction acoustic data area able to adequately predict post-construction fatality (Hein et al. 2013). Therefore, post-construction fatality data collected at nearby wind-energy facilities in similar habitats appear to be the best available predictor of mortality levels and species composition for proposed wind-energy facilities. Estimated bat fatality rates were available from eight studies at wind energy facilities in North and South Dakota, and ranged from 0.16 fatalities/MW/study period at the Buffalo Ridge I, SD, facility (2010) to 2.81 fatalities/MW/study period at the Buffalo Ridge II, SD, facility (2011). Based on estimated fatality rates observed at other Midwest wind energy facilities, fatality rates at the TSWRA site might be expected to be within the range of fatality rates observed at other Midwest wind energy facilities (Table 10). However, uncertainty exists for predicting bat mortality, based on high variation in rates across the country.

Table 10. Midwest Bat Fatality Rates (fatalities/MW/Year) from Publicly Available Studies.

Project Name	State	Fatality Rate (MW/Year)	Reference
Barton I and II	IA	1.85	Derby et al. 2011
BSGF	WI	24.57	Gruver et al. 2009
Buffalo Ridge (Phase I; 1999)	MN	0.74	Johnson et al. 2000
Buffalo Ridge (Phase II; 1998)	MN	2.16	Johnson et al. 2000
Buffalo Ridge (Phase II; 1999)	MN	2.59	Johnson et al. 2000
Buffalo Ridge (Phase II; 2001/Lake Benton I)	MN	4.35	Johnson et al. 2004
Buffalo Ridge (Phase II; 2002/Lake Benton I)	MN	1.64	Johnson et al. 2004
Buffalo Ridge (Phase III; 1999)	MN	2.72	Johnson et al. 2000
Buffalo Ridge (Phase III; 2001/Lake Benton II)	MN	3.71	Johnson et al. 2004
Buffalo Ridge (Phase III; 2002/Lake Benton II)	MN	1.81	Johnson et al. 2004
Buffalo Ridge I (2010)	SD	0.16	Derby et al. 2010
Buffalo Ridge II (2011)	SD	2.81	Derby et al. 2012
Cedar Ridge (2009)	WI	30.61	BHE Environmental 2010
Cedar Ridge (2010)	WI	24.12	BHE Environmental 2011
Crescent Ridge	IL	3.27	Kerlinger et al. 2007
Crystal Lake II	IA	7.42	Derby et al. 2010
Elm Creek	MN	1.49	Derby et al. 2010
Elm Creek II	MN	2.81	Derby et al. 2012
Forward Energy Center	WI	18.17	Grodsky and Drake 2011
Fowler I (2009)	IN	8.09	Good et al. 2011
Fowler I, II, III (2010)	IN	18.96	Good et al. 2011
Fowler I, II, III (2011)	IN	20.19	Good et al. 2012
Fowler I, II, III (2012)	IN	2.96	Good et al. 2013
Fowler III (2009)	IN	1.84	Good et al. 2011
Grand Ridge I	IL	2.1	Derby et al. 2010 Natural Resources Solutions Inc. (NRSI) 2011
Harrow (2010)	Ontario	11.13	
Kewaunee County	WI	6.45	Howe et al. 2002
Moraine II	MN	2.42	Derby et al. 2010
NPPD Ainsworth	NE	1.16	Derby et al. 2007
Pioneer Prairie I (Phase II)	IA	10.06	Chodachek et al. 2012
PrairieWinds ND1 (Minot) 2010	ND	2.13	Derby et al. 2011
PrairieWinds ND1 (Minot) 2011	ND	1.39	Derby et al. 2012
PrairieWinds SD1 (Crow Lake)	SD	1.23	Derby et al. 2012
Ripley (2008)	Ontario	4.67	Jacques Whitford 2009
Rugby	ND	1.6	Derby et al. 2011
Top of Iowa 2003	IA	7.16	Jain 2005
Top of Iowa 2004	IA	10.27	Jain 2005
Wessington Springs (2009)	SD	1.48	Derby et al. 2010
Wessington Springs (2010)	SD	0.41	Derby et al. 2011
Winnebago	IA	4.54	Derby et al. 2010
Barton I and II	IA	1.85	Derby et al. 2011
BSGF	WI	24.57	Gruver et al. 2009

A species-specific collision risk analysis for bats on the TSWRA site is limited by the type of detector used during the study. Both high-frequency and low-frequency bats utilize the TSWRA, and activity levels for each group may vary by year. Typically, *Myotis* species are less commonly recorded in the rotor-swept height or as fatalities at post-construction studies at wind energy facilities than other species, such as hoary and eastern red bats (Kunz et al. 2007b, Arnett et al. 2008). The three special-status bat species with potential to occur within the TSWRA (northern long-eared bat, long-legged bat, western long-eared bat, and western small-footed bat) are all in the *Myotis* genus. Population level impacts due to collision with WTGs are not anticipated for any bat species at the TSWRA due to these factors and the relatively low bat activity levels.

As mentioned above, the TSWRA is within the range of the northern long-eared bat which, is listed as threatened under the ESA. North Dakota is currently not included in Fish and Wildlife Service’s buffer zone where this listing decision would take place as shown in Figure 9. While northern long-eared bats have been documented as fatalities at operating wind facilities, the number of estimated northern long-eared bat fatalities makes up a very small percentage of all estimated bat fatalities (less than 0.01%; Arnett and Baerwald 2013). To date, migratory tree-roosting species (e.g. eastern red bat, hoary bat, and silver-haired bat) compose approximately 75% of reported bat fatalities at wind facilities. While the number of documented northern long-eared bat fatalities at existing wind facilities is low, the project does overlap the known northern long-eared bat range and the potential for collision exists within the project.

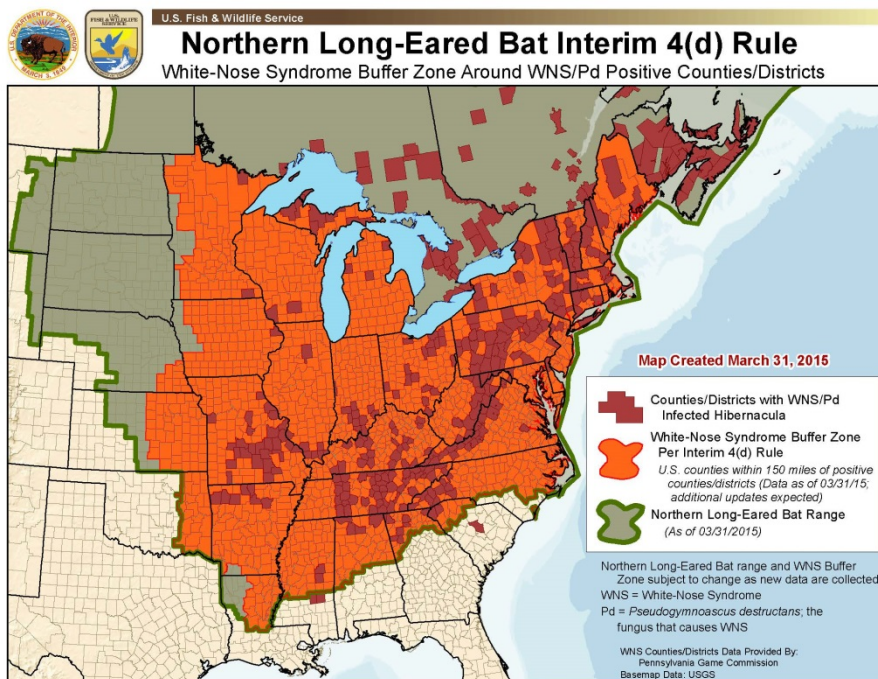


Figure 9. Northern long eared bat habitat range and 4(d) rule buffer map

3.2 Indirect Impacts to Birds and Bats

Construction and O&M of the TSWRA may alter the landscape and habitat conditions so that wildlife use patterns are affected, displacing wildlife away from the project facilities and suitable

habitat. Examples of potential indirect effects during construction and O&M include night lighting, construction noise, and degradation of foraging and nesting habitat. Construction will be conducted primarily during daylight hours; however, if it becomes necessary to conduct work at night, Best Management Practice's (refer to avoidance and minimization of risk section below) will be implemented to avoid and minimize any potential impacts. Construction and O&M noise could impact breeding behavior or reproductive success.

The introduction or spread of invasive weed species that results in changes in prey abundance or species assemblages would also be considered an indirect impact to bird and bat species. Soil disturbance during construction can encourage invasive weeds to encroach into the habitat from areas outside the site, and weed seed can be introduced to the site if construction vehicles and equipment entering the site are not cleaned properly. Invasive weed species have the potential to out-compete native species and change the overall quality of the habitat.

3.2.1 Raptors

Raptors nesting close to turbines have the potential to be impacted by disturbance due to construction or operation of the facility. Birds displaced from wind energy facilities might move to lower quality habitat with fewer disturbances, with an overall effect of reducing breeding success. Most studies on raptor displacement at wind energy facilities, however, indicate effects to be negligible (Howell and Noone 1992; Johnson et al. 2000a, 2003a; Madders and Whitfield 2006). Notable exceptions include a study in Scotland that described territorial golden eagles avoiding the entire wind energy facility area, except when intercepting non-territorial birds (Walker et al. 2005). A study at the Buffalo Ridge wind energy facility in Minnesota found evidence of northern harriers avoiding turbines on both a small scale (less than 100 m from turbines) and a larger scale in the year following construction (Johnson et al. 2000a). Two years following construction, however, no large-scale displacement of northern harriers was detected. The only published report of avoidance of wind turbines by nesting raptors occurred at the Buffalo Ridge facility in Minnesota, where raptor nest density on 101 mi² (262 km²) of land surrounding the wind energy facility was 5.94 nests/39 mi² (101 km²), yet no nests were present in the 12 mi² (31 km²) facility itself, even though habitat was similar (Usgaard et al. 1997). However, this analysis assumes that raptor nests are uniformly distributed across the landscape (an unlikely event), and only two nests would be expected for an area 12 mi² in size if the nests were distributed uniformly. Based on extensive monitoring using helicopter flights and ground observations, raptors continued to nest at a wind energy facility in eastern Washington at approximately the same levels after construction, and several nests were located within a half-mile of turbines (Erickson et al. 2004). At the Foote Creek Rim wind energy facility in southern Wyoming, one pair of red-tailed hawks nested within 0.3 miles (0.5 km) of the turbine strings, and seven red-tailed hawk nests, one great horned owl (*Bubo virginianus*) nest, and one golden eagle nest located within one mile of the wind energy facility successfully fledged young (Johnson et al. 2000b). The golden eagle pair successfully nested a half-mile from the facility for three different years after it became operational. In Oregon, a Swainson's hawk also nested within a quarter-mile (0.4 km) of a turbine string at the Klondike I wind energy facility after the facility was operational (Johnson et al. 2003b). These observations suggest that there will be limited nesting displacement of raptors at the TSWRA. Further discussion of the potential risks associated with the local bald and golden eagle nesting populations are discussed in Appendix A.

3.2.2 Non-Raptor Bird Species

Wind energy facility construction appears to cause small-scale local displacement of grassland passerines. Construction also reduces habitat effectiveness because of the presence of access roads and large gravel pads surrounding turbines (Leddy 1996; Johnson et al. 2000a). Leddy et al. (1999) surveyed bird densities in Conservation Reserve Program (CRP) grasslands at the Buffalo Ridge wind energy facility in Minnesota, and found mean densities of 10 grassland bird species were four times higher at areas located 180 m (591 ft) from turbines than they were at grasslands nearer turbines. Johnson et al. (2000a) found reduced use of habitat by seven of 22 grassland-breeding birds following construction of the Buffalo Ridge wind energy facility. Results from the Stateline wind energy facility in Oregon and Washington (Erickson et al. 2004) and the Combine Hills wind energy facility in Oregon (Young et al. 2005) suggest a relatively small impact of wind energy facilities on grassland-nesting passerines. Transect surveys conducted prior to and after construction of the wind energy facilities found that grassland passerine use was significantly reduced within approximately 50 m (164 ft) of turbine strings, but areas further away from turbine strings did not have reduced bird use. A study conducted by Shaffer et al. (2012) suggested that avoidance/displacement impacts for grassland passerines are species specific. Strong evidence for the avoidance of wind turbines up to 250 m for Grasshopper sparrow (*Ammodramus savannarum*), moderate evidence for Clay-colored Sparrow (*Spizella pallida*) up to 250 m, and no evidence for avoidance or attraction for Savannah Sparrow (*Passerculus sandwichensis*). Results for other species were inconsistent among years or inconclusive due to sample size. There is the potential for small-scale displacement of passerines at the TSWRA.

3.2.3 Bats

Due to the lack of any known maternity roosts or hibernacula for bats in the vicinity of the project, potential indirect impacts to maternity colonies or hibernacula are not anticipated as a result of the project. The habitat within the TSWRA is not expected to concentrate large numbers of bats and this was supported by the baseline studies which indicated that bats likely forage and migrate through the TSWRA in relatively low numbers based on activity rates. Therefore, any potential indirect impacts to foraging or migrating bats resulting from the project are not expected to impact bat populations.

3.3 Special-status Species

No federally-listed threatened or endangered species were observed in the TSWRA during bird use surveys or incidentally. One species, the Sprague's pipit, is classified as a candidate species for listing under the Endangered Species Act (USFWS 2010, 2012a; ESA 1973). In addition, the TSWRA is on the far western edge of the defined range for northern long-eared bat. The sharp-tailed grouse is a species of concern outlined in the USFWS Wind Energy Guidelines. Two eagle species were observed during the study; eagles are protected under the BGEPA (1940) and are discussed in additional detail in Appendix A.

Sprague's Pipit

This passerine species is endemic to mixed-grass prairies of the Northern Great Plains of North America. The decline in the pipit population is largely due to habitat conversion from native prairie to cropland and habitat degradation; pipits require large areas of unfragmented native

prairie without shrubs or trees. In North Dakota, the pipits breed in suitable habitats found in the central and western portions of the state (USGS 2006e, Jones 2010). The pipit has been documented in Adams County and many other counties in North Dakota (USFWS 2012b, 2012c). One Sprague's pipit was observed in spring during fixed-point surveys. Two pipits were observed incidentally during late spring. Minimizing impacts to native vegetation during design and construction of turbines and associated infrastructure would likely help to minimize potential impacts to this species.

Sprague's pipit was observed on two occasions during surveys of the TSWRA; however, species specific surveys were not conducted. Although Sprague's pipits have not been recorded as fatalities at existing wind energy projects, more research is needed to understand potential collision risks to this species. In addition, given the species requirement for large tracks of grassland, impacts from construction may result in decreased habitat.

Northern Long-eared Bat

The TSWRA is within the range of the northern long-eared bat and northern long-eared bats may occur within the TSWRA. There are no known maternity colonies, bat hibernacula, or other areas expected to concentrate bats within the TSWRA. While the number of documented northern long-eared bat fatalities at existing wind facilities is low, the project does overlap the known northern long-eared bat range and the potential for collision exists within the project. Minimizing impacts to wetlands during design and construction of turbines and associated infrastructure should help to minimize impacts to foraging/drinking bats including northern long-eared bat.

Sharp-tailed Grouse

This prairie grouse prefers grassy areas with patches of trees. In the spring, males gather on leks to display for females. Although non-migratory, sharp-tailed grouse may move several miles between seasons to reach optimal habitats for summer and winter. The species has undergone major declines throughout North America, primarily due to habitat loss. Habitat requirements for sharp-tailed grouse are a current research objective for conservation efforts.

A total of five potential sharp-tailed grouse leks were recorded during lek surveys at the TSWRA, with three of these inside of the project boundary (Figure 3). Total number of grouse ranged from 4 to 17 birds at these three areas (Table 6).

To date, concerns over impacts to prairie grouse from wind energy development have typically focused on displacement and disturbance. Collision risk is generally not considered a major concern due to the flight behavior of these species and their tendency to fly below the RSH. However, there is some evidence that suggests that upland game birds may suffer collision mortalities more often than would be expected given their flight characteristics. Johnson and Stephens (2010) reported that upland game birds were the third most common bird type reported in 21 fatality monitoring studies at modern wind facilities in western North America. Ten sharp-tailed grouse fatalities have been reported at existing wind energy projects.

It is currently unknown how prairie grouse, which are accustomed to a relatively low vegetation canopy, would respond to numerous wind turbines hundreds of feet taller than the surrounding landscape. Some scientists speculate that such a skyline may displace prairie grouse hundreds of meters or even miles from their normal range (Manes et al. 2002, USFWS 2003, NWCC 2004). If birds are displaced, it is unknown whether, in time, local populations may become acclimated to elevated structures and return to the area. The USFWS argued that because prairie grouse evolved in habitats with little vertical structure, placement of tall man-made structures, such as wind turbines, in occupied prairie grouse habitat may result in a decrease in habitat suitability (USFWS 2004). Several studies have shown that prairie grouse avoid other anthropogenic features, such as roads, power lines, oil and gas wells, and buildings (Robel et al. 2004, Holloran 2005, Pruett et al. 2009). Much of the infrastructure associated with wind energy facilities, such as power lines and roads, is common to most forms of energy development and it is assumed that impacts would be similar. Nevertheless, there are substantial differences between wind energy facilities and most other forms of energy development, particularly related to human activity. For example, operating gas wells require one visit per day, whereas each wind turbine typically requires only two maintenance visits per year. While results of these studies suggest the potential exists for wind turbines to displace prairie grouse from occupied habitat, well-designed studies examining the potential impacts of wind turbines themselves on prairie grouse have not been completed. Minimizing impacts to native vegetation during design and construction of turbines and associated infrastructure, imposing a 0.5 mile setback around the five (5) known grouse leks in the design of the layout, and burying all collection lines should help to minimize potential impacts to sharp-tailed grouse.

4.0 AVOIDANCE AND MINIMIZATION OF RISK USING BMP's

Thunder Spirit LLC plans to implement a variety of BMP's to reduce the risk to avian and bat species from the project. The following BMP's and ACP's have been implemented or are planned for the TSWRA during the pre-construction, construction, and operation phase of the project.

4.1 Pre-Construction BMP's

Thunder Spirit LLC collected available site-specific information on avian and bat use to guide project siting to avoid and minimize impacts. Other BMP's and ACP's implemented during the pre-construction phase of the TSWRA include:

- The area and intensity of disturbances was minimized during pre-construction monitoring and testing activities;
- Existing roads and transmission corridors have been used to the extent possible while developing site plans;
- The Avian Power Line Interaction Committee (APLIC) guidance on power line siting (APLIC 1994) was followed while planning;
- No lattice or structures that are attractive to birds for perching are including in facility designs;
- Siting access roads and turbines away from wetlands, water bodies, and native prairies to the greatest extent practicable;
- No guy wires will be included on permanent MET towers.

- Site plans minimized the extent of the road network needed for the TSWRA.
- Minimizing impacts to native vegetation and wetlands during design of turbines and associated infrastructure;
- A minimum 2 mile buffer around the eagle nest was instituted while ongoing behavioral observations are being conducted to evaluate eagle use of the Project Area.
- Thunder Spirit imposed a 0.5 mile setback around the five (5) known grouse leks in the design of the layout.

4.2 BMP's during Construction

The following BMP's will be implemented at the TSWRA during construction:

- The area and intensity of disturbance will be minimized to the extent possible during construction including minimizing impacts to native vegetation and wetlands during construction of turbines and associated infrastructure;
- Existing roads will be used for access during construction to the extent possible;
- Non-operational MET towers will be dismantled during construction;
- Thunder Spirit will bury all collection lines and has reduced the overhead radial transmission line to 0.85 miles to reduce the likelihood of avian collisions;
- APLIC guidance on power line construction (APLIC 2006) will be followed;
- A transportation plan will be implemented during construction that includes road design, locations and speed limits to minimize habitat fragmentation and wildlife collisions, and minimize noise effects;
- Lighting plans for the facility are the minimum according to requirements;
- All security lighting will be down-shield and related to infrastructure lights;
- Turbine lighting will be kept to the minimum FAA requirements, and no solid red or white lighting will be used on turbines, associated substations, or other O&M facilities;
- Developing a management plan to prevent the spread of noxious weeds throughout the Project Area or adjacent areas during construction and ongoing operations;
- Any temporarily disturbed areas will be revegetated by reseeding or planting disturbed areas with native material;
- Impacts to wetlands and water resources will be minimized by following all applicable provisions of the Clean Water Act and Rivers and Harbors Act (e.g. developing and implementing a storm water management plan and taking measures to reduce erosion);
- Restricting construction and/or operation activities due to active raptor nests; mapping and flagging raptor nests found during construction; placing turbines as far away from raptor nests as project engineering constraints permit and avoid removal of trees;

4.3 BMP's during Operation

In addition to the intensive monitoring and research program, the following BMP's will be implemented during operation of the TSWRA:

- Management activities such as seeding forbs or maintaining rock piles that attract potential prey will be avoided;
- Parts and equipment which may be used as cover by prey will not be stored in the vicinity of wind turbines;

- Any carcasses (with the exception carcasses being used for post-construction bias trials) found within the TSWRA will be removed immediately assuming the appropriate permits/authorizations have been granted to Thunder Spirit LLC;
- Low level speed limits (< 25 mph) will be maintained on all access roads within the TSWRA;
- Personnel will be trained to be alert for wildlife at all times, especially during low visibility conditions;
- Personnel, contractors, and visitors will be instructed to avoid disturbing wildlife, especially during the breeding seasons and seasonal periods of stress;
- Implementing a Wildlife Incident Reporting System (WIRS) once turbine construction is completed. The WIRS will include protocols for field technicians to report and document avian mortalities during routine maintenance operations (see Section 5.1.6);
- Fire hazards will be reduced from vehicles and human activities (e.g., use spark arrestors on power equipment, avoid driving vehicles off roads, and allow smoking in designated areas only);
- Federal and state measures for handling toxic substances will be followed;
- Effects to wetlands and water resources will be minimized by following provisions of the Clean Water Act (1972);
- Thunder Spirit has committed to a minimum of one year of post-construction mortality avian and bat monitoring;

4.4 Decommissioning

At the end of its useful life, Thunder Spirit LLC will decommission the project facilities. This will include following a decommission plan for the removal of project components. During facility decommissioning, Thunder Spirit will implement practices that will reduce the potential for the project to adversely impact wildlife. The following BMPs and Conservation Measures will be implemented during decommissioning of the Project:

- All turbines and ancillary structures will be removed from the site, except that any facilities more than three feet below the surface will be left in place. Roads will be removed and restored to pre-construction condition unless the landowner specifically requests that roads be left in place.
- On completion of decommissioning, all portions of the area disturbed during decommissioning will be restored to a condition substantially similar to the condition that existed prior to construction; to the extent such restoration is commercially reasonable.
- Whenever possible and with agreement from the landowner, revegetation will be with native species. A seed mix will be developed in consultation with applicable local authorities and any state or local experts.
- Erosion control devices and procedures will be implemented during and after the decommissioning process until site stabilization/restoration is achieved.

5.0 MONITORING AND ADAPTIVE MANAGEMENT PROCESS

The process for addressing potential impacts to bird and bat species from implementation of the

TSWRA is divided into two sections: 1) Post-Construction Monitoring and 2) Adaptive Management based on monitoring results.

Post-construction monitoring is designed to evaluate the project during operation to determine actual impacts. Adaptive management has been designed to use monitoring data to evaluate whether impacts are determined to be significant or unique, and if so, to implement measures to reduce them to acceptable levels or consider some other type of minimization or mitigation.

To help ensure that impacts to avian and bat species can be monitored and mitigated as necessary due to routine operations of the TSWRA, post-construction monitoring results will be reviewed to determine the need for project mitigation. Measures to monitor, avoid, minimize, and mitigate impacts to avian and bat species and their habitats related to operations will be developed as necessary.

5.1 Post-construction Monitoring

Post-construction monitoring for bats and birds is a critical component of this BBCS. Post-construction monitoring will be completed for bats and birds concurrently. Since post-construction monitoring methods are constantly improving as researchers develop new and more accurate methods of survey, flexibility should be incorporated to adopt new survey techniques and protocols as they become available.

Post-construction surveys will focus on mortality surveys for birds and bats. These surveys will be conducted in accordance with industry standards for post-construction fatality monitoring in the region and will be completed to document the number and species of birds and bats killed as a result of the TSWRA. As part of these mortality surveys, the searcher efficiency rate (i.e., the ability of a surveyor to locate a mortality) and carcass removal rate (i.e., the average time that a carcass persists before a scavenger removes it) will be determined for bats and small and large bird size classes. For each mortality identified, the appropriate (i.e., bat, small bird, large bird) searcher efficiency and scavenger removal rate will be used to estimate the actual number of bird and bat mortalities.

5.1.1 Raptor Nest Surveys

Nest surveys will be conducted during the nesting season during the first three years of operations (approximately early to mid-April). Aerial or ground based raptor nest surveys will be conducted within the entire project area and a one-mile buffer for raptors, except for golden eagles. The golden eagle nest surveys and associated mitigation are discussed in the TSWRA's Eagle Management Plan (Appendix A). For golden eagles the nest survey will be done out to 10 miles. The raptor nest survey effort will be focused on species that build large nest structures, such as red-tailed hawk. Other species that nest on the ground or in cavities will be recorded if observed, but will not be the focus of surveys. Where appropriate, construction activities will be limited near active raptor nest sites. Nest locations found within the project area and within buffer will be documented by noting the species, dates of activity, Universal Transverse Mercator (UTM) North American Datum (NAD) 83 coordinates, nest contents (where possible), and behavior. Active raptor nests will be monitored to track the breeding success of resident raptors.

5.1.2 Mortality Surveys

Fatality surveys for baseline monitoring will begin with the next survey season (within four months) after commercial operation delivery (COD) of the project. Monitoring will consist of a minimum of one year of post-construction bird and bat mortality monitoring, in accordance with the WEG (USFWS 2012) or improved protocols following first year results as recommended by the agencies.

In general, TSWRA will implement monitoring of turbines for fatalities pursuant to an enforceable monitoring program established in consultation with the agencies. The current plan for mortality surveys is to implement a “road and pad” design for searches. This includes searching 10 full plots at selected turbines and then searching just the road and pad of all other turbines within the project. Searches would be conducted weekly in the spring, summer, and fall and twice a month in the winter season. Data collected for each carcass will include estimated time since death, condition, type of injury, cover type, distance to nearest WTG location, distance to nearest road, and distance to nearest structure. All observed carcasses will be photo-documented and identified. All mortalities that cannot be identified will be recorded as an unidentified bat or bird. Contingent upon approval and permit by NDGFD and the USFWS, it is recommended that carcasses be collected for use in searcher efficiency and scavenger removal trials.

5.1.2.1 Searcher Efficiency Trials

Searcher efficiency and scavenger rate studies will be used to develop correction factors that will be applied to mortality findings for each surveyed turbine. The corrected data for surveyed turbines will be used to evaluate the mortality per turbine and per MW. Additionally, survey intervals may need to be adjusted based on the findings for these studies in order to ensure precise correction factors, as described by Huso (2009).

Searcher efficiency trials will be conducted throughout the year to correct observed bat and bird mortalities for bias created by the ability of the surveyor to detect bat and bird carcasses. These

will be conducted for each searcher to address differences between searchers. Searcher efficiency trials will be completed during each season to account for different field conditions and weather (i.e., springtime when annual vegetation may be dense, summertime when vegetation is dry and temperatures are hot, etc.) that may affect the ability of the surveyor to locate carcasses. Seasons will be defined as described by Erickson et al. (2003): spring migration (March 16–May 15), breeding season (May 16–August 15), fall migration (August 16–October 31), and winter (November 1–March 15). Although seasonal trials will not address fluke events, they will address the overall time period.

Separate searcher efficiency rates will be determined for bats, small birds (passerines), and large birds (raptors). In order to have an adequate sample size (> 50, Huso [2009]), 20 carcasses will be used for each rate. Bat carcasses collected from the TSWRA will be used for bat searcher efficiency trials, as available. If an insufficient number of bat carcasses are available, small, drab passerines or brown mice carcasses will be used as substitutes. A minimum of two distinct sizes of bird carcasses will be used to determine searcher efficiency rates for passerines and larger birds. As available, bird carcasses collected from the TSWRA

will be used in the searcher efficiency trials; however, substitute carcasses may be used as necessary. In all cases, carcasses used will either be non-native, non-protected species, or species collected under the appropriate permits.

Prior to initiating the searcher efficiency trial, carcass locations will be randomly generated, but constrained so that no more than three carcasses will be located at any one turbine at a time. An additional biologist who is not participating in the searcher efficiency trials will plant carcasses in pre-determined locations. Carcasses will be dropped from waist level, so that they land in a random position and location. The position and location will be recorded for later comparison with actual mortalities. The percentage of planted bats and birds located by surveyors will be used to generate a correction factor to estimate the actual number of bats killed, based on the number of actual mortalities observed.

5.1.2.2 Carcass Removal Trials

Carcass removal trials will be completed during each of the four seasons over the post-construction monitoring period. Different seasonal rates for carcass removal are necessary to address the effects of varying weather conditions, scavenger densities, and scavenger assemblages throughout the season, as well as over time, as scavengers adapt to a novel food source. Separate carcass removal rates will be determined for bats, small birds (passerines), and large birds (raptors). All animals used in the carcass removal trials will be handled with disposable nitrile gloves or an inverted plastic bag to avoid leaving a scent on the carcasses and interfering with the scavenger removal trial (Arnett et al. 2009). Carcasses to be used for the carcass removal trials will be obtained from the same sources as described for the Searcher Efficiency Trials, as described in Section 4.4.

5.1.3 Reporting

An interim monitoring/progress report within three months of the half-way point for the first year of monitoring and a final Monitoring Report within three months of completing the year of post-construction monitoring will be prepared. Both reports will be made available to the appropriate agencies. The final monitoring report will report adjusted and unadjusted annual fatalities for bats and all other bird species on a per-turbine and per megawatt basis. The fatality numbers will be adjusted to account for searcher efficiency and scavenger rates. The monitoring reports shall also summarize the results of the bird and bat behavior and use studies, the results of the searcher efficiency trials, and the results of the carcass removal trials.

5.1.4 Fatality Measures

Thunder Spirit LLC, shall review the final Monitoring Report for the project to evaluate whether any turbines are causing significant bird and/or bat fatalities relative to other turbines included within that particular portion of the project. If one or more turbines are causing significantly disproportionate bird or bat fatalities, then Thunder Spirit LLC, may implement additional focused monitoring and/or management measures designed to reduce the fatalities attributable to those turbines--provided, however, such measures shall not include relocation or permanent shutdown of any turbine.

5.1.5 Wildlife Incident Reporting System

In addition to the post-construction fatality monitoring study described above, Thunder Spirit

LLC will implement a Wildlife Incident Reporting System (WIRS) at the start of operations and it will remain active for the life of the TSWRA. The purpose of the WIRS is to standardize the actions taken by site personnel in response to wildlife incidents encountered in the TSWRA and to fulfill the obligations for reporting wildlife incidents. The WIRS will be utilized by site operations and maintenance personnel who encounter dead or injured birds or bats incidentally while conducting general wind facility or transmission line maintenance activities. The WIRS is designed to provide a means of recording and collecting fatalities in the TSWRA to increase the understanding of wind turbine and wildlife interactions. Any incident involving a State or Federally listed threatened or endangered species or a bald or golden eagle must be reported to the USFWS and NDFGD within 24 hours of identification. Thunder Spirit LLC maintains an ongoing commitment to investigate wildlife incidents involving company facilities and to work cooperatively with federal and state agencies in an effort to prevent and mitigate future bird and wildlife fatalities. It is the responsibility of Thunder Spirit LLC employees and subcontractors to report all avian incidents to their immediate supervisor.

5.2 Adaptive Management

The adaptive management techniques described in this section have been developed to ensure that potentially significant levels of mortality from operation of the TSWRA are effectively mitigated. Changes in federal or status for wildlife species occurring within the project area may result in the addition of, or changes to, adaptive management strategies, as determined through agency recommendations.

Thunder Spirit LLC will meet with the appropriate agencies to discuss mitigation needs if it is determined that a unique or significant event has occurred. Population level impacts will be considered for the Project as well as cumulative impacts due to other developments in the region.

5.2.1 Voluntary Conservation Measures

The determination of how to implement voluntary conservation measures will be determined in coordination with the agencies. Examples of voluntary conservation measures that could be funded through this program include:

- Survey bat activity for comparison with bat fatality monitoring data.
- Feather turbines under normal cut-in speeds.
- Increase cut in speeds if bat fatalities are high.
- Test effectiveness of visual and auditory bird flight diverters in critical locations.
- Survey prey species living around or under turbine pads.
- Contribute funding for retrofitting poles to APLIC standards in areas outside of project.
- Fund development of successful perch deterrents.
- Create alternative perches away from project.
- Remove rock piles in project to discourage increased lagomorph and other small mammal use.
- Work with landowner to manage sheep and calf birthing and pasturing on the site.
- Work with landowners to manage hunting operations on the site –no field dressing or big game processing on the site.

- Contribute funding for regional eagle population studies.
- Fund education on lead poisoning and use of non-lead ammo.
- Fund research on other sensitive species for which little data exists.
- Fund cut-in speed adjustment study for reducing bat fatalities.

6.0 CONCLUSION

This document was written to provide guidance for avoiding, minimizing, and monitoring potential impacts to avian and bat species prior to, during, and after construction of the TSWRA. The measures described in this document are intended to help protect and reduce impacts to wildlife, as well as to monitor potential impacts to wildlife following implementation of the TSWRA. It is anticipated that this BBCS will adaptively manage the TSWRA based on findings following construction.

Appendix A

- Eagle Management Plan for the Thunder Spirit Wind Resource Area

A.1.0 Introduction

This Eagle Management Plan (EMP) is intended to supplement the BBCS developed for the TSWRA. General project information, including background, environmental setting, site-specific avian and bat surveys, and general avian survey results are provided in the BBCS. This appendix evaluates potential risk to bald and golden eagles, presents avoidance and minimization measures for development, construction, and operations of the project that apply to eagles, and describes the post-construction monitoring plans and adaptive management process that will be implemented for the project as they relate to eagles.

A.2.0 Site-specific Surveys

A.2.1 Survey Results

A.2.1.1 Avian Point Counts

The USFWS Eagle Conservation Plan Guidance (ECPG) recommends that avian use surveys cover at least 30% of the area within a 1-km buffer of proposed turbine locations (USFWS 2013). The 2007 avian use survey stations and associated 800 m buffer provided coverage of 43.7% of the area within a 1-km buffer of proposed turbine locations at the TSWRA and the 2011/2012 avian use study provided coverage of 44.3%. Combined, the baseline studies provided coverage of 45.6% of the area within 1 km of proposed turbines (Figure 1).

A total of eight golden eagles were observed during avian point count surveys at the TSWRA (two observations during the 2007 baseline study and 6 observations (including one incidental) during the 2011-2012 baseline study). Of the seven golden eagle observations recorded during avian use surveys, three occurred in the fall, two in the winter, and one each during spring and summer. Spatially within the TSWRA, golden eagle use occurred at avian use points 9 and 15 during the 2007 surveys and points 9, 14, 19, 11, and 13 during 2011-2012 surveys. With the exception of stations 15 and 19, these points lie in the western/southwestern portion of the project boundary (Figures 1).

Only one perched bald eagle was observed during avian point count surveys at the TSWRA. This individual was recorded during the winter season in the 2011-2012 baseline study near avian use station 19, located in the southeastern portion of the boundary (Figure 1).

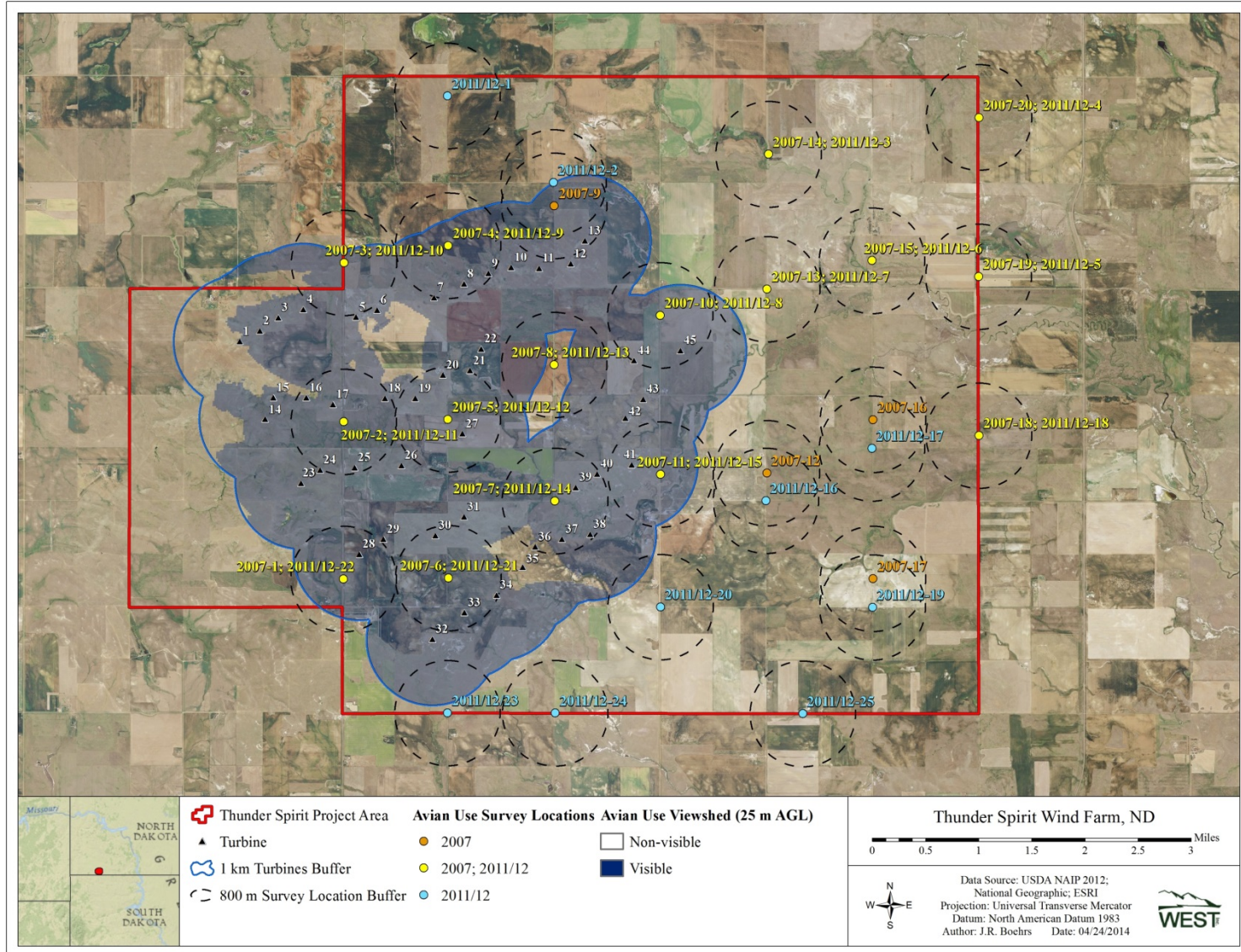


Figure 1. Location of avian use survey plots and associated viewsheds within 1 km of proposed turbine locations at the Thunder Springs Wind Resource Area, Adams County, ND.

A.2.1.2 Raptor Nest Surveys

One active golden eagle nest was located just outside of the southern project boundary during 2013 surveys (Figure 2). An active bald eagle nest was also found during 2013 surveys, approximately 10 miles from the TSWRA boundary (Figure 2). These nests had not been detected during previous nest surveys conducted for the TSWRA. There is also a historic golden eagle nest approximately 5 miles west of the project boundary that was identified as inactive in 2013 (Figure 2).

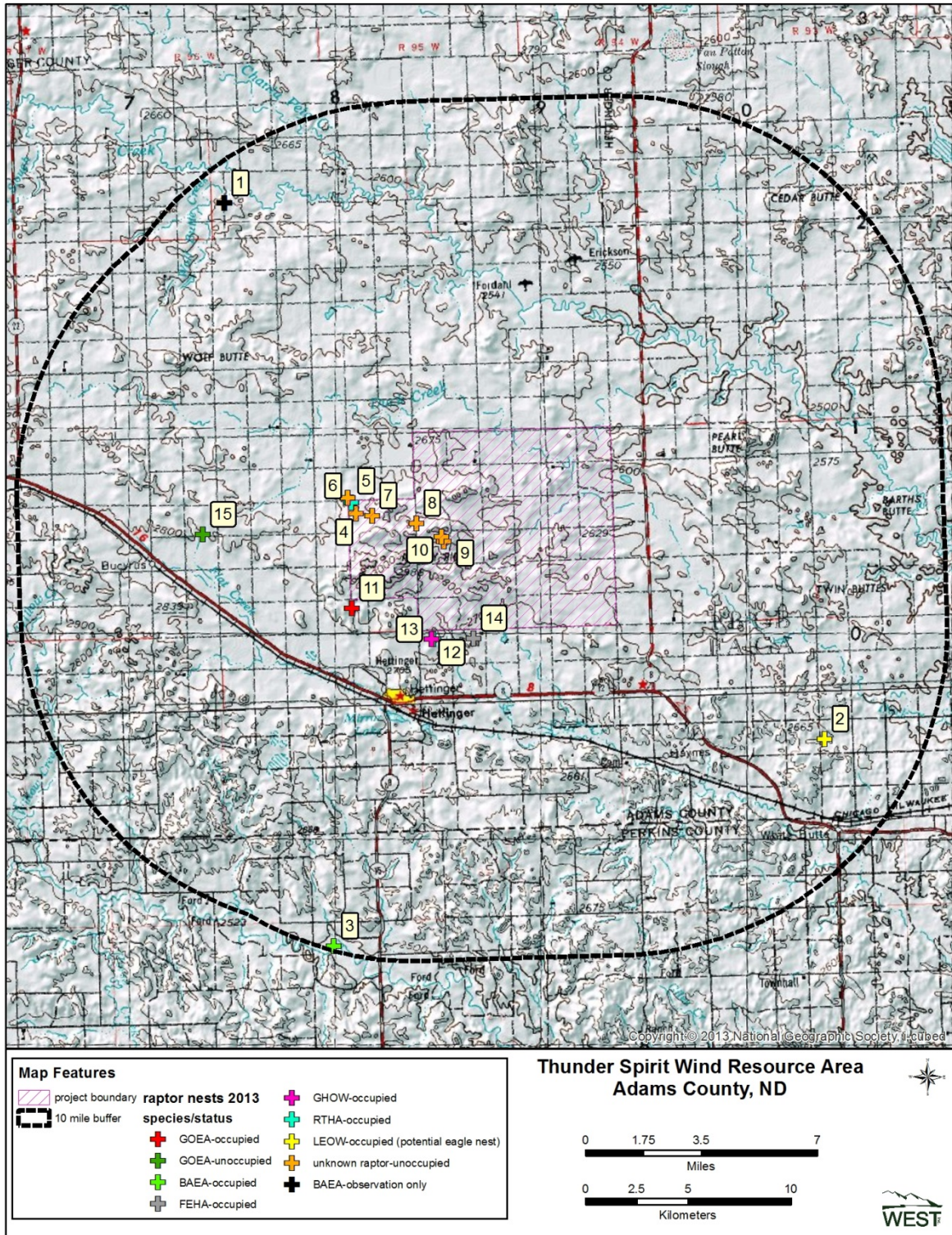


Figure 2. Location of raptor nests identified during the 2013 wildlife baseline studies at the Thunder Spirit Wind Resource Area, Adams County, ND and associated 10-mile buffer.

A.2.2 Discussion

A.2.2.1 Golden Eagles

Based on the two years of avian point count data, overall mean golden eagle use was estimated to be 0.02 golden eagles/plot/20-min survey. Golden eagles were observed flying within the RSH. Golden eagle use was generally located within the western/southwestern portion of the TSWRA. Due to relatively similar use values across seasons, the data suggest that golden eagles show limited use of the TSWRA throughout the year including during migration, breeding, and wintering periods. However, as use is relatively consistent throughout these periods of the annual cycle, the TSWRA does not appear to attract migrant or wintering golden eagles at significant levels.

A.2.2.2 Bald Eagles

Based on the two years of avian point count data, overall mean bald eagle use was estimated to be less than 0.01 bald eagles/plot/20-min survey. Bald eagles were not observed flying within the RSH. The only bald eagle was recorded perched in the vicinity of station 19 (southeastern portion of the project boundary) during the 2011/2012 studies of the TSWRA. Although there was an active bald eagle nest ~10 miles from the project boundary in 2013, the low use estimated from the baseline studies suggests the TSWRA does not appear to attract breeding, migrant, or wintering bald eagles at significant levels.

A.3.0 Assessing Eagle Risk and Predicting Fatalities

A.3.1 Assessing Eagle Risk

A.3.1.1 Nesting and Breeding

Based on the nest surveys conducted for the proposed TSWRA, there was one active golden eagle nest in 2013 located 2.11 miles (3.4 km) from the nearest proposed turbine location. One additional historic golden eagle nest, located ~5 miles from the proposed TSWRA boundary, was inactive in 2013. In addition, there was one active bald eagle nest in 2013 located approximately 10.81 miles (17.4 km) from the nearest proposed turbine location.

As only one occupied golden eagle nest and one occupied bald eagle nest have been identified within the vicinity of the TSWRA, calculation of the average nearest neighbor distance to approximate territory size in accordance with the 2013 ECPG is not possible as at least two occupied nests (per species) would be needed in a given year.

A.3.1.2 Concentration Areas (Communal roosts, foraging areas, migration corridors, and migration stopovers)

The golden eagle data collected to date suggests that golden eagles exhibit relatively low and consistent use of the TSWRA year round. The only bald eagle observed during avian point counts was recorded during the winter season. Although there is the potential for bald and golden eagles to migrate through the project as well as to winter and breed in the area, the data suggest the site does not receive a substantial influx of eagles during migration relative to other seasons. No communal roost locations have been identified within the Project.

A.3.1.3 Eagle Risk Factors

An assessment of the factors known or thought to be associated with increased probability of collisions between eagles and other raptors and wind turbines for the TSWRA is provided in the table located at the end of this section. The risk factors and the science behind the risk factors have been adopted from the ECPG (USFWS 2013). In addition to abundance, the two main risk factors identified in the ECPG are 1) the interaction of topographic features, season, and wind currents that create conditions for high-risk flight behavior near turbines; and 2) behavior that distracts eagles and presumably makes them less vigilant (e.g., active foraging or inter- and intra-specific interactions).

Topography and Wind

The prevailing wind direction is generally westerly (including southwesterly and northwesterly) at the TSWRA. It is generally believed that steeper slopes with aspects that face the prevailing wind direction may create more risky conditions for eagles as these areas are expected to create conditions suitable for strong updrafts of wind that are often targeted by raptors including eagles. The proposed turbine locations have been mapped against slope and aspect at the TSWRA (Figures 4 and 5).

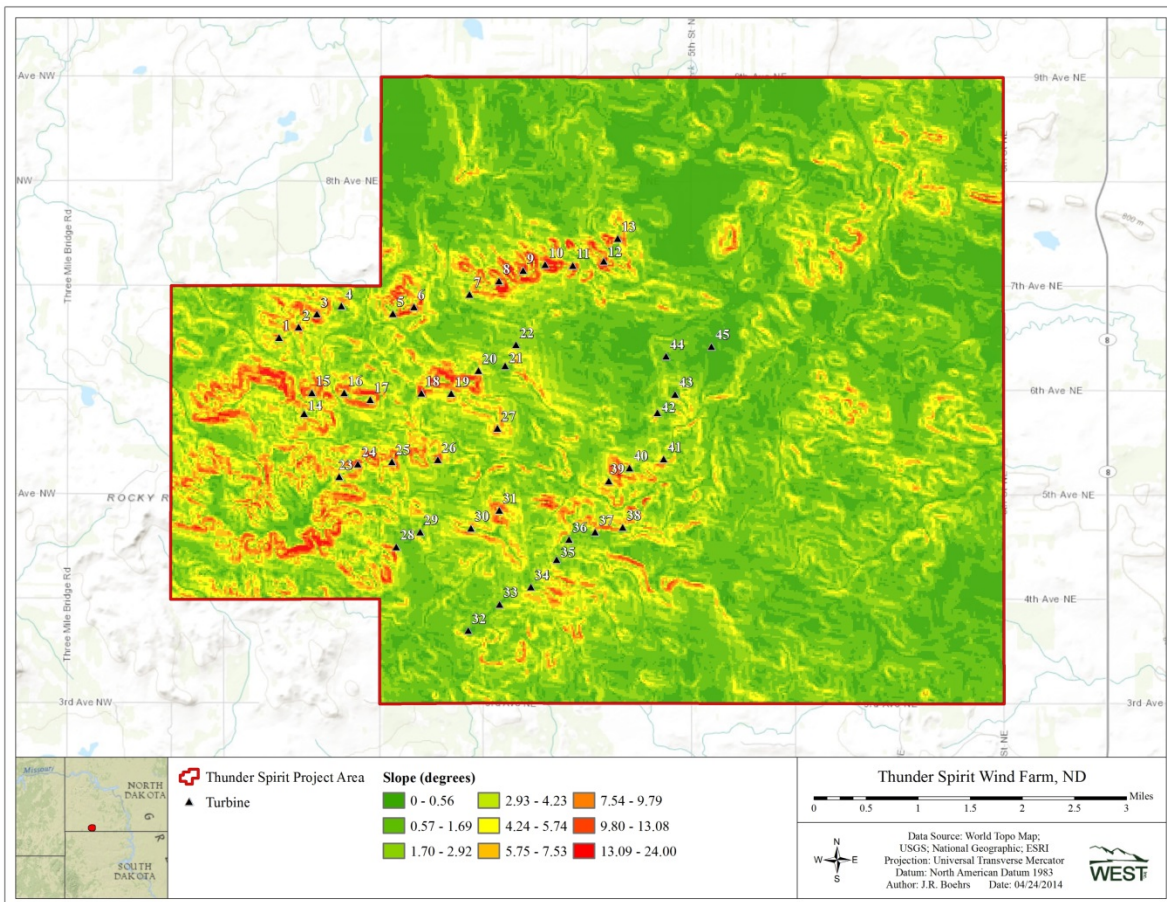


Figure 4. Slope calculations for the Thunder Spirit Wind Resource Area.

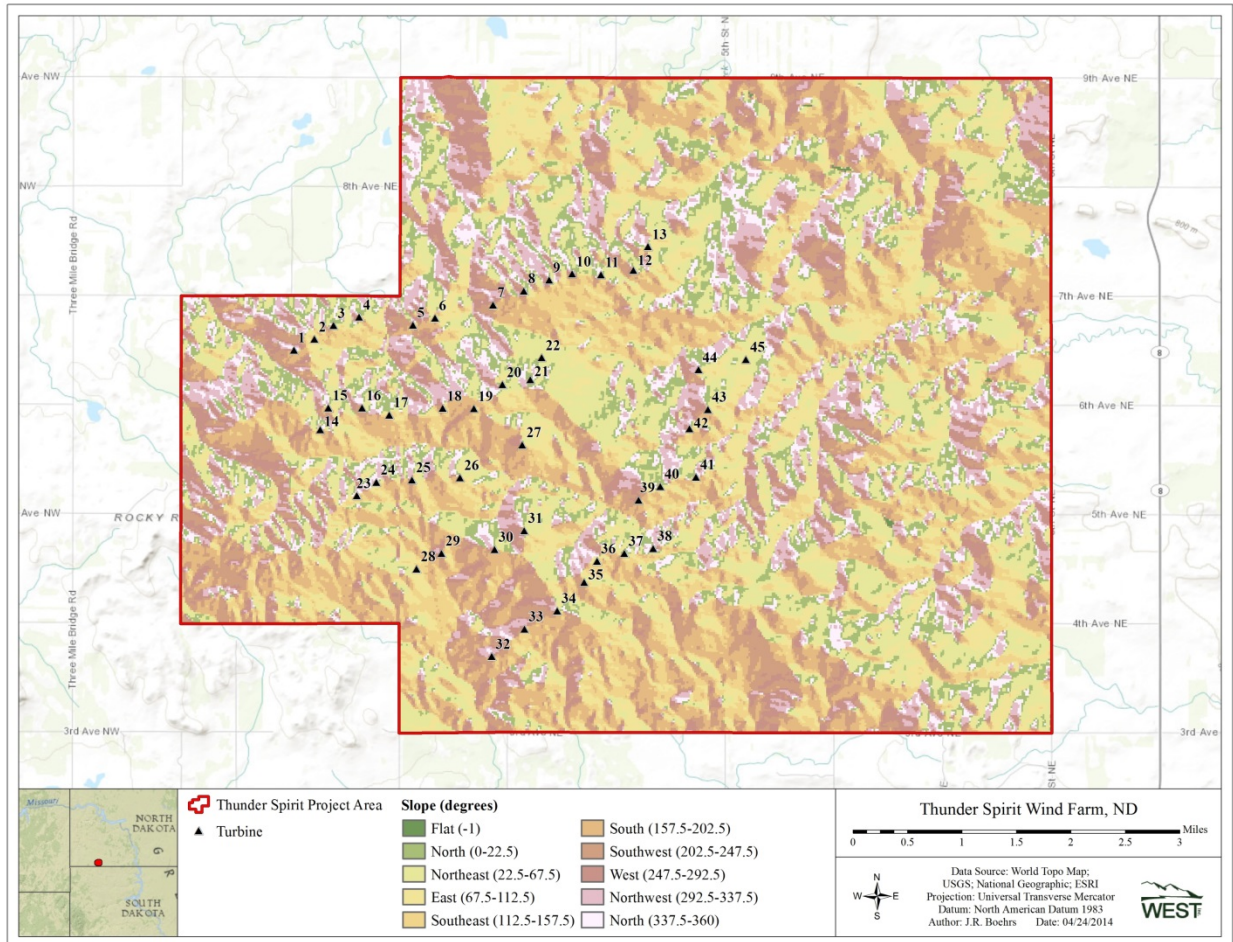


Figure 5. Aspect of the Thunder Spirit Wind Resource Area.

Of the 45 proposed turbine locations, only six have an aspect between 225 degrees and 315 degrees and of these six turbine locations only two have a slope greater than 5 degrees. Based on the assessment of individual turbine locations, it appears that topography and wind conditions at the TSWRA would not generally be expected to create high risk conditions to golden eagles in relation to facility and individual turbine siting.

Intra-specific Interactions

Assuming that intra-specific competition and territorial defense increases collision risk, these behaviors have a low potential to occur within the TSWRA as there is one documented occupied golden eagle nest located 2.11 miles (3.4 km) from the TSWRA. However, no other occupied golden eagle nests were identified within 10 miles during baseline studies. In addition, only one occupied bald eagle nest has been identified and it was located over 10 miles (16 km) from the nearest turbine location. The avian use surveys conducted within the TSWRA did not

document high levels of eagle use or, specifically, territorial interactions between the local breeders.

Table 2. Risk factors listed in the 2013 USFWS Eagle Conservation Plan Guidance and a discussion of these factors for the Thunder Spirit Wind Resource Area.

Risk Factor	Scientific Evidence/Support	Citations	TSWRA Situation	Qualitative Assessment
Bird Density	Mixed findings; likely some relationship but other factors have overriding influence across a range of species	Barrios and Rodriguez (2004), De Lucas et al. (2007), Hunt (2002), Smallwood et al. (2009), Ferrer et al. (2011)	Based on the data collected to date, bald and golden eagle use is relatively low.	Low
Bird Age	Mixed findings. Higher number of fatalities among subadult and adult golden eagles in one area. Higher fatalities among adult white-tailed eagles in another	Hunt (2002), Nygard et al (2010)	Six of the eight golden eagles were recorded as adults and the one bald eagle was identified as an adult as well.	Moderate
Proximity to Nests	White-tailed eagle nesting areas close to turbines have been observed to have low nest success and be abandoned over time.	Nygaard et al (2010)	One occupied golden eagle nest was located within 2.11 miles from the nearest turbine location and one occupied bald eagle nest was located 10.81 miles from the nearest turbine location. One additional historic inactive golden eagle nest is located approximately 5 miles from the TSWRA boundary.	Low to Moderate for Golden Eagles; Low for Bald Eagles
Bird Residency Status	Mixed findings. Higher risk to resident adults in Egyptian vultures (<i>Neophron percnopterus</i>). Higher number of mortalities among subadults and floating adults in golden eagles in one other study.	Barrios and Rodriguez (2004), Hunt (2002)	There was only one occupied eagle nests located within 10 miles of the TSWRA during baseline studies. Low numbers of golden eagles were observed in all seasons. The only bald eagle observed was recorded in winter.	Unknown
Season	Mixed findings. In some cases for some species, risk appears higher in seasons with greater propensity to use slope	Barrios and Rodriguez (2004), De Lucas et al. (2008), Hoover and	Golden eagle use was consistently low throughout the year and only one bald eagle was observed in winter.	Unknown

Table 2. Risk factors listed in the 2013 USFWS Eagle Conservation Plan Guidance and a discussion of these factors for the Thunder Spirit Wind Resource Area.

Risk Factor	Scientific Evidence/Support	Citations	TSWRA Situation	Qualitative Assessment
	soaring (fewer thermals) or kiting flight (windy weather) while hunting.	Morrison (2005), Smallwood et al. (2009)		
Flight Style	Species most at risk perform more frequent flights that can be described as kiting, hovering, and diving for prey.	Smallwood et al. (2009)	Six of the golden eagles were recorded as flapping, one soaring, and flight information was not recorded for the incidental. The one bald eagle was perched.	Low based on observations recorded during baseline studies.
Interaction with Other Birds	Higher risk when interactive behavior is occurring.	Smallwood et al. (2009)	Only one occupied golden eagle nest identified within 10 miles and one bald eagle nest located 10.81 miles from nearest turbine during baseline study. Low potential for territory overlap or defense behaviors within the TSWRA.	Needs further study to determine actual contribution to risk
Active Hunting/Prey Availability	High risk when hunting close to turbines, across a range of species	Barrios and Rodriguez (2004), De Lucas et al. (2008), Hoover and Morrison (2005), Hunt (2002), Smallwood et al. (2009)	Low numbers of eagles observed during baseline studies suggests that TSWRA does not provide high quality/ concentrated prey resources for eagles.	Low
Turbine Height	Mixed, contradictory findings across a range of species	Barclay et al. (2007), De Lucas et al. (2008)	Of the seven golden eagles with recorded flight height information, five were recorded within the RSH and two were recorded below. The one bald eagle was perched.	Moderate
Rotor Speed	Higher risk associated with higher blade-tip speed for golden eagles in one study, but this finding may not be generally applicable.	Chamberlain et al. (2006)	State of the art technology, low RPM's, more space between rotor sweeps; however, tip speeds generally the same	Low
Rotor-swept	Meta-analysis found no effect, but	Barclay et al. (2007)	Most flying eagle observations recorded	Unknown

Table 2. Risk factors listed in the 2013 USFWS Eagle Conservation Plan Guidance and a discussion of these factors for the Thunder Spirit Wind Resource Area.

Risk Factor	Scientific Evidence/Support	Citations	TSWRA Situation	Qualitative Assessment
Area	variation among studies clouds interpretation		during fixed-point avian use surveys within the RSA at any time. However, larger rotors generally have more space and time between sweeps	
Topography	Several studies show higher risk of collisions with turbines on ridge lines and on slopes. Also a higher risk in saddles that present low-energy ridge crossing points.	Barrios and Rodriguez (2004), De Lucas et al. (2008), Hoover and Morrison (2005), Smallwood and Thelander (2004)	Of the 45 proposed turbine locations, only six have an aspect that faces the prevailing wind direction and of these six turbine locations only two have a slope greater than 5 degrees.	Low
Wind Speed	Mixed findings, probably locality dependent.	Barrios and Rodriguez (2004), Hoover and Morrison (2005), Smallwood et al. (2009)	Of the 45 proposed turbine locations, only six have an aspect that faces the prevailing wind direction and of these six turbine locations only two have a slope greater than 5 degrees.	Low

A.3.2 Fatality Predictions

The models that have been developed for predicting eagle fatality levels from wind projects assume pre-construction eagle use relates to post-construction fatality, a hypothesis that is generally supported by results from publicly available studies (Figure 6). While the potential for fatalities cannot be ruled out at the project, based on the publicly available studies, sites with relatively low eagle use such as the TSWRA, have recorded relatively low or no golden eagle fatalities. Assuming a relationship exists between abundance and fatalities, relatively low levels of eagle fatalities would be expected at the project.

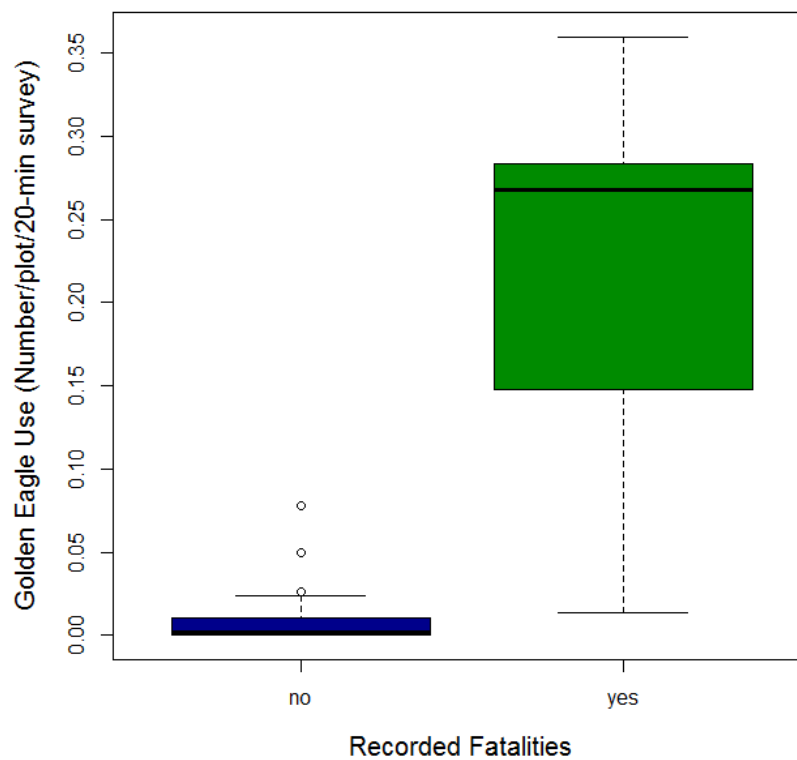


Figure 6. Average pre-construction golden eagle use values for operating facilities in the U.S. with and without observed golden eagle fatalities.

A.3.3 Categorizing Site according to Risk

Based on a “weight of evidence” approach using the USFWS ECPG, the site specific data collected to date and the risk assessments, the TSWRA appears to meet a Category 2 designation. Thunder Spirit LLC is proposing avoidance and minimization measures as outlined in the following section with the intent of reducing the potential risk to eagles at the TSWRA.

A.4.0 Avoidance and Minimization of Risk using Best Management Practices and Advanced Conservation Practices

The site-specific eagle data collected for the TSWRA suggests the site may receive a Category 2 designation according to the USFWS ECPG. However, Thunder Spirit LLC plans to implement a variety of Best Management Practices (BMPs) and Advanced Conservation Practices (ACPs) specifically to reduce the risk to eagles from the project (proposed BMPs for other species are presented in the main body of this BBCS). In addition, adaptive management informed through post-construction monitoring will include actions to avoid, minimize, and/or mitigate impacts to eagles including experimental conservation measures that will be implemented in the event that impacts are realized (see Section 6.0 below). The following BMPs have been implemented or are planned for the project during the pre-construction, construction, and operation phase of the project.

A.4.1 Pre-construction

BMPs and Conservation Measures implemented during the pre-construction phase of the Project include:

- The area and intensity of disturbances was minimized during pre-construction monitoring and testing activities.
- Existing roads and transmission corridors have been used to the extent possible while developing site plans.
- The Avian Power Line Interaction Committee (APLIC) guidance on power line siting (APLIC 1994) was followed while planning.
- Site plans minimized the extent of the road network needed for the TSWRA.
- No lattice or structures that are attractive to birds for perching are including in facility designs.
- No guy wires will be included on permanent MET towers.
- Siting access roads and turbines away from wetlands, water bodies, and native prairies to the greatest extent practicable;
- Minimizing impacts to native vegetation and wetlands during design of turbines and associated infrastructure;
- A minimum 2 mile buffer around the eagle nest was instituted while ongoing behavioral observations are being conducted to evaluate eagle use of the Project Area.
- Thunder Spirit imposed a 0.5 mile setback around the five (5) known grouse leks in the design of the layout. Setbacks to grouse leks have been included here as they should help to minimize potential impacts to foraging golden eagles.

A.4.2 During Construction

BMPs and Conservation Measures implemented during the construction phase of the Project include:

- The area and intensity of disturbance will be minimized to the extent possible during construction including minimizing impacts to native vegetation and wetlands during construction of turbines and associated infrastructure;
- Existing roads will be used for access during construction to the extent possible.
- Non-operational MET towers will be dismantled during construction.
- Thunder Spirit will bury all collection lines and has reduced the overhead radial transmission line to 0.85 miles to reduce the likelihood of avian collisions;
- APLIC guidance on power line construction (APLIC 2006) will be followed.
- A transportation plan will be implemented during construction that includes road design, locations and speed limits to minimize habitat fragmentation and wildlife collisions, and minimize noise effects. This measure should help to reduce carrion availability for eagles.
- Lighting plans for the facility are the minimum according to requirements.
- Developing a management plan to prevent the spread of noxious weeds throughout the Project Area or adjacent areas during construction and ongoing operations;
- Any temporarily disturbed areas will be revegetated by reseeding or planting disturbed areas with native material;
- Impacts to wetlands and water resources will be minimized by following all applicable provisions of the Clean Water Act and Rivers and Harbors Act (e.g. developing and implementing a storm water management plan and taking measures to reduce erosion).
- Restricting construction and/or operation activities due to active raptor nests; mapping and flagging raptor nests found during construction;
- To the extent possible, turbine construction will minimize cutting into hill slopes in an attempt to achieve smooth rounded terrain, rather than sudden berms or cuts to reduce prey abundance

A.4.3 During Operation

BMPs and Conservation Measures implemented during the operational phase of the Project include:

- Management activities such as seeding forbs or maintaining rock piles that attract potential prey will be avoided.
- Parts and equipment which may be used as cover by prey will not be stored in the vicinity of wind turbines.

- Low level speed limits (< 25 mph) will be maintained on all access roads within the TSWRA.
- Personnel will be trained to be alert for wildlife at all times, especially during low visibility conditions.
- Personnel, contractors, and visitors will be instructed to avoid disturbing wildlife, especially during the breeding seasons and seasonal periods of stress
- Implementing a Wildlife Incident Reporting System (WIRS) once turbine construction is completed. The WIRS will include protocols for field technicians to report and document avian mortalities during routine maintenance operations (see Section 5.1.6).
- Fire hazards will be reduced from vehicles and human activities (e.g., use spark arrestors on power equipment, avoid driving vehicles off roads, and allow smoking in designated areas only).
- Federal and state measures for handling toxic substances will be followed.
- Effects to wetlands and water resources will be minimized by following provisions of the Clean Water Act (1972).
- Thunder Spirit has committed to a minimum of one year of post-construction mortality avian and bat monitoring;
- Roads will be plowed during the winter so as not to impede ungulate movement. Snow banks can cause ungulates to run along roads, resulting in their colliding with vehicles. Roadside carcasses attract raptors, subjecting them to collision as well.

A.4.4 Population Status and Local Area Population Thresholds

The USFWS has previously identified annual take levels of 5% of annual production to be sustainable for a range of healthy raptor populations, and annual take levels of 1% of annual production as a relatively benign harvest rate over at least short intervals when population status was uncertain (Millsap and Allen 2006; USFWS 2013). This was the approach used to establish take thresholds at the eagle management unit scale (USFWS Regions for bald eagles and BCRs for golden eagles; USFWS 2009). The TSWRA lies within USFWS Region 6, which has an estimated bald eagle population size of 5,385 (USFWS 2013). The TSWRA also lies within BCR 17, which has an estimated golden eagle population size of 7,800 (USFWS 2013).

The USFWS has identified take rates of between 1% and 5% of the estimated local-area population (43 mile buffer surrounding the project for bald eagles, 140 mile buffer for golden eagles) as significant; with 5% being at the upper end of what might be appropriate under the BGEPA preservation standard, whether offset by compensatory mitigation or not (USFWS 2013). The USFWS ECPG recommends calculating the local-area 5% benchmark as follows:

$$(\text{Local-area} * \text{Regional Eagle Density}) * 0.05.$$

The area within a 43-mile buffer of the TSWRA lies entirely within Region 6 (6,970.16 mi²). The bald eagle density estimate for Region 6 is 0.007 bald eagles/mi² (USFWS 2013). Using the equation above, an estimated local area population size for the project is approximately 49 bald

eagles. Based on this analysis, the local-area 5% benchmark would be approximately 2-3 bald eagles annually.

The area within a 140-mile buffer of the TSWRA encompasses two BCRs (BCR 17 [9,266.89 mi²] and BCR 11 [55,957.00 mi²]). The golden eagle density estimates for BCRs 17 and 11 are 0.0549 and 0.0104 golden eagles/mi², respectively (USFWS 2013). Using the equation above, an estimated local area population size for the project is approximately 1,091 golden eagles. Based on this analysis, the local-area 5% benchmark would be approximately 55 golden eagles annually.

It is important to note that these analyses calculate the upper limit of what take rates might be appropriate under the BGEPA preservation standard for all sources of anthropogenic mortality and should not be considered to apply to the project alone. These benchmarks would apply to the project as well as other cumulative take within the local area population associated with the project.

A.5.0 Post-construction Monitoring

A post-construction monitoring program will be implemented at the TSWRA. The observations made during post-construction monitoring will be reported to the appropriate agencies, and Thunder Spirit LLC will respond with appropriate management decisions depending on the results of the monitoring program. Since post-construction monitoring methods are constantly improving as researchers develop new and more accurate methods of survey, protocols should consider recommendations to adopt new survey techniques as they become available.

A.5.1 Fatality Monitoring

TSWRA will be subject to one year of post-construction monitoring for bald and golden eagles. Post-construction monitoring shall begin after TSWRA is in operation. Monitoring will overlap with the efforts described in the Thunder Spirit BBCS, and will follow protocols directed at detecting all bird and bat carcasses.

Assuming that the necessary permits have been obtained, Thunder Spirit LLC or its consultants will remove all carcasses identified during post-construction monitoring. These surveys will be completed regularly to document the number and species of bird and bat fatalities attributable to the TSWRA. The methods for estimating mortality at the TSWRA will conform to industry standards in the U.S.

A.5.2 Wildlife Incident Report and Handling System

In addition to the post-construction fatality monitoring study described above, Thunder Spirit LLC will implement a Wildlife Incident Reporting System (WIRS) at the start of operations and it will remain active for the life of the TSWRA. The purpose of the WIRS is to standardize the actions taken by site personnel in response to wildlife incidents encountered in the TSWRA and

to fulfill the obligations for reporting wildlife incidents. The WIRS will be utilized by site operations and maintenance personnel who encounter dead or injured birds or bats incidentally while conducting general wind facility or transmission line maintenance activities. Any handling or collecting of avian and bat carcasses will only occur if the appropriate permits/authorizations have been obtained from the agencies. The WIRS is designed to provide a means of recording and collecting fatalities in the TSWRA to increase the understanding of wind turbine and wildlife interactions. Any incident involving a State or Federally listed threatened or endangered species or a bald or golden eagle must be reported to the USFWS and NDFGD within 24 hours of identification. Thunder Spirit LLC maintains an ongoing commitment to investigate wildlife incidents involving company facilities and to work cooperatively with federal and state agencies in an effort to prevent and mitigate future bird and wildlife fatalities. It is the responsibility of Thunder Spirit LLC employees and subcontractors to report all avian incidents to their immediate supervisor.

A.5.3 Reporting

An annual monitoring report will be prepared within three months of completing post-construction monitoring. The report, including all raw monitoring data upon which the report is based, shall be made available to the appropriate agencies. The report will include any eagle carcasses identified and any estimates of eagle mortality given the results of experimental bias studies. As part of the reporting process, all mortalities will be reported to the USFWS and all eagle fatalities will be reported to USFWS for their direction on collection and/or sending carcasses to the national eagle repository.

A.6.0 Adaptive Management

The adaptive management techniques described in this section have been developed to ensure that potentially significant levels of mortality from operation of the TSWRA are effectively mitigated. This section describes the adaptive management process that will be applied for eagles. Changes in federal or state status for golden eagles may result in the addition of, or changes to, adaptive management strategies, as determined through coordination with the agencies.

A.6.1 Adaptive Management Process

Thunder Spirit LLC will meet with USFWS to discuss mitigation needs if it is determined that a unique or significant event has occurred. If it is determined that mitigation is necessary, Thunder Spirit LLC will identify suitable mitigation options in coordination with USFWS. One or more mitigation measures may be applied if a unique or significant event occurs.

A.6.2 Additional ACPs

The following is a list of possible ACP's that may be considered for implementation depending on the results of the post-construction monitoring studies and discussions with the USFWs.

- Consider a variety of eagle monitoring technologies (radar, camera systems, telemetry of eagles, cellular fence).

- Placement of visual and/or auditory bird flight diverters in critical locations.
- Conduct prey base surveys within the TSWRA.
- Fund development of successful perch deterrents.
- Contribute funding for regional eagle population studies.

A.6.3 Agency Interaction

The development of an effective and successful EMP for the TSWRA will depend on coordination between the appropriate agencies and Thunder Spirit LLC. It is anticipated that the process will evolve and that modifications to the process may need to be made while ensuring that the goal of stable or increasing breeding populations of eagles is achieved. As suggested in the USFWS ECPG, Thunder Spirit plans to allow service personnel access to the site to monitor the effects and effectiveness of the avoidance, minimization, and mitigation measures that have been implemented.

A.7.0 Conclusion

This EMP was written to provide guidance for all eagle avoidance, minimization, mitigation and monitoring prior to, during, and after construction of the TSWRA. The measures described in this document are intended to help protect and reduce potential impacts to bald and golden eagles, as well as to monitor potential impacts to eagles following implementation of the TSWRA. It is anticipated that this document will adaptively manage potential eagle impacts from the TSWRA based on findings following construction.

Appendix B

- North Dakota Game and Fish Department Listed Species
- Adams County Species Listed Under the Endangered Species Act

North Dakota's Wildlife Action Plan focuses on 100 species that are considered Species of Conservation Priority. Information relating to the distribution, abundance, habitat requirements, threats, management goals and monitoring techniques for each of these species is included in the Wildlife Action Plan. They are categorized into three levels according to their conservation need:

- **Level I** - Species in greatest need of conservation.
- **Level II** - Species in need of conservation, but have had support from other wildlife programs.
- **Level III** - Species in moderate need of conservation, but are believed to be on the edge of their range in North Dakota.

Level I Species

- Horned Grebe (*Podiceps auritus*)
- American White Pelican (*Pelecanus erythrorhynchos*)
- American Bittern (*Botaurus lentiginosus*)
- Swainson's Hawk (*Buteo swainsoni*)
- Ferruginous Hawk (*Buteo regalis*)
- Yellow Rail (*Coturnicops noveboracensis*)
- Willet (*Catoptrophorus semipalmatus*)
- Upland Sandpiper (*Bartramia longicauda*)
- Long-billed Curlew (*Numenius americanus*)
- Marbled Godwit (*Limosa fedoa*)
- Wilson's Phalarope (*Phalaropus tricolor*)
- Franklin's Gull (*Larus pipixcan*)
- Black Tern (*Chlidonias niger*)
- Black-billed Cuckoo (*Coccyzus erythrophthalmus*)
- Sprague's Pipit (*Anthus spragueii*)
- Grasshopper Sparrow (*Ammodramus savannarum*)
- Baird's Sparrow (*Ammodramus bairdii*)
- Nelson's Sharp-tailed Sparrow (*Ammodramus nelsonii*)
- Lark Bunting (*Calamospiza melanocorys*)
- Chestnut-collared Longspur (*Calcarius ornatus*)
- Canadian Toad (*Bufo hemiophrys*)
- Plains Spadefoot (*Spea bombifrons*)
- Smooth Green Snake (*Liochlorophis vernalis*)
- Western Hognose Snake (*Heterodon nasicus*)
- Black-tailed Prairie Dog (*Cynomys ludovicianus*)
- Sturgeon Chub (*Macrhybopsis gelida*)
- Sicklefin Chub (*Macrhybopsis meeki*)
- Pearl Dace (*Margariscus margarita*)
- Blue Sucker (*Cycleptus elongatus*)

Level II Species

- Northern Pintail (*Anas acuta*)
- Canvasback (*Aythya valisineria*)
- Redhead (*Aythya americana*)
- Northern Harrier (*Circus cyaneus*)
- Golden Eagle (*Aquila chrysaetos*)
- Bald Eagle (*Haliaeetus leucocephalus*)

- Prairie Falcon (*Falco mexicanus*)
- Sharp-tailed Grouse (*Tympanuchus phasianellus*)
- Greater Prairie Chicken (*Tympanuchus cupido*)
- Greater Sage Grouse (*Centrocercus urophasianus*)
- Piping Plover (*Charadrius melodus*)
- American Avocet (*Recurvirostra americana*)
- Least Tern (*Sterna antillarum*)
- Short-eared Owl (*Asio flammeus*)
- Burrowing Owl (*Athene cunicularia*)
- Red-headed Woodpecker (*Melanerpes erythrocephalus*)
- Loggerhead Shrike (*Lanius ludovicianus*)
- Sedge Wren (*Cistothorus platensis*)
- Dickcissel (*Spiza americana*)
- Le Conte's Sparrow (*Ammodramus leconteii*)
- Bobolink (*Dolichonyx oryzivorus*)
- Common Snapping Turtle (*Chelydra serpentina*)
- Short-horned Lizard (*Phrynosoma douglassi*)
- Northern Redbelly Snake (*Storeria occipitomaculata*)
- Pygmy Shrew (*Sorex hoyi*)
- Richardson's Ground Squirrel (*Spermophilus richardsonii*)
- Swift Fox (*Vulpes velox*)
- River Otter (*Lutra canadensis*)
- Black-footed Ferret (*Mustela nigripes*)
- Paddlefish (*Polyodon spathula*)
- Pallid Sturgeon (*Scaphirhynchus albus*)
- Silver Chub (*Macrhybopsis storeriana*)
- Northern Redbelly Dace (*Phoxinus eos*)
- Flathead Chub (*Platygobio gracilis*)
- Trout-perch (*Percopsis omiscomaycus*)
- Threeridge (*Amblema plicata*)
- Wabash Pigtoe (*Fusconaia flava*)
- Mapleleaf (*Quadrula quadrula*)
- Black Sandshell (*Ligumia recta*)
- Creek Heelsplitter (*Lasmigona compressa*)
- Pink Heelsplitter (*Potamilus alatus*)

Level III Species

- Whooping Crane (*Grus americana*)
- Peregrine Falcon (*Falco peregrinus*)
- Brewer's Sparrow (*Spizella breweri*)
- McCown's Longspur (*Calcarius mccownii*)
- Smooth Softshell Turtle (*Apalone mutica*)
- False Map Turtle (*Graptemys pseudogeographica*)
- Northern Prairie Skink (*Eumeces septentrionalis*)
- Northern Sagebrush Lizard (*Sceloporus graciosus*)
- Arctic Shrew (*Sorex arcticus*)
- Western Small-footed Myotis (*Myotis ciliolabrum*)
- Long-eared Myotis (*Myotis evotis*)

Appendix B

- Long-legged Myotis (*Myotis volans*)
- Plains Pocket Mouse (*Perognathus flavescens*)
- Hispid Pocket Mouse (*Chaetodipus hispidus*)
- Sagebrush Vole (*Lemmiscus curtatus*)
- Eastern Spotted Skunk (*Spilogale putoris*)
- Gray Wolf (*Canis lupis*)
- Chestnut Lamprey (*Ichthyomyzon castaneus*)
- Silver Lamprey (*Ichthyomyzon unicuspis*)
- Central Stoneroller (*Campostoma anomalum*)
- Hornyhead Chub (*Nocomis biguttatus*)
- Pugnose Shiner (*Notropis anogenus*)
- Blacknose Shiner (*Notropis heterolepis*)
- Rosyface Shiner (*Notropis rubellus*)
- Finescale Dace (*Phoxinus neogaeus*)
- Yellow Bullhead (*Ameiurus natalis*)
- Flathead Catfish (*Pylodictis olivaris*)
- Logperch (*Percina caprodes*)
- River Darter (*Percina shumardi*)
- Pink Papershell (*Potamilus ohioensis*)

Federally Listed Species Under the Endangered Species Act.
For Adams County, North Dakota

Group	Name	Population	Status
Birds	Whooping crane (<i>Grus americana</i>)	except where EXPN	Endangered
Birds	Sprague's pipit (<i>Anthus spragueii</i>)		Candidate
Mammals	Black-footed ferret (<i>Mustela nigripes</i>)	entire population, except where EXPN	Endangered
Mammals	Northern Long-Eared Bat (<i>Myotis septentrionalis</i>)		Threatened

Appendix C

Pre-construction Study Reports:

- Avian Use Surveys,
- Bat Acoustic Surveys,
- Nest Survey,
- Lek Survey

DRAFT

**Baseline Wildlife Studies for the
Two Creeks Wind Resource Area
Adams County, North Dakota**

**Final Report
June 2007 – October 2007**

Prepared for:

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June 30, 2008

EXECUTIVE SUMMARY

Two Creeks Wind LLC has proposed a wind-energy facility in Adams County, North Dakota, near the town of Hettinger. Two Creeks Wind LLC contracted with Western EcoSystems Technology, Inc. to conduct surveys and monitor wildlife resources in the Two Creeks Wind Resource Area to estimate the impacts of wind-energy facility construction and operations on wildlife.

The principal objectives of this wildlife monitoring study were to: 1) estimate the seasonal, spatial, and temporal use of the study area by birds, particularly raptors; 2) estimate the seasonal and spatial use of the study area by bats; 3) identify any federal and state threatened, endangered, proposed, candidate, or sensitive-status wildlife and their potential habitats that may be affected by the proposed wind-energy facility; 4) describe incidental wildlife observations; 5) estimate any potential impacts to birds and bats that could result from construction and operation of the proposed wind-energy facility; and 6) identify potential project modifications and/or mitigation measures that could reduce negative impacts.

The objective of the fixed-point bird use surveys was to estimate the seasonal, spatial, and temporal use of the Two Creeks Wind Resource Area by birds, particularly raptors, defined here as kites, accipiters, buteos, harriers, eagles, falcons, owls and vultures. Surveys were conducted at 20 points located within the study area approximately once every two weeks during the summer season (June 5 to August 10, 2007), resulting in 95 twenty-minute fixed-point surveys during the summer season. Surveys were also conducted weekly during the fall season (August 24 to October 29, 2007), resulting in 120 twenty-minute fixed-point surveys during the fall season. Fifty-one bird species were observed in the 215 twenty-minute fixed-point surveys that were conducted, with a mean number of species observed per survey of 2.31. A total of 1,517 individual bird observations within 544 separate groups were recorded during the fixed-point surveys, and cumulatively, four species (7.8% of all species) comprised approximately 61.5% of the observations: European starling, horned lark, ring-necked pheasant, and western meadowlark (*Sturnella neglecta*; 13.6%). All other species comprised less than seven percent of the observations individually. A total of 65 individual raptors were observed within the study area, comprising eight species.

To standardize the data for comparison between points, seasons, and with other wind-energy facilities, bird use, frequency of occurrence, and species composition were calculated from observations within an approximate half mile (800 meters) of the point. Bird use by species was calculated as the mean number of birds per 20-minute survey. Upland gamebirds were the most abundant large bird type observed in the summer (0.61 birds/20-minute survey), followed by raptors (0.35) and waterfowl (0.19). Upland gamebirds were also the most abundant large bird type observed in the fall (1.32 birds/20-minute survey), followed by raptors (0.26). Overall, passerines were the most abundant bird type observed in the summer (4.69 birds/plot/20-minute survey) and in the fall (5.35).

During the study, 290 groups totaling 1,082 individuals were observed flying during fixed-point bird use surveys. For all species combined, 93.0% of all flying birds observed were below the likely zone of risk, 6.7% were within the zone of risk, and 0.3% were observed flying above the

zone of risk for typical turbines that could be used in the Two Creeks Wind Resource Area. Bird types most often observed flying within the zone of risk for potential collision with turbine blades were waterfowl (87.5%) and raptors (41.3%). For species with at least 15 separate observations of flying birds, those most often observed within the zone of risk were northern harrier (26.9%), eastern kingbird (15.8%), and horned lark (4.7%). Based on the use (measure of abundance) of the site by each species and the flight characteristics observed for that species, lapland longspur had the highest probability of turbine exposure. The raptor species with relatively high exposure indices were northern harrier, red-tailed hawk, and Swainson's hawk, which were ranked fifth, sixth, and seventh of all species.

For all bird species combined, use was highest at point one (29.00 birds/20-minute survey), followed by points 13 and 14 (13.64 and 13.70, respectively). Use was relatively uniform among the other points. No obvious flyways or concentration areas were observed. No strong association with topographic features within the study area was noted for raptors or other large birds. Although some differences in bird use were detected among survey points, the differences are not large enough to suggest that any portions of the Two Creeks Wind Resource Area should be avoided when siting turbines.

The objective of the acoustic bat surveys was to estimate the seasonal and spatial use of the study area by bats. Two AnaBat® II echolocation detectors were used to monitor bat use at the study from July 23 through October 15, 2007, resulting in a total of 112 detector nights. A total of 126 bat calls were recorded during the 112 bat detector nights. Calls were approximately evenly split between calls less than 35 kHz in frequency (e.g., big brown bat, hoary bat) and calls more than 35 kHz (e.g., *Myotis* bat species). The mean number of bat calls recorded per night per detector was similar between the two locations.

No species protected under the federal Endangered Species Act were recorded during the surveys at the Two Creeks Wind Resource Area. One-hundred-three individuals in 80 groups comprising 14 bird species observed during the fixed-point bird use surveys or as incidental wildlife observations were sensitive species listed by the North Dakota Game and Fish Department or the US Fish and Wildlife Service.

Incidental species bird observed at the Two Creeks Wind Resource Area consisted mostly of sandhill cranes, sharp-tailed grouse, ring-necked pheasant, northern harrier, and Swainson's hawk. Eighteen bird species total were observed, with a total of 100 individuals in 39 groups. Large mammals observed at the Two Creeks Wind Resource Area included pronghorn antelope, white-tailed deer, and mule deer. Other mammals included eastern cottontail rabbit and coyote.

Based on fixed-point bird use data collected for the Two Creeks Wind Resource Area, mean raptor use during the summer was 0.35 birds/plot/20-minute survey and mean use was 0.26 during the fall. These values from the Two Creeks Wind Resource were compared separately to raptor use at other wind-energy facilities that implemented similar protocols to the present study. Similar studies were conducted at 34 other wind-energy facilities in the summer and 32 in the fall. Mean raptor use at Two Creeks Wind Resource would be considered low in summer and fall in comparison to these wind-energy facilities. The Two Creeks Wind Resource area ranked eleventh lowest for mean raptor use in the summer and ranked sixth lowest in the fall. A

regression analysis of raptor use and raptor collision mortality for 11 new-generation wind-energy facilities where similar methods were used to obtain raptor use estimates showed a significant ($R^2 = 81.4\%$) correlation between raptor use and raptor collision mortality. Using this regression to predict raptor collision mortality at Two Creeks Wind Resource Area yields an estimated fatality rate of 0.02/MW/year, or two raptors per year for a 100-MW wind-energy facility.

The mean number of bat passes per detector per night was compared to existing data at other wind-energy facilities where both bat activity and mortality levels were measured. The level of bat activity documented at the Two Creeks Wind Resource Area was much lower than the eastern wind-energy facilities, all of which had fairly high levels of bat mortality, and was slightly lower than the recorded activity levels at the western and Midwestern locations, both of which had relatively low levels of bat mortality. The data collected in the study area do not indicate that substantial numbers of bats migrate through the Two Creeks Wind Resource Area. Some bat mortality will likely occur in the study area; however, the available data indicate it would be lower than that experienced in the east and potentially to levels found at the western and Midwestern locations.

The data collected during this study suggests that the Two Creeks Wind Resource Area is not within a major migratory pathway. Construction and operation of the wind-energy facility may displace some types of grassland nesting birds. However because much of the Two Creeks Wind Resource Area will be sited in previously altered habitats (i.e., tilled agriculture), it is unlikely that displacement of birds would result in any population impacts.

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INTRODUCTION

Two Creeks Wind LLC has proposed a wind-energy facility in Adams County, North Dakota, near the town of Hettinger. Two Creeks Wind LLC contracted with Western EcoSystems Technology, Inc. (WEST) to conduct surveys and monitor wildlife resources in the Two Creeks Wind Resource Area (TCWRA) to estimate the impacts of wind-energy facility construction and operations on wildlife.

The principal objectives of this wildlife monitoring study were to: 1) estimate the seasonal, spatial, and temporal use of the study area by birds, particularly raptors; 2) estimate the seasonal and spatial use of the study area by bats; 3) identify any federal and state threatened, endangered, proposed, candidate, or sensitive-status wildlife and their potential habitats that may be affected by the proposed wind-energy facility; 4) describe incidental wildlife observations; 5) estimate any potential impacts to birds and bats that could result from construction and operation of the proposed wind-energy facility; and 6) identify potential project modifications and/or mitigation measures that could reduce negative impacts.

This report provides results of the baseline surveys at TCWRA conducted from June 5, 2007, through October 29, 2007. Baseline surveys conducted at TCWRA in 2007 included fixed-point bird use surveys, bat acoustic surveys, and incidental wildlife observations. In addition to site-specific data, this report presents existing information and results of studies conducted at other wind-energy facilities. The ability to estimate potential bird and bat mortality at the proposed TCWRA is greatly enhanced by operational monitoring data collected at existing wind-energy facilities. For several wind-energy facilities, standardized data on fixed-point surveys and acoustic bat surveys were collected in association with standardized post-construction (operational) monitoring, allowing comparisons of bird/bat use with bird/bat mortality.

STUDY AREA

The proposed TCWRA is located three miles (4.8 kilometers; km) northeast of Hettinger, North Dakota (Figure 1). The elevation of the project area ranges from approximately 2,559 to 2,963 feet (ft; 780-903 meters [m]) above sea level (Figure 2).

Land in the project area is privately owned. Cropland, planted grasslands, and prairie are predominant in the area (Strong et al. 2005); the latter two habitat types are used for cattle grazing and haying. Small grain agriculture, such as wheat, are common crops in the TCWRA and surrounding area. There are a few scattered wetlands with scattered patches of deciduous trees and shrubs around some of the wetlands. Planted tree rows and shelter belts lie in cultivated fields and near residences. Duck Creek crosses the northeast portion of the TCWRA and its tributaries drain most of the area (Figure 2).

METHODS

The study at TCWRA consisted of the following research components: 1) fixed-point bird use surveys; 2) acoustic bat surveys; and 3) incidental wildlife observations.

Fixed-point Bird Use Surveys

The objective of the fixed-point bird use surveys was to estimate the seasonal, spatial, and temporal use of the study area by birds, particularly raptors, defined here as kites, accipiters, buteos, harriers, eagles, falcons, owls, and vultures. Fixed-point surveys (variable circular plots) were conducted using methods described by Reynolds et al. (1980). The points were selected to survey representative habitats and topography of the study area as defined in spring 2007, while also providing relatively even coverage with minimal overlap of points. All birds seen during fixed-point surveys were recorded. Raptors and other large birds, species of concern, and species not previously seen in the study area that were observed between fixed-point surveys were recorded; coordinates derived from GPS also were noted for species of concern.

Bird Use Survey Plots

Twenty points were selected to achieve optimal coverage of the study area and habitats within the study area (Figure 3). Each survey plot was an approximate half-mile (800-m) radius circle centered on a point and each point was surveyed for 20 minutes (min). All species of birds observed during fixed-point surveys were recorded, and all large birds observed perched within or flying over the plot were recorded and mapped. Small birds (e.g., sparrows) within 328 ft (100 m) of the point were recorded, but not mapped. Observations of birds beyond the plot were recorded, but were not included in the statistical analyses. A unique observation number was assigned to each observation.

The date, start, and end time of the survey period, and weather information such as temperature, wind speed, wind direction, and cloud cover were recorded for each survey. Species or best possible identification, number of individuals, sex and age class (if possible), distance from plot center when first observed, closest distance, altitude above ground, activity (behavior), and habitat(s) were recorded for each observation. The behavior of each bird observed, and the vegetation type in which or over which the bird occurred, were recorded based on the point of first observation. Approximate flight height and flight direction at first observation were recorded to the nearest 15 ft (five-m) interval. Other information recorded about the observation included whether or not the observation was auditory only.

Locations of raptors, other large birds, and species of concern seen during fixed-point bird use surveys were recorded on field maps by observation number. Any comments or unusual observations were recorded in the comments section of the data sheet.

Observation Schedule

Sampling intensity was designed to document bird use and behavior by habitat and season within the study area. Surveys were conducted approximately every other week during the summer season (June 5, 2007 through August 10, 2007) and weekly during the fall season (August 24, 2007 through October 29, 2007). Surveys were conducted during daylight hours and survey

periods varied to approximately cover all daylight hours during a season. To the extent practical, each point was surveyed about the same number of times; however, the schedule varied in response to adverse weather conditions (e.g., rain), which may have caused delays and/or missed surveys.

Acoustic Bat Surveys

The objective of the acoustic bat surveys was to estimate the seasonal and spatial use of the TCWRA by bats. Bats were surveyed at the TCWRA using AnaBat[®] II (AnaBat) ultrasonic detectors coupled with Zero Crossing Analysis Interface Modules (ZCAIM; Titley Electronics Pty Ltd., New South Wales, Australia). Bat detectors are widely used to index and compare bat habitat use. The use of bat detectors for calculating an index for bat impacts has been used at several wind-energy facilities, and is a primary and economically feasible bat risk assessment tool (Kunz et al. 2007a). Detectors were placed at two fixed locations (Figure 4) from July 23, 2007 to October 15, 2007.

AnaBat detectors record bat echolocation calls with a broadband microphone. Incoming echolocation calls were digitally processed by the detector and passed to the ZCAIM for further processing and data storage. Each series of echolocation calls was saved to a file on a high-capacity CompactFlash™ card and these files were then transferred to a computer for analysis. Computer software was used to view digital “sonograms” of the echolocation calls showing change in frequency over time. During analysis, these frequency versus time displays were used to separate bat calls from other types of ultrasonic noise (e.g. wind, rain, insects, etc.) and to assign calls to a high- or low-frequency group (see statistical section). To help minimize interference from extraneous ultrasonic noise, a sensitivity level of six was used. Each detector was placed inside a water-tight plastic container through which a hole was cut in the side for the microphone. The microphone was encased in PVC tubing with drain holes that curved vertically outside the container to minimize potential rainwater damage. AnaBat units were raised approximately one foot above the ground to minimize echo interference and lift the unit above vegetation. Both units were programmed to turn on each night an approximate half-hour before sunset and turn off an approximate half-hour after sunrise.

Sensitive Species

The objective of the sensitive species surveys is to determine the presence or absence and spatial distribution of state- or federal-listed bird species, bird species of conservation concern or other species of interest observed within the study area during other surveys at the TCWRA. Based on information from the North Dakota Game and Fish Department (NDGFD) and the US Fish and Wildlife Service (USFWS), several state-listed bird species could occur in the project area based on habitat.

The fixed-point bird use surveys and incidental observations (see below) will provide some information on the presence/absence of these species; however, areas not covered with the standardized survey plots may include species not observed during other surveys.

Incidental Wildlife Observations

The objective of the incidental wildlife observations was to provide use and occurrence information about wildlife outside the standardized survey areas that might be affected by the proposed wind-energy facility. Incidental wildlife observations were made while observers were within the study area conducting the various surveys. All sightings of raptors, raptor nests, unusual or unique birds, sensitive species, mammals, reptiles, and amphibians were recorded. These observations were recorded in a similar fashion to those recorded during the standardized surveys. The observation number, date, time, species, number of individuals, sex/age class, distance from observer, activity, height above ground (for bird species), habitat, and, in addition, the location of sensitive species was recorded.

Statistical Analysis

Quality Assurance and Quality Control

Quality assurance and quality control (QA/QC) measures were implemented at all stages of the study, including in the field, during data entry and analysis, and report writing. Following field surveys, observers were responsible for inspecting their data forms for completeness, accuracy, and legibility. A sample of records from an electronic database was compared to the raw data forms and any errors detected were corrected. Irregular codes or data suspected as questionable were discussed with the observer and/or project manager. Errors, omissions, or problems identified in later stages of analysis were traced back to the raw data forms, and appropriate changes in all steps were made.

Data Compilation and Storage

A Microsoft® ACCESS database was developed to store, organize, and retrieve survey data. Data were keyed into the electronic database using a pre-defined format to facilitate subsequent QA/QC and data analysis. All data forms, field notebooks, and electronic data files were retained for reference.

Fixed-point Bird Use Surveys

Bird Diversity and Species Richness

A list of all bird species observed during all surveys types was generated for the TCWRA. The total number of unique species and the mean number of species observed per survey (i.e., number of species/plot/20-min survey) were calculated to illustrate and compare differences between seasons for fixed-point bird use surveys.

Bird Use, Composition, and Frequency of Occurrence

Species lists, with the number of observations and the number of groups, were generated by season, including all observations of birds detected regardless of their distance from the observer. For the standardized fixed-point bird use estimates, only observations of birds detected within the plot were used. Estimates of bird use (i.e., number of birds/plot/20-min survey) were used to compare differences between bird types, seasons, and other wind-energy facilities.

The frequency of occurrence by species was calculated as the percent of surveys in which a particular species was observed. Frequency of occurrence provided relative estimates of the bird

diversity of the study area. For example, a particular species might have high use estimates for the study area based on just a few observations of large flocks; however, the frequency of occurrence would indicate that it only occurred during a few of the surveys, therefore making it less likely to be affected by the wind-energy facility.

Bird Flight Height and Behavior

To calculate potential risk to bird species, the first flight height recorded was used to estimate the percentages of birds flying within the likely “zone of risk” (ZOR) for potential collision with typical turbines. Because the type of turbines that will be used at the TCWRA is currently unknown, the likely ZOR was defined as a flight height of between 82 to 410 feet (25 to 125 m) above ground level (AGL), which is the blade height of typical turbines that could be used at the TCWRA.

Bird Exposure Index

A relative index to collision exposure (R) was calculated for bird species observed during the fixed-point bird use surveys using the following formula:

$$R = A * P_f * P_t$$

Where A equals mean relative use for species *i* (observations within a half mile (800 m) of observer) averaged across all surveys, P_f equals proportion of all observations of species *i* where activity was recorded as flying (an index to the approximate percentage of time species *i* spends flying during the daylight period), and P_t equals proportion of all initial flight height observations of species *i* within the likely ZOR for collision with turbine blades. This index does not account for differences in behavior other than flight heights and percent of birds observed flying.

Spatial Use

The objective of mapping observed bird locations was to look for areas of concentrated use by raptors and other large birds within the study area. Data were analyzed by comparing use among points. This information could be used to aid in turbine layout design or adjustments of individual turbines by micro-siting.

Acoustic Bat Surveys

The units of activity were number of bat passes (Hayes 1997). A pass was defined as a continuous series of two or more call notes produced by an individual bat with no pauses between call notes of less than one second (White and Gehrt 2001; Gannon et al. 2003). In this report, the terms bat pass and bat call are used interchangeably. The number of bat passes was determined by downloading the data files to a computer and tallying the number of echolocation passes recorded. Total number of passes was corrected by dividing by the number of detector nights. Bat calls were classified as either high-frequency calls (≥ 35 kHz) that are generally given by small bats (e.g. *Myotis* spp.) or low-frequency (< 35 kHz) that are generally given by larger bats (e.g. silver-haired bat [*Lasiurus noctivagans*], big brown bat [*Eptesicus fuscus*], Townsend’s big-eared bat [*Corynorhinus townsendii*], hoary bat [*Lasiurus cinereus*]). Data determined to be noise (produced by a source other than a bat) or call notes that did not meet the pre-specified criteria to be termed a pass were removed from the analysis. To establish which

species may have produced the high- and low-frequency calls recorded, a list of species expected to occur in the study area was compiled from range maps (Harvey et al. 1999; BCI website).

The total number of bat passes per detector night was used as an index for bat use in the TCWRA. Bat pass data represented levels of bat activity rather than the numbers of individuals present because individuals could not be differentiated by their calls. To predict potential for bat mortality (i.e. low, moderate, high), the mean number of bat passes per detector night was compared to existing data from wind-energy facilities where both bat activity and mortality levels have been measured.

RESULTS

Surveys at the TCWRA occurred from June 5 through October 29, 2007. Excluding bats, 62 animal species were identified: 57 birds and five mammals. Results of these surveys and the specific numbers of unique species observed per survey type are discussed in the sections below.

Fixed-point Bird Use Surveys

Fixed-point bird use surveys were conducted approximately every other week during the summer season (June 5 to August 10, 2007), resulting in 95 twenty-minute fixed-point surveys, and weekly during the fall season (August 24 to October 29, 2007), resulting in 120 twenty-minute fixed-point surveys at the TCWRA during the fall. A total of 215 twenty-minute fixed-point surveys were conducted (Table 1).

Bird Diversity and Species Richness

Fifty-one unique species were observed over the course of all fixed-point bird use surveys, with a mean number of species observed per survey of 2.31 (Table 1). A total of 1,517 individual bird observations within 544 separate groups were recorded during the fixed-point surveys (Table 2). Cumulatively, four species (7.8% of all species) comprised approximately 61.5% of the observations: European starling (*Sturnus vulgaris*; 19.1%), horned lark (*Eremophila alpestris*; 15.0%), ring-necked pheasant (*Phasianus colchicus*; 13.9), and western meadowlark (13.6%). All other species comprised less than seven percent of the observations individually. A total of 65 individual raptors were observed within the study area, comprising eight species (Table 2).

Bird Use, Composition, and Frequency of Occurrence by Season

Mean bird use, percent composition, and frequency of occurrence for all species and bird types are shown in Table 3. The highest overall bird use occurred in the fall (7.33 birds/plot/20-min survey), compared to summer (6.71). The higher use in the fall was in part due to larger numbers upland gamebirds and passerines than were observed during the summer surveys.

Waterfowl

Waterfowl were the fifth most abundant bird type in the summer (0.19 birds/plot/20-min survey) and were not observed during the fall surveys. Waterfowl made up 2.8% of the overall bird use in the summer and 0% in the fall. Waterfowl were observed during 4.3% of summer surveys and composed 2.8% of the total birds observed in the summer. Most observations of waterfowl were

of mallard (*Anas platyrhynchos*), which comprised 94.7 % of the total use for this bird type in the summer (Table 3).

Shorebirds

Shorebirds were the sixth most abundant bird type in the summer (0.08 birds/plot/20-min survey), but were not observed in the fall. Shorebirds made up 1.2% of the overall bird use and were observed during 8.3% of surveys during the summer (Table 3).

Raptors

Raptors were the fourth most abundant bird type in the summer (0.35 birds/plot/20-min survey) and in the fall also (0.26). Raptors comprised 5.2% of the overall bird use in the summer and 3.5% in the fall. Raptors were observed for a similar proportion of the surveys during the summer (25.7%) compared to the fall (20.0%). Most observations of raptors during the summer were of northern harrier (*Circus cyaneus*), which comprised 60.0% of the total use for this bird type in the summer. During the fall, most observations of raptors were comprised of red-tailed hawk (*Buteo jamaicensis*) and northern harrier, which each comprised 30.8% of the total raptor use in the fall (Table 3).

Upland gamebirds

Upland gamebirds were the third most abundant bird type in the summer (0.61 birds/plot/20-min survey) and had the second highest abundance in the fall (1.32). Upland gamebirds made up 9.1% of the overall bird use in the summer and 18.0% in the fall. Upland gamebirds were also observed for a similar proportion of the surveys during summer (32.3%) compared to the fall (25.8%). Most observations of upland gamebirds were of ring-necked pheasant, which composed 95.1% of the total use for this bird type in the summer and 99.2% in the fall (Table 3).

Doves/pigeons

Doves/pigeons were the second most abundant bird type in the summer (0.75 birds/plot/20-min survey) and had the third highest abundance in the fall (0.38). Doves/pigeons comprised 11.2% of the overall bird use in the summer and 5.2% in the fall. Doves/pigeons were observed during 30.3% of fixed-point bird use surveys in the summer compared to in the fall (8.3%). Most observations of doves/pigeons were of mourning dove (*Zenaida macroura*), which comprised more than 60% of the total use for this bird type in both seasons (Table 3).

Passerines

Passerines were the most abundant type in the summer (4.69 birds/plot/20-min survey) as well as in the fall (5.35). Passerines made up 69.9% of the overall bird use in the summer and 73.0% in the fall. Passerines were observed more often in the summer (82%) compared to in the fall (51.7%). Most observations during the summer were of western meadowlark, which comprised over 20% of the total use for this bird type, while European starling comprised nearly 45% of the total use for this bird type during the fall (Table 3).

Other Birds

Other birds were the least abundant bird type in the summer and fall (0.04 and 0.02 birds/plot/20-min survey, respectively). Other birds comprised less than one percent the overall bird use and were observed in less than five percent of the surveys in both seasons (Table 3).

Bird Flight Height and Behavior

Flight height characteristics were estimated for both individual bird species and bird types (Tables 4 and 5). Percentages of observations below, within, and above the likely ZOR of 82 to 410 feet (25 to 125 m) AGL were reported. During the study, 290 groups totaling 1,082 individuals were observed flying during fixed-point bird use surveys. Five species had at least 15 groups observed flying, but none of these species were observed flying within the likely ZOR for at least 50% of the observations (Table 4). For these species with at least 15 separate observations of flying birds, those most often observed within the zone of risk were northern harrier (26.9%), eastern kingbird (*Tyrannus tyrannus*; 15.8%), and horned lark (4.7%). Eight species were always observed flying within the ZOR, but only based upon a small number of groups (one to two observations).

Overall, 6.7% of the bird types observed flying were recorded within the ZOR, 93.0% were below the ZOR, and 0.3% were flying above the ZOR (Table 5). More than half (52.2%) of flying raptor observations were of individuals below the ZOR, 41.3% were within the ZOR, and there were 6.5% of the observations of flying raptors above the ZOR. Raptor subtypes that were observed within the ZOR more often than the overall raptor type were eagles (100.0%), other raptors (100%), and buteos (78.6%). All falcons (100.0%) and most northern harriers (84.6%) were observed flying below the ZOR, while all vultures (100.0%) were observed above the ZOR. Waterfowl (87.5%) and other birds (100.0%) had a higher percentage of birds within the ZOR than raptors, but only based upon a small number of groups (one to four observations). All shorebirds and upland gamebirds, as well as most passerines (95.3%) and doves/pigeons (93.7%) were observed flying below the ZOR (Table 5).

Bird Exposure Index

A relative exposure index (bird use multiplied by proportion of flying observations within the ZOR) was calculated for each species (Table 4). This index is only based on initial flight height observations and relative abundance, and does not account for other possible collision risk factors such as foraging or courtship behavior. No species had exposure indices higher than 1.00. Lapland longspur (*Calcarius lapponicus*) had the highest exposure index of 0.07, followed by horned lark (0.05), and cliff swallow (*Petrochelidon pyrrhonota*; 0.04). Raptors with the highest exposure index (0.02) were northern harrier, red-tailed hawk, and Swainson's hawk (*Buteo swainsoni*).

Spatial Use

Mean use (birds/20-min survey) was plotted by point for all birds combined and all of the major bird types (Figures 5a-h). For all bird species combined, use was highest at point one (29.00 birds/20-min survey). Bird use for the other points ranged from 2.55 to 13.70 birds/20-min survey. The high mean use estimate for point one was due to many observations of passerines (27.55 birds/20-min survey) at that point (Figure 5g). Waterfowl were only observed at four points and the mean use ranged from 0.09 birds/ 20-min survey at point 19 to 0.73 at point 15. Shorebirds were observed at six points and use was consistent among points, ranging from 0.09 to 0.18 birds/20-min survey. Raptors were observed at all but one of the points (point five), and use was very consistent among the remaining points, ranging from 0.09 to 0.82 birds/20-min. survey. Upland gamebirds were observed at all but four points, with the highest use at point five

(4.55 birds/20-min survey) and lowest at point 12 (0.10), and ranged from 0.27 to 3.82 birds/20-min survey at the remaining points. Doves/pigeons were observed at all but seven points with the highest use at points fourteen (2.40) and three (2.27), and the lowest use at points five, seven, 10, and 11 at 0.18 birds/20-min survey. Dove/pigeon use ranged from 0.30 to 1.64 birds/20-min survey at the remaining points. Passerine use was highest at point one (27.55 birds/20-min survey), lowest at point six (1.36), and ranged from 1.73 to 8.60 at the other points. Other birds were only observed at points three, four, 13, 15, and 19, and use ranged from 0.09 to 0.18 birds/20-min survey.

Acoustic Bat Surveys

Eleven species of bat are known or suspected to occur in Adams County, North Dakota (Table 6), some of which are considered sensitive species by the NDGFD (Tables 6 and 7).

A total of 126 bat calls were recorded during 112 bat detector nights (Table 8). Fifty-eight of the calls were more than 35 kHz in frequency (e.g., little brown bat [*Myotis lucifugus*], northern long-eared bat [*Myotis septentrionalis*], eastern red bat [*Lasiurus borealis*]), while the remaining 68 were less than 35 kHz (e.g., big brown bat [*Eptesicus fuscus*], silver-haired bat [*Lasionycteris noctivagans*], hoary bat [*Lasiurus cinereus*]) (Table 8). Noise was recorded on many nights throughout the sample period, which may have interfered with detection of bats. Further AnaBats failed sporadically during the sampling period. The north unit failed to capture data to any great degree during the last two weeks of the study and the south unit failed to record data during a two and a half week period, from August 6-23.

Spatial Variation

Bat activity was similar between the ground AnaBat units in the north end (1.0 passes per detector-night) and south (1.13 passes per detector-night). More low-frequency calls than high-frequency calls were detected at the south location. This was reversed at the north location with more high-frequency calls being detected

Temporal Variation

The earliest call detected occurred on July 23 and the latest was detected on September 29. Calls were fairly regular, between 1 and 7 per night with most nights having 2-4 calls from July 23 and September 6. After early September the calls drop off dramatically. This time period would correspond to the summer breeding and fall bat migration periods.

Species Composition

Species identification for specific passes was possible for two species, the hoary bat and eastern red bat, on limited occasions. A total of seven hoary bat calls (10.3% of low-frequency calls) and one eastern red bat call (1.7% of high-frequency calls) were identified. All other bat calls detected could not be identified to species.

Sensitive Species

The NDGFD and the USFWS list 104 animals as state- or federal-listed threatened and endangered, or sensitive status species for North Dakota (Table 7). Fourteen species, comprised

of one-hundred-three individuals in 80 groups listed by the NDGFD and/or the USFWS were observed during the fixed-point bird use surveys or as incidental wildlife observations (described below).

No species protected under the federal Endangered Species Act (ESA 1973) were recorded during the surveys at the TCWRA. One species, the golden eagle (*Aquila chrysaetos*), while not protected under the Endangered Species Act, is federally protected by the Bald and Golden Protection Act (BGEPA 1940). The golden eagle is also considered a Level-II Species of Conservation Priority by the NDGFD, or a species in need of conservation, but one that has support from other conservation programs. Two golden eagles were observed during fixed-point bird use surveys (Table 8).

The sharp-tailed grouse (*Tympanuchus phasianellus*) is listed as a Level II species by the NDGFD and the USFWS has raised concerns about impacts on leking prairie grouse species (USFWS 2004). One sharp-tailed grouse was observed during fixed-point bird use surveys (Table 8) and 17 were observed as incidentally (Table 8 and see below).

Other species observed during the fixed-point bird use surveys and/or as incidental wildlife observations were all listed as by the NDGFD as Level-I (in greatest need of conservation), Level-II, or Level-III (in moderate need of conservation, but that are on the edge of their range in North Dakota). Most observations were of northern harrier (Level-II; 30 observations), Swainson's hawk (Level-I; *Buteo swainsoni*; 20), and grasshopper sparrow (Level-I; *Ammodramus savannarum*; eight). Prairie falcon (Level-II; *Falco mexicanus*) and upland sandpiper (Level-I; *Bartramia longicauda*) each had three observations, while there were two observations each of lark bunting (Level-I; *Calamospiza melanocorys*), loggerhead shrike (Level-I; *Lanius ludovicianus*), and marbled godwit (Level I; *Limosa fedoa*). One species, ferruginous hawk (Level-I; *Buteo regalis*), was seen as a single observation as an incidental species (Table 8 and see below), while single observations of Baird's sparrow (Level-I; *Ammodramus bairdii*), peregrine falcon (Level-III; *F. peregrinus*), and short-eared owl (Level-II; *Asio flammeus*) occurred during the fixed-point surveys at the TCWRA (Table 8).

Incidental Wildlife Observations

Bird Observations

Observations of state or federally listed species, raptors, and other species of interest observed while in-transit between surveys points were recorded (Table 10). The most abundant bird species recorded were sandhill cranes (*Grus canadensis*; 33 observations), sharp-tailed grouse (17), ring-necked pheasant (14), northern harrier (nine), and Swainson's hawk (also nine). Eighteen species were observed, with a total of 100 individuals in 39 groups.

Mammal Observations

Mammal species were observed throughout the study area. Large mammals observed included 36 pronghorn antelope (*Antilocapra americana*), 13 white-tailed deer (*Odocoileus virginianus*), and three mule deer (*O. hemionus*). Other mammals included five eastern cottontail rabbit (*Silvlagus floridanus*), and one coyote (*Canis latrans*; Table 10).

DISCUSSION AND IMPACT ASSESSMENT

Bird Impacts

Direct Effects

The most probable impact to birds from wind projects is direct mortality or injury due to collisions with turbines or guy wires of meteorological towers (met towers). Collisions may occur with resident birds foraging and flying within the project area or with migrant birds seasonally moving through the project area. Project construction could affect birds through loss of habitat, potential fatalities from construction equipment, and disturbance/displacement effects from construction activities. Impacts from the decommissioning of the facility are anticipated to be similar to construction in terms of noise, disturbance, and equipment. Potential mortality from construction equipment is expected to be very low. Equipment used in wind facility construction generally moves at slow rates or is stationary for long periods (e.g., cranes). The risk of direct mortality to birds from construction is most likely potential destruction of a nest for ground- and shrub-nesting species during initial site clearing.

Substantial data on bird mortality at wind facilities are available from studies in California and throughout the west and Midwest. Of 841 bird fatalities reported from California studies (>70% from the Altamont Pass wind-energy facility, California), 39% were diurnal raptors, 19% were passerines (excluding house sparrow [*Passer domesticus*] and European starling), and 12% were owls. Non-protected birds including house sparrow, European starling, and rock pigeon [*Columba livia*] comprised 15% of the fatalities. Other bird types generally made up less than 10% of the fatalities (Erickson et al. 2002). During 12 fatality monitoring studies conducted at wind-energy facilities outside of California, diurnal raptor fatalities comprised only two percent of the wind-energy facility-related fatalities and raptor mortality averaged 0.03 raptors/turbine/year. Passerines (excluding house sparrows and European starlings) were the most common collision victims, comprising 82% of the 225 fatalities documented. These facilities that were studied outside California have more modern turbines than the older California facilities.

For all bird species combined, estimates of the number of bird fatalities per turbine per year from individual studies ranged from zero at the Searsburg, Vermont (Kerlinger 1997), and Algona, Iowa (Demastes and Trainer, 2000), wind-energy facilities, to 7.7 at the Buffalo Mountain, Tennessee, facility (Nicholson 2003). Using mortality data from the last 10 years from wind-energy facilities throughout the entire United States, the average number of bird collision fatalities is 3.1 birds per megawatt per year or 2.3 per turbine per year (NWCC 2004).

Raptor Use and Exposure Risk

Mean raptor use at the TCWRA was compared with other wind-energy facilities that implemented similar protocols and had data for summer and fall raptor use. Mean raptor use at the TCWRA for the summer and fall (0.35 and 0.26 birds/20-min survey, respectively) were compared separately to raptor use at other wind-energy facilities; similar studies were conducted at 34 other wind-energy facilities in the summer, and 32 in the fall. Summer mean raptor use at other wind-energy facilities ranged from 0.06 to 2.38 birds/20-min survey, and ranged from 0.08

to 3.38 for fall surveys (Figures 6 and 7). Mean raptor use at the TCWRA was eleventh lowest compared to the other sites in the summer at 0.35 raptors/20-min survey (Figure 6; Table 3), and sixth lowest at compared to other sites in the fall at 0.26 raptors/20-min survey (Figure 7; Table 3). Based on the results from these projects a ranking of seasonal raptor mean use was developed as: low (0 – 0.5/survey); low to moderate (0.5 – 1.0/survey); moderate (1.0 – 2.0/survey); high (2.0 – 3.0); and very high (> 3.0). Under this ranking, mean raptor use at TCWRA would be considered low in the summer and fall.

Although high numbers of raptor fatalities have been documented at some wind-energy facilities (e.g. Altamont Pass), a review of studies at wind-energy facilities across the United States reported that only 3.2% of casualties were raptors (Erickson et al. 2001b). Indeed, although raptors occur in most areas with the potential for wind-energy development, individual species appear to differ from one another in their susceptibility to collision (NRC 2007). Results from the Altamont Pass wind-energy facility in California suggest that mortality for some species is not necessarily related to abundance (Orloff and Flannery 1992). American kestrels, red-tailed hawks, and golden eagles (were killed more often, and turkey vultures were killed less often than predicted based on abundance. A recent report from the Buffalo Gap wind-energy facility in Texas, however, suggests that turkey vulture (*Cathartes aura*) may show a higher susceptibility to collision at larger wind turbines than for smaller turbines than previously believed (Tierney 2007). In addition, reports from the High Winds wind-energy facility in California document high American kestrel (*Falco sparverius*) mortality. Relative use by this species at High Winds is six times that at the Altamont Pass facility (Kerlinger et al. 2005). It is likely that many factors, in addition to abundance, are important in predicting raptor mortality.

Exposure indices analysis may also provide insight into what species might be the most likely turbine casualties; however, the index only considers relative probability of exposure based on abundance, proportion of daily activity spent flying, and proportion of flight height of each species within the ZOR for turbines likely to be used at the wind-energy facility. This analysis is based on observations of birds during the daylight period and does not take into consideration flight behavior (e.g. during foraging or courtship) or abundance of nocturnal migrants. It also does not take into consideration habitat selection, the ability to detect and avoid turbines, and other factors that may vary among species and influence likelihood for turbine collision. For these reasons, the actual risk for some species may be lower or higher than indicated by these data.

A regression analysis of raptor use and mortality for 11 new-generation wind-energy facilities, where similar methods were used to estimate raptor use and mortality, found that there was a significant correlation between use and mortality ($R^2 = 81.4\%$; Figure 8). Using this regression to predict raptor collision mortality at the TCWRA, based on an adjusted mean raptor use of 0.28 birds/20-min. survey, yields an estimated fatality rate of 0.02 raptors/MW/year, or two raptor fatalities per year for a 100-MW wind-energy facility. A 90% prediction interval around this estimate is zero to 0.18 raptors/MW/year

Raptor fatalities at wind-energy facilities near the proposed TCWRA location have been relatively low, between zero at a site in Wisconsin (Howe et al. 2002) and 0.04 raptors/MW/year at Buffalo Ridge, Minnesota (Johnson et al. 2000a; Table 11). The predicted raptor mortality

based on use at the TCWRA is very similar to these values (estimate of zero raptors/MW/year with 90% confidence interval of 0-0.16). Based on the relative abundance of northern harrier in the summer and fall (Table 2), and a similar or higher exposure index than other raptor species, there is higher potential for northern harrier fatalities compared to other species.

Non-raptor Use and Exposure Risk

Exposure indices of non-raptors indicated that the Lapland longspur, horned lark, cliff swallow, and mallard are most likely to be exposed to potential collision from wind turbines at the TCWRA. Most non-raptors had relatively low exposure indices due to the majority of individuals flying below the likely ZOR. Due to the low exposure risks at TCWRA, it is unlikely that non-raptor populations will be adversely affected by direct mortality from the operation of the wind-energy facility.

Indirect Effects

The presence of wind turbines may alter the landscape so that wildlife use patterns are affected, displacing wildlife away from the project facilities and suitable habitat. Some studies from wind-energy facilities in Europe consider displacement effects to have a greater impact on birds than collision mortality (Gill et al. 1996, Strickland 2004). The greatest concern with displacement impacts are for wind-energy facilities placed in grassland or other native habitats (Leddy et al. 1999, Mabey and Paul 2007), and disturbance appears to impact feeding, resting, and migrating birds rather than breeding birds (Crockford 1992). Studies on habitat displacement caused by wind-energy facilities have concentrated on grassland passerines, waterfowl, and raptors (NRC 2007). This issue may warrant further investigation if the project significantly impacts native grassland areas.

Raptor Nesting Disturbance

In addition to possible direct effects on raptors within the study area (discussed above), indirect effects caused by disturbance-type impacts, such as construction activity near an active nest or primary foraging area, also have a potential impact on raptor species. Birds displaced from wind-energy facilities might move to areas with fewer disturbances, but lower quality, with an overall effect of reducing breeding success. Most studies on raptor displacement at wind-energy facilities, however, indicate effects to be negligible (Howell and Noone 1992; Johnson et al. 2000a; Whitfield and Madders 2006). Notable exceptions to this include a study in Scotland that described territorial golden eagles avoiding the entire wind-energy facility area except when intercepting non-territorial birds (Walker et al. 2005). A study at the Buffalo Ridge wind-energy facility in Minnesota found evidence of harriers avoiding turbines on both a small scale (< 100 m from turbines) and larger scale in the year following construction (Johnson et al. 2000a) as well as lower raptor nest densities near turbines compared to densities in similar habitat away from turbines (Usgaard et al. 1997).

Information concerning the effect of nesting displacement on specific species is limited; however, a Swainson's hawk was reported to have nested within 0.25 mile (0.8 km) of the turbine string at a wind-energy facility in Oregon, suggesting little disturbance to this species (Johnson et al. 2003b). In addition, at the Foote Creek Rim wind-energy facility in southern Wyoming, one pair of red-tailed hawks nested within 0.3 mile of the turbine strings, and seven

red-tailed hawk, one great horned owl, and one golden eagle nests located within one mile (1.6 km) of the wind-energy facility successfully fledged young (Johnson et al. 2000b). The golden eagle pair successfully nested a half-mile (800 m) from the wind-energy facility for three different years after it became operational. Studies at the Stateline wind-energy facility in Oregon and Washington have not shown any measurable short-term effects to nesting raptors (Erickson et al. 2004). These observations suggest that there will be limited displacement of nesting raptor species at TCWRA, although the creation of a buffer surrounding known nests when siting turbines will further reduce any impact.

Displacement of Non-Raptor Bird Species

Studies concerning displacement of non-raptor species have concentrated on grassland songbirds and waterfowl/waterbirds (Winkelman 1990; Larsen and Madsen 2000; Mabey and Paul 2007). Wind-energy facility construction appears to cause small scale local displacement of grassland songbirds and is likely due to the birds avoiding turbine noise and maintenance activities. Construction also reduces habitat effectiveness because of the presence of access roads and large gravel pads surrounding turbines (Leddy 1996; Johnson et al. 2000b). Leddy et al. (1999) surveyed bird densities in Conservation Reserve Program (CRP) grasslands at the Buffalo Ridge wind-energy facility in Minnesota and found mean densities of 10 grassland bird species. Densities were four times higher at areas located 591 ft (180 m) from turbines than they were at grasslands nearer turbines. The observed species included the western meadowlark, red-winged blackbird (*Agelaius phoeniceus*), and savannah sparrow (*Passerculus sandwichensis*), all of which have been observed within the TCWRA. Johnson et al. (2000b) at the same wind resource area found reduced use of habitat in seven of 22 grassland-breeding birds following construction. Results from the Stateline wind-energy facility, Oregon and Washington (Erickson et al. 2004), and the Combine Hills project, Oregon (Young et al. 2005), suggest a relatively small impact of the wind-energy facilities on grassland nesting passerines. Transect surveys conducted prior to and after construction of the wind-energy facilities found that grassland songbird use was significantly reduced within approximately 164 ft (50 m) of turbine strings; areas further away from turbine strings did not have reduced bird use. Displacement of grassland songbirds may be reduced by siting turbines away from grassland or natural habitats. Turbines sited within agricultural land, similar to the surrounding area, should minimize displacement to lessen any population impacts.

Displacement effects of wind-energy facilities on waterfowl and wading birds appear to be mixed. Studies from the Netherlands and Denmark suggest that densities of these types of species near turbines were lower compared to densities in similar habitats away from turbines (Winkelman 1990; Pedersen and Poulsen 1991). However, a study from a facility in England, found no effect of wind turbines on populations of cormorant (*Phalacrocorax xarbo*), purple sandpipers (*Calidris maritima*), eiders (*Somateria mollissima*), or gulls, although the cormorants were temporarily displaced during construction (Lawrence et al. 2007). At the Buffalo Ridge wind-energy facility, Minnesota, the abundance of several bird types, including shorebirds and waterfowl, were found to be significantly lower at survey plots with turbines than at plots without turbines (Johnson et al 2000b). The report concluded that the area of reduced use was limited primarily to those areas within 328 ft (100 m) of the turbines. Disturbance tends to be greatest for migrating birds while feeding and resting (Crockford 1992; NRC 2007). The

majority of waterfowl/waterbirds using the TCWRA was four groups of mallards comprising a total of 15 individuals. The presence of similar habitat surrounding TCWRA means that any displacement of this species is unlikely to impact the population.

Bat Impacts

Direct Effects

Bat casualties have been reported from most wind-energy facilities where post-construction fatality data are available. Reported estimates of bat mortality at wind-energy facilities have ranged from 0.01 – 47.5 per turbine per year (0.9 – 43.2 bats/MW/year) in the United States, with an average of 3.4 per turbine or 4.6 per MW (NWCC 2004). Most of the bat casualties at wind-energy facilities to date are of a non-hibernating foliage (tree) dwelling migratory species that conduct long-distance migrations between summer breeding and wintering areas, specifically: hoary bat, eastern red bat, and silver-haired bat (Johnson 2005). Arnett et al. (2005) reported from 25 to 38 bat fatalities per turbine during a six-week study period at wind-energy facilities in West Virginia and Pennsylvania. Most of the species killed were eastern red bat, hoary bat, and eastern pipistrelle (Kerns et al. 2005). The West Virginia and Pennsylvania wind-energy facilities are located on prominent forested ridges in the Appalachian Mountains. A large number of hoary bats and silver-haired bats (532) were also found at a southern Alberta, Canada wind-energy facility in 2005 and 2006 (Baerwald 2006). Unlike eastern US wind-energy facilities with high bat mortality, the Alberta facility is in open grasslands and cropfields, although it is adjacent to foothills along the Rocky Mountains (Rowland 2006). The causes of the relatively high number of migratory bat deaths at wind-energy facilities are not well understood (Johnson 2005). Kerns et al. (2005) hypothesized that bats may have been attracted to turbines by ultrasound emissions, ephemeral increases in food sources, or bats may have investigated turbines for roosting sites or to glean insects from turbine blades. Researchers also theorized that clearings made in the forest for turbines and roads may have created attractive foraging areas for bats (Kerns et al. 2005).

Potential Impacts

Assessing the potential impacts of wind energy development to bats at the TCWRA is complicated by our current lack of understanding of why bats collide with wind turbines (Kunz et al 2007b), combined with the inherent difficulties of monitoring elusive, night-flying animals (O’Shea et al. 2003). To date, monitoring studies of wind energy projects suggest that: a) migratory tree-roosting species (eastern red, hoary, and silver-haired bats) comprise almost 75% of reported bats killed (Johnson 2005, Kunz et al. 2007b); b) the majority of collisions occur during the post-breeding or fall migration season (roughly August and September; Gruver 2002; Johnson et al. 2003a); and c) the highest reported fatalities occur at wind facilities located along forested ridge tops in the eastern US (Kunz et al. 2007b), although recent studies in agricultural regions of Iowa and Alberta, Canada, report relatively high fatalities as well (Jain 2005; Baerwald 2006).

Post-construction fatality data collected at wind-energy facilities appear to be the best available predictor of mortality levels and species composition for proposed wind-energy facilities. Some studies of wind-energy facilities have recorded both AnaBat detections per night and bat

mortality (Table 12). The number of bat calls per night as determined from bat detectors shows a rough correlation with bat mortality, but may be misleading because effort, timing of sampling, species recorded, and detector settings (equipment and locations) varies among studies (Kunz et al. 2007b). Thus, our best available estimate of mortality levels at a proposed wind-energy facility involves evaluation of our on-site acoustic bat data in terms of activity levels, seasonal variation, species composition, and topographic features of the project area.

Activity

Bat activity within the TCWRA (mean = 1.13 bat passes per detector-night) was comparable to that observed at facilities in Minnesota and Wyoming, where bat collision mortality was low, and it was much lower than activity recorded at sites in West Virginia and Tennessee, where bat mortality rates were high (Table 13). Thus, based on the presumed relationship between pre-construction bat activity and post-construction fatalities, and assuming that this relationship extends to the Midwest, we expect bat mortality rates at the TCWRA to be similar to the 2.2 bat fatalities/turbine/year reported at the Buffalo Ridge, Minnesota, wind-energy facility, but much lower than the 20.8 fatalities/turbine/year reported at the Buffalo Mountain, Tennessee, facility.

Species Composition

Acoustic bat surveys were unable to determine most bat species detected during the study (only a limited number of calls were identified to hoary bat or eastern red bat), but they were able to distinguish high-frequency from low-frequency species. In the TCWRA, 46.0% of all bat passes were high-frequency and 54% were low-frequency calls, suggesting only slightly higher relative abundance of species such as hoary bats, silver haired bats, and big brown bats.

Topographic Features

The proposed wind-energy facility is not located near any large, known bat colonies or other features that are likely to attract large numbers of bats. As well, the TCWRA does not contain topographic features that may funnel migrating bats, and is lacking large tracts of forest cover, unlike high-mortality sites in the eastern US. However, the relatively large numbers of bat fatalities recently reported in northern Iowa (Jain 2005) and southwestern Alberta (Baerwald 2006) indicate that an open landscape is no guarantee of low mortality. There were relatively even numbers of calls per detector night at each location, suggesting that there is not a topographic or other landscape feature increasing bat use in one area of another. Based on species composition and timing, we expect the majority of bat mortalities to be individuals migrating through the area.

Sensitive Species Use and Exposure Risk

No species protected under the federal Endangered Species Act (ESA 1973) were recorded during the surveys at the TCWRA. One species, the golden eagle (*Aquila chrysaetos*), while no longer protected under the Endangered Species Act, is still federally protected. The golden eagle is also considered a Level-II species by the NDGFD. Altogether, seven NDGFD Level-I species,

six Level-II species, and one Level-III specie were observed during surveys at the TCWRA (Table 8).

The sharp-tailed grouse is one of those listed as a Level II species by the NDGFD. Because sharp-tailed grouse evolved on prairie landscapes with few trees or vertical structures, wildlife researchers have postulated that sharp-tailed grouse may avoid tall vertical structures, such as wind turbines and powerlines (USFWS 2004). However, few researchers have documented the level of avoidance by prairie grouse of wind turbines or other structures. Robel (2002) describes unpublished data that indicate that lesser prairie chickens (*Tympanuchus pallidicinctus*) avoided powerlines, human dwellings, and a large powerplant by distances ranging from a quarter mile to almost one mile (0.4 to 1.6 km). No published studies are available that have examined sharp-tailed grouse response to disturbance at various distances. Eighteen sharp-tailed grouse were observed during the surveys, indicating that sharp-tailed grouse do utilize the TCWRA.

Because surveys were limited to public roads and accessible private roads, the potential exists for other undocumented sensitive species to occur within the TCWRA.

CONCLUSION AND RECOMMENDATIONS

Based on data collected during this study, raptor and all bird use of TCWRA is generally lower than most wind resource areas evaluated throughout the western and Midwestern US using similar methods. Additionally, the bat use data indicated a relatively low amount of bat activity in the study area. Based on the results of the studies to date, bird and bat mortality at the TCWRA would likely be similar or lower than that documented at other wind farms located in the western and Midwestern United States where bird and bat collision mortality has been relatively low.

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Table 1. Summary of bird use, species richness, and sample size by season and overall during the fixed-point bird use surveys in the TCWRA, June 5 through October 29, 2007.

Season	# of Visits	Mean Use	# Species /Survey	# Species	# Surveys Conducted
Summer	5	6.71	3.56	44	95
Fall	6	7.33	1.26	23	120
Overall	11	7.05	2.31	51	215

Table 2. Total number of groups and individuals for each bird type and species by season and overall during the fixed-point bird use surveys in the TCWRA^a, June 5 through October 29, 2007.

Species/Type	Scientific Name	Summer		Fall		Total	
		# grps	# obs	# grps	# obs	# grps	# obs
Waterfowl		5	16	0	0	5	16
Canada goose	<i>Branta canadensis</i>	1	1	0	0	1	1
mallard	<i>Anas platyrhynchos</i>	4	15	0	0	4	15
Shorebirds		7	7	0	0	7	7
killdeer	<i>Charadrius vociferus</i>	3	3	0	0	3	3
marbled godwit	<i>Limosa fedoa</i>	1	1	0	0	1	1
upland sandpiper	<i>Bartramia longicauda</i>	3	3	0	0	3	3
Raptors		31	34	29	31	60	65
<u>Buteos</u>		9	9	13	14	22	23
red-tailed hawk	<i>Buteo jamaicensis</i>	1	1	9	9	10	10
rough-legged hawk	<i>Buteo lagopus</i>	0	0	1	1	1	1
Swainson's hawk	<i>Buteo swainsoni</i>	7	7	3	4	10	11
unidentified buteo		1	1	0	0	1	1
<u>Northern Harrier</u>		18	21	8	9	26	30
northern harrier	<i>Circus cyaneus</i>	18	21	8	9	26	30
<u>Eagles</u>		0	0	2	2	2	2
golden eagle	<i>Aquila chrysaetos</i>	0	0	2	2	2	2
<u>Falcons</u>		2	2	1	1	3	3
peregrine falcon	<i>Falco peregrinus</i>	0	0	1	1	1	1
prairie falcon	<i>Falco mexicanus</i>	2	2	0	0	2	2
<u>Owls</u>		1	1	0	0	1	1
short-eared owl	<i>Asio flammeus</i>	1	1	0	0	1	1
<u>Other Raptors</u>		0	0	5	5	5	5
unidentified hawk		0	0	4	4	4	4
unidentified raptor		0	0	1	1	1	1
<u>Vultures</u>		1	1	0	0	1	1
turkey vulture	<i>Cathartes aura</i>	1	1	0	0	1	1

Table 2. Total number of groups and individuals for each bird type and species by season and overall during the fixed-point bird use surveys in the TCWRA^a, June 5 through October 29, 2007.

Species/Type	Scientific Name	Summer		Fall		Total	
		# grps	# obs	# grps	# obs	# grps	# obs
Upland Gamebirds		32	57	38	158	70	215
gray partridge	<i>Perdix perdix</i>	2	3	0	0	2	3
ring-necked pheasant	<i>Phasianus colchicus</i>	30	54	37	157	67	211
sharp-tailed grouse	<i>Tympanuchus phasianellus</i>	0	0	1	1	1	1
Doves/Pigeons		42	73	12	46	54	119
mourning dove	<i>Zenaida macroura</i>	41	71	10	31	51	102
rock pigeon	<i>Columba livia</i>	1	2	2	15	3	17
Passerines		252	447	90	642	342	1,089
American crow	<i>Corvus brachyrhynchos</i>	4	5	2	2	6	7
American goldfinch	<i>Carduelis tristis</i>	3	6	1	1	4	7
American robin	<i>Turdus migratorius</i>	5	7	1	4	6	11
Baird's sparrow	<i>Ammodramus bairdii</i>	1	1	0	0	1	1
barn swallow	<i>Hirundo rustica</i>	12	20	1	4	13	24
black-capped chickadee	<i>Poecile atricapillus</i>	0	0	1	1	1	1
bobolink	<i>Dolichonyx oryzivorus</i>	16	28	0	0	16	28
Brewer's blackbird	<i>Euphagus cyanocephalus</i>	5	19	0	0	5	19
brown thrasher	<i>Toxostoma rufum</i>	1	1	0	0	1	1
brown-headed cowbird	<i>Molothrus ater</i>	15	47	0	0	15	47
cliff swallow	<i>Petrochelidon pyrrhonota</i>	4	25	0	0	4	25
common grackle	<i>Quiscalus quiscula</i>	3	10	0	0	3	10
eastern kingbird	<i>Tyrannus tyrannus</i>	24	31	0	0	24	31
European starling	<i>Sturnus vulgaris</i>	1	1	2	288	3	289
grasshopper sparrow	<i>Ammodramus savannarum</i>	7	8	0	0	7	8
horned lark	<i>Eremophila alpestris</i>	11	30	28	197	39	227
Lapland longspur	<i>Calcarius lapponicus</i>	0	0	1	15	1	15
lark bunting	<i>Calamospiza melanocorys</i>	2	2	0	0	2	2
loggerhead shrike	<i>Lanius ludovicianus</i>	1	1	0	0	1	1
northern rough-winged swallow	<i>Stelgidopteryx serripennis</i>	2	14	0	0	2	14
red-winged blackbird	<i>Agelaius phoeniceus</i>	17	26	0	0	17	26

Table 2. Total number of groups and individuals for each bird type and species by season and overall during the fixed-point bird use surveys in the TCWRA^a, June 5 through October 29, 2007.

Species/Type	Scientific Name	Summer		Fall		Total	
		# grps	# obs	# grps	# obs	# grps	# obs
savannah sparrow	<i>Passerculus sandwichensis</i>	25	28	2	3	27	31
song sparrow	<i>Melospiza melodia</i>	1	1	0	0	1	1
tree swallow	<i>Tachycineta bicolor</i>	1	2	0	0	1	2
unidentified sparrow		4	6	5	6	9	12
vesper sparrow	<i>Pooecetes gramineus</i>	3	3	1	5	4	8
warbling vireo	<i>Vireo gilvus</i>	1	1	0	0	1	1
western kingbird	<i>Tyrannus verticalis</i>	20	33	0	0	20	33
western meadowlark	<i>Sturnella neglecta</i>	62	90	45	116	107	206
yellow-rumped warbler	<i>Dendroica coronata</i>	1	1	0	0	1	1
Other Birds		4	4	2	2	6	6
common nighthawk	<i>Chordeiles minor</i>	1	1	0	0	1	1
downy woodpecker	<i>Picoides pubescens</i>	0	0	1	1	1	1
northern flicker	<i>Colaptes auratus</i>	3	3	1	1	4	4
Total		373	638	171	879	544	1,517

^a All individuals observed, including those outside the half-mile (800 m) plot.

Table 3. Mean bird use (number/plot/20-min survey), percent of total composition (%), and frequency of occurrence (%) for each bird type and species by season during the fixed-point bird use surveys at the TCWRA, June 5 through October 29, 2007.

Species/Type	Use		% Composition		% Frequency	
	Summer	Fall	Summer	Fall	Summer	Fall
Waterfowl	0.19	0	2.8	0	4.3	0
Canada goose	0.01	0	0.1	0	1.0	0
mallard	0.18	0	2.6	0	4.3	0
Shorebirds	0.08	0	1.2	0	8.3	0
Killdeer	0.03	0	0.5	0	3.3	0
marbled godwit	0.01	0	0.1	0	1.0	0
upland sandpiper	0.04	0	0.6	0	4.0	0
Raptors	0.35	0.26	5.2	3.5	25.7	20.0
<i>Buteos</i>	<i>0.09</i>	<i>0.12</i>	<i>1.4</i>	<i>1.6</i>	<i>9.3</i>	<i>9.2</i>
red-tailed hawk	0.01	0.08	0.2	1.0	1.3	6.7
rough-legged hawk	0	0.01	0	0.1	0	0.8
Swainson's hawk	0.07	0.03	1.0	0.5	7.0	2.5
unidentified buteo	0.01	0	0.1	0	1.0	0
<i>Northern Harrier</i>	<i>0.21</i>	<i>0.08</i>	<i>3.1</i>	<i>1.0</i>	<i>15.0</i>	<i>6.7</i>
northern harrier	0.21	0.08	3.1	1.0	15.0	6.7
<i>Eagles</i>	<i>0</i>	<i>0.02</i>	<i>0</i>	<i>0.2</i>	<i>0</i>	<i>1.7</i>
golden eagle	0	0.02	0	0.2	0	1.7
<i>Falcons</i>	<i>0.02</i>	<i>0.01</i>	<i>0.3</i>	<i>0.1</i>	<i>2.0</i>	<i>0.8</i>
peregrine falcon	0	0.01	0	0.1	0	0.8
prairie falcon	0.02	0	0.3	0	2.0	0
<i>Owls</i>	<i>0.01</i>	<i>0</i>	<i>0.2</i>	<i>0</i>	<i>1.3</i>	<i>0</i>
short-eared owl	0.01	0	0.2	0	1.3	0
<i>Other Raptors</i>	<i>0</i>	<i>0.04</i>	<i>0</i>	<i>0.6</i>	<i>0</i>	<i>4.2</i>
unidentified hawk	0	0.03	0	0.5	0	3.3
unidentified raptor	0	0.01	0	0.1	0	0.8
<i>Vultures</i>	<i>0.01</i>	<i>0</i>	<i>0.1</i>	<i>0</i>	<i>1.0</i>	<i>0</i>
turkey vulture	0.01	0	0.1	0	1.0	0

Table 3. Mean bird use (number/plot/20-min survey), percent of total composition (%), and frequency of occurrence (%) for each bird type and species by season during the fixed-point bird use surveys at the TCWRA, June 5 through October 29, 2007.

Species/Type	Use		% Composition		% Frequency	
	Summer	Fall	Summer	Fall	Summer	Fall
Upland Gamebirds	0.61	1.32	9.1	18.0	32.3	25.8
gray partridge	0.04	0	0.5	0	2.3	0
ring-necked pheasant	0.58	1.31	8.6	17.9	30.0	25.8
sharp-tailed grouse	0	0.01	0	0.1	0	0.8
Doves/Pigeons	0.75	0.38	11.2	5.2	30.3	8.3
mourning dove	0.73	0.26	10.9	3.5	29.3	7.5
rock pigeon	0.02	0.13	0.3	1.7	1.0	1.7
Passerines	4.69	5.35	69.9	73.0	82.0	51.7
American crow	0.06	0.02	0.8	0.2	4.7	1.7
American goldfinch	0.06	0.01	0.9	0.1	3.0	0.8
American robin	0.08	0.03	1.1	0.5	5.3	0.8
Baird's sparrow	0.01	0	0.1	0	1.0	0
barn swallow	0.21	0.03	3.2	0.5	13.0	0.8
black-capped chickadee	0	0.01	0	0.1	0	0.8
Bobolink	0.30	0	4.5	0	15.3	0
Brewer's blackbird	0.20	0	2.9	0	4.3	0
brown thrasher	0.01	0	0.1	0	1.0	0
brown-headed cowbird	0.47	0	7.0	0	15.0	0
cliff swallow	0.25	0	3.7	0	3.0	0
common grackle	0.13	0	1.9	0	3.7	0
eastern kingbird	0.33	0	5.0	0	24.3	0
European starling	0.01	2.40	0.1	32.8	1.0	0.8
grasshopper sparrow	0.09	0	1.3	0	7.7	0
horned lark	0.30	1.64	4.5	22.4	11.3	21.7
Lapland longspur	0	0.13	0	1.7	0	0.8
lark bunting	0.02	0	0.3	0	2.0	0
loggerhead shrike	0.01	0	0.1	0	1.0	0
northern rough-winged swallow	0.14	0	2.1	0	2.0	0

Table 3. Mean bird use (number/plot/20-min survey), percent of total composition (%), and frequency of occurrence (%) for each bird type and species by season during the fixed-point bird use surveys at the TCWRA, June 5 through October 29, 2007.

Species/Type	Use		% Composition		% Frequency	
	Summer	Fall	Summer	Fall	Summer	Fall
red-winged blackbird	0.28	0	4.1	0	17.0	0
savannah sparrow	0.30	0.03	4.5	0.3	25.0	1.7
song sparrow	0.01	0	0.1	0	1.0	0
tree swallow	0.02	0	0.3	0	1.0	0
unidentified sparrow	0.06	0.05	0.9	0.7	4.0	3.3
vesper sparrow	0.04	0.04	0.5	0.6	3.7	0.8
warbling vireo	0.01	0	0.1	0	1.0	0
western kingbird	0.33	0	4.9	0	18.0	0
western meadowlark	0.96	0.97	14.3	13.2	57.0	30.8
yellow-rumped warbler	0.01	0	0.1	0	1.0	0
Other Birds	0.04	0.02	0.6	0.2	4.0	1.7
common nighthawk	0.01	0	0.1	0	1.0	0
downy woodpecker	0	0.01	0	0.1	0	0.8
northern flicker	0.03	0.01	0.4	0.1	3.0	0.8
Overall	6.71	7.33	100.0	100.0		

Table 4. Relative exposure index and flight characteristics by species during the fixed-point bird use surveys at the TCWRA, June 5 through October 29, 2007.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying Initially in ZOR^a	Exposure Index	% Within ZOR[†] at any time
Lapland longspur	1	0.07	100.0	100.0	0.07	100.0
horned lark	33	1.03	93.4	4.7	0.05	4.7
cliff swallow	4	0.11	100.0	32.0	0.04	32.0
mallard	3	0.08	46.7	85.7	0.03	85.7
northern harrier	23	0.14	86.7	15.4	0.02	26.9
red-tailed hawk	6	0.05	60.0	83.3	0.02	100.0
Swainson's hawk	6	0.05	63.6	71.4	0.02	71.4
mourning dove	32	0.47	60.8	3.2	0.01	3.2
rock pigeon	3	0.08	100.0	17.6	0.01	17.6
unidentified sparrow	7	0.05	91.7	18.2	0.01	18.2
unidentified hawk	2	0.02	50.0	100.0	0.01	100.0
golden eagle	2	0.01	100.0	100.0	0.01	100.0
tree swallow	1	0.01	100.0	100.0	0.01	100.0
brown-headed cowbird	11	0.21	78.7	2.7	<0.01	2.7
eastern kingbird	15	0.15	61.3	5.3	<0.01	15.8
northern rough-winged swallow	1	0.06	7.1	100.0	<0.01	100.0
American crow	3	0.03	57.1	25.0	<0.01	25.0
Canada goose	1	<0.01	100.0	100.0	<0.01	100.0
common nighthawk	1	<0.01	100.0	100.0	<0.01	100.0
rough-legged hawk	1	<0.01	100.0	100.0	<0.01	100.0
European starling	3	1.31	100.0	0	0	0
bobolink	15	0.14	89.3	0	0	0
barn swallow	12	0.12	83.3	0	0	0
Brewer's blackbird	5	0.09	100.0	0	0	0
common grackle	3	0.06	100.0	0	0	0

Table 4. Relative exposure index and flight characteristics by species during the fixed-point bird use surveys at the TCWRA, June 5 through October 29, 2007.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying Initially in ZOR^a	Exposure Index	% Within ZOR[†] at any time
American robin	4	0.05	81.8	0	0	0
grasshopper sparrow	1	0.04	25.0	0	0	0
American goldfinch	2	0.03	57.1	0	0	0

[†]ZOR, the likely “zone of risk” for collision with turbine blades, or 82-410 ft (25-125 m) AGL.

Table 5. Flight height characteristics by bird type during the fixed-point bird use surveys in the TCWRA June 5 through October 29, 2007.

Type	# Obs Flying	# Groups Flying	Mean Flight Height	% Obs Flying	% within Flight Height Categories		
					0-82 ft	82-410 ft†	> 410 ft
Waterfowl	8	4	40.00	50.0	12.5	87.5	0
Shorebirds	3	3	6.33	42.9	100.0	0	0
Raptors	46	42	60.10	70.8	52.2	41.3	6.5
<i>Buteos</i>	14	13	117.31	60.9	7.1	78.6	14.3
<i>Northern Harrier</i>	26	23	10.61	86.7	84.6	15.4	0
<i>Eagles</i>	2	2	75.00	100.0	0	100.0	0
<i>Falcons</i>	1	1	5.00	33.3	100.0	0	0
<i>Owls</i>	0	0	0	0	0	0	0
<i>Other Raptors</i>	2	2	100.00	40.0	0	100.0	0
<i>Vultures</i>	1	1	400.00	100.0	0	0	100.0
Upland Gamebirds	79	15	1.80	36.7	100.0	0	0
Doves/Pigeons	79	35	9.40	66.4	93.7	6.3	0
Passerines	866	190	6.43	79.5	95.3	4.7	0
Other Birds	1	1	100.00	16.7	0	100.0	0
Overall	1082	290	15.11	71.3	93.0	6.7	0.3

†ZOR, the likely “zone of risk” for collision with turbine blades, or 82-410 ft (25-125 m) AGL.

Table 6. Bat species determined from range-maps (Harvey et al. 1999; BCI website) as likely to occur within the TCWRA, sorted by call frequency.

High-frequency (≥ 35 kHz)		Low frequency (< 35 kHz)	
Eastern Red Bat*	<i>Lasiurus borealis</i>	Big Brown Bat	<i>Eptesicus fuscus</i>
Northern Long-eared Bat [†]	<i>Myotis septentrionalis</i>	Silver-haired Bat*	<i>Lasionycteris noctivagans</i>
Little Brown Bat [†]	<i>Myotis lucifugus</i>	Hoary Bat*	<i>Lasiurus cinereus</i>
Western Small-footed Bat** [†]	<i>Myotis ciliolabrum</i>	Townsend's Big-eared Bat**	<i>Corynorhinus townsendii</i>
Western Long-eared Bat**	<i>Myotis evotis</i>	Fringed Bat**	<i>Myotis thysanodes</i>
Long-legged Bat**	<i>Myotis volans</i>		

*long-distance migrant; **on the edge or just outside species range, [†]species listed as sensitive by the NDGFD.

Table 7. North Dakota state and federal special/sensitive status species listed by the USFWS or the NDGFD.

Common Name	Scientific Name	USFWS	NDGFD
Birds			
American avocet	<i>Recurvirostra americana</i>		II
American bittern	<i>Botaurus lentiginosus</i>		I
American white pelican	<i>Pelecanus erythrorhynchos</i>		I
Baird's sparrow	<i>Ammodramus bairdii</i>		I
bald eagle	<i>Haliaeetus leucocephalus</i>	EA	II
black tern	<i>Chlidonias niger</i>		I
black-billed cuckoo	<i>Coccyzus erythrophthalmus</i>		I
bobolink	<i>Dolichonyx oryzivorus</i>		II
brewer's sparrow	<i>Spizella breweri</i>		III
burrowing owl	<i>Athene cunicularia</i>		II
canvasback	<i>Aythya valisineria</i>		II
chestnut-collared longspur	<i>Calcarius ornatus</i>		I
dickcissel	<i>Spiza americana</i>		II
Eskimo curlew	<i>Numenius borealis</i>	E	
ferruginous hawk	<i>Buteo regalis</i>		I
Franklin's gull	<i>Larus pipixcan</i>		I
golden eagle	<i>Aquila chrysaetos</i>	EA	II
grasshopper sparrow	<i>Ammodramus savannarum</i>		I
greater prairie chicken	<i>Tympanuchus cupido</i>	SoC*	II
greater sage-grouse	<i>Centrocercus urophasianus</i>	C*	II
horned grebe	<i>Podiceps auritus</i>		I
lark bunting	<i>Calamospiza melanocorys</i>		I
Le Conte's sparrow	<i>Ammodramus leconteii</i>		II
least tern	<i>Sterna antillarum</i>	E	E/II
loggerhead shrike	<i>Lanius ludovicianus</i>		II
long-billed curlew	<i>Numenius americanus</i>		I
marbled godwit	<i>Limosa fedoa</i>		I
McCown's longspur	<i>Calcarius mccownii</i>		III
nelson's sharp-tailed sparrow	<i>Ammodramus nelsonii</i>		I
northern harrier	<i>Circus cyaneus</i>		II
northern pintail	<i>Anas acuta</i>		II
peregrine falcon	<i>Falco peregrinus</i>		III
piping plover	<i>Charadrius melodus</i>		T/II
prairie falcon	<i>Falco mexicanus</i>		II
redhead	<i>Aythya americana</i>		II
red-headed woodpecker	<i>Melanerpes erythrocephalus</i>		II
sedge wren	<i>Cistothorus platensis</i>		II
sharp-tailed grouse	<i>Tympanuchus phasianellus</i>	SoC*	II

Table 7. North Dakota state and federal special/sensitive status species listed by the USFWS or the NDGFD.

Common Name	Scientific Name	USFWS NDGFD	
short-eared owl	<i>Asio flammeus</i>		II
Sprague's pipit	<i>Anthus spragueii</i>		I
Swainson's hawk	<i>Buteo swainsoni</i>		I
upland sandpiper	<i>Bartramia longicauda</i>		I
whooping crane	<i>Grus americana</i>	E	E/III
willet	<i>Catoptrophorus semipalmatus</i>		I
Wilson's phalarope	<i>Phalaropus tricolor</i>		I
yellow rail	<i>Coturnicops noveboracensis</i>		I
Bats			
long-eared myotis	<i>Myotis evotis</i>		III
long-legged myotis	<i>Myotis volans</i>		III
western small-footed myotis	<i>Myotis ciliolabrum</i>		III
Other Mammals			
arctic shrew	<i>Sorex arcticus</i>		III
black-footed ferret	<i>Mustela nigripes</i>		II
black-tailed prairie dog	<i>Cynomys ludovicianus</i>		I
eastern spotted skunk	<i>Spilogale putoris</i>		III
gray wolf	<i>Canis lupus</i>		III
hispid pocket mouse	<i>Chaetodipus hispidus</i>		III
plains pocket mouse	<i>Perognathus flavescens</i>		III
pygmy shrew	<i>Sorex hoyi</i>		II
Richardson's ground squirrel	<i>Spermophilus richardsonii</i>		II
river otter	<i>Lutra canadensis</i>		II
sagebrush vole	<i>Lemmyscus curtatus</i>		III
swift fox	<i>Vulpes velox</i>		II
Amphibians			
Canadian toad	<i>Bufo hemiophrys</i>		I
plains spadefoot	<i>Spea bombifrons</i>		I
Reptiles			
common snapping turtle	<i>Chelydra serpentina</i>		II
false map turtle	<i>Graptemys pseudogeographica</i>		III
northern prairie skink	<i>Eumeces septentrionalis</i>		III
northern redbelly snake	<i>Storeria occipitomaculata</i>		II
northern sagebrush lizard	<i>Sceloporus graciosus</i>		III
short-horned lizard	<i>Phrynosoma douglassi</i>		II
smooth green snake	<i>Liochlorophis vernalis</i>		I
smooth softshell turtle	<i>Apalone mutica</i>		III
western hognose snake	<i>Heterodon nasicus</i>		I
Fish			
blacknose shiner	<i>Notropis heterolepis</i>		III

Table 7. North Dakota state and federal special/sensitive status species listed by the USFWS or the NDGFD.

Common Name	Scientific Name	USFWS NDGFD
blue sucker	<i>Cycleptus elongatus</i>	I
central stoneroller	<i>Campostoma anomalum</i>	III
chestnut lamprey	<i>Ichthyomyzon castaneus</i>	III
finescale dace	<i>Phoxinus neogaeus</i>	III
flathead catfish	<i>Pylodictis olivaris</i>	III
flathead chub	<i>Platygobio gracilis</i>	II
hornyhead chub	<i>Nocomis biguttatus</i>	III
logperch	<i>Percina caprodes</i>	III
northern redbelly dace	<i>Phoxinus eos</i>	II
paddlefish	<i>Polyodon spathula</i>	II
pallid sturgeon	<i>Scaphirhynchus albus</i>	II
pearl dace	<i>Margariscus margarita</i>	I
pugnose shiner	<i>Notropis anogenus</i>	III
river darter	<i>Percina shumardi</i>	III
rosyface shiner	<i>Notropis rubellus</i>	III
sicklefin chub	<i>Macrhybopsis meeki</i>	I
silver chub	<i>Macrhybopsis storeriana</i>	II
silver lamprey	<i>Ichthyomyzon unicuspis</i>	III
sturgeon chub	<i>Macrhybopsis gelida</i>	I
trout-perch	<i>Percopsis omiscomaycus</i>	II
yellow bullhead	<i>Ameiurus natalis</i>	III
Mollusks		
black sandshell	<i>Ligumia recta</i>	II
creek heelsplitter	<i>Lasmigona compressa</i>	II
mapleleaf	<i>Quadrula quadrula</i>	II
pink heelsplitter	<i>Potamilus alatus</i>	II
pink papershell	<i>Potamilus ohiensis</i>	III
threeridge	<i>Amblema plicata</i>	II
Wabash pigtoe	<i>Fusconaia flava</i>	II
black sandshell	<i>Ligumia recta</i>	II
Insects		
Dakota skipper	<i>Hesperia dacotae</i>	C
American burying beetle	<i>Nicrophorus americanus</i>	E

USFWS: C-Candidate; E-Endangered; EA-Bald and Golden Eagle Protection Act; SoC-Species of Concern; T-Threatened

NDGFD: E-Endangered; T-Threatened; Levels are for species of State Conservation Concern: Level-I - Species in greatest need of conservation; Level-II - Species in need of conservation, but that have had support from other wildlife programs; Level-III - Species in moderate need of conservation, but that are on the edge of their range in North Dakota

Data from ND Outdoors (2004) and the USFWS Online (2008). Additionally, prairie grouse species considered a SoC by the USFWS (2004).

Table 8. Summary of sensitive species observed at the TCWRA during fixed-point bird use surveys (FP) and as incidental wildlife observations (Inc), June 5 – October 29, 2007.

Common Name	Scientific Name	USFWS Status	NDGFD Status	FP		Inc		Total	
				Grps	Obs	Grps	Obs	Grps	Obs
northern harrier	<i>Circus cyaneus</i>		II	26	30	9	9	35	39
Swainson's hawk	<i>Buteo swainsoni</i>		I	10	11	7	9	17	20
sharp-tailed grouse	<i>Tympanuchus phasianellus</i>	SoC*	II	1	1	2	17	3	18
grasshopper sparrow	<i>Ammodramus savannarum</i>		I	7	8	0	0	7	8
prairie falcon	<i>Falco mexicanus</i>		II	2	2	1	1	3	3
upland sandpiper	<i>Bartramia longicauda</i>		I	3	3	0	0	3	3
golden eagle	<i>Aquila chrysaetos</i>	EA	II	2	2	0	0	2	2
lark bunting	<i>Calamospiza melanocorys</i>		I	2	2	0	0	2	2
loggerhead shrike	<i>Lanius ludovicianus</i>		II	1	1	1	1	2	2
marbled godwit	<i>Limosa fedoa</i>		I	1	1	1	1	2	2
Baird's sparrow	<i>Ammodramus bairdii</i>		I	1	1	0	0	1	1
ferruginous hawk	<i>Buteo regalis</i>		I	0	0	1	1	1	1
peregrine falcon	<i>Falco peregrinus</i>		III	1	1	0	0	1	1
short-eared owl	<i>Asio flammeus</i>		II	1	1	0	0	1	1
Overall				58	64	22	39	80	103

USFWS: C-Candidate; E-Endangered; EA-Bald and Golden Eagle Protection Act; SoC-Species of Concern; T-Threatened

NDGFD: E-Endangered; T-Threatened; Levels are for species of State Conservation Concern: Level-I - Species in greatest need of conservation; Level-II - Species in need of conservation, but that have had support from other wildlife programs; Level-III - Species in moderate need of conservation, but that are on the edge of their range in North Dakota.

Data from ND Outdoors (2004) and the USFWS Online (2008). Additionally, prairie grouse species considered a SoC by the USFWS (2004).

Table 9. Summary of AnaBat results of the acoustic bat surveys conducted at the TCWRA, May 23 – September 22, 2007.

AnaBat Location	# of HF Bat Passes	# of LF Bat Passes	Total Bat Passes	Detector-Nights	Bat Passes/Det-Night
2024 (south)	25	42	67	53	1.26
2037 (north)	33	26	59	59	1.00
Total	58	68	126	112	1.13

Table 10. Incidental wildlife observed while conducting all surveys at the TCWRA.

Species	Scientific Name	# grps	#obs
Birds			
sandhill crane	<i>Grus canadensis</i>	1	33
sharp-tailed grouse	<i>Tympanuchus phasianellus</i>	2	17
ring-necked pheasant	<i>Phasianus colchicus</i>	4	14
northern harrier	<i>Circus cyaneus</i>	9	9
Swainson's hawk	<i>Buteo swainsoni</i>	7	9
red-tailed hawk	<i>Buteo jamaicensis</i>	3	3
mallard	<i>Anas platyrhynchos</i>	1	2
vesper sparrow	<i>Pooecetes gramineus</i>	1	2
broad-winged hawk	<i>Buteo platypterus</i>	1	1
ferruginous hawk	<i>Buteo regalis</i>	1	1
great-horned owl	<i>Bubo virginianus</i>	1	1
loggerhead shrike	<i>Lanius ludovicianus</i>	1	1
marbled godwit	<i>Limosa fedoa</i>	1	1
merlin	<i>Falco columbarius</i>	1	1
northern flicker	<i>Colaptes auratus</i>	1	1
prairie falcon	<i>Falco mexicanus</i>	1	1
savannah sparrow	<i>Passerculus sandwichensis</i>	1	1
unidentified hawk		1	1
white-throated sparrow	<i>Zonotrichia albicollis</i>	1	1
Bird Subtotal		39	100
Mammals			
pronghorn antelope	<i>Antilocapra americana</i>	8	36
white-tailed deer	<i>Odocoileus virginianus</i>	7	13
eastern cottontail	<i>Silvilagus floridanus</i>	2	5
mule deer	<i>Odocoileus hemionus</i>	3	3
coyote	<i>Canis latrans</i>	1	1
Mammal Subtotal		21	58

Table 11. All bird and raptor fatality estimates for several wind-energy facilities in the US.

Facility Name	# of Turbines	# of MW	Bird Fatalities		Raptor Fatalities	
			/Turbine	/MW	/Turbine	/MW
Altamont, CA ¹	5,400	518	0.90	8.1	0.14	1.50
Montezuma Hills, CA ²	600	60	NA	NA	0.05	0.48
San Geronio, CA ³	2,900	300	2.31	9.23	0.01	0.04
Stateline, OR/WA ⁴	454	300	1.93	2.56	0.05	0.08
Vansycle, OR ⁵	38	25	0.63	0.96	0	0
Klondike, OR ⁶	16	24	1.42	0.95	0	0
Nine Canyon, WA ⁷	37	48	3.59	2.76	0.07	0.05
Foote Creek Rim, WY Phase I and II ^{8,9}	72	43	1.50	2.50	0.03	0.05
Foote Creek Rim, WY Phase III ⁹	33	25	1.49	1.99	0.04	0.06
Wisconsin (MG&E and PSC) ¹⁰	31	20	1.30	1.97	0	0
Buffalo Ridge, MN, Phase I ¹¹	73	22	0.98	3.27	0.01	0.04
Buffalo Ridge, MN, Phase II ¹¹	143	107	2.27	3.03	0	0
Buffalo Ridge, MN, Phase III ¹¹	139	104	4.45	5.93	0	0
Buffalo Mountain, TN ¹²	3	2	7.70	11.55	0	0
Mountaineer, WV ¹³	44	68	4.04	3.00	NA	NA
Top of Iowa, IA ¹⁴	89	80	0.65	0.72	.01	.01

¹Smallwood and Thelander 2004; ²Howell et al. 1991; ³McCrary et al. 1986; ⁴WEST, Inc. and Northwest Wildlife Consultants, Inc. 2004; ⁵Erickson et al. 2000c; ⁶Johnson et al. 2003b; ⁷WEST, Inc. and Northwest Wildlife Consultants, Inc. 2003; ⁸Young et al. 2003c; ⁹Young et al. 2003c; ¹⁰Howe et al. 2002; ¹¹Johnson et al. 2000b; ¹²Nicholson 2001; ¹³Kerns and Kerlinger 2004; ¹⁴Koford et al. 2005.

Table 12. Bat mortality estimates at US wind-energy facilities.

Location and Number of Turbines	Turbine Size	Year	Number of Bat Fatalities Found	Annual Bat Fatalities per Turbine	Annual Bat Fatalities per MW
Buffalo Ridge, MN Phase 1 73 turbines ^{1,2,3}	330 kw 53 m high	1994- 1998	20	0.1	0.3
Buffalo Ridge, MN Phase 2&3 281 turbines ^{3,4,5}	750 kw 74 m high	1998- 2002	400	2.0	2.7
Kewaunee County, WI 31 turbines ⁶	660 kw 89 m high	1999- 2001	72	4.3	6.5
Foote Creek Rim, WY 105 turbines ^{7,8,9,10}	660 kw 61 m high	1999- 2002	135	1.3	2.0
Buffalo Mountain, TN 3 turbines ^{11, 12}	660 kw 89 m high	2001- 2003	119	19.7	29.8
Mountaineer, WV 44 turbines ¹³	1.5 MW 102 m high	2003	475	40.9	27.3
Stateline, OR/WA border 399 turbines ¹⁴	660 kw 74 m high	1999- 2003	150	1.1	1.7
Klondike, OR ¹⁵ 16 turbines	1.5 MW 100 m high	2002	6	1.2	0.8
Vansycle, OR ¹⁶ 38 turbines	660 kw 74 m high	1999	28	0.7	1.1
Nine Canyon, WA ¹⁷ 37 turbines	1.3 MW 91 m high	2003	27	3.2	2.5

¹Osborn et al. 1996; ²Johnson et al. 2000a; ³Johnson et al. 2003a; ⁴Johnson et al. 2003c; ⁵Krenz and McMillan 2000; ⁶Howe et al. 2002; ⁷Johnson et al. 2000b; ⁸Young et al. 2002; ⁹Young et al. 2003c; ¹⁰Gruver 2002; ¹¹Nicholson 2001; ¹²Nichololon 2003; ¹³Kerns and Kerlinger 2004; ¹⁴Erickson et al. 2004; ¹⁵Johnson et al. 2003b; ¹⁶Erickson et al. 2000a; ¹⁷Erickson et al. 2003c.

Table 13. Wind-energy facilities in the US with both pre-construction AnaBat sampling data and post-construction mortality data for bat species (adapted from Kunz et al. 2007b).

Wind-Energy Facility	Activity (#/detector night)	Mortality (bats/turbine/year)	Reference
Two Creeks, ND	1.13	–	This study
Foote Creek Rim, WY	2.2	1.3	Gruver 2002
Buffalo Ridge, MN	2.1	2.2	Johnson et al. 2004
Buffalo Mountain, TN	23.7	20.8	Fiedler 2004
Top of Iowa, IA	34.9	10.2	Koford et al. 2005
Mountaineer, WV	38.3	38.0	Arnett et al. 2005

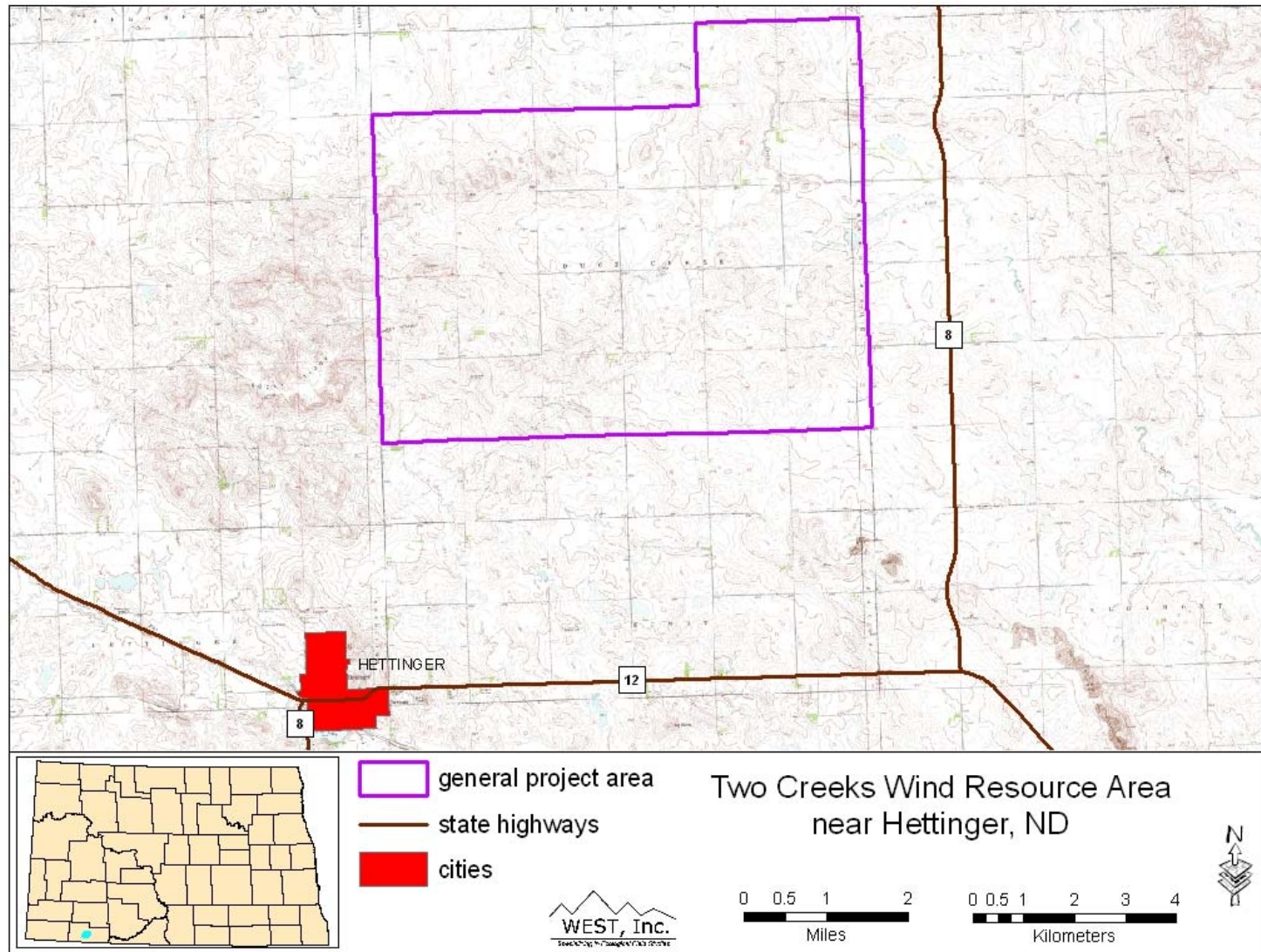


Figure 1. Location of the TCWRA.

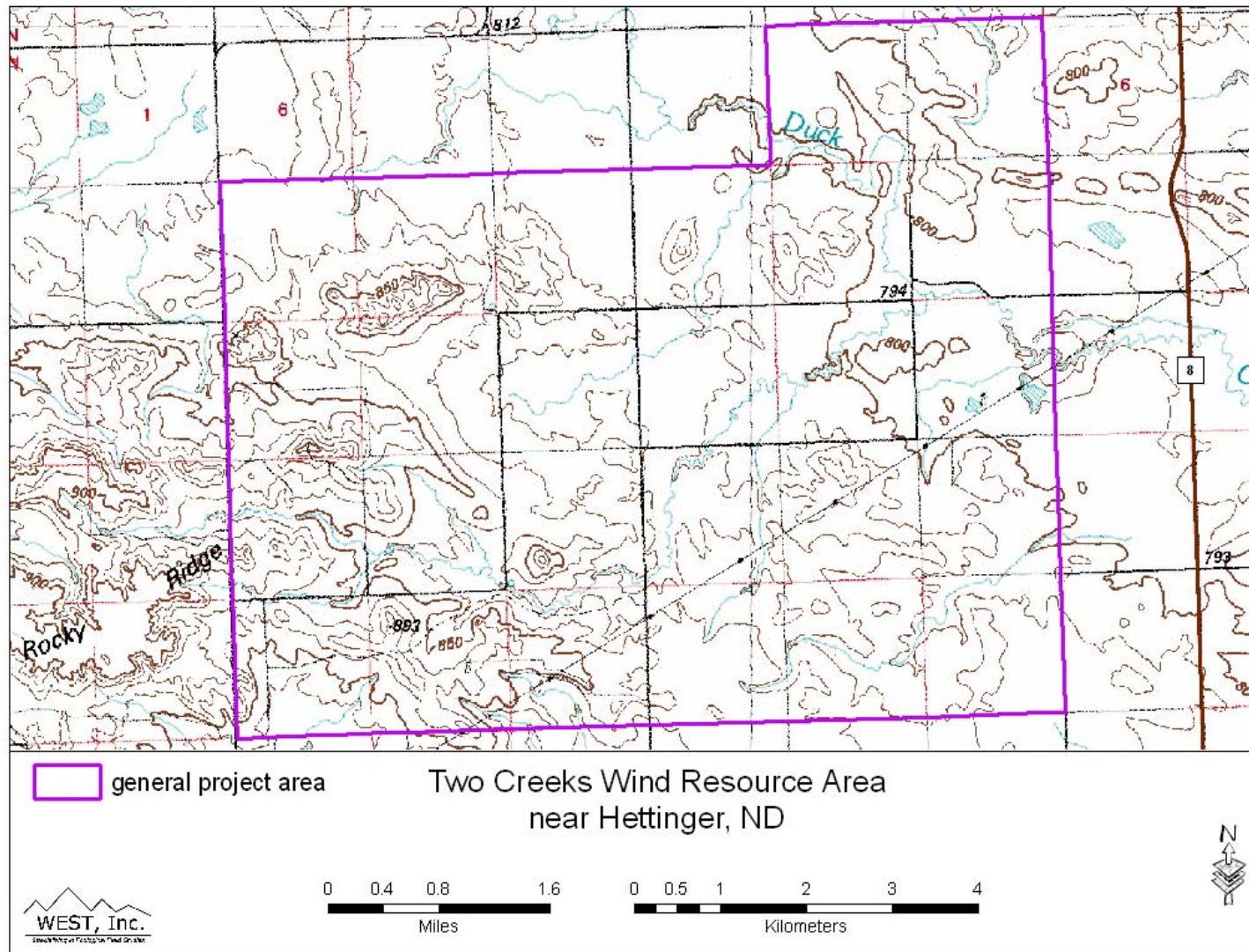


Figure 2. Overview of the TCWRA.

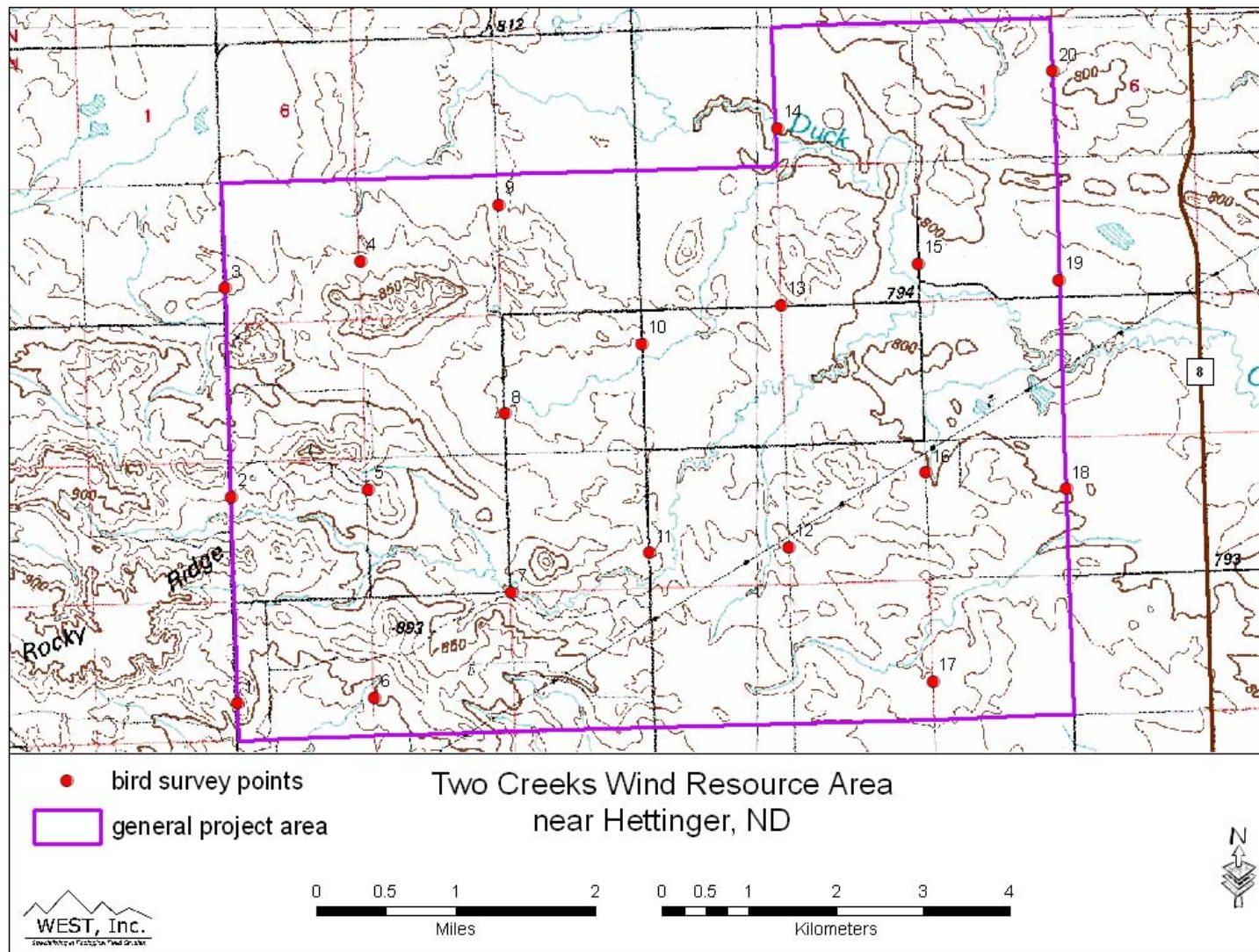


Figure 3. Fixed-point bird use survey points at the TCWRA.

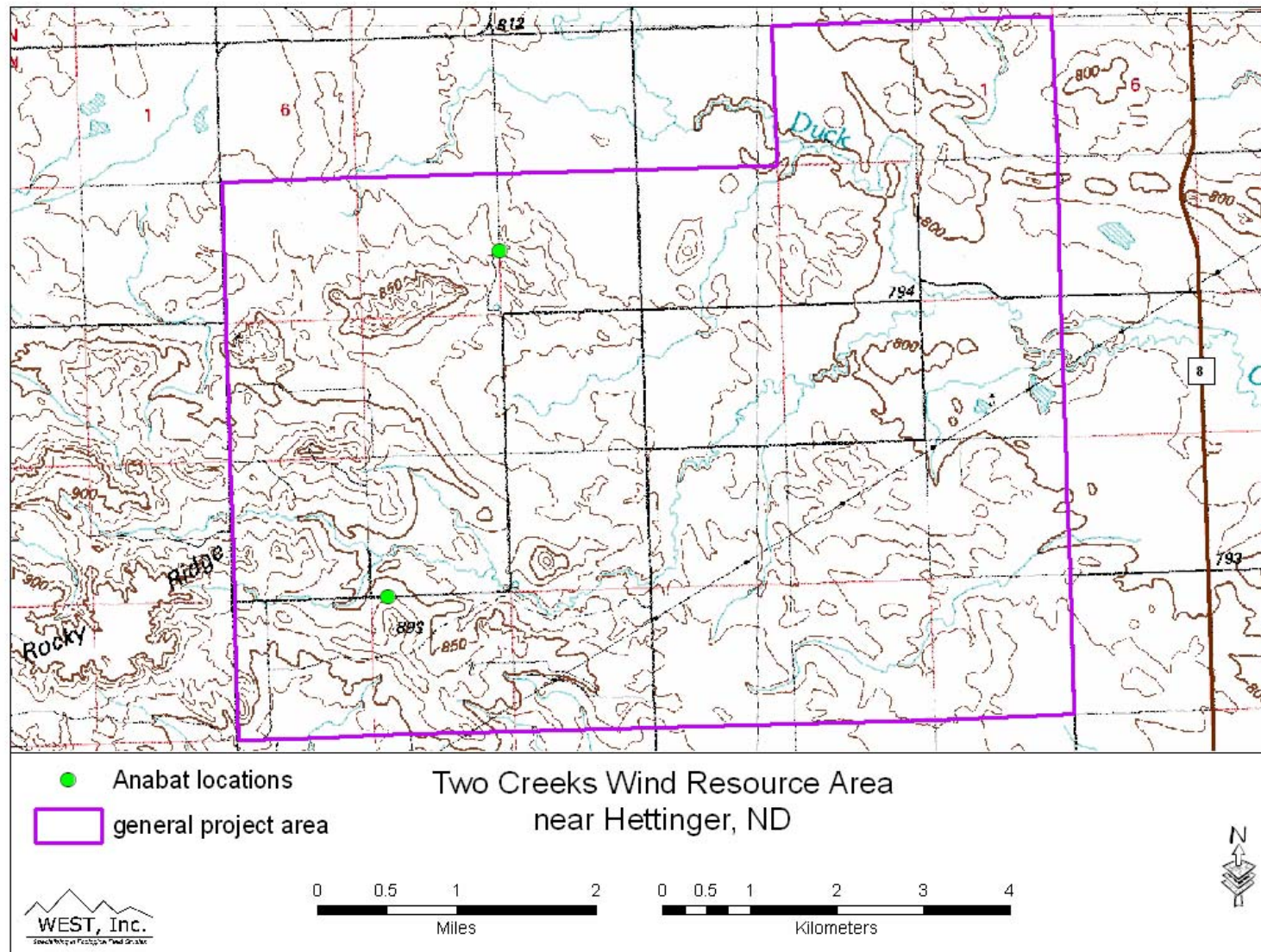


Figure 4. AnaBat sampling locations at the TCWRA.

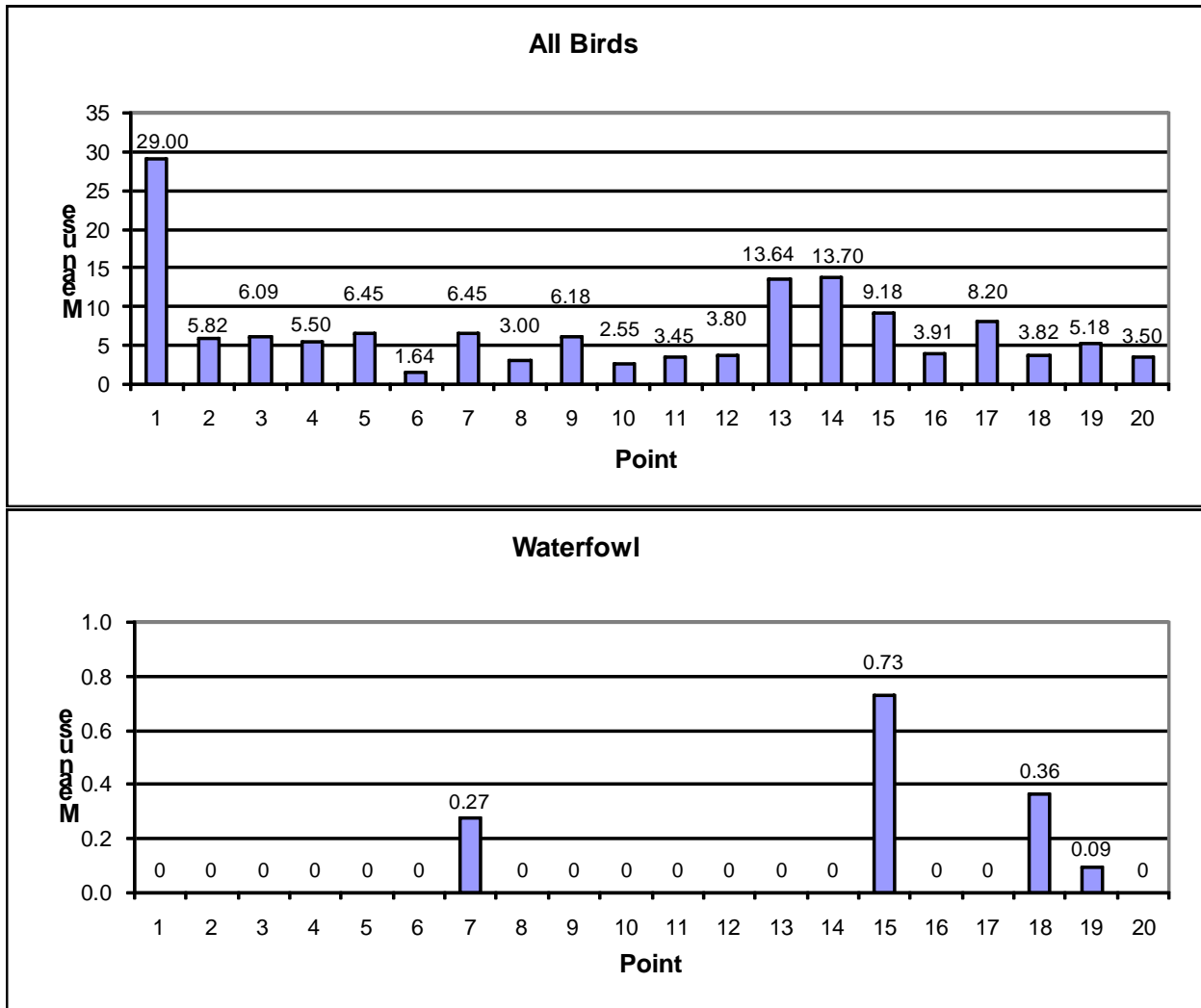


Figure 5a-b. Mean use (birds/20-min survey) at each fixed-point bird use survey point for all birds and waterfowl at the TCWRA.

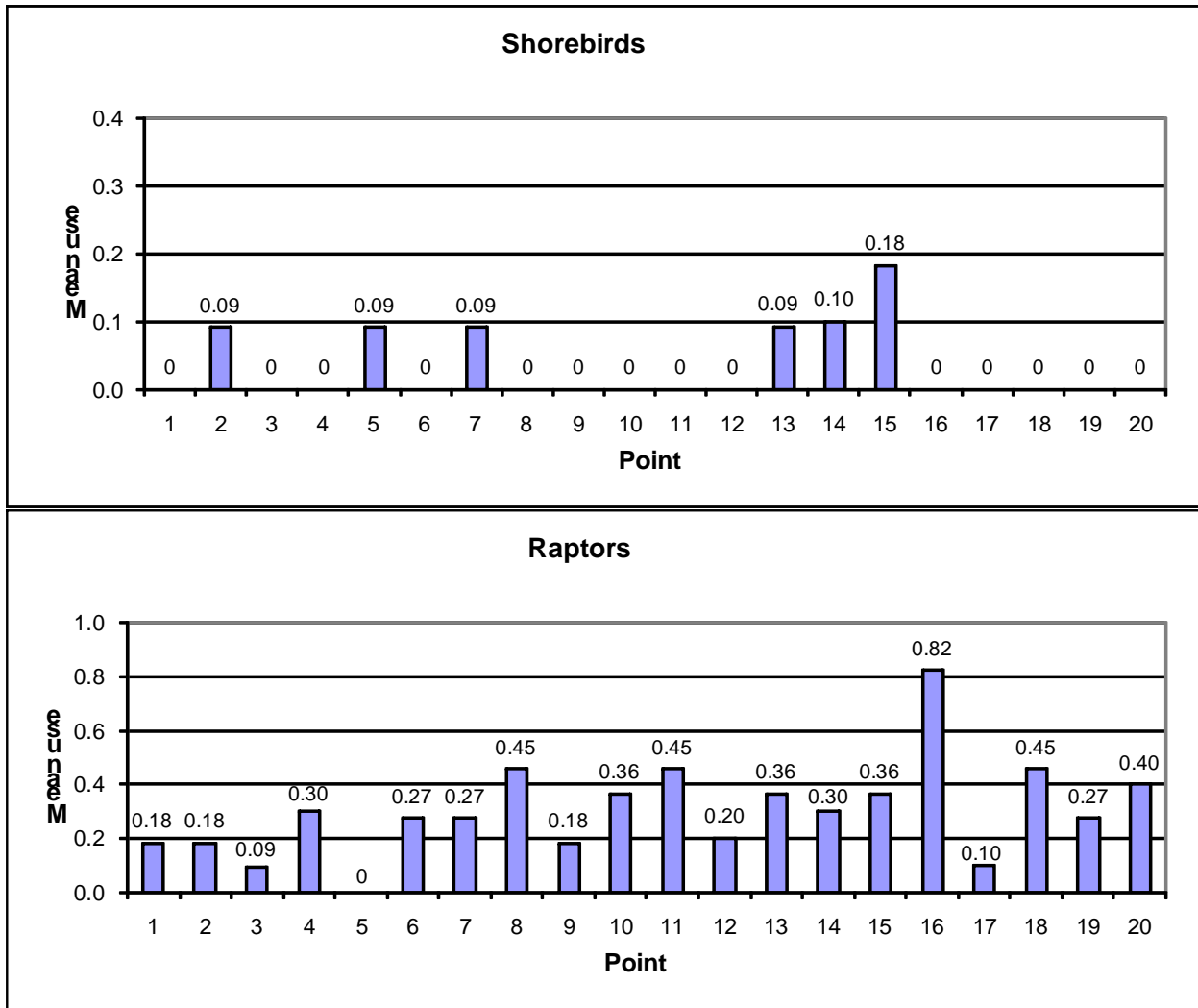


Figure 5 c-d. Mean use (birds/20-min survey) at each fixed-point bird use survey point for shorebirds and raptors at the TCWRA.

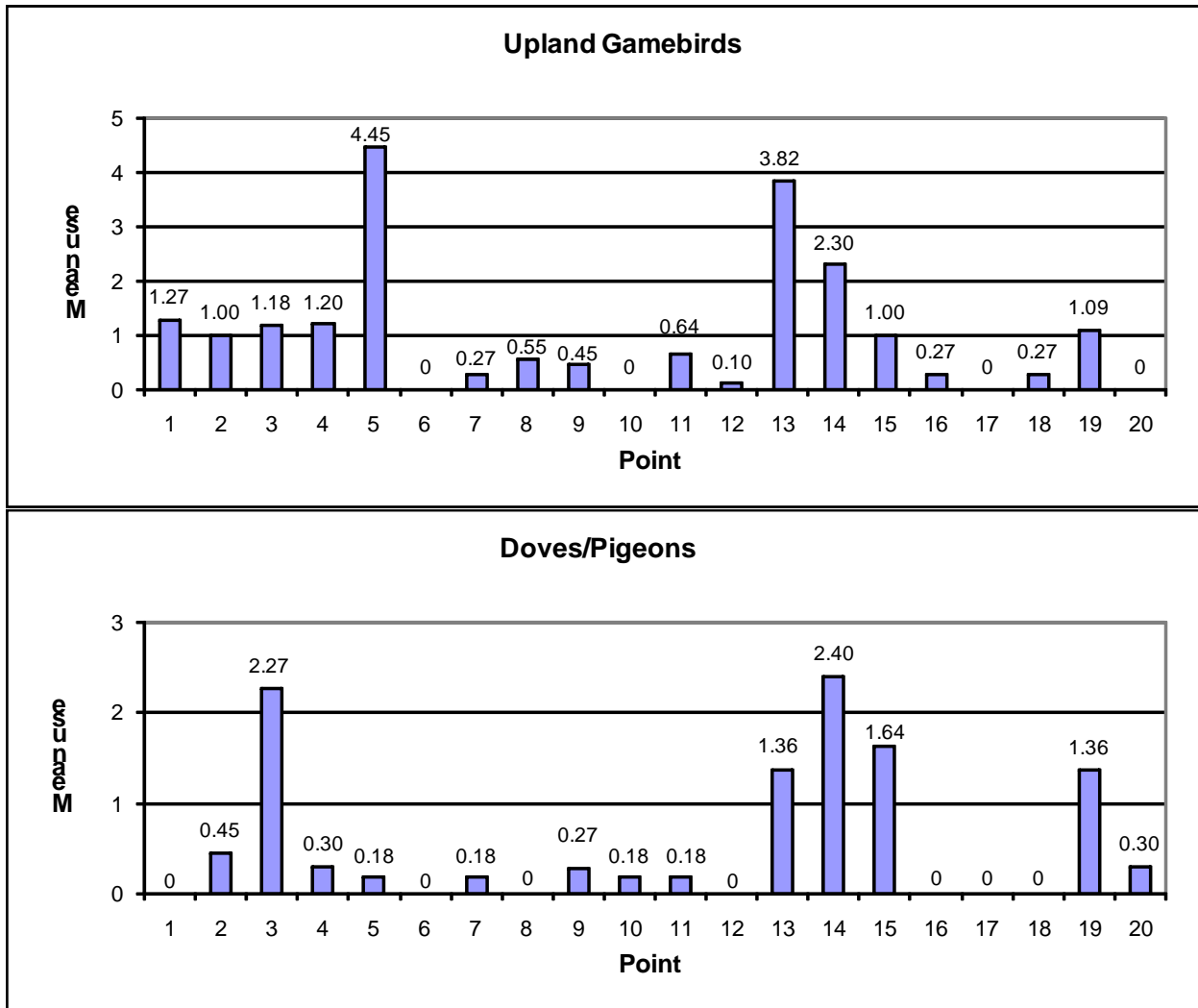


Figure 5 e-f. Mean use (birds/20-min survey) at each fixed-point bird use survey point for upland gamebirds and dove/pigeons at the TCWRA.

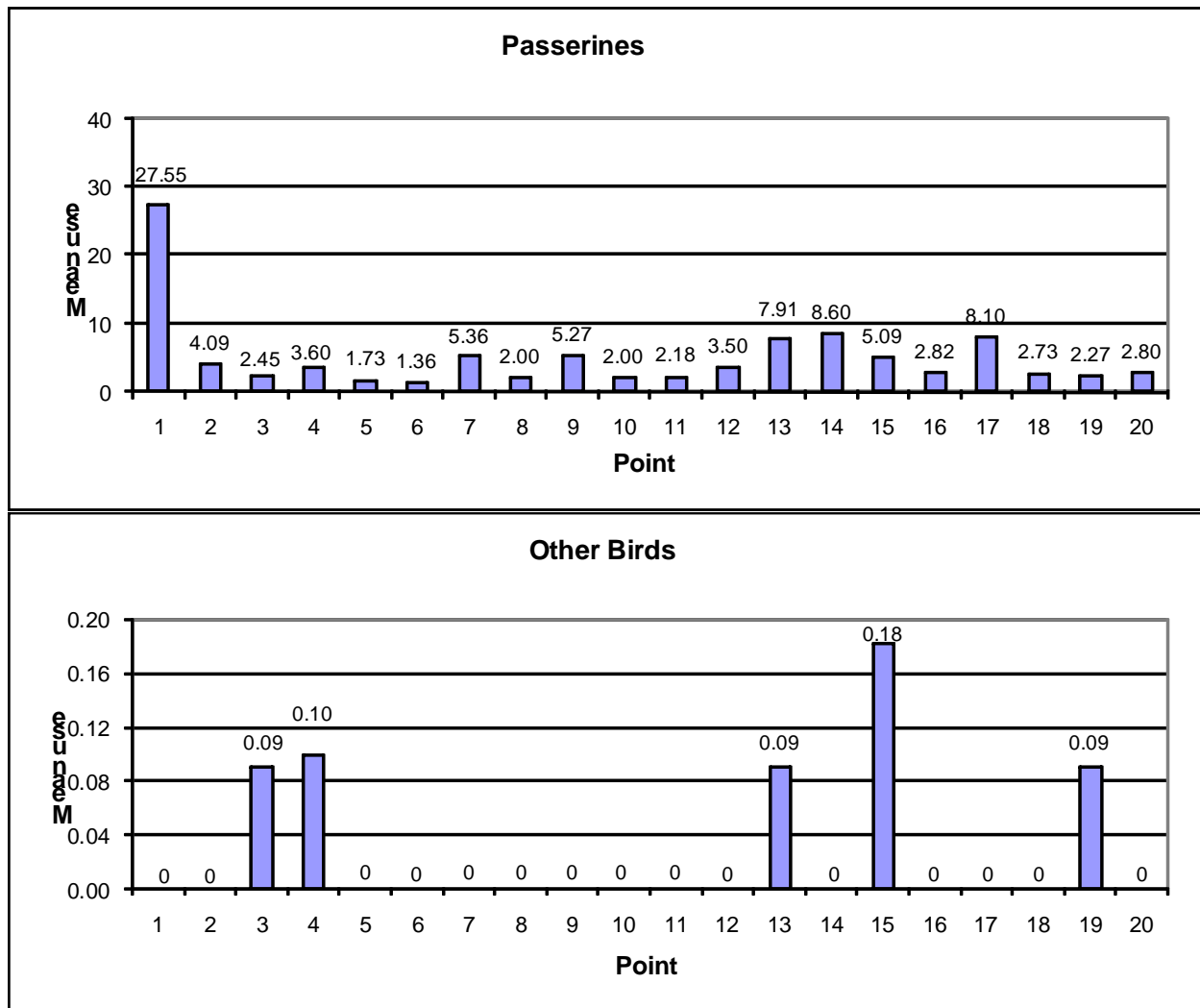


Figure 5 g-h. Mean use (birds/20-min survey) at each fixed-point bird use survey point for passerines and other birds at the TCWRA.

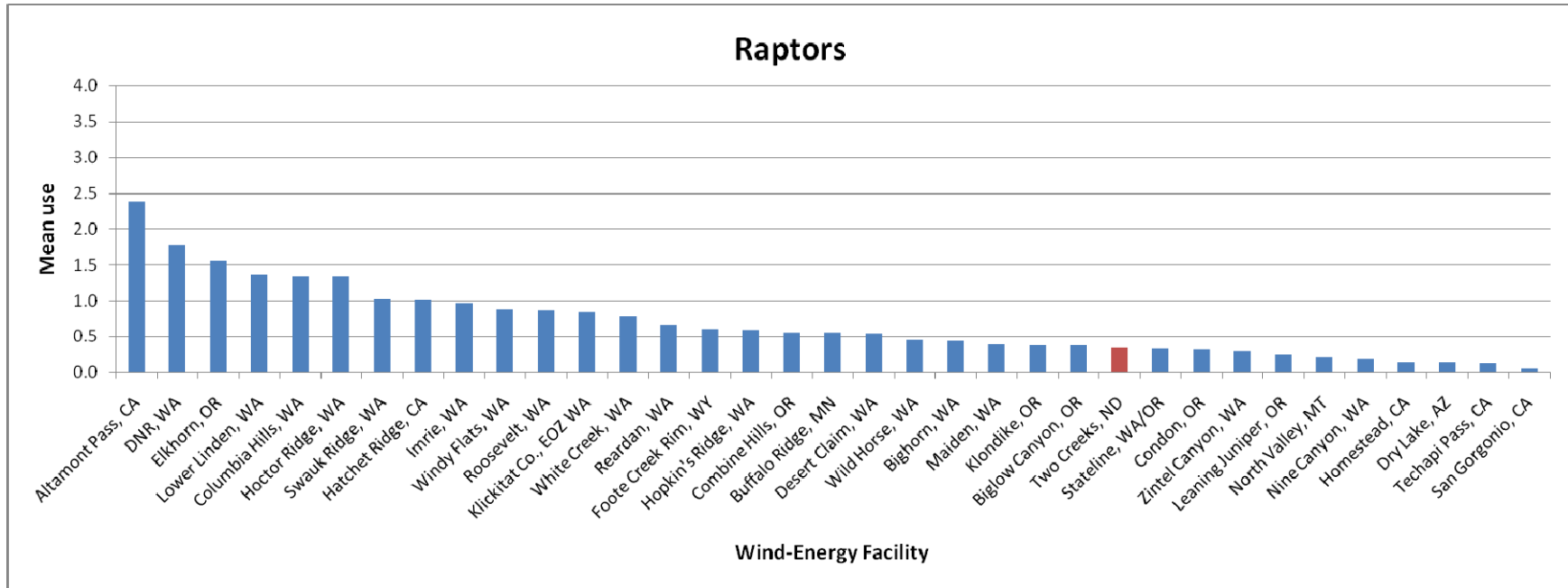


Figure 6. Comparison of raptor use in the summer between the TCWRA and other US wind-energy facilities.

Data from the following sources:

Location	Source	Location	Source	Location	Source	Location	Source
Two Creeks, ND	This study						
Altamont Pass, CA	Erickson et al. 2002	Windy Flats, WA	Johnson et al. 2007	Wild Horse, WA	Erickson et al. 2003b	Leaning Juniper, OR	NWC and WEST 2005b
DNR, WA	Johnson et al. 2006	Roosevelt, WA	NWC and WEST 2004	Big Horn, WA	Johnson et al. 2004a	North Valley, MT	
Elkhorn, OR	WEST 2005a	Klickitat Co., EOZ WA	WEST and NWC 2003a	Invenergy_Vantage	WEST 2007 b	Nine Canyon, WA	Erickson et al. 2001a
Lower Linden, WA	Johnson 2007b	White Creek, WA	NWC and WEST 2005a	Maiden, WA	Erickson et al. 2002	Homestead, CA	WEST et al. 2007
Columbia Hills, WA	Erickson et al. 2002	Reardon, WA	WEST 2005b	Klondike, OR	Johnson et al. 2002	Dry Lake, AZ	Young et al. 2007c
Hocor Ridge, WA	Johnson et al. 2006b	Footo Creek Rim, WY	Erickson et al. 2002	Biglow Canyon, OR	WEST 2007	Tehachapi Pass, CA	Erickson et al. 2002
Swauk Ridge, WA	Erickson et al. 2003a	Hopkin's Ridge, WA	Young et al. 2003a	Biglow Reference	WEST 2007	San Geronio, CA	Erickson et al. 2002
Hatchet Ridge, CA	Young et al. 2007b	Combine Hills, OR	Young et al. 2003d	Stateline, WA/OR	Erickson et al. 2002		
Imrie, WA	Johnson et al. 2006c	Buffalo Ridge, MN	Erickson et al. 2002	Condon, OR	Erickson et al. 2002		
		Desert Claim, WA	Young et al. 2003b	Zintel Canyon, WA	Erickson et al. 2002		

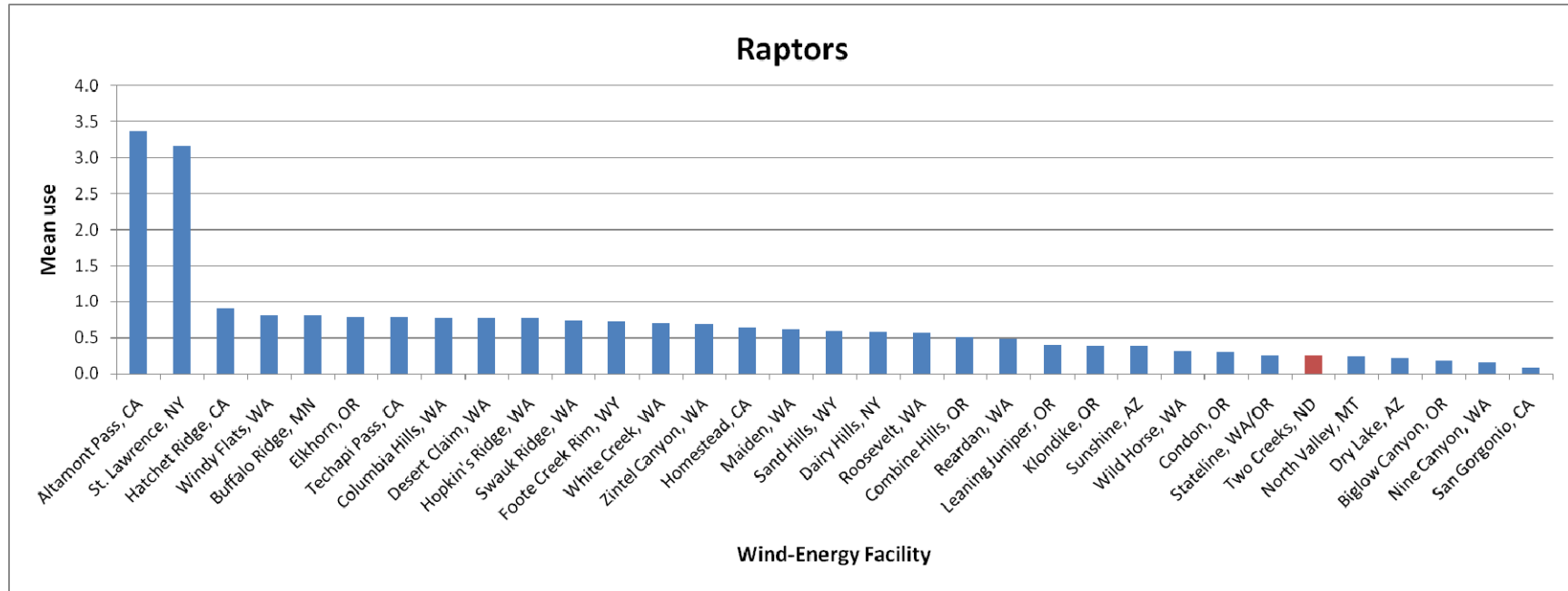


Figure 7. Comparison of raptor use in the fall between the TCWRA and other US wind-energy facilities.

Data from the following sources:

Location	Source	Location	Source	Location	Source	Location	Source
Two Creeks, ND	This study						
Altamont Pass, CA	Erickson et al. 2002	Desert Claim, WA		Sand Hills, WY		Wild Horse, WA	
St. Lawrence, NY		Hopkin's Ridge, CA		Dairy Hills, NY		Condon, OR	Erickson et al. 2002
Hatchet Ridge, CA		Swauk Ridge, WA		Roosevelt, WA		Stateline, WA/OR	Erickson et al. 2002
Windy Flats, WA		Footee Creek Rim, WY	Erickson et al. 2002	Combine Hills, OR		North Valley, MT	
Buffalo Ridge, MN	Erickson et al. 2002	White Creek, WA		Reardon, WA		Dry Lake, AZ	
Elkhorn, OR		Zintel Canyon, WA	Erickson et al. 2002	Leaning Juniper, OR		Biglow Canyon, OR	
Tehachapi Pass, CA	Erickson et al. 2002	Homestead, CA		Klondike, OR		Nine Canyon, WA	
Columbia Hills, WA	Erickson et al. 2002	Maiden, WA	Erickson et al. 2002	Sunshine, AZ		San Geronio, CA	Erickson et al. 2002

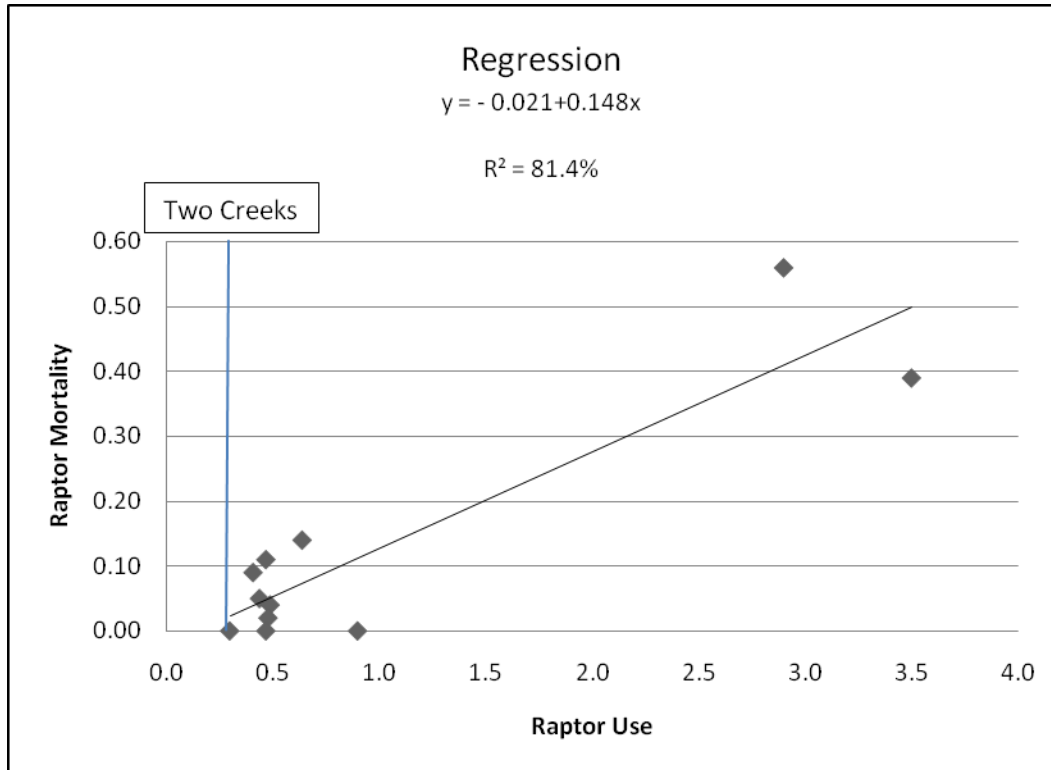


Figure 8. Regression analysis comparing raptor use estimations versus estimated raptor mortality.

Data from the following sources:

Raptor Use	Raptor Mortality	Wind-Energy Facility	Study
0.3	0	Vansycle, OR	Erickson et al. 2000b
0.41	0.09	Stateline WA/OR	Erickson et al. 2002
0.44	0.05	Nine Canyon Phase I and II, WA	Erickson et al. 2002
0.47	0	Klondike, OR	Johnson et al. 2003b
0.47	0.11	Klondike II, OR	NWC and WEST 2007
0.48	0.02	Buffalo Ridge, MN	Erickson et al. 2002
0.49	0.04	Foote Creek Rim, WY	Erickson et al. 2002
0.64	0.14	Hopkin's Ridge	Young et al. 2007a
0.9	0	Combine Hills, OR	Young et al. 2005
2.9	0.56	Diablo Winds, CA	WEST 2006a
3.5	0.39	High Winds, CA	Kerlinger et al. 2005a

**Wildlife Baseline Studies for the
Thunder Spirit Wind Resource Area
Adams County, North Dakota**

**Final Report
April 2011 – March 2012**

Prepared for:

Thunder Spirit Wind LLC

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February 12, 2013



NATURAL RESOURCES ♦ SCIENTIFIC SOLUTIONS

EXECUTIVE SUMMARY

Thunder Spirit Wind LLC has proposed development of the Thunder Spirit Wind Resource Area (TSWRA) near the town of Hettinger in Adams County, North Dakota. Thunder Spirit Wind LLC requested that Western EcoSystems Technology, Inc. develop and assist in implementing a standardized protocol for baseline wildlife studies. The principal objectives of the study were to: 1) provide site-specific bird resource and use data and 2) provide information that could be used in project planning and design of the facility to minimize impacts to birds. Results pertaining to bat surveys are included in a separate report. Baseline surveys were conducted from April 6, 2011, through March 13, 2012.

The objective of the fixed-point bird use surveys was to estimate the seasonal and spatial use of the project area by birds, particularly raptors. Four hundred 20-min fixed-point bird use surveys were conducted at 25 points within the TSWRA during the course of 18 visits.

A total of 3,386 individual bird observations within 715 separate groups were recorded during the fixed-point surveys. Regardless of bird size, two species accounted for 58.2% of the observations: sandhill cranes and horned larks. The most abundant large bird species observed was the sandhill crane (1,125 individuals). The most abundant small bird species was the horned lark with 844 individuals recorded. Two hundred ninety-six individual raptors in 228 groups were recorded within the TSWRA, representing eight species. The northern harrier was the raptor species observed most often (123 individuals), followed by the Swainson's hawk (99).

The highest overall large bird use occurred during spring (17.93 birds/plot/20-min survey); mean use in summer was 2.27, 1.43 in fall, and 1.78 in winter. Small bird use was highest during winter (5.99) followed by summer (4.49), fall (3.30), and spring (2.84). Raptor use was highest in fall (1.12 birds/plot/20-min survey) compared to spring (0.97), summer (0.74), and winter (0.18). Higher fall use was mostly due to Swainson's hawks, northern harriers, and red-tailed hawks.

Passerine use (excluding large corvids) was highest in winter (5.99 birds/plot/20-min survey) followed by summer (4.48), fall (3.30), and spring (2.81). Horned larks had the highest use of any passerine species in winter (4.53 birds/plot/20-min survey) and fall (2.40). In summer, lark buntings had the highest passerine use (0.95 birds/plot/20-min survey) while the western meadowlark had the highest use (0.60) in spring.

Flight height characteristics were observed during fixed-point surveys. Overall, 79.5% of large birds observed flying were initially observed within the rotor-swept-heights (RSH). Waterbirds had the highest percentage of flying birds within the RSH (95.6%) followed by buteos with 85.4% and waterfowl (73.7%; Table 3). Overall, raptors were observed within the RSH 50.6% of the time. A relative collision risk exposure index was calculated for each bird species. Sandhill cranes had a collision risk exposure index (3.02), higher than any other large bird species. The raptor with the highest collision risk exposure index was the Swainson's hawk (0.15). The

passerine species with the highest collision risk exposure index was the snow bunting with an index of 0.05.

Incidental wildlife observations were recorded while conducting fixed-point surveys, moving between fixed-point locations, and traveling in the TSWRA. Twenty-seven bird species were observed incidentally, totaling 910 birds within 146 groups. The most commonly observed bird was the Canada goose (404 individuals), followed by the northern pintail (100) and sharp-tailed grouse (88). Overall, seven species of raptors and four owl species were observed incidentally. Five bird species were only observed incidentally. Five mammal species were observed incidentally; the most commonly observed species were the pronghorn (87) and white-tailed deer (50).

No federally-listed threatened or endangered species were observed in the TSWRA. The Sprague's pipit, is a candidate species for listing under the Endangered Species Act; three individuals were observed during the study. Overall, twenty-one sensitive bird species were observed during the study. The Swainson's hawk (150 individuals) was the most commonly observed sensitive species, followed by the northern harrier (142), and northern pintail (141). One bald eagle and six golden eagles were observed; eagles are protected under the Bald and Golden Eagle Protection Act. Several species observed are North Dakota 100 Species of Conservation Priority.

Annual raptor use in the TSWRA (0.68 raptors/plot/20-min survey) was compared to annual raptor use at other wind energy facilities. Based on the results from these facilities, a ranking of mean annual raptor use was developed. Using this ranking, mean raptor use in the TSWRA is considered to be low to moderate. Compared to the other wind energy facilities, raptor use in the TSWRA ranked 14 of 44 projects reviewed.

Based on the relative abundance of Swainson's hawks throughout the year and a higher exposure index than other raptor species, there is higher potential for Swainson's hawks fatalities compared to other species. It is expected that risk to raptors would be slightly higher during fall.

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INTRODUCTION

Thunder Spirit Wind LLC (Thunder Spirit) has proposed development of the Thunder Spirit Wind Resource Area (TSWRA) in Adams County, North Dakota (Figure 1). Thunder Spirit requested that Western EcoSystems Technology, Inc. (WEST) develop and assist in implementing a standardized protocol for baseline wildlife studies in the TSWRA. Studies were conducted to estimate impacts of the proposed wind energy facility on wildlife and to assist with siting turbines to minimize impacts to wildlife resources.

The principal objectives of the study were to: 1) provide site-specific bird resource and use data that would be useful in evaluating potential impacts from the proposed facility and 2) provide information that could be used in project planning and design of the facility to minimize impacts to birds. Results from bat surveys are presented in a separate report.

Baseline surveys were conducted from April 6, 2011, through March 13, 2012, and consisted of fixed-point bird use surveys, acoustic bat surveys, raptor nest surveys, and sharp-tailed grouse lek surveys. This report includes a detailed discussion on the avian use survey aspects of the surveys, with bat studies (Derby and Sichmeller 2013) and raptor nest and lek surveys (Derby and Thorn 2013) discussed in separate reports. In addition to site-specific data, this report presents existing information and results of studies conducted at other wind energy facilities. Where possible, comparisons with regional and local studies were made.

STUDY AREA

The proposed TSWRA is in Adams County, North Dakota, approximately 3.6 kilometers (2.2 miles) northeast of Hettinger, North Dakota (Figure 1). The general boundary of the TSWRA encompasses about 9,310.2 hectares (ha; 23,006 acres [ac]). The area is a mixed landscape of grassland (about 53%) and agricultural areas (about 46%), including small areas of rural homes, shrubs and trees, and other developed areas. Elevation ranges from 779 to 902 feet (ft; 237.4 to 274.9 meters [m]) above sea level. There are about 210.4 ha (520 ac) of wetlands in 97 basins, excluding streams; about 96% of those wetlands are freshwater emergent wetlands (USFWS NWI 2011).

The number and size of wind turbines that will be installed within TSWRA area is currently unknown.

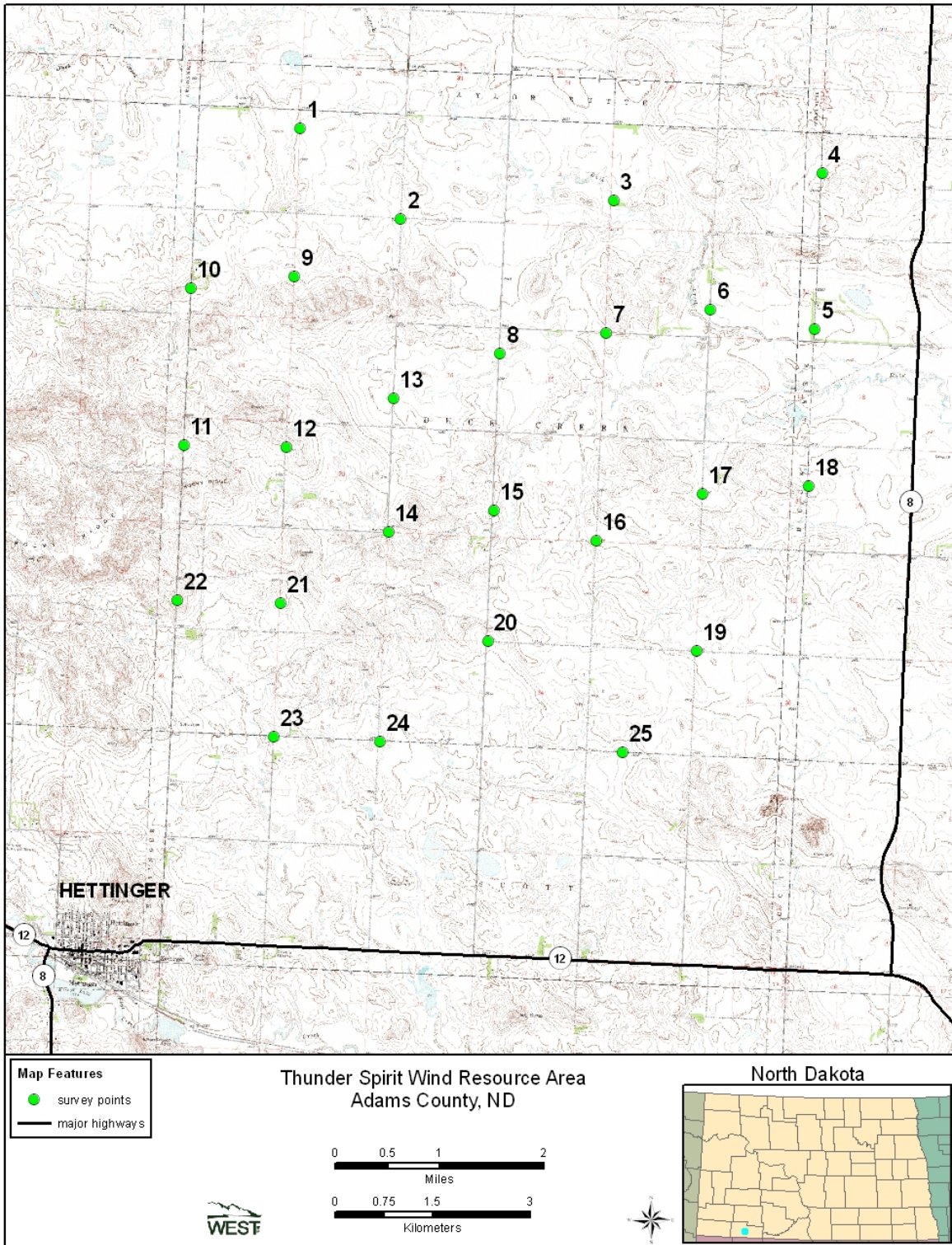


Figure 1. Location and fixed-point survey locations of the Thunder Spirit Wind Resource Area in Adams County, North Dakota.

METHODS

The baseline wildlife studies for avian species at TSWRA consisted of fixed-point bird use surveys. Incidental wildlife observations were recorded while conducting fixed-point bird use surveys.

Fixed-Point Bird Use Surveys

The objective of the fixed-point bird use surveys was to estimate the seasonal and spatial use of the project area by birds, particularly raptors (defined here as kites, accipiters, buteos, harriers, eagles, falcons, and ospreys [*Pandion haliaetus*]). Fixed-point surveys (variable circular plots) were conducted using methods described by Reynolds et al. (1980).

Bird Use Survey Plots

Twenty-five points were selected to encompass representative habitats and topography of the TSWRA, while also providing relatively even coverage of the area (Figure 1). Each survey plot was an 800-m (2,625-ft) radius circle centered on the point.

Bird Use Survey Methods

An attempt was made to record all birds observed during each 20-minute (min) fixed-point survey, regardless of distance from observer. Observations of large birds beyond the 800-m radius were recorded, but were not included in the statistical analyses; for small birds, observations beyond the 100-m (328-ft) radius were excluded from analysis. Large birds included waterbirds, waterfowl, shorebirds, raptors, owls, upland game birds, doves/pigeons, large corvids (e.g., ravens, magpies, and crows), and goatsuckers. Passerines (excluding large corvids) and woodpeckers were considered small birds.

The date, start and end time of the survey period, and weather information (e.g., temperature, wind speed, wind direction, and cloud cover) were recorded for each survey. Species or best possible identification, number of individuals, sex and age class (if possible), distance from plot center when first observed, closest distance, altitude above ground, activity (behavior), and habitat(s) were recorded for each observation. The behavior of each bird observed, and the vegetation type in which or over which the bird occurred, were recorded based on the point of first observation. Approximate flight height and distance from plot center at first observation were recorded to the nearest 5-m (16-ft) interval. Other information recorded about the observation included whether or not the observation was auditory only and the 10-min interval of the 20-min survey in which it was first observed. Locations of raptors, other large birds, and species of concern observed during fixed-point surveys were recorded on field maps.

Incidental wildlife observations were recorded while conducting fixed-point surveys, moving between fixed-point locations, and traveling in the TSWRA. All raptors, unusual or unique birds, and sensitive bird species were documented. All mammals, reptiles, and amphibians were also recorded. The observation number, date, time, species, number of individuals, sex/age class, distance from observer, activity, height above ground (for bird species), and habitat were recorded. The location of sensitive species was recorded.

Bird Use Observation Schedule

Each fixed-point bird use survey point was surveyed approximately every two weeks in fall (September 1 to November 15) and spring (March 15 to May 31) with even numbered points surveyed one week and odd numbered points the next week, and once per month during summer (June 1 to August 31) and winter (November 16 to March 14).

Surveys were carried out during daylight hours and survey periods varied to approximately include all daylight hours during a season. To the extent practical, each point was surveyed the same number of times. However, the schedule varied in response to adverse weather conditions (e.g., fog and/or rain) which caused delays and/or missed surveys.

Statistical Analysis

Fixed-Point Bird Use Surveys

Species lists, (with number of observations and groups) were generated by season and included all observations of birds detected, regardless of their distance from the observer (Appendix A).

Species Diversity and Species Richness

Bird diversity was illustrated by the total number of unique species observed. Species richness was calculated as the mean number of species observed per plot per survey (i.e., number of species/plot/20-min survey). Species richness by season was calculated by first 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.

Bird Use, Percent of Use, and Frequency of Occurrence

For the standardized fixed-point bird use estimates, only observations of large birds detected within the 800-m radius plot were used in the analysis. For small birds, only observations within a 100-m radius were used. The metric used to represent mean bird use was number of birds per plot per 20-minute survey. A visit is defined as the length of time it takes to survey all of the points one time. Mean use by season was calculated by first averaging the total number of birds observed within each plot during a visit, then averaging across plots within each visit, followed by averaging across visits within the season. Overall mean use was calculated as a weighted average of seasonal values by the number of days in each season. Estimates of mean bird use (i.e., number of birds/plot/20-min survey) were used to compare differences between bird types, seasons, survey points, and other wind energy facilities.

Percent of use was calculated as the proportion of large or small bird mean use that was attributable to a particular bird type or species. Frequency of occurrence was calculated as the percent of surveys in which a particular bird type or species was observed. When considered together, frequency of occurrence and percent composition provide relative measures of species use of the proposed wind energy facility. For example, a particular species might have

high use estimates based on just a few observations of large groups and the frequency of occurrence would indicate that the species only occurred during a few of the surveys. Therefore, even though the species exhibited high use, only a few, large groups accounted for that use, suggesting that the species might be less likely to be negatively affected by the construction and operation of the wind energy facility. Conversely, a species that has a relatively low percentage of use, but a relatively high frequency of occurrence would have longer-term exposure to the facility, increasing the likelihood that this species may be affected by the facility.

Bird Flight Height and Behavior

The flight height recorded during the initial observation was used to calculate mean flight height and the percentage of birds flying within the likely rotor-swept height (RSH) for collision with turbine blades of 25 – 150 m (82 to 492 ft) above ground level. This is the blade height range of turbines that could be used in the TSWRA. The percentage of individuals flying within the RSH at any time was calculated using the lowest and highest flight heights recorded.

Collision Risk Exposure Index

The exposure index is used as a relative measure of how often birds fly at heights similar to heights of turbine blades of modern wind turbines, thus putting them at risk for collision. A relative index of collision risk exposure (R) was calculated for bird species observed during the fixed-point bird use surveys using the following formula:

$$R = A * P_f * P_t$$

where A equals mean relative use for species *i* (large bird observations within 800 m of the observer or 100 m for small birds) averaged across all surveys, P_f equals the proportion of all observations of species *i* where activity was recorded as flying (an index to the approximate percentage of time species *i* spends flying during the daylight period), and P_t equals the proportion of all initial flight height observations of species *i* within the likely RSH.

Spatial Use

Data were analyzed by comparing use among plots to look for areas of concentrated use by raptors and other large birds within the TSWRA. This information can be useful in turbine layout design or for micro-siting turbine location.

RESULTS

Surveys were completed from April 6, 2011 through March 13, 2012. Seventy-three bird species and five mammal species were observed.

Fixed-Point Bird Use Surveys

Four hundred 20-min fixed-point bird use surveys were conducted within the TSWRA during the course of 18 visits (Table 1).

Table 1. Number of visits, surveys, unique species, and species richness (species/plot^a/20-min survey) by season, observed during fixed-point bird use surveys at the Thunder Spirit Wind Resource Area from April 6, 2011, to March 13, 2012.

Season	Number of Visits	Number of Surveys	Number of Unique Species	Species Richness	
				Large Birds	Small Birds
Spring	4	79	51	1.68	1.73
Summer	4	90	47	1.29	2.52
Fall	5	120	21	0.80	0.58
Winter	5	111	16	0.38	0.34
Overall	18	400	68	0.97	1.24

^a 800-meter radius for large birds and 100-meter radius for small birds

A total of 3,682 individual bird observations within 943 separate groups were recorded during the fixed-point surveys (Appendix A). Regardless of bird size, two species (2.9% of all unique species observed during fixed-point surveys) accounted for 53.5% of the observations: sandhill cranes (*Grus canadensis*) and horned larks (*Eremophila alpestris*). All other species accounted for less than 5% of the observations individually. The most abundant large bird species observed was the sandhill crane (1,125 individuals in 4 groups; Appendix A). The most abundant small bird species was the horned lark with 844 individuals recorded within 91 groups.

Two hundred ninety-six individual raptors in 228 groups were recorded within the TSWRA, representing eight species (Appendix A). The northern harrier (*Circus cyaneus*) was the raptor species observed most often (123 individuals in 109 groups), followed by the Swainson's hawk (*Buteo swainsoni*; 99 individuals in 47 groups).

Species Diversity and Species Richness

Sixty-eight unique species were observed during fixed-point bird use surveys (species diversity), with a mean of 0.97 species/800-m plot/20-min survey (species richness) for large birds and a mean of 1.24 species/100-m plot/20-min survey for small birds (Table 1). Species diversity was highest during spring (51 species) compared to summer (47), fall (21), and winter (16). Species richness for large birds was highest in spring (1.68 species/survey), followed by summer (1.29), fall (0.80), and winter (0.38). Small bird species richness was highest in summer (2.52 species/survey) followed by spring (1.73), fall (0.58), and winter (0.34; Table 1).

Bird Use, Percent of Use, and Frequency of Occurrence

Mean bird use, percent of use, and frequency of occurrence were calculated by season for all bird types and raptor subtypes (Table 2) and species (Appendix B-1 and B-2). The highest overall large bird use occurred during spring (17.93 birds/plot/20-min survey); mean use in summer was 2.27, 1.43 in fall, and 1.78 in winter (Table 2). Small bird use was highest during winter (5.99) followed by summer (4.49), fall (3.30), and spring (2.84).

Table 2. Mean bird use (number of birds/plot^a/20-min survey), percent of total use (%), and frequency of occurrence (%) by bird type, raptor subtype, and season, observed during fixed-point bird use surveys at the Thunder Spirit Wind Resource Area April 6, 2011, to March 13, 2012.

Bird Type / Subtype	Bird Use				% of Use				% Frequency			
	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter
Waterbirds	14.80	0	0	0	82.6	0	0	0	5.3	0	0	0
Waterfowl	1.24	0.39	0.05	0.96	6.9	17.3	3.5	53.6	35.6	18.5	0.8	3.5
Shorebirds	0.20	0.15	0	0	1.1	6.5	0	0	15.1	10.2	0	0
Gulls/Terns	0.18	0	0	0	1.0	0	0	0	1.3	0	0	0
Raptors	0.97	0.74	1.12	0.18	5.4	32.5	77.9	9.9	54.7	45.2	51.7	17.6
<i>Buteos</i>	0.42	0.24	0.82	0.09	2.3	10.4	57.6	5.0	32.9	19.2	34.2	9.0
<i>Northern Harrier</i>	0.54	0.48	0.28	0.04	3.0	21.1	19.2	2.4	35.8	33.5	25.8	4.3
<i>Eagles</i>	0.01	0.01	<0.01	0.03	<0.1	0.4	0.6	1.5	1.3	1.0	0.8	2.6
<i>Falcons</i>	0	0	<0.01	0	0	0	0.6	0	0	0	0.8	0
<i>Other Raptors</i>	0	0.01	0	0.02	0	0.6	0	0.9	0	1.2	0	1.7
Owls	0.01	0.02	0	<0.01	<0.1	1.1	0	0.5	1.2	1.2	0	0.8
Upland Game Birds	0	0.12	0.05	0.34	0	5.1	3.5	18.8	0	11.5	2.5	11.5
Doves/Pigeons	0.13	0.82	0.21	0.31	0.7	36.1	14.5	17.3	6.3	22.2	10.8	2.5
Large Corvids	0.39	0.03	0	0	2.2	1.4	0	0	5.1	3.2	0	0
Goatsuckers	0	0	<0.01	0	0	0	0.6	0	0	0	0.8	0
Large Birds Overall	17.93	2.27	1.43	1.78	100	100	100	100				
Passerines ^b	2.81	4.48	3.30	5.99	99.1	99.8	100	100	78.2	90.8	51.7	30.9
Woodpeckers	0.03	0.01	0	0	0.9	0.2	0	0	1.3	1.0	0	0
Small Birds Overall	2.84	4.49	3.30	5.99	100	100	100	100				

^a. 800-meter radius for large birds and 100-meters for small birds.

^b excluding large corvids

Waterbirds

Waterbirds, consisting only of sandhill cranes, were only observed in spring (14.80 birds/plot/20-min survey; Table 2; Appendix A). Sandhill cranes accounted for about 83% of large bird use in spring and but observed in only 5.3% of spring surveys (i.e., a few larger flocks).

Waterfowl

Waterfowl had highest use in spring (1.24 birds/plot/20-min survey; Table 2). Waterfowl accounted for about 53.6% of large bird use in winter, 17.3% of use in summer, and 6.9% of use in spring. Percent of use for waterfowl in fall was relatively small (3.5%). Waterfowl were observed more frequently in spring and summer surveys (Table 2) than in other seasons.

Shorebirds

Shorebird were observed only in spring and summer and bird use was similar in both seasons (0.20 birds/plot/20-min survey in spring 0.15 in summer; Table 2). Shorebirds accounted for 6.5% of overall large bird use in summer and 1.1% in spring. Shorebirds were observed during 15.1% of the surveys in spring and 10.2% of summer surveys (Table 2).

Gulls/Terns

The ring-billed gull (*Larus delawarensis*) was the only gull/tern observed during fixed-point surveys and they were only observed during spring (0.18 birds/plot/20-min survey; Table 2; Appendix A). The ring-billed gull accounted for 1.0% of overall large bird use in spring and was observed during 1.3% of the surveys in spring (Table 2).

Raptors

Raptor use was highest in fall (1.12 birds/plot/20-min survey) compared to spring (0.97), summer (0.74), and winter (0.18; Table 2). Higher fall use was mostly due to Swainson's hawks, northern harrier, and red-tailed hawk (*Buteo jamaicensis*; 0.55 birds/plot/20-min survey, 0.28, and 0.22, respectively; Appendix B-1). The raptor subtypes buteos and northern harrier exhibited highest use in fall whereas the raptor subtype eagles use was highest in winter (0.03). In fall, raptors accounted for about 77.9% of mean large bird use and in summer raptors accounted for 32.5% of use; in spring and winter, raptors accounted for less than 10% of mean use (Table 2). Raptors were observed during 54.7% of surveys in spring, 51.7% in fall, 45.2% in summer, and 17.6% in winter (Table 2).

Owls

Owl use was recorded during spring, summer, and winter; use was highest in summer (0.02 birds/plot/20-min survey), 0.01% in spring, and <0.01 in winter (Table 2). Owls accounted for 1.1% of overall large bird use during summer and <1% during spring and winter. Owls were observed during 1.2% of surveys in spring and summer and 0.8% of winter surveys (Table 2).

Upland Game Birds

Upland game birds had higher use during winter (0.34 birds/plot/20-min survey) than in summer (0.12) and fall (0.05; Table 2); upland game birds were not observed during spring. Upland game birds accounted for 18.8% of overall large bird use in winter, 5.1% of summer use, and

3.5% in fall. Upland game birds were observed during 11.5% of surveys in summer and winter and 2.5% in fall (Table 2).

Doves/Pigeons

Highest use by doves/pigeons was recorded during summer (0.82 birds/plot/20-min survey) compared to other seasons (Table 2). Doves/pigeons accounted for 36.1% of overall large bird use during summer, 17.3% during winter, 14.5% during fall, and less than 0.7% during spring. Doves/pigeons were observed in 22.2% of summer surveys compared to 11.0% or less in other seasons (Table 2).

Large Corvids

American crow (*Corvus brachyrhynchos*) was the only large corvid observed and it was only observed in spring and summer (Table 2; Appendix A). Use by this species was higher in spring (0.39 birds/plot/20-min survey) than in summer (0.03; Table 2; Appendix B-1). American crows accounted for 2.2% of overall large bird use in spring and 1.4% in summer. Crows were observed during 5.1% of spring surveys and 3.2% of summer surveys (Table 2).

Goatsuckers

The common nighthawk (*Chordeiles minor*) was the only goatsucker observed; one individual was observed during fall (Appendix A). Use by this species was <0.01 birds/plot/20-min survey, accounted for 0.6% of overall large bird use in fall, and was observed during 0.8% of fall surveys (Table 2).

Passerines

Passerine use (excluding large corvids) was highest in winter (5.99 birds/plot/20-min survey) followed by summer (4.48), fall (3.30), and spring (2.81; Table 2). Horned larks had the highest use of any passerine species in winter (4.53 birds/plot/20-min survey) and fall (2.40; Appendix B-2). In summer, lark buntings (*Calamospiza melanocorys*) had the highest passerine use (0.95 birds/plot/20-min survey) while the western meadowlark (*Sturnella neglecta*) had the highest use (0.60) in spring. Passerine use accounted for >99% of small bird use in all seasons (Table 2). Passerines were observed in 90.8% of summer surveys, 78.2% of spring surveys, 51.7% of fall surveys, and 30.9% of winter surveys.

Woodpeckers

Woodpeckers were only observed in spring and summer; use was higher in spring (0.03 birds/plot/20-min survey) than in summer (0.01; Table 2). Woodpeckers accounted for <1% of bird use in spring and summer. Woodpeckers were observed during 1.3% of surveys in spring and 1.0% of surveys in summer.

Bird Flight Height and Behavior

Flight height characteristics were summarized for both bird types (Table 3) and bird species (Appendices C-1 and C-2) observed during fixed-point surveys.

For large bird species, 306 single birds or groups totaling 1,747 individuals were observed flying within the 800-m plot (Table 3). Overall, 79.5% of large birds observed flying were recorded initially within the RSH, 17.6% were below the RSH, and 3.0% were observed flying above the RSH. Waterbirds had the highest percentage birds flying initially within the RSH (95.6%) followed by buteos with (85.4%), waterfowl (73.7%), and eagles (60%; Table 3). Overall, flying raptors were observed within the RSH 50.6% of the time. Thirteen percent of flying northern harriers were observed within the RSH. The only raptor subtype to fly above the RSH was buteo (1.6%). Flying waterbirds also flew above the RSH (4.4%).

A total of 1,357 passerines (excluding large corvids) and other small birds in 300 groups were recorded flying within 100 meters of the survey plots. The majority of flying passerines were observed below the RSH (94.6%), while 5.4% were recorded within the RSH; no passerines were observed flying above the RSH (Table 3).

Of all large bird species, four species had at least 20 groups observed flying (Appendix C-1). Of these four species, flying Swainson's hawks were observed within the RSH at any time during 97.4% of observations followed by the red-tailed hawk (90.3%), mallard (*Anas platyrhynchos*; 56.8%), and northern harrier (21.7%; Appendix C-1).

Of all passerine (excluding large corvids) and small bird species, four species had at least 20 groups observed flying (Appendix C-2). Of those species, the horned lark was recorded flying within the RSH (at any time) 7.1% of the time. The other three species, the western meadowlark, lark bunting, and red-winged blackbird (*Agelaius phoeniceus*), did not fly within the RSH.

Table 3. Flight height characteristics by bird type^a and raptor subtype, observed during fixed-point bird use surveys at the Thunder Spirit Wind Resource Area from April 6, 2011 to March 13, 2012.

Bird Type/Subtype	Number of Groups Flying	Number Observed Flying	Flight Height (meters)	% Observed Flying	% within Flight Height Categories		
					0 - 25 meters	25 - 150 meters ^b	> 150 meters
Waterbirds	4	1,125	162.50	100	0	95.6	4.4
Waterfowl	50	194	25.70	78.2	26.3	73.7	0
Shorebirds	18	23	9.72	79.3	82.6	17.4	0
Gulls/Terns	1	14	20.00	100	100	0	0
Raptors	191	245	35.79	82.8	48.6	50.6	0.8
<i>Buteos</i>	81	123	63.98	75.5	13.0	85.4	1.6
<i>Northern Harrier</i>	103	115	13.37	93.5	87.0	13.0	0
<i>Eagles</i>	5	5	35.00	83.3	40.0	60.0	0
<i>Falcons</i>	0	0	0	0	0	0	0
Other Raptors	2	2	51.00	66.7	50.0	50	0
Owls	1	2	10.00	50.0	100	0	0
Upland Game Birds	10	22	1.50	40.7	100	0	0
Doves/Pigeons	27	92	11.19	61.7	70.7	29.3	0
Large Corvids	3	29	23.33	87.9	48.3	51.7	0
Goatsuckers	1	1	15.00	100	100	0	0
Large Birds Overall	306	1,747	30.65	89.5	17.6	79.5	3.0
Passerines ^c	299	1,356	4.66	81.2	94.6	5.4	0
Woodpeckers	1	1	10.00	33.3	100	0	0
Small Birds Overall	300	1,357	4.68	81.2	94.6	5.4	0

^a 800-meter radius for large birds and 100-meter for small birds.

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

^c excluding large corvids

Collision Exposure Index

A relative collision risk exposure index was calculated for each bird species (Table 4 and Appendices C-1 and C-2). Sandhill cranes had a collision risk exposure index (3.02) higher than other large bird species. The raptor with the highest exposure index was the Swainson's hawk (0.15); all other raptor species had a collision risk exposure index of 0.04 or less (Table 4).

Based on observations within 100 m, the identified passerine species (excluding large corvids) with the highest collision risk exposure index was the snow bunting (*Plectrophenax nivalis*), with an index of 0.05, followed by the horned lark (0.02) and common grackle (<0.01; Table 4).

Table 4. Relative collision risk exposure index, mean bird use (number of birds/plot^c/20-min survey), and flight characteristics for bird species^a observed during fixed-point bird use surveys at the Thunder Spirit Wind Resource Area from April 6, 2011 to March 13, 2012.

Species	Number of Groups Flying	Overall Mean Use	% Flying	% Flying Within RSH ^b Based on Initial Observation	Exposure Index	% Within RSH at Any Time
Large Bird Species^c						
sandhill crane	4	3.16	100	95.6	3.02	95.6
Canada goose	6	0.29	95.0	100	0.27	100
Swainson's hawk	37	0.2	77.8	94.8	0.15	97.4
rock pigeon	9	0.24	68.4	41.5	0.07	56.9
northern pintail	13	0.11	85.4	57.1	0.06	60.0
mallard	22	0.21	58.7	38.6	0.05	56.8
red-tailed hawk	29	0.09	70.5	64.5	0.04	90.3
American crow	3	0.09	87.9	51.7	0.04	51.7
northern harrier	103	0.31	93.5	13.0	0.04	21.7
rough-legged hawk	15	0.05	78.9	80.0	0.03	86.7
unidentified duck	2	0.02	100	100	0.02	100
golden eagle	5	0.01	100	60.0	<0.01	80.0
killdeer	14	0.06	85.7	11.1	<0.01	11.1
marbled godwit	2	0.01	60.0	66.7	<0.01	66.7
gadwall	3	0.01	80.0	25.0	<0.01	25.0
unidentified hawk	2	<0.01	66.7	50.0	<0.01	50.0
Small Bird Species^c						
unidentified passerine	6	0.28	99.0	44.7	0.12	59.2
snow bunting	1	0.05	100	100	0.05	100
horned lark	70	2.11	95.7	0.8	0.02	7.1
common grackle	8	0.04	93.3	7.1	<0.01	7.1

^a Only includes species with exposure indices greater than zero;

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

^c 800-meter radius for large birds and 100-meter for small birds

Spatial Use

For all large bird species combined, use was highest at points 4 and 18 (32.4 birds/20-min survey and 30.6 respectively; Figure 2; Appendix D). Bird use at other points ranged from 7.39 to 0.50 birds/20-min survey. The relatively higher mean use estimates for points 4 and 18 was largely due to waterbird use.

Raptor use was highest at points 21 (2.77 birds/20-min survey) and 25 (2.08) and ranged from 0.06 to 1.47 birds/20-min survey at other points (Figure 2). The higher raptor use at these two points was mainly due to use by buteos; buteo use was highest at points 21 (2.46 birds/20-min survey) and 25 (1.77). Eagle use, recorded at five points, was highest at point 9 (0.20 birds/20-min survey). Northern harriers were observed at all points except 23 and use was highest at point 17 (1.00 birds/20-min survey).

Waterfowl use was highest at point 22 (3.53 birds/20-min survey) and ranged from zero to 1.50 at other points. Upland game bird use was highest at points 5 (0.72 birds/20-min survey) and 9 (0.60). Shorebird use was highest at point 14 (0.33 birds/20-min survey); use at other points ranged from zero to 0.28 birds/20-min survey (Appendix D).

Passerine (excluding large corvids) use, focused within 100 m, was highest at point 19 with 22.4 birds/20-min survey. The second highest use occurred at point 25 (11.3). Mean use at other points ranged from 0.71 to 7.57 birds/20-min survey (Figure 2).

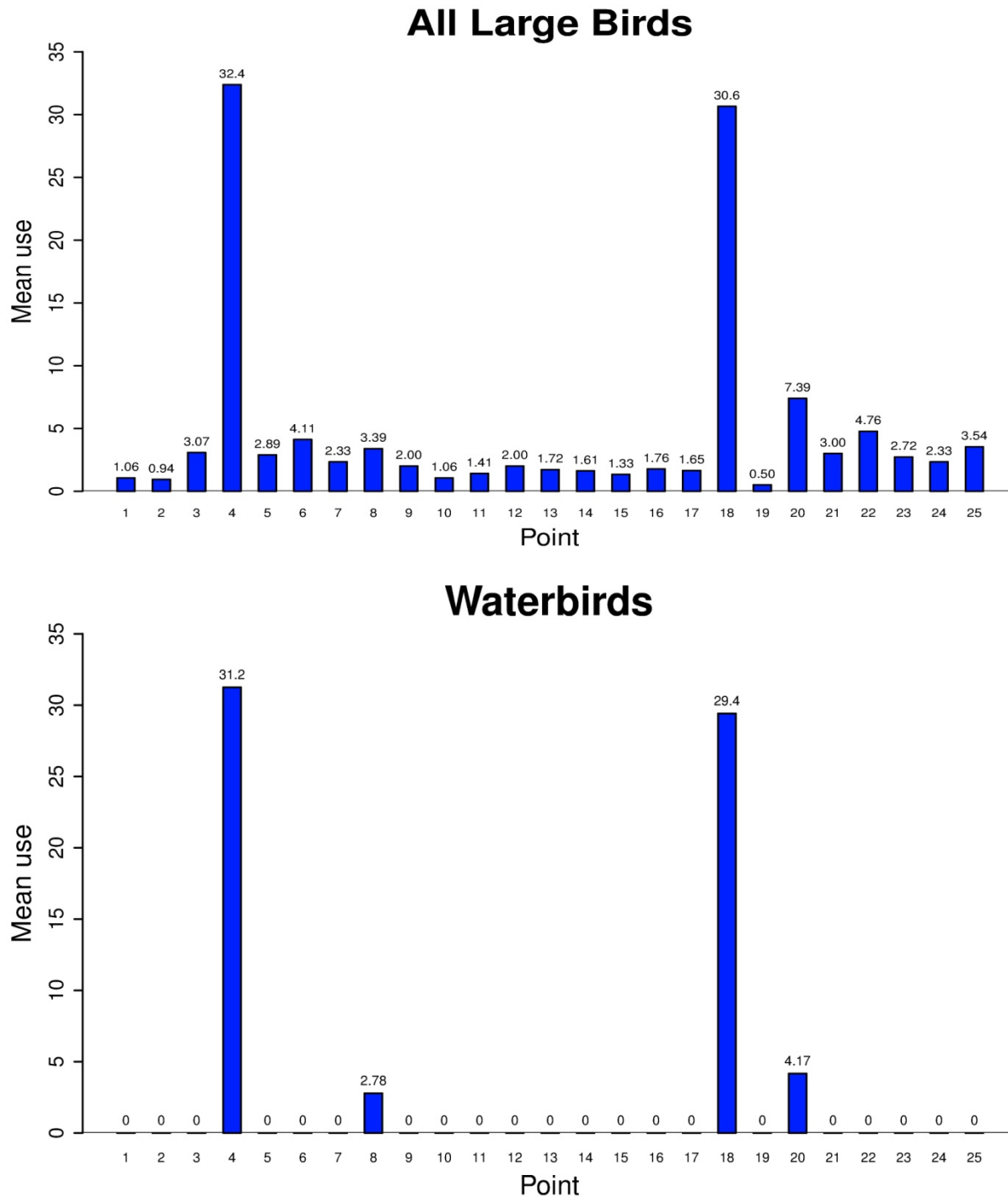


Figure 2. Mean use (number of birds/20-min survey) at each fixed-point survey point for all large birds, major bird types, and raptor subtypes at the Thunder Spirit Wind Resource Area from April 6, 2011 to March 13, 2012. Results are given for large birds within 800 meters of observer; passerine observations (excluding large corvids) were focused within 100 meters. Note variable scaling of y-axis.

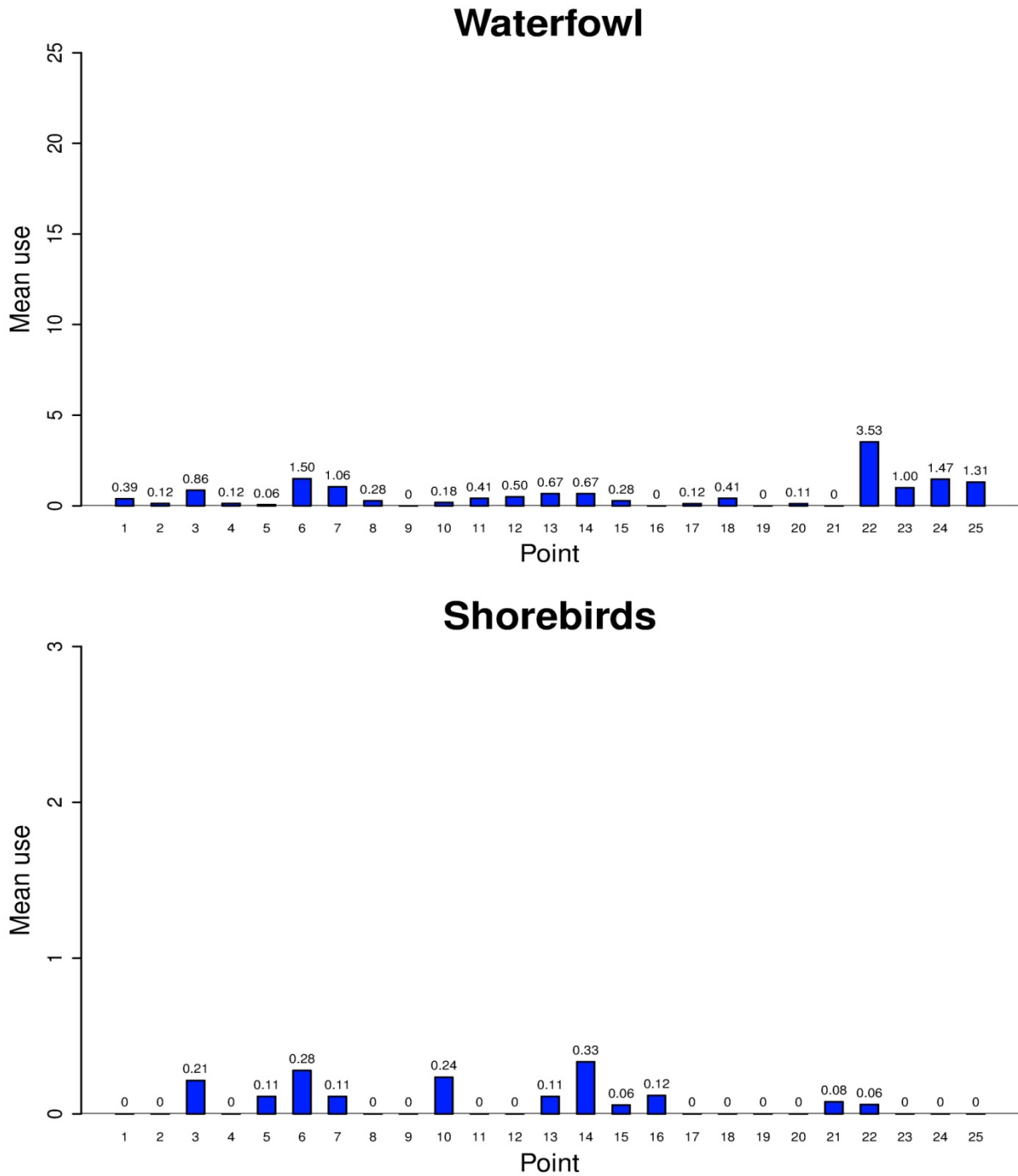


Figure 2 (continued). Mean use (number of birds/20-min survey) at each fixed-point survey point for all large birds, major bird types, and raptor subtypes at the Thunder Spirit Wind Resource Area from April 6, 2011 to March 13, 2012. Results are given for large birds within 800 meters of observer; passerine observations (excluding large corvids) were focused within 100 meters. Note variable scaling of y-axis.

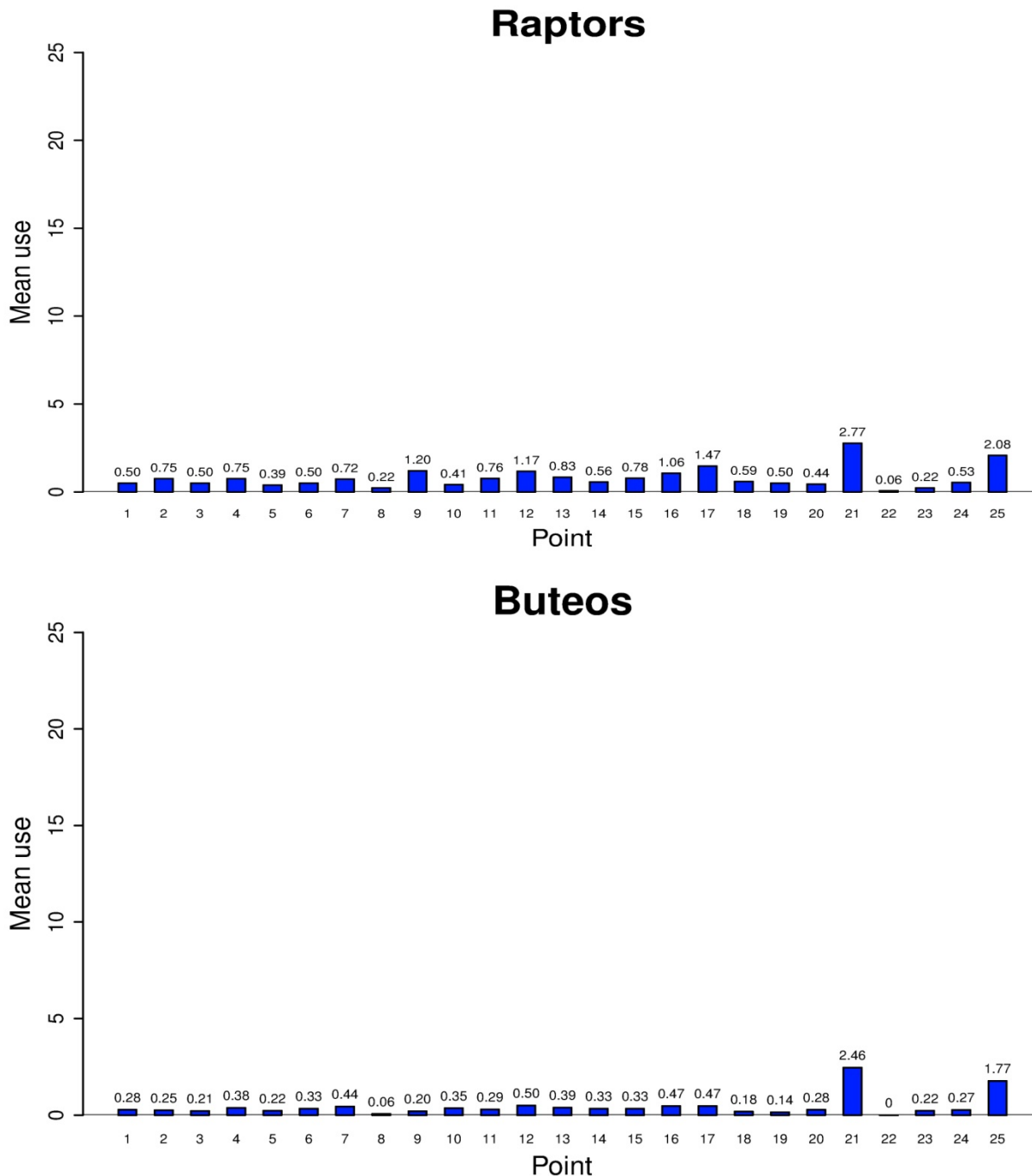


Figure 2 (continued). Mean use (number of birds/20-min survey) at each fixed-point survey point for all large birds, major bird types, and raptor subtypes at the Thunder Spirit Wind Resource Area from April 6, 2011, to March 13, 2012. Results are given for large birds within 800 meters of observer; passerine observations (excluding large corvids) were focused within 100 meters. Note variable scaling of y-axis.

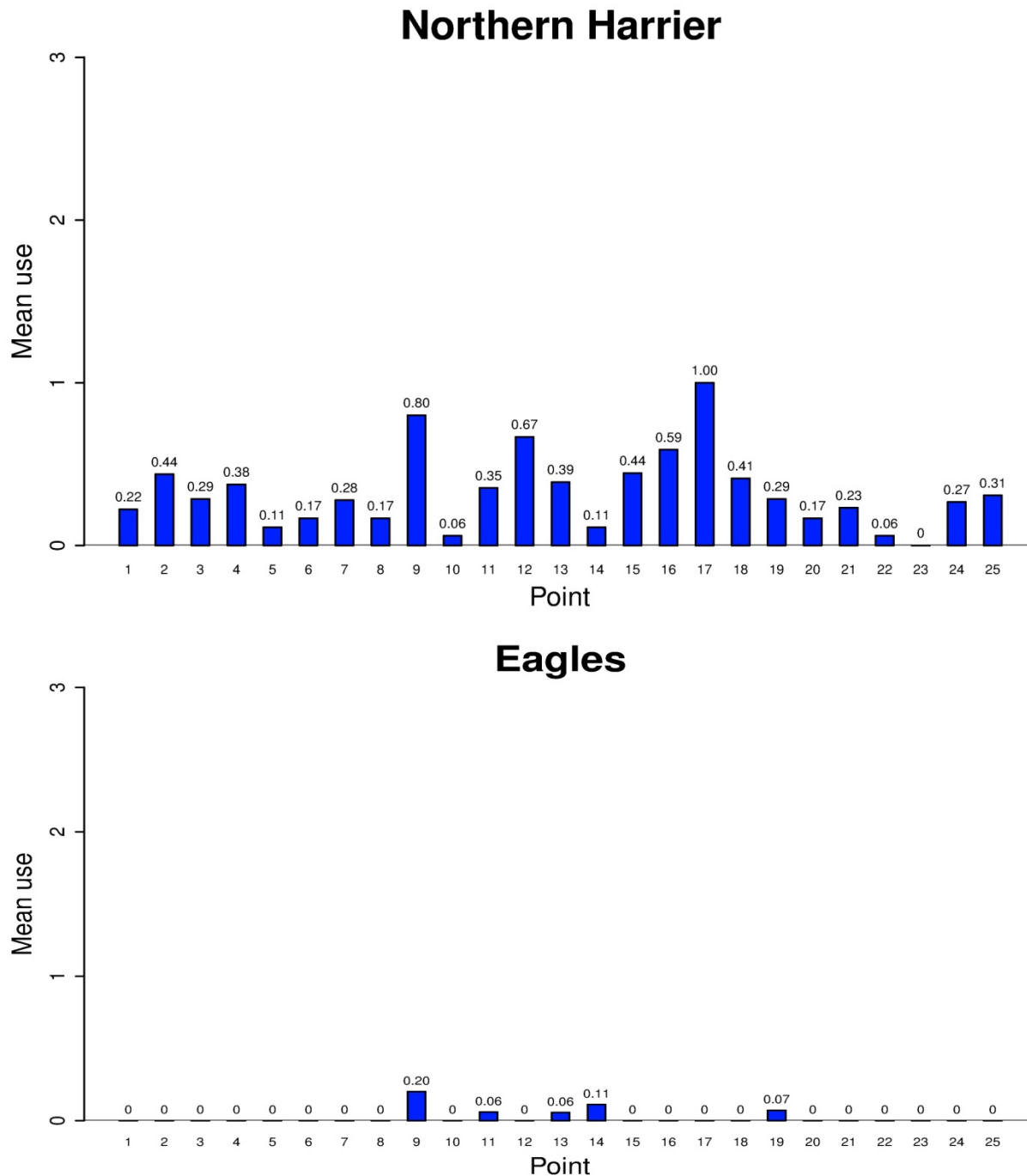
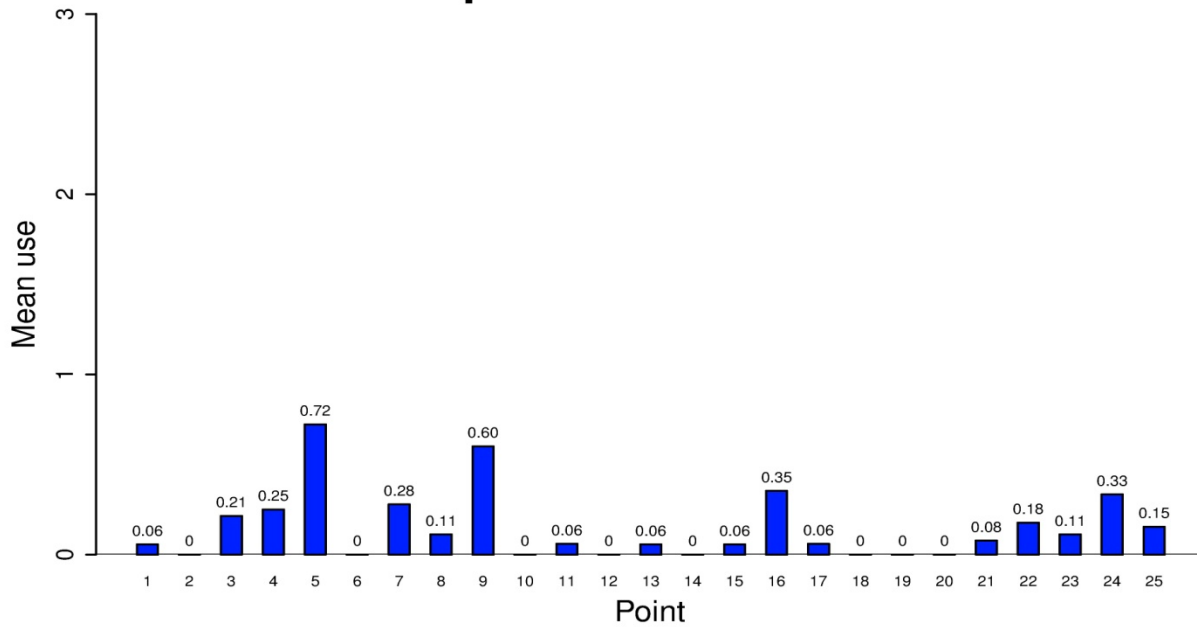


Figure 2 (continued). Mean use (number of birds/20-min survey) at each fixed-point survey point for all large birds, major bird types, and raptor subtypes at the Thunder Spirit Wind Resource Area from April 6, 2011, to March 13, 2012. Results are given for large birds within 800 meters of observer; passerine observations (excluding large corvids) were focused within 100 meters. Note variable scaling of y-axis.

Upland Game Birds



Passerines

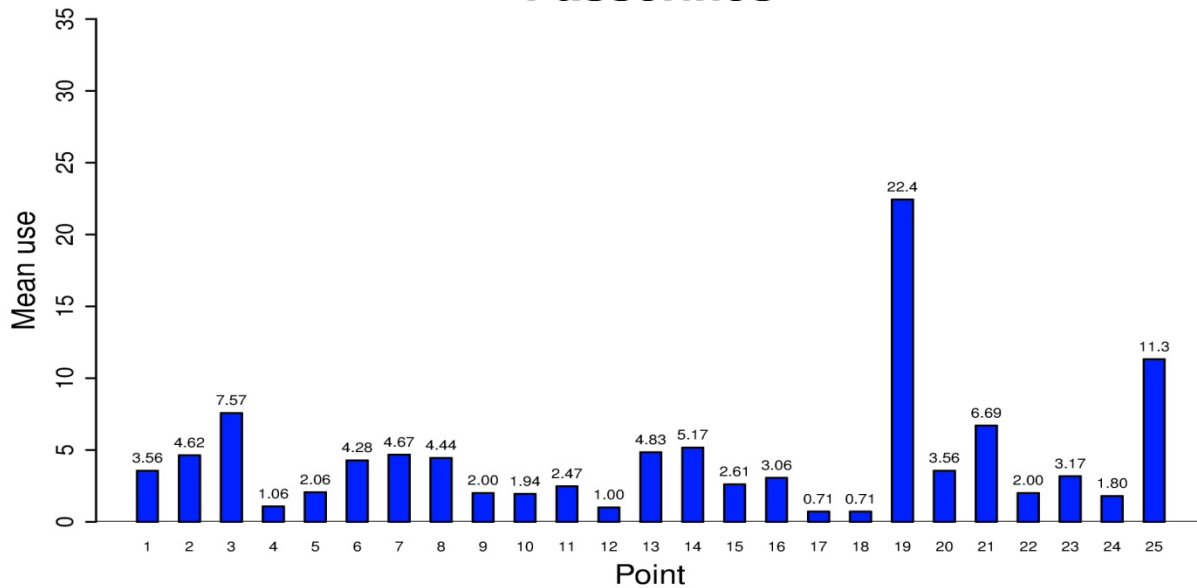


Figure 2 (continued). Mean use (number of birds/20-min survey) at each fixed-point survey point for all large birds, major bird types, and raptor subtypes at the Thunder Spirit Wind Resource Area from April 6, 2011, to March 13, 2012. Results are given for large birds within 800 meters of observer; passerine observations (excluding large corvids) were focused within 100 meters. Note variable scaling of y-axis.

Incidental Wildlife Observations

Twenty-seven bird species were observed incidentally, totaling 910 birds within 146 groups (Table 5). The most commonly observed bird was the Canada goose (*Branta canadensis*; 404 individuals), followed by the northern pintail (*Anas acuta*; 100 individuals) and sharp-tailed grouse (*Tympanuchus phasianellus*; 88 individuals). Overall, seven species of raptors and four owl species were observed incidentally. Five bird species were only observed incidentally. Five mammal species was observed incidentally; the most commonly observed species were the pronghorn (*Antilocapra americana*; 87 individuals) and white-tailed deer (*Odocoileus virginianus*; 50 individuals).

Table 5. Incidental wildlife (number of groups and individuals) observed at the Thunder Spirit Wind Resource Area from April 6, 2011 to March 13, 2012.

Species	Scientific Name	Groups	Individuals
Canada goose	<i>Branta canadensis</i>	2	404
northern pintail	<i>Anas acuta</i>	1	100
sharp-tailed grouse	<i>Tympanuchus phasianellus</i>	13	88
mallard	<i>Anas platyrhynchos</i>	3	54
Swainson's hawk	<i>Buteo swainsoni</i>	25	51
redhead*	<i>Aythya americana</i>	1	50
gadwall	<i>Anas strepera</i>	2	38
red-tailed hawk	<i>Buteo jamaicensis</i>	33	36
northern harrier	<i>Circus cyaneus</i>	15	19
rough-legged hawk	<i>Buteo lagopus</i>	12	13
great horned owl*	<i>Bubo virginianus</i>	7	11
American wigeon	<i>Anas americana</i>	1	6
green-winged teal*	<i>Anas crecca</i>	1	6
American kestrel	<i>Falco sparverius</i>	4	5
loggerhead shrike	<i>Lanius ludovicianus</i>	5	5
unidentified hawk		4	5
burrowing owl*	<i>Athene cunicularia</i>	2	2
short-eared owl	<i>Asio flammeus</i>	2	2
unidentified raptor		2	2
upland sandpiper	<i>Bartramia longicauda</i>	2	2
brown thrasher	<i>Toxostoma rufum</i>	1	2
Sprague's pipit	<i>Anthus spragueii</i>	1	2
American bittern*	<i>Botaurus lentiginosus</i>	1	1
ferruginous hawk	<i>Buteo regalis</i>	1	1
golden eagle	<i>Aquila chrysaetos</i>	1	1
marbled godwit	<i>Limosa fedoa</i>	1	1
northern shoveler	<i>Anas clypeata</i>	1	1
snowy owl	<i>Bubo scandiacus</i>	1	1
willet	<i>Catoptrophorus semipalmatus</i>	1	1
Bird Subtotal	27 Species	146	910
pronghorn	<i>Antilocapra americana</i>	10	87
white-tailed deer	<i>Odocoileus virginianus</i>	14	50
mule deer	<i>Odocoileus hemionus</i>	1	7
coyote	<i>Canis latrans</i>	2	2
white-tailed jackrabbit	<i>Lepus townsendii</i>	1	1
Mammal Subtotal	5 Species	28	147

* bird species only observed incidentally

Sensitive Species Observations

Twenty-one sensitive bird species were observed during fixed-point surveys and incidentally (Table 6). The Swainson's hawk (150 individuals) was the most commonly observed sensitive species, followed by the northern harrier (142 individuals), and northern pintail (141 individuals). All of the species in Table 6 are included in the North Dakota 100 Species of Conservation Priority (NDGFD 2004). One species, the Sprague's pipit (*Anthus spragueii*), is a federal candidate species (USFWS 2011, 2012e); three individuals were observed during point surveys or incidentally. One bald eagle (*Haliaeetus leucocephalus*) and six golden eagles (*Aquila chrysaetos*) were observed. Both eagle species are also protected under the Bald and Golden Eagle Protection Act (BGEPA 1940).

Table 6. Number of groups, individuals, and status of sensitive species observed, regardless of distance from observer, during fixed-point bird use surveys and as incidental wildlife observations at the Thunder Spirit Wind Resource Area from April 6, 2011, to March 13, 2012.

Species	Scientific Name	Status	Fixed-Point		Incidental Observations		Total	
			Groups	Individuals	Groups	Individuals	Groups	Individuals
Swainson's hawk	<i>Buteo swainsoni</i>	ND Level I	47	99	25	51	72	150
northern harrier	<i>Circus cyaneus</i>	ND Level II	109	123	15	19	124	142
northern pintail	<i>Anas acuta</i>	ND Level II	16	41	1	100	17	141
sharp-tailed grouse	<i>Tympanuchus phasianellus</i>	ND Level II	6	10	13	88	19	98
lark bunting	<i>Calamospiza melanocorys</i>	ND Level I	32	88	0	0	32	88
redhead	<i>Aythya americana</i>	ND Level II	0	0	1	50	1	50
bobolink	<i>Dolichonyx oryzivorus</i>	ND Level II	21	28	0	0	21	28
grasshopper sparrow	<i>Ammodramus savannarum</i>	ND Level I	14	15	0	0	14	15
chestnut-collared longspur	<i>Calcarius ornatus</i>	ND Level I	10	15	0	0	10	15
loggerhead shrike	<i>Lanius ludovicianus</i>	ND Level II	8	9	5	5	13	14
golden eagle	<i>Aquila chrysaetos</i>	ND Level II, EA	5	5	1	1	6	6
marbled godwit	<i>Limosa fedoa</i>	ND Level I	3	5	1	1	4	6
short-eared owl	<i>Asio flammeus</i>	ND Level II	2	3	2	2	4	5
upland sandpiper	<i>Bartramia longicauda</i>	ND Level I	2	2	2	2	4	4
red-headed woodpecker	<i>Melanerpes erythrocephalus</i>	ND Level II	2	3	0	0	2	3
Sprague's pipit	<i>Anthus spragueii</i>	ND Level I, FC	1	1	1	2	2	3
burrowing owl	<i>Athene cunicularia</i>	ND Level II	0	0	2	2	2	2
ferruginous hawk	<i>Buteo regalis</i>	ND Level I	1	1	1	1	2	2
willet	<i>Catoptrophorus semipalmatus</i>	ND Level I	1	1	1	1	2	2
American bittern	<i>Botaurus lentiginosus</i>	ND Level I	0	0	1	1	1	1
bald eagle	<i>Haliaeetus leucocephalus</i>	ND Level II, EA	1	1	0	0	1	1
Total	21 species		281	450	72	326	353	776

FC = federal candidate species (USFWS 2011, 2012e);
 ND Level I, Level II = North Dakota Species of Conservation Priority (NDGFD 2004);
 EA = Bald and Golden Eagle Protection Act (BGEPA 1940)

DISCUSSION AND IMPACT ASSESSMENT

Fixed-Point Surveys

Large bird use, consisting largely of sandhill cranes, was highest in the spring (Appendix B-1). All of the cranes were observed on April 12, 2012 and all were flying, with over 90% of them flying in a northerly direction. This suggests that the cranes were migrating through the area. The cranes were observed near survey points 4 and 18 (Figure 2), which are along the eastern edge of the TSWRA (Figure 1) but reasons for this are unclear and they likely were simply flying over the site. Sandhill crane use at these two points greatly increased the overall large bird use estimate.

Small bird use was highest in winter, primarily due to horned larks which made up about 76% of passerine observations in winter (Appendix B-2). Horned larks, a common bird in North Dakota, showed significant increases in use of areas near turbines at the Combine Hills facility in Oregon, possibly because the cleared turbine pads and access roads provided habitat preferred by this species (Young et al. 2005). Horned larks are a common species observed within wind farms and are often the dominate species found as fatalities.

The Swainson's hawk was one of the raptors observed most often during fixed-point surveys (Appendix A). The hawk, which is a Species of Conservation Priority in North Dakota (NDGFD 2004), was also observed frequently incidentally (Table 5) and one nest was located during nest surveys in 2011 (Derby and Thorn 2013). The Swainson's hawk had the highest collision risk exposure index of any raptor (Appendix C-1). During fixed-point surveys, the hawk was observed most often at survey points 21 and 25 (Figure 2), but reasons for this are unclear.

Other survey points with relatively higher use were points 19 and 25 (passerines) and point 22 (waterfowl). Points 22, 21, 25, and 19 are all located in the southern part of the TSWRA (Figure 1) but the significance of this occurrence is unknown.

Potential Impacts

Impacts to wildlife and their habitats from wind energy facilities can be direct or indirect. Direct impacts are those with the potential to cause fatalities from construction and operation of the proposed wind energy facility. Indirect impacts include the displacement of wildlife, either temporarily or permanently, during construction of, or during the operational period of a wind energy facility.

Direct Effects

The most probable direct impact to birds from wind energy facilities is mortality or injury due to collisions with turbines or guy wires of met towers. Collisions may occur with resident birds foraging and flying within the study area or with migrant birds seasonally moving through the study area. Project construction could directly affect birds through potential fatalities caused by construction equipment. Potential mortality from construction equipment is expected to be low.

Equipment used in wind energy facility construction generally moves at slow rates or is stationary for long periods (e.g., cranes). The risk of direct mortality to birds from construction is most likely potential destruction of a nest for ground- and shrub-nesting species during initial site clearing. Impacts from the decommissioning of the facility are anticipated to be similar to construction in terms of noise, disturbance, and equipment.

Substantial data on bird mortality at wind energy facilities are available from studies across North America. Of 841 bird fatalities reported from California studies (>70% from the Altamont Pass facility in California), approximately 39% were raptors, about 19% were passerines (excluding house sparrows [*Passer domesticus*] and European starlings [*Sturnus vulgaris*]), and about 12% were owls (Erickson et al. 2002b). Non-protected birds (e.g., birds not protected by the Migratory Bird Treaty Act [MBTA 1918] or the Endangered Species Act [ESA 1973]), including house sparrows, European starlings, and rock pigeons (*Columba livia*), accounted for about 15% of the fatalities. Other bird types generally made up less than 10% of the fatalities (Erickson et al. 2002b). During 12 fatality monitoring studies conducted outside of California, raptor fatalities accounted for approximately 2% of the wind energy facility-related fatalities and raptor mortality averaged 0.03 fatalities/turbine/year (Erickson et al. 2002b). Passerines (excluding house sparrows and European starlings) were the most common collision victims, accounting for about 82% of the 225 fatalities documented.

Using mortality data from a 10-year period from wind energy facilities throughout the United States, the average number of bird collision fatalities was 3.1 fatalities per megawatt (MW) per year, or 2.3 fatalities per turbine per year (NWCC 2004). In a comparison of wind energy facilities in the Midwest, overall bird fatality rates ranged from 0.42 to 8.25 fatalities/MW/year (Appendix E). When examining fatality estimates from facilities in North America, overall bird fatality rates ranged from 0.15 to 11.02 fatalities/MW/year (Appendix E). Given that all the facilities in Appendix E documented some level of direct mortality to birds, it is reasonable to assume that the operation of a wind energy facility within the TSWRA would have some direct impact on birds migrating through the area, as well as on those birds residing in the area. The level of this anticipated impact is discussed below.

Raptor Use and Collision Risk Exposure

Although high numbers of raptor fatalities have been documented at some wind energy facilities (e.g., the Altamont Pass facility), a review of studies at wind energy facilities across the United States reported that only 3.2% of fatalities were raptors (Erickson et al. 2001b). While raptors occur in most areas with the potential for wind energy development, individual species appear to differ from one another in their susceptibility to collision (NRC 2007). Results from the Altamont Pass facility in California suggest that mortality for some species is not necessarily related to abundance (Orloff and Flannery 1992). American kestrels (*Falco sparverius*), red-tailed hawks, and golden eagles were killed more often than predicted based on abundance. For example, relatively few northern harrier fatalities have been reported at existing wind energy facilities, despite the fact they are commonly observed during fixed-point bird counts at these facilities (Erickson et al. 2001b, Whitfield and Madders 2006, Smallwood and Karas 2009). It is likely that

many factors, in addition to abundance, are important in predicting raptor mortality as well as other bird mortality.

There is some evidence that migrating raptors are more vulnerable to turbine collision than residents (Orloff and Flannery 1993, DeLucas et al. 2004). Migrating raptors are known to concentrate in rather narrow streams along linear topographic features such as coastlines, rivers, and ridges (Liguori 2005, USFWS 2008); ridges and coastlines are often ideal locations for wind energy facilities, which could place concentrations of raptors at risk of collision with wind energy facilities. Over large migration distances, raptors rely on vertical lift to promote soaring and gliding flight; this strategy allows migrants to conserve energy (Kerlinger 1989, Bildstein 2006). However, this tactic may also make migrant raptors more vulnerable to turbine collisions (Barrios and Rodriguez 2004, Hoover and Morrison 2005) because it could bring them into proximity with wind turbines located on ridges and coastlines. The TSWRA is not located near a coast line or other feature that would appear to funnel migrating raptors.

Although collision mortality is well documented at most wind energy facilities, population level effects attributable to collisions have not been detected (Carrete et al. 2009, Pearce-Higgins et al. 2012); however, few studies have addressed this issue (Johnson and Stephens 2011). Impacts to golden eagles in the Altamont Pass wind energy facility have been evaluated and investigated for over 25 years. Recent studies have not demonstrated breeding population level impacts despite high individual mortality (Hunt 2002). Based on a 4-year study, the resident golden eagle population appeared to be self-sustaining, despite sustaining comparatively high levels of fatalities. However, the effect of these fatalities on golden eagle populations wintering within and adjacent to the Altamont Pass facility was unknown (Hunt 2002). Additional research conducted by Hunt and Hunt (2006) found that all 58 territories occupied by golden eagle pairs in the Altamont Pass facility in 2000 remained active in 2005.

Collision risk exposure indices analysis may also provide insight into which species might be the most likely turbine casualties. However, the index only considers relative probability of collision exposure based on abundance, proportion of observations flying, and proportion of flight height of each species within the RSH for turbines likely to be used at the wind energy facility. This analysis is based on observations of birds during the surveys and does not take into consideration behavior (e.g. foraging, courtship), habitat selection, the varying ability among species to detect and avoid turbines, and other factors that may vary among species and influence likelihood for turbine collision. For these reasons, the index is only a relative index among species (i.e., comparison between species observed during studies at TSWRA) observed during the surveys and within the study area and cannot be compared to other wind resource areas. Actual risk for some species may be lower or higher than indicated by these data. In the TSWRA, the raptor species with the highest exposure index was the Swainson's hawk, with an exposure index of 0.15 (Table 4). The red-tailed hawk and northern harrier had exposure indices of 0.04, the rough-legged hawk (*Buteo lagopus*) had an index of 0.03, and other raptors had an exposure index of <0.01, primarily due to lower use estimates by these species or a relatively low proportion of flight heights observed in the RSH. Based on flight

information and abundance, it is expected that most raptor fatalities would be Swainson's hawks and red-tailed hawks.

Annual raptor use in the TSWRA (0.68 raptors/plot/20-min survey) was compared to annual raptor use at other wind energy facilities (Figure 3). The mean annual raptor use at these other wind energy facilities ranged from 0.06 raptors/20-min survey to 2.34 raptors/20-min survey. Based on the results from these facilities, a ranking of mean annual raptor use was developed as: low (0 – 0.5 raptors/plot/20-min survey); low to moderate (0.5 – 1.0); moderate (1.0 – 2.0); high (2.0 – 3.0); and very high (> 3.0). Using this ranking, mean raptor use in the TSWRA is considered to be low to moderate. Compared to the other wind energy facilities, raptor use in the TSWRA ranked 14 of 44 projects reviewed (Figure 3).

Overall raptor mortality was compared at other wind energy facilities across North America, some of which also had raptor use estimates (Appendix F). Estimated use values at the facilities ranged from 2.16 raptors/20-min survey at the Diablo Winds wind energy facility in California (WEST 2006, 2008) to 0.13 raptors /20-min survey at the Dry Lake I wind energy facility in Arizona (Thompson et al. 2011). Raptor fatality estimates at these sites ranged from 0.59 raptors/MW/year at the Munnsville wind facility (Stantec 2009b) to zero raptors/MW/year at numerous wind energy facilities. Assuming a positive correlation between use and fatality rates exists, Fatality rates at the TSWRA would be much lower than the fatality rates at Diablo Winds in California and would likely be similar to the rates seen at sites in the Pacific Northwest (Appendix F).

Raptors

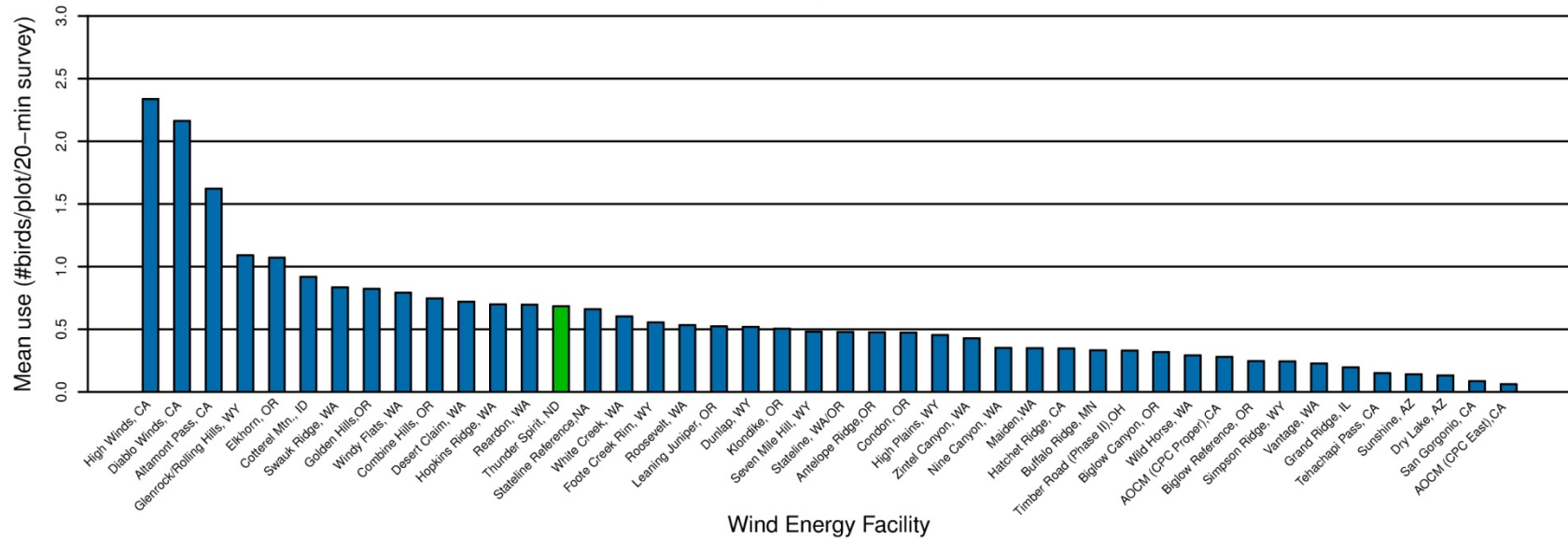


Figure 3. Comparison of annual raptor use (birds/plot/20-min survey) between the Thunder Spirit Wind Resource Area and other US wind energy facilities.

Data from the following sources:

Study and Location	Reference	Study and Location	Reference	Study and Location	Reference
Thunder Spirit, ND	This study.				
High Winds, CA	Kerlinger et al. 2005	Foote Creek Rim, WY	Johnson et al. 2000b	Timber Road (Phase II), OH	Good et al. 2010
Diablo Winds, CA	WEST 2006	Roosevelt, WA	NWC and WEST 2004	Biglow Canyon, OR	WEST 2005c
Altamont Pass, CA	Orloff and Flannery 1992	Leaning Juniper, OR	Kronner et al. 2005	Wild Horse, WA	Erickson et al. 2003d
Glenrock/Rolling Hills, WY	Johnson et al. 2008a	Dunlap, WY	Johnson et al. 2009a	AOCM (CPC Proper), CA	Chatfield et al. 2010a
Elkhorn, OR	WEST 2005a	Klondike, OR	Johnson et al. 2002a	Biglow Reference, OR	WEST 2005c
Cotterel Mtn., ID	BLM 2006	Seven Mile Hill, WY	Johnson et al. 2008b	Simpson Ridge, WY	Johnson et al. 2000b
Swauk Ridge, WA	Erickson et al. 2003c	Stataline, WA/OR	Erickson et al. 2003b	Vantage, WA	WEST 2007
Golden Hills, OR	Jeffrey et al. 2008	Antelope Ridge, OR	WEST 2009	Grand Ridge, IL	Derby et al. 2009
Windy Flats, WA	Johnson et al. 2007	Condon, OR	Erickson et al. 2002b	Tehachapi Pass, CA	Anderson et al. 2000, Erickson et al. 2002b
Combine Hills, OR	Young et al. 2003c	High Plains, WY	Johnson et al. 2009b	Sunshine, AZ	WEST and the CPRS 2006
Desert Claim, WA	Young et al. 2003d	Zintel Canyon, WA	Erickson et al. 2002a, 2003a	Dry Lake, AZ	Young et al. 2007a
Hopkin's Ridge, WA	Young et al. 2003e	Nine Canyon, WA	Erickson et al. 2001a	San Geronio, CA	Anderson et al. 2000, Erickson et al. 2002b
Reardon, WA	WEST 2005b	Maiden, WA	Young et al. 2002	AOCM (CPC East), CA	Chatfield et al. 2010a
Stataline Reference	URS et al. 2001	Hatchel Ridge, CA	Young et al. 2007b		
White Creek, WA	NWC and WEST 2005	Buffalo Ridge, MN	Johnson et al. 2000a		

Sensitive Species Use

No federally-listed threatened or endangered species were observed in the TSWRA during bird use surveys or incidentally. One species, the Sprague's pipit, is classified as a candidate species for listing under the Endangered Species Act (USFWS 2010, 2012a; ESA 1973). Two eagle species were observed during the study; eagles are protected under the BGEPA (1940).

Bald Eagle

The bald eagle is a North Dakota Species of Conservation Priority (NDGFD 2004) and is also protected under the BGEPA (1940). Generally, bald eagles select habitats along major rivers, lakes, and reservoirs (USGS 2006a, 2006c). Nests are typically built in tall, large trees in mature forests. However, with increasing bald eagle populations, nesting eagles are also found in areas away from major waterbodies. Bald eagle nesting has not been documented in Adams County in recent years (USGS 2006a, 2006b; Johnson 2010). Bald eagles may also be found during migration and winter periods in areas away from major rivers if sufficient forage is available. Fish is the primary food source of the eagle, but the eagle may also feed on birds, mammals, and carrion. During this study, one bald eagle was observed (Appendix A) perched during fixed-point surveys in winter. The TSWRA does not appear to receive significant bald eagle use at any time during the year.

Golden Eagle

The golden eagle is also a North Dakota Species of Conservation Priority (NDGFD 2004) and is protected under the BGEPA. This eagle is a large bird of prey that prefers open country, such as prairies, tundra, or open areas in forest, particularly in hilly or mountainous terrain (All About Birds 2011). Golden eagles primarily eat small mammals such as rabbits, ground squirrels, and prairie dogs, although they are capable of taking larger prey. In North Dakota, golden eagles nest in the southwest portion of the state (DeLong 2004, USGS 2006d). Historically, a golden eagle nest was observed within seven miles of the western edge of the TSWRA (USFWS Ecological Services, Bismarck, North Dakota, 2012, pers. comm.). Five golden eagles were observed during fixed-point surveys and one was observed incidentally (Table 6); observations occurred in all seasons, possibly of the same bird or birds (Appendix A). Five birds were observed flying during fixed-point surveys; four of those were flying within the RSH at some point during the observation (Appendix C-1). The collision risk exposure index (<0.01) for golden eagles was relatively low. While there was not significant use of the project area during any season, use was consistent. It is not known if use was from birds that have nested at the location seven miles to the west.

Sprague's Pipit

This passerine species is endemic to mixed-grass prairies of the Northern Great Plains of North America. The decline in the pipit population is largely due to habitat conversion from native prairie to cropland and habitat degradation; pipits require large areas of unfragmented native prairie without shrubs or trees. In North Dakota, the pipits breed in suitable habitats found in the central and western portions of the state (USGS 2006e, Jones 2010). The pipit has been documented in Adams County and many other counties in North Dakota (USFWS 2012b, 2012c). One Sprague's pipit was observed in spring during fixed-point surveys (Appendix A).

Two pipits were observed incidentally during late spring. Minimizing impacts to larger tracts of native prairie would likely minimize potential impact to this species.

Non-Raptor Use and Collision Risk Exposure

Passerines

Passerines (primarily perching birds) have been the most abundant bird fatality at wind energy facilities, excluding facilities in California (Erickson et al. 2001b, 2002b), often accounting for more than 80% of the bird fatalities. Both migrant and resident passerine fatalities have been observed. Given that passerines made up a large proportion of the birds observed during this study, passerines would be expected to make up a large proportion of bird fatalities in the TSWRA. However, there has not been a clearly demonstrated correlation between high passerine use and high mortality as there appears to be with raptors. Collision risk exposure indices indicate that the snow bunting is a likely passerine (excluding large corvids) to be exposed to collision with wind turbine blades in the TSWRA during the winter. Another passerine species likely at risk based on abundance and flight behavior is the horned lark (Table 4). Most non-raptors had relatively low exposure indices due to the majority of individuals flying below the likely RSH. It is unlikely that non-raptor populations will be adversely affected by direct mortality from the operation of the wind energy facility given their overall populations and overall low impacts to any one species.

Waterbirds

Waterbirds (composed only of sandhill cranes) were the bird type with the highest collision risk exposure index of any bird type or species (3.02; Appendix C-1). All of the sandhill cranes observed during fixed-point surveys (1,125 individuals) were flying and 95.6% of those individuals were within the RSH at some point.

There is some potential for this species to collide with wind turbines at the TSWRA; however, this species is rarely reported as a fatality from wind energy facilities in the US, even though the sandhill crane is a relatively common species, and has never been found as a fatality within the migration corridor. Of publically available data, only three sandhill crane fatalities at wind energy facilities are known: one fatality at Altamont Pass in California (Smallwood and Karas 2009), and two fatalities from a facility in west Texas (N. Gates, USFWS, pers. comm., Stehn 2011).

Data are available from various wind energy facilities in North and South Dakota where migrating sandhill crane use was recorded in conjunction with post-construction fatality monitoring (Derby et al. 2012). For all six facilities combined, over 30,000 observations of sandhill cranes were recorded (flying or foraging) within the vicinity of the wind energy facilities during spring and fall studies, yet no crane fatalities were found during daily turbine checks. At Forward Energy Center, a wind energy facility in southern Wisconsin, located near the Horicon National Wildlife Refuge, no crane fatalities were found during fatality monitoring studies in the fall of 2008, spring and fall of 2009, and in the spring of 2010 (Grodsky and Drake 2011). Sandhill cranes do not appear to be overly susceptible to turbine collision at any time of they year, and this appears to be especially true during migration.

Because whooping (*Grus americana*) and sandhill cranes utilize similar habitats during migration and frequently travel in the same flocks, the presence of sandhill cranes may indicate suitability of an area for whooping cranes. The whooping crane is an endangered species protected under the ESA (ESA 1973, USFWS 2012d). The US Fish and Wildlife Service (USFWS) has expressed concern over potential impacts to whooping cranes from wind-energy facility development. Whooping cranes generally migrate at 1,000-5,000 ft, altitudes well above turbine height (Stehn 1998), and thus for the most part are unlikely to collide with turbines. However, as whooping cranes ascend and descend during takeoff and landing, or migrate during inclement weather, they may fly at lower altitudes and may fly within the flight altitudes corresponding to the rotor-swept areas. No sandhill crane use was documented on the ground, all use was as the cranes were migrating at height. It is unclear at what level the area may provide available roosting and foraging habitat for cranes.

The TSWRA is at the western edge of the approximately 200-mile wide migration corridor identified by the USFWS that passes through central North Dakota (CWCTP 2009). Although no whooping cranes were observed during this study, whooping cranes have been observed in the vicinity, as close as 9 miles to the southwest in 1994 (CWCTP 2011). Additional observations within about 30 miles of the TSWRA were recorded from 1970 to 2002 (CWCTP 2011).

The relatively low rate of crane collisions with turbines makes it unlikely that cranes will be affected by the proposed TSWRA.

Indirect Effects

The presence of wind turbines may alter the landscape so that wildlife use patterns are affected, displacing wildlife away from the project facilities and suitable habitat. In addition to direct effects through collision mortality, wind energy development results in indirect effects such as direct loss of habitat where infrastructure is placed and indirect loss of habitat through behavioral avoidance and perhaps habitat fragmentation. Examples of potential indirect loss of habitat near wind facilities include behavioral displacement (avoidance) by birds, which may lead to decreased overall habitat availability and/or breeding and nesting habitat for local populations. It also includes increased habitat fragmentation (e.g., more habitat edges through roads) which could provide more generalized habitats and resistance-free travel lanes for predators and competitors in, for example, large grasslands and forests. This may impact the survivorship and reproductive ability of birds in the facility vicinity. Wind energy facility construction appears to cause small-scale local displacement of some grassland passerines and is likely due to the birds avoiding turbine noise and maintenance activities. Construction also may reduce habitat effectiveness because of the presence of access roads and large gravel pads surrounding turbines (Leddy 1996, Johnson et al. 2000a).

Some studies from wind energy facilities in Europe consider displacement effects to have a greater impact on birds than collision mortality (Gill et al. 1996). The greatest concern with displacement impacts for wind energy facilities has been where these facilities have been constructed in native habitats such as grasslands or shrublands and particularly for raptors, passerines, and waterfowl (Leddy et al. 1999, Mabey and Paul 2007). Results from studies at

the Stateline wind energy facility in Washington and Oregon (Erickson et al. 2004) and the Buffalo Ridge wind energy facility in Minnesota (Johnson et al. 2000a) suggest that breeding birds are also affected by wind-facility operations at some level.

Raptor Displacement

In addition to possible direct effects on raptors within the study area (discussed above), indirect effects caused by disturbance-type impacts, such as construction activity near an active nest or primary foraging area, also have a potential to impact raptor species.

Birds displaced from wind energy facilities might move to areas with fewer disturbances, but with lower quality habitat, with an overall effect of reducing breeding success. Most studies on raptor displacement at wind energy facilities, however, indicate displacement effects to be negligible (Howell and Noone 1992; Johnson et al. 2000a, 2003; Madders and Whitfield 2006). Notable exceptions to this include a study in Scotland that described territorial golden eagles avoiding the entire wind energy facility area, except when intercepting non-territorial birds (Walker et al. 2005). A study at the Buffalo Ridge wind energy facility in Minnesota found evidence of northern harriers avoiding turbines on both a small scale (less than 100 m from turbines) and on a larger scale in the year following construction (Johnson et al. 2000a). Two years following construction however, no large-scale displacement of northern harriers was detected (Johnson et al. 2002b). However, at a wind facility in Wisconsin, raptor abundance (five species) was 47% less post-construction compared to pre-construction levels even though US breeding bird survey data for the area showed no difference among years in raptor abundance (Garvin et al. 2011).

Avoidance of wind turbines by nesting raptors has only been reported in one publically available study (Usgaard et al. 1997). Avoidance of wind turbines by nesting raptors occurred at the Buffalo Ridge wind energy facility in Minnesota, where raptor nest density on 101 square miles (mi^2 ; 262 square kilometer [km^2]) of land surrounding a wind energy facility was 5.94 nests/39 mi^2 (5.94 nests/101 km^2), yet no nests were present in the 12 mi^2 (31 km^2) facility itself, even though habitat was similar (Usgaard et al. 1997). However, this analysis assumes that raptor nests are uniformly distributed across the landscape, an unlikely event, and even though no nests were found, only two nests would be expected for an area 12 mi^2 in size if the nests were distributed uniformly.

Several studies have shown no avoidance behavior by nesting raptors (Erickson et al. 2004; Johnson et al. 2000, 2003). At a wind energy facility in eastern Washington, based on extensive monitoring using helicopter flights and ground observations, raptors still nested in the study area at approximately the same levels after construction, and several nests were located within a half-mile (0.8 km) of turbines (Erickson et al. 2004). At the Foote Creek Rim wind energy facility in southern Wyoming, one pair of red-tailed hawks nested within 0.3 miles (0.5 km) of the turbine strings, and seven red-tailed hawk nests, one great horned owl (*Bubo virginianus*) nest, and one golden eagle nest located within one mile of the facility successfully fledged young (Johnson et al. 2000b). The golden eagle pair successfully nested a half-mile from the facility for three different years after it became operational. A Swainson's hawk also nested within a

quarter-mile (0.4 km) of a turbine string at the Klondike I wind energy facility in Oregon after the facility was operational (Johnson et al. 2003).

The TSWRA contains potential raptor nesting opportunities in the form of scattered shelterbelts and tree rows. In 2011, a great horned owl nest was observed within the TSWRA and a Swainson's hawk nest was within a mile of the eastern edge of the study area. Historically, a golden eagle nest was located within seven miles of the western edge of the TSWRA. However, no eagle nests were observed during an aerial survey in 2011. Because limited or no displacement of nesting raptors has been documented at other sites and the likelihood of significant raptor nesting in the TSWRA is limited, there should be limited to no nesting displacement of raptors. The creation of spatial disturbance avoidance zones, or buffers, surrounding known raptor nests when siting turbines should limit potential displacement impacts, particularly during construction.

Displacement of Non-Raptor Bird Species

Passerines

Studies concerning displacement of non-raptor species have concentrated on grassland passerines and waterfowl/waterbirds (Winkelman 1990, Larsen and Madsen 2000, Mabey and Paul 2007). Wind energy facility construction appears to cause small scale local displacement of grassland passerines and is likely due to the birds avoiding turbine noise and maintenance activities. Construction also fragments the habitat because of the presence of access roads and large gravel pads surrounding turbines (Leddy 1996, Johnson et al. 2000a). Leddy et al. (1999) surveyed bird densities in Conservation Reserve Program grasslands at the Buffalo Ridge wind energy facility in Minnesota and found mean densities of 10 grassland bird species were four times higher at areas located 180 m (591 feet) from turbines than they were at grasslands nearer turbines. Johnson et al. (2000a) found reduced use of habitat by seven of 22 grassland-breeding birds following construction of the Minnesota Buffalo Ridge facility. Shaffer and Johnson (2009) examined displacement of grassland birds at two wind energy facilities in the northern Great Plains. Killdeer (*Charadrius vociferus*), western meadowlark, and chestnut-collared longspur (*Calcarius ornatus*) did not show any avoidance of wind turbines. However, grasshopper sparrow (*Ammodramus savannarum*) and clay-colored sparrow (*Spizella pallida*) showed avoidance out to 200 m (656 ft). Displacement of grassland passerines may be reduced by siting turbines away from grassland or native habitats. Turbines sited within agricultural land, as is common in the TSWRA, should minimize displacement impacts to passerines.

Prairie Grouse

Ninety-eight sharp-tailed grouse observations were recorded during the study. In 2011, five leks were observed in or near the TSWRA during spring lek surveys (Derby and Thorn 2013). Much debate has occurred recently regarding the potential impacts of wind energy facilities on prairie grouse. Under a set of voluntary guidelines, the USFWS has taken a precautionary approach and recommends wind turbines be placed at least five miles (about eight km) from known prairie grouse lek locations (USFWS 2003). The USFWS argues that because prairie grouse evolved in habitats with little vertical structure, placement of tall man-made structures (e.g., wind

turbines) in occupied prairie grouse habitat may result in a decrease in habitat suitability (USFWS 2004). While the potential exists for wind turbines to displace prairie grouse from occupied habitat, studies examining the extent of this potential impacts are currently lacking.

CONCLUSIONS

The principal objectives of the study were to: 1) provide site-specific bird resource and use data and 2) provide information that could be used in project planning and design of the facility to minimize impacts to birds. Results pertaining to bat surveys are included in a separate report. Baseline surveys were conducted from April 6, 2011, through March 13, 2012.

Two species accounted for 58.2% of the observations: sandhill cranes and horned larks. Two hundred ninety-six individual raptors in 228 groups were recorded within the TSWRA, representing eight species. The northern harrier was the raptor species observed most often (123 individuals), followed by the Swainson's hawk (99). Raptor use was highest in fall (1.12 birds/plot/20-min survey) compared to spring (0.97), summer (0.74), and winter (0.18). Annual raptor use in the TSWRA (0.68 raptors/plot/20-min survey) was compared to annual raptor use at other wind energy facilities. Compared to the other wind energy facilities, raptor use in the TSWRA was low to moderate. Based on the relative abundance of Swainson's hawks throughout the year and a higher exposure index than other raptor species, there is higher potential for Swainson's hawks fatalities compared to other species. It is expected that risk to raptors would be slightly higher during fall.

No federally-listed threatened or endangered species were observed in the TSWRA. The Sprague's pipit, is a candidate species for listing under the Endangered Species Act; three individuals were observed during the study. One bald eagle and six golden eagles were observed; eagles are protected under the Bald and Golden Eagle Protection Act. Several species observed are North Dakota 100 Species of Conservation Priority.

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APPENDICES

Appendix A. Summary of number of bird groups (# grps) and individuals (# obs), regardless of distance from observer, observed during fixed-point use surveys at the Thunder Spirit Wind Resource Area, April 6, 2011 to March 13, 2012.

Bird Type/Subtype/ Species	Scientific Name	Spring		Summer		Fall		Winter		Total	
		# grps	# obs	# grps	# obs	# grps	# obs	# grps	# obs	# grps	# obs
Waterbirds		4	1,125	0	0	0	0	0	0	4	1,125
sandhill crane	<i>Grus canadensis</i>	4	1,125	0	0	0	0	0	0	4	1,125
Waterfowl		50	98	17	34	1	6	6	110	74	248
American wigeon	<i>Anas americana</i>	1	2	1	1	0	0	0	0	2	3
blue-winged teal	<i>Anas discors</i>	3	5	2	3	0	0	0	0	5	8
Canada goose	<i>Branta canadensis</i>	5	6	0	0	0	0	5	95	10	101
gadwall	<i>Anas strepera</i>	2	3	2	2	0	0	0	0	4	5
mallard	<i>Anas platyrhynchos</i>	21	51	10	24	0	0	0	0	31	75
northern pintail	<i>Anas acuta</i>	14	25	1	1	0	0	1	15	16	41
northern shoveler	<i>Anas clypeata</i>	4	6	0	0	0	0	0	0	4	6
unidentified duck		0	0	1	3	1	6	0	0	2	9
Shorebirds		12	16	11	13	0	0	0	0	23	29
killdeer	<i>Charadrius vociferus</i>	10	13	7	8	0	0	0	0	17	21
marbled godwit	<i>Limosa fedoa</i>	1	2	2	3	0	0	0	0	3	5
upland sandpiper	<i>Bartramia longicauda</i>	1	1	1	1	0	0	0	0	2	2
willet	<i>Catoptrophorus semipalmatus</i>	0	0	1	1	0	0	0	0	1	1
Gulls/Terns		1	14	0	0	0	0	0	0	1	14
ring-billed gull	<i>Larus delawarensis</i>	1	14	0	0	0	0	0	0	1	14
Raptors		66	76	61	66	81	134	20	20	228	296
<u><i>Buteos</i></u>		30	33	21	21	48	99	10	10	109	163
ferruginous hawk	<i>Buteo regalis</i>	0	0	0	0	1	1	0	0	1	1
red-tailed hawk	<i>Buteo jamaicensis</i>	8	8	7	7	25	27	2	2	42	44
rough-legged hawk	<i>Buteo lagopus</i>	6	6	0	0	5	5	8	8	19	19
Swainson's hawk	<i>Buteo swainsoni</i>	16	19	14	14	17	66	0	0	47	99
<u><i>Northern Harrier</i></u>		35	42	38	43	31	33	5	5	109	123
northern harrier	<i>Circus cyaneus</i>	35	42	38	43	31	33	5	5	109	123
<u><i>Eagles</i></u>		1	1	1	1	1	1	3	3	6	6
bald eagle	<i>Haliaeetus leucocephalus</i>	0	0	0	0	0	0	1	1	1	1
golden eagle	<i>Aquila chrysaetos</i>	1	1	1	1	1	1	2	2	5	5
<u><i>Falcons</i></u>		0	0	0	0	1	1	0	0	1	1
American kestrel	<i>Falco sparverius</i>	0	0	0	0	1	1	0	0	1	1
<u><i>Other Raptors</i></u>		0	0	1	1	0	0	2	2	3	3
unidentified hawk		0	0	1	1	0	0	2	2	3	3

Appendix A. Summary of number of bird groups (# grps) and individuals (# obs), regardless of distance from observer, observed during fixed-point use surveys at the Thunder Spirit Wind Resource Area, April 6, 2011 to March 13, 2012.

Bird Type/Subtype/ Species	Scientific Name	Spring		Summer		Fall		Winter		Total	
		# grps	# obs	# grps	# obs	# grps	# obs	# grps	# obs	# grps	# obs
Owls		1	1	1	2	0	0	1	1	3	4
short-eared owl	<i>Asio flammeus</i>	1	1	1	2	0	0	0	0	2	3
snowy owl	<i>Bubo scandiacus</i>	0	0	0	0	0	0	1	1	1	1
Upland Game Birds		0	0	10	10	4	6	21	38	35	54
ring-necked pheasant	<i>Phasianus colchicus</i>	0	0	10	10	0	0	19	34	29	44
sharp-tailed grouse	<i>Tympanuchus phasianellus</i>	0	0	0	0	4	6	2	4	6	10
Doves/Pigeons		5	10	25	77	13	25	4	37	47	149
mourning dove	<i>Zenaida macroura</i>	4	7	23	35	10	12	0	0	37	54
rock pigeon	<i>Columba livia</i>	1	3	2	42	3	13	4	37	10	95
Large Corvids		4	30	3	3	0	0	0	0	7	33
American crow	<i>Corvus brachyrhynchos</i>	4	30	3	3	0	0	0	0	7	33
Passerines^a		136	222	252	400	71	396	57	706	516	1,724
American goldfinch	<i>Carduelis tristis</i>	0	0	3	5	0	0	0	0	3	5
American robin	<i>Turdus migratorius</i>	2	2	3	4	0	0	0	0	5	6
American tree sparrow	<i>Spizella arborea</i>	0	0	0	0	0	0	1	12	1	12
barn swallow	<i>Hirundo rustica</i>	5	7	11	20	3	7	0	0	19	34
blue jay	<i>Cyanocitta cristata</i>	0	0	1	1	0	0	0	0	1	1
bobolink	<i>Dolichonyx oryzivorus</i>	3	5	18	23	0	0	0	0	21	28
Brewer's blackbird	<i>Euphagus cyanocephalus</i>	2	19	1	1	0	0	0	0	3	20
brown-headed cowbird	<i>Molothrus ater</i>	3	5	7	11	0	0	0	0	10	16
brown thrasher	<i>Toxostoma rufum</i>	0	0	1	1	0	0	0	0	1	1
chestnut-collared longspur	<i>Calcarius ornatus</i>	5	7	5	8	0	0	0	0	10	15
chipping sparrow	<i>Spizella passerina</i>	1	1	2	3	0	0	0	0	3	4
clay-colored sparrow	<i>Spizella pallida</i>	4	4	3	3	0	0	0	0	7	7
common grackle	<i>Quiscalus quiscula</i>	2	3	6	11	1	1	0	0	9	15
dark-eyed junco	<i>Junco hyemalis</i>	1	1	0	0	0	0	0	0	1	1
eastern kingbird	<i>Tyrannus tyrannus</i>	2	2	11	17	1	2	0	0	14	21
eastern phoebe	<i>Sayornis phoebe</i>	1	1	0	0	0	0	0	0	1	1
grasshopper sparrow	<i>Ammodramus savannarum</i>	6	6	8	9	0	0	0	0	14	15
hermit thrush	<i>Catharus guttatus</i>	1	1	0	0	0	0	0	0	1	1
horned lark	<i>Eremophila alpestris</i>	16	30	13	19	23	288	39	507	91	844
house wren	<i>Troglodytes aedon</i>	0	0	1	1	0	0	0	0	1	1
lark bunting	<i>Calamospiza melanocorys</i>	2	6	29	81	1	1	0	0	32	88
lark sparrow	<i>Chondestes grammacus</i>	1	1	3	3	0	0	0	0	4	4
least flycatcher	<i>Empidonax minimus</i>	1	1	0	0	0	0	0	0	1	1
Lincoln's sparrow	<i>Melospiza lincolni</i>	0	0	1	1	0	0	0	0	1	1

Appendix A. Summary of number of bird groups (# grps) and individuals (# obs), regardless of distance from observer, observed during fixed-point use surveys at the Thunder Spirit Wind Resource Area, April 6, 2011 to March 13, 2012.

Bird Type/Subtype/ Species	Scientific Name	Spring		Summer		Fall		Winter		Total	
		# grps	# obs	# grps	# obs	# grps	# obs	# grps	# obs	# grps	# obs
loggerhead shrike	<i>Lanius ludovicianus</i>	3	3	5	6	0	0	0	0	8	9
orchard oriole	<i>Icterus spurius</i>	1	1	0	0	0	0	0	0	1	1
pine siskin	<i>Carduelis pinus</i>	0	0	0	0	0	0	1	30	1	30
red-winged blackbird	<i>Agelaius phoeniceus</i>	13	19	36	56	0	0	0	0	49	75
savannah sparrow	<i>Passerculus sandwichensis</i>	5	5	6	7	0	0	0	0	11	12
snow bunting	<i>Plectrophenax nivalis</i>	0	0	0	0	0	0	1	20	1	20
Sprague's pipit	<i>Anthus spragueii</i>	1	1	0	0	0	0	0	0	1	1
tree swallow	<i>Tachycineta bicolor</i>	5	11	2	3	1	3	0	0	8	17
unidentified passerine		0	0	0	0	0	0	7	104	7	104
unidentified sparrow		0	0	1	1	11	45	1	25	13	71
vesper sparrow	<i>Pooecetes gramineus</i>	6	10	6	7	5	11	0	0	17	28
western kingbird	<i>Tyrannus verticalis</i>	2	2	19	43	1	1	0	0	22	46
western meadowlark	<i>Sturnella neglecta</i>	41	48	48	53	24	37	7	8	120	146
white-crowned sparrow	<i>Zonotrichia leucophrys</i>	1	20	0	0	0	0	0	0	1	20
yellow warbler	<i>Dendroica petechia</i>	0	0	2	2	0	0	0	0	2	2
Goatsuckers		0	0	0	0	1	1	0	0	1	1
common nighthawk	<i>Chordeiles minor</i>	0	0	0	0	1	1	0	0	1	1
Woodpeckers		2	2	2	3	0	0	0	0	4	5
northern flicker	<i>Colaptes auratus</i>	1	1	1	1	0	0	0	0	2	2
red-headed woodpecker	<i>Melanerpes erythrocephalus</i>	1	1	1	2	0	0	0	0	2	3
Total		281	1,594	382	608	171	568	109	912	943	3,682

^a excluding large corvids

Appendix B-1. Mean bird use (number of birds/plot^a/20-min survey), percent of total use (%), and frequency of occurrence (%) for large birds by season during fixed-point bird use surveys at the Thunder Spirit Wind Resource Area from April 6, 2011 to March 13, 2012.

Bird Type/Subtype/Species	Bird Use				% of Use				% Frequency			
	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter
Waterbirds	14.80	0	0	0	82.6	0	0	0	5.3	0	0	0
sandhill crane	14.80	0	0	0	82.6	0	0	0	5.3	0	0	0
Waterfowl	1.24	0.39	0.05	0.96	6.9	17.3	3.5	53.6	35.6	18.5	0.8	3.5
American wigeon	0.02	0.01	0	0	0.1	0.4	0	0	1.2	1	0	0
blue-winged teal	0.06	0.03	0	0	0.3	1.4	0	0	3.8	2.2	0	0
Canada goose	0.08	0	0	0.83	0.4	0	0	46.3	6.4	0	0	2.6
gadwall	0.04	0.02	0	0	0.2	1.1	0	0	2.6	2.5	0	0
mallard	0.65	0.28	0	0	3.6	12.1	0	0	24.2	11.2	0	0
northern pintail	0.32	0.01	0	0.13	1.8	0.6	0	7.3	17.8	1.2	0	0.9
northern shoveler	0.08	0	0	0	0.4	0	0	0	5	0	0	0
unidentified duck	0	0.04	0.05	0	0	1.7	3.5	0	0	1.2	0.8	0
Shorebirds	0.20	0.15	0	0	1.1	6.5	0	0	15.1	10.2	0	0
killdeer	0.17	0.10	0	0	0.9	4.2	0	0	12.7	8.2	0	0
marbled godwit	0.02	0.03	0	0	0.1	1.4	0	0	1.2	2.2	0	0
upland sandpiper	0.01	0.01	0	0	<0.1	0.4	0	0	1.2	1	0	0
willet	0	0.01	0	0	0	0.4	0	0	0	1	0	0
Gulls/Terns	0.18	0	0	0	1.0	0	0	0	1.3	0	0	0
ring-billed gull	0.18	0	0	0	1.0	0	0	0	1.3	0	0	0
Raptors	0.97	0.74	1.12	0.18	5.4	32.5	77.9	9.9	54.7	45.2	51.7	17.6
<i>Buteos</i>	<i>0.42</i>	<i>0.24</i>	<i>0.82</i>	<i>0.09</i>	<i>2.3</i>	<i>10.4</i>	<i>57.6</i>	<i>5</i>	<i>32.9</i>	<i>19.2</i>	<i>34.2</i>	<i>9</i>
ferruginous hawk	0	0	<0.01	0	0	0	0.6	0	0	0	0.8	0
red-tailed hawk	0.10	0.08	0.22	0.02	0.6	3.5	15.7	0.9	9.1	8	20	1.7
rough-legged hawk	0.08	0	0.04	0.07	0.4	0	2.9	4.1	7.8	0	4.2	7.3
Swainson's hawk	0.24	0.16	0.55	0	1.3	6.8	38.4	0	18.6	14.5	12.5	0
<i>Northern Harrier</i>	<i>0.54</i>	<i>0.48</i>	<i>0.28</i>	<i>0.04</i>	<i>3.0</i>	<i>21.1</i>	<i>19.2</i>	<i>2.4</i>	<i>35.8</i>	<i>33.5</i>	<i>25.8</i>	<i>4.3</i>
northern harrier	0.54	0.48	0.28	0.04	3.0	21.1	19.2	2.4	35.8	33.5	25.8	4.3
<i>Eagles</i>	<i>0.01</i>	<i>0.01</i>	<i><0.01</i>	<i>0.03</i>	<i><0.1</i>	<i>0.4</i>	<i>0.6</i>	<i>1.5</i>	<i>1.3</i>	<i>1</i>	<i>0.8</i>	<i>2.6</i>
bald eagle	0	0	0	<0.01	0	0	0	0.5	0	0	0	0.9
golden eagle	0.01	0.01	<0.01	0.02	<0.1	0.4	0.6	1	1.3	1	0.8	1.8
<i>Falcons</i>	<i>0</i>	<i>0</i>	<i><0.01</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0.6</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0.8</i>	<i>0</i>
American kestrel	0	0	<0.01	0	0	0	0.6	0	0	0	0.8	0
<i>Other Raptors</i>	<i>0</i>	<i>0.01</i>	<i>0</i>	<i>0.02</i>	<i>0</i>	<i>0.6</i>	<i>0</i>	<i>0.9</i>	<i>0</i>	<i>1.2</i>	<i>0</i>	<i>1.7</i>
unidentified hawk	0	0.01	0	0.02	0	0.6	0	0.9	0	1.2	0	1.7

Appendix B-1. Mean bird use (number of birds/plot^a/20-min survey), percent of total use (%), and frequency of occurrence (%) for large birds by season during fixed-point bird use surveys at the Thunder Spirit Wind Resource Area from April 6, 2011 to March 13, 2012.

Bird Type/Subtype/Species	Bird Use				% of Use				% Frequency			
	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter
Owls	0.01	0.02	0	<0.01	<0.1	1.1	0	0.5	1.2	1.2	0	0.8
short-eared owl	0.01	0.02	0	0	<0.1	1.1	0	0	1.2	1.2	0	0
snowy owl	0	0	0	<0.01	0	0	0	0.5	0	0	0	0.8
Upland Game Birds	0	0.12	0.05	0.34	0	5.1	3.5	18.8	0	11.5	2.5	11.5
ring-necked pheasant	0	0.12	0	0.30	0	5.1	0	16.8	0	11.5	0	11.5
sharp-tailed grouse	0	0	0.05	0.03	0	0	3.5	1.9	0	0	2.5	1.7
Doves/Pigeons	0.13	0.82	0.21	0.31	0.7	36.1	14.5	17.3	6.3	22.2	10.8	2.5
mourning dove	0.09	0.40	0.10	0	0.5	17.6	7	0	5	21.2	8.3	0
rock pigeon	0.04	0.42	0.11	0.31	0.2	18.5	7.6	17.3	1.2	2	2.5	2.5
Large Corvids	0.39	0.03	0	0	2.2	1.4	0	0	5.1	3.2	0	0
American crow	0.39	0.03	0	0	2.2	1.4	0	0	5.1	3.2	0	0
Goatsuckers	0	0	<0.01	0	0	0	0.6	0	0	0	0.8	0
common nighthawk	0	0	<0.01	0	0	0	0.6	0	0	0	0.8	0
Overall	17.93	2.27	1.43	1.78	100	100	100	100				

^a 800-meter radius for large birds

Appendix B-2. Mean bird use (number of birds/plot^a/20-min survey), percent of total use (%), and frequency of occurrence (%) for small birds by season during fixed-point bird use surveys at the Thunder Spirit Wind Resource Area from April 6, 2011 to March 13, 2012.

Type/Species	Bird Use				% of Use				% Frequency			
	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter
Passerines^b	2.81	4.48	3.30	5.99	99.1	99.8	100	100	78.2	90.8	51.7	30.9
American goldfinch	0	0.06	0	0	0	1.3	0	0	0	3.5	0	0
American robin	0.03	0.04	0	0	0.9	1	0	0	2.6	3.5	0	0
American tree sparrow	0	0	0	0.10	0	0	0	1.7	0	0	0	0.8
barn swallow	0.09	0.23	0.06	0	3.1	5.2	1.8	0	6.3	13.0	2.5	0
blue jay	0	0.01	0	0	0	0.2	0	0	0	1.0	0	0
bobolink	0.07	0.26	0	0	2.3	5.9	0	0	3.9	19.5	0	0
Brewer's blackbird	0.23	0.01	0	0	8.0	0.3	0	0	1.2	1.2	0	0
brown-headed cowbird	0.07	0.13	0	0	2.3	2.8	0	0	3.9	8.0	0	0
brown thrasher	0	0.01	0	0	0	0.3	0	0	0	1.2	0	0
chestnut-collared longspur	0.09	0.09	0	0	3.1	2	0	0	6.3	5.5	0	0
chipping sparrow	0.01	0.04	0	0	0.4	0.8	0	0	1.2	2.5	0	0
clay-colored sparrow	0.05	0.03	0	0	1.8	0.7	0	0	5.1	3.2	0	0
common grackle	0.04	0.13	<0.01	0	1.3	2.9	0.3	0	2.4	5.8	0.8	0
dark-eyed junco	0.01	0	0	0	0.4	0	0	0	1.2	0	0	0
eastern kingbird	0.03	0.18	0.02	0	0.9	4.0	0.5	0	2.6	11.0	0.8	0
eastern phoebe	0.01	0	0	0	0.5	0	0	0	1.3	0	0	0
grasshopper sparrow	0.07	0.11	0	0	2.5	2.4	0	0	7.1	9.8	0	0
hermit thrush	0.01	0	0	0	0.5	0	0	0	1.3	0	0	0
horned lark	0.39	0.21	2.40	4.53	13.6	4.6	72.7	75.7	20.3	13.2	18.3	20.7
house wren	0	0.01	0	0	0	0.2	0	0	0	1.0	0	0
lark bunting	0.08	0.95	<0.01	0	2.8	21.1	0.3	0	2.6	24.2	0.8	0
lark sparrow	0.01	0.04	0	0	0.5	0.8	0	0	1.3	3.8	0	0
least flycatcher	0.01	0	0	0	0.5	0	0	0	1.3	0	0	0
Lincoln's sparrow	0	0.01	0	0	0	0.3	0	0	0	1.2	0	0
loggerhead shrike	0.04	0.07	0	0	1.4	1.5	0	0	3.9	4.8	0	0
orchard oriole	0.01	0	0	0	0.5	0	0	0	1.3	0	0	0
pine siskin	0	0	0	0.25	0	0	0	4.2	0	0	0	0.8
red-winged blackbird	0.24	0.58	0	0	8.6	13.0	0	0	16.7	28.8	0	0
savannah sparrow	0.06	0.08	0	0	2.3	1.8	0	0	6.5	6.8	0	0
snow bunting	0	0	0	0.17	0	0	0	2.8	0	0	0	0.8
Sprague's pipit	0.01	0	0	0	0.4	0	0	0	1.2	0	0	0
tree swallow	0.14	0.04	0.02	0	5.0	0.8	0.8	0	6.4	2.5	0.8	0
unidentified passerine	0	0	0	0.87	0	0	0	14.5	0	0	0	5.8

Appendix B-2. Mean bird use (number of birds/plot^a/20-min survey), percent of total use (%), and frequency of occurrence (%) for small birds by season during fixed-point bird use surveys at the Thunder Spirit Wind Resource Area from April 6, 2011 to March 13, 2012.

Type/Species	Bird Use				% of Use				% Frequency			
	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter
unidentified sparrow	0	0.01	0.38	0	0	0.2	11.4	0	0	1.0	9.2	0
vesper sparrow	0.12	0.08	0.09	0	4.3	1.7	2.8	0	7.4	6.5	4.2	0
western kingbird	0.02	0.44	<0.01	0	0.8	9.9	0.3	0	2.4	18	0.8	0
western meadowlark	0.60	0.60	0.31	0.07	21.1	13.4	9.3	1.2	51.5	48.5	20	5.2
white-crowned sparrow	0.26	0	0	0	9.3	0	0	0	1.3	0	0	0
yellow warbler	0	0.02	0	0	0	0.6	0	0	0	2.5	0	0
Woodpeckers	0.03	0.01	0	0	0.9	0.2	0	0	1.3	1.0	0	0
northern flicker	0.01	0.01	0	0	0.5	0.2	0	0	1.3	1.0	0	0
red-headed woodpecker	0.01	0	0	0	0.5	0	0	0	1.3	0	0	0
Overall	2.84	4.49	3.30	5.99	100	100	100	100				

^a 100-meter (m) radius plot for small birds;

^b excluding large corvids

Appendix C-1. Relative collision risk exposure index, mean bird use (birds/plot/20-min survey), and flight characteristics for large birds observed during fixed-point bird use surveys at the Thunder Spirit Wind Resource Area April 6, 2011 to March 13, 2012. Large bird observations were limited to within 800 meters of observer.

Species	Number of Groups Flying	Bird Use	% Flying	% Flying Within RSH^a Based on Initial Observation	Exposure Index	% Within RSH at Any Time
sandhill crane	4	3.16	100	95.6	3.02	95.6
Canada goose	6	0.29	95.0	100	0.27	100
Swainson's hawk	37	0.20	77.8	94.8	0.15	97.4
rock pigeon	9	0.24	68.4	41.5	0.07	56.9
northern pintail	13	0.11	85.4	57.1	0.06	60.0
mallard	22	0.21	58.7	38.6	0.05	56.8
red-tailed hawk	29	0.09	70.5	64.5	0.04	90.3
American crow	3	0.09	87.9	51.7	0.04	51.7
northern harrier	103	0.31	93.5	13.0	0.04	21.7
rough-legged hawk	15	0.05	78.9	80.0	0.03	86.7
unidentified duck	2	0.02	100	100	0.02	100
golden eagle	5	0.01	100	60.0	<0.01	80.0
killdeer	14	0.06	85.7	11.1	<0.01	11.1
marbled godwit	2	0.01	60.0	66.7	<0.01	66.7
gadwall	3	0.01	80.0	25.0	<0.01	25.0
unidentified hawk	2	<0.01	66.7	50.0	<0.01	50.0
mourning dove	18	0.14	50.0	0	0	0
ring-necked pheasant	7	0.13	36.4	0	0	0
ring-billed gull	1	0.04	100	0	0	100
sharp-tailed grouse	3	0.02	60.0	0	0	0
blue-winged teal	2	0.02	37.5	0	0	0
northern shoveler	2	0.02	50.0	0	0	0
short-eared owl	1	<0.01	66.7	0	0	0
American wigeon	0	<0.01	0	0	0	0
upland sandpiper	1	<0.01	50.0	0	0	0
bald eagle	0	<0.01	0	0	0	0
snowy owl	0	<0.01	0	0	0	0
willet	1	<0.01	100	0	0	0
ferruginous hawk	0	<0.01	0	0	0	0
common nighthawk	1	<0.01	100	0	0	0
American kestrel	0	<0.01	0	0	0	0

^a RSH: the likely "rotor swept height" for potential collision with a turbine blade, or 25 to 150 meters (82 to 492 feet) above ground level

Appendix C-2. Relative collision risk exposure index, mean bird use (birds/plot/20-min survey), and flight characteristics for small birds observed during fixed-point bird use surveys at the Thunder Spirit Wind Resource Area from April 6, 2011 to March 13, 2012. Small bird observations were limited to within 100 meters of observer.

Species	Number of Groups Flying	Bird Use	% Flying	% Flying Within RSH^a Based on Initial Observation	Exposure Index	% Within RSH at Any Time
unidentified passerine	6	0.28	99	44.7	0.12	59.2
snow bunting	1	0.05	100	100	0.05	100
horned lark	70	2.11	95.7	0.8	0.02	7.1
common grackle	8	0.04	93.3	7.1	<0.01	7.1
western meadowlark	41	0.37	36.3	0	0	0
lark bunting	20	0.26	54.1	0	0	0
red-winged blackbird	31	0.2	65.3	0	0	0
western kingbird	18	0.12	56.5	0	0	0
barn swallow	19	0.09	100	0	0	0
pine siskin	1	0.08	100	0	0	0
bobolink	11	0.08	57.1	0	0	0
unidentified sparrow	11	0.08	97.8	0	0	0
vesper sparrow	8	0.06	64.3	0	0	0
white-crowned sparrow	1	0.06	100	0	0	0
eastern kingbird	6	0.05	33.3	0	0	0
Brewer's blackbird	3	0.05	100	0	0	0
brown-headed cowbird	3	0.05	18.8	0	0	0
tree swallow	8	0.05	100	0	0	0
grasshopper sparrow	2	0.04	13.3	0	0	0
chestnut-collared longspur	9	0.04	86.7	0	0	0
savannah sparrow	5	0.03	50	0	0	0
American tree sparrow	1	0.03	100	0	0	0
loggerhead shrike	4	0.03	44.4	0	0	0
clay-colored sparrow	3	0.02	42.9	0	0	0
American robin	2	0.02	50	0	0	0
American goldfinch	1	0.02	60	0	0	0
lark sparrow	1	0.01	25	0	0	0
chipping sparrow	0	0.01	0	0	0	0
yellow warbler	1	<0.01	50	0	0	0
northern flicker	1	<0.01	50	0	0	0
Lincoln's sparrow	0	<0.01	0	0	0	0
brown thrasher	1	<0.01	100	0	0	0
red-headed woodpecker	0	<0.01	0	0	0	0
orchard oriole	1	<0.01	100	0	0	0
least flycatcher	0	<0.01	0	0	0	0
hermit thrush	1	<0.01	100	0	0	0
eastern phoebe	0	<0.01	0	0	0	0
dark-eyed junco	1	<0.01	100	0	0	0
Sprague's pipit	0	<0.01	0	0	0	0
house wren	0	<0.01	0	0	0	0
blue jay	0	<0.01	0	0	0	0

^a RSH: the likely "rotor swept height" for potential collision with a turbine blade, or 25 to 150 meters (82 to 492 feet) above ground level

Appendix D. Mean use (birds/20-minute survey) by survey point for all birds^a, major bird types, and raptor subtypes observed during fixed-point bird use surveys at the Thunder Spirit Wind Resource Area from April 6, 2011 to March 13, 2012.

Bird Type / Subtype	Survey Point																								
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Waterbirds	0	0	0	31.25	0	0	0	2.78	0	0	0	0	0	0	0	0	29.41	0	4.17	0	0	0	0	0	0
Waterfowl	0.39	0.12	0.86	0.12	0.06	1.50	1.06	0.28	0	0.18	0.41	0.50	0.67	0.67	0.28	0	0.12	0.41	0	0.11	0	3.53	1.00	1.47	1.31
Shorebirds	0	0	0.21	0	0.11	0.28	0.11	0	0	0.24	0	0	0.11	0.33	0.06	0.12	0	0	0	0.08	0.06	0	0	0	0
Gulls/ Terns	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.82	0	0	0
Raptors	0.50	0.75	0.50	0.75	0.39	0.50	0.72	0.22	1.20	0.41	0.76	1.17	0.83	0.56	0.78	1.06	1.47	0.59	0.50	0.44	2.77	0.06	0.22	0.53	2.08
<i>Buteos</i>	0.28	0.25	0.21	0.38	0.22	0.33	0.44	0.06	0.20	0.35	0.29	0.50	0.39	0.33	0.33	0.47	0.47	0.18	0.14	0.28	2.46	0	0.22	0.27	1.77
<i>Northern Harrier</i>	0.22	0.44	0.29	0.38	0.11	0.17	0.28	0.17	0.80	0.06	0.35	0.67	0.39	0.11	0.44	0.59	1.00	0.41	0.29	0.17	0.23	0.06	0	0.27	0.31
<i>Eagles</i>	0	0	0	0	0	0	0	0	0.20	0	0.06	0	0.06	0.11	0	0	0	0	0.07	0	0	0	0	0	0
<i>Falcons</i>	0	0	0	0	0.06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Other Raptors</i>	0	0.06	0	0	0	0	0	0	0	0.06	0	0	0	0	0	0	0	0	0	0.08	0	0	0	0	0
Owls	0	0.06	0	0	0	0	0	0	0	0	0	0	0.06	0	0	0	0	0.12	0	0	0	0	0	0	0
Upland Game Birds	0.06	0	0.21	0.25	0.72	0	0.28	0.11	0.60	0	0.06	0	0.06	0	0.06	0.35	0.06	0	0	0	0.08	0.18	0.11	0.33	0.15
Doves/ Pigeons	0.06	0	1.14	0	1.56	1.83	0.17	0	0.20	0.24	0.12	0.33	0	0.06	0.17	0	0	0.12	0	2.11	0.08	0.12	0.56	0	0
Large Corvids	0.06	0	0.07	0	0.06	0	0	0	0	0.06	0	0	0	0	0.24	0	0	0	0.56	0	0	0.83	0	0	0
Goat-suckers	0	0	0.07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
All Large Birds	1.06	0.94	3.07	32.38	2.89	4.11	2.33	3.39	2.00	1.06	1.41	2.00	1.72	1.61	1.33	1.76	1.65	30.65	0.50	7.39	3.00	4.76	2.72	2.33	3.54
Passerines	3.56	4.62	7.57	1.06	2.06	4.28	4.67	4.44	2.00	1.94	2.47	1.00	4.83	5.17	2.61	3.06	0.71	0.71	22.43	3.56	6.69	2.00	3.17	1.80	11.31
Wood-peckers	0	0	0	0	0.17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
All Small Birds	3.56	4.62	7.57	1.06	2.22	4.28	4.67	4.44	2.00	1.94	2.47	1.00	4.83	5.17	2.61	3.06	0.71	0.71	22.43	3.56	6.69	2.00	3.17	1.80	11.31

^a 800-meter radius for large birds and 100-meter for small birds

Appendix E. Bird fatality estimates (bird fatalities/megawatt/year) and characteristics for wind energy facilities in North America, grouped by geographic region.

Wind Energy Facility	Fatality Estimate	Number of Turbines	Total Megawatts
<i>Midwest</i>			
Wessington Springs, SD	8.25	34	51
Blue Sky Green Field, WI	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	5.59	33	49.5
Barton I & II, IA	5.50	80	160
Buffalo Ridge I, SD (2010)	5.06	24	50.4
Buffalo Ridge, MN (Phase I; 1996)	4.14	73	25
Winnebago, IA	3.88	10	20
Rugby, ND	3.82	71	149
Cedar Ridge, WI (2010)	3.72	41	68
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
Buffalo Ridge, MN (Phase I; 1997)	2.51	73	25
Buffalo Ridge, MN (Phase II; 1998)	2.47	143	107.25
Kewaunee County, WI	1.95	31	20.46
NPPD Ainsworth, NE	1.63	36	20.5
Elm Creek, MN	1.55	67	100
PrairieWinds ND1 (Minot), ND	1.48	80	115.5
Buffalo Ridge, MN (Phase I; 1999)	1.43	73	25
Top of Iowa, IA (2004)	0.81	89	80
Grand Ridge, IL	0.48	66	99
Top of Iowa, IA (2003)	0.42	89	80
<i>Rocky Mountains</i>			
Foot Creek Rim, WY (Phase I; 1999)	3.4	69	41.4
Foot Creek Rim, WY (Phase I; 2000)	2.42	69	41.4
Foot Creek Rim, WY (Phase I; 2001-2002)	1.93	69	41.4
Summerview, Alb (2006)	1.06	39	70.2
<i>Southern Plains</i>			
Buffalo Gap I, TX	1.32	67	134
Barton Chapel, TX	1.15	60	120
Buffalo Gap II, TX	0.15	155	233

Appendix E. Bird fatality estimates (bird fatalities/megawatt/year) and characteristics for wind energy facilities in North America, grouped by geographic region.

Wind Energy Facility	Fatality Estimate	Number of Turbines	Total Megawatts
<i>Northeast</i>			
Mount Storm, WV (2009)	5.73	132	264
Maple Ridge, NY (2007)	3.44	195	321.75
Lempster, NH (2009)	3.38	12	24
Casselman, PA (Spring & Fall 2008)	3.13	23	34.5
Noble Bliss, NY (2008)	2.86	67	100
Mountaineer, WV (2003)	2.69	44	66
Stetson Mountain, ME (2009)	2.68	38	57
Noble Ellenburg, NY (2009)	2.66	54	80
Lempster, NH (2010)	2.64	12	24
Mount Storm, WV (2010)	2.6	132	264
Noble Bliss, NY (2009)	2.28	67	100
Noble Clinton, NY (2008)	2.17	67	100
Maple Ridge, NY (2008)	2.07	195	321.75
Noble Altona, NY	1.84	65	97.5
Mars Hill, ME (2008)	1.76	28	42
Noble Wethersfield, NY	1.7	84	126
Mars Hill, ME (2007)	1.67	28	42
Noble Chateaugay, NY	1.66	71	106.5
Munnsville, NY (2008)	1.48	23	34.5
Noble Ellenburg, NY (2008)	1.4	54	80
Cohocton/Dutch Hill, NY (2009)	1.39	50	125
Cohocton/Dutch Hills, NY (2010)	1.32	50	125
Noble Clinton, NY (2009)	1.11	67	100
<i>Southeast</i>			
Buffalo Mountain, TN (2000-2003)	11.02	3	1.98
Buffalo Mountain, TN (2005)	1.1	18	28.98
<i>Southwest</i>			
Dry Lake I, AZ	2.22	30	63
<i>California</i>			
Pine Tree, CA	8.3	90	135
Shiloh I, CA	6.96	100	150
Dillon, CA	4.71	45	45
Diablo Winds, CA	4.29	31	20.46
High Winds, CA (2004)	1.62	90	162
High Winds, CA (2005)	1.1	90	162
Alite, CA	0.55	8	24

Appendix E. Bird fatality estimates (bird fatalities/megawatt/year) and characteristics for wind energy facilities in North America, grouped by geographic region.

Wind Energy Facility	Fatality Estimate	Number of Turbines	Total Megawatts
<i>Pacific Northwest</i>			
Leaning Juniper, OR	6.66	67	100.5
Biglow Canyon, OR (Phase II; 2009/2010)	5.53	65	150
Tuolumne (Windy Point I), WA	3.2	62	136.6
Stateline, OR/WA (2002)	3.17	454	263
Klondike II, OR	3.14	50	75
Klondike III (Phase I), OR	3.02	125	223.6
Hopkins Ridge, WA (2008)	2.99	87	156.6
Klondike IIIa (Phase II), OR	2.8	51	76.5
Nine Canyon, WA	2.76	37	48.1
Stateline, OR/WA (2003)	2.68	454	263
Combine Hills, OR	2.56	41	41
Big Horn, WA	2.54	133	199.5
Biglow Canyon, OR (Phase I; 2009)	2.47	76	125.4
Hay Canyon, OR	2.21	48	100.8
Elkhorn, OR (2010)	1.95	61	101
Pebble Springs, OR	1.93	47	98.7
Biglow Canyon, OR (Phase I; 2008)	1.76	76	125.4
Wild Horse, WA	1.55	127	229
Goodnoe, WA	1.4	47	94
Hopkins Ridge, WA (2006)	1.23	83	150
Stateline, OR/WA (2006)	1.23	454	263
Klondike, OR	0.95	16	24
Vansycle, OR	0.95	38	24.9
Elkhorn, OR (2008)	0.64	61	101
Marengo I, WA (2009)	0.27	78	140.4
Marengo II, WA (2009)	0.16	39	70.2

Appendix E. Bird fatality estimates (bird fatalities/megawatt/year) and characteristics for wind energy facilities in North America.

Data from the following sources:

Wind Energy Facility	Fatality Estimate	Wind Energy Facility	Fatality Estimate
Alite, CA	Chatfield et al. 2010b	Klondike III, OR	Gritski et al. 2010
Barton I&II, IA	Derby et al. 2011a	Klondike IIIa, OR	Gritski et al. 2011
Barton Chapel, TX	WEST 2011	Leaning Juniper, OR	Kronneret al. 2007
Big Horn, WA	Kronner et al. 2008	Lempster, NH (2009)	Tidhar et al. 2010
Biglow Canyon, OR (Phase I; 08)	Jeffrey et al. 2009b	Lempster, NH (2010)	Tidhar et al. 2011
Biglow Canyon, OR (Phase I; 09)	Enk et al. 2010	Maple Ridge, NY (07)	Jain et al. 2009a
Biglow Canyon, OR (Phase II; 09-10)	Enk et al. 2011b	Maple Ridge, NY (08)	Jain et al. 2009b
Blue Sky Green Field, WI	Gruver et al. 2009	Marengo I, WA (09)	URS Corporation 2010b
Buffalo Gap I, TX	Tierney 2007	Marengo II, WA (09)	URS Corporation 2010c
Buffalo Gap II, TX	Tierney 2009	Mars Hill, ME (07)	Stantec 2008
Buffalo Mountain, TN (00-03)	Nicholson et al. 2005	Mars Hill, ME (08)	Stantec 2009a
Buffalo Mountain, TN (05)	Fiedler et al. 2007	Moraine II, MN	Derby et al. 2010e
Buffalo Ridge, MN (Phase I; 96)	Johnson et al. 2000a	Mount Storm, WV (09)	Young et al. 2009a, 2010b
Buffalo Ridge, MN (Phase I; 97)	Johnson et al. 2000a	Mount Storm, WV (10)	Young et al. 2010a, 2011
Buffalo Ridge, MN (Phase I; 98)	Johnson et al. 2000a	Mountaineer, WV	Kerns and Kerlinger 2004
Buffalo Ridge, MN (Phase I; 99)	Johnson et al. 2000a	Munnsville, NY (08)	Stantec 2009b
Buffalo Ridge, MN (Phase II; 98)	Johnson et al. 2000a	Nine Canyon, WA	Erickson et al. 2003a
Buffalo Ridge, MN (Phase II; 99)	Johnson et al. 2000a	Noble Altona, NY	Jain et al. 2011a
Buffalo Ridge, MN (Phase III; 99)	Johnson et al. 2000a	Noble Bliss, NY (08)	Jain et al. 2009c
Buffalo Ridge I, SD (10)	Derby et al. 2010c	Noble Bliss, NY (09)	Jain et al. 2010a
Casselman, PA (Spring & Fall 08)	Arnett et al. 2009	Noble Chateaugay, NY	Jain et al. 2011b
Cedar Ridge, WI (09)	BHE Environmental 2010	Noble Clinton, NY (08)	Jain et al. 2009d
Cedar Ridge, WI (10)	BHE Environmental 2011	Noble Clinton, NY (09)	Jain et al. 2010a
Cohocton/Dutch Hill, NY (09)	Stantec 2010	Noble Ellenburg, NY (08)	Jain et al. 2009e
Cohocton/Dutch Hill, NY (10)	Stantec 2011	Noble Ellenburg, NY (09)	Jain et al. 2010b
Combine Hills, OR	Young et al. 2006	Noble Wethersfield, NY	Jain et al. 2011c
Diablo Winds, CA	WEST 2006, 2008	NPPD Ainsworth, NE	Derby et al. 2007
Dillon, CA	Chatfield et al. 2009	Pebble Springs, OR	Gritski and Kronner 2010b
Dry Lake I, AZ	Thompson et al. 2011	Pine Tree, CA	BioResource Consultants 2010
Elkhorn, OR (2008)	Jeffrey et al. 2009a	PrairieWinds ND1 (Minot), ND	Derby et al. 2011c
Elkhorn, OR (2010)	Enk et al. 2011a	Ripley, Ont (08)	Jacques Whitford 2009
Elm Creek, MN	Derby et al. 2010d	Rugby, ND	Derby et al. 2011b
Foote Creek Rim, WY (Phase I; 99)	Young et al. 2003a	Shiloh I, CA	Kerlinger et al. 2010
Foote Creek Rim, WY (Phase I; 00)	Young et al. 2003a	Stateline, OR/WA (02)	Erickson et al. 2004
Foote Creek Rim, WY (Ph. I; 01-02)	Young et al. 2003a	Stateline, OR/WA (03)	Erickson et al. 2004
Goodnoe, WA	URS Corporation 2010a	Stateline, OR/WA (06)	Erickson et al. 2007
Grand Ridge, IL	Derby et al. 2010a	Stetson Mountain, ME (09)	Stantec 2009c
Hay Canyon, OR	Gritski and Kronner 2010a	Summerview, Alb (2006)	Brown and Hamilton 2006
High Winds, CA (2004)	Kerlinger et al. 2006	Top of Iowa, IA (03)	Jain 2005
High Winds, CA (2005)	Kerlinger et al. 2006	Top of Iowa, IA (04)	Jain 2005
Hopkins Ridge, WA (2006)	Young et al. 2007c	Tuolumne (Windy Point I), WA	Enz and Bay 2010
Hopkins Ridge, WA (2008)	Young et al. 2009b	Vansycle, OR	Erickson et al. 2000
Kewaunee County, WI	Howe et al. 2002	Wessington Springs, SD	Derby et al. 2010b
Klondike, OR	Johnson et al. 2003	Wild Horse, WA	Erickson et al. 2008
Klondike II, OR	NWC and WEST 2007	Winnebago, IA	Derby et al. 2010f

Appendix F. Raptor use estimates (raptors/plot/20-min survey), fatality estimates (fatalities/megawatt/year), and characteristics for wind energy facilities in North America, grouped by geographic region.

Wind Energy Facility	Use Estimate	Raptor Fatality Estimate	Number of Turbines	Total Megawatts
<i>Midwest</i>				
Buffalo Ridge, MN (Phase I; 1996)		0.47	73	25
Moraine II, MN		0.37	33	49.5
Winnebago, IA		0.27	10	20
Buffalo Ridge I, SD (2010)		0.2	24	50.4
NPPD Ainsworth, NE		0.06	36	20.5
Wessington Springs, SD	0.232	0.06	34	51
PrairieWinds ND1 (Minot), ND		0.05	80	115.5
Rugby, ND		0.05	71	149
Kewaunee County, WI		0	31	20.46
Buffalo Ridge, MN (Phase I; 1997)		0	73	25
Buffalo Ridge, MN (Phase I; 1998)		0	73	25
Buffalo Ridge, MN (Phase I; 1999)		0	73	25
Grand Ridge, IL	0.195	0	66	99
Elm Creek, MN		0	67	100
Buffalo Ridge, MN (Phase III; 1999)		0	138	103.5
Buffalo Ridge, MN (Phase II; 1998)		0	143	107.25
Buffalo Ridge, MN (Phase II; 1999)		0	143	107.25
Blue Sky Green Field, WI		0	88	145
Barton I & II, IA		0	80	160
<i>Rocky Mountains</i>				
Summerview, Alb (2006)		0.11	39	70.2
Foote Creek Rim, WY (Phase I; 1999)	0.554	0.08	69	41.4
Foote Creek Rim, WY (Phase I; 2000)		0.05	69	41.4
Foote Creek Rim, WY (Phase I; 2001-2002)		0	69	41.4
<i>Southern Plains</i>				
Barton Chapel, TX		0.25	60	120
Buffalo Gap I, TX		0.1	67	134
Buffalo Gap II, TX		0	155	233
<i>Northeast</i>				
Munnsville, NY (2008)		0.59	23	34.5
Noble Ellenburg, NY (2009)		0.49	54	80
Noble Ellenburg, NY (2008)		0.32	54	80
Noble Clinton, NY (2008)		0.29	67	100
Maple Ridge, NY (2007)		0.25	195	321.75
Noble Clinton, NY (2009)		0.24	67	100
Noble Bliss, NY (2009)		0.18	67	100
Noble Bliss, NY (2008)		0.1	67	100
Mount Storm, WV (2010)		0.1	132	264
Maple Ridge, NY (2008)		0.03	195	321.75
Lempster, NH (2009)		0	12	24
Lempster, NH (2010)		0	12	24
Casselman, PA (Spring & Fall 2008)		0	23	34.5
Mars Hill, ME (2007)		0	28	42
Mars Hill, ME (2008)		0	28	42
Noble Altona, NY		0	65	97.5
Mount Storm, WV (2009)		0	132	264
<i>Southeast</i>				
Buffalo Mountain, TN (2000-2003)		0	3	1.98
Buffalo Mountain, TN (2005)		0	18	28.98

Appendix F. Raptor use estimates (raptors/plot/20-min survey), fatality estimates (fatalities/megawatt/year), and characteristics for wind energy facilities in North America, grouped by geographic region.

Wind Energy Facility	Use Estimate	Raptor Fatality Estimate	Number of Turbines	Total Megawatts
Southwest				
Dry Lake I, AZ	0.13	0	30	63
California				
Shiloh I, CA		0.42	100	150
Diablo Winds, CA	2.161	0.4	31	20.46
Pine Tree, CA		0.133	90	135
Alite, CA		0.12	8	24
Dillon, CA		0	45	45
Pacific Northwest				
Tuolumne (Windy Point I), WA	0.77	0.29	62	136.6
Goodnoe, WA		0.17	47	94
Leaning Juniper, OR	0.522	0.16	67	100.5
Klondike III (Phase I), OR		0.15	125	223.6
Hopkins Ridge, WA (2006)	0.698	0.14	83	150
Biglow Canyon, OR (Phase II; 2009/2010)		0.14	65	150
Big Horn, WA	0.511	0.11	133	199.5
Stateline, OR/WA (2006)		0.11	454	263
Stateline, OR/WA (2002)	0.478	0.09	454	263
Stateline, OR/WA (2003)		0.09	454	263
Elkhorn, OR (2010)		0.08	61	101
Hopkins Ridge, WA (2008)		0.07	87	156.6
Wild Horse, WA	0.291	0.07	127	229
Klondike II, OR	0.504	0.06	50	75
Klondike IIIa (Phase II), OR		0.06	51	76.5
Elkhorn, OR (2008)	1.07	0.06	61	101
Marengo II, WA (2009)		0.05	39	70.2
Pebble Springs, OR		0.04	47	98.7
Biglow Canyon, OR (Phase I; 2009)		0.04	76	125.4
Nine Canyon, WA	0.35	0.03	37	48.1
Biglow Canyon, OR (Phase I; 2008)		0.03	76	125.4
Klondike, OR	0.504	0	16	24
Vansycle, OR	0.66	0	38	24.9
Combine Hills, OR	0.746	0	41	41
Hay Canyon, OR		0	48	100.8
Marengo I, WA (2009)		0	78	140.4

Appendix F. Raptor use estimates (raptors/plot/20-min survey), fatality estimates (fatalities/megawatt/year), and characteristics for wind energy facilities in North America.

Data from the following sources:

Wind Energy Facility	Use Estimate	Fatality Estimate	Wind Energy Facility	Use Estimate	Fatality Estimate
Alite, CA		Chatfield et al. 2010b	Klondike III (Phase I), OR		Gritski et al. 2010
Barton I&II, IA		Derby et al. 2011a	Klondike IIIa (Phase II), OR		Gritski et al. 2011
Barton Chapel, TX		WEST 2011	Leaning Juniper, OR	Kronner et al. 2005	Kronner et al. 2007
Big Horn, WA	Johnson and Erickson 2004	Kronner et al. 2008	Lempster, NH (09)		Tidhar et al. 2010
Biglow Canyon, OR (Phase I; 08)		Jeffrey et al. 2009b	Lempster, NH (10)		Tidhar et al. 2011
Biglow Canyon, OR (Phase I; 09)		Enk et al. 2010	Maple Ridge, NY (07)		Jain et al. 2009a
Biglow Canyon, OR (Phase II; 09/10)		Enket al. 2011b	Maple Ridge, NY (08)		Jain et al. 2009b
Blue Sky Green Field, WI		Gruver et al. 2009	Marengo I, WA (09)		URS Corporation 2010b
Buffalo Gap I, TX		Tierney 2007	Marengo II, WA (09)		URS Corporation 2010c
Buffalo Gap II, TX		Tierney 2009	Mars Hill, ME (07)		Stantec 2008
Buffalo Mountain, TN (00-03)		Nicholson et al. 2005	Mars Hill, ME (08)		Stantec 2009a
Buffalo Mountain, TN (05)		Fiedler et al. 2007	Moraine II, MN		Derby et al. 2010e
Buffalo Ridge, MN (Phase I; 1996)		Johnson et al. 2000a	Mount Storm, WV (09)		Younget al. 2009a, 2010b
Buffalo Ridge, MN (Phase I; 1997)		Johnson et al. 2000a	Mount Storm, WV (10)		Younget al. 2010a, 2011
Buffalo Ridge, MN (Phase I; 1998)		Johnson et al. 2000a	Munnsville, NY (08)		Stantec 2009b
Buffalo Ridge, MN (Phase I; 1999)		Johnson et al. 2000a	Nine Canyon, WA	Erickson et al. 2001a	Erickson et al. 2003a
Buffalo Ridge, MN (Phase II; 1998)		Johnson et al. 2000a	Noble Altona, NY		Jain et al. 2011a
Buffalo Ridge, MN (Phase II; 1999)		Johnson et al. 2000a	Noble Bliss, NY (08)		Jain et al. 2009c
Buffalo Ridge, MN (Phase III; 1999)		Johnson et al. 2000a	Noble Bliss, NY (09)		Jain et al. 2010c
Buffalo Ridge I, SD (10)		Derby et al. 2010c	Noble Clinton, NY (08)		Jain et al. 2009d
Casselman, PA (Spring & Fall 08)		Arnett et al. 2009	Noble Clinton, NY (09)		Jain et al. 2010a
Combine Hills, OR	Young et al. 2003c	Younget al. 2006	Noble Ellenburg, NY (08)		Jain et al. 2009e
Diablo Winds, CA	WEST 2006	WEST 2006, 2008	Noble Ellenburg, NY (09)		Jain et al. 2010b
Dillon, CA		Chatfield et al. 2009	NPPD Ainsworth, NE		Derby et al. 2007
Dry Lake, AZ	Thompson et al. 2011	Thompson et al. 2011	Pebble Springs, OR		Gritski and Kronner 2010b
Elkhorn, OR (08)	WEST 2005a	Jeffrey et al. 2009a	Pine Tree, CA		BioResource Consultants 2010
Elkhorn, OR (10)		Enk et al. 2011a	PrairieWinds ND1 (Minot), ND		Derby et al. 2011c
Elm Creek, MN		Derby et al. 2010d	Rugby, ND		Derby et al. 2011b
Foote Creek Rim, WY (Phase I; 99)	Johnson et al. 2000b	Young et al. 2003a	Shiloh I, CA		Kerlinger et al. 2010
Foote Creek Rim, WY (Phase I; 00)		Young et al. 2003a	Stateline, OR/WA (02)	Erickson et al. 2003b	Erickson et al. 2004
Foote Creek Rim, WY (Phase I; 01-02)		Young et al. 2003a	Stateline, OR/WA (03)		Erickson et al. 2004
Goodnoe, WA		URS Corporation 2010a	Stateline, OR/WA (06)		Erickson et al. 2007
Grand Ridge, IL	Derby et al. 2009	Derby et al. 2010a	Summerview, Alb (06)		Brown and Hamilton 2006
Hay Canyon, OR		Gritski and Kronner 2010a	Tuolumne (Windy Point I), WA	Johnson et al. 2006	Enz and Bay 2010
Hopkins Ridge, WA (06)	Younget al. 2003e	Young et al. 2007c	Vansycle, OR	WCIA and WEST 1997	Erickson et al. 2000
Hopkins Ridge, WA (08)		Young et al. 2009b	Wessington Springs, SD	Derby et al. 2008	Derby et al. 2010b
Kewaunee County, WI		Howe et al. 2002	Wild Horse, WA	Erickson et al. 2003d	Erickson et al. 2008
Klondike, OR	Johnson et al. 2002a	Johnson et al. 2003	Winnebago, IA		Derby et al. 2010f
Klondike II, OR	Johnson 2004	NWC and WEST 2007			

Bat Acoustic Studies for the Thunder Spirit Wind Resource Area Adams County, North Dakota

**Final Report
May – October 2011**



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NATURAL RESOURCES ♦ SCIENTIFIC SOLUTIONS

EXECUTIVE SUMMARY

Thunder Spirit Wind LLC contracted with Western EcoSystems Technology, Inc. to develop and implement a standardized protocol for baseline studies of bat use for the Thunder Spirit Wind Resource Area (TSWRA). The bat acoustic survey conducted at the TSWRA was designed to achieve several objectives: 1) estimate levels of bat activity throughout the TSWRA during summer reproduction and fall migration; 2) characterize patterns of temporal variation in levels of bat activity; 3) estimate the activity levels of species of interest (i.e., hoary bats and eastern red bats); and 4) assess the potential risk wind energy development poses to bats flying at the approximate height of turbine blades.

Passive acoustic sampling using AnaBat II SD1 ultrasonic bat call detectors was used to quantify bat use in the TSWRA between May 25 and October 20, 2011, for a total of 489 detector-nights. AnaBat bat call detectors were paired at one meteorological tower, where detectors were placed near the ground (one meter) and within the rotor-swept height (approximately 50 meters). Two other acoustic monitoring stations were placed near the ground (one meter).

Four hundred and six bat passes were recorded during the survey period; overall bat activity was 0.78 ± 0.08 bat passes per detector-night. AnaBats at ground stations (TS1g, TS2g, and TS3g) recorded 364 bat passes on 374 detector-nights for a mean of 0.92 bat passes per detector-night, while the raised station (TS1r) recorded 42 bat passes on 115 detector nights for a mean of 0.37 passes per detector-night. Similarly low call rates were recorded at two ground detectors in 2007.

Bat activity in the TSWRA was higher at the ground stations (0.92) than at the raised station (0.37). TS3g recorded the fewest bat passes per detector-night (0.65), while TS1g recorded the most (1.44). Activity at TS2g (0.67) was very similar to TS3g. The raised detector recorded the fewest bat passes of all AnaBats (0.37).

Overall bat activity was higher during the fall, averaging 1.13 bat passes per detector-night compared to 0.62 in summer. Generally, bat activity was relatively low until mid-July, rose during the period from July 23 to September 2, and then fell to lower levels again for the rest of the monitoring period. The week of highest overall bat activity, while still low overall, was the week of July 27 to August 2 (2.61 passes per detector-night).

Bat activity at ground stations was lower in the summer (0.73 bat passes per detector-night) and higher in fall (1.30). Weekly bat activity at ground stations was generally low from late May to late July, rose in July, August, and early September, then was lower for the rest of the monitoring period. The raised station also had lower bat activity in the summer (0.28 bat passes per detector-night) and higher bat activity in the fall (0.61). Weekly bat activity at the raised station was first recorded in early July, was somewhat higher in August and September, and then ceased in mid-September.

Passes by high-frequency (HF) bats (62.8% of all passes) outnumbered passes by low-frequency (LF) bats (37.2%), and this pattern was largely consistent among ground stations. LF passes outnumbered HF passes at the raised station. HF and LF bat activity was higher in fall (0.67 bat passes per detector-night and 0.46 respectively) than in summer (0.43 and 0.19 respectively). The week of peak activity for HF bat species was July 27 to August 2; for LF bat species, the week of peak activity was August 24 to August 30. Weekly bat activity for both HF and LF bat species was relatively low early in the monitoring period. HF bat activity was highest from late July through August while LF bat species had the highest activity in late August and early September.

Fourteen bat passes (3.4% of bat passes) were attributable to hoary bats; hoary bats were recorded at all stations except station TS2g and were detected more by TS1g and the raised detector than by any other detectors. Passes attributable to eastern red bats accounted for 1.2% of all bat passes; eastern red bat calls were recorded at stations TS1r and TS2g only. Eastern red bat activity was highest during late summer and early fall (July 30 - August 8). More hoary bats were detected (14) than eastern red bats (5) within the TSWRA. The week of peak activity for the eastern red bat was July 30 to August 8; for the hoary bat, the week of peak activity was July 26 to August 1.

STUDY PARTICIPANTS

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REPORT REFERENCE

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INTRODUCTION

Thunder Spirit Wind LLC (Thunder Spirit) is considering the development of the Thunder Spirit Wind Resource Area (TSWRA) in Adams County, North Dakota. Thunder Spirit contracted with Western EcoSystems Technology, Inc. (WEST) to develop and implement a standardized protocol for baseline studies of bat use for the TSWRA. The bat acoustic survey conducted at the TSWRA was designed to achieve several objectives: 1) estimate levels of bat activity throughout the TSWRA during summer reproduction and fall migration; 2) characterize patterns of temporal variation in levels of bat activity; 3) estimate the activity levels of species of interest (i.e., hoary bats [*Lasiurus cinereus*] and eastern red bats [*Lasiurus borealis*]); and 4) assess the potential risk wind energy development poses to bats flying at the approximate height of turbine blades. Passive acoustic sampling using AnaBat II SD1 ultrasonic bat call detectors was used to quantify bat use in the TSWRA.

Survey methods followed the recommendations of the Wind Energy Guidelines (USFWS 2012) and Kunz et al. (2007a) to determine effort for acoustic monitoring studies. The following final report describes the results of acoustic monitoring surveys conducted at the TSWRA between May 25 and October 20, 2011.

STUDY AREA

The proposed TSWRA is in Adams County, North Dakota, approximately 3.6 kilometers (2.2 miles) northeast of Hettinger, North Dakota (Figure 1). The general boundary of the TSWRA encompasses about 9,310.2 hectares (ha; 23,006 acres [ac]). The area is a mixed landscape of grassland (about 53%) and agricultural areas (about 46%), including small areas of rural homes, shrubs and trees, and other developed areas. Elevation ranges from 779 to 902 feet (ft; 237.4 to 274.9 meters [m]) above sea level. There are about 210.4 ha (520 ac) of wetlands in 97 basins, excluding streams, in the TSWRA; about 96% of those wetlands are freshwater emergent wetlands (NWI 2011).

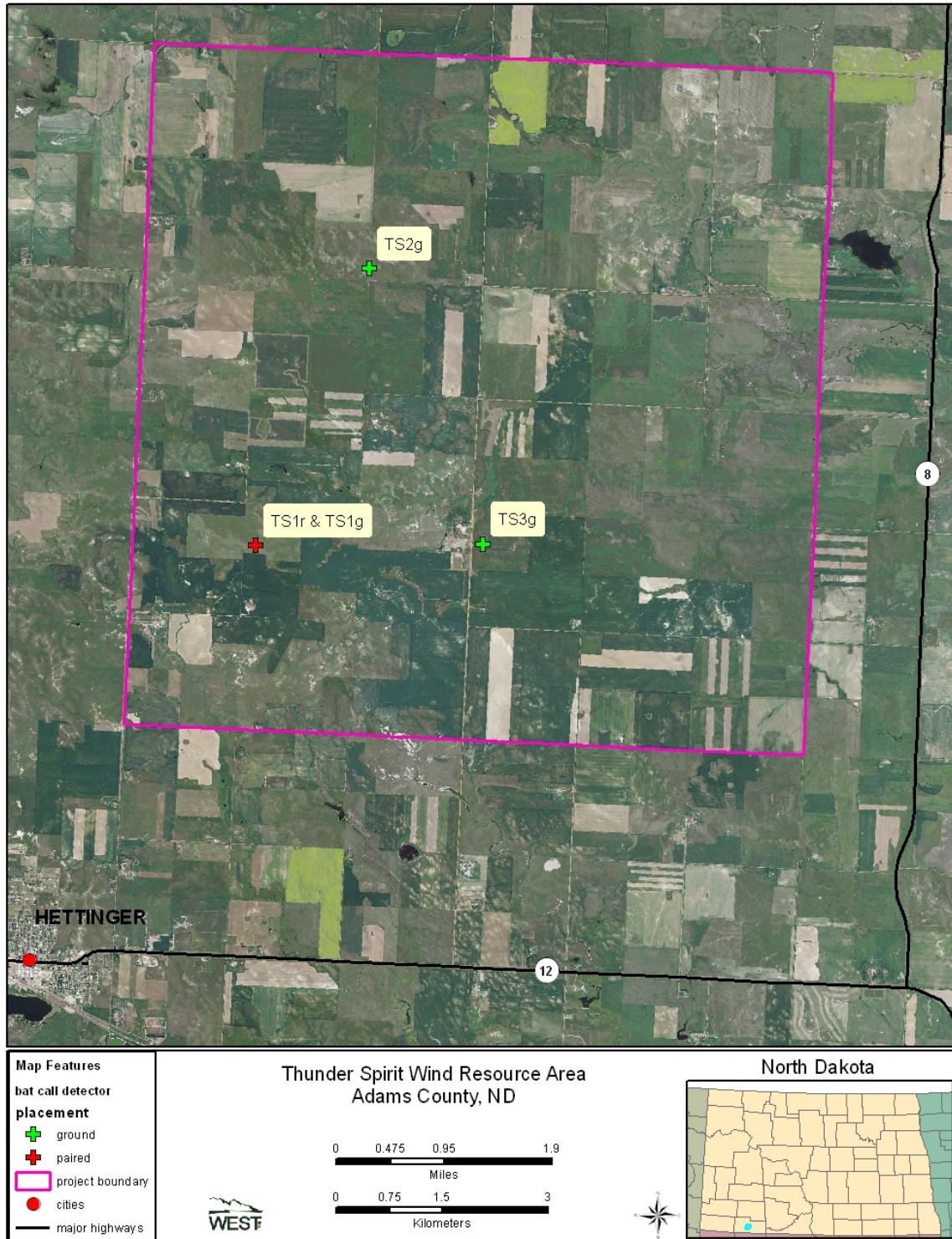


Figure 1. Project location and bat acoustic call sampling stations at the Thunder Spirit Wind Resource Area.

Bat Species of North Dakota

Ten species of bat have the potential to occur in North Dakota (Table 1; Harvey et al. 1999, BCI 2011). There are three Level III Species of Conservation Priority (NDGFD 2004) known to occur in North Dakota (Table 1).

Table 1. Bat species with potential to occur in North Dakota (Harvey et al. 1999, Bat Conservation International 2012), categorized by echolocation call frequency.

Common Name	Scientific Name
High-frequency (> 30 kHz)	
eastern red bat ^{1,2}	<i>Lasiurus borealis</i>
little brown bat ¹	<i>Myotis lucifugus</i>
long-legged bat ^{1,3}	<i>Myotis volans</i>
northern long-eared bat ¹	<i>Myotis septentrionalis</i>
western long-eared bat ^{1,3}	<i>Myotis evotis</i>
western small-footed bat ³	<i>Myotis ciliolabrum</i>
Low-frequency (< 30 kHz)	
big brown bat ¹	<i>Eptesicus fuscus</i>
hoary bat ^{1,2}	<i>Lasiurus cinereus</i>
silver-haired bat ^{1,2}	<i>Lasionycteris noctivagans</i>
Townsend's big-eared bat	<i>Corynorhinus townsendii</i>

¹ species known to have been killed at wind energy facilities; species found as fatalities reported by Kunz et al. 2007b

² long-distance migrant

³ Level III Species of Conservation Priority (NDGFD 2004))

METHODS

Bat Acoustic Surveys

The objectives of the bat acoustic surveys were to: 1) estimate levels of bat activity throughout the TSWRA during summer reproduction and fall migration; 2) characterize patterns of temporal variation in levels of bat activity; 3) estimate the activity levels of species of interest (i.e., hoary bats and eastern red bats); and 4) assess the potential risk wind energy development poses to bats flying 30 to 80 m (98 to 262 ft) above ground level (AGL), within the approximate height of turbine blades.

Detector Stations

Bat call detectors are commonly used in baseline wildlife surveys to calculate an index of impacts to bats from wind energy development (Arnett 2007, Kunz et al. 2007a). Species activity levels and composition can vary with altitude (Baerwald and Barclay 2009; Collins and Jones 2009), so monitoring at different heights is important for characterizing overall bat use patterns (Kunz et al. 2007b). Ground-based detectors likely detect a more complete sample of the bat species present within the project area, whereas elevated detectors may give a more accurate assessment of risk to bat species flying at turbine blade height (Kunz et al. 2007b).

The detection range of AnaBat bat call detectors depends on a number of factors (e.g., echolocation call characteristics, microphone sensitivity, habitat, the orientation of the flying bat, atmospheric conditions; Limpens and McCracken 2004), but is generally less than 30 m (98 ft) due to atmospheric absorption of echolocation pulses (Fenton 1991). To standardize acoustic sampling effort across the TSWRA, AnaBat detectors were calibrated and sensitivity levels were set to six (Larson and Hayes 2000), which reduced interference from extraneous ultrasonic noise (Brooks and Ford 2005).

Four AnaBat™ II SD1 bat call detectors (Titley™ Scientific, Australia) were used during the 2011 study. Two AnaBats were paired at one meteorological (met) tower, with one detector at ground level (approximately one m AGL) and another within the rotor-swept height (approximately 50 m [164 ft] AGL; Figure 1). The other two detectors were placed at ground stations in short grass habitats near agricultural fields.

Ground AnaBats were placed inside a plastic weather-resistant container with a hole cut in the side through which the microphone extended. Each microphone was encased in a 45-degree angle poly-vinyl chloride (PVC) tube; holes were drilled in the PVC tubes to allow water to drain out. The raised AnaBat microphone was elevated on the met tower using a pulley system and housed in a Bat-Hat (EME Systems, California). Bat-Hat weatherproof housing was modified by replacing the Plexiglas reflector plate with a 45-degree angle PVC elbow. The Bat-Hat was altered because detectors protected using un-modified Bat-Hats may detect lower activity and species richness than are actually present, while detectors protected with a 45-degree PVC elbow have been found to detect similar numbers and quality of bat calls as detectors exposed to the environment (Britzke et al. 2010).

Monitoring Schedule

Bat calls were monitored in the TSWRA using four AnaBat II SD1 ultrasonic detectors from May 25 to October 20, 2011. This date range gives complete coverage of summer reproduction (May 25 to July 31) and fall migration (August 1 to October 20) periods. AnaBats were programmed to turn on approximately 30 minutes (min) before sunset and turn off approximately 30 min after sunrise each night.

Data Collection and Call Analysis

AnaBat bat call detectors use a broadband high-frequency microphone to detect the echolocation calls of bats. Incoming echolocation calls are digitally processed and stored by the detector. The integrated zero crossings analysis interface module (ZCAIM) produces a file that, when viewed in appropriate software (i.e., Analook ®; 2008, C. Corben), displays digital sonograms of the echolocation calls that show change in frequency over time. Frequency versus time displays were used to separate bat calls from other types of ultrasonic noise (e.g., wind, insects, etc.) and to identify the call frequency classification and species (when possible) of bat that generated the calls. Data determined to be noise (produced by a source other than a bat) or call notes that did not meet the pre-specified criteria to be termed a pass were removed from the analysis.

For each detector location, bat passes were sorted into two groups based on their minimum frequency; this grouping corresponded roughly to the bat species groups of interest. For example, most species of *Myotis* bats, as well as eastern red bats, echolocate at frequencies greater than 30 kilohertz (kHz; High Frequency [HF]), whereas species such as the big brown bat (*Eptesicus fuscus*), silver-haired bat (*Lasionycteris noctivagans*), and hoary bat typically emit echolocation calls below 30 kHz (Low Frequency [LF]). To establish which species may have produced passes in each category, a list of species expected to occur in the study area was compiled from range maps (Table 1; Harvey et al. 1999, BCI 2011).

An experienced bat acoustic analyst qualitatively identified the echolocation calls of hoary bats and eastern red bats recorded by AnaBat bat call detectors through visual comparison of echolocation call metrics (e.g., minimum frequency, slope, duration) to reference calls of known bats (Yates and Muzika 2006). Calls that had a distinct U-shape and that exhibited variability in the minimum frequency across the call sequence were identified as belonging to the *Lasiurus* genus (C. Corben, pers. comm.). Hoary and eastern red bats were distinguished based on minimum frequency. Hoary bats typically produce calls with minimum frequencies between 18 and 24 kHz, whereas eastern red bats typically emit calls with minimum frequencies between 30 and 43 kHz (J. Szewczak, pers. comm.). Only sequences containing three or more calls were used for species identification. These are conservative parameters and given the high intraspecific variability of *Lasiurus* calls and the number of call files that were too fragmented for proper identification, it is likely that more hoary and eastern red bat calls were recorded than were positively identified.

Statistical Analysis

The standard metric used for measuring bat activity was the number of bat passes per detector-night, and this metric was used as an index of bat activity in the project area. A bat pass was defined as a sequence of echolocation calls produced by an individual bat consisting of series of at least two calls (pulses) with no pause between calls of more than one second (White and Gehrt 2001, Gannon et al. 2003). A detector-night was defined as one detector operating for one entire night. The terms bat pass and bat call are used interchangeably in this report. Bat passes per detector-night were calculated for all bats, for HF and LF categories, and for hoary bats and eastern red bats. Because individuals cannot be differentiated by their calls, bat pass data represent relative levels of bat activity rather than the total numbers of individuals present (e.g., several calls could be from several bats or from the same bat recorded multiple times). To assess potential for bat mortality, the number of bat passes per detector-night recorded at TSWRA was compared to existing data at other wind-energy facilities in the Midwest (Appendix A).

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

The fall migration period (July 30 – October 14) represents the period between dissolution of maternity colonies and onset of the swarming and hibernation seasons (Fleming and Eby 2005). During this time, bats begin moving toward wintering areas and many species of bats initiate reproductive behaviors (Cryan 2008). This period of increased landscape-scale movement and reproductive behavior is often associated with increased levels of bat fatalities at operational wind energy facilities (Arnett et al. 2008).

RESULTS

Bat Acoustic Surveys

Bat activity was monitored at three locations (Figure 1) using four AnaBats for a total of 489 detector-nights between May 25 and October 20, 2011. AnaBats were operating for 82% of the sampling period (Figure 2); the raised detector (TS1r) had a broken cable for a couple of weeks and TS3g had an internal clock issue near the end of the survey period.

Four hundred and six bat passes were recorded during the survey period; overall bat activity was 0.78 ± 0.08 bat passes per detector-night (Table 2). AnaBats at ground stations (TS1g, TS2g, and TS3g) recorded 364 bat passes on 374 detector-nights for a mean (\pm standard error) of 0.92 ± 0.09 bat passes per detector-night, while the raised station (TS1r) recorded 42 bat passes on 115 detector nights for a mean of 0.37 ± 0.08 per detector-night (Table 2).

Spatial Variation

Bat activity in the TSWRA was higher at the ground stations (0.92 ± 0.09) than at the raised station (0.37 ± 0.08 ; Table 2; Figure 3). Among ground stations, TS3g recorded the fewest bat passes per detector-night (0.65 ± 0.12), while TS1g recorded the most (1.44 ± 0.19). Activity at TS2g (0.67 ± 0.09) was very similar to TS3g. The raised detector recorded the fewest bat passes of all AnaBats (0.37 ± 0.08 ; Table 2, Figure 3).

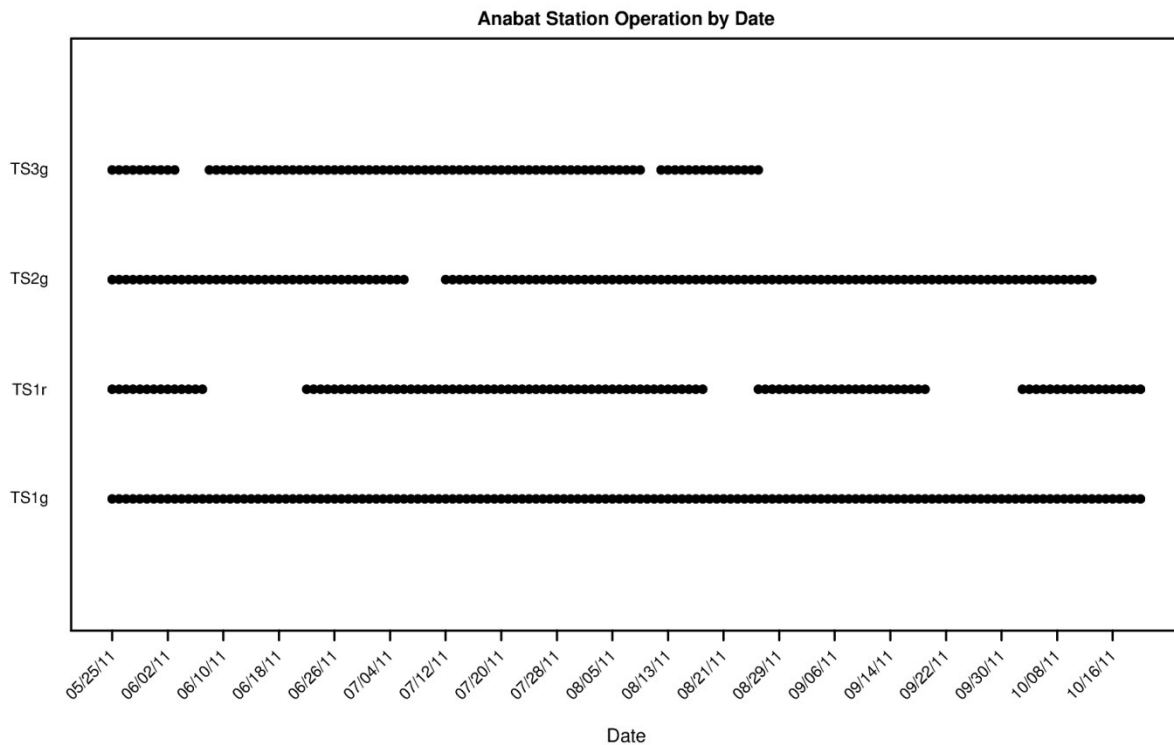


Figure 2. Number of AnaBat bat call detectors (n = 4) operating at the Thunder Spirit Wind Resource Area during each night from May 25 to October 20, 2011.

Table 2. Number of bat passes by frequency (high-frequency [HF], low-frequency [LF]), species, and all bats; detector-nights; and bat passes per detector-night at ground and raised stations at the Thunder Spirit Wind Resource Area from May 25 to October 20, 2011.

AnaBat Station	Location	# of HF Bat Passes	# of LF Bat Passes	# of Eastern Red Bat Passes[*]	# of Hoary Bat Passes^{**}	Total Bat Passes	Detector-Nights	Bat Passes/Night^{***}
TS1g	ground	147	68	0	9	215	149	1.44±0.19
TS1r	raised	12	30	2	4	42	115	0.37±0.08
TS2g	ground	56	36	3	0	92	137	0.67±0.09
TS3g	ground	40	17	0	1	57	88	0.65±0.12
Total Ground		243	121	3	10	364	374	0.92±0.09
Total Raised		12	30	2	4	42	115	0.37±0.08
Overall		255	151	5	14	406	489	0.78±0.08

^{*} eastern red bat passes were included in high-frequency (HF) numbers.

^{**} hoary bat passes were included in low-frequency (LF) numbers.

^{***} ± bootstrapped standard error.

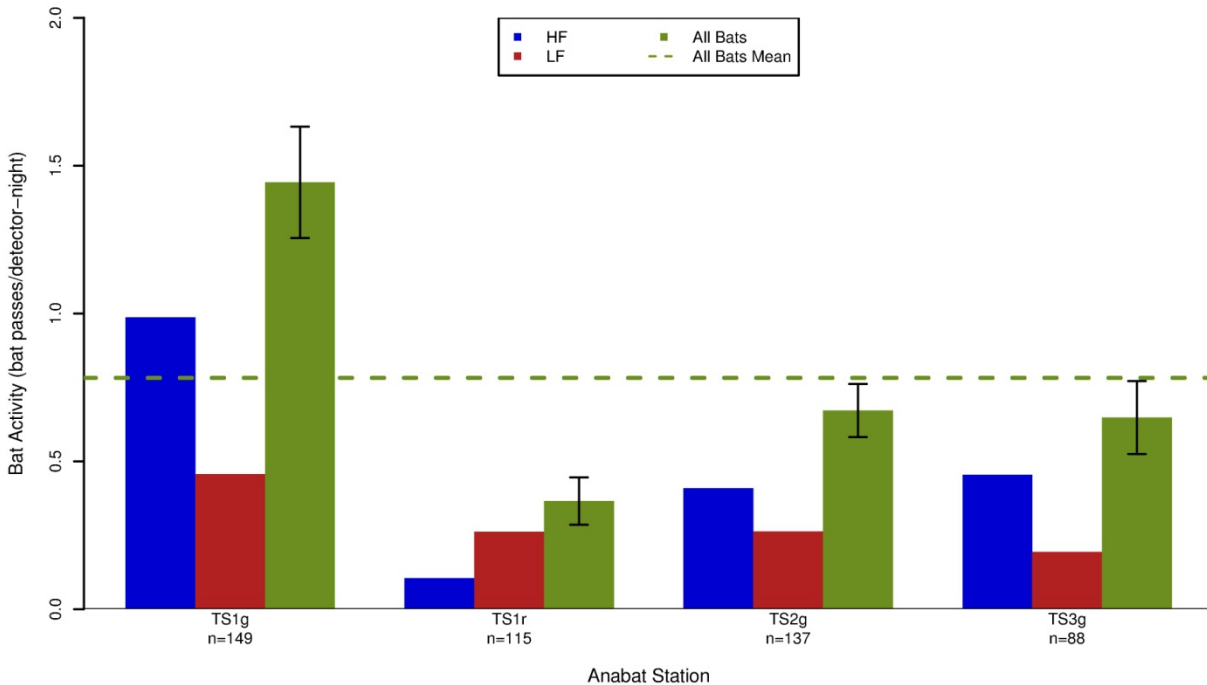


Figure 3. Number of high-frequency (HF) and low-frequency (LF) bat passes per detector-night recorded at AnaBat bat call detector stations in the Thunder Spirit Wind Resource Area from May 25 to October 20, 2011. The bootstrapped standard errors are represented by the black error bars on the 'All Bats' columns.

Temporal Variation

Overall bat activity was higher during the fall, averaging 1.13 bat passes per detector-night compared to 0.62 in summer (Table 3; Figure 4). Generally, bat activity was very low until mid-July, higher during the period from July 23 to September 2, and lower again for the rest of the monitoring period (Figure 5). The week of highest overall bat activity was the week of July 27 to August 2 (2.61 passes per detector-night; Table 4).

Bat activity at ground stations was lower in the summer (0.73 bat passes per detector-night) and higher in fall (1.30; Table 3, Figure 4). Weekly bat activity at ground stations was generally low from late May to late July, higher in late July, August, and early September, and lower for the rest of the monitoring period (Figure 6).

The raised station also had lower bat activity in the summer (0.28 bat passes per detector-night) and higher bat activity in the fall (0.61; Table 3, Figure 4). Weekly bat activity at the raised station was first recorded in early July, was somewhat higher in August and September, and then ceased in mid-September (Figure 6).

Table 3. Bat activity (bat passes per detector-night) by call frequency (high-frequency [HF] and low-frequency [LF]) and for all bats, by season and overall, recorded at ground (n = 3) and raised stations (n = 1) in the Thunder Spirit Wind Resource Area from May 25 to October 20, 2011.

Station	Call Frequency	Summer	Fall	Fall Migration	Overall
		May 25 – Jul 31	Aug 1 – Oct 20	Aug 1 – Sep 29	May 25 – Oct 20
TS1g	LF	0.25	0.63	0.71	0.46
	HF	0.96	1.01	1.19	0.99
	AB	1.21	1.64	1.91	1.44
TS1r	LF	0.17	0.34	0.44	0.26
	HF	0.11	0.10	0.18	0.10
	AB	0.28	0.44	0.61	0.37
TS2g	LF	0.22	0.30	0.29	0.26
	HF	0.37	0.45	0.47	0.41
	AB	0.59	0.74	0.76	0.67
TS3g	LF	0.11	0.42	0.38	0.19
	HF	0.28	0.92	0.85	0.45
	AB	0.39	1.33	1.23	0.65
Ground Station	LF	0.19±0.04	0.46±0.07	0.45±0.07	
Totals	HF	0.53±0.09	0.84±0.11	0.79±0.12	
	AB	0.73±0.12	1.30±0.14	1.24±0.14	
Raised Station	LF	0.17±0.08	0.44±0.10	0.34±0.09	
Totals	HF	0.11±0.06	0.18±0.07	0.10±0.04	
	AB	0.28±0.12	0.61±0.14	0.44±0.10	
Overall	LF	0.19±0.04	0.46±0.07	0.42±0.07	
	HF	0.43±0.08	0.67±0.09	0.62±0.09	
	AB	0.62±0.11	1.13±0.13	1.04±0.12	

Table 4. The week of highest bat activity (bat passes per detector-night) sorted by call frequency (high-frequency [HF] and low-frequency [LF]), species, and all bats at the Thunder Spirit Wind Resource Area for the period May 25 to October 20, 2011.

Species/Group	Week of Highest Bat Activity	Bat Passes per Detector-Night
HF	7/27 – 8/02	1.93
LF	8/24 – 8/30	1.30
Eastern Red Bats	7/30 – 8/08	0.11
Hoary Bats	7/26 – 8/01	0.25
All Bats	7/27 – 8/02	2.61

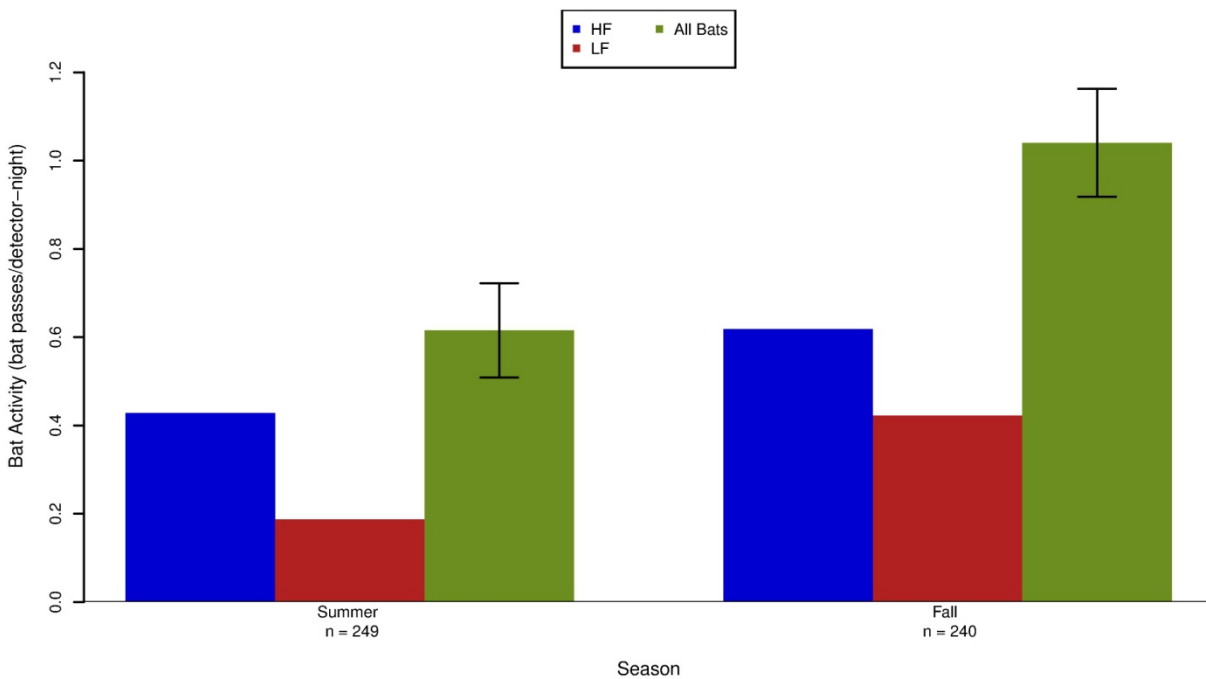


Figure 4. Seasonal bat activity (bat passes per detector-night) by high-frequency (HF), low-frequency (LF), and all bats at the Thunder Spirit Wind Resource Area from May 25 to October 20, 2011. The bootstrapped standard errors are represented on the 'All Bats' columns.

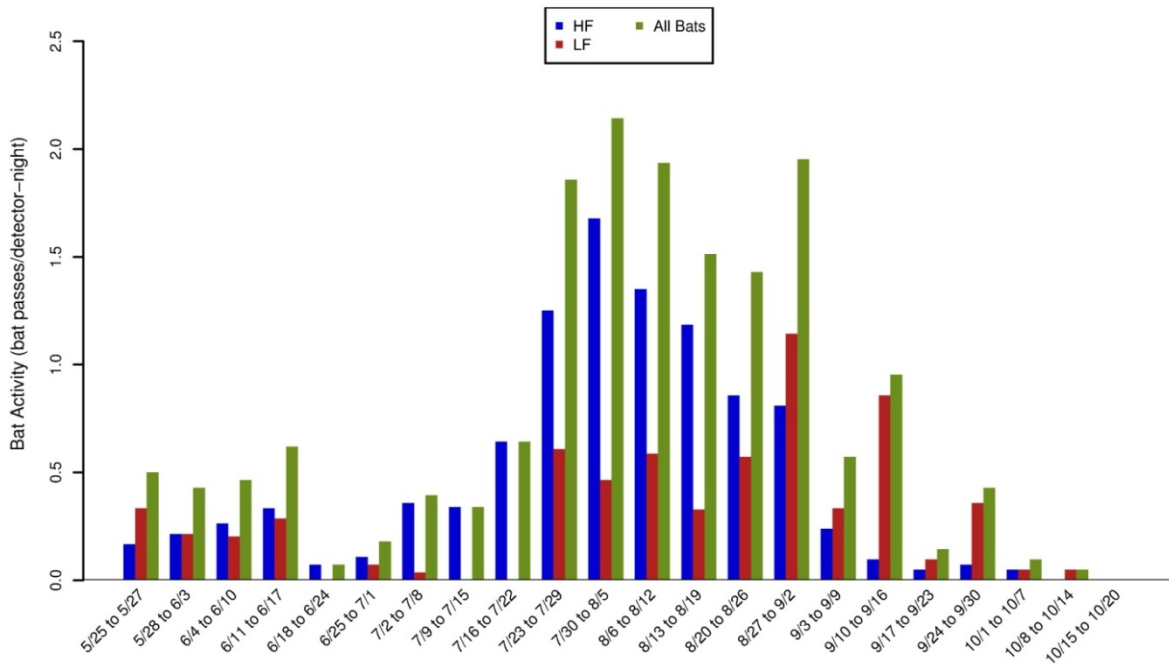


Figure 5. Weekly bat activity (bat passes per detector-night) by high-frequency (HF), low-frequency (LF), and all bats at the Thunder Spirit Wind Resource Area for the period May 25 to October 20, 2011.

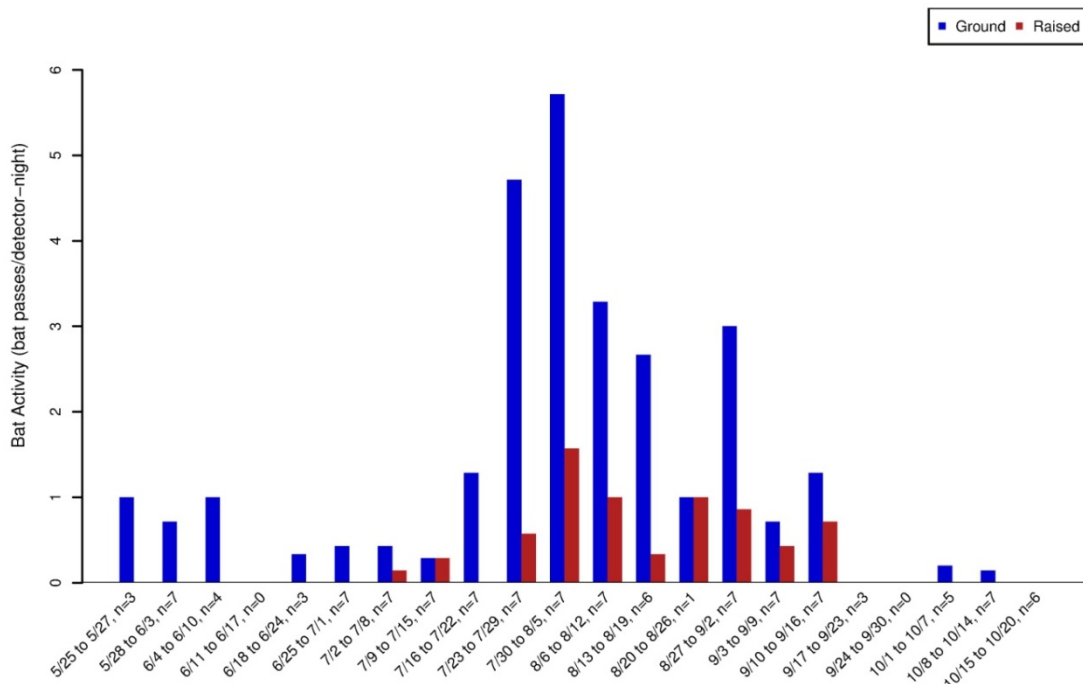


Figure 6. Weekly bat activity (bat passes per detector-night) at ground and raised stations at the Thunder Spirit Wind Resource Area from May 25 to October 20, 2011.

Species Composition

Frequencies

Passes by HF bats (62.8% of all passes) outnumbered passes by LF bats (37.2%), and this pattern was largely consistent among ground stations (Table 2). LF passes outnumbered HF passes at the raised station TS1r (Table 2). HF and LF bat activity was higher in fall (0.67 bat passes per detector-night and 0.46 respectively) than in summer (0.43 and 0.19 respectively; Table 3; Figure 4). The week of peak activity for HF bat species was July 27 to August 2; for LF bat species, the week of peak activity was August 24 to August 30 (Table 4). Weekly bat activity for both HF and LF bat species was relatively low early in the monitoring period (Figure 5). HF bat activity was highest from late July through August while LF bat species had the highest activity in late August and early September.

Species

Fourteen bat passes (3.4% of bat passes) were attributable to hoary bats; hoary bats were recorded at all stations except station TS2g and were detected more by TS1g and the raised detector (TS1r) than by any other detectors (Table 2; Figure 7). Passes attributable to eastern red bats accounted for 1.2% of all bat passes; eastern red bat calls were recorded at stations TS1r and TS2g but not at TS1g or TS3g (Table 2; Figure 7).

Eastern red bat activity was highest during late summer and early fall (July 30 - August 8; Table 4, Figure 8). More hoary bats were detected (14) than eastern red bats (5) within the TSWRA (Table 2). The week of peak activity for the eastern red bat was July 30 to August 8; for the hoary bat, the week of peak activity was July 26 to August 1 (Table 4).

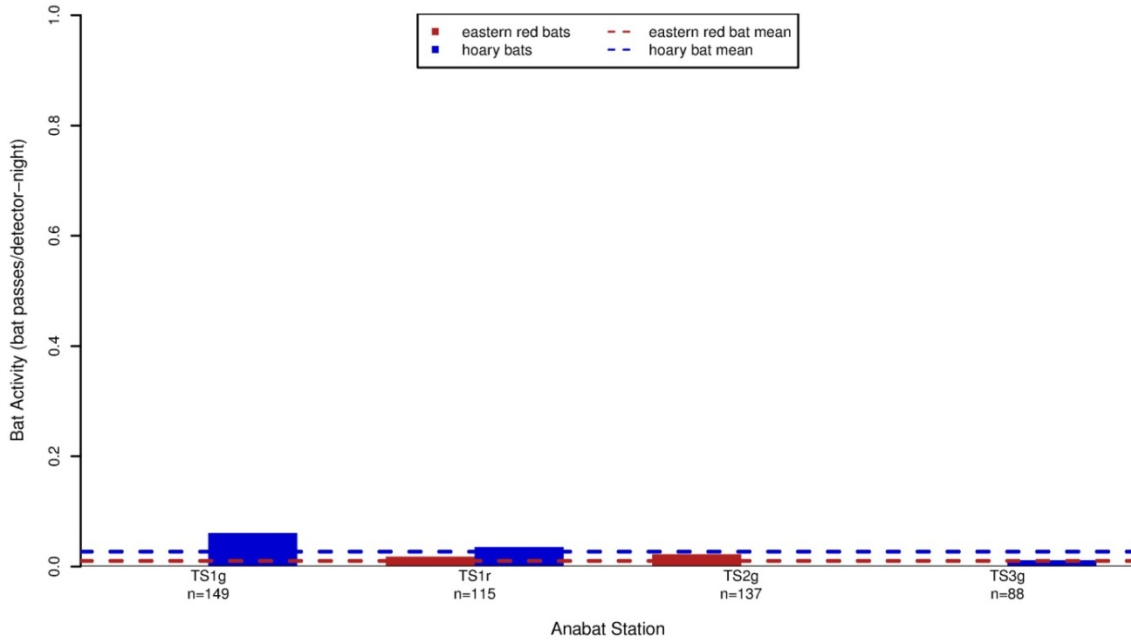


Figure 7. Number of passes per detector-night by eastern red bats and hoary bats at ground (n = 3) and raised stations (n = 1) at the Thunder Spirit Wind Resource Area from May 25 to October 20, 2011.

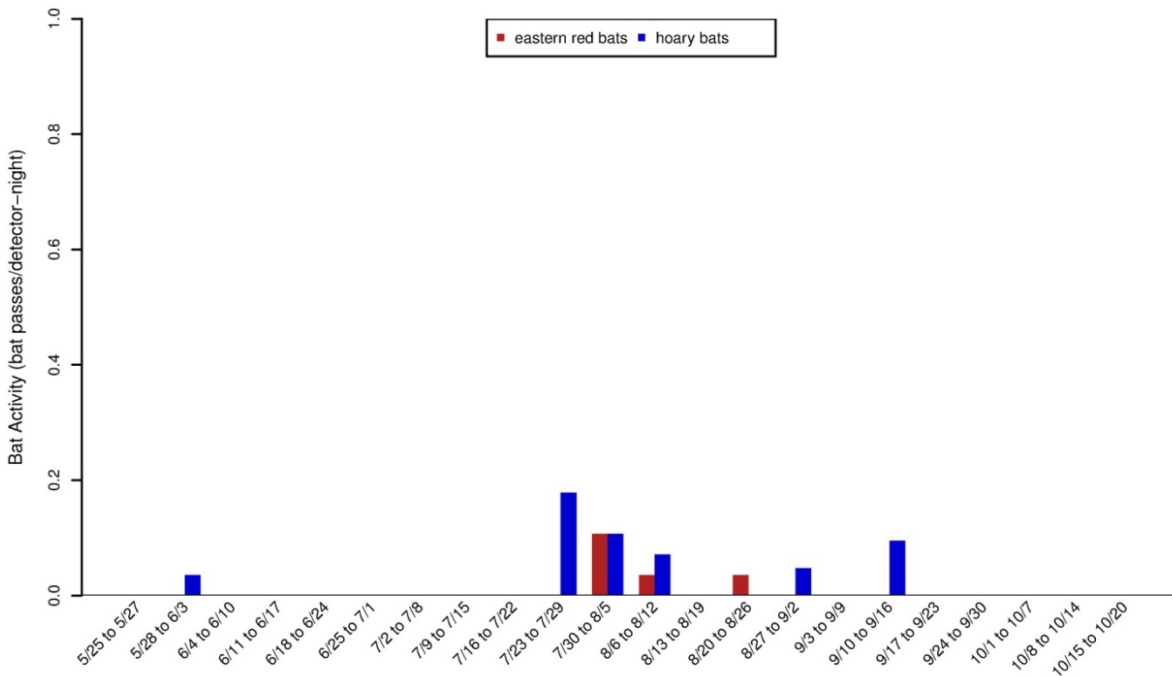


Figure 8. Weekly activity (bat passes per detector-night) of hoary bat and eastern red bats at the Thunder Spirit Wind Resource Area from May 25 to October 20, 2011.

DISCUSSION

Potential Bat Impacts

Assessing the potential impacts of wind energy development to bats at the TSWRA is complicated because the causes of bat fatalities at turbines are poorly understood (Kunz et al. 2007a, 2007b; Baerwald et al. 2008; Cryan and Barclay 2009; Long et al. 2010a, 2010b) and monitoring elusive, night-flying animals is inherently difficult (O'Shea et al. 2003). Although installed capacity for wind energy has increased rapidly in recent years, release of study results from these existing wind energy facilities has lagged behind the influx of newly proposed facilities (Kunz et al. 2007b); therefore, it is often the case that information gleaned from existing wind energy facilities is not available to inform assessments at proposed facilities. To date, post-construction monitoring studies of wind energy facilities suggest that:

- 1) Bat mortality shows a rough positive correlation with bat activity (Kunz et al. 2007b);
- 2) The majority of fatalities occur during the post-breeding or fall migration season (roughly August and September; Johnson 2005, Arnett et al. 2008);
- 3) Migratory tree-roosting species (e.g., eastern red, hoary, and silver-haired bats) account for approximately 75% of reported bats killed (Arnett et al. 2008, Gruver et al. 2009), and;
- 4) The level of bat fatalities may depend on many variables, including local environmental characteristics and/or specific weather conditions, but no single predictive factor has yet been identified. However, some of the highest reported bat fatality rates recorded to date have occurred at wind energy facilities located along forested ridge tops in the eastern and northeastern US and at some wind energy facilities in agricultural regions of the Midwest (Appendix A).

Based on these patterns, current guidance to estimate potential fatality levels at a proposed wind energy facility involves evaluation of on-site acoustic monitoring data in terms of activity levels, seasonal variation, and species composition (Kunz et al. 2007b), as well as comparison to regional fatality patterns.

Overall Bat Activity

To date, relatively few studies of wind energy facilities have recorded both bat passes per detector-night and bat fatality rates (Appendix A). Although it has been assumed that an association may exist for pre-construction activity and post-construction fatalities (Kunz et al. 2007b), to date such a relationship has not been established empirically due to insufficient data.

For those studies that measured both activity and fatality rates, about 75% of data were collected using bat call detectors placed near the ground and none of the detectors were located near features considered attractive to bats. Therefore, this report relies largely on the

mean bat activity for ground-based detectors to assess potential risk of bat fatalities at the TSWRA relative to other studies with similar data (see Appendix A).

While inconsistencies among studies (e.g., differences in study period length and timing, type of equipment, placement of equipment, and presentation of data) do not allow for direct comparison across studies, some generalizations can be made. For facilities that have estimated pre-construction activity and post-construction fatalities, the highest number of bat passes per detector night (38.3) corresponds with the highest number of bat fatalities/megawatt (MW)/year (31.69). The facilities with the lowest bat activity (1.9 bat passes per detector night) had fatality estimates of 4.5 bat fatalities/MW /year or less. However, for the facilities presented in Appendix A, there does not appear to be a consistent relationship between bat activity and bat fatalities for the projects in between the lowest and highest. For example, fatalities were relatively moderate (10.27 fatalities/MW/study period) at the Top of Iowa wind energy facility in 2004 despite high activity (35.7 bat passes/detector-night; Jain 2005), and lower bat activity at the Blue Sky Green Field, Wisconsin wind energy facility (7.7 bat passes/detector-night; Gruver 2008) corresponded with a relatively high fatality estimate (24.57 fatalities/MW/study period; Gruver et al. 2009).

It is unclear whether monitoring bat activity near ground level accurately represents activity at all heights or if it is an effective method for estimating bat fatality rates. Researchers have suggested that bat activity near the ground may not be representative of bat fatality rates (Hayes and Gruver 2000, Baerwald and Barclay 2009). At the TSWRA, fall bat activity recorded by the ground detectors was higher (0.92 ± 0.09) than activity at the raised detector (0.37 ± 0.08 ; Table 2). However, with only one raised detector, conclusions based on a comparison between ground and raised detectors should be made with caution.

Overall bat activity recorded within the TSWRA (0.78 ± 0.08) bat passes per detector-night; Table 2) is considered relatively low and was lower than any bat activity estimate given in Appendix A. In addition, the bat activity level at two stations within the TSWRA in 2007 was also low (1.13 passes/detector night; Derby et al. 2008). Thus, based on the expected relationship between pre-construction bat activity and post-construction fatalities, bat fatality rates at the TSWRA would be expected to be low.

Spatial Variation

The proposed wind energy facility is not located near any large, known bat colonies or other features that are likely to attract large numbers of bats. As well, the TSWRA does not contain topographic features that may funnel migrating bats and is lacking large tracts of forest cover, unlike facilities with higher fatality rates in the eastern US. All the detectors were located in grassland with agricultural areas nearby, which is typical of the TSWRA. This suggests that the data recorded at the stations should be indicative of bat use of the area. Bat activity recorded at the ground detectors varied between stations. The raised detector recorded approximately half the number of bat calls as the ground detectors at all but one ground detector (TS3g).

Temporal Variation

Higher overall bat activity occurred within the TSWRA during the fall. The week of highest bat activity was the week of July 27 to August 2. Higher activity in July likely corresponds with the reproductive seasons of bats, when pups are being weaned and foraging rates are high among adult females and newly flying juveniles (Barclay 1989).

At both ground and raised stations, the highest number of bat passes was recorded during the fall. This likely corresponds with the fall migration period in which bats may be moving through the area (Fleming and Eby 2005). Most bat fatality studies at wind energy facilities in the US have shown a peak in fatality rates in August and September (the fall migration period) and generally lower fatality rate earlier in the summer and very low fatality rate during the spring (Johnson 2005, Arnett et al. 2008). While the survey effort varied among the different studies, a general association between the timing of increased bat call rates and timing of fatality rate was suggested in the studies that combine activity and fatality surveys, with both call rates and fatalities peaking during the fall migration period. Based on the available data, it is expected that bat fatalities at the TSWRA, which are expected to be lower overall, will be highest late summer to early fall.

Species Composition

Approximately 62.8% of passes recorded at the detector stations were by HF bats, suggesting higher relative abundance of species such as eastern red bats and little brown bats (Table 1). Some HF bat carcasses (e.g., little brown bat) have been found in relatively high proportions during fatality monitoring studies (e.g., Kerns and Kerlinger 2004, Jain 2005, Brown and Hamilton 2006, Gruver et al. 2009). However, *Myotis* species are typically less commonly recorded in the rotor-swept height or as fatalities at post-construction studies at wind energy facilities than other species, such as hoary and eastern red bats (Kunz et al. 2007b, Arnett et al. 2008). The remaining 37.2% of bat passes at the TSWRA were LF bats (e.g., hoary bat, silver-haired bat, and big brown bat; Table 2).

Raised detector stations mimic potential turbine locations, and it is expected that bat species flying at rotor-swept height and detected at raised stations are the most vulnerable to collision with turbine blades. Hoary bats were detected at each ground station except TS2g and at the raised station, indicating that this species has an elevated collision risk as well. Some low-frequency species, such as hoary bat and silver-haired bat, have been found as fatalities in higher proportions than other species (Arnett et al. 2008). Hoary bats and silver-haired bats could potentially have a higher collision risk within the TSWRA.

Eastern red bats (five total passes) were detected at only one ground station (TS2g) and at the raised station (TS1r), and may have a higher risk of collision injury or fatality than other bat species (Table 2). In some regions, eastern red bats account for the majority of bat fatalities found during searches (Arnett et al. 2008). At five Midwestern wind energy facilities, eastern red bats accounted for 22.3% of all bat fatalities and were the second most commonly found species (Jain 2005; Johnson et al. 2002, 2003a, 2004; Howe et al. 2002; Kerlinger et al. 2007; Gruver et al. 2009).

Potential Bat Fatality Rates

Bat fatality rates from studies at wind energy facilities across North America have ranged from 0.1 to 38.3 bat fatalities/MW/year (Appendix A). In general, fatality rates have been highest in the northeast and lowest in the northwest, although a high degree of variation in fatality rates is present for most regions. To date, the highest levels of bat fatalities have been reported from turbines set on forested Appalachian ridges (Arnett et al. 2008). Bat fatality studies have been conducted at 17 wind energy facilities located in the Midwest, but only one public study of bat fatality rates at wind energy facilities has been conducted in North Dakota. Thus far, bat fatality rates at wind energy facilities located in agricultural regions of Illinois, Iowa, Minnesota, North Dakota, South Dakota, and Wisconsin have ranged from 0.16 to 30.61 bats/MW/year (Appendix A), with the higher rates coming from Wisconsin, Illinois, and eastern Minnesota and Iowa. However, recent reports of moderate to high levels of bat fatalities in agricultural settings in Iowa (Jain 2005); Alberta, Canada (Baerwald 2008); suggest that the lack of forested areas does not guarantee low bat fatality rates at wind energy facilities.

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Appendix A. North American Fatality Summary Tables

Appendix A. Wind energy facilities in North America with fatality data for bat species, grouped by geographic region. Bat activity rates are included where available.

Wind Energy Facility	Bat Activity Estimate^A	Bat Activity Dates	Fatality Estimate^B	No. of Turbines	Total MW
Thunder Spirit (this study)	0.78^C	5/25/11-10/20/11			
Midwest					
Cedar Ridge, WI (2009)	9.97 ^{C,E,F}	7/16/07-9/30/07	30.61	41	67.6
Blue Sky Green Field, WI	7.7 [†]	7/24/07-10/29/07	24.57	88	145
Cedar Ridge, WI (2010)	9.97 ^{C,E,F}	7/16/07-09/30/07	24.12	41	68
Forward Energy Center, WI	6.97	8/5/08-11/08/08	18.17	86	129
Top of Iowa, IA (2004)	35.7	5/26/04-9/24/04	10.27	89	80
Crystal Lake II, IA			7.42	80	200
Top of Iowa, IA (2003)			7.16	89	80
Kewaunee County, WI			6.45	31	20.46
Ripley, Ont. (2008)			4.67	38	76
Winnebago, IA			4.54	10	20
Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)	2.2 ^D	6/15/01-9/15/01	4.35	143	107.2
Buffalo Ridge, MN (Phase III; 2001/Lake Benton II)	2.2 ^D	6/15/01-9/15/01	3.71	138	103.5
Crescent Ridge, IL			3.27	33	54.45
Buffalo Ridge, MN (Phase III; 1999)			2.72	138	103.5
					107.2
Buffalo Ridge, MN (Phase II; 1999)			2.59	143	5
Moraine II, MN			2.42	33	49.5
					107.2
Buffalo Ridge, MN (Phase II; 1998)			2.16	143	5
Prairie Winds (Minot), ND			2.13	80	115.5
Grand Ridge, IL			2.1	66	99
Buffalo Ridge, MN (Phase III; 2002/Lake Benton II)	1.9 ^D	6/15/02-9/15/02	1.81	138	103.5
Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)	1.9 ^D	6/15/02-9/15/02	1.64	143	107.2
Elm Creek, MN			1.49	67	100
Wessington Springs, SD			1.48	34	51
NPPD Ainsworth, NE			1.16	36	20.5
Buffalo Ridge, MN (Phase I; 1999)			0.74	73	25
Buffalo Ridge I, SD (2010)			0.16	24	50.4
Rocky Mountains					
Summerview, Alb. (2008)	7.65 ^D	07/15/06-07-09/30/06-07	11.42	39	70.2
Judith Gap, MT			8.93	90	135
Foot Creek Rim, WY (Phase I; 1999)			3.97	69	41.4
Foot Creek Rim, WY (Phase I; 2001-2002)	2.2 ^{D,E}	6/15/01-9/1/01	1.57	69	41.4
Foot Creek Rim, WY (Phase I; 2000)	2.2 ^{D,E}	6/15/00-9/1/00	1.05	69	41.4
Southern Plains					
Barton Chapel, TX			3.06	60	120
Buffalo Gap II, TX			0.14	155	233
Buffalo Gap I, TX			0.1	67	134

Appendix A. Wind energy facilities in North America with fatality data for bat species, grouped by geographic region. Bat activity rates are included where available.

Wind Energy Facility	Bat Activity Estimate^A	Bat Activity Dates	Fatality Estimate^B	No. of Turbines	Total MW
Southwest					
Dry Lake, AZ	8.8	4/29/10-11/10/10	4.29	30	63
California					
Shiloh I, CA			3.92	100	150
High Winds, CA (2004)			2.51	90	162
Dillon, CA			2.17	45	45
High Winds, CA (2005)			1.52	90	162
Alite, CA			0.24	8	24
Pacific Northwest					
Biglow Canyon, OR (Phase II; 2009/2010)			2.71	65	150
Nine Canyon, WA			2.47	37	48.1
Stateline, OR/WA 2003			2.29	454	263
Biglow Canyon, OR (Phase I; 2008)			1.99	76	125.4
Leaning Juniper, OR			1.98	67	100.5
Big Horn, WA			1.9	133	199.5
Combine Hills, OR			1.88	41	41
Pebble Springs, OR			1.55	47	98.7
Hopkins Ridge, WA (2008)			1.39	87	156.6
Elkhorn, OR (2008)			1.26	61	101
Vansycle, OR			1.12	38	24.9
Klondike III, OR			1.11	122	375
Stateline, OR/WA 2002			1.09	454	263
Tuolumne (Windy Point I), WA			0.94	62	136.6
Klondike, OR			0.77	16	24
Hopkins Ridge, WA (2006)			0.63	83	150
Biglow Canyon, OR (Phase I; 2009)			0.58	76	125.4
Hay Canyon, OR			0.53	48	100.8
Klondike II, OR			0.41	50	75
Wild Horse, WA			0.39	127	229
Goodnoe, WA			0.34	47	94
Marengo II, WA (2009)			0.27	39	70.2
Marengo I, WA (2009)			0.17	39	70.2
Klondike IIIa, OR			0.16	125	375
Northeast					
Mountaineer, WV	38.3 ^E	8/1/04-9/14/04	31.69	44	68
Mount Storm, WV (2009)			24.32	132	264
Mount Storm, WV (2010)			15.18	132	264
Casselman, PA (Spring & Fall 2008)			12.61	23	34.5
Maple Ridge, NY (2006)			11.21	120	198
					321.7
Maple Ridge, NY (2007)			9.42	195	5
Cohocton/Dutch Hill, NY (2009)			8.62	50	125
Noble Bliss, NY (2008)			7.8	67	100
Mount Storm, WV (Fall 2008)	35.2	7/20/08-10/12/08	6.62	82	164
Wolfe Island, Ont (July-December 2009)			6.42	86	197.8
					321.7
Maple Ridge, NY (2008)			4.96	195	5
Noble Clinton, NY (2009)	1.9 ^C	8/1/09-09/31/09	4.5	67	100
Noble Ellenburg, NY (2009)	16.1 ^C	8/16/09-09/15/09	3.91	54	80
Noble Bliss, NY (2009)			3.85	67	100

Appendix A. Wind energy facilities in North America with fatality data for bat species, grouped by geographic region. Bat activity rates are included where available.

Wind Energy Facility	Bat Activity Estimate^A	Bat Activity Dates	Fatality Estimate^B	No. of Turbines	Total MW
Lempster, NH (2010)			3.57	12	24
Noble Ellenburg, NY (2008)			3.46	54	80
Noble Clinton, NY (2008)	2.1 ^C	8/8/08-09/31/08	3.14	67	100
Lempster, NH (2009)			3.11	12	24
Mars Hill, ME (2007)			2.91	28	42
Munnsville, NY (2008)			1.93	23	34.5
Stetson Mountain, ME (2009)	28.5	7/10/09-10/15/09	1.4	38	57
Mars Hill, ME (2008)			0.45	28	42
<i>Southeast</i>					
Buffalo Mountain, TN (2005)			39.70	18	28.98
Buffalo Mountain, TN (2000-2003)	23.7 ^E		31.54	3	1.98

A = Bat passes per detector-night

B = Number of fatalities per megawatt per year

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

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

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

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

Appendix A1 (continued). Wind energy facilities in North America with fatality data for bat species, grouped by geographic region. Bat activity rates are included where available.

Data from the following sources:

Project, Location	Activity Reference	Fatality Reference	Project, Location	Activity Reference	Fatality Reference
Alite, CA		Chatfield et al. 2010	Klondike, OR		Johnson et al. 2003b
Barton Chapel, TX		WEST 2011	Klondike II, OR		NWC and WEST 2007
Big Horn, WA		Kronner et al. 2008	Klondike III, OR		Gritski et al. 2009a
Biglow Canyon, OR (Phase I; 2008)		Jeffrey et al. 2009a	Klondike IIIa, OR		Gritski et al. 2009b
Biglow Canyon, OR (Phase I; 2009)		Enk et al. 2010	Leaning Juniper, OR		Kronner et al. 2007
Biglow Canyon, OR (Phase II; 2009/2010)		Enk et al. 2011	Lempster, NH (2009)		Tidhar et al. 2010
Blue Sky Green Field, WI	Gruver 2008	Gruver et al. 2009	Lempster, NH (2010)		Tidhar et al. 2011
Buffalo Gap I, TX		Tierney 2007	Maple Ridge, NY (2006)		Jain et al. 2007
Buffalo Gap II, TX		Tierney 2009	Maple Ridge, NY (2007)		Jain et al. 2009a
Buffalo Mountain, TN (2000-2003)	Fiedler 2004	Nicholson et al. 2005	Maple Ridge, NY (2008)		Jain et al. 2009d
Buffalo Mountain, TN (2005)		Fiedler et al. 2007	Marengo I, WA (2009)		URS Corporation 2010b
Buffalo Ridge, MN (Phase I; 1999)		Johnson et al. 2000	Marengo II, WA (2009)		URS Corporation 2010c
Buffalo Ridge, MN (Phase II; 1998)		Johnson et al. 2000	Mars Hill, ME (2007)		Stantec 2008
Buffalo Ridge, MN (Phase II; 1999)		Johnson et al. 2000	Mars Hill, ME (2008)		Stantec 2009a
Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)	Johnson et al. 2004	Johnson et al. 2004	Moraine II, MN		Derby et al. 2010d
Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)	Johnson et al. 2004	Johnson et al. 2004	Mount Storm, WV (Fall 08)	Young et al. 2009b	Young et al. 2009b
Buffalo Ridge, MN (Phase III; 1999)		Johnson et al. 2000	Mount Storm, WV (2009)		Young et al. 2009a, 2010a
Buffalo Ridge, MN (Phase III; 2001/Lake Benton II)	Johnson et al. 2004	Johnson et al. 2004	Mount Storm, WV (2010)		Young et al. 2010b, 2011
Buffalo Ridge, MN (Phase III; 2002/Lake Benton II)	Johnson et al. 2004	Johnson et al. 2004		Arnett et al. 2005, Arnett pers. comm.	Arnett et al. 2005
Buffalo Ridge I, SD (2010)		Derby et al. 2010b	Mountaineer, WV		Stantec 2009b
Casselman, PA (Spring & Fall 2008)		Arnett et al. 2009	Munnsville, NY (2008)		
Cedar Ridge, WI (2009)	BHE Environmental 2008	BHE Environmental 2010	Nine Canyon, WA		Erickson et al. 2003
Cedar Ridge, WI (2010)	BHE Environmental 2008	BHE Environmental 2011	Noble Bliss, NY (2008)		Jain et al. 2009e
Cohocton/Dutch Hill, NY (2009)		Stantec 2010	Noble Bliss, NY (2009)		Jain et al. 2010a
Combine Hills, OR		Young et al. 2006	Noble Clinton, NY (2008)	Reynolds 2010a	Jain et al. 2009c
Crescent Ridge, IL		Kerlinger et al. 2007	Noble Clinton, NY (2009)	Reynolds 2010a	Jain et al. 2010b
Crystal Lake II, IA		Derby et al. 2010a	Noble Ellenburg, NY (08)		Jain et al. 2009b
Dillon, CA		Chatfield et al. 2009	Noble Ellenburg, NY (09)	Reynolds 2010b	Jain et al. 2010c
Dry Lake, AZ	Thompson et al. 2011	Thompson et al. 2011	NPPD Ainsworth, NE		Derby et al. 2007
Elkhorn, OR (2008)		Jeffrey et al. 2009b	Pebble Springs, OR		Gritski and Kronner 2010b
Elm Creek, MN		Derby et al. 2010c	Prairie Winds ND1 (Minot), ND		Derby et al. 2011
Foote Creek Rim, WY (Phase I; 1999)		Young et al. 2003	Ripley, Ont (2008)		Jacques Whitford 2009
Foote Creek Rim, WY (Phase I; 2000)	Gruver 2002	Young et al. 2003	Shiloh I, CA		Kerlinger et al. 2010
Foote Creek Rim, WY (Phase I; 2001-2002)	Gruver 2002	Young et al. 2003	Stateline, OR/WA 2002		Erickson et al. 2004
Forward Energy Center, WI	Watt and Drake 2011	Grodsky and Drake 2011	Stateline, OR/WA 2003		Erickson et al. 2004
Goodnoe, WA		URS Corporation 2010a	Stetson Mountain, ME (2009)	Stantec 2009c	Stantec 2009c
Grand Ridge, IL		Derby et al. 2010g	Summerview, Alb (2008)	Baerwald 2008	Baerwald 2008
Hay Canyon, OR		Gritski and Kronner 2010a	Top of Iowa, IA (2003)		Jain 2005
High Winds, CA (2004)		Kerlinger et al. 2006	Top of Iowa, IA (2004)	Jain 2005	Jain 2005
High Winds, CA (2005)		Kerlinger et al. 2006	Tuolumne (Windy Point I), WA		Enz and Bay 2010
Hopkins Ridge, WA (2006)		Young et al. 2007	Vansycle, OR		Erickson et al. 2000
Hopkins Ridge, WA (2008)		Young et al. 2009c	Wessington Springs, SD		Derby et al. 2010f
Judith Gap, MT		TRC 2008	Wild Horse, WA		Erickson et al. 2008
Kewaunee County, WI		Howe et al. 2002	Winnebago, IA		Derby et al. 2010e
			Wolfe Island, Ont (July-December 2009)		Stantec Ltd. 2010

**Wildlife Baseline Studies for the
Thunder Spirit Wind Farm
Adams County, North Dakota**

**Sharp-tailed Grouse Lek and Raptor Nest Report
Spring 2011**

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NATURAL RESOURCES ♦ SCIENTIFIC SOLUTIONS

EXECUTIVE SUMMARY

Western EcoSystems Technology, Inc. conducted aerial sharp-tailed grouse lek and aerial and ground-based raptor nest surveys in April and May 2011 at the Thunder Spirit Wind Farm which is located northeast of the city Hettinger in central Adams County, North Dakota. This report presents results of those surveys.

Aerial sharp-tailed grouse lek surveys were conducted during three time periods (April 27-28, May 3, and May 5, 2011) at the Thunder Spirit Wind Farm. During each period, approximately 327.1 kilometers (203.3 miles) of transects were surveyed. A total of five potential sharp-tailed grouse leks were recorded with two of those outside the project boundary but within 1 mile of the boundary.

Two raptor nests were documented during both aerial and ground-based surveys in or within 16.1 kilometers (10 miles) of the Thunder Spirit Wind Farm. Both were active with a great horned owl nest within the project boundary and a Swainson's hawk nest located approximately 1.2 kilometers (0.75 miles) outside the boundary. No nests were observed which had the structure consistent with that of an eagle nest. Both native and planted grassland habitat is present in and around the Thunder Spirit Wind Farm and could provide suitable nesting habitat for the ground nesting northern harrier and burrowing owl.

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INTRODUCTION

Thunder Spirit Wind LLC is proposing to construct a wind energy facility in Adams County North Dakota referred to as the Thunder Spirit Wind Farm (TSWF). Thunder Spirit Wind, LLC contracted Western EcoSystems Technology, Inc. (WEST) to develop and implement a standardized protocol for baseline wildlife studies at the TSWF to estimate impacts of the proposed wind energy facility on wildlife and to assist with siting turbines to minimize impacts to wildlife resources.

This report presents results of aerial sharp-tailed grouse (*Tympanuchus phasianellus*) lek surveys, aerial, large raptor nest surveys, and ground base raptor nest surveys conducted during April and May 2011. Data includes sharp-tailed grouse observations and locations and raptor nest locations and status.

STUDY AREA

The TSWF, currently about 23,006 acres (ac; 93.1 square kilometers [km²]; 36.0 square miles [mi²]) is located in southwest North Dakota and more specifically northeast of the city of Hettinger in central Adams County. The landscape within the TSWF is rolling to flat with several low buttes and ridges found within the project area. Most of the historical short-grass prairie has been converted to agricultural use with crop production and livestock grazing the primary practices. Trees and shrubs can be found mainly around farmsteads and within planted shelter belts. There is a mixture of natural and man-made wetlands scattered throughout the TSWF.

METHODS

Aerial Sharp-tailed Grouse Lek Surveys

The objective of the aerial sharp-tailed grouse lek survey was to determine the approximate location of sharp-tailed grouse leks and provide a general sense of sharp-tailed grouse use within and immediately adjacent to the TSWF during the normal lekking period (early April through mid-May). Survey methodology was similar to that used for greater prairie chickens (*Tympanuchus cupido*) in Oklahoma (Martin and Knopf 1981).

Survey Methods

North/south running transects started 800 meters (m; 0.5 miles [mi]) outside the east/west project boundary and were placed at approximate 400 m (0.25 mi) intervals, covering the entire TSWF (Figure 1). Each transect was approximately 11.3 km (7 mi) long and extended 800 m (0.5 mi) beyond the north/south boundary. Each transect was flown by fixed-winged aircraft at an approximate height of 30 to 46 m (100 – 150 feet [ft]) during three separate survey periods. Surveys began approximately one half hour before sunrise. The location of any suspected sharp-tailed grouse lek was recorded with a global positioning system (GPS) unit. The number and activity of birds at each location was also recorded.

Raptor Nest Surveys

The objective of the raptor nest surveys was to locate and record potential raptor nests that may be subject to disturbance and/or displacement effects by wind-energy facility construction and/or operation. Surveys were focused on large, stick nest structures, and did not include searches for cavity nests or nests on the ground.

Survey Methods

Two survey methods were used to document potential raptor nests within and adjacent to the NRWRA. Suitable habitat (large trees, power poles, rocky outcroppings) within a 16.1 kilometer (km; 10 mi) buffer surrounding the project boundary was surveyed by fixed-winged aircraft to document large nest structures indicative of eagle nests. A GPS unit was used to record potential eagle nest locations.

A second type of raptor nest survey was ground based and completed by having a field biologist record potential raptor nests while conducting weekly avian use surveys during leaf off conditions within and immediately adjacent to the project. Potential raptor nests were recorded on aerial photo maps and digitized with geographic information system (GIS) software. Other information recorded included nest status, nest height, and nest material.



Figure 1. Sharp-tailed grouse observations at the Thunder Spirit Wind Farm during spring 2011.

RESULTS

Aerial Sharp-tailed Grouse Lek Surveys

Approximately 327.1 km (203.3 mi) of transects were surveyed during each of three time periods (April 27 & 28, May 3, and May 5). One confirmed (birds observed in courtship behavior at the same location during more than one survey) lek; three probable (birds observed in courtship behavior during only one survey) leks; one possible (birds observed in the same general location during more than one survey but showing little or no courtship behavior) lek were identified (Table 1; Figure 1). Confirmed lek TS-GR1 was located within the project boundary in planted grassland habitat (Figure 1). Two of the three probable leks were located in native prairie habitat, outside of the project boundary while the third was within the boundary in alfalfa hay cropland (Figure 1). The one possible lek, TS-GR4, was located in an unknown grassland habitat type, inside the project boundary (Figure 1).

Table 1. Summary of aerial sharp-tailed grouse surveys conducted during spring 2011 at the Thunder Spirit Wind Farm.

Survey Period	Date First Observed	Observation ID	Highest Total	Number Displaying	Lek
1	4/28/2011	TS-GR1	7	7	confirmed
	4/28/2011	TS-GR2	18	+/-13	probable
2	5/3/2011	TS-GR3	6	4	probable
	5/3/2011	TS-GR4	4	0	possible
3	5/5/2011	TS-GR5	17	+/-13	probable

Raptor Nest Surveys

Two active raptor nests were recorded during aerial and ground surveys (Figure 2). Neither of which were occupied by eagles. Nest TS-RN1 was located within the TSWF and occupied by a great horned owl (*Bubo virginianus*; Figure 2). An active Swainson's hawk (*Buteo swainsoni*) nest (TS-RN2) was located approximately 1.2 km (0.75 mi) outside of the eastern project boundary (Figure 2). No other potential raptor nest structures were observed during aerial or ground surveys.

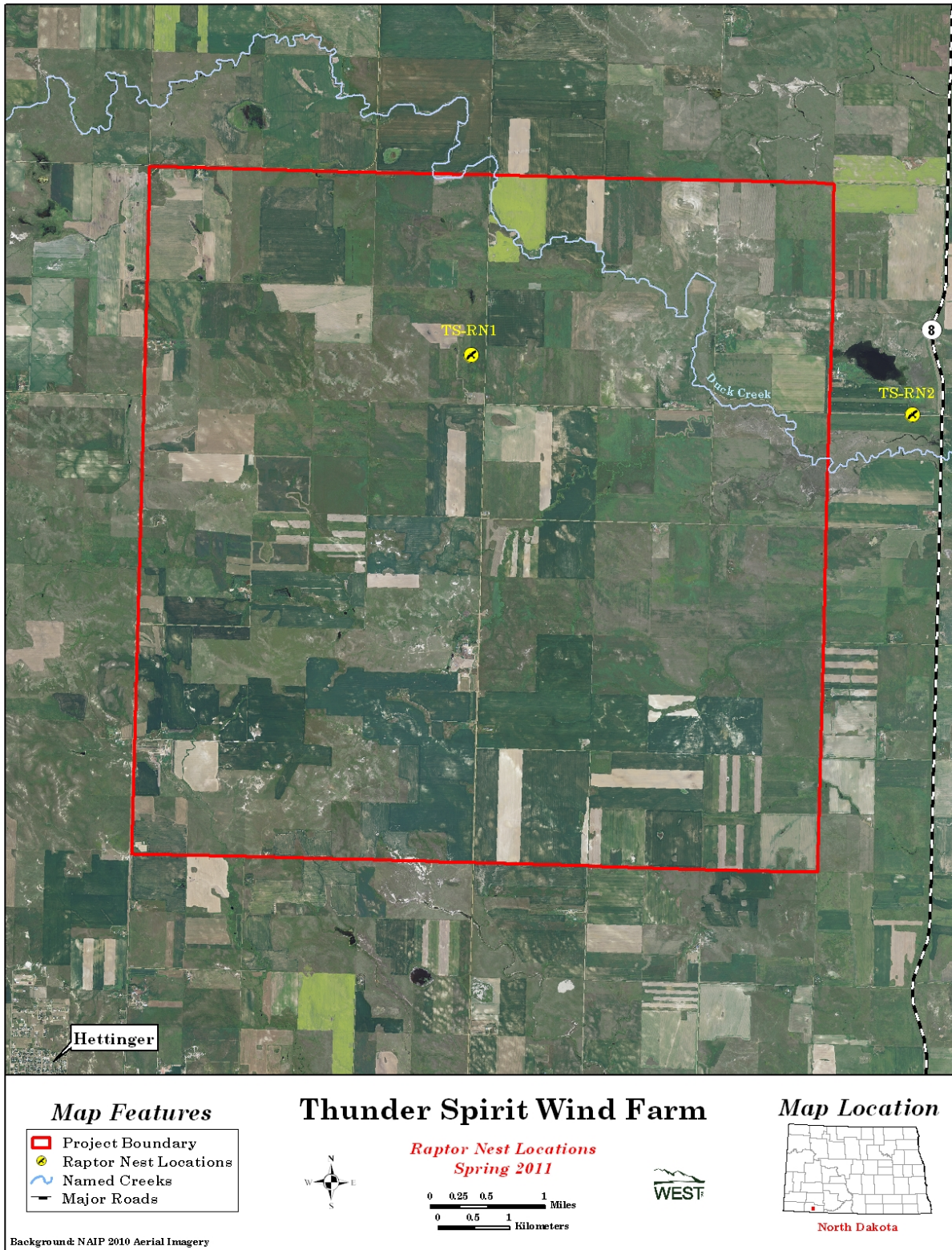


Figure 2. Raptor nest locations at the Thunder Spirit Wind Farm during spring 2011.

DISCUSSION

Aerial Sharp-tailed Grouse Lek Surveys

The start of aerial surveys was delayed due to persistent snow cover across the project area and the availability of survey aircraft. Aircraft availability also caused all three surveys to be conducted within a nine day period in late April/early May. This time frame however, likely fell during peak sharp-tailed grouse lekking activity within this part of their range (SDGFP undated). Also, the TSWF and 0.8 km (0.5 mi) buffer were completely surveyed during each survey period. Therefore, it is likely the majority of leks used in 2011 within and immediately adjacent to the project were detected.

Observation TS-GR4 was considered a possible lek location even though no courtship behavior was observed because of the habitat in which the birds were observed in and reluctance of the birds to leave the area. All other sharp-tailed grouse observation locations had males displaying during one or more survey periods.

Raptor Nest Survey

Based on both ground and aerial surveys, it does not appear that the TSWF and surrounding area has high raptor nesting density. Although no potential eagle nests were observed in or within 16.1 km (10 mi) of the project boundary, it is possible a nest went undetected, especially during aerial surveys of the buffer area, because only the most likely eagle nesting habitat was surveyed in the buffer. There is a historic golden eagle nest approximately 5 miles west of the project boundary that was not detected during surveys.

Both native and planted grassland habitat is present in and around the TSWF and could provide suitable nesting habitat for the ground nesting northern harrier (*Circus cyaneus*) and burrowing owl (*Athene cunicularia*).

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