Avian Use Surveys
for the Big Blue River Wind Project
Henry County, Indiana

December 2015 – November 2016

Prepared for:

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EXECUTIVE SUMMARY

Calpine Corporation (Calpine) is assessing the feasibility of developing the Big Blue River Wind Project (BBRWP) located in Henry County, Indiana. Calpine asked Western Ecosystems Technology, Inc. (WEST) to conduct fixed-point count avian use surveys to estimate potential impacts of the BBRWP to eagles and other birds consistent with the US Fish and Wildlife Service (USFWS) *Eagle Conservation Plan Guidance* and USFWS *Land-Based Wind Energy Guidelines*.

Ten-minute small bird and 60-minute large bird fixed-point count surveys were conducted at 43 points in the BBRWP from December 3, 2015 through June 30, 2016, and at 46 points from July 1, 2016 through November 29, 2016 due to a small change in the project boundary. Seven bald eagles were observed throughout all surveys. Five occurred during large bird use surveys, one during small bird surveys, and one incidental. Overall eagle use within the BBRWP was low, with only three minutes recorded for eagles flying within the rotor swept height. The BBRWP lacks suitable bald eagle nesting and hunting habitat throughout the majority development area. Summit Lake State Park, located outside the BBWRP, and Province Ponds Fish and Wildlife Area, a small lake and wetland located in the northeast portion of the BBWRP, boundary provide more suitable habitat for nesting and foraging.

Eighty-four unique bird species were observed during all fixed-point count avian use surveys in the BBRWP. European starling, red-winged blackbird, and horned lark were the most abundant bird species observed during small bird fixed-point count surveys at BBRWP. Canada geese and turkey vultures were the most abundant birds observed during the large bird fixed-point count surveys. Turkey vulture and red-tailed hawk were the most frequently observed large bird species in the BBRWP.

No species protected by the federal Endangered Species Act were observed during the surveys. Two state-endangered species were observed: northern harrier and osprey. In addition, five species of concern were observed: bald eagle, common nighthawk, red-shouldered hawk, sandhill crane, and sharp-shinned hawk. The potential for collision with turbines for these species is expected to be low due to their low abundance and the relatively low fatality numbers documented at other wind energy facilities with publicly available data.

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TABLE OF CONTENTS

EXECUTIVE SUMMARY i
INTRODUCTION 1
STUDY AREA 1
METHODS 4
Fixed-Point Count Avian Use Surveys 4
Survey Plots 4
Survey Methods 4
Observation Schedule 5
Statistical Analysis 5
Quality Assurance and Quality Control 5
Data Compilation and Storage 5
Fixed-Point Count Avian Use Surveys 6
Bird Diversity and Species Richness 6
Mean Use, Seasonal Variations, and Frequency of Occurrence 6
Bird Flight Height and Behavior 6
Spatial Use and Mapping 6
Raptor Nest Surveys 6
RESULTS 7
Fixed-Point Count Avian Use Surveys 7
Eagles 7
Small Bird Use Surveys 9
Bird Diversity and Abundance 9
Species Richness, Mean Use, and Seasonal Variation 9
Large Bird Use Surveys 13
Bird Diversity and Abundance 13
Species Richness, Mean Use, and Seasonal Variation 13
Flight Height and Behavior 15
Spatial Use and Mapping 15
Sensitive Species Observations 18
Incidental Observations 20
Raptor Nest Survey 20
DISCUSSION 24
Eagles 24

Passerines 24
Large Birds 25
Diurnal Raptors 25
Sensitive Species 29
Northern Harrier 29
Sandhill Crane 29
Osprey, Common Nighthawk, Red-shouldered Hawk, and Sharp-shinned Hawk 29
REFERENCES 30

LIST OF TABLES

Table 1. Eagle observations summary at the Big Blue River Wind Project from December 3, 2015 to November 29, 2016 7
Table 2. Summary of species richness (species/100-meter plot/10-minute survey) of small birds and sample size during the fixed-point count small bird use surveys conducted in the Big River Wind Project from December 3, 2015 - November 29, 2016. 9
Table 3. Mean bird use (number of birds/100-meter plot/10-minute survey), percent use, and frequency of occurrence (%) by season for small bird and large bird species by type and/or subtype during the small bird fixed-point count surveys conducted in the Big Blue River Wind Project from December 3, 2015 to November 29, 2016. 10
Table 4. Summary of large bird species richness (species/800-meter plot/60-minute survey) and sample size during large bird fixed-point count surveys conducted in the Big Blue River Wind Project from December 3, 2015 to November 29, 2016. 13
Table 5. Mean bird use (number of birds/800-meter plot/60-minute survey), percent use, and frequency of occurrence (%) by season for all large birds by type and/or subtype during large bird fixed-point count surveys conducted in the Big Blue River Wind Project from December 3, 2015 to November 29, 2016. 14
Table 6. Flight height characteristics of large birds by bird type and raptor subtype during the 60-minute fixed-point count avian use survey[a] conducted in the Big Blue River Wind Project from December 3, 2015, to November 29, 2016. 15
Table 7. Mean use (number of birds/60-minute survey) by point for large birds observed during large bird fixed-point count avian use surveys conducted in the Big Blue River Wind Project from December 3, 2015 to November 29, 2016. 16
Table 7, continued. Mean use (number of birds/60-minute survey) by point for large birds observed during large bird fixed-point count avian use surveys conducted in the Big Blue River Wind Project from December 3, 2015 to November 29, 2016. 17
Table 8. Summary of sensitive species observed incidentally or during fixed-point (FP) count avian use surveys conducted in the Big Blue River Wind Project from December 3, 2015 to November 29, 2016. 18

Table 9. Incidental wildlife recorded while conducting all surveys at the Big Blue River Wind Project from December 3, 2015 to November 29, 2016. 20

Table 10. Summary of nests located within the Big Blue River Wind Project and a 2-mile buffer, Henry county, Indiana from March 2 to March 15, 2016 21

LIST OF FIGURES

Figure 1. Location of the Big Blue River Wind Project area boundary, Henry County, Indiana. 2

Figure 2. Land cover types and fixed-point count stations in the Big Blue River Wind Project area, Henry County, Indiana (Homer et al. 2015, US Geological Survey National Land Cover Database 2011).... 3

Figure 3. Project boundary and flight paths of eagles observed during fixed-point count avian use surveys conducted within the Big Blue River Wind Project, Henry County, Indiana from December 3, 2015 to November 29, 2016. 8

Figure 4. Flight paths of sensitive species observed during fixed-point count avian use surveys conducted within the Big Blue River Wind Project, Henry County, Indiana from December 3 to November 29, 2016. 19

Figure 5. Raptor nest locations in the Big Blue River Wind Project, Henry County, Indiana during ground-based surveys from March 2 to March 15, 2016. 23

Figure 6. Comparison of diurnal raptor use (number of raptors/800-meter plot/20-minute survey) observed during fixed-point count avian use surveys at the Big Blue River Wind Project from December 3, 2015 to November 29, 2016, and annual diurnal raptor use recorded during comparable surveys at other North American wind energy projects. 27

Figure 6 (*continued*). Comparison of diurnal raptor use (number of raptors/800-meter plot/20-minute survey) observed during fixed-point count avian use surveys at the Big Blue River Wind Project from December 3, 2015 to November 29, 2016, and annual diurnal raptor use recorded during comparable surveys at other North American wind energy projects. 28

LIST OF APPENDICES

Appendix A. Descriptive Statistics for the Species Recorded During the 10-minute Fixed-Point Count Small Bird Use Surveys Conducted at the Big Blue River Wind Project in Henry County, Indiana, from December 3, 2015 to November 29, 2016

Appendix B. Descriptive Statistics for the Species Recorded During the 60-minute Fixed-Point Count Large Bird Use Surveys conducted at the Big Blue River Wind Project in Henry County, Indiana, from December 3, 2015 to November 29, 2016

Appendix C. North American Fatality Summary Table

Appendix D. Studies at North American Wind Energy Facilities that have Reported Species Composition of Bird Fatalities

INTRODUCTION

Calpine is currently assessing the feasibility of developing the Big Blue River Wind Project (BBRWP) to be located in east-central Indiana. Calpine asked Western Ecosystems Technology, Inc. (WEST) to conduct fixed-point count avian use surveys to estimate potential impacts of the BBRWP on eagles and other bird species consistent with the tiered process outlined in the US Fish and Wildlife Service (USFWS) *Land-Based Wind Energy Guidelines* (USFWS 2012) and the USFWS *Eagle Conservation Plan Guidance* (ECPG; USFWS 2013).

STUDY AREA

The BBRWP Project Area is to be located in Henry County, approximately 12 miles (mi; 19 kilometers [km]) southwest of the city of Muncie in east-central Indiana (Figure 1). The Project Area has a flat topography that is dominated by cultivated agriculture. Corn (*Zea mays*), and soy bean (*Glycine max*) are the most common crop types present. Grassland, developed areas (e.g., farmsteads), and forests compose a small portion of the Project Area (Homer et al. 2015, US Geological Survey National Land Cover Data 2011; Figure 2).

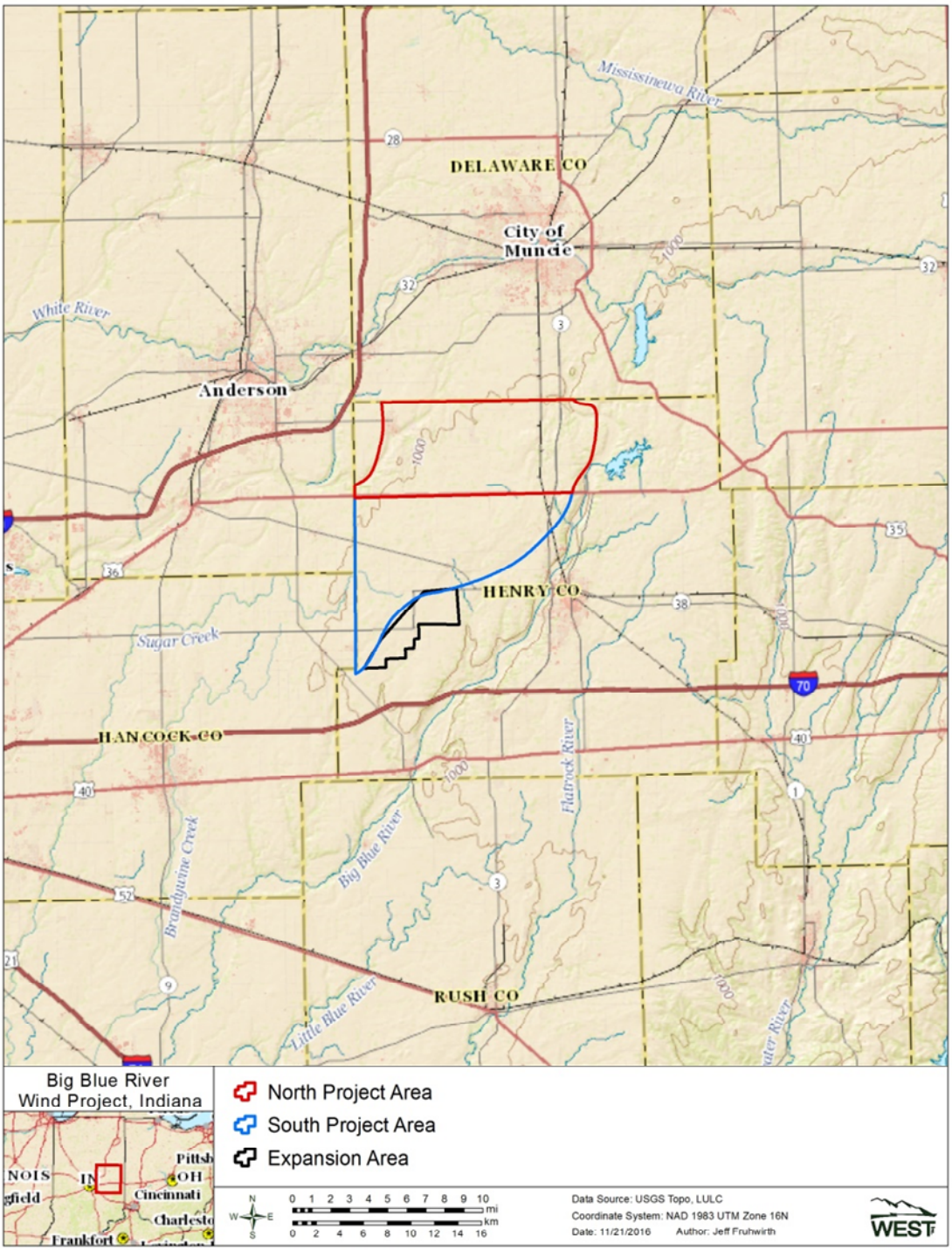

Figure 1. Location of the Big Blue River Wind Project area boundary, Henry County, Indiana.

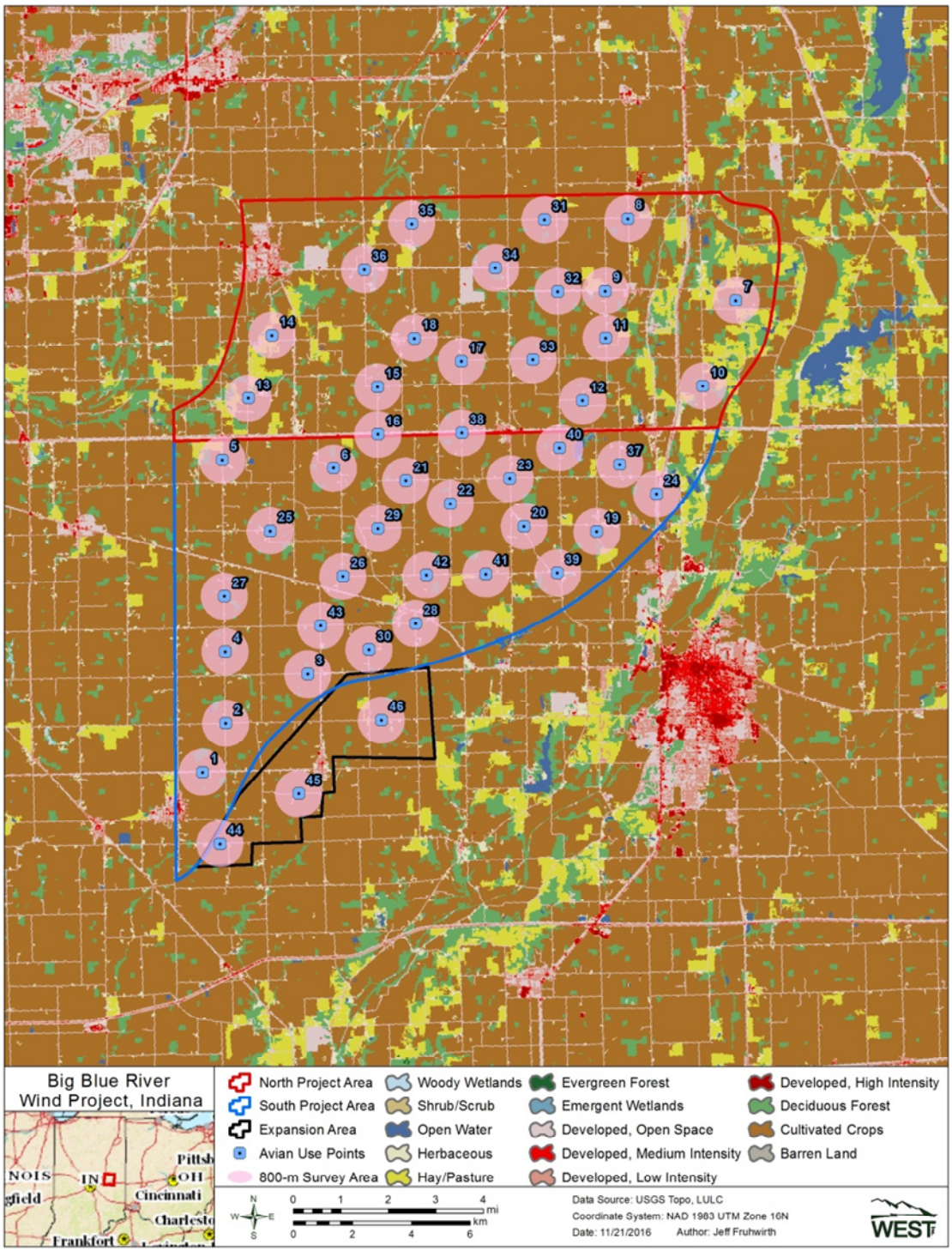

Figure 2. Land cover types and fixed-point count stations in the Big Blue River Wind Project area, Henry County, Indiana (Homer et al. 2015, US Geological Survey National Land Cover Database 2011).

METHODS

The studies in the Project Area consisted of the following: 1) small bird fixed-point count surveys, 2) large bird fixed-point count surveys, 3) incidental surveys, and 4) raptor nest surveys.

Fixed-Point Count Avian Use Surveys

The objective of the fixed-point count avian use surveys was to estimate the seasonal and spatial use of the study area by eagles and other bird species. Fixed-point count avian use surveys (using variable circular plots) were conducted in the Project Area using methods described by Reynolds et al. (1980) and were consistent with methods recommended in the USFWS *Land-Based Wind Energy Guidelines* and ECPG.

Survey Plots

Forty-three points were initially selected within the Project Area resulting in coverage of 30% of the study area (see North and South Project Areas; Figure 2). In July 2016, the Project Area boundary was expanded slightly to the south, and three additional survey points were added to maintain 30% coverage (see Expansion Area; Figure 2). Each survey plot was a 100-m (656-feet [ft]) radius circle centered on the point for small birds, within an 800-m (2,625-ft) radius circle centered on the point for large birds.

Survey Methods

Small bird fixed-point count surveys and large bird fixed-point count surveys were conducted once per month for the duration of one year at all survey points within the North and South Project Areas, and for five months at the three points within the Expansion Area. The first 10 minutes of each survey focused on small birds and passerines within a 200-m (656-ft) plot. Small birds were defined as cuckoos, hummingbirds, swifts, woodpeckers, and passerines. The goal of the 10-minute survey was to record use of the Project Area by passerines and sensitive species throughout the year. The next 60 minutes of each survey focused on eagles and large birds within an 800-m (2,625-ft) plot. The 60-minute large bird surveys were used to obtain estimates of eagle use and risk, and were consistent with the ECPG (USFWS 2013). Large birds also included waterbirds, waterfowl, shorebirds, diurnal raptors, vultures, upland game birds, doves and pigeons, large corvids, and goatsuckers. Eagles and threatened and endangered species were recorded during both small and large bird surveys.

The date, start and end time, and weather information (e.g., temperature, wind speed and direction, and cloud cover) were recorded for each survey. Species or best possible identification, number of individuals, sex and age class (if identifiable), distance from plot center when first observed, closest distance, altitude above ground, activity (behavior), and habitat(s) were recorded for each observation. Bird behavior and habitat type were recorded based on the point of first observation. Behavior categories included soaring flight, flapping-gliding, hunting, kiting-hovering, stooping/diving at prey, stooping or diving in an antagonistic context with other

bird species, perched, being mobbed, undulating/territorial flight, auditory, and other (noted in comments). Approximate flight height and distance from plot center at first observation were recorded to the nearest 5-m (16-ft) interval. Other information collected included if the observation was auditory only, as well as the 10-minute intervals of the survey during which the observation first occurred. Locations of eagles and species of concern recorded during surveys were recorded on field maps by unique observation number. Comments were recorded on the data sheet. For all eagle observations, additional behavior and habitat data was recorded during each 1-minute interval the bird was within view during the 60-minute surveys, in accordance with ECPG.

Observation Schedule

Ten-minute small bird and 60-minute large bird fixed-point count surveys were conducted at 43 points in the Project Area from December 3, 2015 through June 30, 2016, and at 46 points from July 1, 2016 through November 29, 2016. Fixed-point count avian use surveys were conducted monthly at each of the survey points, with 12 – 14 points being surveyed each week; surveys were conducted throughout daylight hours. A pre-established schedule was developed prior to the field surveys to ensure that each point was surveyed approximately the same number of times, to spread survey times throughout the day, and to minimize travel time between plots.

Eagles and federally or state-listed species observed within the Project Area but outside of scheduled survey times were recorded on in-transit or incidental wildlife observation data sheets. The data recorded were similar to those recorded during scheduled surveys, including observation number, location, date, time, species, number of individuals, distance from observer (meters [m]), sex/age class, and habitat.

Statistical Analysis

For analysis purposes, a visit was defined as the required length of time (days) to survey all of the plots once within the Project Area.

Quality Assurance and Quality Control

Quality assurance and quality control measures were implemented at all stages of the surveys, including in the field, during data entry and analysis, and report writing. Observers were responsible for inspecting data forms for completeness, accuracy, and legibility following each field survey. Potentially erroneous data were identified using a series of database queries. Irregular codes or data suspected as questionable were discussed with the observer and/or Project manager. Errors, omissions, or problems identified in later stages of analysis were traced back to the raw data forms, and appropriate changes in all steps were made.

Data Compilation and Storage

A Microsoft® SQL database was developed to store, organize, and retrieve survey data. Data were keyed into the electronic database using a pre-defined protocol to facilitate subsequent quality assurance and quality control, and data analysis. All data forms and electronic data files were retained for reference.

Fixed-Point Count Avian Use Surveys

Bird Diversity and Species Richness

Species richness (total number of unique species observed) was used to assess species diversity. Species lists and counts, including the number of individual observations and groups, were generated by season and included all observations of birds detected, regardless of their distance from the observer. In some cases, the tally of observations represented repeated sightings of the same individual. Species richness was calculated as the mean number of species observed per plot per survey, and was compared between seasons.

Mean Use, Seasonal Variations, and Frequency of Occurrence

Small birds detected within 100 m (656 ft) and large birds detected within 800 m (2,625 ft) of survey points were used to calculate mean use and frequency of occurrence. The first 20 minutes of each large bird fixed-point count survey was used to calculate raptor use of the Project Area in order to compare use rates to other wind energy projects with similarly collected raptor use data. For analysis, seasons were distinguished as spring (March 1 – May 1), summer (May 2 - August 31), fall (September 1 – November 29), and winter (November 30 – February 28). Seasonal mean use was calculated by first averaging the total number of birds observed within each survey plot during a visit, then averaging across survey 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. Frequency of occurrence provides a relative measure of species exposure in the Project Area and was calculated as the percent of surveys in which a particular bird type or species was observed.

Bird Flight Height and Behavior

The flight height recorded during the initial observation was used to calculate the percentage of birds flying within the rotor swept heights (RSH; estimated to be between 25 – 150 m [82 – 492 ft] above ground level) and mean flight height during the fixed-point count large bird use surveys. The percentage of birds flying within the RSH at any time was calculated using the lowest and highest flight heights recorded. Auditory only observations were excluded from flight height calculations.

Spatial Use and Mapping

Spatial use in the Project Area was evaluated by comparing mean use by point location and qualitative review of flight paths. Flight paths of all eagle and sensitive species were digitized and mapped in order to examine spatial patterns of use within the Project Area.

Raptor Nest Surveys

The purpose of the raptor nest survey was to identify raptor nest locations within 3.2 km (2 mi) of the Project Area. WEST performed a raptor nest survey from March 2 – March 15, 2016, when bald eagles and most of the regionally nesting raptors were expected to be engaged in nesting activity, but before trees had fully leafed out, permitting greater visibility of the nests.

Areas containing potentially suitable raptor and eagle nest habitat, such as riparian forested areas, shelterbelts, and woodlots were surveyed for potential raptor nests (defined here as stick nest structures large enough to accommodate a buteo-sized raptor or larger) from public roads within 3.2 km (2 mi) of the Project Area boundary. All potential nest sites were recorded using Locus Pro™ tablet software, and locations were digitized into Geographic Information System. The following data were recorded for each nest: location, species occupying nest, nest activity, nest substrate, and nest condition.

RESULTS

Fixed-Point Count Avian Use Surveys

A total of 1,062 10-minute small bird and 60-minute large bird fixed-point count avian use surveys were conducted within the Project Area during 12 visits for each point in the North and South Project areas and during 5 visits for each point within the Expansion Area. During all types of fixed-point count avian use surveys in the Project Area, 84 unique species were observed.

Eagles

Five bald eagles (*Haliaeetus leucocephalus*) in five separate groups were observed during the large bird use surveys conducted in the Project Area. All five eagles were observed flying within 800 m (2,625 ft) but only 1 eagle flew below 200 m, within the RSH, for a total of three eagle-minutes as defined within the ECPG. Of the five bald eagles recorded during large bird use surveys, three were observed within the South and Southern Expansion Areas (Figure 3). Two bald eagle observations in two groups were recorded incidentally or during the small bird use surveys (Table 1). All eagles detected within the Project Area during fixed-point count avian use surveys were observed either soaring or flying with one of these also observed perching.

Table 1. Eagle observations summary at the Big Blue River Wind Project from December 3, 2015 to November 29, 2016

Survey Type	Date	Survey Location	Species	Age	First Flight (m)	Lowest Flight (m)	Highest Flight (m)	Total min's	Risk min's
fixed point sb	4/6/16	7	BAEA	J	800	150	800	6	0
fixed point lb	1/18/16	27	BAEA	A	500	500	1000	1	0
fixed point lb	7/22/16	37	BAEA	I	400	400	1000	28	0
fixed point lb	10/26/16	40	BAEA	A	700	10	700	21	3
fixed point lb	5/3/16	7	BAEA	A	300	300	5000	7	0
fixed point lb	2/2/16	9	BAEA	A	500	500	800	4	0
incidental	3/4/16	see [1]	BAEA	J					
Total		**7**						**67**	**3**

BAEA = Bald eagle
16N644510e 4432001n;Near Summit Lake[1]
Height = Ht; Minutes = min's; Large bird = lb; Small bird = sb
Juvenile = J, Adult = A, Immature = I

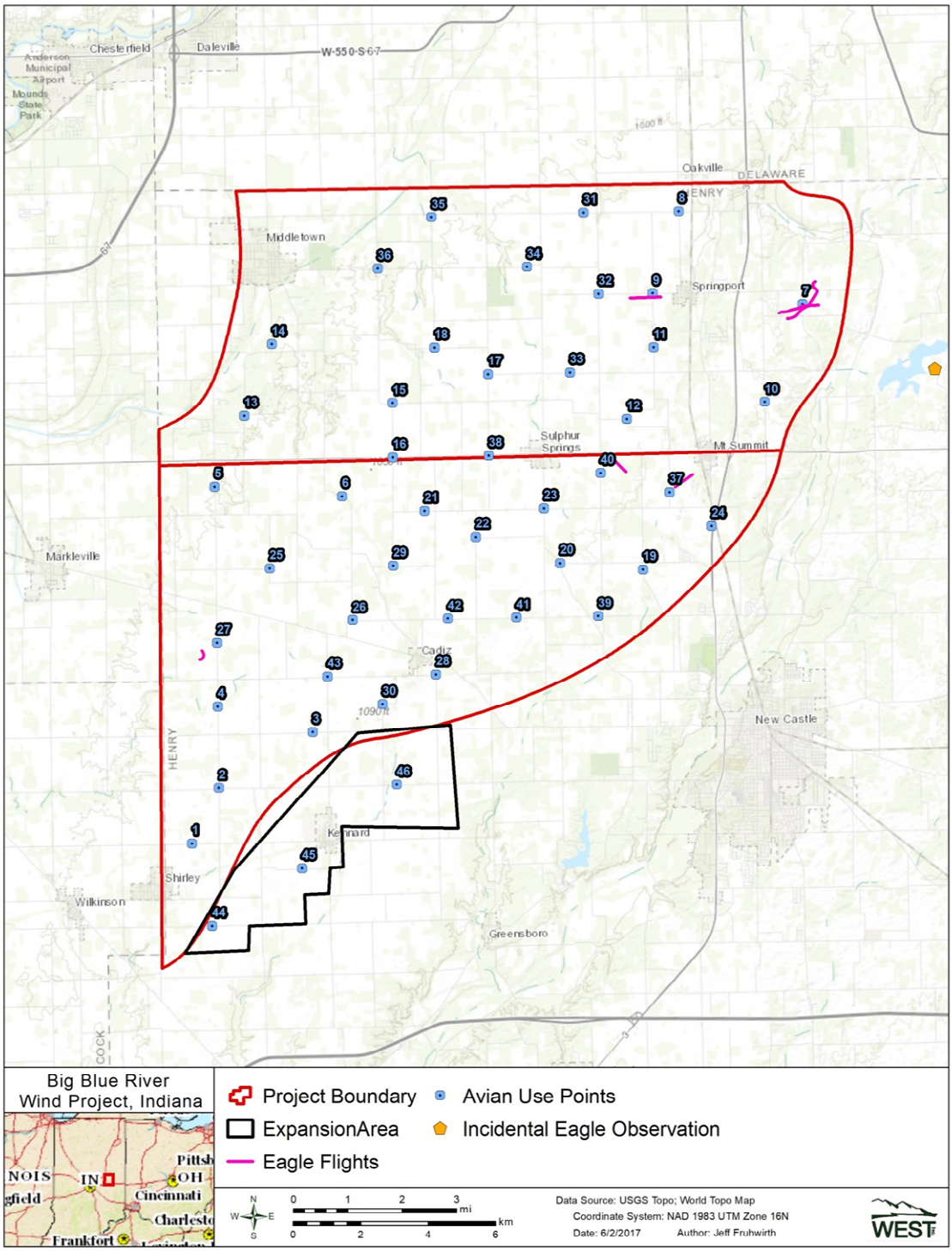

Figure 3. Project boundary and flight paths of eagles observed during fixed-point count avian use surveys conducted within the Big Blue River Wind Project, Henry County, Indiana from December 3, 2015 to November 29, 2016.

Small Bird Use Surveys

Bird Diversity and Abundance

A total of 6,116 bird observations were recorded within 2,255 separate groups belonging to 74 unique species of both small and large birds during the 10-minute small bird fixed-point count surveys in the Project Area (Appendix A). European starling (*Sturnus vulgaris*), red-winged blackbird (*Agelaius phoeniceus*) and horned lark (*Eremophila alpestris*) were the most abundant bird species observed during small bird fixed-point count surveys conducted in the Project Area (Appendix A).

Species Richness, Mean Use, and Seasonal Variation

Overall mean richness of small birds was 3.2 species/100-m plot/10-minute survey in the Project Area (Table 2). Small bird species richness varied seasonally, with summer having the highest richness (5 species of small birds/100-m plot/10-minute survey, followed by spring (3.5 species of small birds/100-m plot/10-minute survey), fall (2.1 species of small birds/100-m plot/10-minute survey), and winter (1.5 species of small birds/100-m plot/10-minute survey).

Table 2. Summary of species richness (species/100-meter plot/10-minute survey) of small birds and sample size during the fixed-point count small bird use surveys conducted in the Big River Wind Project from December 3, 2015 - November 29, 2016.

Season	# of Visits	Species Richness	# Surveys Conducted
Spring	2	3.5	86
Summer	4	5.0	178
Fall	3	2.1	138
Winter	3	1.5	129
Overall	**12**	**3.2**	**531**

For the Project Area, mean small bird use was highest in the fall (11.5 birds/100-m plot/10-minute survey), followed by summer (10.0 birds/100-m plot/10-minute survey), winter (8.4 birds/100-m plot/10-minute survey), and spring (6.0 birds/100-m plot/10-minute survey; Table 3).

Table 3. Mean bird use (number of birds/100-meter plot/10-minute survey), percent use, and frequency of occurrence (%) by season for small bird and large bird species by type and/or subtype during the small bird fixed-point count surveys conducted in the Big Blue River Wind Project from December 3, 2015 to November 29, 2016.

	Mean Use				% Use				% Frequency			
Bird Type	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
Passerines	*5.14*	*8.63*	*10.4*	*6.78*	*86.3*	*86.5*	*90.1*	*80.9*	*93*	*97.8*	*79*	*65.9*
American goldfinch	0.09	0.35	0.18	0.02	1.6	3.5	1.6	0.3	9.3	31.4	15.9	2.3
American redstart	0	<0.01	0	0	0	<0.1	0	0	0	0.6	0	0
American robin	0.71	0.65	0.28	0.16	11.9	6.5	2.4	1.8	45.3	47.3	12.3	9.3
American tree sparrow	0	0	<0.01	0.08	0	0	<0.1	0.9	0	0	0.7	0.8
Baltimore oriole	0	<0.01	0	0	0	<0.1	0	0	0	0.6	0	0
barn swallow	0.03	0.24	0.05	0	0.6	2.4	0.4	0	3.5	18.1	1.4	0
black-capped chickadee	0	<0.01	0	0	0	<0.1	0	0	0	0.6	0	0
black-throated blue warbler	0	0	<0.01	0	0	0	<0.1	0	0	0	0.7	0
blue jay	0.27	0.21	0.46	0.16	4.5	2.1	4	1.9	14	20.6	24.6	12.4
brown-headed cowbird	0.02	0.04	1.07	0	0.4	0.4	9.2	0	2.3	3.5	2.9	0
brown thrasher	0.02	0.04	0	0	0.4	0.4	0	0	2.3	4.1	0	0
Carolina chickadee	0.01	0.01	<0.01	0.03	0.2	0.1	<0.1	0.4	1.2	1.2	0.7	3.1
Carolina wren	0	<0.01	0.03	0	0	<0.1	0.3	0	0	0.6	2.9	0
cedar waxwing	0	0.03	0.07	0	0	0.3	0.6	0	0	2.9	0.7	0
chipping sparrow	0.06	0.25	0.04	0	1	2.5	0.4	0	5.8	23	1.4	0
common grackle	0.13	0.43	0.37	0	2.1	4.3	3.2	0	10.5	17.3	1.4	0
common yellowthroat	0	0.02	0	0	0	0.2	0	0	0	1.7	0	0
dickcissel	0.02	0.02	0	0	0.4	0.2	0	0	2.3	1.7	0	0
eastern bluebird	0.03	0.16	0.09	0.08	0.6	1.6	0.8	0.9	3.5	6.9	5.8	3.1
eastern kingbird	0	0.02	0	0	0	0.2	0	0	0	1.7	0	0
eastern meadowlark	0.15	0.15	0.02	0	2.5	1.5	0.2	0	12.8	8.6	0.7	0
eastern phoebe	0	<0.01	<0.01	0	0	<0.1	<0.1	0	0	0.6	0.7	0
eastern towhee	0	<0.01	0	0	0	<0.1	0	0	0	0.6	0	0
eastern wood-pewee	0	0.03	0	0	0	0.3	0	0	0	3.4	0	0
European starling	0.45	2.47	2.42	3.81	7.6	24.7	21	45.5	14	28.7	21	28.7
field sparrow	0.07	0.22	0	0	1.2	2.2	0	0	7	21.8	0	0
golden-crowned kinglet	0	<0.01	0	0	0	<0.1	0	0	0	0.6	0	0
grasshopper sparrow	0	0.01	0	0	0	0.1	0	0	0	1.2	0	0
gray catbird	0	0.04	0.03	0	0	0.4	0.3	0	0	4	2.2	0

Table 3. Mean bird use (number of birds/100-meter plot/10-minute survey), percent use, and frequency of occurrence (%) by season for small bird and large bird species by type and/or subtype during the small bird fixed-point count surveys conducted in the Big Blue River Wind Project from December 3, 2015 to November 29, 2016.

	Mean Use				% Use				% Frequency			
Bird Type	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
horned lark	0.98	0.5	0.86	1.67	16.4	5	7.4	19.9	58.1	40.9	37	33.3
house finch	0.01	0.02	0.02	0	0.2	0.2	0.2	0	1.2	1.7	2.2	0
house sparrow	0.07	0.23	0.22	0.41	1.2	2.3	1.9	4.9	7	17.7	6.5	3.1
house wren	0	0.05	0	0	0	0.5	0	0	0	4.1	0	0
indigo bunting	0	0.19	0	0	0	1.9	0	0	0	17.6	0	0
Lapland longspur	0	0	0	0.02	0	0	0	0.2	0	0	0	0.8
northern cardinal	0.28	0.17	0.03	0.08	4.7	1.7	0.3	0.9	27.9	16.6	1.4	7
northern mockingbird	0.02	0.02	0	0	0.4	0.2	0	0	2.3	2.3	0	0
northern rough-winged swallow	0	0.02	0	0	0	0.2	0	0	0	0.6	0	0
palm warbler	0	0.01	0.02	0	0	0.1	0.2	0	0	1.1	1.4	0
red-eyed vireo	0	0.02	0	0	0	0.2	0	0	0	1.7	0	0
red-winged blackbird	1.23	1.34	1.36	0.09	20.7	13.4	11.8	1.1	52.3	47.6	14.5	3.1
Savannah sparrow	0.02	0.03	<0.01	0	0.4	0.3	<0.1	0	2.3	3.5	0.7	0
song sparrow	0.24	0.38	0.06	0.02	4.1	3.9	0.5	0.3	24.4	37.3	2.9	1.6
tufted titmouse	0.1	0.11	0.01	0.04	1.8	1.1	0.1	0.5	10.5	11	1.4	3.9
unidentified blackbird	0	0	2.54	0	0	0	22	0	0	0	2.2	0
unidentified bluebird	0	<0.01	0	0	0	<0.1	0	0	0	0.6	0	0
unidentified flycatcher	0	<0.01	0	0	0	<0.1	0	0	0	0.6	0	0
unidentified sparrow	0.02	0.02	0	0.03	0.4	0.2	0	0.4	2.3	1.1	0	1.6
unidentified swallow	0.02	<0.01	0.11	0	0.4	<0.1	0.9	0	1.2	0.5	1.4	0
unidentified warbler	0	<0.01	<0.01	0	0	<0.1	<0.1	0	0	0.6	0.7	0
vesper sparrow	0.01	0.01	0	0	0.2	0.1	0	0	1.2	1.2	0	0
warbling vireo	0	0.02	0	0	0	0.2	0	0	0	2.3	0	0
white-breasted nuthatch	0.03	0.02	0.01	0.09	0.6	0.2	0.1	1	3.5	1.7	1.4	8.5
wood thrush	0	0.01	0	0	0	0.1	0	0	0	1.2	0	0
Cuckoos	*0*	*0.02*	*0*	*0*	*0*	*0.2*	*0*	*0*	*0*	*1.7*	*0*	*0*
yellow-billed cuckoo	0	0.02	0	0	0	0.2	0	0	0	1.7	0	0
Swifts/Hummingbirds	*0*	*0.04*	*0.02*	*0*	*0*	*0.4*	*0.2*	*0*	*0*	*2.8*	*0.7*	*0*
chimney swift	0	0.04	0.02	0	0	0.4	0.2	0	0	2.8	0.7	0
Woodpeckers	*0.2*	*0.12*	*0.12*	*0.16*	*3.3*	*1.2*	*1.1*	*1.9*	*19.8*	*10.5*	*10.9*	*14*

Table 3. Mean bird use (number of birds/100-meter plot/10-minute survey), percent use, and frequency of occurrence (%) by season for small bird and large bird species by type and/or subtype during the small bird fixed-point count surveys conducted in the Big Blue River Wind Project from December 3, 2015 to November 29, 2016.

	Mean Use				% Use				% Frequency			
Bird Type	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
downy woodpecker	0	<0.01	0.03	<0.01	0	<0.1	0.3	<0.1	0	0.6	2.9	0.8
northern flicker	0.01	0.04	0.07	0.03	0.2	0.4	0.6	0.4	1.2	4.1	6.5	3.1
pileated woodpecker	0.02	0.01	<0.01	0.03	0.4	0.1	<0.1	0.4	2.3	1.2	0.7	3.1
red-bellied woodpecker	0.08	0.03	0.02	0.06	1.4	0.3	0.2	0.7	8.1	3.5	2.2	6.2
red-headed woodpecker	0.02	0.02	0	<0.01	0.4	0.2	0	<0.1	2.3	1.7	0	0.8
unidentified woodpecker	0.06	<0.01	0	0.02	1	<0.1	0	0.3	5.8	0.6	0	2.3
Kingfishers	*0*	*0.01*	*0.02*	*<0.01*	*0*	*0.1*	*0.2*	*<0.1*	*0*	*1.2*	*1.4*	*0.8*
belted kingfisher	0	0.01	0.02	<0.01	0	0.1	0.2	<0.1	0	1.2	1.4	0.8
Unidentified Birds	*0.62*	*1.15*	*0.97*	*1.43*	*10.4*	*11.6*	*8.4*	*17.1*	*3.5*	*14.1*	*23.2*	*14.7*
unidentified bird (medium)	0	0	0	0.02	0	0	0	0.3	0	0	0	0.8
unidentified bird (small)	0.62	1.15	0.97	1.41	10.4	11.6	8.4	16.8	3.5	14.1	23.2	14
Small Birds Overall	**6.0**	**10.0**	**11.5**	**8.4**	**100**	**100**	**100**	**100**				

Large Bird Use Surveys

Bird Diversity and Abundance

A total of 3,067 bird observations were recorded within 948 separate groups belonging to 30 unique species of birds during the 60-minute large bird fixed-point count surveys in the Project Area (Appendix B).

Canada geese (*Branta canadensis*; 91 observations of 859 individuals) and turkey vulture (*Cathartes aura*; 267 observations of 515 individuals) were the most abundant birds observed during surveys in the Project Area. Turkey vulture and red-tailed hawk (*Buteo jamaicensis; 186* observations of 216 individuals) were the most frequently observed large birds in the Project Area (Appendix B).

Species Richness, Mean Use, and Seasonal Variation

Mean large bird species richness was 1.34 species/800-m plot/60-minute surveys in the Project Area (Table 4). Large bird species richness varied seasonally, with spring having the highest richness (1.77 species of large birds/800-m plot/60-minute survey), followed by winter (1.33 species of large birds/800-m plot/60-minute survey), summer (1.28 species of large birds/800-m plot/60-minute survey), and fall (1.14 species of large birds/800-m plot/60-minute survey).

Table 4. Summary of large bird species richness (species/800-meter plot/60-minute survey) and sample size during large bird fixed-point count surveys conducted in the Big Blue River Wind Project from December 3, 2015 to November 29, 2016.

Season	# of Visits	Large Bird Species Richness	# Surveys Conducted
Spring	2	1.77	86
Summer	4	1.28	178
Fall	3	1.14	138
Winter	3	1.33	129
Overall	**12**	**1.34**	**531**

In the Project Area, mean large bird use was highest in the winter (12.9 birds/800-m plot/60-minute survey), followed by spring (4.3 birds/800-m plot/60-minute survey), fall (4.2 birds/800-m plot/60-minute survey), and summer (2.6 birds/800-m plot/60-minute survey; Table 5). Canada geese comprised the majority of winter large bird use.

Table 5. Mean bird use (number of birds/800-meter plot/60-minute survey), percent use, and frequency of occurrence (%) by season for all large birds by type and/or subtype during large bird fixed-point count surveys conducted in the Big Blue River Wind Project from December 3, 2015 to November 29, 2016.

	Mean Use				% Use				% Frequency			
Bird Species	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
Waterbirds	0.33	0.31	0.03	1.27	7.6	11.8	0.7	9.9	16.3	20.9	2.2	3.9
Waterfowl	1.72	0.52	1.43	10.09	40.3	20.1	33.8	78.4	31.4	9.3	2.9	24
Shorebirds	0	0	<0.01	0	0	0	0.2	0	0	0	0.7	0
Diurnal Raptors	1.03	0.73	0.8	1.39	24.3	28.1	19	10.8	54.7	45.7	45.7	65.9
Accipiters	0.09	0.05	0.07	0.07	2.2	2	1.5	0.5	8.1	5.2	6.5	7
Buteos	0.7	0.42	0.32	0.69	16.3	16.1	7.5	5.4	40.7	26.3	23.2	41.9
Northern Harrier	0.02	<0.01	0.1	0.09	0.5	0.2	2.4	0.7	2.3	0.5	8.7	6.2
Eagles	0	0.01	<0.01	0.02	0	0.4	0.2	0.1	0	1.2	0.7	1.6
Falcons	0.1	0.14	0.22	0.14	2.5	5.4	5.3	1.1	8.1	11.8	15.9	10.9
Osprey	0	<0.01	0	0	0	0.2	0	0	0	0.5	0	0
Other Raptors	0.12	0.1	0.09	0.39	2.7	3.7	2.1	3	8.1	8	5.1	24.8
Vultures	1.19	1.01	1.68	0.02	27.8	38.8	39.8	0.2	48.8	38.3	42	2.3
Upland Game Birds	0	0.03	<0.01	0	0	1.1	0.2	0	0	2.9	0.7	0
Doves/Pigeons	0	0	0.08	0	0	0	1.9	0	0	0	1.4	0
Large Corvids	0	0	0.19	0.1	0	0	4.5	0.8	0	0	1.4	1.6
Large Bird Overall	**4.3**	**2.6**	**4.2**	**12.9**	**100**	**100**	**100**	**100**				

Flight Height and Behavior

Approximately 38.6% of diurnal raptors were initially observed flying within the RSH, 29.4% were observed flying below the RSH, and 32% were observed flying above the RSH during the 60-minute fixed-point count avian use survey (Table 5). Apart from a single osprey (*Pandion haliaetus*) flying within the RSH (100%), doves and pigeons (72.7%) and accipiters (61.5%) had the highest percentage of observations recorded within RSH in the Project Area. Five eagles in five separate groups were observed flying during fixed-point count avian use surveys in the Project Area (Table 6). Values in this table reflect initial observations. All initial observations of eagles occurred at heights greater than 150 m; one eagle later flew under 200 m flight height.

Table 6. Flight height characteristics of large birds by bird type and raptor subtype during the 60-minute fixed-point count avian use survey[a] conducted in the Big Blue River Wind Project from December 3, 2015, to November 29, 2016.

Bird Type	# Groups Flying	# Obs Flying	Mean Flight Height (m)	% ObsFlying	% within Flight Height Categories		
					0 - 25 m	25 - 150 m[b]	> 150 m
Waterbirds	70	246	153.79	98.8	2	27.2	70.7
Waterfowl	126	1641	144.83	94.5	4.7	50.9	44.4
Shorebirds	1	1	1	100	100	0	0
Diurnal Raptors	295	347	176.34	68.4	29.4	38.6	32
Accipiters	26	26	80.54	74.3	23.1	61.5	15.4
Buteos	149	184	205.46	69.2	20.1	42.4	37.5
Northern Harrier	27	28	16.22	100	82.1	17.9	0
Eagles	5	5	480	100	0	0	100
Falcons	34	39	31.85	47	61.5	35.9	2.6
Osprey	1	1	50	100	0	100	0
Other Raptors	53	64	289.49	71.9	18.8	31.2	50
Vultures	262	504	245.41	98.2	4.8	47	48.2
Upland Game Birds	0	0	0	0	0	0	0
Doves/Pigeons	2	11	21.5	100	27.3	72.7	0
Large Corvids	5	27	28	69.2	85.2	14.8	0
Large Bird Overall	**761**	**2,777**	**191.2**	**90.7**	**8.5**	**46.3**	**45.3**

[a.] 800-meter radius plot for large birds.
[b.] The likely RSH for potential collision with a turbine blade, or 25 – 150 m (82 – 492 ft) above ground level.
Note: groups (grps); observations (obs)

Spatial Use and Mapping

Overall bird use varied by location. In the Project Area, bird use was highest at point 37 (51 birds/60-minute survey), followed by points 1, 19, and 22 (14.7, 13.3, and 13 birds/60-minute survey, respectively; Table 7). The higher use estimates at these points were comprised of waterfowl and waterbird observations during the winter season. Raptor use during the fixed-point count avian use surveys was relatively low at all point locations in the Project Area. Eagle use was also low, with eagles being observed at only five points (0.1 eagle use/60-minute survey for points 7, 9, 27, 37, and 40; Table 7), three of the five observations were recorded in the northeast corner of the Project area, closest to Summit Lake State Park and other small bodies of water (Figure 3).

Table 7. Mean use (number of birds/60-minute survey) by point for large birds observed during large bird fixed-point count avian use surveys conducted in the Big Blue River Wind Project from December 3, 2015 to November 29, 2016.

	Survey Points (1-22)																					
Bird Type	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**
Waterbirds	8.3	0.2	0.1	0.2	0.1	0.2	0.3	0.3	0.2	0.1	0.6	0.2	0.2	0	0.2	0.3	0.2	0.3	0.8	0.17	0.1	0.1
Waterfowl	4.2	5.0	0	6.7	0.2	2.9	2.8	1.7	4.2	9.8	0	0.6	1.6	0.3	0.1	0.2	0.0	0.5	9.8	0	0.4	8.6
Shorebirds	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diurnal Raptors	0.8	0.8	0.8	1.2	1.4	1.3	0.3	1.1	2.5	0.8	1.3	1.3	0.8	0.4	1.2	0.9	0.9	0.6	0.8	0.4	1.8	0.5
Accipiters	0	0	0	0	0	0.1	0.1	0.1	0.2	0.2	0	0.1	0.4	0	0.1	0.1	0.1	0.2	0	0	0	0.1
Buteos	0.8	0.3	0.5	0.8	1.2	0.4	0	0.5	1.4	0.6	0.7	1	0.2	0.4	0.4	0.6	0.2	0.2	0.3	0.4	0.8	0.2
Northern Harrier	0	0	0	0	0	0	0.1	0	0.1	0	0	0.1	0	0	0.3	0	0.1	0.1	0.3	0	0.1	0.2
Eagles	0	0	0	0	0	0	0.1	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0
Falcons	0	0	0.1	0.3	0	0.7	0	0	0.2	0	0.4	0.1	0	0	0.1	0.1	0.1	0.1	0.1	0	0.8	0.1
Osprey	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0.0	0	0	0	0
Other Raptors	0.1	0.5	0.3	0	0.3	0.1	0.1	0.5	0.6	0.1	0.3	0.1	0.1	0	0.3	0.2	0.5	0.1	0.2	0	0.2	0
Vultures	0.4	0.9	0.3	1	1.4	1.0	1.8	1.3	1.5	1.3	0.7	0.8	1	1.2	1	0.5	1.2	0.7	1.9	1.4	1	3.8
Upland Game Birds	0	0	0.1	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Doves/Pigeons	0	0	0.7	0	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Large Corvids	0.8	0.8	0	0.3	0	0	0	0	1.4	0	0	0	0	0	0	0	0	0	0	0	0	0
Bird Overall	14.7	7.7	1.9	9.3	3.3	5.4	5.2	4.3	9.8	12.0	2.6	2.9	3.5	1.9	2.4	1.8	2.3	2.1	13.3	2	3.3	13

Table 7, continued. Mean use (number of birds/60-minute survey) by point for large birds observed during large bird fixed-point count avian use surveys conducted in the Big Blue River Wind Project from December 3, 2015 to November 29, 2016.

Bird Type	Survey Points (23-46)																							
	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46
Waterbirds	0	0	0	0.5	0.1	0	0.8	0	0	0	1.8	0.3	0.2	0	0.1	0.3	0.8	2.6	0.2	0.3	0.1	0	0.3	0.3
Waterfowl	0.2	7.2	2.7	0	0.7	0	0.3	0	0.5	0	4.2	0.2	0.8	1	49.3	8.8	2.8	7	0	0	0	0	0	0
Shorebirds	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diurnal Raptors	0.8	0.8	0.8	0.7	0.7	1	0.9	1.3	0.7	1	0.8	2.6	0.9	0.5	0.8	0.7	0.8	1.4	0.3	0.7	0.8	1	2.5	0.3
Accipiters	0	0	0	0.2	0	0.2	0	0.1	0.1	0	0.2	0.1	0.3	0	0.1	0	0.2	0	0	0.1	0	0	0	0
Buteos	0.8	0.8	0.3	0.3	0.3	0.3	0.7	0.6	0.3	0.4	0.5	0.8	0.5	0.3	0.6	0.4	0.4	0.9	0.1	0.3	0.5	0	1.3	0
Northern Harrier	0	0	0.2	0	0	0.1	0.1	0.1	0	0	0	0.4	0	0	0.1	0	0	0.1	0.1	0	0.1	0	0	0
Eagles	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0.1	0	0	0.1	0	0	0	0	0	0
Falcons	0	0	0.4	0.1	0.1	0.4	0.1	0.4	0.2	0.2	0.1	0.5	0.1	0.1	0	0.1	0.1	0	0.1	0.2	0.1	1	1	0.3
Osprey	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Raptors	0	0.1	0	0.1	0.2	0.1	0.1	0.2	0.1	0.4	0.1	0.8	0.1	0.1	0	0.2	0.1	0.3	0.1	0.1	0.1	0	0.3	0
Vultures	1.1	0.5	1	0.8	0.6	0.3	0.4	0.3	0.8	2.3	0.6	0.9	0.9	0.5	0.8	1	0.8	0.4	1.8	0.8	0	0.5	0.3	0
Upland Game Birds	0	0	0	0	0	0.1	0	0.1	0	0	0	0	0.1	0	0.1	0	0	0	0	0	0	0	0	0
Doves/Pigeons	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Large Corvids	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bird Overall	2.1	8.5	4.5	1.9	2	1.4	2.5	1.7	2	3.3	7.3	3.9	2.8	2	51	10.7	5.2	11.4	2.3	1.7	0.8	1.5	3	0.5

Sensitive Species Observations

Seven sensitive species totaling 441 observations in 62 groups were recorded during the fixed-point count avian use surveys (Table 8); sandhill cranes were the most numerous sensitive species (*Grus canadensis*; Appendix B).

Northern harriers (*Circus cyaneus*) were the second-most commonly observed sensitive species at the Project Area for a total of 33 individuals in 32 separate observations. Most northern harriers were observed in the fall and winter and were likely seasonal migrants. Red-shouldered hawk (*Buteo lineatus*) observations were most common near survey points 21 and 29 in the Project Area (Figure 4) and in the fall (Appendix B). The rest of the sensitive species were observed infrequently at the Project Area and flight paths of these species do not show any concentrated use or habitat use pattern (Figure 4).

Table 8. Summary of sensitive species observed incidentally or during fixed-point (FP) count avian use surveys conducted in the Big Blue River Wind Project from December 3, 2015 to November 29, 2016.

			Large Bird FP		Small Bird FP		Incidental		Total	
Species	**Scientific Name**	**Status[a]**	**# of grps**	**# of obs**	**# of grps**	**# of obs**	**# of grps**	**# of obs**	**# of grps**	**# of obs**
bald eagle	*Haliaeetus leucocephalus*	SC	5	5	1	1	1	1	7	7
common nighthawk	*Chordeiles minor*	SC	0	0	0	0	1	1	1	1
northern harrier	*Circus cyaneus*	SE	27	28	3	3	2	2	32	33
osprey	*Pandion haliaetus*	SE	1	1	0	0	0	0	1	1
red-shouldered hawk	*Buteo lineatus*	SC	4	5	1	1	4	4	9	10
sandhill crane	*Grus canadensis*	SC	6	164	0	0	1	220	7	384
sharp-shinned hawk	*Accipiter striatus*	SC	5	5	0	0	0	0	5	5
Total	**7 species**		**48**	**208**	**5**	**5**	**9**	**228**	**62**	**441**

[a] SE = state endangered , SC=state species of concern (IDNR 2016)
Groups (grps); observations (obs)

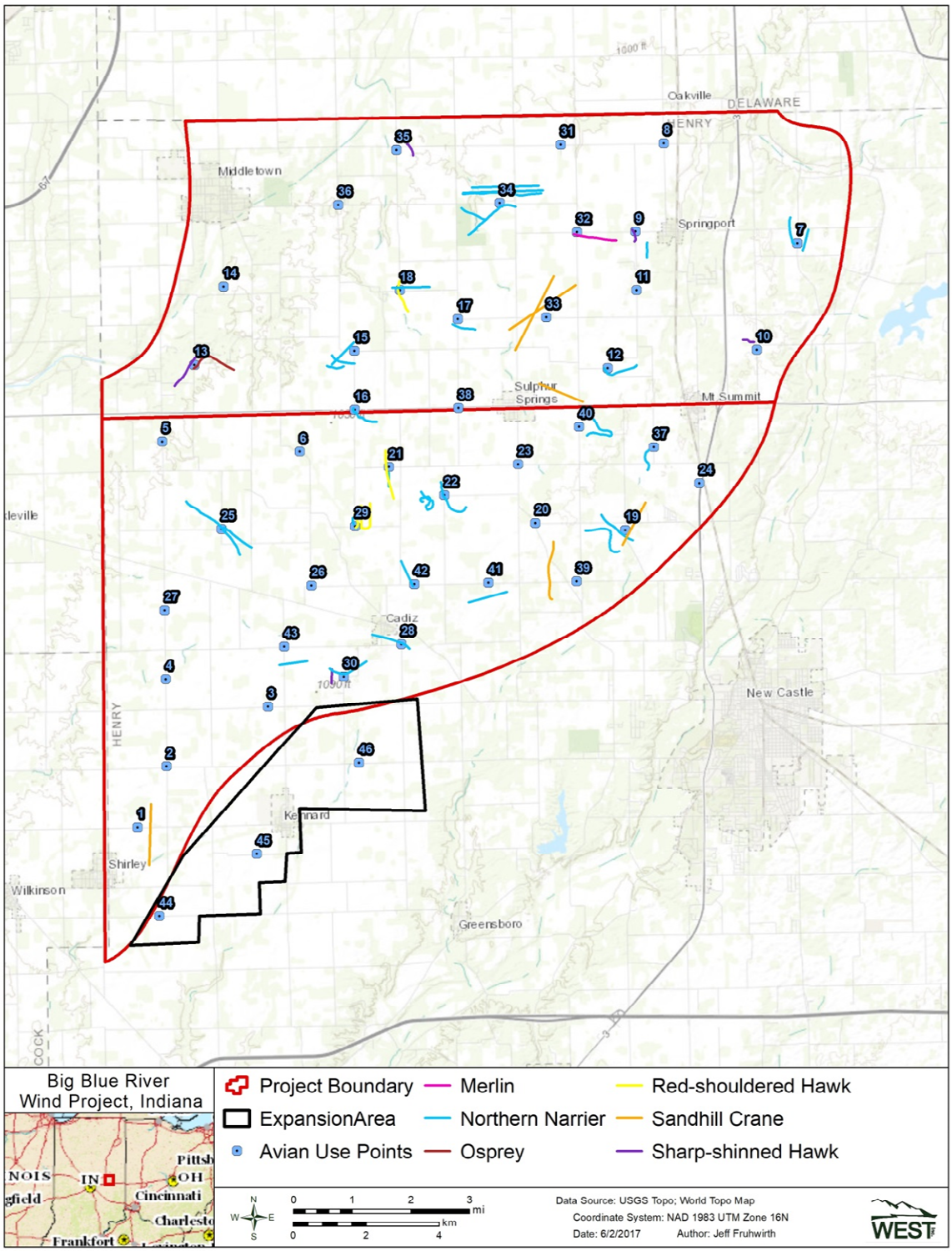

Figure 4. Flight paths of sensitive species observed during fixed-point count avian use surveys conducted within the Big Blue River Wind Project, Henry County, Indiana from December 3 to November 29, 2016.

Incidental Observations

Five bird species were observed incidentally in the Project Area, totaling 228 individuals within 9 separate groups (Table 9). Common nighthawk (*Chordeiles minor*), a state species of special concern, was only seen incidentally within the Project Area.

Table 9. Incidental wildlife recorded while conducting all surveys at the Big Blue River Wind Project from December 3, 2015 to November 29, 2016.

Species	Scientific Name	# grps	# obs
sandhill crane	*Grus canadensis*	1	220
bald eagle	*Haliaeetus leucocephalus*	1	1
northern harrier	*Circus cyaneus*	2	2
red-shouldered hawk	*Buteo lineatus*	4	4
common nighthawk	*Chordeiles minor*	1	1
Bird Subtotal		**9**	**228**

Raptor Nest Survey

No eagle and 55 raptor nests were observed within the 3.2 km (2-mi) survey area (Table 10; Figure 5). All nests observed were small, and less than 4 ft (1.22 m) in diameter and located along woodlot edges. USFWS provided information that three eagle nests occur 8 – 10 mi (12.87 – 16.01 km) from the Project Area boundary. Sixteen active raptor nests were observed, while 39 were inactive. Fourteen of the active raptor nests were occupied by red-tailed hawks, and the remaining two were occupied by great-horned owls.

Table 10. Summary of nests located within the Big Blue River Wind Project and a 2-mile buffer, Henry county, Indiana from March 2 to March 15, 2016

NEST ID[1]	Species[2]	Nest Status	Nest Type	Nest Condition	Nest Height (~ft)	Substrate Height	Nest Aspect	UTM NAD83	
								Easting	Northing
RN1	Unknown	Inactive	Small Stick	Intact	30	-	S	614239	4439582
RN2	Unknown	Inactive	Small Stick	Intact	30	-	S	643396	4438922
RN3	RTHA	Active	Medium Stick	Intact	25	25	S	629262	4440337
RN4	Unknown	Inactive	Small Stick	Intact	30	30	W	626993	4440524
RN5	Unknown	Inactive	Small Stick	Intact	25	25	W	625713	4440506
RN6	RTHA	Active	Medium Stick	Intact	18	18	E	620974	4438974
RN7	RTHA	Active	Medium Stick	Intact	30	30	N	621941	4436509
RN8	Unknown	Inactive	Small Stick	Intact	30	30	W	623723	4437176
RN9	Unknown	Inactive	Small Stick	Intact	20	20	W	632083	4439181
RN10	Unknown	Inactive	Small Stick	Intact	30	20	W	628183	4435529
RN11	Unknown	Inactive	Small Stick	Intact	15	15	W	635561	4436315
RN12	Unknown	Inactive	Small Stick	Intact	20	-	E	638141	4436872
RN13	Unknown	Inactive	Small Stick	Intact	25	25	E	644082	4438221
RN14	Unknown	Inactive	Small Stick	Intact	20	20	S	644468	4434315
RN15	GHOW	Active	Medium Stick	Intact	20	20	N	644021	4433276
RN16	Unknown	Inactive	Small Stick	Intact	25	25	N	642192	4430869
RN17	Unknown	Inactive	Small Stick	Intact	25	25	N	643737	4430344
RN18	Unknown	Inactive	Small Stick	Intact	20	30	W	640806	4436879
RN19	Unknown	Inactive	Small Stick	Intact	15	30	N	641577	4435945
RN20	Unknown	Inactive	Small Stick	Intact	20	35	N	642602	4433930
RN21	RTHA	Active	Medium Stick	Intact	30	40	W	643999	4435279
RN22	Unknown	Inactive	Small Stick	Intact	25	25	S	641966	4433978
RN23	Unknown	Inactive	Small Stick	Intact	15	20	W	639612	4435160
RN24	GHOW	Active	Medium Stick	Intact	20	25	N	639292	4433628
RN25	Unknown	Inactive	Small Stick	Intact	20	25	S	640503	4429594
RN26	RTHA	Active	Medium Stick	Intact	25	30	S	636442	4437141
RN27	Unknown	Inactive	Small Stick	Intact	25	30	N	630016	4431779
RN28	RTHA	Active	Medium Stick	Intact	20	30	N	628914	4428104
RN29	RTHA	Active	Medium Stick	Intact	25	30	N	633377	4427266
RN30	Unknown	Inactive	Small Stick	Intact	25	30	N	630715	4427417
RN31	RTHA	Active	Medium Stick	Intact	25	30	E	622752	4428399
RN32	Unknown	Inactive	Small Stick	Intact	20	25	E	622736	4428341
RN33	Unknown	Inactive	Small Stick	Intact	20	25	N	622402	4423536

Table 10. Summary of nests located within the Big Blue River Wind Project and a 2-mile buffer, Henry county, Indiana from March 2 to March 15, 2016

NEST ID[1]	Species[2]	Nest Status	Nest Type	Nest Condition	Nest Height (~ft)	Substrate Height	Nest Aspect	UTM NAD83	
								Easting	Northing
RN34	Unknown	Inactive	Small Stick	Intact	30	32	N	623568	4422156
RN35	RTHA	Active	Medium Stick	Intact	12	15	E	629751	4422985
RN36	Unknown	Inactive	Small Stick	Intact	25	30	N	622739	4425580
RN37	Unknown	Inactive	Small Stick	Intact	20	25	W	621632	4428656
RN38	RTHA	Active	Medium Stick	Intact	25	30	E	629369	4426798
RN39	RTHA	Active	Medium Stick	Intact	20	25	W	633158	4424041
RN40	Unknown	Inactive	Small Stick	Intact	32	35	N	635328	4425599
RN41	RTHA	Active	Medium Stick	Intact	25	30	N	634064	4424082
RN42	Unknown	Inactive	Small Stick	Intact	25	30	W	622257	4425513
RN43	Unknown	Inactive	Small Stick	Intact	20	25	E	621517	4429552
RN44	Unknown	Inactive	Small Stick	Intact	10	15	S	622428	4430630
SRN1	Unknown	Inactive	Small Stick	Intact	20	20	S	624296	4413050
SRN2	Unknown	Inactive	Small Stick	Intact	20	20	S	624296	4413050
SRN3	RTHA	ACTIVE	Medium Stick	Intact	20	20	N	630033	4419011
SRN4	Unknown	Inactive	Small Stick	Intact	20	20	N	629957	4418987
SRN5	Unknown	Inactive	Small Stick	Intact	20	20	N	637870	4422248
SRN6	RTHA	Active	Medium Stick	Intact	15	15	N	637841	4422090
SRN7	Unknown	Inactive	Small Stick	Intact	10	10	N	628750	4418816
SRN8	Unknown	Inactive	Small Stick	Intact	15	15	N	619529	4417016
SRN9	Unknown	Inactive	Small Stick	Intact	20	20	N	623774	4418325
SRN10	Unknown	Inactive	Small Stick	Intact	20	20	N	622561	4418667
SRN11	Unknown	Inactive	Small Stick	Intact	20	20	E	620797	4414041

[1] Defined by WEST.
[2] RTHA= red-tailed hawk; GHOW= great horned owl

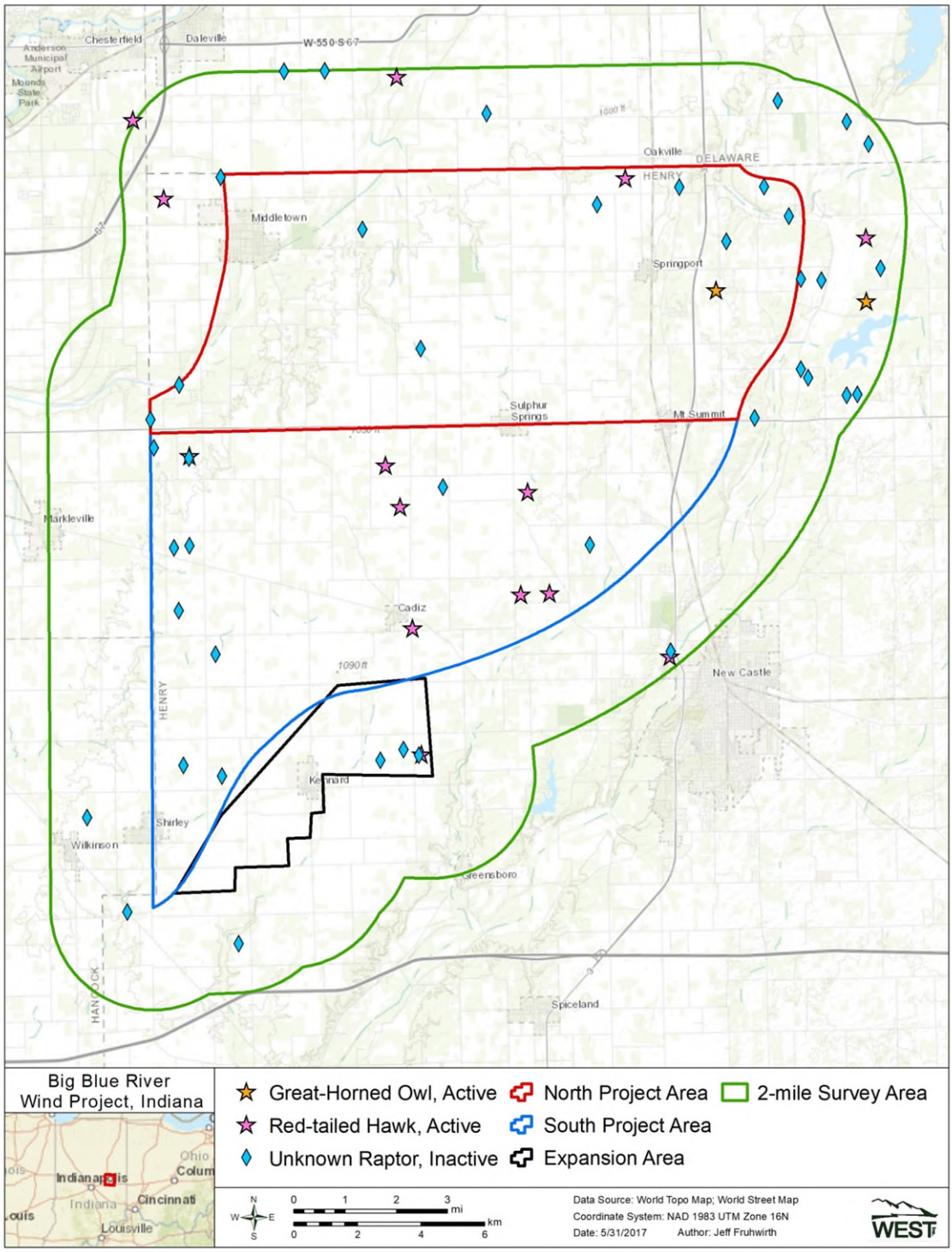

Figure 5. Raptor nest locations in the Big Blue River Wind Project, Henry County, Indiana during ground-based surveys from March 2 to March 15, 2016.

DISCUSSION

The primary objective of the avian use surveys was to estimate potential impacts of the project to eagles. A secondary objective was to estimate impacts to other bird species

Eagles

The Project Area lacks suitable bald eagle nesting and hunting habitat throughout most of the development area, and low levels of eagle use were recorded in cropland areas that comprise the majority of the Project Area. Areas outside of the Project Area, such as Summit Lake State Park (less than 2 mi [3.2 km] northeast of the Project Area) and the Province Pond Fish and Wildlife Area, a small lake and wetland located in the northeast portion of the Project Area, provide more suitable nesting and foraging areas for bald eagles.

Bald eagle collisions with wind turbines are relatively rare compared to the golden eagle (*Aquila chrysaetos*). To date, the USFWS has confirmed 49 bald eagles as mortalities at wind energy projects (USFWS 2018) with an additional six reported by Pagel et al. (2013). As of 2016, over 52,000 wind turbines were operating within the United States, with a total installed wind capacity of 82,183 mw (AWEA 2017). The low level of bald eagle mortality relative to the large number of operating turbines suggests that the risk for collision of bald eagles with wind turbines is low considering the species' large and increasing population and widespread distribution across North America (Buehler 2000, Allison 2012). The combination of a low level of recorded bald eagle use, and a lack of highly suitable habitat throughout the majority of the Project area that would attract bald eagles within the Project Area suggests the risk of bald eagle collision is low.

No golden eagles were recorded during the survey. Golden eagles are rare in the Midwest and eastern US. Golden eagles are most commonly found in the western U.S. To date no golden eagle fatalities have been reported within the eastern U.S. Golden eagles have a wide range of winter distribution (USFWS 2011, 2016a), and are recorded in low numbers within Indiana. During the last 10 years, three golden eagle observations were reported on eBird near Muncie, Indiana (eBird 2016); two of these observations were within the last year, one at Summit Lake State Park and one at Prairie Creek Reservoir. No golden eagles were observed within the Project Area during 619 hours of fixed-point count avian use surveys. In addition, golden eagle habitat is rare within the Project Area, as they prefer open shrublands and grasslands (USFWS 2011, 2016b). Golden eagle fatalities are not expected to occur at the Project Area based on the lack of use and the location of the Project Area outside of the core range of the golden eagle.

Passerines

Most of the passerines observed during the fixed-point count avian use surveys were common species that are typical of tilled agricultural fields and grasslands in the Midwest (Appendices A and B), suggesting that songbird mortality will be similar to fatality rates recorded at other Midwest wind energy projects. No federally or state-listed small bird species were observed in

the Project Area. Erickson et al. (2014) completed an analysis of passerine mortality at 116 wind-energy facilities in the US and Canada. After accounting for imperfect detection and loss of carcasses due to scavenging, Erickson compared fatality rates for individual bird species to species population sizes in North America. For all wind energy facilities currently in operation, Erickson et al. (2014) estimated that about 134,000 to 230,000 small passerine fatalities from collision with wind turbines occur annually, or 2.10 to 3.35 small birds per megawatt (MW) of installed capacity. When adjusted for species composition, this indicates that about 368,000 fatalities for all bird species are caused annually by collisions with wind turbines. Other human-related sources of bird deaths, (e.g., communication towers, buildings, and domestic cats [*Felis catus*]) have been estimated to kill millions to billions of birds each year. Loss et al. (2013) estimated a similar number of wind related bird mortality in the U.S., between 140,000 – 328,00 annually.

Large Birds

The most abundant large bird species recorded during avian use surveys were waterfowl such as Canada geese. Waterfowl were most commonly observed in the fall and winter and were likely associated with migration. Waterfowl do not appear to be particularly susceptible to collision with wind turbines. In an analysis of 116 studies of bird mortality at over 70 facilities, waterfowl made up 2.7% of 4,975 fatalities found (Erickson et al. 2014). In a database of 208 publicly available fatality studies, 207 waterfowl fatalities out of 7,993 total fatalities (2.58%) were documented, (see Appendix D for a list of facilities and references).

Canada goose appears to be especially adept at avoiding collisions with wind turbines. In the Midwest, the Top of Iowa Windfarm is located in cropland between three Wildlife Management Areas (WMAs) with historically high bird use, including migrant and resident waterfowl, shorebirds, raptors, and songbirds. Approximately one million total goose-use days and 120,000 total duck-use days were recorded in the WMAs during the fall and early winter, and no waterfowl fatalities were documented during concurrent and standardized wind project fatality studies (Jain 2005). Similar findings were observed at the Buffalo Ridge Wind Project in southwestern Minnesota and the Grand Ridge Wind Project in northern Illinois. Buffalo Ridge is located in an area with relatively high waterfowl use, as well as other waterbird use and some shorebird use. Five of the 42 fatalities observed during the fatality studies were waterfowl, including two mallards (*Anas platyrhynchos*), two American coots (*Fulica americana*), and one blue-winged teal (*A. discors*; Johnson et al. 2002b). Additionally, at the Grand Ridge Wind Project waterfowl accounted for 27% of all birds observed in a year-long avian point count survey, but only one waterfowl fatality was found (Derby et al. 2010g)

Diurnal Raptors

Annual mean raptor use (within the first 20 minutes of 60-minute surveys) recorded in the Project Area (0.41 raptors/800-m plot/20-minute survey) was low compared with 46 other publicly available wind energy facilities that implemented similar protocols and had data for three or four seasons (Figure 6). The annual mean raptor use at these wind energy facilities ranged from 0.06 to 2.34 raptors/800-m plot/20-minute survey (Figure 6). A relative ranking of

annual mean raptor use was developed based on the results from these wind energy facilities as low (0 – 0.5 raptors/800-m plot/20-minute survey), low to moderate (0.5 – 1.0 raptors/800-m plot/20-minute survey), moderate (1.0 – 2.0 raptors/800-m plot/20-minute survey), high (2.0 – 3.0 raptors/800-m plot/20-minute survey), and very high (more than 3.0 raptors/800-m plot/20-minute survey). Under this ranking, annual mean diurnal raptor use in the Project Area is considered to be low.

Raptor fatality rates in the Midwest have ranged from zero to 0.47 raptor fatalities per megawatt (MW) per year (fatalities/MW/year; Appendix C). Potential impacts to individuals in the Project Area are unlikely to cause significant adverse impacts to local or regional raptor populations because mortality rates are expected to be similar to other Midwestern wind energy projects, and the most commonly observed raptor species during surveys were red-tailed hawks, a common species in North America.

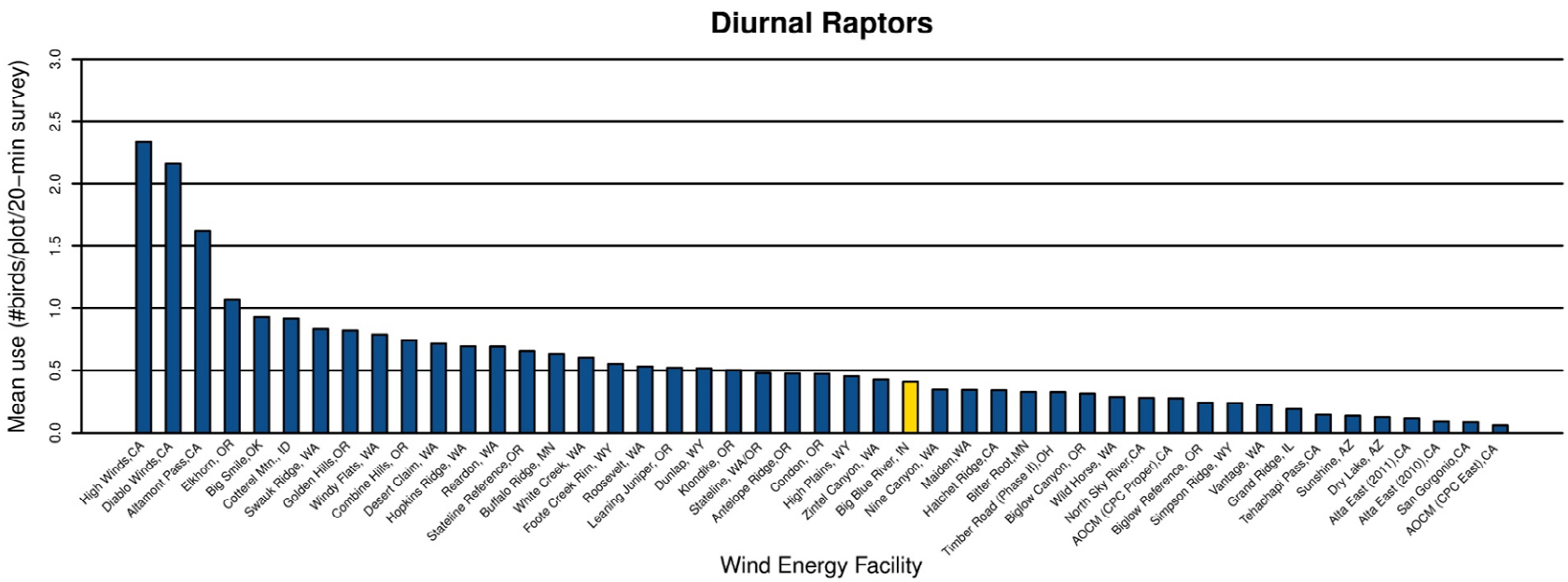

Figure 6. Comparison of diurnal raptor use (number of raptors/800-meter plot/20-minute survey) observed during fixed-point count avian use surveys at the Big Blue River Wind Project from December 3, 2015 to November 29, 2016, and annual diurnal raptor use recorded during comparable surveys at other North American wind energy projects.

Figure 6 (*continued*). Comparison of diurnal raptor use (number of raptors/800-meter plot/20-minute survey) observed during fixed-point count avian use surveys at the Big Blue River Wind Project from December 3, 2015 to November 29, 2016, and annual diurnal raptor use recorded during comparable surveys at other North American wind energy projects.

Data from the following sources:

Study and Location	Reference	Study and Location	Reference	Study and Location	Reference
Big Blue River, IN	This study.				
High Winds, CA	Kerlinger et al. 2005	Foote Creek Rim, WY	Johnson et al. 2000b	Wild Horse, WA	Erickson et al. 2003d
Diablo Winds, CA (05-07)	WEST 2006	Roosevelt, WA	NWC and WEST 2004	North Sky River, CA	Erickson et al. 2011
Altamont Pass, CA	Orloff and Flannery 1992	Leaning Juniper, OR	Kronner et al. 2005	AOCM (CPC Proper), CA	Chatfield et al. 2010a
Elkhorn, OR	WEST 2005a	Dunlap, WY	Johnson et al. 2009a	Biglow Reference, OR	WEST 2005c
Big Smile, OK (12-13)	Derby et al. 2010a	Klondike, OR	Johnson et al. 2002	Simpson Ridge, WY	Johnson et al. 2000b
Cotterel Mtn., ID	BLM 2006	Stateline, WA/OR	Erickson et al. 2003a	Vantage, WA	Jeffrey et al. 2007
Swauk Ridge, WA	Erickson et al. 2003b	Antelope Ridge, OR	WEST 2009	Grand Ridge, IL	Derby et al. 2009
Golden Hills, OR	Jeffrey et al. 2008	Condon, OR	Erickson et al. 2002b	Tehachapi Pass, CA	Anderson et al. 2000, Erickson et al. 2002b
Windy Flats, WA	Johnson et al. 2007	High Plains, WY	Johnson et al. 2009b	Sunshine, AZ	WEST and the CPRS 2006
Combine Hills, OR	Young et al. 2003d	Zintel Canyon, WA	Erickson et al. 2002a, 2003c	Dry Lake, AZ	Young et al. 2007c
Desert Claim, WA	Young et al. 2003b	Nine Canyon, WA	Erickson et al. 2001	Alta East (2011), CA	Chatfield et al. 2011
Hopkins Ridge, WA	Young et al. 2003a	Maiden, WA	Young et al. 2002	Alta East (2010), CA	Chatfield et al. 2011
Reardon, WA	WEST 2005b	Hatchet Ridge, CA	Young et al. 2007b	San Gorgonio, CA	Anderson et al. 2000, Erickson et al. 2002b
Stateline Reference, OR	URS et al. 2001	Bitter Root. MN	Derby and Dahl 2009	AOCM (CPC East), CA	Chatfield et al. 2010a
Buffalo Ridge, MN	Johnson et al. 2000a	Timber Road (Phase II), OH	Good et al. 2010		
White Creek, WA	NWC and WEST 2005	Biglow Canyon, OR	WEST 2005c		

Sensitive Species

No species protected by the federal Endangered Species Act (Public Law 93-205 1973) were observed during the surveys. Two Indiana endangered species were observed: northern harrier, and osprey. In addition, five species of concern were observed: bald eagle, common nighthawk, red-shouldered hawk, sandhill crane and sharp-shinned hawk (*Accipiter striatus*).

Northern Harrier

Northern harriers are commonly observed during fixed-point count avian use surveys at wind energy projects, yet no fatalities of this species have been recorded in the Midwest (Table 12, Appendix D). The lack of fatalities is likely due to the northern harrier hunting and flight habits; northern harriers generally hunt and fly at low elevations, and therefore, have a low risk of collision with modern wind turbines (Whitfield and Madders 2005). Northern harriers were most commonly observed during fall migration and winter, suggesting a low potential for suitable nesting habitat in the Project Area.

Sandhill Crane

Sandhill cranes were observed during the winter migration period in the Project Area but do not seem to be especially susceptible to turbine collisions. At one wind energy facility located in the sandhill crane central flyway, 296 sandhill crane observations were recorded in 2009, and 386 observations in 2010, but no fatalities were reported (Wessington Springs, South Dakota; Derby et al. 2010g, 2011d). Only three sandhill crane fatalities have been reported to date in the U.S., two occurring in west Texas and one in west central California. Based on the lack of sandhill crane fatalities at other wind energy facilities in the Midwest, the potential for sandhill cranes to collide with wind turbines in the Project Area appears to be limited. Sandhill cranes were only observed during migration, and their preferred habitat such as wetlands and grasslands are not commonly found within the Project Area (USFWS 2016c).

Osprey, Common Nighthawk, Red-shouldered Hawk, and Sharp-shinned Hawk

The use by osprey and common nighthawk was low within the Project Area, with only one observation each. There are no known fatality records for either of these species at wind energy projects in the Midwest, with publicly available data, and the risk to these species is expected to be low (Table 12, Appendix D). Red-shouldered hawks were also observed in low numbers (10 observations in 9 groups; Table 8) but since there are no known fatality records (Table 12), risk for this species is also expected to be low. Sharp-shinned hawk was the third most common fatality found at other wind energy facilities in the Midwest (after red-tailed hawk and American kestrel; Table 12). Five observations in five groups suggest low use of the Project Area by sharp-shinned hawks and therefore at low risk for collision with turbines.

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Appendix A. Descriptive Statistics for the Species Recorded During the 10-minute Fixed-Point Count Small Bird Use Surveys Conducted at the Big Blue River Wind Project in Henry County, Indiana, from December 3, 2015 to November 29, 2016

Appendix A. Summary[1] of individual and group observations for all seasons by species and bird type for 10-minute fixed-point count small bird use surveys conducted at the Big Blue River Wind Project from December 3, 2015 to November 29, 2016.

		Spring		Summer		Fall		Winter		Overall	
Bird Species	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Waterbirds		**0**	**0**	**4**	**4**	**1**	**1**	**1**	**1**	**6**	**6**
great blue heron	*Ardea herodias*	0	0	4	4	1	1	1	1	6	6
Waterfowl		**4**	**7**	**7**	**9**	**5**	**89**	**11**	**105**	**27**	**210**
Canada goose	*Branta canadensis*	3	4	5	6	3	83	9	100	20	193
mallard	*Anas platyrhynchos*	0	0	2	3	0	0	0	0	2	3
unidentified duck	NA	0	0	0	0	2	6	2	5	4	11
wood duck	*Aix sponsa*	1	3	0	0	0	0	0	0	1	3
Shorebirds		**42**	**71**	**57**	**62**	**34**	**55**	**4**	**4**	**137**	**192**
American woodcock	*Scolopax minor*	1	2	0	0	0	0	0	0	1	2
killdeer	*Charadrius vociferus*	40	48	57	62	34	55	4	4	135	169
unidentified sandpiper	NA	1	21	0	0	0	0	0	0	1	21
Diurnal Raptors		**3**	**3**	**12**	**12**	**13**	**13**	**5**	**5**	**33**	**33**
Accipiters		*1*	*1*	*3*	*3*	*2*	*2*	*1*	*1*	*7*	*7*
Cooper's hawk	*Accipiter cooperii*	1	1	3	3	1	1	1	1	6	6
unidentified accipiter	*Accipiter spp*	0	0	0	0	1	1	0	0	1	1
Buteos		*0*	*0*	*8*	*8*	*6*	*6*	*3*	*3*	*17*	*17*
red-shouldered hawk	*Buteo lineatus*	0	0	0	0	1	1	0	0	1	1
red-tailed hawk	*Buteo jamaicensis*	0	0	8	8	5	5	2	2	15	15
unidentified buteo	*Buteo sp*	0	0	0	0	0	0	1	1	1	1
Northern Harrier		*1*	*1*	*0*	*0*	*2*	*2*	*0*	*0*	*3*	*3*
northern harrier	*Circus cyaneus*	1	1	0	0	2	2	0	0	3	3
Eagles		*1*	*1*	*0*	*0*	*0*	*0*	*0*	*0*	*1*	*1*
bald eagle	*Haliaeetus leucocephalus*	1	1	0	0	0	0	0	0	1	1
Falcons		*0*	*0*	*1*	*1*	*3*	*3*	*1*	*1*	*5*	*5*
American kestrel	*Falco sparverius*	0	0	1	1	3	3	1	1	5	5
Vultures		*2*	*2*	*0*	*0*	*6*	*6*	*0*	*0*	*8*	*8*
turkey vulture	*Cathartes aura*	2	2	0	0	6	6	0	0	8	8
Upland Game Birds		*0*	*0*	*5*	*5*	*0*	*0*	*0*	*0*	*5*	*5*
northern bobwhite	*Colinus virginianus*	0	0	5	5	0	0	0	0	5	5
Doves/Pigeons		*17*	*25*	*55*	*86*	*12*	*51*	*8*	*24*	*92*	*186*
mourning dove	*Zenaida macroura*	16	24	51	64	8	24	8	24	83	136
rock pigeon	*Columba livia*	1	1	4	22	4	27	0	0	9	50
Large Corvids		*37*	*38*	*61*	*63*	*59*	*65*	*52*	*65*	*209*	*231*
American crow	*Corvus brachyrhynchos*	37	38	61	63	59	65	52	65	209	231
Cuckoos		*0*	*0*	*3*	*3*	*0*	*0*	*0*	*0*	*3*	*3*
yellow-billed cuckoo	*Coccyzus americanus*	0	0	3	3	0	0	0	0	3	3

Appendix A. Summary[1] of individual and group observations for all seasons by species and bird type for 10-minute fixed-point count small bird use surveys conducted at the Big Blue River Wind Project from December 3, 2015 to November 29, 2016.

		Spring		Summer		Fall		Winter		Overall	
Bird Species	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Passerines		*300*	*442*	*846*	*1506*	*254*	*1754*	*166*	*875*	*1566*	*4577*
American goldfinch	*Spinus tristis*	8	8	56	61	22	25	3	3	89	97
American redstart	*Setophaga ruticilla*	0	0	1	1	0	0	0	0	1	1
American robin	*Turdus migratorius*	41	61	86	113	18	42	12	20	157	236
American tree sparrow	*Spizella arborea*	0	0	0	0	1	1	1	10	2	11
Baltimore oriole	*Icterus galbula*	0	0	1	1	0	0	0	0	1	1
barn swallow	*Hirundo rustica*	3	3	33	43	2	7	0	0	38	53
black-capped chickadee	*Poecile atricapilla*	0	0	1	1	0	0	0	0	1	1
black-throated blue warbler	*Setophaga caerulescens*	0	0	0	0	1	1	0	0	1	1
blue jay	*Cyanocitta cristata*	12	23	36	36	37	67	16	21	101	147
brown-headed cowbird	*Molothrus ater*	2	2	6	7	5	147	0	0	13	156
brown thrasher	*Toxostoma rufum*	2	2	7	7	0	0	0	0	9	9
Carolina chickadee	*Poecile carolinensis*	1	1	2	2	1	1	4	4	8	8
Carolina wren	*Thryothorus ludovicianus*	0	0	1	1	4	4	0	0	5	5
cedar waxwing	*Bombycilla cedrorum*	0	0	5	6	1	10	0	0	6	16
chipping sparrow	*Spizella passerina*	5	5	41	43	2	6	0	0	48	54
common grackle	*Quiscalus quiscula*	9	11	31	74	2	51	0	0	42	136
common yellowthroat	*Geothlypis trichas*	0	0	3	3	0	0	0	0	3	3
dickcissel	*Spiza americana*	2	2	3	4	0	0	0	0	5	6
eastern bluebird	*Sialia sialis*	3	3	12	29	8	12	4	10	27	54
eastern kingbird	*Tyrannus tyrannus*	0	0	3	3	0	0	0	0	3	3
eastern meadowlark	*Sturnella magna*	12	13	15	26	1	3	0	0	28	42
eastern phoebe	*Sayornis phoebe*	0	0	1	1	1	1	0	0	2	2
eastern towhee	*Pipilo erythrophthalmus*	0	0	1	1	0	0	0	0	1	1
eastern wood-pewee	*Contopus virens*	0	0	6	6	0	0	0	0	6	6
European starling	*Sturnus vulgaris*	13	39	53	430	33	342	41	492	140	1303
field sparrow	*Spizella pusilla*	6	6	38	39	0	0	0	0	44	45
golden-crowned kinglet	*Regulus satrapa*	0	0	1	1	0	0	0	0	1	1
grasshopper sparrow	*Ammodramus savannarum*	0	0	2	2	0	0	0	0	2	2
gray catbird	*Dumetella carolinensis*	0	0	7	7	3	4	0	0	10	11
horned lark	*Eremophila alpestris*	56	84	75	87	56	121	47	215	234	507
house finch	*Haemorhous mexicanus*	1	1	3	3	3	3	0	0	7	7
house sparrow	*Passer domesticus*	6	6	31	41	10	31	4	53	51	131
house wren	*Troglodytes aedon*	0	0	7	8	0	0	0	0	7	8
indigo bunting	*Passerina cyanea*	0	0	32	33	0	0	0	0	32	33
Lapland longspur	*Calcarius lapponicus*	0	0	0	0	0	0	1	2	1	2

Appendix A. Summary[1] of individual and group observations for all seasons by species and bird type for 10-minute fixed-point count small bird use surveys conducted at the Big Blue River Wind Project from December 3, 2015 to November 29, 2016.

		Spring		Summer		Fall		Winter		Overall	
Bird Species	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
northern cardinal	*Cardinalis cardinalis*	24	24	30	30	2	4	9	10	65	68
northern mockingbird	*Mimus polyglottos*	2	2	4	4	0	0	0	0	6	6
northern rough-winged swallow	*Stelgidopteryx serripennis*	0	0	1	4	0	0	0	0	1	4
palm warbler	*Setophaga palmarum*	0	0	2	2	2	3	0	0	4	5
red-eyed vireo	*Vireo olivaceus*	0	0	4	4	0	0	0	0	4	4
red-winged blackbird	*Agelaius phoeniceus*	53	106	96	232	23	188	4	12	176	538
Savannah sparrow	*Passerculus sandwichensis*	2	2	6	6	1	1	0	0	9	9
song sparrow	*Melospiza melodia*	21	21	67	67	4	8	2	3	94	99
tufted titmouse	*Baeolophus bicolor*	9	9	19	19	2	2	5	5	35	35
unidentified blackbird	NA	0	0	0	0	3	351	0	0	3	351
unidentified bluebird	NA	0	0	1	1	1	300	0	0	2	301
unidentified flycatcher	NA	0	0	1	1	0	0	0	0	1	1
unidentified sparrow	NA	2	2	2	3	0	0	2	4	6	9
unidentified swallow	NA	1	2	1	1	2	15	0	0	4	18
unidentified warbler	NA	0	0	1	1	1	1	0	0	2	2
vesper sparrow	*Pooecetes gramineus*	1	1	2	2	0	0	0	0	3	3
warbling vireo	*Vireo gilvus*	0	0	4	4	0	0	0	0	4	4
white-breasted nuthatch	*Sitta carolinensis*	3	3	3	3	2	2	11	11	19	19
wood thrush	*Hylocichla mustelina*	0	0	2	2	0	0	0	0	2	2
Swifts/Hummingbirds		*0*	*0*	*5*	*8*	*1*	*3*	*0*	*0*	*6*	*11*
chimney swift	*Chaetura pelagica*	0	0	5	8	1	3	0	0	6	11
Woodpeckers		*17*	*17*	*20*	*20*	*17*	*17*	*22*	*22*	*76*	*76*
downy woodpecker	*Picoides pubescens*	0	0	1	1	4	4	1	1	6	6
northern flicker	*Colaptes auratus*	1	1	7	7	9	9	5	5	22	22
pileated woodpecker	*Dryocopus pileatus*	2	2	2	2	1	1	4	4	9	9
red-bellied woodpecker	*Melanerpes carolinus*	7	7	6	6	3	3	8	8	24	24
red-headed woodpecker	*Melanerpes erythrocephalus*	2	2	3	3	0	0	1	1	6	6
unidentified woodpecker	NA	5	5	1	1	0	0	3	3	9	9
Kingfishers		*0*	*0*	*2*	*2*	*2*	*3*	*1*	*1*	*5*	*6*
belted kingfisher	*Megaceryle alcyon*	0	0	2	2	2	3	1	1	5	6
Unidentified Birds		*3*	*53*	*25*	*200*	*32*	*134*	*22*	*185*	*82*	*572*
unidentified bird (medium)	NA	0	0	0	0	0	0	1	3	1	3
unidentified bird (small)	NA	3	53	25	200	32	134	21	182	81	569
Overall	**NA**	**425**	**658**	**1,102**	**1,980**	**436**	**2,191**	**292**	**1,287**	**2,255**	**6,116**

[1]Regardless of distance from observer. Groups (grps); observations (obs).

Appendix B. Descriptive Statistics for the Species Recorded During the 60-minute Fixed-Point Count Large Bird Use Surveys conducted at the Big Blue River Wind Project in Henry County, Indiana, from December 3, 2015 to November 29, 2016

Appendix B. Summary[1] of individual and group observations for all seasons by species and bird type for 60-minute fixed-point count large bird use surveys conducted at Big Blue River Wind Project area from December 3, 2015 to November 29, 2016.

		Spring		Summer		Fall		Winter		Overall	
Bird Species	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Waterbirds		*20*	*28*	*43*	*53*	*4*	*4*	*6*	*164*	*73*	*249*
double-crested cormorant	*Phalacrocorax auritus*	0	0	0	0	1	1	0	0	1	1
great blue heron	*Ardea herodias*	20	28	42	51	3	3	0	0	65	82
green heron	*Butorides virescens*	0	0	1	2	0	0	0	0	1	2
sandhill crane	*Grus canadensis*	0	0	0	0	0	0	6	164	6	164
Waterfowl		*49*	*148*	*23*	*90*	*6*	*197*	*74*	*1302*	*152*	*1737*
blue-winged teal	*Anas discors*	1	2	0	0	0	0	0	0	1	2
Canada goose	*Branta canadensis*	27	73	10	37	6	197	48	552	91	859
canvasback	*Aythya valisineria*	1	2	0	0	0	0	0	0	1	2
mallard	*Anas platyrhynchos*	6	29	3	5	0	0	2	7	11	41
northern pintail	*Anas acuta*	0	0	0	0	0	0	1	8	1	8
snow goose	*Chen caerulescens*	0	0	0	0	0	0	1	1	1	1
unidentified duck	NA	12	38	10	48	0	0	14	286	36	372
unidentified goose	NA	0	0	0	0	0	0	5	318	5	318
unidentified waterfowl	NA	1	2	0	0	0	0	3	130	4	132
wood duck	*Aix sponsa*	1	2	0	0	0	0	0	0	1	2
Shorebirds		*0*	*0*	*0*	*0*	*1*	*1*	*0*	*0*	*1*	*1*
killdeer	*Charadrius vociferus*	0	0	0	0	1	1	0	0	1	1
Diurnal Raptors		**78**	**89**	**118**	**128**	**95**	**111**	**147**	**179**	**438**	**507**
Accipiters		*7*	*8*	*9*	*9*	*9*	*9*	*9*	*9*	*34*	*35*
Cooper's hawk	*Accipiter cooperii*	6	7	5	5	5	5	2	2	18	19
sharp-shinned hawk	*Accipiter striatus*	0	0	2	2	2	2	1	1	5	5
unidentified accipiter	*Accipiter spp*	1	1	2	2	2	2	6	6	11	11
Buteos		*51*	*60*	*67*	*73*	*38*	*44*	*66*	*89*	*222*	*266*
red-shouldered hawk	*Buteo lineatus*	0	0	1	2	3	3	0	0	4	5
red-tailed hawk	*Buteo jamaicensis*	44	52	66	71	28	32	48	61	186	216
unidentified buteo	*Buteo sp*	7	8	0	0	7	9	18	28	32	45
Northern Harrier		*2*	*2*	*1*	*1*	*13*	*14*	*11*	*11*	*27*	*28*
northern harrier	*Circus cyaneus*	2	2	1	1	13	14	11	11	27	28
Eagles		*0*	*0*	*2*	*2*	*1*	*1*	*2*	*2*	*5*	*5*
bald eagle	*Haliaeetus leucocephalus*	0	0	2	2	1	1	2	2	5	5

Appendix B. Summary[1] of individual and group observations for all seasons by species and bird type for 60-minute fixed-point count large bird use surveys conducted at Big Blue River Wind Project area from December 3, 2015 to November 29, 2016.

		Spring		Summer		Fall		Winter		Overall	
Bird Species	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Falcons		*8*	*9*	*22*	*25*	*25*	*31*	*16*	*18*	*71*	*83*
American kestrel	*Falco sparverius*	8	9	22	25	24	30	15	17	69	81
merlin	*Falco columbarius*	0	0	0	0	1	1	0	0	1	1
unidentified falcon	*Falco sp*	0	0	0	0	0	0	1	1	1	1
Osprey		*0*	*0*	*1*	*1*	*0*	*0*	*0*	*0*	*1*	*1*
osprey	*Pandion haliaetus*	0	0	1	1	0	0	0	0	1	1
Other Raptors		*10*	*10*	*16*	*17*	*9*	*12*	*43*	*50*	*78*	*89*
unidentified hawk	NA	2	2	7	8	2	2	1	1	12	13
unidentified raptor	NA	8	8	9	9	7	10	42	49	66	76
Vultures		*65*	*102*	*103*	*176*	*96*	*234*	*3*	*3*	*267*	*515*
turkey vulture	*Cathartes aura*	65	102	103	176	96	234	3	3	267	515
Upland Game Birds		*0*	*0*	*5*	*5*	*1*	*1*	*0*	*0*	*6*	*6*
northern bobwhite	*Colinus virginianus*	0	0	5	5	1	1	0	0	6	6
Doves/Pigeons		*0*	*0*	*0*	*0*	*2*	*11*	*0*	*0*	*2*	*11*
rock pigeon	*Columba livia*	0	0	0	0	2	11	0	0	2	11
Large Corvids		*0*	*0*	*0*	*0*	*4*	*26*	*3*	*13*	*7*	*39*
American crow	*Corvus brachyrhynchos*	0	0	0	0	4	26	3	13	7	39
Woodpeckers		*0*	*0*	*0*	*0*	*1*	*1*	*1*	*1*	*2*	*2*
northern flicker	*Colaptes auratus*	0	0	0	0	1	1	0	0	1	1
pileated woodpecker	*Dryocopus pileatus*	0	0	0	0	0	0	1	1	1	1
Overall		**212**	**367**	**292**	**452**	**210**	**586**	**234**	**1,662**	**948**	**3,067**

[1]Regardless of distance from observer. Groups (grps); observations (obs).

Appendix C. North American Fatality Summary Table

Appendix C. All bird and raptor mortality estimates (birds per megawatt [MW] per year) and habitat types for North American wind energy facilities.

Project	All Bird Mortalities (birds/MW/ year)	Raptor Mortalities (raptors/MW/ year)	Predominant Habitat Type	Citation
Alite, CA (2009-2010)	0.55	0.12	Shrub/scrub & grassland	Chatfield et al. 2010b
Alta Wind I, CA (2011-2012)	7.07	0.27	Woodland, grassland, shrubland	Chatfield et al. 2012
Alta Wind I-V, CA (2013-2014)	7.8	0.08	NA	Chatfield et al. 2014
Alta Wind II-V, CA (2011-2012)	1.66	0.05	Desert scrub	Chatfield et al. 2012
Alta VIII, CA (2012-2013)	0.66	0.02	Grassland and riparian	Chatfield and Bay 2014
Barton I & II, IA (2010-2011)	5.5	0	Agriculture	Derby et al. 2011a
Barton Chapel, TX (2009-2010)	1.15	0.25	Agriculture/forest	WEST 2011
Beech Ridge, WV (2012)	1.19	0.01	Forest	Tidhar et al. 2013b
Beech Ridge, WV (2013)	1.48	0.01	Forest	Young et al. 2014b
Big Blue, MN (2013)	0.6	0	Agriculture	Fagen Engineering 2014
Big Blue, MN (2014)	0.37	0	Agriculture	Fagen Engineering 2015
Big Horn, WA (2006-2007)	2.54	0.11	Agriculture/grassland	Kronner et al. 2008
Big Smile, OK (2012-2013)	0.09	0	Grassland, agriculture	Derby et al. 2013b
Biglow Canyon, OR (Phase I; 2008)	1.76	0.03	Agriculture/grassland	Jeffrey et al. 2009a
Biglow Canyon, OR (Phase I; 2009)	2.47	0	Agriculture/grassland	Enk et al. 2010
Biglow Canyon, OR (Phase II; 2009-2010)	5.53	0.14	Agriculture	Enk et al. 2011a
Biglow Canyon, OR (Phase II; 2010-2011)	2.68	0.03	Grassland/shrub-steppe, agriculture	Enk et al. 2012b
Biglow Canyon, OR (Phase III; 2010-2011)	2.28	0.05	Grassland/shrub-steppe, agriculture	Enk et al. 2012a
Blue Sky Green Field, WI (2008; 2009)	7.17	0	Agriculture	Gruver et al. 2009
Buffalo Gap I, TX (2006)	1.32	0.1	Grassland	Tierney 2007
Buffalo Gap II, TX (2007-2008)	0.15	0	Forest	Tierney 2009
Buffalo Mountain, TN (2000-2003)	11.02	0	Forest	Nicholson et al. 2005
Buffalo Mountain, TN (2005)	1.1	0	Forest	Fiedler et al. 2007
Buffalo Ridge, MN (Phase I; 1996)	4.14	0	Agriculture	Johnson et al. 2000a
Buffalo Ridge, MN (Phase I; 1997)	2.51	0	Agriculture	Johnson et al. 2000a
Buffalo Ridge, MN (Phase I; 1998)	3.14	0	Agriculture	Johnson et al. 2000a
Buffalo Ridge, MN (Phase I; 1999)	1.43	0.47	Agriculture	Johnson et al. 2000a
Buffalo Ridge, MN (Phase II; 1998)	2.47	0	Agriculture	Johnson et al. 2000a
Buffalo Ridge, MN (Phase II; 1999)	3.57	0	Agriculture	Johnson et al. 2000a
Buffalo Ridge, MN (Phase III; 1999)	5.93	0	Agriculture	Johnson et al. 2000a
Buffalo Ridge I, SD (2009-2010)	5.06	0.2	Agriculture/grassland	Derby et al. 2010c
Buffalo Ridge II, SD (2011-2012)	1.99	0	Agriculture, grassland	Derby et al. 2012a
Casselman, PA (2008)	1.51	0	Forest	Arnett et al. 2009b
Casselman, PA (2009)	2.88	0	Forest, pasture, grassland	Arnett et al. 2010

Appendix C. All bird and raptor mortality estimates (birds per megawatt [MW] per year) and habitat types for North American wind energy facilities.

Project	All Bird Mortalities (birds/MW/ year)	Raptor Mortalities (raptors/MW/ year)	Predominant Habitat Type	Citation
Cedar Ridge, WI (2009)	6.55	0.18	Agriculture	BHE Environmental 2010
Cedar Ridge, WI (2010)	3.72	0.13	Agriculture	BHE Environmental 2011
Cohocton/Dutch Hill, NY (2009)	1.39	0	Agriculture/forest	Stantec 2010
Cohocton/Dutch Hills, NY (2010)	1.32	0.08	Agriculture, forest	Stantec 2011a
Combine Hills, OR (Phase I; 2004-2005)	2.56	0	Agriculture/grassland	Young et al. 2006
Combine Hills, OR (2011)	2.33	0.05	Grassland/shrub-steppe, agriculture	Enz et al. 2012
Criterion, MD (2011)	6.4	0.02	Forest, agriculture	Young et al. 2012a
Criterion, MD (2012)	2.14	NA	Forest, agriculture	Young et al. 2013
Criterion, MD (2013)	3.49	NA	Forest, agriculture	Young et al. 2014a
Diablo Winds, CA (2005-2007)	4.29	0.4	NA	WEST 2006, 2008
Dillon, CA (2008-2009)	4.71	0	Desert	Chatfield et al. 2009
Dry Lake I, AZ (2009-2010)	2.02	0	Desert grassland/forested	Thompson et al. 2011
Dry Lake II, AZ (2011-2012)	1.57	0	Desert grassland/forested	Thompson and Bay 2012
Elkhorn, OR (2008)	0.64	0.06	Shrub/scrub & agriculture	Jeffrey et al. 2009b
Elkhorn, OR (2010)	1.95	0.08	Shrub/scrub & agriculture	Enk et al. 2011b
Elm Creek, MN (2009-2010)	1.55	0	Agriculture	Derby et al. 2010d
Elm Creek II, MN (2011-2012)	3.64	0	Agriculture, grassland	Derby et al. 2012b
Foote Creek Rim, WY (Phase I; 1999)	3.4	0.08	Grassland	Young et al. 2003c
Foote Creek Rim, WY (Phase I; 2000)	2.42	0.05	Grassland	Young et al. 2003c
Foote Creek Rim, WY (Phase I; 2001-02)	1.93	0	Grassland	Young et al. 2003c
Fowler I, IN (2009)	2.83	0	Agriculture	Johnson et al. 2010a
Goodnoe, WA (2009-2010)	1.4	0.17	Grassland and shrub-steppe	URS Corporation 2010a
Grand Ridge I, IL (2009-2010)	0.48	0	Agriculture	Derby et al. 2010h
Harvest Wind, WA (2010-2012)	2.94	0.23	Grassland/shrub-steppe	Downes and Gritski 2012a
Hay Canyon, OR (2009-2010)	2.21	0	Agriculture	Gritski and Kronner 2010a
High Sheldon, NY (2010)	1.76	0.06	Agriculture	Tidhar et al. 2012a
High Sheldon, NY (2011)	1.57	0	Agriculture	Tidhar et al. 2012b
High Winds, CA (2003-2004)	1.62	0.5	Agriculture/grassland	Kerlinger et al. 2006
High Winds, CA (2004-2005)	1.1	0.28	Agriculture/grassland	Kerlinger et al. 2006
Hopkins Ridge, WA (2006)	1.23	0.14	Agriculture/grassland	Young et al. 2007a
Hopkins Ridge, WA (2008)	2.99	0.07	Agriculture/grassland	Young et al. 2009c
Kewaunee County, WI (1999-2001)	1.95	0	Agriculture	Howe et al. 2002
Kittitas Valley, WA (2011-2012)	1.06	0.09	Sagebrush-steppe, grassland	Stantec Consulting Services 2012

Appendix C. All bird and raptor mortality estimates (birds per megawatt [MW] per year) and habitat types for North American wind energy facilities.

Project	All Bird Mortalities (birds/MW/ year)	Raptor Mortalities (raptors/MW/ year)	Predominant Habitat Type	Citation
Klondike, OR (2002-2003)	0.95	0	Agriculture/grassland	Johnson et al. 2003
Klondike II, OR (2005-2006)	3.14	0.06	Agriculture/grassland	NWC and WEST 2007
Klondike III (Phase I), OR (2007-2009)	3.02	0.15	Agriculture/grassland	Gritski et al. 2010
Klondike IIIa (Phase II), OR (2008-2010)	2.61	0.06	Grassland/shrub-steppe and agriculture	Gritski et al. 2011
Leaning Juniper, OR (2006-2008)	6.66	0.16	Agriculture	Gritski et al. 2008
Lempster, NH (2009)	3.38	0	Grasslands/forest/rocky embankments	Tidhar et al. 2010
Lempster, NH (2010)	2.64	0	Grasslands/forest/rocky embankments	Tidhar et al. 2011
Linden Ranch, WA (2010-2011)	6.65	0.27	Grassland/shrub-steppe, agriculture	Enz and Bay 2011
Locust Ridge, PA (Phase II; 2009)	0.84	0	Grassland	Arnett et al. 2011
Locust Ridge, PA (Phase II; 2010)	0.76	0	Grassland	Arnett et al. 2011
Maple Ridge, NY (2007)	2.34	NA	Agriculture/forested	Jain et al. 2009a
Maple Ridge, NY (2007-2008)	2.07	0.03	Agriculture/forested	Jain et al. 2009d
Marengo I, WA (2009-2010)	0.27	0	Agriculture	URS Corporation 2010b
Marengo II, WA (2009-2010)	0.16	0.05	Agriculture	URS Corporation 2010c
Mars Hill, ME (2007)	1.67	0	Forest	Stantec 2008
Mars Hill, ME (2008)	1.76	0	Forest	Stantec 2009a
Milford I, UT (2010-2011)	0.56	NA	Desert shrub	Stantec 2011b
Milford I & II, UT (2011-2012)	0.73	0.04	Desert shrub	Stantec 2012b
Montezuma I, CA (2011)	5.19	1.06	Agriculture and grasslands	ICF International 2012
Montezuma I, CA (2012)	8.91	0.79	Agriculture and grasslands	ICF International 2013
Montezuma II, CA (2012-2013)	1.08	0.46	Agriculture	Harvey & Associates 2013
Moraine II, MN (2009)	5.59	0.37	Agriculture/grassland	Derby et al. 2010e
Mount Storm, WV (2009)	3.85	0	Forest	Young et al. 2009a, 2010b
Mount Storm, WV (2010)	2.6	0.1	Forest	Young et al. 2010a, 2011b
Mount Storm, WV (2011)	4.24	0.03	Forest	Young et al. 2011a, 2012b
Mountaineer, WV (2003)	2.69	0.07	Forest	Kerns and Kerlinger 2004
Munnsville, NY (2008)	1.48	0.59	Agriculture/forest	Stantec 2009b
Mustang Hills, CA (2012-2013)	1.66	0.08	Grasslands and riparian	Chatfield and Bay 2014
Nine Canyon, WA (2002-2003)	2.76	0.03	Agriculture/grassland	Erickson et al. 2003c
Noble Altona, NY (2010)	1.84	0	Forest	Jain et al. 2011b
Noble Bliss, NY (2008)	1.3	0.1	Agriculture/forest	Jain et al. 2009e
Noble Bliss, NY (2009)	2.28	0.12	Agriculture/forest	Jain et al. 2010a
Noble Chateaugay, NY (2010)	1.66	0.08	Agriculture	Jain et al. 2011c

Appendix C. All bird and raptor mortality estimates (birds per megawatt [MW] per year) and habitat types for North American wind energy facilities.

Project	All Bird Mortalities (birds/MW/ year)	Raptor Mortalities (raptors/MW/ year)	Predominant Habitat Type	Citation
Noble Clinton, NY (2008)	1.59	0.1	Agriculture/forest	Jain et al. 2009c
Noble Clinton, NY (2009)	1.11	0.16	Agriculture/forest	Jain et al. 2010b
Noble Ellenburg, NY (2008)	0.83	0.11	Agriculture/forest	Jain et al. 2009b
Noble Ellenburg, NY (2009)	2.66	0.25	Agriculture/forest	Jain et al. 2010c
Noble Wethersfield, NY (2010)	1.7	0.13	Agriculture	Jain et al. 2011a
NPPD Ainsworth, NE (2006)	1.63	0.06	Agriculture/grassland	Derby et al. 2007
Palouse Wind, WA (2012-2013)	0.72	NA	Agriculture and grasslands	Stantec 2013a
Pebble Springs, OR (2009-2010)	1.93	0.04	Grassland	Gritski and Kronner 2010b
Pine Tree, CA (2009-2010, 2011)	17.44	NA	Grassland	BioResource Consultants 2012
Pinnacle, WV (2012)	3.99	0	Forest	Hein et al. 2013
Pinyon Pines I & II, CA (2013-2014)	1.18	NA	NA	Chatfield and Russo 2014
Pioneer Prairie I, IA (Phase II; 2011-2012)	0.27	0	Agriculture, grassland	Chodachek et al. 2012
PrairieWinds ND1 (Minot), ND (2010)	1.48	0.05	Agriculture	Derby et al. 2011c
PrairieWinds ND1 (Minot), ND (2011)	1.56	0.05	Agriculture, grassland	Derby et al. 2012c
PrairieWinds SD1, SD (2011-2012)	1.41	0	Grassland	Derby et al. 2012d
PrairieWinds SD1, SD (2012-2013)	2.01	0.03	Grassland	Derby et al. 2013a
PrairieWinds SD1, SD (2013-2014)	1.66	0.17	Grassland	Derby et al. 2014
Rail Splitter, IL (2012-2013)	0.84	0	Agriculture	Good et al. 2013b
Record Hill, ME (2012)	3.7	NA	Forest	Stantec 2013b
Record Hill, ME (2014)	1.84	NA	Forest	Stantec 2015
Red Hills, OK (2012-2013)	0.08	0.04	Grassland	Derby et al. 2013c
Ripley, Ont (2008)	3.09	0.1	Agriculture	Jacques Whitford 2009
Rollins, ME (2012)	2.9	NA	Forest	Stantec 2013c
Rugby, ND (2010-2011)	3.82	0.06	Agriculture	Derby et al. 2011b
Shiloh I, CA (2006-2009)	6.96	0.42	Agriculture/grassland	Kerlinger et al. 2009
Shiloh II, CA (2009-2010)	1.9	0.11	Agriculture	Kerlinger et al. 2010, 2013a
Shiloh II, CA (2010-2011)	2.8	0.44	Agriculture	Kerlinger et al. 2013a
Shiloh III, CA (2012-2013)	3.3	NA	NA	Kerlinger et al. 2013b
Solano III, CA (2012-2013)	1.6	0.95	NA	AECOM 2013
Stateline, OR/WA (2001-2002)	3.17	0.09	Agriculture/grassland	Erickson et al. 2004
Stateline, OR/WA (2003)	2.68	0.09	Agriculture/grassland	Erickson et al. 2004
Stateline, OR/WA (2006)	1.23	0.11	Agriculture/grassland	Erickson et al. 2007
Stetson Mountain I, ME (2009)	2.68	0	Forest	Stantec 2009c
Stetson Mountain I, ME (2011)	1.18	0	Forest	Normandeau Associates 2011

Appendix C. All bird and raptor mortality estimates (birds per megawatt [MW] per year) and habitat types for North American wind energy facilities.

Project	All Bird Mortalities (birds/MW/ year)	Raptor Mortalities (raptors/MW/ year)	Predominant Habitat Type	Citation
Stetson Mountain I, ME (2013)	6.95	0	Forest	Stantec 2014
Stetson Mountain II, ME (2010)	1.42	0	Forest	Normandeau Associates 2010
Stetson Mountain II, ME (2012)	3.37	0	Forest	Stantec 2013e
Summerview, Alb (2005-2006)	1.06	0.11	Agriculture	Brown and Hamilton 2006b
Top Crop I & II (2012-2013)	0.6	NA	Agriculture	Good et al. 2013a
Top of Iowa, IA (2003)	0.42	0	Agriculture	Jain 2005
Top of Iowa, IA (2004)	0.81	0.17	Agriculture	Jain 2005
Tuolumne (Windy Point I), WA (2009-2010)	3.2	0.29	Grassland/shrub-steppe, agriculture and forest	Enz and Bay 2010
Vansycle, OR (1999)	0.95	0	Agriculture/grassland	Erickson et al. 2000
Vantage, WA (2010-2011)	1.27	0.29	Shrub-steppe, grassland	Ventus Environmental Solutions 2012
Wessington Springs, SD (2009)	8.25	0.06	Grassland	Derby et al. 2010g
Wessington Springs, SD (2010)	0.89	0.07	Grassland	Derby et al. 2011d
White Creek, WA (2007-2011)	4.05	0.47	Grassland/shrub-steppe, agriculture	Downes and Gritski 2012b
Wild Horse, WA (2007)	1.55	0.09	Grassland	Erickson et al. 2008
Windy Flats, WA (2010-2011)	8.45	0.04	Grassland/shrub-steppe, agriculture	Enz et al. 2011
Winnebago, IA (2009-2010)	3.88	0.27	Agriculture/grassland	Derby et al. 2010f

Appendix D. Studies at North American Wind Energy Facilities that have Reported Species Composition of Bird Fatalities

Appendix D. Summary of publicly available studies at modern North American wind energy facilities that report fatality and species data for birds.

Data from the following sources:

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

Appendix D. Summary of publicly available studies at modern North American wind energy facilities that report fatality and species data for birds.

Data from the following sources:

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