The logo for SWCA (Southwest Consulting & Associates) is positioned vertically on the left side of the page. It consists of the letters 'S', 'W', 'C', and 'A' stacked vertically in a large, light blue, serif font. The letters are partially cut off at the top and bottom edges of the page.

Avian Use Survey Report for the Proposed Crowned Ridge I Wind Facility, Grant and Codington Counties, South Dakota

November 2018

PREPARED FOR

Crowned Ridge Wind, LLC

PREPARED BY

SWCA Environmental Consultants

**AVIAN USE SURVEY REPORT FOR THE
PROPOSED CROWNED RIDGE I WIND FACILITY,
GRANT AND CODINGTON COUNTIES, SOUTH DAKOTA**

Prepared for

Crowned Ridge Wind, LLC
700 Universe Blvd
Juno Beach Florida, 33408

Prepared by

SWCA Environmental Consultants
116 North 4th Street, Suite 200
Bismarck, North Dakota 58501
(701) 258-6622
www.swca.com

SWCA Project No. 44511

November 2018

CONTENTS

Contents	i
Figures.....	i
Tables.....	i
1 Introduction	1
2 Methods	1
2.1 Large Bird Use Surveys.....	1
2.2 Small Bird Use Surveys.....	3
3 Data Analysis	3
4 Results	4
4.1 Large Bird Use.....	4
4.1.1 Species.....	5
4.1.2 Seasonality.....	7
4.1.3 Flight Height.....	8
4.1.4 Behavior.....	9
4.1.5 Time of Day.....	10
4.1.6 Eagle Observations.....	11
4.2 Small Bird Use.....	11
4.2.1 Species.....	12
4.2.2 Seasonality.....	14
4.2.3 Flight Height.....	16
4.2.4 Behavior and Initial Detection.....	18
4.2.5 Time of Day.....	19
4.2.6 Vegetation Type.....	19
5 Discussion	22
5.1 Large Bird Use Surveys.....	22
5.2 Small Bird Surveys.....	23
6 Literature Cited	24

Figures

Figure 1. Project location and study area showing point count survey plots.....	2
---	---

Tables

Table 1. Number and Relative Abundance of Large Bird Observations by Point Count Location.....	4
Table 2. Total Large Bird Species Composition, Abundance, and Occurrence.....	6
Table 3. Number of Large Bird Species Observations by Month.....	7
Table 4. Number of Large Bird Observations Per Flight Height Bin.....	8
Table 5. Number and Frequency of Large Bird Observations Per Type of Behavior.....	10
Table 6. Number of Large Bird Observations and Surveys by Hour Per Month.....	10
Table 7. Number and Relative Abundance of Small Bird Observations Per Point Count Location.....	11
Table 8. Total Small Bird Species Composition, Abundance, and Occurrence.....	13
Table 9. Number of Small Bird Observations by Month.....	15
Table 10. Number of Small Bird Observations Per Flight Height Bin.....	16
Table 11. Number and Frequency of Small Bird Observations Per Type of Behavior.....	18
Table 12. Number of Small Bird Observations and Surveys by Hour Per Month.....	19

Table 13. Habitat Type, Number of Species, and Number of Observations Per Point Count Location 19
Table 14. Number of Observations per Species per Habitat Type 21

1 INTRODUCTION

Crowned Ridge Wind, LLC, an indirect, wholly owned subsidiary of NextEra Energy Resources, LLC, plans to develop an approximately 300-megawatt (-MW) wind facility known as the Crowned Ridge I Wind Energy Facility (the project) in Grant and Codington Counties, South Dakota. The project will produce energy sold to Xcel Energy through a power purchase agreement. A new transmission line will be constructed to connect the wind facility to Otter Tail Power's Big Stone South 230-kilovolt (-kV) substation near Big Stone City, South Dakota. Construction is anticipated to commence in early 2019, and the Project is scheduled to achieve commercial operation at or before the end of 2019. This report addresses the study area comprising approximately 58,548 acres of land as provided to SWCA on March 21, 2017.

Crowned Ridge Wind, LLC, contracted SWCA Environmental Consultants (SWCA) to conduct large and small bird use surveys in the study area. The objectives of the surveys were to characterize the activity, spatial distribution, and relative abundance of avian species in the study area. This report summarizes the methods and results of large and small bird use surveys conducted from April 1, 2017, through November 30, 2017, in the study area.

2 METHODS

2.1 Large Bird Use Surveys

SWCA developed the large bird use survey protocols in accordance with recommendations set forth in the U.S. Fish and Wildlife Service's (USFWS's) *Land-Based Wind Energy Guidelines* (USFWS 2012) and *Eagle Conservation Plan Guidance Module 1 – Land-based Wind Energy Version 2* (ECPG) (USFWS 2013). The purpose of these studies is to characterize the activity, spatial distribution, and relative abundance of diurnal raptors and other large bird species using the study area. The survey data is useful to identify potential high-use areas in the study area that may be avoided during project design to avoid and minimize potential risk to large birds.

Large birds generally are defined as those the size of waterfowl or larger and include raptors, vultures, waterfowl, herons, pelicans, and corvids. Federally listed species, state-listed species, and large flocks of small birds also were considered target groups during large bird use surveys.

SWCA used a spatially balanced sampling design to establish 29 circular point count locations, each with a survey area of 800 meters (m) (2,625 feet) in radius, throughout the study area provided by the proponent on March 21, 2017 (Figure 1). This sampling method captures the variability in habitat and vegetation conditions, topography, and potential turbine numbers and densities within the study area. These locations allowed for more than 30% survey coverage of the study area, exceeding recommendations in the ECPG (USFWS 2013). Point count locations were micro-sited in the field to minimize obstructed views of the surrounding terrain and corresponding airspace.

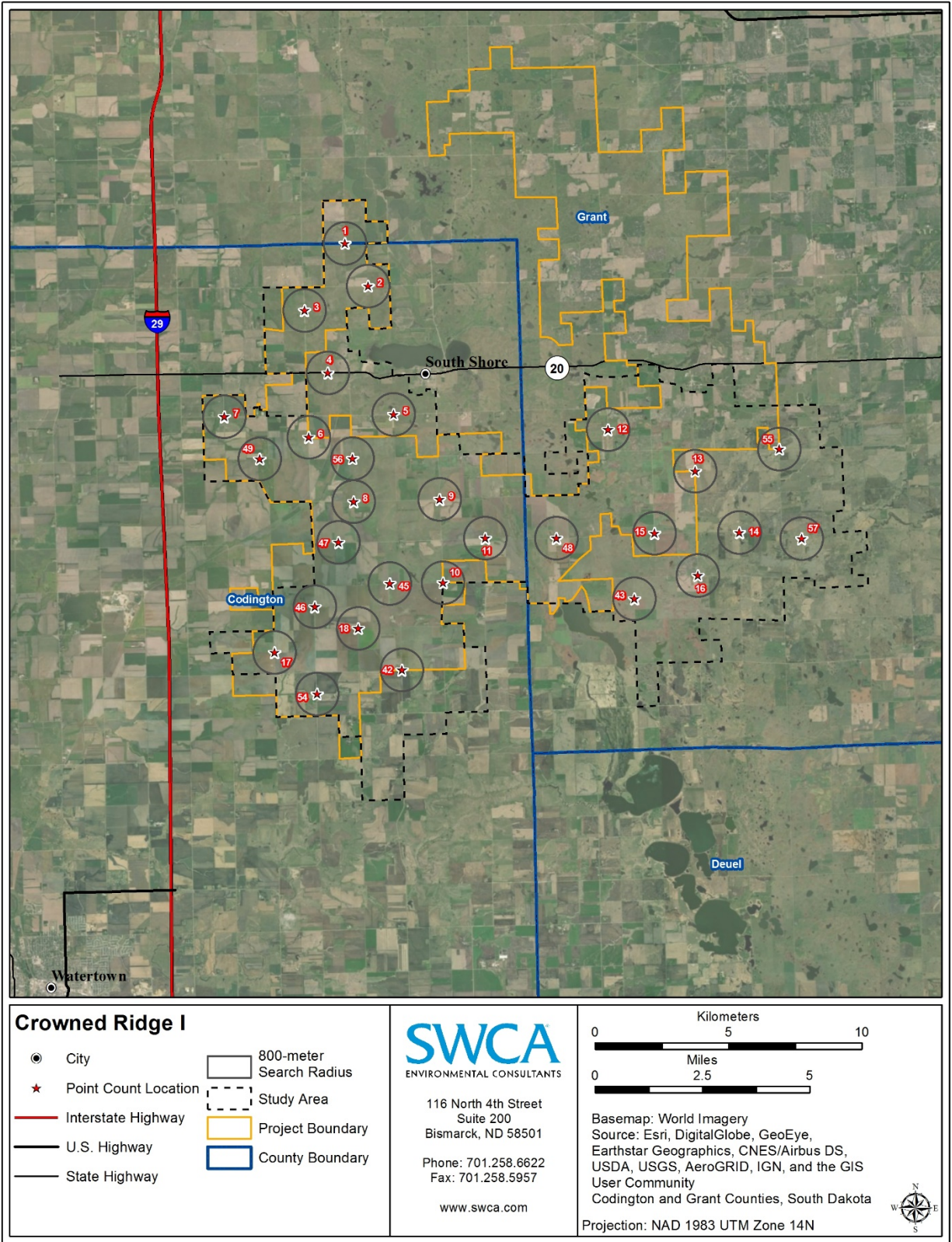


Figure 1. Project location and study area showing point count survey plots.

SWCA completed surveys of each of the 29 point count locations once a month for 8 months (232 surveys total for the project). The surveys lasted for 1 hour per survey date at each of the 29 point count locations, in accordance with ECPG guidance (USFWS 2013: Technical Appendix C). The schedule was designed and implemented to provide survey coverage across all hours for each of the point count locations in accordance with ECPG guidance. The schedule also was designed such that multiple large bird use surveys conducted on any given day were separated spatially to increase the likelihood of independent observations.

SWCA collected the following data for each large bird observation within the 800-m-radius survey areas: species, age, sex, number of individuals, distance to bird(s), azimuth to bird(s), estimated flight height within three bins (0–30 m [0–98 feet], 30–200 m [98–656 feet], and 200+ m [656+ feet]), flight direction, beginning and ending time of presence within the point count location, flight time (recorded as number of seconds), behavioral activity, and interactions with other birds. SWCA also collected flight pathway information per recommendations in Strickland et al. (2011) and the ECPG (USFWS 2013). Flight pathway data were collected for raptor species. Flight pathways within the point count location 800m survey area were digitally recorded using ArcGIS Collector software. This software allowed biologists to record the flight path as a spatial data layer, which overlaid aerial imagery displaying relevant landforms in each survey area. The data was uploaded and analyzed using geographic information system (GIS) software.

2.2 Small Bird Use Surveys

SWCA developed the small bird use survey protocols in accordance with recommendations set forth in the USFWS's *Land-Based Wind Energy Guidelines* (USFWS 2012). The purpose of small bird use surveys is to characterize the activity, spatial distribution, and relative abundance of passerine and other small bird species using the study area. To understand small bird use in the study area across all daylight hours, SWCA conducted small bird point count surveys in conjunction with the large bird use surveys.

Small birds generally are defined as those smaller in size than a crow and include passerine species. Federally listed species, state-listed species, and large flocks of small birds also were considered target groups during small bird use surveys. The small bird use surveys were conducted at the same point count locations as the large bird use surveys (see Figure 1). The biologists recorded all birds detected within a 100-m-radius (328-foot-radius) of each location for 10 minutes before beginning the large bird use surveys.

SWCA collected the following data for each observation made during the small bird use surveys: species, number of observations by species, age and sex, behavior, method of detection (visual or auditory), estimated distance from the observer to each bird, time each bird or group of birds was detected within the point count location survey area, temperature, wind speed and direction, cloud cover, and precipitation. In addition, the biologists recorded large bird species observed outside of the 100-m-radius survey areas as incidental observations during the small bird surveys.

3 DATA ANALYSIS

Data collected during the large bird use surveys allow for robust analysis of large bird use in the study area. Analysis of these data provides the following metrics: species composition, diversity, and abundance; relative abundance and frequency of observations per guild and species; eagle and raptor use (number of observations/60-minute-survey/800-m-radius survey plot) and minutes (eagle flight minutes within 800-m-radius survey plot up to 200 m [656 feet] in height); large bird use (large bird observations/survey period/800-m-radius survey plot); comparisons of use below, in, and above the rotor swept area; vegetation type near observations; and notable behavior or flight patterns. In addition, analysis has the potential to identify potential high-use areas in the study area that may be avoided during project design to avoid or minimize the potential risk to birds.

The small bird point count survey data were analyzed to measure different indices of abundance for the project. Analysis of small bird use survey data provides the following metrics: species composition, diversity, and abundance; frequency of observations per guild and species; small bird use (number of observations/8-minute survey/100-m-radius survey plot); comparisons of use below, in, and above the rotor-swept area; and notable behavior patterns observed during the survey. Small bird use also was compared between seasons to understand the relative use by individuals and species between seasons.

4 RESULTS

4.1 Large Bird Use

SWCA performed 232 surveys across the 29 point count locations in the study area from April 1, 2017, through November 30, 2017. In total, large bird use surveys were conducted for 13,920 survey minutes (232 survey hours). The survey efforts were evenly distributed across the 29 point count locations. All point count locations were surveyed for 60 minutes monthly for 8 months.

No large birds were observed during 86 (37.1%) of the 232 surveys. During the remaining 146 surveys, SWCA recorded 356 large bird observations (Table 1). The number of observations per point count locations ranged from three to 26 (mean = 12.3, standard deviation = 6.9). Relative abundance (i.e., the percentage of total large bird observations made at an individual point count location) ranged from 1.1% to 7.3% (see Table 1).

Table 1. Number and Relative Abundance of Large Bird Observations by Point Count Location

Point Count Location	Number of Observations	Relative Abundance*
CR01	9	2.5
CR02	18	5.1
CR03	17	4.8
CR04	14	3.9
CR05	26	7.3
CR06	10	2.8
CR07	10	2.8
CR08	9	2.5
CR09	11	3.1
CR10	22	6.2
CR11	12	3.4
CR12	13	3.7
CR13	13	3.7
CR14	26	7.3
CR15	23	6.5
CR16	25	7.0
CR17	6	1.7
CR18	8	2.2

Point Count Location	Number of Observations	Relative Abundance*
CR42	4	1.1
CR43	8	2.2
CR45	15	4.2
CR46	3	0.8
CR47	7	2.0
CR48	11	3.1
CR49	8	2.2
CR54	6	1.7
CR55	9	2.5
CR56	6	1.7
CR57	7	2.0
Total	356	100.0

* Relative abundance is expressed as the percentage of total large bird observations (n=356) recorded at an individual point count location.

4.1.1 Species

The 356 large bird observations consisted of 35 species (Table 2). Twelve raptor species were recorded: American kestrel (*Falco sparverius*), Cooper's hawk (*Accipiter cooperii*), ferruginous hawk (*Buteo regalis*), merlin (*Falco columbarius*), northern harrier (*Circus cyaneus*), peregrine falcon (*Falco peregrinus*), prairie falcon (*Falco mexicanus*), rough-legged hawk (*Buteo lagopus*), red-shouldered hawk (*Buteo lineatus*), red-tailed hawk (*Buteo jamaicensis*), sharp-shinned hawk (*Accipiter striatus*), and Swainson's hawk (*Buteo swainsoni*).

The 23 non-raptor species recorded were American crow (*Corvus brachyrhynchos*), American white pelican (*Pelecanus erythrorhynchos*), blue-winged teal (*Spatula discors*), California gull (*Larus californicus*), Canada goose (*Branta canadensis*), double-crested cormorant (*Phalacrocorax auritus*), Franklin's gull (*Leucophaeus pipixcan*), gadwall (*Mareca strepera*), great blue heron (*Ardea herodias*), great egret (*Ardea alba*), greater prairie-chicken (*Tympanuchus cupido*), greater yellowlegs (*Tringa melanoleuca*), marbled godwit (*Limosa fedoa*), mallard (*Anas platyrhynchos*), northern pintail (*Anas acuta*), ring-billed gull (*Larus delawarensis*), ring-necked pheasant (*Phasianus colchicus*), snow goose (*Chen caerulescens*), sharp-tailed grouse (*Tympanuchus phasianellus*), turkey vulture (*Cathartes aura*), Wilson's snipe (*Gallinago delicata*), wild turkey (*Meleagris gallopavo*), and wood duck (*Aix sponsa*).

Northern harrier (*Circus cyaneus*) and red-tailed hawk (*Buteo jamaicensis*) each accounted for 50 observations (14.0% of total observations). Swainson's hawk (*Buteo swainsoni*) accounted for nine observations (2.5% of total observations), and American kestrel (*Falco sparverius*) accounted for six observations (1.7% of total observations). Collectively, these four species accounted for 115 observations (32.3% of total observations).

SWCA recorded northern harrier during 36 of the 232 surveys (15.5% of total surveys), red-tailed hawk during 36 surveys (15.5% of total surveys), Swainson's hawk during six surveys (2.6% of total surveys), and American kestrel during five surveys (2.2% of total surveys) (see Table 2). SWCA determined the frequency of species occurrence during the 232 large bird surveys, with 19 of the 35 large bird species (54.3%) observed during more than 1% of the 232 surveys and 16 of the 35 large bird species (45.7%) observed during less than 1% of the 232 surveys.

SWCA's biologists recorded four large bird species recognized by the USFWS as birds of conservation concern (BCC) within the study area: ferruginous hawk, peregrine falcon, prairie falcon, and marbled godwit (USFWS 2008). No bald eagles (*Haliaeetus leucocephalus*) or golden eagles (*Aquila chrysaetos*) were observed within the study area. No state or federally listed species were observed.

Table 2. Total Large Bird Species Composition, Abundance, and Occurrence

Large Bird Species	Abundance*	Relative Abundance†	Number of Surveys During Which Species Was Recorded	Frequency of Occurrence‡
American crow	4	1.1	4	1.7
American kestrel	6	1.7	5	2.2
American white pelican	20	5.6	17	7.3
Blue-winged teal	2	0.6	2	0.9
California gull	1	0.3	1	0.4
Canada goose	39	11.0	35	15.1
Cooper's hawk	2	0.6	2	0.9
Double-crested cormorant	6	1.7	5	2.2
Ferruginous hawk	4	1.1	4	1.7
Franklin's gull	46	12.9	21	9.1
Gadwall	2	0.6	2	0.9
Great blue heron	3	0.8	3	1.3
Great egret	2	0.6	2	0.9
Greater prairie-chicken	1	0.3	1	0.4
Greater yellowlegs	1	0.3	1	0.4
Marbled godwit	3	0.8	2	0.9
Mallard	27	7.6	22	9.5
Merlin	3	0.8	2	0.9
Norther harrier	50	14.0	36	15.5
Peregrine falcon	1	0.3	1	0.4
Northern pintail	2	0.6	2	0.9
Prairie falcon	4	1.1	4	1.7
Ring-billed gull	21	5.9	17	7.3
Rough-legged hawk	5	1.4	3	1.3
Ring-necked pheasant	11	3.1	11	4.7
Red-shouldered hawk	1	0.3	1	0.4
Red-tailed hawk	50	14.0	36	15.5
Snow goose	2	0.6	2	0.9
Sharp-shinned hawk	1	0.3	1	0.4
Sharp-tailed grouse	1	0.3	6	2.6
Swainson's hawk	9	2.5	6	2.6
Turkey vulture	21	5.9	16	6.9

Large Bird Species	Abundance*	Relative Abundance†	Number of Surveys During Which Species Was Recorded	Frequency of Occurrence‡
Wilson's snipe	1	0.3	1	0.4
Wild turkey	3	0.8	3	1.3
Wood duck	1	0.3	1	0.4
Total	356	100	-	62.9

* Abundance = total number of observations per species.

† Relative abundance = the percentage of large bird observations (n=356) recorded at an individual point count location.

‡ Frequency = percentage of all surveys (n=232) during which the species or group was recorded.

§ The total number of surveys with at least one large bird observation (regardless of number of species) is 146.

¶ The percentage of surveys with at least one large bird or flock observation (146 of 232 = 62.9 %).

4.1.2 Seasonality

Monthly totals for large bird species observed during the study period are provided in Table 3. Large bird observations varied considerably between months, ranging from 1 to 31 observations per month. The two lowest monthly totals occurred in October and November (see Table 3).

Canada goose was the only species recorded each month. Seasonal occurrence of migratory species is evident for several species. For example, biologists recorded Swainson's hawk during the species' expected breeding season in July and migratory season in August and September. Conversely, biologists recorded rough-legged hawk (*Buteo lagopus*) only during its expected migratory and overwintering season in November.

Table 3. Number of Large Bird Species Observations by Month

Large Bird Species	2017							
	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
American crow	1	1	1	0	0	1	0	0
American kestrel	0	0	0	1	1	2	0	2
American white pelican	0	0	5	10	5	0	0	0
Blue-winged teal	0	0	0	1	1	0	0	0
California gull	0	0	0	1	0	0	0	0
Canada goose	5	6	4	2	4	4	6	8
Cooper's hawk	0	0	1	0	0	1	0	0
Double-crested cormorant	0	0	1	1	1	2	1	0
Ferruginous hawk	1	2	0	0	0	1	0	0
Franklin's gull	0	0	0	0	15	31	0	0
Gadwall	0	0	0	0	0	0	2	0
Great blue heron	0	0	1	0	1	1	0	0
Great egret	0	0	1	0	0	1	0	0
Greater prairie-chicken	0	0	0	0	0	1	0	0
Greater yellowlegs	0	0	0	0	0	1	0	0

Large Bird Species	2017							
	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Marbled godwit	0	0	3	0	0	0	0	0
Mallard	12	5	7	2	0	0	1	0
Merlin	0	0	0	0	0	0	3	0
Norther harrier	8	10	8	6	2	13	3	0
Peregrine falcon	0	0	1	0	0	0	0	0
Northern pintail	1	1	0	0	0	0	0	0
Prairie falcon	0	0	0	0	4	0	0	0
Ring-billed gull	5	0	10	6	0	0	0	0
Rough-legged hawk	0	0	0	0	0	0	0	5
Ring-necked pheasant	1	0	2	3	2	2	0	1
Red-shouldered hawk	0	0	1	0	0	0	0	0
Red-tailed hawk	8	7	1	6	10	17	1	0
Snow goose	0	0	0	0	0	0	0	2
Sharp-shinned hawk	0	0	0	0	0	1	0	0
Sharp-tailed grouse	0	1	0	0	0	0	0	0
Swainson's hawk	0	0	0	1	1	7	0	0
Turkey vulture	0	0	2	6	4	9	0	0
Wilson's snipe	0	0	0	0	0	1	0	0
Wild turkey	1	0	0	1	0	0	0	1
Wood duck	0	0	0	0	0	1	0	0
Total	43	33	49	47	51	97	17	19

4.1.3 Flight Height

The estimated flight height upon initial detection of an observation was recorded to characterize raptor use within the zone between 0 to 200 m aboveground, which the USFWS recognizes as a zone with potential for collisions between raptors and wind turbine infrastructure. Two-hundred nine flight observations out of the total flight 356 observations (58.7% of total observations) were of large birds flying within this zone (Table 4). However, 172 of the observations (48.3% of total observations) were of large birds flying below 30 m aboveground and therefore may be considered outside the rotor-swept zone for wind turbine models typically used at commercial wind energy facilities (31–200 m). A total of 147 flight observations (41.3% of total observations) were of large birds flying above 200 m aboveground. A total of 37 observations (10.4% of total observations) were of large birds flying within the rotor-swept zone.

Table 4. Number of Large Bird Observations Per Flight Height Bin

Large Bird Species	Flight Height Bin (meters)		
	0–30	31–200	>200
American crow	3	0	1
American kestrel	4	0	2
American white pelican	2	6	12

Large Bird Species	Flight Height Bin (meters)		
	0–30	31–200	>200
Blue-winged teal	2	0	0
California gull	1	0	0
Canada goose	18	2	19
Cooper's hawk	0	0	2
Double-crested cormorant	2	0	4
Ferruginous hawk	1	1	2
Franklin's gull	4	12	30
Gadwall	1	0	1
Great blue heron	1	0	2
Great egret	1	0	1
Greater prairie-chicken	1	0	0
Greater yellowlegs	0	0	1
Marbled godwit	2	0	1
Mallard	26	0	1
Merlin	2	0	1
Norther harrier	42	1	7
Peregrine falcon	0	0	1
Northern pintail	2	0	0
Prairie falcon	0	0	4
Ring-billed gull	19	0	2
Rough-legged hawk	1	0	4
Ring-necked pheasant	11	0	0
Red-shouldered hawk	0	0	1
Red-tailed hawk	15	7	28
Snow goose	0	1	1
Sharp-shinned hawk	0	0	1
Sharp-tailed grouse	1	0	0
Swainson's hawk	1	2	6
Turkey vulture	4	5	12
Wilson's snipe	1	0	0
Wild turkey	3	0	0
Wood duck	1	0	0
Total	172	37	147

4.1.4 Behavior

Large bird observations per type of behavior are provided in Table 5. Most of the observations (163 of 356; 45.8%) were of large birds exhibiting the behavior of powered flight. The biologists recorded large

birds demonstrating the behavior of circle soaring (64; 18.0%), gliding (31; 8.7%), soaring (12; 3.4%), and hovering (five; 1.4%). Eighty-one observations (22.8%) were of large birds exhibiting non-flight behavior (e.g., calling, foraging, perching).

Table 5. Number and Frequency of Large Bird Observations Per Type of Behavior

Behavior	Number of Observations	Frequency (percent)
Circle soaring	64	18.0
Gliding	31	8.7
Powered flight	163	45.8
Hovering	5	1.4
Soaring	12	3.4
Calling	13	3.7
Foraging	54	15.2
Perched	14	3.9
Total	356	100.0

4.1.5 Time of Day

SWCA's biologists conducted the surveys between 6:00 a.m. and 5:00 p.m., with hourly average number of large bird observations ranging from 1.4 to 3.6 per survey (Table 6). The biologists recorded very few observations in the early morning (6:00 a.m.) and early evening (4:00 p.m.) hours relative to other hours. The 10:00 a.m., 11:00 a.m., 12:00 p.m., and 5:00 p.m. hours were associated with an uptick in observations per survey, which averaged 3.2, 3.6, 3.4, and 3.5, respectively. Table 6 provides the total number of observations for each survey hour, number of surveys per hour, and average number of observations per survey in each hour during the study period.

Table 6. Number of Large Bird Observations and Surveys by Hour Per Month

Month	6:00 a.m.	7:00 a.m.	8:00 a.m.	9:00 a.m.	10:00 a.m.	11:00 a.m.	12:00 p.m.	1:00 p.m.	2:00 p.m.	3:00 p.m.	4:00 p.m.	5:00 p.m.
April	0	10	10	8	0	5	3	1	1	3	2	0
May	1	3	3	1	0	6	4	3	1	8	3	0
June	0	5	4	8	5	2	2	8	5	2	4	4
July	5	1	3	3	7	0	7	2	7	4	5	3
August	3	6	2	5	6	2	21	4	0	6	2	0
September	6	6	5	11	14	22	4	13	13	15	4	0
October	4	1	3	1	1	1	0	0	3	0	3	0
November	0	1	2	1	6	9	0	0	0	0	0	0
Number of observations per hour	18	29	31	34	38	47	41	31	27	33	20	7

Month	6:00 a.m.	7:00 a.m.	8:00 a.m.	9:00 a.m.	10:00 a.m.	11:00 a.m.	12:00 p.m.	1:00 p.m.	2:00 p.m.	3:00 p.m.	4:00 p.m.	5:00 p.m.
Number of surveys per hour	9	15	20	14	12	13	12	12	12	11	14	2
Average number of observations per survey	2.0	1.9	1.6	2.4	3.2	3.6	3.4	2.6	2.3	3.0	1.4	3.5

4.1.6 Eagle Observations

During the 8-month study period, the biologists did not record golden eagles, bald eagles, or any unknown eagle species as incidental or large bird observations. Thus, no areas in the study area were identified as potential high-use areas for eagles.

4.2 Small Bird Use

SWCA performed 232 surveys across the 29 point count locations in the study area from April 1, 2017, through November 30, 2017. The survey efforts were evenly distributed across the 29 point count locations. All locations were surveyed for 10 minutes per survey for eight survey sessions. The small bird use surveys took place before the large bird use surveys at each point count location.

No small birds were observed during 37 of the surveys (15.9% of total surveys). During the remaining 195 surveys, SWCA biologists recorded 644 observations (Table 7). The number of observations per point count location ranged from 11 to 44 (mean = 22.2, standard deviation = 7.9). Relative abundance (i.e., the percentage of total small bird observations made at an individual point count location) ranged from 1.7% to 6.8% (see Table 7).

Table 7. Number and Relative Abundance of Small Bird Observations Per Point Count Location

Point Count Location	Number of Observations	Relative Abundance*
CR01	22	3.4
CR02	20	3.1
CR03	29	4.5
CR04	17	2.6
CR05	19	3.0
CR06	11	1.7
CR07	39	6.1
CR08	18	2.8
CR09	17	2.6
CR10	18	2.8
CR11	14	2.2
CR12	22	3.4
CR13	15	2.3
CR14	29	4.5

Point Count Location	Number of Observations	Relative Abundance*
CR15	24	3.7
CR16	24	3.7
CR17	25	4.0
CR18	16	2.5
CR42	27	4.2
CR43	20	3.1
CR45	26	4.0
CR46	15	2.3
CR47	20	3.1
CR48	37	5.8
CR49	44	6.8
CR54	13	2.0
CR55	27	4.2
CR56	19	3.0
CR57	16	2.5
Total	644	100.0

*Relative abundance = the percentage of total small bird observations (n=644) recorded at an individual point count location.

4.2.1 Species

The 644 total small bird observations consisted of 54 species and individuals that could not be identified to species but were placed in two generic categories (unknown sparrow and unknown blackbird species) (Table 8). Western meadowlark (*Sturnella neglecta*) accounted for 113 of the 644 observations (17.5% of total observations), followed by red-winged blackbird (*Agelaius phoeniceus*) with 95 observations (14.7% of total observations), and American robin (*Turdus migratorius*) with 30 observations (4.7% total observations). Collectively, these three species accounted for 238 (36.9%) of all observations.

SWCA recorded western meadowlark during 85 of the 232 surveys (36.6% of total surveys), followed by red-winged blackbird during 62 surveys (26.7% of total surveys), and American robin during 26 surveys (11.2% of total surveys). SWCA detected the frequency of species occurrence during the 232 small bird surveys, with 34 of the 55 small bird species (61.8%) observed during more than 1% of the 232 surveys and 21 of 55 of the small bird species (38.2%) observed during less than 1% of the 232 surveys (see Table 8).

SWCA's biologists recorded four small bird species recognized by the USFWS as BCC within the study area: the chestnut-collard longspur (*Calcarius ornatus*), grasshopper sparrow (*Ammodramus savannarum*), willow flycatcher (*Empidonax traillii*), red-headed woodpecker (*Melanerpes erythrocephalus*) (USFWS 2008). No observations of federally threatened red knots occurred during the 8-month survey period.

Table 8. Total Small Bird Species Composition, Abundance, and Occurrence

Small Bird Species	Abundance*	Relative Abundance†	Number of Surveys During Which Species Was Recorded	Frequency of Occurrence‡
American goldfinch	30	4.7	25	10.8
American robin	30	4.7	26	11.2
American tree sparrow	7	1.1	7	3.0
Barn swallow	30	4.7	22	9.5
Black-billed magpie	2	0.3	2	0.9
Brown headed cowbird	28	4.3	24	10.3
Blue-headed vireo	1	0.2	1	0.4
Blue jay	5	0.8	3	1.3
Bobolink	20	3.1	14	6.0
Brewer's blackbird	12	1.9	12	5.2
Brown thrasher	2	0.3	2	0.9
Clay-colored sparrow	9	1.4	9	3.9
Cedar waxwing	4	0.6	4	1.7
Chestnut-collared longspur	2	0.3	2	0.9
Chipping sparrow	6	0.9	6	2.6
Cliff swallow	12	1.9	11	4.7
Common grackle	14	2.2	12	5.2
Common nighthawk	2	0.3	2	0.9
Common yellowthroat	2	0.3	2	0.9
Dickcissel	8	1.2	8	3.4
Downy woodpecker	2	0.3	2	0.9
Eastern kingbird	15	2.3	15	6.5
European starling	8	1.2	8	3.4
Field sparrow	3	0.5	3	1.3
Grasshopper sparrow	23	3.6	22	9.5
Horned lark	14	2.2	14	6.0
House sparrow	2	0.3	2	0.9
House wren	2	0.3	2	0.9
Killdeer	30	4.7	26	11.2
Lapland longspur	3	0.5	3	1.3
Lincoln's sparrow	1	0.2	1	0.4
Mourning dove	16	2.5	15	6.5
Northern flicker	3	0.5	3	1.3
Northern Rough-wing swallow	5	0.8	5	2.2
Orange-crowned oriole	1	0.2	1	0.4
Orchard oriole	1	0.2	1	0.4

Small Bird Species	Abundance*	Relative Abundance†	Number of Surveys During Which Species Was Recorded	Frequency of Occurrence‡
Pine warbler	1	0.2	1	0.4
Red-headed woodpecker	1	0.2	1	0.4
Rusty blackbird	1	0.2	1	0.4
Red-winged blackbird	95	14.8	62	26.7
Savannah sparrow	21	3.2	17	7.4
Sedge wren	2	0.3	2	0.9
Song sparrow	21	3.3	19	8.2
Tree swallow	5	0.8	5	2.2
Unknown sparrow spp.	3	0.5	3	1.3
Unknown blackbird spp.	2	0.3	2	0.9
Upland sandpiper	3	0.5	3	1.3
Vesper sparrow	7	1.1	7	3.0
Western kingbird	2	0.3	2	0.9
Western meadowlark	113	17.5	85	36.6
Willow flycatcher	1	0.2	1	0.4
Willet	1	0.2	1	0.4
White-rumped sandpiper	1	0.2	11	4.7
Yellow warbler	1	0.2	1	0.4
Yellow-headed blackbird	5	0.8	5	2.2
Yellow-rumped warbler	3	0.5	2	0.9
Total	644	100	195§	84.1¶

* Abundance refers to the total number of observations per species or group.

† Relative abundance is expressed as the percentage of small bird observations (n=644) recorded at an individual point count location.

‡ Frequency is expressed as the percentage of all surveys (n=232) during which the species or group was recorded.

§ The total number of surveys with at least one small bird observation (regardless of number of species) is 195 and is not the sum of individual species.

¶ The percentage of surveys with at least one small bird observation (195 of 232 = 84.1%).

4.2.2 Seasonality

Table 9 provides monthly totals for the small bird species observed across all point count locations during the study period. The total number of small bird observations per month varied considerably between months, ranging from 18 to 143. The two lowest monthly totals occurred during the late-fall and winter period in October and November (see Table 9). No species were recorded during all 8 months of the survey period; however, western meadowlark, red-winged blackbird, and horned lark were recorded during 7 of the 8 months.

Table 9. Number of Small Bird Observations by Month

Small Bird Species	2017							
	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov
American goldfinch	0	0	4	5	11	10	0	0
American robin	4	3	4	6	7	3	3	0
American tree sparrow	0	0	1	0	0	0	0	6
Barn swallow	0	4	2	10	5	9	0	0
Black-billed magpie	0	0	0	0	0	0	1	1
Brown headed cowbird	0	6	15	7	0	0	0	0
Blue-headed vireo	0	0	0	0	0	1	0	0
Blue jay	0	3	2	0	0	0	0	0
Bobolink	0	3	16	1	0	0	0	0
Brewer's blackbird	0	0	0	4	3	0	3	2
Brown thrasher	0	1	0	0	1	0	0	0
Clay-colored sparrow	0	0	1	2	2	3	1	0
Cedar waxwing	0	0	0	0	1	1	1	1
Chestnut-collared longspur	0	0	0	1	0	1	0	0
Chipping sparrow	0	2	2	2	0	0	0	0
Cliff swallow	0	2	2	6	0	2	0	0
Common grackle	1	0	4	2	5	2	0	0
Common nighthawk	0	0	1	1	0	0	0	0
Common yellowthroat	0	0	1	0	0	1	0	0
Dickcissel	0	0	1	7	0	0	0	0
Downy woodpecker	0	0	0	0	0	1	0	1
Eastern kingbird	0	0	2	6	7	0	0	0
European starling	0	0	0	2	1	5	0	0
Field sparrow	1	0	1	0	0	0	0	1
Grasshopper sparrow	0	9	4	9	1	0	0	0
Horned lark	1	1	4	3	1	3	0	1
House sparrow	0	0	0	0	1	1	0	0
House wren	0	0	0	1	0	1	0	0
Killdeer	12	7	6	4	1	0	0	0
Lapland longspur	1	0	0	0	0	0	0	2
Lincoln's sparrow	0	0	0	0	0	1	0	0
Mourning dove	0	1	2	5	2	6	0	0
Northern flicker	0	0	2	0	0	1	0	0
Northern Rough-wing swallow	0	0	0	4	1	0	0	0
Orange-crowned oriole	0	0	0	0	0	1	0	0
Orchard oriole	0	0	0	1	0	0	0	0
Pine warbler	0	0	0	1	0	0	0	0

Small Bird Species	2017							
	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov
Red-headed woodpecker	1	0	0	1	0	0	0	0
Rusty blackbird	0	0	0	0	0	1	0	0
Red-winged blackbird	29	29	24	5	3	2	3	0
Savannah sparrow	0	0	6	3	2	8	2	0
Sedge wren	0	0	1	1	0	0	0	0
Song sparrow	1	7	3	4	5	1	0	0
Tree swallow	0	3	2	0	0	0	0	0
Unknown sparrow spp.	0	0	0	1	0	0	0	0
Unknown blackbird spp.	0	0	0	0	0	4	0	0
Upland sandpiper	0	2	1	0	0	0	0	0
Vesper sparrow	0	2	1	2	2	0	0	0
Western kingbird	0	0	1	1	0	0	0	0
Western meadowlark	25	26	25	6	6	21	4	0
Willow flycatcher	0	0	0	1	0	0	0	0
Willet	0	0	0	0	1	0	0	0
White-rumped sandpiper	0	0	0	0	0	1	0	0
Yellow warbler	0	0	0	0	1	0	0	0
Yellow-headed blackbird	0	1	2	2	0	0	0	0
Yellow-rumped warbler	0	0	0	0	0	0	0	3
Total species observed/month	76	112	143	116	70	91	18	18

4.2.3 Flight Height

The estimated flight height upon initial detection of an observation was recorded to characterize small bird use within the zone between 0 to 200 m aboveground, which the USFWS recognizes as a zone with potential for collisions between avian species and wind turbine infrastructure. Eighteen flight observations of the of the total 644 flight observations (2.8% of total observations) were of small birds flying in the 31 to 200 m aboveground zone (Table 10). Most of the flight observations (625, 97.0% of total observations) were of small birds flying below 30 m and therefore may be considered outside the rotor-swept zone for wind turbine models typically used at commercial wind energy facilities (31–200 m). Only one observation of small birds flying above 200 m was made.

Table 10. Number of Small Bird Observations Per Flight Height Bin

Small Bird Species	Flight Height Bin (meters)		
	0–30	31–200	>200
American goldfinch	29	1	0
American robin	30	0	0
American tree sparrow	7	0	0
Barn swallow	28	1	1
Black-billed magpie	2	0	0

Small Bird Species	Flight Height Bin (meters)		
	0–30	31–200	>200
Brown headed cowbird	27	1	0
Blue-headed vireo	0	1	0
Blue jay	5	0	0
Bobolink	20	0	0
Brewer's blackbird	12	0	0
Brown thrasher	2	0	0
Clay-colored sparrow	9	0	0
Cedar waxwing	4	0	0
Chestnut-collared longspur	2	0	0
Chipping sparrow	6	0	0
Cliff swallow	11	1	0
Common grackle	11	3	0
Common nighthawk	2	0	0
Common yellowthroat	2	0	0
Dickcissel	8	0	0
Downy woodpecker	2	0	0
Eastern kingbird	15	0	0
European starling	8	0	0
Field sparrow	3	0	0
Grasshopper sparrow	23	0	0
Horned lark	13	1	0
House sparrow	0	2	0
House wren	2	0	0
Killdeer	30	0	0
Lapland longspur	3	0	0
Lincoln's sparrow	1	0	0
Mourning dove	16	0	0
Northern flicker	3	0	0
Northern Rough-wing swallow	5	0	0
Orange-crowned oriole	1	0	0
Orchard oriole	1	0	0
Pine warbler	1	0	0
Red-headed woodpecker	1	0	0
Rusty blackbird	0	1	0
Red-winged blackbird	95	0	0
Savannah sparrow	20	1	0
Sedge wren	1	1	0
Song sparrow	20	1	0

Small Bird Species	Flight Height Bin (meters)		
	0–30	31–200	>200
Tree swallow	5	0	0
Unknown sparrow spp.	3	0	0
Unknown blackbird spp.	2	0	0
Upland sandpiper	3	0	0
Vesper sparrow	7	0	0
Western kingbird	2	0	0
Western meadowlark	109	4	0
Willow flycatcher	1	0	0
Willet	1	0	0
White-rumped sandpiper	1	0	0
Yellow warbler	1	0	0
Yellow-headed blackbird	5	0	0
Yellow-rumped warbler	3	0	0
Total	625	18	1

4.2.4 Behavior and Initial Detection

During the small bird use surveys, the biologists recorded the method by which each bird was initially detected (visual or aural detection) and the bird’s behavior upon initial detection. Most of the observations (250 of 644, or 38.8 %) were of calling individuals (Table 11). Powered flight was the next most frequently observed behavior, totaling 206 (32.0%) of the observations. The remaining flight categories (circle soaring, gliding, hovering, and soaring) accounted for one observation. Of the 644 observations, 306 (47.5 %) were made by aural detection (e.g., singing).

Table 11. Number and Frequency of Small Bird Observations Per Type of Behavior

Behavior	Number of Observations	Frequency (percent)
Calling	250	38.8
Copulating	0	0.0
Circle Soaring	0	0.0
Displaying	2	0.3
Foraging	33	5.1
Gliding	0	0.0
Hovering	1	0.2
Perched	86	13.4
Powered flight	206	32.0
Singing	66	10.3
Total	644	100.0

4.2.5 Time of Day

The highest average number of small bird observations by hour for the 232 small bird surveys was during the 1:00 p.m. hour, which averaged 4.9 small bird observations per hour. The number of observations across hours was slightly skewed toward the morning hours of 6:00 a.m., 7:00 a.m., and 8:00 a.m., which averaged 4.8, 4.4, and 4.3 observations per survey hour, respectively, during the 8-month study. The average number of observations was evenly distributed across the remaining hours. Table 12 presents the total number of observations for each hour, the number of surveys per hour, and the average number of observations per survey in each hour during the study period.

Table 12. Number of Small Bird Observations and Surveys by Hour Per Month

Month	6 a.m.	7 a.m.	8 a.m.	9 a.m.	10 a.m.	11 a.m.	12 p.m.	1 p.m.	2 p.m.	3 p.m.	4 p.m.	5 p.m.
April	0	20	5	13	0	8	4	6	1	11	9	0
May	0	18	17	7	7	13	7	21	0	12	10	0
June	0	20	9	22	24	4	20	16	6	10	9	3
July	19	10	13	13	5	10	6	9	14	7	7	3
August	15	13	17	2	2	7	3	1	3	7	7	0
September	24	17	11	11	5	4	3	0	0	10	6	0
October	0	2	1	1	0	2	0	4	0	0	1	0
November	0	1	4	1	1	2	4	4	0	0	0	0
Number of observations per hour	58	101	77	70	44	50	47	61	24	57	49	6
Number of surveys per hour	12	23	18	19	12	17	18	20	8	16	16	2
Average number of observations per survey	4.8	4.4	4.3	3.7	3.7	2.9	2.6	4.9	3.0	3.6	3.1	3.0

4.2.6 Vegetation Type

Table 13 presents the dominant National Landcover Dataset (U.S. Geological Survey 2014) habitat type and the number of species and observations for each of the 29 100-m-radius point count locations. Biologists recorded approximately 25% more species (54) and made approximately 62.4% more observations (402) in point count locations dominated by tallgrass prairie than species (41) and observations (242) in survey plots located in an agricultural setting. Species richness based on habitat type ranged from 9 to 22 species per point count location.

Table 13. Habitat Type, Number of Species, and Number of Observations Per Point Count Location

Survey Plot	Habitat Type	Number of Species	Number of Observations
CR01	Tallgrass prairie	15	22
CR02	Tallgrass prairie	22	20
CR03	Tallgrass prairie	9	29

Survey Plot	Habitat Type	Number of Species	Number of Observations
CR04	Tallgrass prairie	10	17
CR05	Tallgrass prairie	8	19
CR06	Agriculture	9	11
CR07	Agriculture	18	39
CR08	Tallgrass prairie	10	18
CR09	Tallgrass prairie	14	17
CR10	Tallgrass prairie	11	18
CR11	Agriculture	11	14
CR12	Tallgrass prairie	14	22
CR13	Agriculture	9	15
CR14	Agriculture	13	29
CR15	Tallgrass prairie	11	24
CR16	Tallgrass prairie	12	24
CR17	Tallgrass prairie	16	26
CR18	Agriculture	13	16
CR42	Agriculture	17	27
CR43	Tallgrass prairie	12	20
CR45	Tallgrass prairie	16	26
CR46	Agriculture	13	15
CR47	Agriculture	12	20
CR48	Tallgrass prairie	15	37
CR49	Tallgrass prairie	21	44
CR54	Agriculture	9	13
CR55	Agriculture	14	27
CR56	Tallgrass prairie	9	19
CR57	Agriculture	10	16
Summary	Agriculture	41	242
	Tallgrass prairie	54	402

Forty-five of the 54 (83.3%) species had an equal or higher number of observations in tallgrass prairie point count locations than in agriculture locations (Table 14). Four species—rusty blackbird (*Euphagus carolinus*), unknown sparrow (*Passer spp.*), yellow warbler (*Setophaga petechia*), and yellow-rumped warbler (*Setophaga coronata*)—were observed only on agriculture-dominated point count locations; however, there were only eight observations total of those species.

Table 14. Number of Observations per Species per Habitat Type

Small Bird Species	Number of Observations	
	Agriculture	Tallgrass Prairie
American goldfinch	10	20
American robin	12	18
American tree sparrow	2	5
Barn swallow	17	13
Black-billed magpie	1	1
Brown headed cowbird	10	18
Blue-headed vireo	0	1
Blue jay	0	5
Bobolink	4	16
Brewer's blackbird	6	6
Brown thrasher	0	2
Clay-colored sparrow	5	4
Cedar waxwing	1	3
Chestnut-collared longspur	1	1
Chipping sparrow	0	6
Cliff swallow	4	8
Common grackle	7	7
Common nighthawk	0	2
Common yellowthroat	1	1
Dickcissel	4	4
Downy woodpecker	0	2
Eastern kingbird	6	9
European starling	5	3
Field sparrow	2	1
Grasshopper sparrow	3	20
Horned lark	9	5
House sparrow	1	1
House wren	0	2
Killdeer	15	15
Lapland longspur	1	2
Lincoln's sparrow	0	1
Mourning dove	10	6
Northern flicker	1	2
Northern Rough-wing swallow	2	3
Orange-crowned oriole	0	1
Orchard oriole	0	1
Pine warbler	0	1

Small Bird Species	Number of Observations	
	Agriculture	Tallgrass Prairie
Red-headed woodpecker	0	1
Rusty blackbird	1	0
Red-winged blackbird	34	61
Savannah sparrow	7	14
Sedge wren	0	2
Song sparrow	11	10
Tree swallow	3	2
Unknown sparrow spp.	3	0
Unknown blackbird spp.	0	2
Upland sandpiper	1	2
Vesper sparrow	3	4
Western kingbird	1	1
Western meadowlark	33	80
Willow flycatcher	0	1
Willet	0	1
White-rumped sandpiper	0	1
Yellow warbler	1	0
Yellow-headed blackbird	1	4
Yellow-rumped warbler	3	0
Total	242	402

5 DISCUSSION

Numerous studies have been conducted across the United States to allow for better prediction of the potential of avian mortality associated with wind energy facilities. Multiple variables could affect avian species' risk at wind energy facilities, including vegetation type(s) and habitat suitability, overall landscape and geographic characteristics, avian population densities, migration paths, or a species' use of an area. The objective of the avian point count surveys for this project was to characterize the activity, spatial distribution, and relative abundance of avian species within the study area.

5.1 Large Bird Use Surveys

The large bird use survey results are summarized below:

- SWCA conducted monthly surveys at 29 point count locations from April 1, 2017, to November 30, 2017.
- In all, 232 surveys were completed for a total of 13,920 survey-minutes.
- A total of 356 large bird observations were recorded during 146 of the 232 surveys.
- Twelve raptor species and 23 non-raptor species were recorded.

- Flight altitudes for 209 of the 356 observations occurred within the potential for collision zone (0–200 m aboveground); however, 172 of the 209 observations (48.3%) occurred below 30 m aboveground, which is outside the typical turbine rotor-swept area (31–200 m).
- No golden eagle, bald eagle, or unidentified eagle observations were recorded across the 29 survey plots. Thus, no areas in the study area were identified as potential eagle high-use areas.
- Biologists recorded four large bird species recognized by the USFWS as BCC species within the study area: ferruginous hawk, peregrine falcon, prairie falcon, and marbled godwit.
- All species observed during the 8-month survey period were typical for the region and seasons.

5.2 Small Bird Surveys

The small bird use survey results are summarized below:

- SWCA conducted monthly surveys at 29 point count locations from April 1, 2017 to November 30, 2017.
- In all, 232 surveys were completed.
- A total of 644 observations were recorded during 185 of the 232 surveys.
- Fifty-five species were identified during the surveys.
- Flight altitudes for 643 of the 644 observations occurred within the 0–200 m aboveground zone; however, 625 of these 643 observations (97.2%) occurred below 30 m, which is outside the typical turbine rotor-swept area (31–200 m).
- Western meadowlark accounted for 113 (17.5%) of the 644 observations. Three species (western meadowlark, red-winged blackbird, and American robin) accounted for 238 (36.9%) of the 644 observations.
- The biologists recorded higher numbers of species (54 versus 41) and observations (242 versus 402) in survey plots dominated by tallgrass prairie than in plots in an agricultural setting.
- The biologists recorded four small bird species recognized by the USFWS as BCC within the study area: the chestnut-collard longspur, grasshopper sparrow, willow flycatcher, and red-headed woodpecker.
- All species observed during the 8-month survey period were typical for the region and seasons.

6 LITERATURE CITED

- Strickland, M.D., E.B. Arnett, W.P. Erickson, D.H. Johnson, G.D. Johnson, M.L. Morrison, J.A. Shaffer, and W. Warren-Hicks. 2011. *Comprehensive Guide to Studying Wind Energy/Wildlife Interactions*. Prepared for the National Wind Coordinating Collaborative, Washington, D.C.
- U.S. Fish and Wildlife Service. 2008. Birds of Conservation Concern 2008. U.S. Department of Interior, Fish and Wildlife Service, Division of Migratory Bird Management, Arlington, Virginia.
- . 2012. *Land-Based Wind Energy Guidelines*. Wind Turbine Guidelines Advisory Committee. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Washington, D.C.
- . 2013. *Eagle Conservation Plan Guidance Module 1 – Land-based Wind Energy*, Version 2. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Division of Migratory Bird Management, Washington, D.C.
- . 2018. *Information, Planning, and Consultation System (IPAC System)*. <https://www.fws.gov/ipac/>. Accessed October 2018.
- U.S. Geological Survey. 2014. National Land Cover Dataset. <https://gapanalysis.usgs.gov/gaplandcover/data/download>. Accessed October 2018.