Avian Use Study
Rail Tie Wind Project
Albany County, Wyoming

Final Report

January – December, 2020

Prepared for:

ConnectGen Albany County LLC

1001 McKinney, Suite 700
Houston, TX 77002

Prepared by:

Karl Kosciuch, Diem Pham, and Michael Gerringer

Western EcoSystems Technology, Inc.
415 W 17th Street #200
Cheyenne, WY 82007

February 18, 2021

EXECUTIVE SUMMARY

ConnectGen contracted Western EcoSystems Technology, Inc. (WEST) to conduct a pre-construction avian use study within the Project Area. The objectives of the study were to collect information on small and large bird species that occur in the Project Area and the spatial and temporal patterns of avian use. This site-specific avian use data can then be used to inform a risk assessment of the Project.

The Project Area encompasses approximately 10,538 hectares (ha; 26,041 acres [ac]) in Albany County, Wyoming, adjacent to the town of Tie Siding. WEST established 25 fixed point avian use survey locations within the Rail Tie Project Area during the first year (January – December 2019) of avian use surveys, providing 41.24% coverage of the Project Area. Each point is centered on a circular survey plot with an 800-meter (m) radius for large birds and a 100-m radius for small birds. Surveys were conducted once per month, January – December, 2020.

Overall, 295 avian use surveys were conducted for large birds and 295 for small birds within the Project. Seventeen species of large bird and 26 species of small bird were recorded, totaling 43 species of birds observed or heard over the study period. No federal- or state-threatened or endangered species were recorded within the Project Area, however, 11 Wyoming Department of Game and Fish species of greatest conservation need were recorded, including six large bird species and five small bird species.

Large bird mean use was highest during summer (3.40 observations/800-m plot/90-min survey) and fall (3.40), followed by spring (1.77) and winter (1.59). Large corvids accounted for the majority of use during winter, spring, and fall whereas diurnal raptors comprised the majority of use during summer. 100% of waterfowl and gulls/terns, 72.2% of vultures, 49.5% of diurnal raptors, and 30.3% of large corvids were observed flying at rotor swept heights (RSH) heights. Large bird use ranged from 1.00 observations/800-m plot/90-min survey (Point 18) to 4.25 (point 24) across points. Most of the large bird use observed at Point 24 can be attributed to waterfowl and large corvid use.

Small bird mean use was highest during spring, followed by summer, winter, and fall. Passerines accounted for 100% of small bird use during winter, summer, and fall and nearly 100% of use during spring. Small birds were mainly (95.1%) observed below the RSH. Small bird mean use was highest at points 23 (3.25 observations/100-m plot/10-min survey), 24 (2.67), and 21 (2.00).

Pre-construction avian use data do not reliably predict post-construction mortality rates (Ferrer et al., 2012, Loss et al. 2013), likely due to complex interactions of biological, site, and landscape factors (Marques et al. 2014). Thus, developing quantitative predictions of the number of fatalities of particular species or species group using pre-construction data is not feasible except for a few select species (e.g., golden eagle). Alternatively, pre-construction use data can be examined in the context of known local or regional fatality trends to better understand the potential for generalized avian mortality at operational wind facilities.

The large bird species with the highest mean use during 90-min surveys was common raven, followed by turkey vulture and black-billed magpie. Corvids (i.e., common raven, black-billed magpie) are not widely represented in fatality monitoring studies (AWWI 2019, WEST 2019), and although abundant at the Project, mortality of these species is not likely to be reflective of mean use. AWWI (2019) found that diurnal raptors ranked second in percent composition of unadjusted bird fatalities in 193 studies at wind facilities throughout the U.S. Thus, the potential for raptor fatalities exists, but the specific patterns cannot be predicted. Although large bird and small bird use varied among points, unique landscape features or bird attractants (e.g., waterbodies) were not evident on the landscape. The only exception is that there is water located near one of the three survey points where small bird use was highest. However, water (i.e. lakes, streams) is present near a number of other survey points where small bird use was low. Small bird use was highest in spring, which is reflective of spring migration and lowest during winter which is reflective of the harsh winter in the Wyoming Basin. Large bird use was highest during summer and fall, which is reflective of the summer breeding season, when large birds are actively foraging for food and defending territories, and the fall migration season.

STUDY PARTICIPANTS

Karl Kosciuch, PhD	Project Manager
Michael Gerringer	Report Writer
Karl Kosciuch, PhD	Senior Reviewer
Carmen Boyd	Project Tracking and Data Manager
Diem Pham	Statistician
Catherine Read	Data Analyst
Brian Barbieri	GIS Technician
Jesse Hiler	Field Supervisor
Greg Johnson	Field Biologist

REPORT REFERENCE

Kosciuch, K., M. Gerringer, and D. Pham. 2021. Avian Use Study at the Rail Tie Wind Project, Albany County, Wyoming Final Report, January – December, 2020. Prepared for ConnectGen Houston, Texas. Prepared by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming. February 2021.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

INTRODUCTION

ConnectGen is proposing the development of the 504 megawatt (MW) Rail Tie Wind Project (Project) in Albany County, Wyoming (Figure 1). To support the development of the Project, ConnectGen contracted Western EcoSystems Technology, Inc. (WEST) to conduct a second year of pre-construction avian use surveys within the Project Area. Study methodology was based upon the recommendations in the U.S. Fish and Wildlife Service's (USFWS) 2012 *Final Land-Based Wind Energy Guidelines* (WEG), Appendix C(1)(a) of the 2013 USFWS *Eagle Conservation Plan Guidance* (ECPG), USFWS *Revisions to Regulations for Eagle Incidental Take and Take of Eagle Nests* (2016 Final Eagle Rule [81 Federal Regulation 91494 (December 16, 2016)]), and the Wyoming Game and Fish Department's (WGFD) Wildlife Protection Recommendations for Wind Energy Development in Wyoming (WGFD 2010).

The objectives of the study were to collect information on species that occur in the Project Area and the spatial and temporal patterns of avian use, which can then be used to inform a risk assessment of the Project for birds (USFWS 2012). This report summarizes results from the second year of avian use surveys at the Project.

PROJECT AREA

The proposed 26,041-ac (10,538-ha) Project Area is located near the town of Tie Siding and is situated along the Colorado-Wyoming border (Figure 1). The Project is at an approximate elevation of 7,700 feet (ft; 2,347 meters [m]) and is bisected by US Highway 287. The majority of the Project is managed as private land (81%) with small inholdings of state-managed land (19%) located throughout the Project (Figure 1). The Project primarily consists of low mountain slopes with ponderosa pine (*Pinus ponderosa*) and lodgepole pine (*P. contorta*) habitat, rock outcroppings, and rocky cliffs, and nearly level floodplains with grassland, shrub steppe, and rangeland habitat. According to the National Land Cover Database (Yang et al. 2018, Multi-Resolution Land Characteristics 2019), the Project Area is dominated by shrub/scrub (16,711.9 ac [6,763.1 ha; 64.2%]) followed by herbaceous grassland (7,949.0 ac [3,216.8 ha; 30.5%]; Table 1, Figure 2). Evergreen forest (approximately 2.5% of the land cover), emergent herbaceous wetlands (2.1%), and woody wetlands (0.5%; Table 1, Figure 2). Developed open space, open water, deciduous forest, barren land, and developed low and medium intensity land each compose less than 0.3% of the Project.

The majority (72%) of the Project Area is in the Level III Southern Rockies Ecoregion, but a portion (28%) of the western half of the project is located within the Level III Wyoming Basin Ecoregion in southeastern Wyoming (US Environmental Protection Agency [USEPA 2016]). The Level III Southern Rockies Ecoregion is characterized by high-elevation terrain including high mountains, alpine cirques, glacial moraines, and wide valleys while the Level III Wyoming Basin Ecoregion is characterized by basin, plain, desert, and isolated mountain terrain. The landscape within the Project Area varies from relatively flat land to rolling hills and drainages with elevations ranging from 2,305 m (7,562 ft) to 2,530 m (8,300 ft).

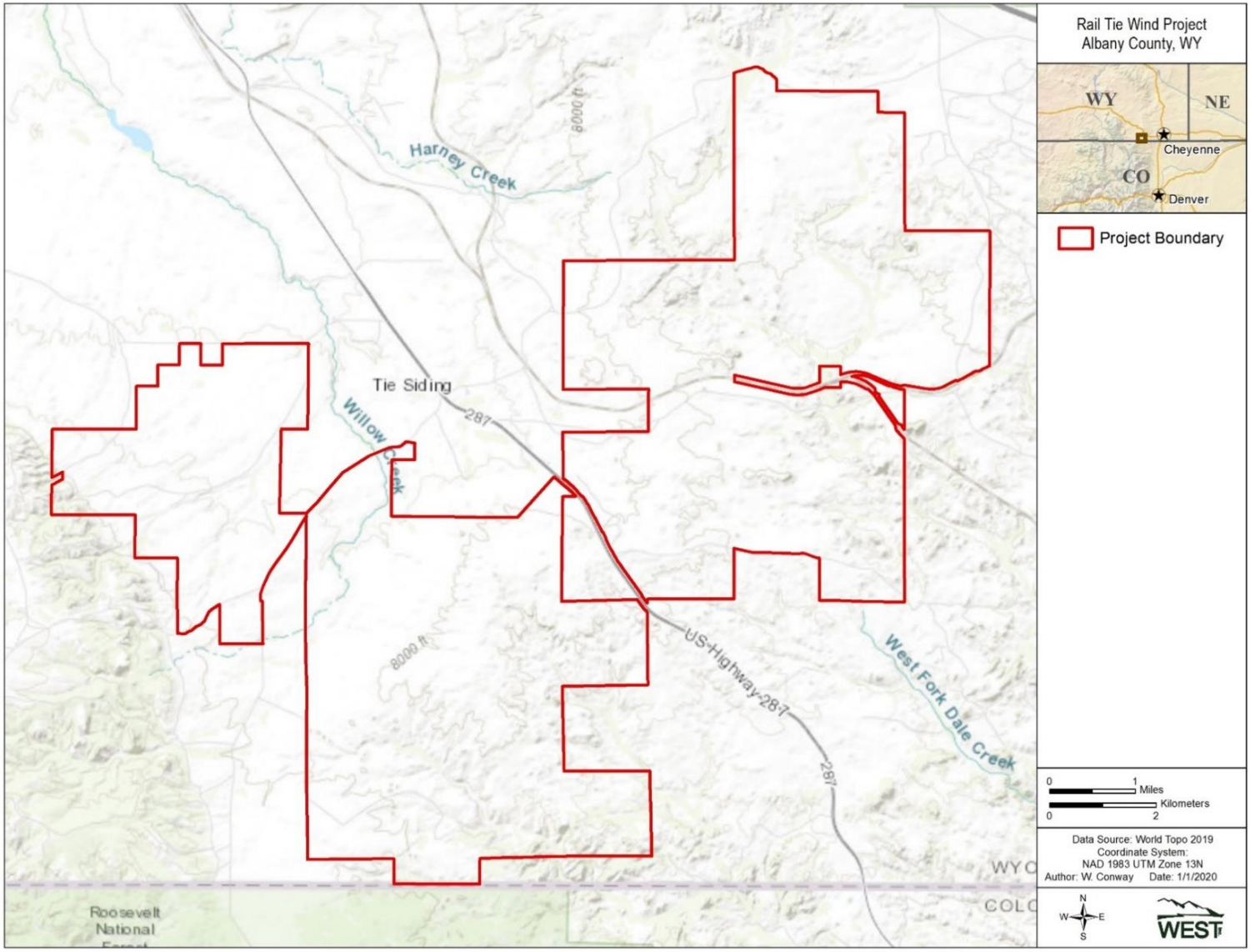


Figure 1. Location of the Rail Tie Wind Project in Albany County, Wyoming.

Table 1. Land cover, coverage (acres), and percent (%) composition within the Rail Tie Wind Project in Albany County, Wyoming.

Land Cover	Coverage (acres)	% Composition
Shrub/Scrub	16,711.9	64.2
Herbaceous	7,949.0	30.5
Evergreen Forest	641.9	2.5
Emergent Herbaceous Wetlands	554.7	2.1
Woody Wetlands	120.3	0.5
Developed, Open Space	48.3	0.2
Deciduous Forest	5.7	<0.1
Barren Land	5.0	<0.1
Developed, Low Intensity	4.0	<0.1
Open Water	0.2	<0.1
Developed, Medium Intensity	0.1	<0.1
Total	**26,041.1**	**100**

Source: National Land Cover Database (Yang et al. 2018, Multi-Resolution Land Characteristics 2019)

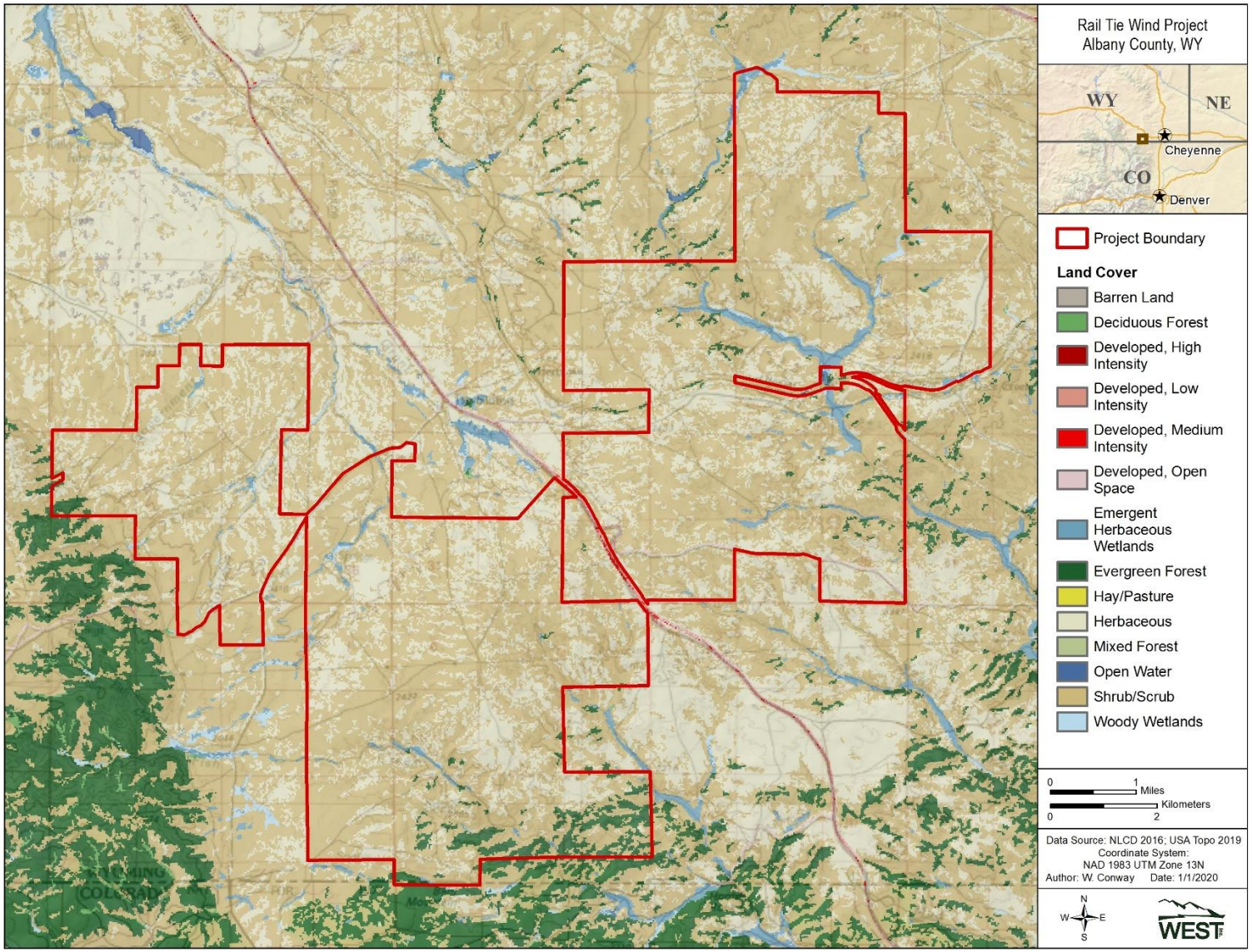


Figure 2. Land cover at the Rail Tie Wind Project in Albany County, Wyoming.

METHODS

Definitions

Species of concern are defined per the WEG as any species that 1) is either a) listed as an endangered, threatened or candidate species under the Endangered Species Act, subject to the Migratory Bird Treaty Act or Bald and Golden Eagle Protection Act; b) is designated by law, regulation, or other formal process for protection and/or management by the relevant agency or other authority; or c) has been shown to be significantly adversely affected by wind energy development, and 2) is determined to be possibly affected by the Project (USFWS 2012).

Large birds are defined as waterbirds, waterfowl, shorebirds, gulls/terns, diurnal raptors (i.e., kites, accipiters, buteos, eagles, falcons, northern harrier, and osprey), owls, vultures, upland game birds, doves/pigeons, goatsuckers, large corvids (e.g., magpies, crows, and ravens).

Small birds are defined as cuckoos, swifts/hummingbirds, woodpeckers, kingfishers, and passerines.

Study Design

Large Birds

The objective of large bird use surveys was to collect information on species occurrence in the Project Area and the spatial and temporal patterns of avian use, which can then be used to inform a risk assessment of the Project for birds. Adhering to stipulations pertaining to spatial coverage of a proposed wind Project Area described in the Eagle Conservation Plan Guidance (ECPG; USFWS 2013), and stipulations included in the Eagle Rule Revision (USFWS 2016), WEST established 25 fixed point avian use survey locations within Project Area during the first year of avian use surveys (Figure 3). These points provide 44.31 percent coverage of the current Project Area with each point encompassing an 800-meter (m; 2624 feet [ft]) radius viewshed. Large bird surveys were conducted for 90-minute (min; 1.5-hour [hr]) periods during which time behavior is documented. Given the large size of the Project and the level of effort and difficulty involved in accessing various groupings of points due to deep snow conditions, the order in which groups of points were surveyed during each visit was randomized rather than randomizing the order in which individual points were surveyed. A round is defined as the period of time necessary to survey all points once; the ECPG recommends that each fixed point location is surveyed a minimum of 12 times per year.

Small Birds

The objective of small bird use surveys is to collect information on the species that occur in the Project Area and the spatial and temporal patterns of use of the Project including use by passerines and other non-raptor avian species. Small bird surveys are conducted at the same fixed point locations established for large bird surveys (Figure 3). However, in contrast to large

bird surveys, small bird surveys are conducted for 10-min periods, immediately prior to large bird surveys, and encompass a 100-m radius viewshed. Within this 100-m viewshed all avian observations are recorded. Because small bird surveys are conducted immediately prior to large bird surveys at a given point, the schedule for small bird surveys coincides with that for large bird surveys.

Survey Schedule

Surveys were conducted once per month, January – December, 2020, as specified in the ECPG, and 2016 Final Eagle Rule during all seasons. Seasons were defined as spring (March 1 – June 30), summer (July 1 – August 31), fall (September 1 – November 30), and winter (December 1 – February 28). Surveys were conducted during daylight hours as specified in the ECPG, and 2016 Final Eagle Rule, and survey times at survey points were randomized to cover all daylight hours during a season. Surveys were conducted under all weather conditions except when visibility was less than 800 m horizontally and 200 m vertically (USFWS 2016).

Survey Methods

Biologists recorded the following information for each survey: date, start and end time, and weather (i.e., temperature, wind speed, wind direction, precipitation, and percent cloud cover). Additionally, the following data were recorded for each group of birds observed:

- Observation number
- Species (or best possible identification)
- Number of individuals
- Sex and age class (if possible)
- Distance from survey plot center to the nearest five m interval (first & closest)
- Flight height above ground level (AGL) to the nearest five m interval (first, lowest, and highest)
- Flight direction (first observed)
- Dominant landcover type
- Activity (e.g., flying, perched)
- Observation type (visual or aural)
- Flight paths and perch locations of eagles and other large birds

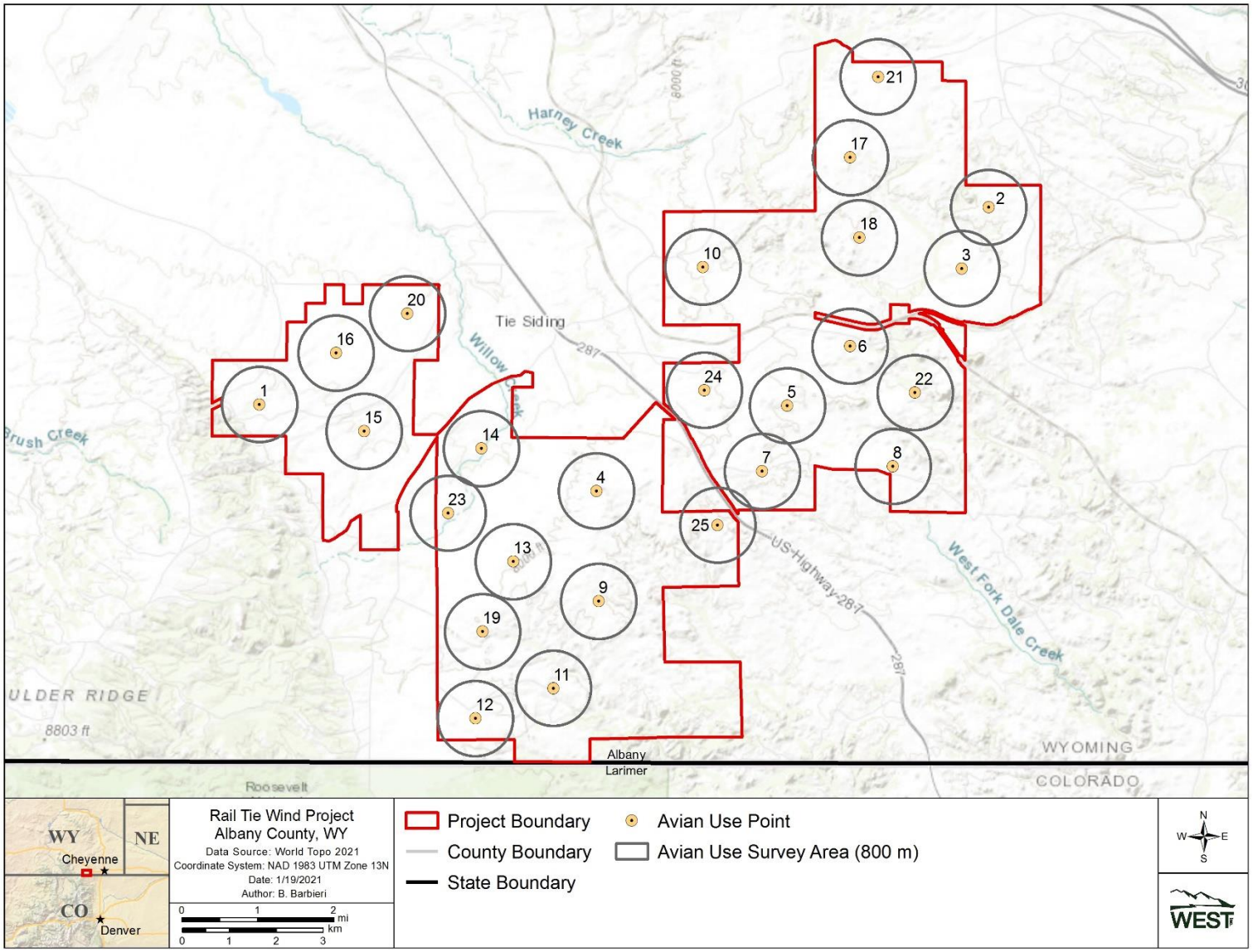


Figure 3. Avian use survey points and plots at the Rail Tie Wind Project in Albany County, Wyoming, January – December, 2020.

Incidental Observations

Incidental observations are wildlife seen outside of the standardized surveys but within the Project Area, and are focused on federal- or state-protected species, unusually large congregations of individuals, and species not yet recorded during surveys. Data recorded for incidentally observed species were similar to that recorded during scheduled surveys.

Data Management

Quality Assurance and Quality Control

WEST implemented quality assurance and quality control (QA/QC) measures at all stages of the study, including in the field, during data entry and analysis, and report writing. Following surveys, biologists were responsible for inspecting data forms for completeness, accuracy, and legibility. If errors or anomalies were found within the data, follow-up measures were implemented including discussions and review of field data with field technicians and/or Project Managers. WEST traced back any errors, omissions, or problems identified in later stages of analysis to the raw data forms where appropriate changes and measures were implemented, no matter what stage of analysis. Multiple reviews were conducted as QA/QC measures.

Data Compilation and Storage

A Microsoft® SQL database was specifically developed to store, organize, and retrieve survey data. Project data were keyed into the electronic database using a pre-defined format to facilitate subsequent QA/QC and data analysis. WEST retained all data forms and electronic data files for reference.

Statistical Analysis

A *visit* was defined as surveying all of the survey plots once within the Project Area and could occur across multiple dates but had to be completed in a single season (e.g., spring). If extreme weather conditions prevented all plots from being surveyed during a visit, then a visit might not have constituted a complete survey of all plots. A *survey* was defined as a single 10 min or 90 min count of birds. In some cases, a count of bird observations may represent repeated observations of the same individual. Only observations within the survey plot were included for data analysis.

Mean Use, Percent of Use, and Frequency of Occurrence

Mean use is the average number of birds observed per plot per survey for small or large birds. Small bird use (per 100-m plot per 10-min survey) and large bird use (per 800-m plot per 90-min survey) is calculated by: 1) summing birds per plot per visit, 2) averaging number of birds over plots within a visit, and 3) averaging number of birds across visits within a season. Overall mean use was calculated as a weighted average of seasonal values by the number of days in each season. *Percent of use* was calculated as the percentage of small or large bird use that was attributable to a particular bird type or species. *Frequency of occurrence* was calculated as the percent of surveys in which a particular bird type or species was observed.

Mean use and frequency of occurrence describe different aspects of relative abundance, in that mean use is based on the number of birds (i.e., large groups can produce high estimates), whereas frequency of occurrence is based on the number of groups (i.e., it is not influenced by group size). Qualitative comparisons were made with these metrics among bird types, seasons, and survey points to help one understand how birds are using the Project Area over time and space.

Flight Height

Bird flight heights are important metrics to assess relative potential exposure to turbine blades and were used to calculate the percentage of large birds and small birds observed flying within the rotor-swept height (RSH) of proposed turbines. A RSH of 200 m AGL was assumed for the purpose of the analysis. Flight height recorded during the initial observation was used to calculate the percentage of birds flying within the RSH and mean flight height.

Spatial Use

Mean use was calculated by survey point for large birds and small birds to make spatial comparisons among the survey points. Additionally, flight paths of eagles were mapped during large bird use surveys to qualitatively show flight path location compared to Project Area characteristics (e.g., topographic features) to identify if there were areas of concentration or consistent flight patterns within the Project Area.

RESULTS

Overall, 295 avian use surveys (442.5 total hours) were conducted for large birds and 295 surveys (49.2 hours) for small birds within the Project Area (Table 2). Seventeen species of large birds and 26 species of small birds totaling 43 species of birds were observed or heard over the year study. Study results are summarized below, supplemented by the appendices, which present species-level detail on the following: scientific names and numbers of groups and observations seen during surveys but not limited to viewshed (Appendices A1 and A2), avian use, percent of use, and frequency of occurrence by season (Appendices B1 and B2), and mean use by survey point (Appendix C).

Table 2. Summary of survey effort at the Rail Tie Wind Project in Albany County, Wyoming, January – December 2020.

	Large Birds		Small Birds	
Season[1]	**# Visits[2]**	**# Surveys[3]**	**# Visits[2]**	**# Surveys[3]**
Spring	4	99	4	99
Summer	2	50	2	50
Fall	3	71	3	71
Winter	3	75	3	75
Overall	12	295	12	295

[1] Season dates: Spring (March 1 – June 30, 2020), Summer (July 1 – August 31, 2020), Fall (September 1 – November 30, 2020), and Winter (January 1 – February 28, 2020 and December 1 – December 31, 2020)

[2] A visit was defined as surveying all of the survey plots once within the Project Area and could occur across multiple dates but had to be completed in a single season.

[3] A survey was defined as a single 10 min or 90 min count of birds.

Sensitive Species

No federal- or state-threatened or endangered species were recorded within the Project Area. Eleven Wyoming Department of Game and Fish species of greatest conservation need were recorded, including six large bird species and five small bird species (Table 3).

Table 3. Summary of group and individual observations of sensitive species observed at the Rail Tie Wind Project during the small bird and large bird use surveys and as incidental wildlife observations, January – December, 2020.

			Surveys		Incidental		Total	
Species	**Scientific Name**	**Status**	**# of grps**	**# of obs**	**# of grps**	**# of obs**	**# of grps**	**# of obs**
golden eagle	*Aquila chrysaetos*	SGCN; BGEPA	22	22	6	6	28	28
ferruginous hawk	*Buteo regalis*	SGCN	40	40	7	8	47	48
Swainson's hawk	*Buteo swainsoni*	SGCN	24	25	5	5	29	30
American kestrel	*Falco sparverius*	SGCN	19	20	7	8	26	28
bald eagle	*Haliaeetus leucocephalus*	SGCN; BGEPA	7	7	3	3	10	10
white-faced ibis	*Plegadis chihi*	SGCN	0	0	1	1	1	1
Large Birds Overall	***6 species***		**112**	**114**	**29**	**31**	**141**	**145**
red crossbill	*Loxia curvirostra*	SGCN	1	3	0	0	1	3
Clark's nutcracker	*Nucifraga columbiana*	SGCN	5	9	3	3	8	12
sage thrasher	*Oreoscoptes montanus*	SGCN	2	2	2	2	4	4
thick-billed longspur	*Rhynchophanes mccownii*	SGCN	4	11	0	0	4	11
Brewer's sparrow	*Spizella breweri*	SGCN	1	1	0	0	1	1
Small Birds Overall	**5 species**		**13**	**26**	**5**	**5**	**18**	**31**

grps=groups, obs=observations

SGCN = Species of Greatest Conservation Need

BGEPA = Bald and Golden Eagle Protection Act

Large Birds

Seventeen species of large birds were observed or heard over 442.5 hours of surveys during the study period. A summary of all groups and individual observations of large birds is provided in Appendix A1.

Mean Use, Percent of Use, and Frequency of Occurrence

Mean use, percent of use, and frequency of occurrence were calculated by season for large bird types (Figures 4a, 4b, 4c) and species (Appendix B1). Large bird mean use ranged from 1.59 observations/800-m plot/90-min survey to 3.40 among seasons and was highest during summer (3.40) and fall (3.40), followed by spring (1.77) and winter (1.59; Figure 4a). Overall, Large bird mean use was 2.41 observations/800-m plot/90-min survey. Large bird mean use during winter, spring, and fall was greatest for large corvids (Figure 4a). Large bird mean use during summer was greatest for diurnal raptors followed by large corvids and vultures (Figure 4a; Appendix B1).

Large corvids accounted for the majority of use during winter (87.4%), spring (50.1%), and fall (59.0%) whereas diurnal raptors comprised the majority of use during summer (44.1%; Figure 4b; Appendix B1). Large bird frequency of occurrence varied among seasons, with large corvids the most frequently observed during winter (53.3%) and fall (63.6%), diurnal raptors the most frequently observed during spring (51.5%) and summer (62.0%; Figure 4c; Appendix B1).

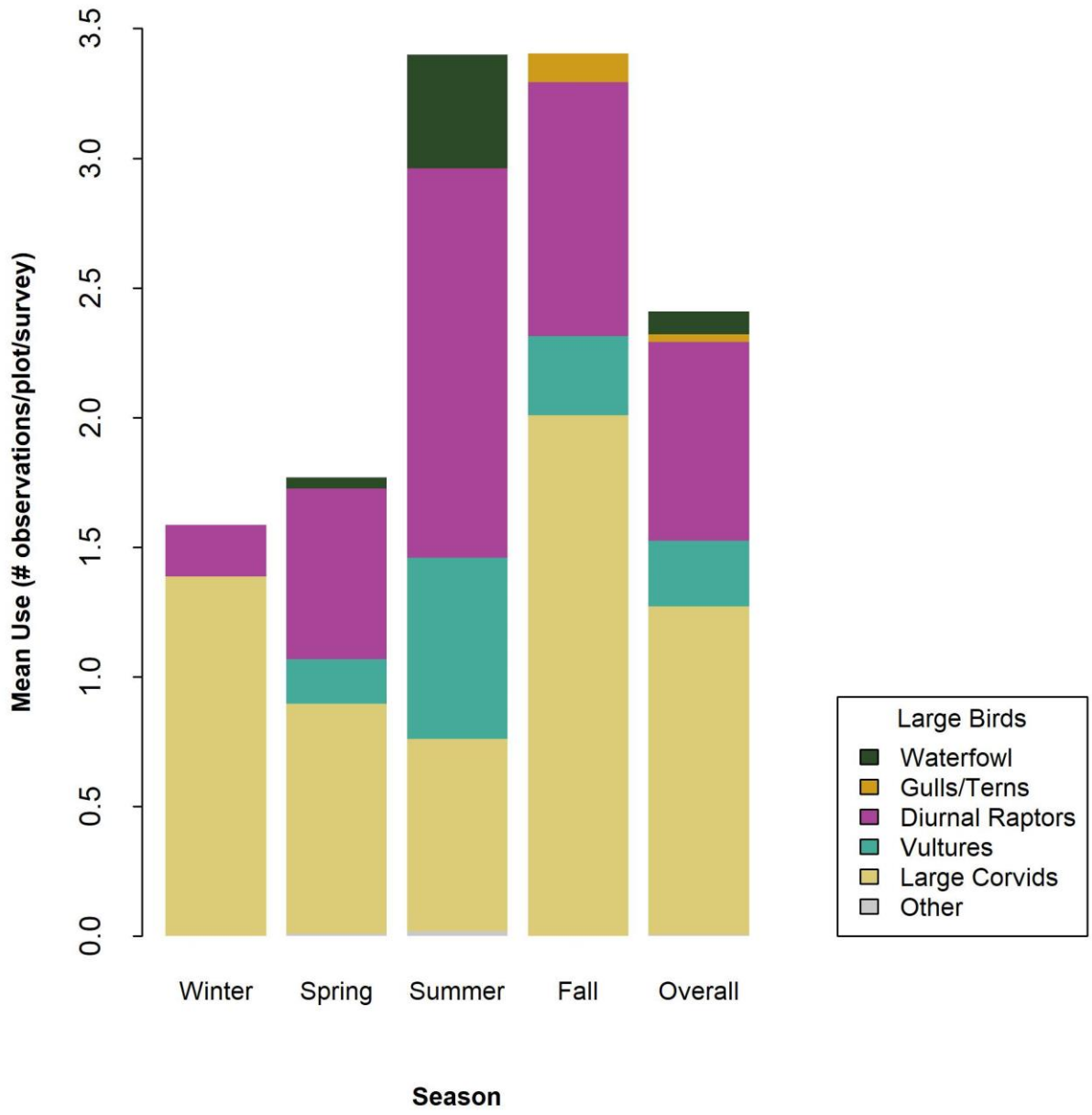


Figure 4a. Large bird mean use by season and bird type at the Rail Tie Wind Project in Albany County, Wyoming, January – December, 2020.

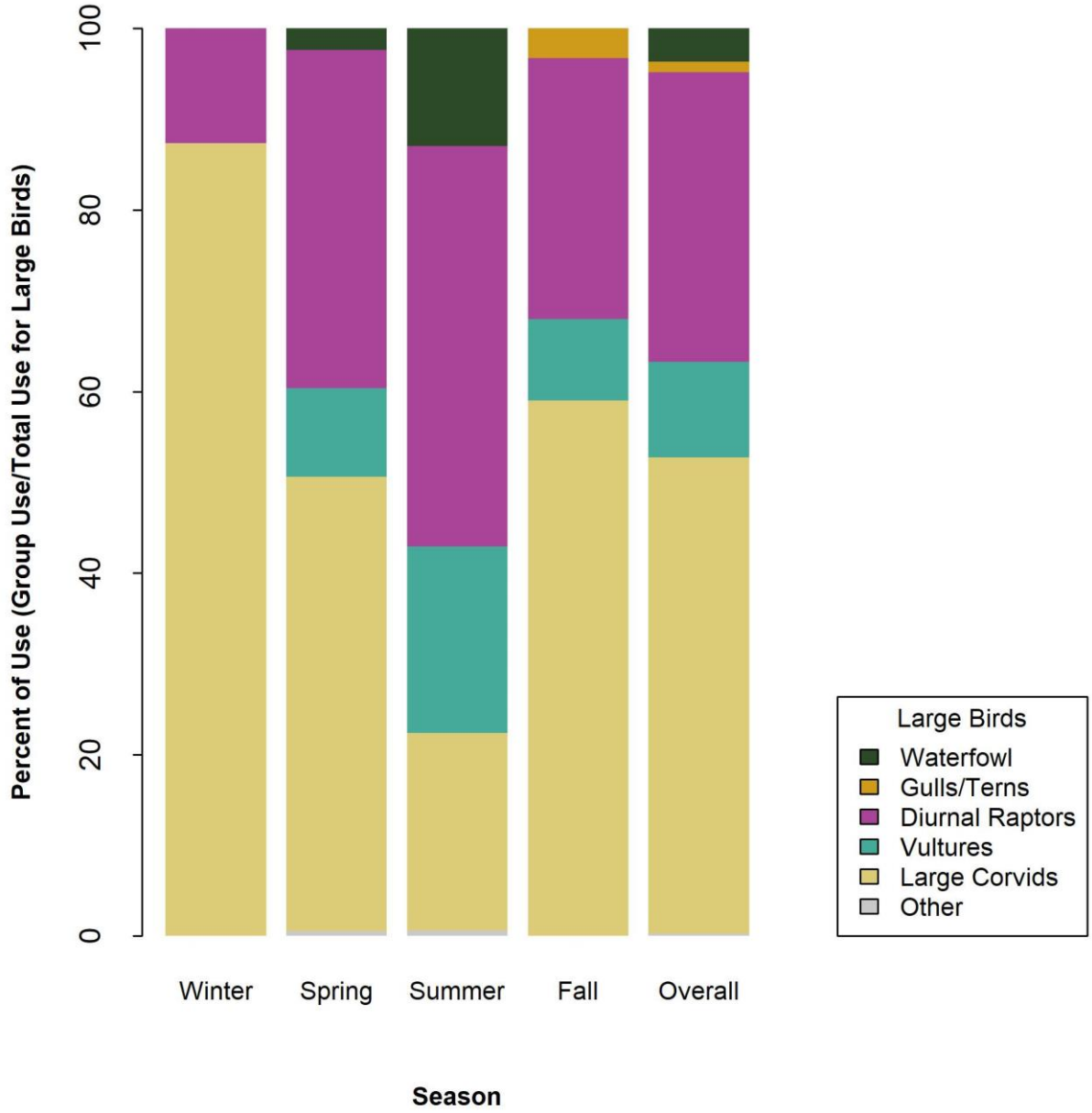


Figure 4b. Large bird percent of use by season and bird type at the Rail Tie Wind Project in Albany County, Wyoming, January – December, 2020.

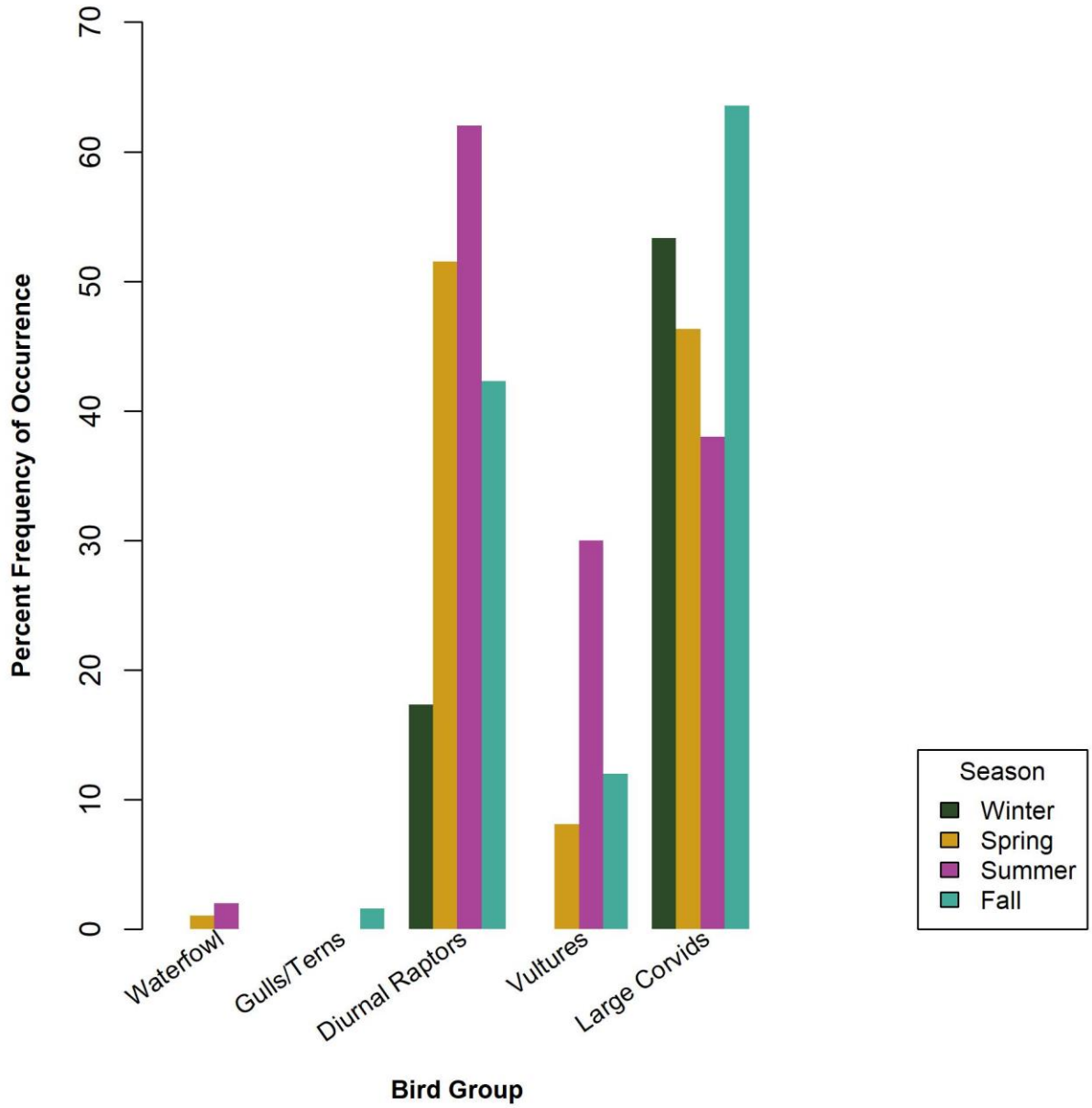


Figure 4c. Large bird frequency of occurrence by season and bird type at the Rail Tie Wind Project in Albany County, Wyoming, January – December, 2020.

Flight Height

Mean large bird flight heights ranged from 18.0 m (59.0 ft) for northern harriers to 102.0 m (334.6 ft) for eagles. One hundred percent (100%) of waterfowl and gulls/terns, 72.2% of vultures, 49.5% of diurnal raptors, and 30.3% of large corvids were observed flying at RSH heights (Table 4). The majority (69.7%) of large corvids recorded were observed flying at heights below the RSH and no large corvids were observed flying above the rotor swept zone (Table 4). A small percentage of

diurnal raptors (2.5%) and vultures (4.2%) were observed flying at heights above the RSH (Table 4).

Table 4. Group and individual observation flight height characteristics by bird type[a] and passerine subtype observed within 800-m radius plots during bird use surveys at the Rail Tie Wind Project in Albany County, Wyoming, January – December, 2020.

Bird Type	% Obs Flying	# Grps Flying	# Obs Flying	Mean Flight Height (m)	% within Flight height Categories		
					0<25 m	25-200 m[b]	>200 m
Waterfowl	**2**	**26**	**100**	**68**	**0**	**100**	**0**
Gulls/Terns	**1**	**7**	**100**	**30**	**0**	**100**	**0**
Diurnal Raptors	**193**	**202**	**90.2**	**48**	**48.0**	**49.5**	**2.5**
Buteos	*97*	*103*	*86.6*	*51*	*34.0*	*65.0*	*1.0*
Northern Harrier	*26*	*26*	*100*	*18*	*80.8*	*19.2*	*0*
Eagles	*23*	*23*	*88.5*	*102*	*39.1*	*43.5*	*17.4*
Falcons	*38*	*39*	*92.9*	*24*	*66.7*	*33.3*	*0*
Other Raptors	*9*	*11*	*100*	*52*	*54.5*	*45.5*	*0*
Vultures	**55**	**72**	**96.0**	**64**	**23.6**	**72.2**	**4.2**
Doves/Pigeons	**0**	**0**	**0**	**NA**	**NA**	**NA**	**NA**
Large Corvids	**244**	**333**	**89.5**	**23**	**69.7**	**30.3**	**0**
Large Birds Overall	**495**	**640**	**90.7**	**37**	**54.1**	**44.7**	**1.3**

[a]800-meter (m) for large birds.

[b] The likely rotor-swept height for potential collision with a turbine blade, or 25 to 200 m (82 to 656 feet) above ground level.

[c] Zeroes values indicate that the species was observed but was not flying.

grp=groups, obs=observations

Spatial Variation

Mean Use by Point

Large bird use ranged from 1.00 observations/800-m plot/90-min survey (Point 18) to 4.25 (point 24) across points (Figure 5; Appendix C). Mean use by point maps for all large birds, raptors, and eagles are provided in Appendix D. Most of the large bird use observed at Point 24 was waterfowl use (1.83) and large corvid use (1.17; Appendix C). Waterfowl use at Point 24 is based on a single flock of Canada geese observed flying through the study site. The second highest large bird use value was observed at point 23 (4.08) with large corvids accounting for the majority (2.25) of use at this point (Figure 5; Appendix C). The next highest large bird use values were observed at points 14 (3.75) and 3 (3.58). Large bird use at all other points was 3.25 observations/800-m plot/90-min survey or lower (Figure 5; Appendix C).

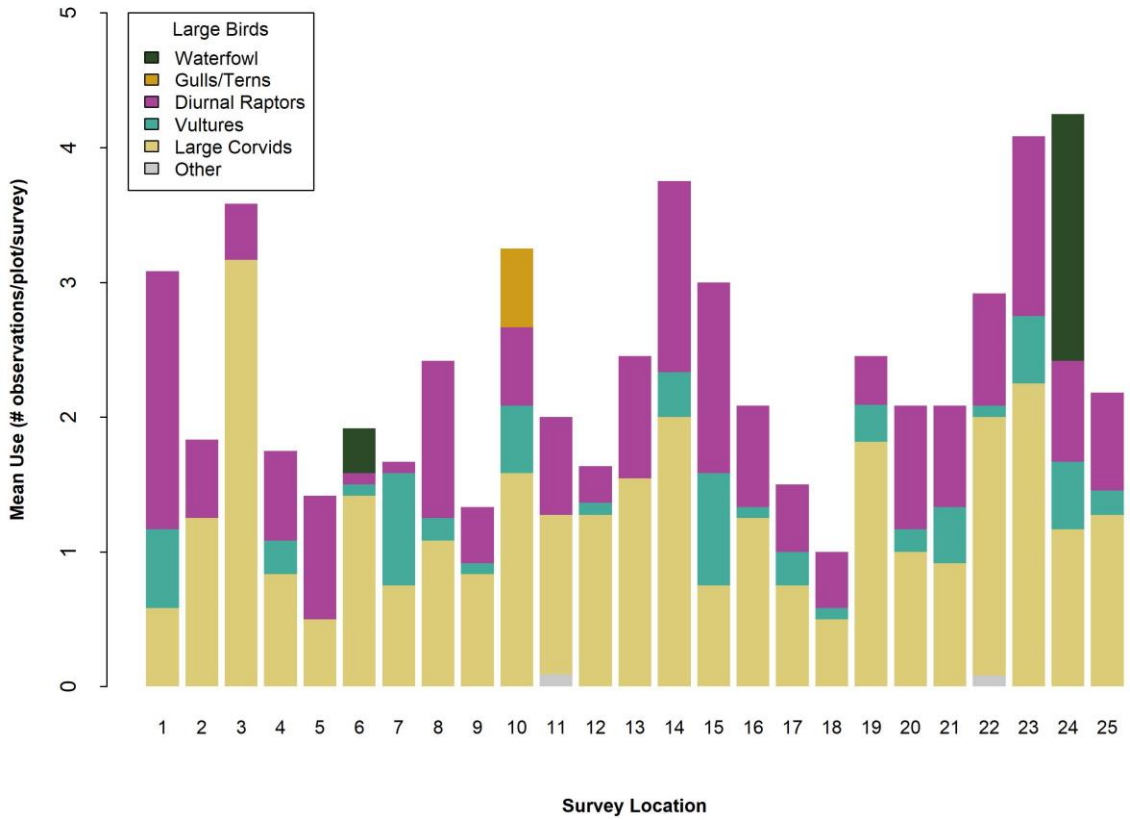


Figure 5. Large Bird Mean Use by Point by bird type at the Rail Tie Wind Project in Albany County, Wyoming, January – December, 2020.

Incidental Observations

Six large bird species were observed incidentally within the Project Area and study period, outside of the avian use surveys (Table 5). These included eight blue-winged teal observations, four golden eagle observations, three bald eagle observations, two ferruginous hawk observations, one northern harrier observation, and one white-faced ibis observation (Table 5).

Table 5. Group and individual observation bird species incidentally observed outside of the standardized fixed-point use surveys at the Rail Tie Wind Energy Project in Albany County, Wyoming, January – December, 2020.

Species	Scientific Name	# grps [a]	# obs [b]
white-faced ibis	*Plegadis chihi*	1	1
blue-winged teal	*Spatula discors*	1	8
ferruginous hawk	*Buteo regalis*	2	2
northern harrier	*Circus hudsonius*	1	1
golden eagle	*Aquila chrysaetos*	4	4
bald eagle	*Haliaeetus leucocephalus*	3	3
Total	***6 species***	**12**	**19**

[a] grps = groups

[b] obs = observations

Small Birds

Twenty-six species of small birds were observed or heard over 49.2 hours of surveys during the study period. A summary of all groups and individual observations of large birds is provided in Appendix A1.

Mean Use, Percent of Use, and Frequency of Occurrence

Mean use, percent of use, and frequency of occurrence were calculated by season for small bird types (Figures 6a, 6b, 6c) and species (Appendix B2). Small bird mean use ranged from 0.19 observations/100-m plot/10-min survey to 3.21 among seasons and was highest during spring (3.21), followed by summer (0.76), winter (0.39), and fall (0.19; Figure 6a). Overall, small bird mean use was 1.34 observations/100-m plot/10-min survey. Passerines accounted for all small bird use during winter, summer, and fall, and nearly all use during spring (Figure 6a). Woodpecker use occurred during spring only (Figure 6a).

Similarly, passerines accounted for 100% of use during winter, summer, and fall and nearly 100% of use during spring (99.4%; Figure 6b). During spring woodpeckers accounted for the remainder (0.6%) of small bird use (Figure 6b). Passerine frequency of occurrence was greatest during spring, followed by summer, fall, and winter (Figure 6c).

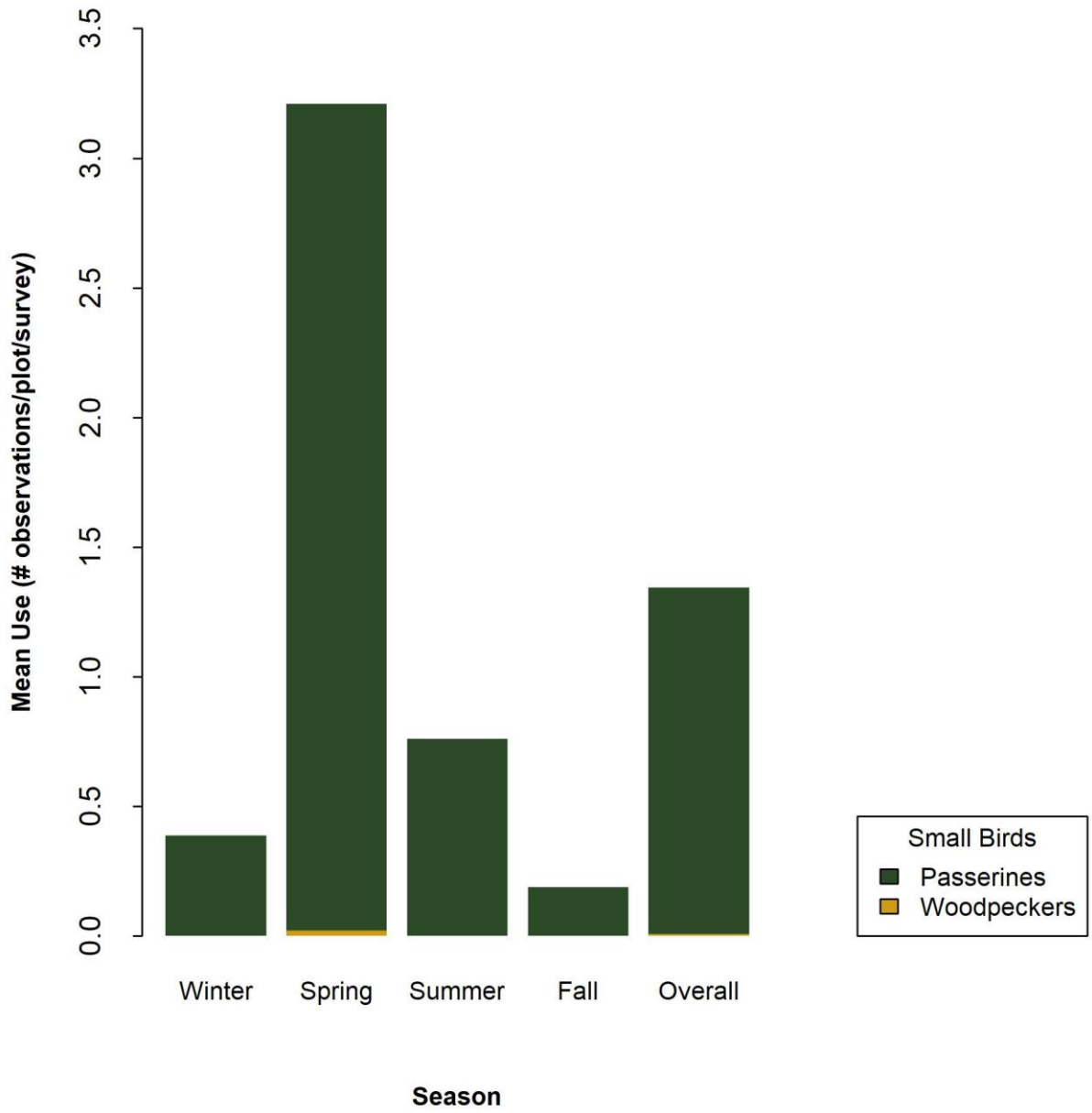


Figure 6a. Small bird mean use (# observations/plot/10 minute survey) by season and bird type at the Rail Tie Wind Project in Albany County, Wyoming, January – December 2020.

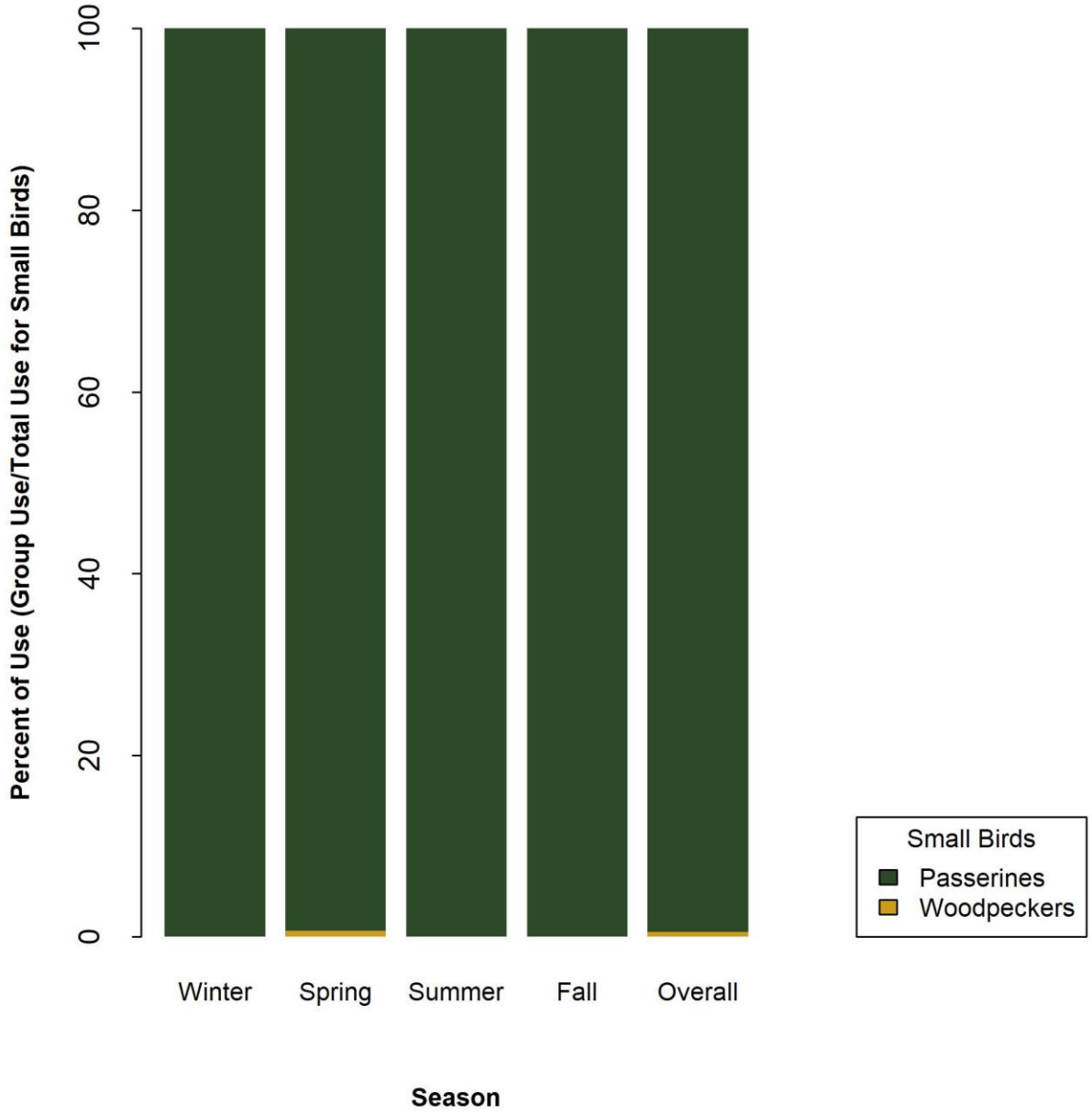


Figure 6b. Small bird percent of use by season and bird type at the Rail Tie Wind Project in Albany County, Wyoming, January – December, 2020.

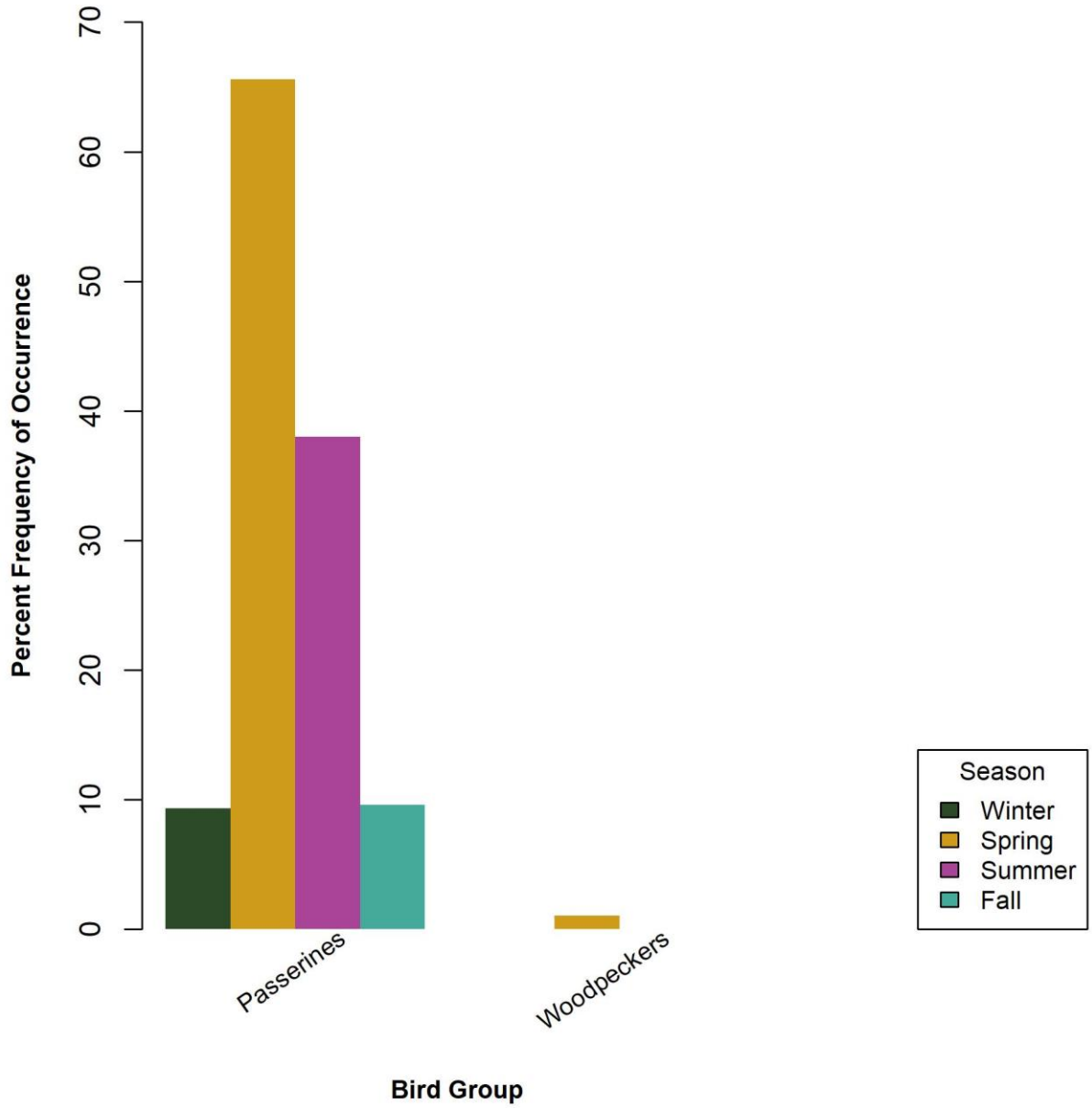


Figure 6c. Small bird frequency of occurrence by season and bird type at the Rail Tie Wind Project in Albany County, Wyoming, January – December, 2020.

Flight Height

Small bird flight heights ranged from 4.0 m (13.1 ft) for mimids and shrikes to 10.0 m (32.8 ft) for swallows (Table 6). Small birds were mainly (95.1%) observed below the RSH. Bird types recorded within the RSH included blackbirds/orioles (12.5%) and grassland/sparrows (5.0%), whereas all other species groups were recorded below the RSH (Table 6). No small birds were observed flying above RSH (Table 6).

Table 6. Group and individual observation flight height characteristics by bird type[a] and passerine subtype during bird use surveys at the Rail Tie Wind Project in Albany County, Wyoming, January – December, 2020.

Bird Type	% Obs Flying	# Grps Flying	# Obs Flying	Mean Flight Height (m)	% within Flight height Categories		
					0<25 m	25-200 m[b]	>200 m
Passerines	**103**	**221**	**55.5**	**7**	**95.0**	**5.0**	**0**
Blackbirds/Orioles	*20*	*32*	*25.6*	*10*	*87.5*	*12.5*	*0*
Finches/Crossbills	*2*	*6*	*100*	*7*	*100*	*0*	*0*
Flycatchers	*1*	*1*	*100*	*10*	*100*	*0*	*0*
Grassland/Sparrows	*57*	*141*	*71.2*	*6*	*95.0*	*5.0*	*0*
Mimids	*0*	*0*	*0*	*NA*	*NA*	*NA*	*NA*
Swallows	*2*	*5*	*100*	*9*	*100*	*0*	*0*
Shrikes	*1*	*1*	*100*	*10*	*100*	*0*	*0*
Thrushes	*17*	*31*	*77.5*	*9*	*100*	*0*	*0*
Titmice/Chickadees	*1*	*1*	*33.3*	*4*	*100*	*0*	*0*
Warblers	*0*	*0*	*0*	*NA*	*NA*	*NA*	*NA*
Wrens	*0*	*0*	*0*	*NA*	*NA*	*NA*	*NA*
Corvids(Subtype)	*2*	*3*	*42.9*	*10*	*100*	*0*	*0*
Woodpeckers	**1**	**2**	**100**	**5**	**100**	**0**	**0**
Small Birds Overall	**104**	**223**	**55.8**	**7**	**95.1**	**4.9**	**0**

[a]100-meter (m) for small birds.

[b] The likely rotor-swept height for potential collision with a turbine blade, or 25 to 200 m (82 to 565 feet) above ground level.

[c] Zeroes and NA values indicate that the species was observed but was not flying.

grp=groups, obs=observations

Spatial Variation

Mean Use by Point

Small bird use ranged from zero observations/100-m plot/10-minute survey at point 25 to 3.25 at point 23 (Figure 7; Appendix D). Small bird use was highest at point 23 (3.25), 24 (2.67), and point 21 (2.00). The highest use value for passerines was at point 23 (3.25). Woodpecker use occurred at point 11 only (Figure 7, Appendix C).

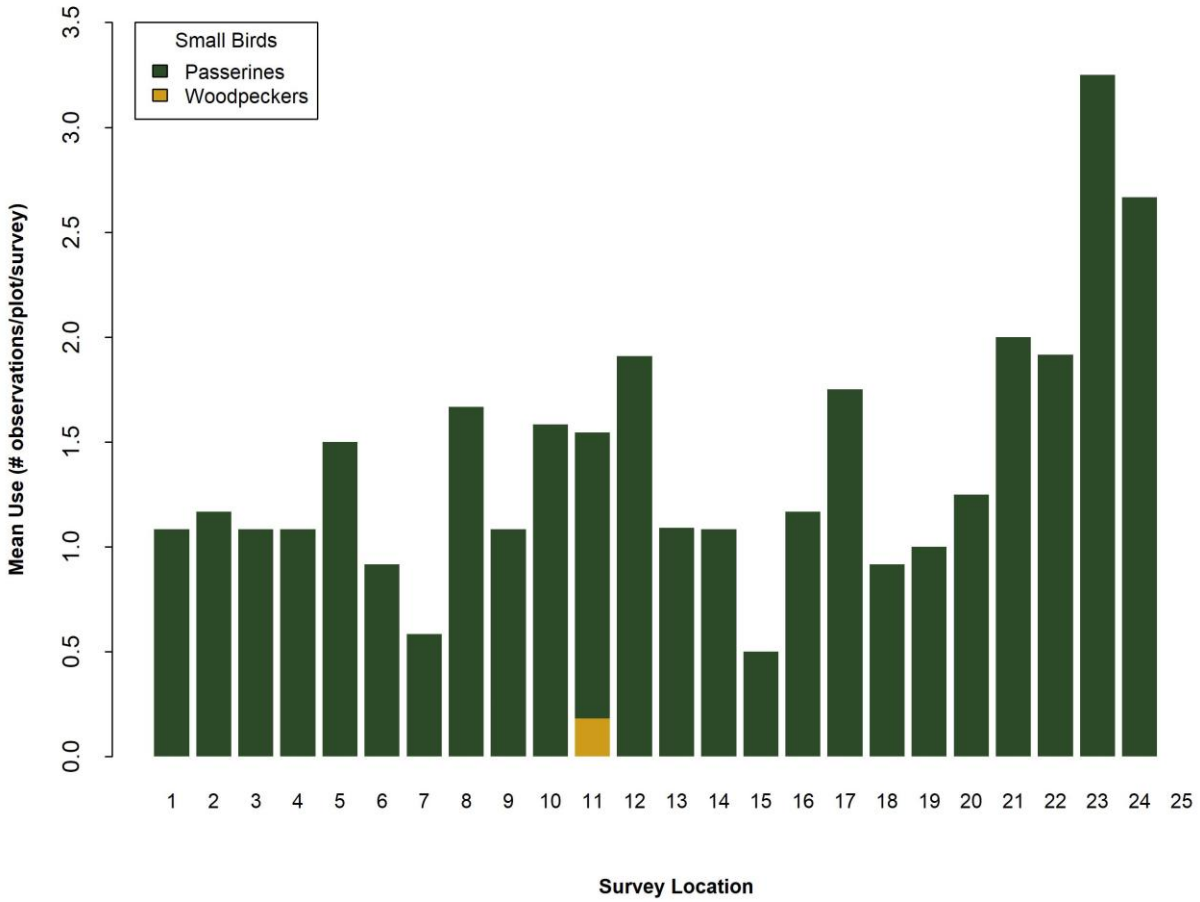


Figure 7. Small bird mean use by survey point at the Rail Tie Wind Project in Albany County, Wyoming, January – December, 2020.

DISCUSSION

The WEG outline a structured approach to evaluating risk to wildlife posed by wind energy facility development (USFWS 2012), and avian use data collected prior to construction at proposed wind facilities can be used to understand species composition, and spatial and temporal use patterns. However, pre-construction avian use data do not reliably predict post-construction mortality rates (Ferrer et al., 2012, Loss et al. 2013), likely due to complex interactions of biological, site, and landscape factors (Marques et al. 2014). Thus, developing quantitative predictions of the number of fatalities of particular species or species group using pre-construction data is not feasible except for a few select species (e.g., golden eagle). Alternatively, pre-construction use data can be examined in the context of known local or regional fatality trends to better understand the potential for generalized avian mortality at operational wind facilities.

For example, if pre-construction avian studies at a proposed wind farm show that certain species are abundant and are also known to have high fatality rates at wind facilities in the region, it can be reasonably concluded that collision risk would be higher for this species than a species that is

uncommon and has low known fatality rates (Erickson et al. 2014, AWWI 2019). However, conclusions regarding the number of individuals or the spatial distribution among turbines are beyond the inferential limits of pre-construction data combined with local and regional fatality patterns. Further, little inference can be made about collision risk potential for species with low mean use or that occurred infrequently. Thus, pre-construction use data from the Project are coupled with mortality patterns from other operating wind projects to provide generalizations regarding the potential risk to species posed by Project development.

Species Composition

The large bird species composition varied among seasons, and because summer and fall were the seasons with the comparatively highest mean use, we examined mean use by species within summer and fall. The large bird species with the highest mean use during 90-min surveys was common raven, followed by turkey vulture, and black-billed magpie. These species were not among the most common species observed at three National Wildlife Refuges in Wyoming Basin Ecoregion (Griscom et al. 2010), which might be attributable to the survey locations in the National Wildlife Refuges near water. Corvids (i.e., common raven, black-billed magpie) are not widely represented in fatality monitoring studies (AWWI 2019, WEST 2019), and although abundant at the Project, mortality of these species is not likely to be reflective of mean use. In other words, collision risk is low for corvids in general at wind facilities. Although not one of the top five species found as fatalities in the Mountain Prairie region, turkey vulture rank in the top five in the Southwest Region (WEST 2019) and in the top 10 nationally (AWWI 2019), and it is possible that mortality of this species could occur as it was observed at the Project.

As described earlier, the relationship between use and mortality is not well defined (Ferrer et al. 2012), and in some cases species with relatively low mean use values could collide with turbines based on a number of factors (Marques et al. 2014). For example, raptors often do not have high mean use values compared to species that aggregate in groups such as ducks, geese, and blackbirds. However, in a summary of fatality monitoring data from 193 studies at wind facilities across the U.S., AWWI (2019) found that diurnal raptors ranked second in percent composition of unadjusted bird fatalities. To provide insight into mortality patterns regionally, WEST (2019) summarized data by USFWS regions; the Project occurs in the Mountain Prairie Region. The top five raptor species reported across 33 studies in the Mountain Prairie Region included golden eagle, red-tailed hawk, American Kestrel, Swainson's hawk, and ferruginous hawk, all of which were observed at the Project. Raptor fatality rates ranged from approximately 0.20 fatalities/MW/year to 0.04 fatalities/MW/year (WEST 2019). Thus, given the relationship between raptor activity and collision risk with operating wind turbines is not well understood, the limited conclusion that can be reached from the data is that there is some potential risk of collision for any raptor species observed to occur albeit over a time period that cannot be specified and that fatality rates could fall within the range from other studies conducted at wind energy projects within the region (Watson et al. 2018).

The small bird species with the highest mean use during 10-min surveys was horned lark, which was the most abundant species observed in surveys at three National Wildlife Refuges in Wyoming Basin Ecoregion (Griscom et al. 2010). Thus, based on the abundance of horned lark

regionally and at the Project and given mortality patterns at other wind facilities nationally and specifically in the USFWS Mountain Prairie Region, horned lark fatalities could occur at the Project (Erickson et al. 2014, WEST 2019); however, the number cannot be predicted. Fatalities of other small bird species frequently observed at the Project such as western meadowlark could occur based on available mortality data (Erickson et al. 2014, WEST 2019), but methods to reliably predict species composition or fatality rates have not been developed. Using data from 116 studies at wind facilities throughout the U.S., Erickson et al. (2014) found that, at most, estimated wind turbine mortality affected 0.029% of the national small bird population and was not anticipated to result in population level effects. Thus, small bird mortality at the Project is not expected to have population level effects (Erickson et al. 2014).

Spatial Patterns

Large bird mean use during 90-min surveys varied widely from 1.00 observations/800-m plot/90-min survey (point 18) to 4.25 (point 24) across points. Most of the large bird use observed at Point 24 was comprised of waterfowl (mean use = 1.83) and large corvids (mean use = 1.17). The second highest large bird use value was observed at point 23 (4.08) where large corvids accounted for the majority (2.25) of use at this point. As Canada geese associate with water, and there is no water near Point 24, use by this species at this point is unlikely to be an indicator of future use. Diurnal raptor use also varied widely with mean use during 90-min surveys greater than 1.0 at five points with all of the five points located in open shrub-steppe habitat that could provide foraging opportunities. Thus, based on general habitat type, and after an examination for bird attractants (e.g., waterbodies) near the points with highest mean use, we could not identify unique landscape features that could have influenced the variability in spatial use by large birds as high use points shared landscape traits with low use points

Small bird mean use during 10-min surveys varied widely among points from 0 to 3.25 birds/plot/10-min survey and was largely influenced by occurrence of horned lark. Points (23, 24, and 21) with the greatest use were not clustered in the same areas; point 23 is located in the western portion of the Project, Point 24 in the center of the Project, and Point 21 in the northeastern portion of the Project. All three points with the highest mean use are located within land cover typical of that throughout the project (shrub-scrub and herbaceous). Point 23 is located near water which could be a factor in the higher use observed at this point. However, water is present near a number of other survey points where small bird use was low. At Points 24 and 21, we could not identify unique landscape features that could have influenced the variability in spatial use by small birds as these high use points shared landscape traits with low use points.

Temporal Patterns

Large bird mean use during 90-min surveys was highest in summer and fall, which reflects the seasonal use by waterfowl at lakes in the region and the diversity of diurnal raptors that nest in the area and migrate through during fall. Seasonality in raptor fatality rates is not as evident as in songbirds, but in a summary of fatality monitoring data from 193 studies at wind facilities in the U.S., AWWI (2019) found a peak in fatalities in fall, which could be attributed to fall migration. Thus, reaching conclusions about seasonal collision risk to raptors is limited, and consistent with

the previous conclusion, if a raptor species occurs in a given season, there is the potential for a fatality to occur.

The Project is proposed in a landscape that is subjected to harsh winters with temperatures frequently below zero with winds regularly approaching 40 miles per hour creating blowing and drifting snow (NCDC 2020). Thus, the low mean use for small birds in fall and winter reflects the difficulty of existing in the local conditions throughout late fall and winter. Spring and summer had the highest mean use over the survey year, with spring use (3.21) considerably higher than summer use (0.76). Higher small bird use observed during spring is likely reflective of the greater diversity of species passing through during migration and the fact that birds are often more vocal during spring as they defend their breeding territories and attract mates. However, overall high use of small birds within a project area may not be indicative of their collision risk with turbines. Using data from 116 studies at wind facilities throughout the U.S., Erickson et al. (2014) found that mortality of small passerines peaked during fall migration in September and October, with a smaller peak in April and May during spring migration; mortality was lowest in winter, and low during the breeding season (June and July). Based on use patterns observed at the Project, it is expected that temporal patterns in collision risk would be reflective of those observed throughout the U.S.

REFERENCES

81 Federal Register (FR) 242: 91494-91554. 2016. Eagle Permits; Revisions to Regulations for Eagle Incidental Take and Take of Eagle Nests; Final Rule. Department of the Interior Fish and Wildlife Service. 81 FR 91494. December 16, 2016. Available online: https://www.gpo.gov/fdsys/pkg/FR-2016-12-16/pdf/2016-29908.pdf

American Wind Wildlife Institute (AWWI). 2019. AWWI Technical Report: A Summary of Bird Fatality Data in a Nationwide Database. Washington, DC. Available at: https://awwi.org/wp-content/uploads/2019/02/AWWI-Bird-Technical-Report-02_25_19.pdf

Erickson, W. P., M. M. Wolfe, K. J. Bay, D. H. Johnson, and J. L. Gehring. 2014. A comprehensive analysis of small passerine fatalities from collision with turbines at wind energy facilities. PLOS ONE 9: e107491.

Ferrer, M., M. de Lucas, G. F. E. Janss, E. Casadoa, A. R. Munoz, M. J. Bechard, C. P. Calabuig. 2012. Weak relationship between risk assessment studies and recorded mortality at wind facilities. Journal of Applied Ecology 49:38-46.

ESRI. 2013. World Topographic Map. ArcGIS Resource Center. ESRI, producers of ArcGIS software. ESRI, Redlands, California. Last modified January 10, 2019. Information online: http://www.arcgis.com/home/item.html?id=30e5fe3149c34df1ba922e6f5bbf808f

Griscom, H. and D. Keinath. 2010. Inventory of upland songbirds on Mortenson Lake, Hutton Lake, and Bamforth National Wildlife Refuges. USGS Award no. G09AC00266.

Marques, A. T., H. Batalha, S. Rodrigues, H. Costa, M. J. R. Perira, C. Fonseca, M. Mascarenhas, and J. Bernardino. 2014. Understanding bird collisions at wind farms: an updated review of the causes and possible mitigation strategies. Biological Conservation 179:40–52.

Multi-Resolution Land Characteristics (MRLC). 2019. National Land Cover Database (NLCD) 2011. Multi-Resolution Land Characteristics (MRLC) Consortium. US Geological Survey (USGS) Earth Resources Observation and Science (EROS) Center, MRLC Project, Sioux Falls, South Dakota. May 10, 2019.

National Climatic Data Center (NCDC). Climate of Wyoming. Accessed 1/15/2020. Available online at: https://www.ncdc.noaa.gov/climatenormals/clim60/states/Clim_WY_01.pdf

US Fish and Wildlife Service (USFWS). 2012. Land-Based Wind Energy Guidelines. March 23, 2012. 82 pp. Available online: http://www.fws.gov/cno/pdf/Energy/2012_Wind_Energy_Guidelines_final.pdf

US Fish and Wildlife Service. 2013. Eagle Conservation Plan Guidance: Module 1 - Land-Based Wind Energy, Version 2. U.S. Department of the Interior, Fish and Wildlife Service, Division of Migratory Bird Management. April 2013. 103 pp. + frontmatter. Available online: https://www.fws.gov/migratorybirds/pdf/management/eagleconservationplanguidance.pdf

US Fish and Wildlife Service. 2016. Eagle Permits; Revisions to Regulations for Eagle Incidental Take and Take of Eagle Nests; Proposed Rule. 50 CFR 13 and 22. United State Fish and Wildlife Service, Department of the Interior. 81 Federal Register (FR) 88:227933-27976. May 6, 2016.

Watson, R. T., P. S. Kolar, M. Ferrer, T. Nygård, N. Johnston, W. G. Hunt, H. A. Smit-Robinson, C. J. Farmer, M. M. Huso, and T. E. Katzner. 2018. Raptor interactions with wind energy: Case studies from around the world. Journal of Raptor Research 1:1-18.

Western EcoSystems Technology, Inc. (WEST). 2019. Regional summaries of wildlife fatalities at wind facilities in the United States. Annual report from the Renew Database. Published by WEST, Inc. December 31, 2019.

Wyoming Game and Fish Department (WGFD). 2010. Wildlife Protection Recommendations for Wind Energy Development in Wyoming, WGFD, Cheyenne, Wyoming. November 17, 2010. Available online: https://wgfd.wyo.gov/WGFD/media/content/PDF/Habitat/Habitat%20Information/Wind%20Energy%20Development/Wildlife-Protection-Recommendations-for-Wind-Energy-Development.pdf

Appendix A. All Bird Types and Species Observed at the Rail Tie Wind Project, in Albany County, Wyoming during Avian use Surveys, January – December, 2020.

Appendix A1. Numbers of groups and observations by bird type and species for large bird use surveys at all distances at the Rail Tie Wind Project in Albany County, Wyoming, January – December, 2020.

		Winter		Spring		Summer		Fall		Total	
Type/Species	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Waterfowl		**0**	**0**	**1**	**4**	**2**	**23**	**0**	**0**	**3**	**27**
Canada goose	*Branta canadensis*	0	0	0	0	1	22	0	0	1	22
unidentified duck		0	0	1	4	1	1	0	0	2	5
Gulls/Terns		**0**	**0**	**0**	**0**	**0**	**0**	**1**	**7**	**1**	**7**
ring-billed gull	*Larus delawarensis*	0	0	0	0	0	0	1	7	1	7
Diurnal Raptors		**20**	**20**	**71**	**73**	**70**	**78**	**72**	**72**	**233**	**243**
Buteos		*9*	*9*	*35*	*37*	*30*	*35*	*47*	*47*	*121*	*128*
red-tailed hawk	*Buteo jamaicensis*	0	0	8	8	8	8	17	17	33	33
rough-legged hawk	*Buteo lagopus*	7	7	1	1	0	0	3	3	11	11
ferruginous hawk	*Buteo regalis*	0	0	13	13	8	8	19	19	40	40
unidentified buteo		2	2	6	7	3	8	2	2	13	19
Swainson's hawk	*Buteo swainsoni*	0	0	7	8	11	11	6	6	24	25
Northern Harrier		*3*	*3*	*14*	*14*	*4*	*4*	*5*	*5*	*26*	*26*
northern harrier	*Circus hudsonius*	3	3	14	14	4	4	5	5	26	26
Eagles		*6*	*6*	*6*	*6*	*7*	*7*	*13*	*13*	*32*	*32*
golden eagle	*Aquila chrysaetos*	6	6	4	4	4	4	8	8	22	22
bald eagle	*Haliaeetus leucocephalus*	0	0	2	2	1	1	4	4	7	7
unidentified eagle		0	0	0	0	2	2	1	1	3	3
Falcons		*1*	*1*	*12*	*12*	*22*	*23*	*7*	*7*	*42*	*43*
Merlin	*Falco columbarius*	0	0	1	1	0	0	0	0	1	1
prairie falcon	*Falco mexicanus*	0	0	3	3	12	12	6	6	21	21
American kestrel	*Falco sparverius*	0	0	8	8	10	11	1	1	19	20
unidentified falcon		1	1	0	0	0	0	0	0	1	1
Other Raptors		*1*	*1*	*4*	*4*	*7*	*9*	*0*	*0*	*12*	*14*
unidentified raptor		1	1	4	4	7	9	0	0	12	14
Vultures		**0**	**0**	**9**	**17**	**30**	**36**	**18**	**23**	**57**	**76**
turkey vulture	*Cathartes aura*	0	0	9	17	30	36	18	23	57	76
Doves/Pigeons		**0**	**0**	**1**	**1**	**1**	**1**	**0**	**0**	**2**	**2**
mourning dove	*Zenaida macroura*	0	0	1	1	1	1	0	0	2	2
Large Corvids		**71**	**104**	**59**	**90**	**31**	**39**	**111**	**143**	**272**	**376**
American crow	*Corvus brachyrhynchos*	0	0	0	0	2	2	0	0	2	2

Appendix A1. Numbers of groups and observations by bird type and species for large bird use surveys at all distances at the Rail Tie Wind Project in Albany County, Wyoming, January – December, 2020.

		Winter		Spring		Summer		Fall		Total	
Type/Species	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
common raven	*Corvus corax*	61	93	51	74	28	36	89	113	229	316
black-billed magpie	*Pica hudsonia*	10	11	8	16	1	1	22	30	41	58
Overall		**91**	**124**	**141**	**185**	**134**	**177**	**202**	**245**	**568**	**731**

obs = observations, grps = groups

Appendix A2. Numbers of groups and observations by bird type and species for 10-minute small bird use surveys at all distances at the Rail Tie Wind Project in Albany County, Wyoming, January – December, 2020.

		Winter		Spring		Summer		Fall		Total	
Type/Species	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Passerines		**8**	**30**	**172**	**335**	**27**	**39**	**10**	**14**	**217**	**418**
Blackbirds/Orioles		*0*	*0*	*70*	*135*	*1*	*1*	*0*	*0*	*71*	*136*
red-winged blackbird	*Agelaius phoeniceus*	0	0	3	13	0	0	0	0	3	13
Brewer's blackbird	*Euphagus cyanocephalus*	0	0	6	17	0	0	0	0	6	17
brown-headed cowbird	*Molothrus ater*	0	0	1	2	0	0	0	0	1	2
common grackle	*Quiscalus quiscula*	0	0	1	24	0	0	0	0	1	24
western meadowlark	*Sturnella neglecta*	0	0	59	79	1	1	0	0	60	80
Finches/Crossbills		*2*	*6*	*0*	*0*	*0*	*0*	*0*	*0*	*2*	*6*
gray-crowned rosy finch	*Leucosticte tephrocotis*	1	3	0	0	0	0	0	0	1	3
red crossbill	*Loxia curvirostra*	1	3	0	0	0	0	0	0	1	3
Flycatchers		*0*	*0*	*1*	*1*	*0*	*0*	*0*	*0*	*1*	*1*
western kingbird	*Tyrannus verticalis*	0	0	1	1	0	0	0	0	1	1
Grassland/Sparrows		*4*	*19*	*68*	*146*	*16*	*26*	*4*	*7*	*92*	*198*
horned lark	*Eremophila alpestris*	4	19	53	125	12	16	3	6	72	166
green-tailed towhee	*Pipilo chlorurus*	0	0	0	0	0	0	1	1	1	1
vesper sparrow	*Pooecetes gramineus*	0	0	12	16	1	1	0	0	13	17
thick-billed longspur	*Rhynchophanes mccownii*	0	0	1	2	3	9	0	0	4	11
Brewer's sparrow	*Spizella breweri*	0	0	1	1	0	0	0	0	1	1
unidentified sparrow		0	0	1	2	0	0	0	0	1	2
Mimids		*0*	*0*	*0*	*0*	*2*	*2*	*0*	*0*	*2*	*2*
sage thrasher	*Oreoscoptes montanus*	0	0	0	0	2	2	0	0	2	2
Swallows		*0*	*0*	*1*	*4*	*1*	*1*	*0*	*0*	*2*	*5*
cliff swallow	*Petrochelidon pyrrhonota*	0	0	0	0	1	1	0	0	1	1
tree swallow	*Tachycineta bicolor*	0	0	1	4	0	0	0	0	1	4
Shrikes		*0*	*0*	*1*	*1*	*0*	*0*	*0*	*0*	*1*	*1*
loggerhead shrike	*Lanius ludovicianus*	0	0	1	1	0	0	0	0	1	1
Thrushes		*0*	*0*	*19*	*34*	*6*	*8*	*1*	*2*	*26*	*44*
mountain bluebird	*Sialia currucoides*	0	0	16	31	5	7	1	2	22	40
American robin	*Turdus migratorius*	0	0	3	3	1	1	0	0	4	4
Titmice/Chickadees		*0*	*0*	*1*	*1*	*0*	*0*	*2*	*2*	*3*	*3*

Appendix A2. Numbers of groups and observations by bird type and species for 10-minute small bird use surveys at all distances at the Rail Tie Wind Project in Albany County, Wyoming, January – December, 2020.

		Winter		Spring		Summer		Fall		Total	
Type/Species	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
mountain chickadee	*Poecile gambeli*	0	0	1	1	0	0	2	2	3	3
Warblers		*0*	*0*	*1*	*2*	*0*	*0*	*1*	*1*	*2*	*3*
Wilson's warbler	*Cardellina pusilla*	0	0	0	0	0	0	1	1	1	1
yellow warbler	*Setophaga petechia*	0	0	1	2	0	0	0	0	1	2
Wrens		*0*	*0*	*7*	*7*	*1*	*1*	*2*	*2*	*10*	*10*
rock wren	*Salpinctes obsoletus*	0	0	6	6	1	1	2	2	9	9
house wren	*Troglodytes aedon*	0	0	1	1	0	0	0	0	1	1
Corvids		*2*	*5*	*3*	*4*	*0*	*0*	*0*	*0*	*5*	*9*
Clark's nutcracker	*Nucifraga columbiana*	2	5	3	4	0	0	0	0	5	9
Woodpeckers		**0**	**0**	**1**	**2**	**0**	**0**	**0**	**0**	**1**	**2**
northern flicker	*Colaptes auratus*	0	0	1	2	0	0	0	0	1	2
Overall		**8**	**30**	**173**	**337**	**27**	**39**	**10**	**14**	**218**	**420**

obs = observations, grps = groups

Appendix B. Bird Use, Percent of Use, and Frequency of Occurrence for Large Birds and Small Birds Observed during Avian Use Surveys at the Rail Tie Wind Project in Albany County, Wyoming, January – December, 2020

Appendix B1. Mean use (number of birds/plot[1]/90-minute survey), percent of use, and frequency of occurrence (%) for each large bird type and species by season during the avian use surveys at the Rail Tie Wind Project in Albany County, Wyoming, January – December, 2020.

	Mean Use				% of Use				% Frequency			
Type/Species	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**
Waterfowl	**0**	**0.04**	**0.44**	**0**	**0**	**2.4**	**12.9**	**0**	**0**	**1.0**	**2.0**	**0**
Canada goose	0	0	0.44	0	0	0	12.9	0	0	0	2.0	0
unidentified duck	0	0.04	0	0	0	2.4	0	0	0	1.0	0	0
Gulls/Terns	**0**	**0**	**0**	**0.11**	**0**	**0**	**0**	**3.3**	**0**	**0**	**0**	**1.6**
ring-billed gull	0	0	0	0.11	0	0	0	3.3	0	0	0	1.6
Diurnal Raptors	**0.20**	**0.66**	**1.50**	**0.98**	**12.6**	**37.3**	**44.1**	**28.7**	**17.3**	**51.5**	**62.0**	**42.3**
Buteos	*0.09*	*0.33*	*0.64*	*0.66*	*5.9*	*18.9*	*18.8*	*19.5*	*9.3*	*28.3*	*36.0*	*29.5*
red-tailed hawk	0	0.08	0.16	0.26	0	4.5	4.7	7.6	0	8.0	14.0	13.5
rough-legged hawk	0.09	0.01	0	0.04	5.9	0.6	0	1.2	9.3	1.0	0	2.7
ferruginous hawk	0	0.13	0.14	0.26	0	7.5	4.1	7.6	0	12.2	12.0	16.3
unidentified buteo	0	0.03	0.14	0.03	0	1.8	4.1	0.8	0	3.1	4.0	2.7
Swainson's hawk	0	0.08	0.20	0.08	0	4.5	5.9	2.3	0	6.0	16.0	5.3
Northern Harrier	*0.04*	*0.14*	*0.08*	*0.07*	*2.5*	*8.0*	*2.4*	*2.0*	*4.0*	*14.1*	*6.0*	*5.6*
northern harrier	0.04	0.14	0.08	0.07	2.5	8.0	2.4	2.0	4.0	14.1	6.0	5.6
Eagles	*0.07*	*0.04*	*0.14*	*0.14*	*4.2*	*2.3*	*4.1*	*4.1*	*5.3*	*4.1*	*10.0*	*13.8*
golden eagle	0.07	0.02	0.08	0.10	4.2	1.2	2.4	2.8	5.3	2.0	6.0	9.6
bald eagle	0	0.02	0.02	0.04	0	1.2	0.6	1.2	0	2.0	2.0	4.3
unidentified eagle	0	0	0.04	0	0	0	1.2	0	0	0	2.0	0
Falcons	*0*	*0.12*	*0.46*	*0.11*	*0*	*6.9*	*13.5*	*3.1*	*0*	*12.3*	*32.0*	*7.4*
Merlin	0	0.01	0	0	0	0.6	0	0	0	1.0	0	0
prairie falcon	0	0.03	0.24	0.09	0	1.7	7.1	2.6	0	3.1	16.0	7.4
American kestrel	0	0.08	0.22	0.02	0	4.6	6.5	0.5	0	8.2	18.0	1.6
Other Raptors	*0*	*0.02*	*0.18*	*0*	*0*	*1.1*	*5.3*	*0*	*0*	*2.0*	*10.0*	*0*
unidentified raptor	0	0.02	0.18	0	0	1.1	5.3	0	0	2.0	10.0	0
Vultures	**0**	**0.17**	**0.70**	**0.31**	**0**	**9.8**	**20.6**	**9.0**	**0**	**8.1**	**30.0**	**12.0**
turkey vulture	0	0.17	0.70	0.31	0	9.8	20.6	9.0	0	8.1	30.0	12.0
Doves/Pigeons	**0**	**0.01**	**0.02**	**0**	**0**	**0.6**	**0.6**	**0**	**0**	**1.0**	**2.0**	**0**
mourning dove	0	0.01	0.02	0	0	0.6	0.6	0	0	1.0	2.0	0
Large Corvids	**1.39**	**0.89**	**0.74**	**2.01**	**87.4**	**50.1**	**21.8**	**59.0**	**53.3**	**46.3**	**38.0**	**63.6**
American crow	0	0	0.04	0	0	0	1.2	0	0	0	2.0	0

Appendix B1. Mean use (number of birds/plot[1]/90-minute survey), percent of use, and frequency of occurrence (%) for each large bird type and species by season during the avian use surveys at the Rail Tie Wind Project in Albany County, Wyoming, January – December, 2020.

	Mean Use				% of Use				% Frequency			
Type/Species	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**
common raven	1.24	0.73	0.68	1.59	78.2	41.0	20.0	46.6	49.3	43.3	36.0	57.7
black-billed magpie	0.15	0.16	0.02	0.42	9.2	9.0	0.6	12.4	8.0	6.0	2.0	20.2
Overall	**1.59**	**1.77**	**3.40**	**3.40**	**100**	**100**	**100**	**100**	**NA**	**NA**	**NA**	**NA**

[1] 800-meter radius plot for large birds

Appendix B2. Mean bird use (number of birds/plot[1]/10-minute survey), percent of use, and frequency of occurrence (%) for each small bird type and species by season during the avian use surveys at the Rail Tie Wind Project in Albany County, Wyoming, January – December 2020.

	Mean Use				% of Use				% Frequency			
Type/Species	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**
Passerines	**0.39**	**3.19**	**0.76**	**0.19**	**100**	**99.4**	**100**	**100**	**9.3**	**65.6**	**38.0**	**9.6**
Blackbirds/Orioles	*0*	*1.24*	*0.02*	*0*	*0*	*38.8*	*2.6*	*0*	*0*	*39.3*	*2.0*	*0*
red-winged blackbird	0	0.02	0	0	0	0.6	0	0	0	2.0	0	0
Brewer's blackbird	0	0.17	0	0	0	5.3	0	0	0	6.0	0	0
brown-headed cowbird	0	0.02	0	0	0	0.6	0	0	0	1.0	0	0
common grackle	0	0.24	0	0	0	7.5	0	0	0	1.0	0	0
western meadowlark	0	0.79	0.02	0	0	24.7	2.6	0	0	37.3	2.0	0
Finches/Crossbills	*0.08*	*0*	*0*	*0*	*20.7*	*0*	*0*	*0*	*2.7*	*0*	*0*	*0*
gray-crowned rosy finch	0.04	0	0	0	10.3	0	0	0	1.3	0	0	0
red crossbill	0.04	0	0	0	10.3	0	0	0	1.3	0	0	0
Flycatchers	*0*	*0.01*	*0*	*0*	*0*	*0.3*	*0*	*0*	*0*	*1.0*	*0*	*0*
western kingbird	0	0.01	0	0	0	0.3	0	0	0	1.0	0	0
Grassland/Sparrows	*0.25*	*1.47*	*0.52*	*0.09*	*65.5*	*45.7*	*68.4*	*49.3*	*5.3*	*47.3*	*24.0*	*5.3*
horned lark	0.25	1.26	0.32	0.08	65.5	39.2	42.1	42.3	5.3	44.3	20.0	4.0
green-tailed towhee	0	0	0	0.01	0	0	0	7.0	0	0	0	1.3
vesper sparrow	0	0.16	0.02	0	0	5.0	2.6	0	0	11.0	2.0	0
thick-billed longspur	0	0.02	0.18	0	0	0.6	23.7	0	0	1.0	4.0	0
Brewer's sparrow	0	0.01	0	0	0	0.3	0	0	0	1.0	0	0
unidentified sparrow	0	0.02	0	0	0	0.6	0	0	0	1.0	0	0
Mimids	*0*	*0*	*0.04*	*0*	*0*	*0*	*5.3*	*0*	*0*	*0*	*4.0*	*0*
sage thrasher	0	0	0.04	0	0	0	5.3	0	0	0	4.0	0
Swallows	*0*	*0.04*	*0.02*	*0*	*0*	*1.2*	*2.6*	*0*	*0*	*1.0*	*2.0*	*0*
cliff swallow	0	0	0.02	0	0	0	2.6	0	0	0	2.0	0
tree swallow	0	0.04	0	0	0	1.2	0	0	0	1.0	0	0
Shrikes	*0*	*0.01*	*0*	*0*	*0*	*0.3*	*0*	*0*	*0*	*1.0*	*0*	*0*
loggerhead shrike	0	0.01	0	0	0	0.3	0	0	0	1.0	0	0
Thrushes	*0*	*0.32*	*0.14*	*0.03*	*0*	*9.8*	*18.4*	*14.1*	*0*	*17.3*	*8.0*	*1.3*
mountain bluebird	0	0.29	0.14	0.03	0	9.2	18.4	14.1	0	15.3	8.0	1.3

Appendix B2. Mean bird use (number of birds/plot[1]/10-minute survey), percent of use, and frequency of occurrence (%) for each small bird type and species by season during the avian use surveys at the Rail Tie Wind Project in Albany County, Wyoming, January – December 2020.

	Mean Use				% of Use				% Frequency			
Type/Species	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**
American robin	0	0.02	0	0	0	0.6	0	0	0	2.0	0	0
Titmice/Chickadees	*0*	*0.01*	*0*	*0.03*	*0*	*0.3*	*0*	*15.4*	*0*	*1.0*	*0*	*2.9*
mountain chickadee	0	0.01	0	0.03	0	0.3	0	15.4	0	1.0	0	2.9
Warblers	*0*	*0*	*0*	*0.01*	*0*	*0*	*0*	*7.0*	*0*	*0*	*0*	*1.3*
Wilson's warbler	0	0	0	0.01	0	0	0	7.0	0	0	0	1.3
Wrens	*0*	*0.06*	*0.02*	*0.03*	*0*	*1.9*	*2.6*	*14.1*	*0*	*5.0*	*2.0*	*2.7*
rock wren	0	0.06	0.02	0.03	0	1.9	2.6	14.1	0	5.0	2.0	2.7
Corvids	*0.05*	*0.03*	*0*	*0*	*13.8*	*1.0*	*0*	*0*	*1.3*	*2.0*	*0*	*0*
Clark's nutcracker	0.05	0.03	0	0	13.8	1.0	0	0	1.3	2.0	0	0
Woodpeckers	**0**	**0.02**	**0**	**0**	**0**	**0.6**	**0**	**0**	**0**	**1.0**	**0**	**0**
northern flicker	0	0.02	0	0	0	0.6	0	0	0	1.0	0	0
Overall	**0.39**	**3.21**	**0.76**	**0.19**	**100**	**100**	**100**	**100**	**NA**	**NA**	**NA**	**NA**

[1] 100-meter radius plot for small birds.

Appendix C. Mean Use by Point for All Birds, Bird Types, and Diurnal Raptor Subtypes during Avian Use Surveys at the Rail Tie Wind Project in Albany County, Wyoming, January – December, 2020

Appendix C. Mean use by point for small birds (# observations/100-m plot/10-min survey) and large birds (# observations/800-m plot/90-min survey) observed at the Rail Tie Wind Project in Albany County, Wyoming, January – December, 2020.

	Survey Point												
Bird Type	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Waterfowl	**0**	**0**	**0**	**0**	**0**	**0.33**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Gulls/Terns	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.58**	**0**	**0**	**0**
Diurnal Raptors	**1.92**	**0.58**	**0.42**	**0.67**	**0.92**	**0.08**	**0.08**	**1.17**	**0.42**	**0.58**	**0.73**	**0.27**	**0.91**
Buteos	*1.42*	*0.33*	*0.08*	*0.33*	*0.75*	*0*	*0*	*0.75*	*0.08*	*0.42*	*0.27*	*0*	*0.55*
Northern Harrier	*0*	*0.08*	*0.17*	*0.17*	*0*	*0.08*	*0*	*0.08*	*0.17*	*0*	*0*	*0*	*0*
Eagles	*0.17*	*0.08*	*0.08*	*0*	*0.08*	*0*	*0*	*0*	*0*	*0.08*	*0.09*	*0.09*	*0.09*
Falcons	*0.25*	*0*	*0.08*	*0.17*	*0.08*	*0*	*0*	*0.08*	*0.17*	*0.08*	*0.36*	*0.09*	*0.27*
Other Raptors	*0.08*	*0.08*	*0*	*0*	*0*	*0*	*0.08*	*0.25*	*0*	*0*	*0*	*0.09*	*0*
Vultures	**0.58**	**0**	**0**	**0.25**	**0**	**0.08**	**0.83**	**0.17**	**0.08**	**0.50**	**0**	**0.09**	**0**
Doves/Pigeons	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.09**	**0**	**0**
Large Corvids	**0.58**	**1.25**	**3.17**	**0.83**	**0.50**	**1.42**	**0.75**	**1.08**	**0.83**	**1.58**	**1.18**	**1.27**	**1.55**
All Large Birds	**3.08**	**1.83**	**3.58**	**1.75**	**1.42**	**1.92**	**1.67**	**2.42**	**1.33**	**3.25**	**2.00**	**1.64**	**2.45**
Passerines	**1.08**	**1.17**	**1.08**	**1.08**	**1.50**	**0.92**	**0.58**	**1.67**	**1.08**	**1.58**	**1.36**	**1.91**	**1.09**
Woodpeckers	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.18**	**0**	**0**
All Small Birds	**1.08**	**1.17**	**1.08**	**1.08**	**1.50**	**0.92**	**0.58**	**1.67**	**1.08**	**1.58**	**1.55**	**1.91**	**1.09**

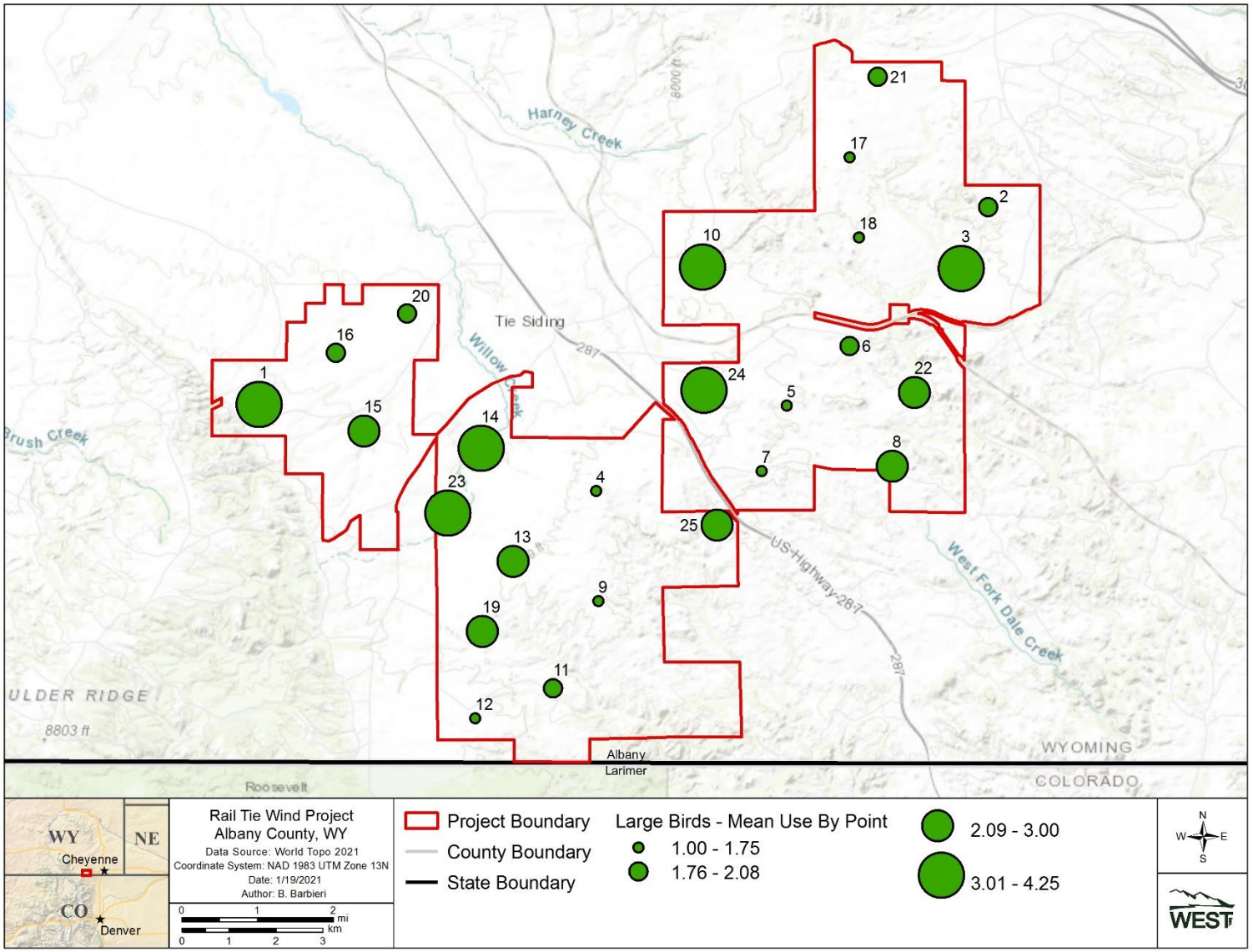
Appendix C. Mean use by point for small birds (# observations/100-m plot/10-min survey) and large birds (# observations/800-m plot/90-min survey) observed at the Rail Tie Wind Project in Albany County, Wyoming, January – December, 2020.

	Survey Point											
Bird Type	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**
Waterfowl	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1.83**	**0**

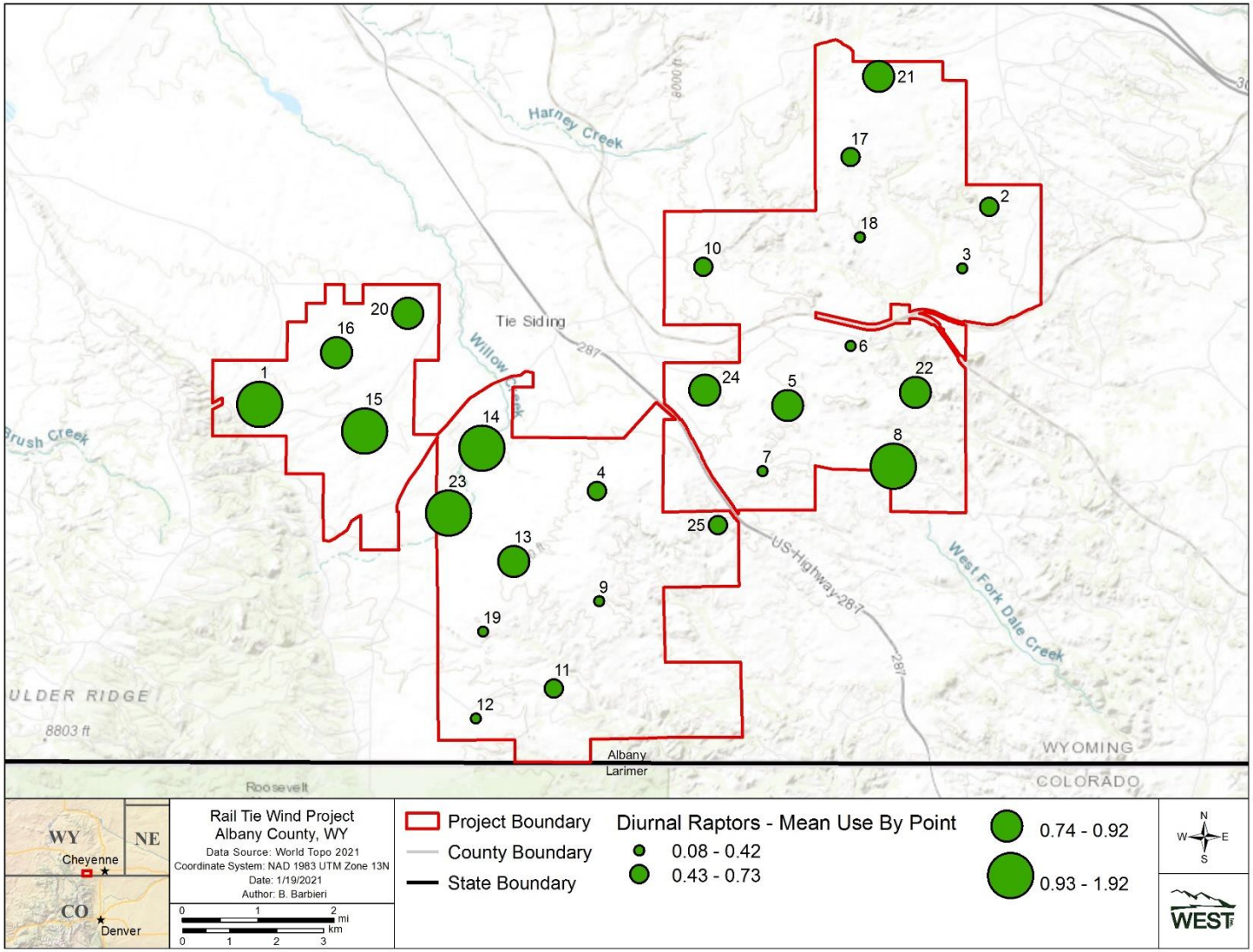
Appendix C. Mean use by point for small birds (# observations/100-m plot/10-min survey) and large birds (# observations/800-m plot/90-min survey) observed at the Rail Tie Wind Project in Albany County, Wyoming, January – December, 2020.

	Survey Point											
Bird Type	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**
Gulls/Terns	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Diurnal Raptors	**1.42**	**1.42**	**0.75**	**0.50**	**0.42**	**0.36**	**0.92**	**0.75**	**0.83**	**1.33**	**0.75**	**0.73**
Buteos	*0.67*	*0.67*	*0.25*	*0.25*	*0.08*	*0*	*0.42*	*0.58*	*0.50*	*0.83*	*0.42*	*0.36*
Northern Harrier	*0.42*	*0.17*	*0.17*	*0.17*	*0*	*0.09*	*0.17*	*0*	*0*	*0.08*	*0.17*	*0*
Eagles	*0.08*	*0.17*	*0.25*	*0.08*	*0*	*0.18*	*0.17*	*0.08*	*0.17*	*0.08*	*0*	*0.18*
Falcons	*0.25*	*0.17*	*0.08*	*0*	*0.25*	*0.09*	*0.17*	*0.08*	*0.17*	*0.33*	*0.17*	*0.18*
Other Raptors	*0*	*0.25*	*0*	*0*	*0.08*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Vultures	**0.33**	**0.83**	**0.08**	**0.25**	**0.08**	**0.27**	**0.17**	**0.42**	**0.08**	**0.50**	**0.50**	**0.18**
Doves/Pigeons	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.08**	**0**	**0**	**0**
Large Corvids	**2.00**	**0.75**	**1.25**	**0.75**	**0.50**	**1.82**	**1.00**	**0.92**	**1.92**	**2.25**	**1.17**	**1.27**
All Large Birds	**3.75**	**3.00**	**2.08**	**1.50**	**1.00**	**2.45**	**2.08**	**2.08**	**2.92**	**4.08**	**4.25**	**2.18**
Passerines	**1.08**	**0.50**	**1.17**	**1.75**	**0.92**	**1.00**	**1.25**	**2.00**	**1.92**	**3.25**	**2.67**	**0**
Woodpeckers	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
All Small Birds	**1.08**	**0.50**	**1.17**	**1.75**	**0.92**	**1.00**	**1.25**	**2.00**	**1.92**	**3.25**	**2.67**	**0**

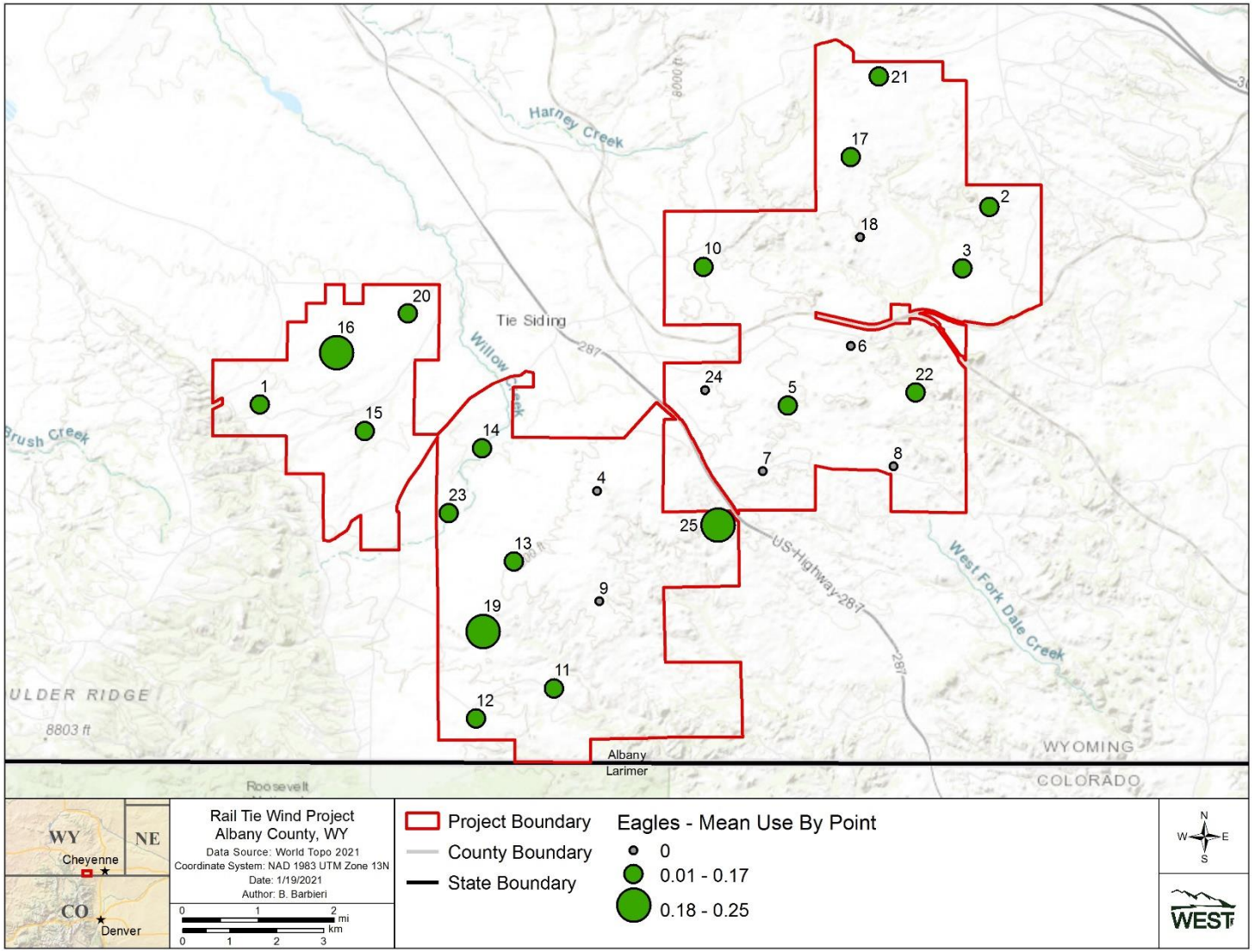
Appendix D. Mean Use by Point Maps for All Large Birds, Raptors, Eagles, and All Small Birds During Avian Use at the Rail Tie Wind Project in Albany County, Wyoming, January – December, 2020



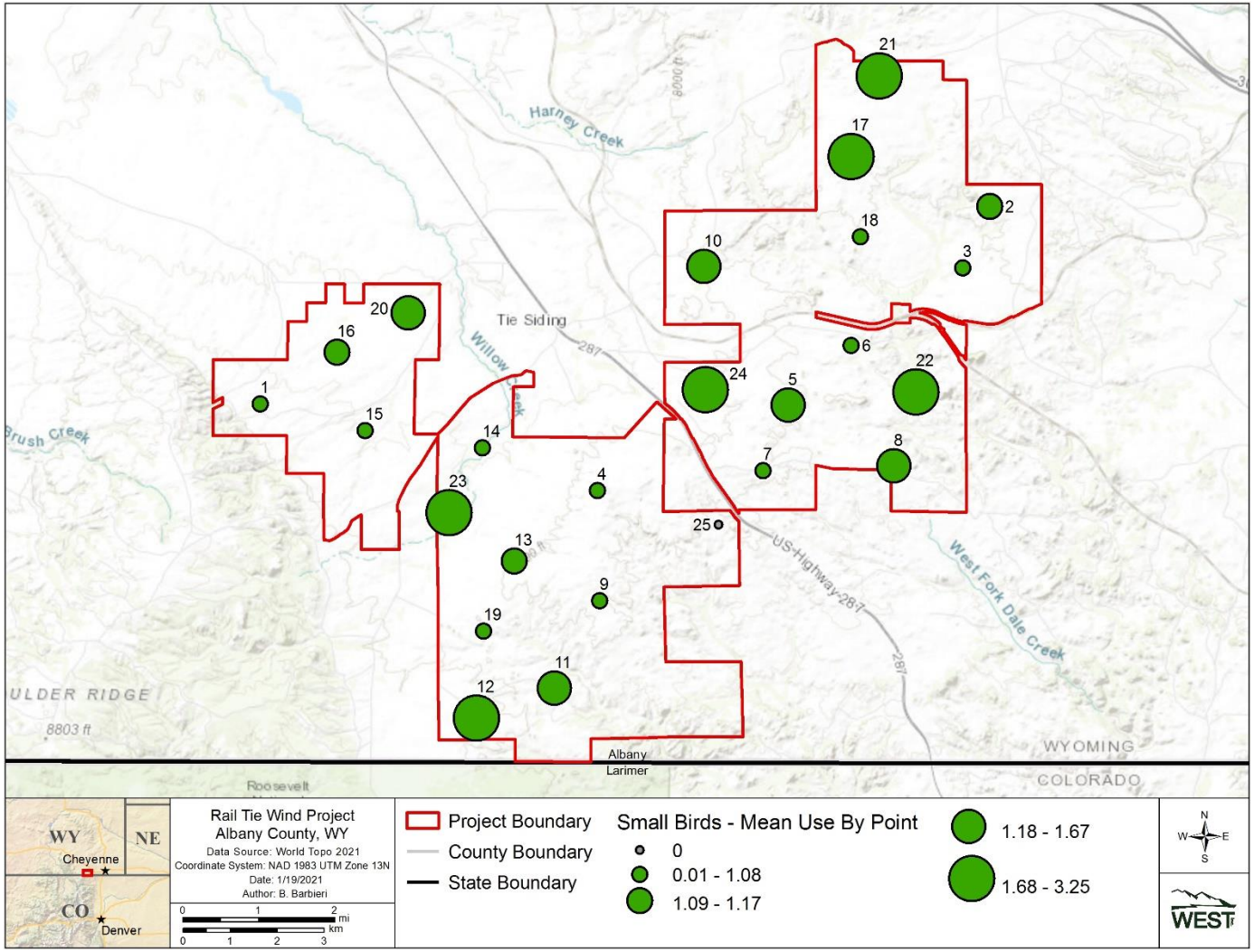
Appendix D1. Mean use by point for all large birds at the Rail Tie Wind Project in Albany County, Wyoming, January – December, 2020.



Appendix D2. Mean use by point for diurnal raptors at the Rail Tie Wind Project in Albany County, Wyoming, January – December, 2020.



Appendix D3. Mean use by point for eagles at the Rail Tie Wind Project in Albany County, Wyoming, January – December, 2020.



Appendix D4. Mean use by point for all small birds at the Rail Tie Wind Project in Albany County, Wyoming, January – December, 2020.