Appendix F

Wildlife Studies for the Bitter Root Wind Resource Area Yellow Medicine and Lincoln Counties, Minnesota

(Attached)

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Annual Report
March 25, 2008 – October 8, 2008

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EXECUTIVE SUMMARY

Buffalo Ridge Power Partners, LLC is proposing to develop a wind-energy facility in the Bitter Root Wind Resource Area (BRWRA; about 16,300 acres), located in Yellow Medicine and Lincoln Counties, Minnesota. Buffalo Ridge Power Partners requested that Western EcoSystems Technology, Inc. develop and implement a standardized protocol for wildlife studies in the BRWRA with the purpose of estimating impacts of the proposed wind-energy facility on wildlife and to assist with siting turbines to minimize impacts to wildlife resources. The scope of the wildlife studies included fixed-point bird use surveys, breeding bird transect use surveys, raptor nest survey, acoustic bat surveys, prairie grouse lek surveys, and incidental wildlife observations. This report presents the results of the field work conducted for the project which occurred from March 25 through October 8, 2008.

The objective of the fixed-point bird use surveys was to estimate the use of the study area by birds, particularly raptors. Ten points were selected to achieve coverage of the study area. All raptors and large birds observed perched or flying within 800 m of the survey point were recorded and mapped. Small birds within 100 m of the point were recorded, but not mapped. Surveys were conducted approximately every two weeks during spring, summer, and fall. Surveys occurred during daylight hours and survey periods varied to approximately cover all daylight hours during a season.

A total of 149 twenty-minute fixed-point surveys were conducted at the BRWRA. Sixty-eight unique species were observed, with a mean number of species observed per survey of 3.40. A total of 14,656 individual bird observations within 675 separate groups were recorded during the surveys. Three species accounted for approximately 89% of the observations: snow goose, red-winged blackbird, and Canada goose. A total of 37 individual raptors were recorded within the BRWRA, representing 5 identified species. The highest overall bird use occurred in the spring (233.38 birds/plot/20-min survey). Passerines were the most abundant bird type in the summer and fall and waterfowl were the most abundant bird type in the spring.

Waterfowl had the highest use in spring (226.38 birds/plot/20-min survey) compared to other times of the year. Waterfowl accounted for 97% of bird use in spring, about 24% in summer and about 26% in fall. Raptor use was higher in the fall (0.35 birds/plot/20-min survey) than in spring and summer. The northern harrier accounted for over half (0.14) of spring raptor use. In summer, the red-tailed hawk accounted for almost all (0.15) raptor use. Both species were equally represented (0.10) in fall raptor use. Passerine use was highest in fall (10.23 birds/plot/20-min survey) compared to summer, and spring. The red-winged blackbird accounted for most passerine use in all seasons.

For all bird species combined, use was highest at point #2 (275 birds/20-min survey), followed by points #3 and #10. For waterfowl, most use occurred at point #2 (271). Raptors were observed at eight of the 10 points and mean use was fairly consistent at the used points. Most passerine use occurred at point #3 (11.9).

The annual mean raptor use at the BRWRA (0.259 birds/20-min survey) was compared with other wind-energy facilities that implemented similar protocols and had data for three or four

seasons. Similar studies were conducted at 36 other wind-energy facilities. Based on the results from these projects, mean raptor use at BRWRA is considered to be low. A regression analysis of raptor use and mortality for 13 new-generation wind-energy facilities found that there was a significant correlation between use and mortality. Using this regression to predict raptor collision mortality at the BRWRA, the estimated fatality rate would be zero, or no raptor fatalities per year for each 100-MW of wind-energy development.

Passerines have been the most abundant avian fatality at wind energy facilities outside California. Given that passerines made up a large proportion of the birds observed in the summer and fall, we would expect passerines to make up a large proportion of fatalities at the BRWRA. In the spring, substantial concentrations of waterfowl (mainly snow geese) were observed at the BRWRA. Based on available evidence, waterfowl do not seem especially vulnerable to turbine collisions and significant mortality impacts are not likely.

The objectives of the transect bird use surveys were to identify bird use and distribution within the study area. Observers walked slowly along 14 pre-determined 800-m line transects in grasslands. Observers recorded observations for 50-meter segments along each transect. Each of the 14 transects was surveyed at least twice from early June to early July, 2008.

A total of 32 five-minute transect surveys were conducted. Forty-one unique species were identified; the mean number of species observed per survey was 5.85. A total of 758 individual bird observations within 417 separate groups were recorded. Three species accounted for 55% of the individual observations. These were mallard, bobolink, and red-winged blackbird. Waterfowl had a mean use of 3.05 birds/transect/survey and were observed in 53.6% of the surveys. The only raptor species observed during transect surveys was the northern harrier. Mean bird use for this raptor was 0.05 birds/transect/survey. Mean use was highest for passerines (16.39 birds/transect/survey). Within the group passerines, the bobolink and red-winged blackbird were the two species with the highest mean use. For all bird species combined, use was highest at transects 9 (57.5 birds/ survey) and 6 (48.0). Waterfowl had the highest mean use by far at transect 9 (32.50). Passerine use was highest at transect 6 (37.0). Raptors were observed at only two transects and use was split equally (0.50 at transects 10 and 11). Grassland birds and sparrows had a mean bird use of 4.0 or over at transects 3, 4, 6, and 11.

The objective of the raptor nest surveys was to locate and record raptor nest locations. Surveys were focused on locating large, stick nest structures. Surveys were completed by walking and driving along public roads and accessible private roads and looking for raptor nest structures within areas of suitable habitat. No raptor nests were observed on the BRWRA.

The objective of the prairie grouse lek surveys was to locate leks in the study area. Lek surveys were conducted twice at the BRWRA during spring 2008. No prairie grouse leks were observed during lek surveys.

The objective of the bat use surveys was to estimate the seasonal and spatial use of the BRWRA by bats. Bats were surveyed using one AnaBat® II bat detector and one AnaBat® SD-1 bat detector. Bat activity was surveyed using the two detectors from July 15 to September 23, 2008.

One detector was located on the ground and the other was initially on the ground and then raised to a newly built meteorological tower at that site, for a total of three locations.

Bat activity was monitored at three sampling locations on a total of 71 nights. Anabat units recorded 5,302 bat passes on 142 detector-nights, resulting in a mean of 37.9 bat passes per detector-night. Bat activity for all bats was highest at location 3597 (ground) with 66.8 bat passes per detector-night. Bat activity peaked during the period from July 30 through August 18. Peak bat activity occurred on July 30 when 216 passes per detector-night were recorded. Overall, passes by low-frequency bats (4,853) outnumbered passes by mid- and high-frequency bats (219; 230). The proportion of high-, mid-, and low-frequency bat passes was similar among all AnaBat locations. Hoary bats accounted for 16.6% of total passes detected and they were detected at every location on all 71 days of AnaBat operation.

Bat activity within the BRWRA (mean = 37.94 bat passes per detector-night) was high compared to that observed at facilities throughout the U.S. Based on the presumed relationship between pre-construction bat activity and post-construction fatalities, we expect bat mortality rates at BRWRA to be similar to or greater than the 10.2 bat fatalities/turbine/year reported at Top of Iowa, Iowa, but lower than the 38 fatalities/turbine/year reported at Mountaineer, West Virginia.

The objective of incidental wildlife observations was to provide records of wildlife seen outside of the standardized surveys. Incidental observations recorded by observers traveling around the site included seven species of raptors. Only the rough-legged hawk was not observed during fixed-point or transect surveys.

A species was deemed sensitive if it was given protected status under the Endangered Species Act, protected by the Minnesota Department of Natural Resources, or listed as a Species of Greatest Conservation Need by Bird Conservation Minnesota. None of the species observed during the course of the study were protected by the Endangered Species Act. Two bird species, the American white pelican and the loggerhead shrike, were protected by the Minnesota Department of Natural Resources, and sixteen species were listed as Species in Greatest Conservation Need by Bird Conservation Minnesota.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

Buffalo Ridge Power Partners, LLC (Buffalo Ridge) is proposing to develop a wind-energy facility in the Bitter Root Wind Resource Area (BRWRA), located in Yellow Medicine and Lincoln Counties, Minnesota. Buffalo Ridge requested that Western EcoSystems Technology, Inc. (WEST) develop and implement a standardized protocol for wildlife studies in the BRWRA with the purpose of estimating impacts of the proposed wind-energy facility on wildlife and to assist with siting turbines to minimize impacts to wildlife resources. These protocols, which were reviewed and commented on by staff of the Minnesota Department of Natural Resources and the U.S. Fish and Wildlife Service in April 2008, are similar to those used at other wind-energy facilities across the nation, and follow the guidance of the National Wind Coordinating Collaborative (Anderson et al. 1999). The protocols have been developed based on WEST's experience studying wildlife at proposed wind-energy facilities throughout the US and were designed to help predict potential impacts to bird (particularly raptors) and bat species.

The following is an annual report describing the results of surveys during the spring, summer, and fall of 2008. The scope of the wildlife studies included fixed-point bird use surveys, breeding bird transect use surveys, raptor nest survey, acoustic bat surveys, prairie grouse lek surveys, and incidental wildlife observations.

The principal objectives of this wildlife monitoring study were to: 1) estimate the use of the survey area by birds, particularly raptors, defined here as kites, accipiters, buteos, harriers, eagles, falcons, and owls; 2) estimate species use and distribution of birds within the survey area, particularly grassland nesting birds; 3) identify the species and estimate the density of nesting raptors in the study area; 4) estimate the density and use of prairie grouse and identify leks in the study area; 5) estimate the use of the study area by bats; 6) identify any federal and state threatened, endangered, proposed, candidate, or sensitive-status wildlife that may be affected by the proposed wind-energy facility; 7) describe incidental observations; and 8) estimate any potential impacts to birds and bats that could result from construction and operation of the proposed wind-energy facility.

STUDY AREA

The proposed BRWRA, about 6,598 hectares (16,300 acres), is located in western Minnesota in Yellow Medicine and Lincoln Counties. It occurs within the Coteau Moraines physiographic subsection which is included in the Prairie Parkland Province (MNDNR 1993). This subsection was once almost entirely tallgrass prairie but has now been converted largely to cultivated agriculture. Topography in the study area ranges from flat to slightly rolling, with no hills, ridges or other areas of pronounced topography. Elevations in the study area range from approximately 439 meters (1,440 feet) in the eastern part to 531 meters (1,742 feet) in the western portion. Dominant soils are loamy well-drained soils with thick dark surface horizons; soils are primarily Mollisols-Aquolls and Udolls with some Borolls and Ustolls.

Landuse is about 63% cropland and 34% grassland (Minnesota Gap Analysis). Ownership is about 90% private, 8% Minnesota Department of Natural Resources land (mostly Wildlife

Management Areas), and less than 2% county and federal land (Minnesota Gap Analysis-Stewardship data).

METHODS

Wildlife studies included fixed-point bird use surveys, transect bird use surveys, raptor nest surveys, acoustic bat surveys, prairie grouse lek surveys, and incidental wildlife observations.

Fixed-Point Bird Use Surveys

The objective of the fixed-point bird use surveys was to estimate the use of the study area by birds, particularly raptors. Fixed-point surveys (variable circular plots) were conducted using methods described by Reynolds et al. (1980). The points were selected to survey representative habitats and topography of the study area, while also providing relatively even coverage.

Bird Use Survey Plots
Ten points were selected to achieve coverage of the study area and habitats within the study area (Figure 1). Each plot was an approximate 800-m radius circle centered on the point.

Bird Survey Methods
Survey time at each point was 20 minutes. All raptors and large birds observed perched or flying within 800 m of the survey point were recorded and mapped. Small birds (e.g., sparrows) within 100 m (328 ft) of the point were recorded, but not mapped. Observations of birds beyond the 800-m (2,625-ft) radius were recorded, but were not included in the statistical analyses. A unique observation number was assigned to each observation.

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

Observation Schedule
Sampling intensity was designed to document bird use and behavior by habitat and season within the study area. Surveys were conducted approximately every two weeks during spring (defined as April 1 to May 31), summer (June 1 to August 15), and fall (August 16 to October 15). Surveys were conducted during daylight hours and survey periods varied to approximately cover all daylight hours during a season. To the extent practical, each point was surveyed about the same number of times; however, the schedule varied in response to adverse weather conditions (e.g., fog and/or rain), which may have caused delays and/or missed surveys.

Transect Grassland Bird Use Surveys

The objectives of the transect bird use surveys were to identify grassland bird use and distribution within the study area, and to provide baseline data on grassland bird distribution if post-construction comparisons are desirable in the future.

Bird Use Survey Transects

Originally, sixteen paired transects were mapped for inclusion in the study, but two of the transects were underwater and were therefore excluded from the study. An observer walked slowly along the pre-determined 800-m line transects (Figure 2). Transects were oriented east/west and located within the BRWRA in areas of grassland. Transects were followed using GPS units and observers recorded all birds detected by sight or sound.

Bird Survey Methods

Observers recorded observations for 50-m segments along each transect. The "block" for which birds were recorded was 50 m (160 ft) long (as the surveyor moved along the transect) by 100 m (320 ft) wide (50 m on either side of the transect). Each transect was approximately 800 m long and included 16 blocks.

In addition to the species observed and location, the following data were recorded for each transect survey: date, start and end time of observation period, transect number, species or best possible identification, number of individuals, behavior, first altitude above ground, flight direction, and auditory-only observations. Weather information, such as temperature, wind speed, wind direction, precipitation, and cloud cover also were recorded for each transect survey. Transects were established, relocated, and followed using GPS units with pre-recorded waypoints.

Observation Schedule

Each of the 14 transects was surveyed at least twice from early June to early July, 2008. The first visit (June 5) was aborted due to inclement weather; four transects had been completed and are included in the analysis. During the second (June 18, 19, and 20) and third visits (July 1 and 2), all 14 transects were surveyed. Surveys were conducted from sunrise to 10:00 a.m. All species observed by sight or sound were recorded.

Raptor Nest Surveys

The objective of the raptor nest surveys was to locate and record raptor nests that may be subject to disturbance and/or displacement effects by wind-energy facility construction and/or operation. Surveys were focused on large, stick nest structures, and did not include searches for cavity nests and ground nests. Surveys were completed by walking and driving along public roads and accessible private roads and looking for raptor nest structures within areas of suitable habitat (trees, rock outcrops, etc). Location, as well as nesting substrate and current status (inactive, active, incubating, young in nest), were recorded for each nest.

Prairie Grouse Lek Surveys

The objective of the prairie grouse lek surveys was to locate leks in the study area that may be subject to disturbance effects from the wind-energy facility construction and/or operation. Lek surveys were conducted twice at the BRWRA during spring 2008. Surveys occurred from public roads and accessible private roads that bordered grassland areas. Surveys were driven from 30 min prior to sunrise until two hours after sunrise. Observers stopped for a minimum of five min to listen and look for displaying or vocalizing grouse. If a lek was located, the observer mapped the location or recorded UTM coordinates and recorded the number of males, females, and birds of unknown sex attending the lek. Other information, such as weather conditions, vegetation/ topography descriptions, etc. was also recorded. To the extent possible, surveys were conducted on relatively calm mornings.

Bat Surveys

The objective of the bat use surveys was to estimate the seasonal and spatial use of the BRWRA by bats.

Bat Survey Locations
Detectors were placed at two fixed locations. One detector was located on the ground and the other was initially on the ground and then raised to a height of approximately 50 m (164 ft) on a newly erected meteorological tower at that site (Figure 3).

Bat Survey Methods
Bats were surveyed using one AnaBat® II bat detector and one AnaBat® SD-1 bat detector (Titley Electronics Pty Ltd., NSW, Australia) coupled with Zero Crossing Analysis Interface Modules (ZCAIM; Titley Electronics Pty Ltd., NSW, Australia). Bat detectors are a recommended method to index and compare habitat use by bats. The use of bat detectors for calculating an index to bat impacts has been used at several wind-energy facilities (Kunz et al. 2007a), and is a primary and economically feasible bat risk assessment tool (Arnett 2007).

AnaBat detectors record bat echolocation calls with a broadband microphone. The echolocation sounds are then translated into frequencies audible to humans by dividing the frequencies by a predetermined ratio. A division ratio of 16 was used for the study. Bat echolocation detectors also detect other ultrasonic sounds made by insects, raindrops hitting vegetation, and other sources. A sensitivity level of six was used to reduce interference from these other sources of ultrasonic noise. Calls were recorded to a compact flash memory card with large storage capacity. All units were programmed to turn on each night an approximate half-hour before sunset and turn off an approximate half-hour after sunrise. Ground-based AnaBat detectors were placed inside plastic weather-tight containers with a hole cut in the side of the container for the microphone to extend through. Microphones were encased in PVC tubing with drain holes that curved skyward at 45 degrees outside the container to minimize the potential for water damage due to rain. Containers were raised approximately 1 m (3.3 ft) off the ground to minimize echo interference and lift the unit above vegetation. The elevated AnaBat microphone was mounted approximately 50 m (164 ft) on the meteorological tower and encased in a Bat-Hat weatherproof housing system (EME Systems, Berkeley, California). The microphone was attached to a coaxial cable that transmitted ultrasonic sounds to an AnaBat unit at the base of the tower.

Data Collection Schedule
Bat activity was surveyed using two detectors from July 15 to September 23, 2008, a period including the likely fall bat migration at this site.

Incidental Wildlife Observations

The objective of incidental wildlife observations was to provide records of wildlife seen outside of the standardized surveys. Raptors and other sensitive, unusual, or unique species were recorded in a similar fashion to standardized surveys. The observation number, date, time, species, number of individuals, sex/age class, distance from observer, activity, height above ground (for bird species), habitat, and, in the case of sensitive species, the location was recorded.

Identification of Sensitive Species

A species was deemed sensitive if it was given protected status under the Endangered Species Act (ESA 1973; USFWS 2009), protected by the Minnesota Department of Natural Resources (MNDNR 2009), or listed as a Species of Greatest Conservation Need by Bird Conservation Minnesota (BCM 2009).

Statistical Analysis

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

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

Fixed-Point Bird Use Surveys
<u>Bird Diversity and Species Richness</u>
Bird diversity was illustrated by the total number of unique species observed. Species lists, with the number of observations and the number of groups, were generated by season, including all observations of birds detected regardless of their distance from the observer. Species richness was calculated as the mean number of species observed per survey (i.e., number of

species/plot/20-min survey). Species diversity and richness were compared between seasons for fixed-point bird use surveys.

Bird Use, Composition, and Frequency of Occurrence

For the standardized fixed-point bird use estimates, only observations of birds detected within the 800-m radius plot were used. Estimates of bird use (i.e., number of birds/plot/20-min survey) were used to compare differences between bird types, seasons, and other wind-energy facilities.

The frequency of occurrence was calculated as the percent of surveys in which a particular species/bird type is observed. Percent composition was calculated as the proportion of the overall mean use for a particular species/bird type. Frequency of occurrence and percent composition provide relative estimates of species exposure to the wind project. For example, a species may have high use estimates for the site based on just a few observations of large flocks; however, the frequency of occurrence will indicate that it occurs during very few of the surveys and therefore, may be less likely affected by the project.

Spatial Use

Data were analyzed by comparing use among plots; the objective was to look for areas of concentrated use by raptors and other large birds within the study area. This information can be useful in turbine layout design or adjustments of individual turbines for micro-siting.

Transect Grassland Bird Use Surveys

Bird Diversity and Species Richness

Bird diversity was illustrated ay the total number of unique species observed. Species lists, with the number of observations and the number of groups, were generated by season, including all observations of birds detected regardless of their distance from the transect. Species richness was calculated as the mean number of species observed per survey (i.e., number of species/transect/survey period). Species diversity and richness were compared between seasons for transect use surveys.

Bird Use, Composition, and Frequency of Occurrence

For the standardized bird use estimates, only observations of birds detected within 50-m on either side of the transect were used. Estimates of bird use (i.e., number of birds/transect) were used to compare differences between bird types and seasons.

The frequency of occurrence was calculated as the percent of surveys in which a particular species/bird type is observed. Percent composition was calculated as the proportion of the overall mean use for a particular species/bird type. Frequency of occurrence and percent composition provide relative estimates of species exposure to the wind project.

Bat Surveys

The units of activity were number of bat passes (Hayes 1997). A pass was defined as a continuous series of two or more call notes produced by an individual bat with no pauses between call notes of less than one second (Gannon et al. 2003; White and Gehrt 2001). In this report, the terms bat pass and bat call are used interchangeably. The number of bat passes was determined by downloading the data files to a computer and tallying the number of echolocation passes recorded. Total number of passes was corrected for effort by dividing by the number of detector nights. Bat calls were classified as either high-frequency calls ($\geq$ 35 kHz) that are generally given by small bats (e.g. *Myotis* sp.) or low-frequency (< 35 kHz) that are generally given by larger bats (e.g. silver-haired bat [*Lasionycteris noctivagans*], big brown bat [*Eptesicus fuscus*], hoary bat [*Lasiurus cinereus*]). Data determined to be noise (produced by a source other than a bat) or call notes that did not meet the pre-specified criteria to be termed a pass were removed from the analysis. To establish which species may have produced the high- and low-frequency calls recorded, a list of species expected to occur in the study area was compiled from range maps (Table 1; BCI website; Harvey et al. 1999).

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

RESULTS

This interim report presents the results of the field work conducted in the spring, summer, and fall of 2008 for the BRWRA. Fieldwork on the project occurred from March 25 through October 8, 2008.

Fixed-Point Bird Use Surveys

A total of 149 twenty-minute fixed-point surveys were conducted at the BRWRA (Table 2).

Bird Diversity and Species Richness
Sixty-eight unique species were observed over the course of all fixed-point use surveys. The mean number of species observed was 3.40 species/point/survey period (Table 2). More unique species were observed during the summer (47 species), followed by spring (44), and fall (33). The mean number of species per survey was higher in the spring (4.22 species/point/survey period) and summer (3.58) compared to the fall (2.25; Table 2). A total of 14,656 individual bird observations within 675 separate groups were recorded during the fixed-point surveys (Table 3). Cumulatively, three species (4.4% of all species) accounted for approximately 89% of the observations: snow goose (*Chen caerulescens*), red-winged blackbird (*Agelaius phoeniceus*), and Canada goose (*Branta canadensis*). No other species accounted for more than 2% of the observations (Table 3). A total of 37 individual raptors were recorded within the BRWRA, representing five identified species and one unknown species of buteo (Table 3).

Bird Use, Composition, and Frequency of Occurrence
Mean bird use, percent composition, and frequency of occurrence for all species and bird types by season are shown in Table 4. The highest overall bird use occurred in the spring (233.38 birds/plot/20-min survey), followed by fall (21.00), and summer (9.54). Passerines were the most

abundant bird type in the summer and fall and waterfowl were the most abundant bird type in the spring.

Waterbirds

Waterbirds had the highest use in summer (1.11 birds/plot/20-min survey) compared to other times of the year (fall 0.18 and spring 0.80; Table 4). The American white pelican (*Pelecanus erythrorhynchos*) had the highest summer bird use (0.74) of all waterbirds. In summer, waterbirds accounted for about 12% of the overall bird use and were observed in about 30% of summer surveys. The American white pelican accounted for 7.7% of overall bird use and was observed in about 18% of summer surveys.

Waterfowl

Waterfowl had by far the highest use in spring (226.38 birds/plot/20-min survey) compared to other times of the year (summer 2.27, and fall 5.53; Table 4). Within the waterfowl bird group, the snow goose (*Chen caerulescens*), only observed during spring, had a bird use of 208.70. Waterfowl accounted for 97% of bird use in spring, about 24% in summer, and about 26% in fall and were observed in about 24% - 66% of all surveys. The snow goose accounted for about 89% of bird use in spring.

Shorebirds

Shorebirds had the highest use in spring (0.38 birds/plot/20-min survey) compared to other times of the year (summer 0.20, and fall 0.30; Table 4). Shorebirds accounted for less than 3% of the overall bird use in all three seasons. Shorebirds were observed during 12.5% - 24.0 of the surveys.

Rails/Coots

The American coot (*Fulica americana*) use was highest in fall (3.38 birds/plot/20-min survey) and less in spring (1.50) and summer (1.35; Table 4). Coots contributed 16.1% of all fall bird use and 14.1% of all summer bird use. Coots were observed in 13.5 to 25% of all surveys.

Raptors

Raptor use was higher in the fall (0.35 birds/plot/20-min survey) than in spring (0.24) and summer (0.19; Table 4). The northern harrier (*Circus cyaneus*) accounted for over half (0.14) of spring raptor use. In summer, the red-tailed hawk (*Buteo jamaicensis*) accounted for almost all (0.15) raptor use. Both species were equally represented (0.10) in fall raptor use. Raptors accounted for less than 2% of the overall bird use in during all three seasons. Raptors were observed during 20.0% of surveys in the spring, 30.0% in the summer, and 25% in fall.

Vultures

The turkey vulture (*Cathartes aura*) use was highest in fall (0.10 birds/plot/20-min survey; Table 4). Summer vulture use was 0.02 and no vultures were observed in spring). In fall, the turkey vulture accounted for very little (0.5) of bird use and was only observed in 5% of fall surveys.

Upland Gamebirds

Upland gamebird use was highest in spring (1.16 birds/plot/20-min survey) and relatively similar in summer (0.54) and fall (0.45; Table 4). The ring-necked pheasant (*Phasianus colchicus*) accounted for almost all of upland gamebird use. One group of 5 sharp-tailed grouse were observed at point 2 during the fall counts. Upland gamebirds, primarily pheasants, accounted for a small amount of overall bird use (0.5 - 5.6%) but were frequently observed during surveys (20 - 68%), particularly in the spring (68%).

Doves/Pigeons

Dove/pigeon use was highest in the summer (0.76 birds/plot/20-min survey), slightly less in fall (0.50) and much less in spring (0.06; Table 4). Doves/pigeons did not account for much of overall bird use (<0.1 – 8.0%) and were not observed during very many surveys (4 – 17%).

Passerines

Passerine use was highest in fall (10.23 birds/plot/20-min survey) compared to summer (3.07), spring (2.74; Table 4). The red-winged blackbird (*Agelaius phoeniceus*) accounted for most passerine use in all seasons. Passerines were just 1.2% of spring bird use but were about 32% of summer bird use and about 49% of fall use. Passerines were frequently observed in surveys during all seasons (75.0 – 83.1%).

Sensitive Species Observations

None of the species observed were protected by the Endangered Species Act. Two bird species are protected by the Minnesota Department of Natural Resources and 13 species were Species in Greatest Conservation Need (Table 5).

Spatial Use

For all bird species combined, use was highest at point #2 (275 birds/20-min survey), followed by points #3 (160) and #10 (104). Bird use at other points ranged from 19.5 to 80.4 (Figure 4). For waterfowl, most use occurred at point #2 (271); points #3 (146) and #10 (95.8) were used to a lesser extent. Rail and coot use occurred at only two points with point #4 accounting for almost all the use. Raptors were observed at eight of the 10 points and mean use was fairly consistent at the used points. Most passerine use occurred at point #3 (11.9); bird use at other points ranged from 1.47 to 7.13. Upland gamebird use was spread quite uniformly between all points.

Transect Bird Use Surveys

Bird use transect surveys were conducted at the BRWRA three times during the summer. A total of 32 five-minute transect surveys were conducted (Table 6).

Bird Diversity and Species Richness

Forty-one unique species were identified during the transect use surveys and the mean number of species observed per transect per survey period was 5.85 (Table 6). A total of 758 individual bird observations within 417 separate groups were recorded (Table 7). Cumulatively, three species (7% of all species) accounted for 55% of the individual observations. These were mallard (*Anas platyrhynchos*), bobolink (*Dolichonyx oryzivorus*), and red-winged blackbird. All other species accounted for 6% or less of the observations individually.

Bird Use, Composition, and Frequency of Occurrence

Mean bird use estimates, percent of total composition, and frequency of occurrence for all species and bird types are shown in Table 8.

Waterbirds

Waterbird species had a mean bird use of 0.18 birds/transect/survey. Waterbirds were observed in 13.1% of the surveys and accounted for 0.9% of the overall use.

Waterfowl

Waterfowl had a mean use of 3.05 birds/transect/survey; the mallard had a mean use of 1.57, the highest of all waterfowl species. Waterfowl were observed in 53.6% of the surveys but only accounted for 14.6% of the overall use.

Shorebirds

Killdeer (*Charadrius vociferus*) were the only shorebird observed and had a mean use of 0.05 birds/transect/survey. Shorebirds were observed in 2.4% of the surveys and accounted for 0.2% of the overall use.

Rails/Coots

Coots and rails had a mean bird use of 0.30 birds/transect/survey. Coots and rails were observed in 17.9% of the surveys and accounted for 1.4% of the overall use.

Raptors

The only raptor observed during transects was the northern harrier (*Circus cyaneus*). Mean bird use for this raptor was 0.05 birds/transect/survey. Raptors were observed in 4.8% of the surveys and accounted for 0.2% of the overall use.

Upland Gamebirds

The ring-necked pheasant (*Phasianus colchicus*) was the only upland gamebird observed during transect surveys. Mean bird use for the pheasant was 0.39 birds/transect/survey. Pheasants were observed in 25% of the surveys but only accounted 1.9% of the overall use.

Passerines

Mean use was highest for passerines (16.39 birds/transect/survey). Most of passerine use was accounted for by the subtype blackbirds/orioles (13.21). Within the group passerines, the bobolink (4.82) and red-winged blackbird (6.52) were the two species with the highest mean use. Passerines were observed in all transect surveys and accounted for 78.7% of overall use.

Sensitive Species Observations

None of the species observed were protected by the Endangered Species Act. One bird species was protected by the Minnesota Department of Natural Resources and eight species were Species in Greatest Conservation Need (Table 5).

Spatial Use

Mean use (birds/tsurvey) was plotted by transect for all birds combined, waterbirds, waterfowl, shorebirds, rails/coots, raptors, upland gamebirds, passerines, and passerine subtypes (Figure 5). For all bird species combined, use was highest at transects 9 (57.5 birds/ survey) and 6 (48.0). Bird use for the other transects ranged from 1.5 to 33.3 birds/survey. Waterfowl had the highest mean use by far at transect 9 (32.50). Passerine use was highest at transect 6 (37.0). Raptors were

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Raptor Nest Surveys

No raptor nests were observed on the BRWRA.

Prairie Grouse Lek Surveys

No prairie grouse leks were observed during lek surveys.

Bat Surveys

Bat activity was monitored at three sampling locations on a total of 71 nights during the period July 15 to September 23, 2008. Anabat units recorded 5,302 bat passes on 142 detector-nights (Table 9). Averaging bat passes per detector-night across locations, a mean of 37.9 bat passes per detector-night.

Spatial Variation
Bat activity for all bats was highest at location 3597 (ground) with 66.8 bat passes per detector-night (Table 9 and Figure 3). Bat activity at location 1660 was slightly lower at 41.6 passes per detector-night. The least bat activity occurred at location 3597 (elevated) with 5.4 bat calls per detector-night.

The AnaBat unit at location 3597 was moved from a ground position to an elevated position on a newly constructed met tower on August 16, 2008 (Figure 3). Although the number of detector-nights was similar for the ground position (32) and the elevated position (39), there were many more bat passes recorded at the ground position (2139) as opposed to the elevated position (210).

Temporal Variation
Bat activity peaked during the period from July 29 through August 18 (Figure 6), when there were four nights with more than 100 bat passes per detector-night. Peak bat activity occurred on July 30 when 216 passes per detector-night were recorded. Use dropped off precipitously at location 3597 the week of August 12-18, when the unit was moved from ground based to elevated on the met tower while unit 1660 decreased at a slower rate until mid- to late-September.

Species Composition
Overall, passes by low-frequency bats (LF; 4,853) outnumbered passes by mid- and high-frequency bats (MF; 219; HF; 230; Table 9). The proportion of HF, MF, and LF bat passes was similar among all AnaBat locations.

Species identification for specific passes was possible for the hoary bat; therefore, passes by this species could be separated from passes by other low-frequency bats. Hoary bats accounted for

16.6% of total passes detected within the study area and were detected at every location on all 71 days of AnaBat operation.

Incidental Wildlife Observations

Incidental observations recorded by observers traveling around the site included seven species of raptors (Table 10). Only the rough-legged hawk (*Buteo lagopus*) was not observed during fixed-point or transect surveys.

Sensitive Species Observations

None of the species observed incidentally were protected by the Endangered Species Act. One bird species was protected by the Minnesota Department of Natural Resources and ten species were Species in Greatest Conservation Need (Table 5) by Bird Conservation Minnesota.

DISCUSSION

Bird Use

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

Substantial data on bird mortality at wind-energy facilities are available from studies in California and throughout the west and Midwest. Of 841 bird fatalities reported from California studies (>70% from the Altamont Pass facility in California), 39% were diurnal raptors, 19% were passerines (excluding house sparrows [*Passer domesticus*] and European starlings [*Sturnus vulgaris*]), and 12% were owls. Non-protected birds including house sparrows, European starlings, and rock doves (*Columba livia*) accounted for 15% of the fatalities. Other bird types generally made up less than 10% of the fatalities (Erickson et al. 2002b). During 12 fatality monitoring studies conducted outside of California, diurnal raptor fatalities accounted for 2% of the wind-energy facility-related fatalities and raptor mortality averaged 0.03/turbine/year. Passerines (excluding house sparrows and European starlings) were the most common collision victims, comprising 82% of the 225 fatalities documented. For all bird species combined, estimates of the number of bird fatalities per turbine per year from individual studies ranged from zero at the Searsburg wind-energy facility in Vermont (Kerlinger 1997) and the Algona facility in Iowa (Demastes and Trainer 2000), to 7.7 at the Buffalo Mountain facility in Tennessee (Nicholson 2003). Using mortality data from the last 10 years from wind projects throughout the entire United States, the average number of bird collision fatalities is 3.1 per megawatt per year, or 2.3 per turbine per year (NWCC 2004).

Raptor Use

The annual mean raptor use at the BRWRA (0.259 birds/20-min survey) was compared with other wind-energy facilities that implemented similar protocols and had data for three or four seasons (Figure 7). Similar studies were conducted at 36 other wind-energy facilities. The annual mean raptor use at these wind-energy facilities ranged from 0.09 birds/20-min survey at the San Gorgonio wind-energy facility in California to 2.34 birds/20-min survey at the High Winds facility, also in California. Based on the results from these projects, a ranking of seasonal raptor mean use was developed as: low (0 – 0.5 birds/plot/20-min survey); low to moderate (0.5 – 1.0); moderate (1.0 – 2.0); high (2.0 – 3.0); and very high (> 3.0). Using this ranking, mean raptor use at BRWRA is considered to be low, ranking 29th compared to the other 36 wind-energy facilities (Figure 7).

Although high numbers of raptor fatalities have been documented at some wind-energy facilities (e.g. Altamont Pass), a review of studies at wind-energy facilities across the United States reported that only 3.2% of casualties were raptors (Erickson et al. 2001a). Indeed, although raptors occur in most areas with the potential for wind-energy development, individual species appear to differ from one another in their susceptibility to collision (NRC 2007). Results from Altamont Pass in California suggest that mortality for some species is not necessarily related to abundance (Orloff and Flannery 1992). American kestrels, red-tailed hawks, and golden eagles were killed more often than predicted based on abundance. Thus far, only three northern harrier fatalities at existing wind energy facilities have been reported in publicly available documents, despite the fact they are commonly observed during point counts at these projects (Erickson et al. 2001a; Whitfield and Madders 2006). Because northern harriers often hunt close to the ground, risk of collision with turbine blades is considered low for this species. In addition, reports from the High Winds wind-energy facility in California document high American kestrel mortality. Relative use by American kestrels at the High Winds facility is almost six times the use of American kestrels at the Altamont Pass facility (Kerlinger 2005). It is likely that many factors, in addition to abundance, are important in predicting raptor mortality.

A regression analysis of raptor use and mortality for 13 new-generation wind-energy facilities, where similar methods were used to estimate raptor use and mortality, found that there was a significant correlation between use and mortality (R^2 = 69.9%; Figure 8). Using this regression to predict raptor collision mortality at the BRWRA, based on a mean raptor use of 0.259 birds/20-min survey, yields an estimated fatality rate of no raptors/MW/year, or no raptor fatalities per year for each 100-MW of wind-energy development. A 90% prediction interval around this estimate is zero to 0.24 raptors/MW/year.

Because few raptor species targeted during nest surveys (i.e., red-tails and other tree nesting species) have been observed as fatalities at newer wind energy facilities, correlations are very low between the number of collision fatalities and raptor nest density within one mile of project facilities. Raptors nesting closest to turbines likely have higher probabilities of being impacted from collision with turbines given their use of the area, but data on nests very close to turbines (e.g., within ½ mile) are currently inadequate to determine the level of these impacts. The existing wind plant with the highest reported nest density is Foote Creek Rim, Wyoming. Most of the nests within two miles of the wind energy facility are red-tailed hawks (Johnson et al. 2000b), but no red-tailed hawk fatalities have been documented at this site (Young et al. 2003c). There were no active raptor nests observed in the BRWRA.

Non-Raptor Use

Passerines (primarily perching birds) have been the most abundant bird fatality at wind energy facilities outside California (Erickson et al. 2001a, 2002b), often comprising more than 80% of the bird fatalities. Both migrant and resident passerine fatalities have been observed. Given that passerines made up a large proportion of the birds observed in the summer and fall, we would expect passerines to make up a fairly large proportion of fatalities at the BRWRA.

In the spring, substantial concentrations of waterfowl (mainly snow geese) were observed at the BRWRA. Wind-energy facilities with year-round use by water dependent species have shown the highest mortality, although the levels of waterfowl/waterbird/shorebird mortality appear insignificant compared to the use of the sites by these groups. Of 1,033 avian carcasses collected at U.S. wind-energy facilities, waterbirds accounted for 2%, waterfowl for 3%, and shorebirds for <1% (Erickson et al. 2002b). At the Klondike, Oregon wind-energy facilities, only two Canada goose fatalities were documented (Johnson et al. 2003b) even though 43 flocks totaling 4,845 individual Canada geese were observed during pre-construction surveys (Johnson et al. 2002a). The recently constructed Top of Iowa Wind Project is located in cropland between three Wildlife Management Areas (WMAs) with historically high bird use, including migrant and resident waterfowl. During a recent study, approximately one million goose-use days and 120,000 duck-use days were recorded in the WMAs during the fall and early winter, and no waterfowl fatalities were documented during concurrent and standardized wind project fatality studies (Koford et al. 2005). Similar findings were observed at the Buffalo Ridge Wind Project in southwestern Minnesota, which is located in an area with relatively high waterfowl/waterbird use and some shorebird use. Snow geese, Canada geese and mallards were the most common waterfowl observed. Three of the 55 fatalities observed during the fatality monitoring studies were waterfowl, including two mallards and one blue-winged teal (*Anas discors*). Two American coots, one grebe, and one shorebird fatality were also found (Johnson et al. 2002b). Based on available evidence, waterfowl do not seem especially vulnerable to turbine collisions and low mortality impacts would be expected at the BRWRA.

Temporal and Spatial Use

Overall bird use of the project area was higher during the spring and fall migration periods (Table 4), driven largely by high waterfowl use during these time periods. This is consistent with the project area being located near the prairie pothole region which experience high waterfowl migrations. During the fixed-point bird use surveys, bird use and waterfowl use was highest at point #2 (275 birds/20-min survey) probably due to the proximity of several lakes to the west of point #2. Point #3 had the second highest bird and waterfowl use, possibly due to the presence of the Sioux Nation State Wildlife Management Area; passerine use was highest at point #3. During the summer breeding bird transect surveys, use was highest at transects 9 and 6, both of which were located in the western portion of the project area near the Sioux Nation State Wildlife Management Area. While all transects were located within grasslands, the proximity to the Wildlife Management Area potentially impacted the overall bird use along these transects.

Raptor Displacement

In addition to possible direct effects on raptors within the study area (discussed above), indirect effects caused by disturbance-type impacts, such as construction activity near an active nest or primary foraging area, also have a potential impact on raptor species. Although no active raptor nests were observed within the BRWRA, the potential exists for raptors to build nests in the area. Birds displaced from wind-energy facilities might move to areas with fewer disturbances, but lower habitat quality, with a possible overall effect of reducing breeding success. Most studies on raptor displacement at wind-energy facilities, however, indicate effects to be negligible (Howell and Noone 1992; Johnson et al. 2000a, 2003b; Madders and Whitfield 2006). Notable exceptions to this include a study in Scotland that described territorial golden eagles avoiding the entire wind-energy facility area, except when intercepting non-territorial birds (Walker et al. 2005). A study at the Buffalo Ridge wind-energy facility in Minnesota found evidence of northern harriers avoiding turbines on both a small scale (< 328 ft [100 m] from turbines) and a larger scale in the year following construction (Johnson et al. 2000a). Two years following construction, however, no large-scale displacement of northern harriers was detected.

The only published report of avoidance of wind turbines by nesting raptors occurred at Buffalo Ridge, Minnesota, where raptor nest density on 101 mi^2 of land surrounding a wind project was 5.94/39 mi^2, yet no nests were present in the 12 mi^2 wind-energy facility itself, even though habitat was similar (Usgaard et al. 1997). However, this analysis assumes that raptor nests are uniformly distributed across the landscape, an unlikely event, and even though no nests were found, only two would be expected for an area 12 mi^2 in size if the nests were distributed uniformly. At a wind energy facility in eastern Washington, based on extensive monitoring using helicopter flights and ground observations, raptors still nested in the area at approximately the same levels after construction, and several nests were located within 0.5 miles of turbines (Erickson et al. 2004). At the Foote Creek Rim Wind-Energy Facility in southern Wyoming, one pair of red-tailed hawks nested within 0.3 mile of the turbine strings, and seven red-tailed hawk, one great horned owl, and one golden eagle nests located within one mile of the wind-energy facility successfully fledged young (Johnson et al. 2000b). The golden eagle pair successfully nested 0.5 mile from the wind-energy facility for three different years after it became operational. A Swainson's hawk also nested within 0.25 mi (0.8 km) of a turbine string at the Klondike I wind-energy facility in Oregon after the facility was operational (Johnson et al. 2003b). These observations suggest that there will be limited nesting displacement of raptors at the BRWRA, although the creation of a buffer surrounding new nests when siting turbines could further reduce any impact.

Displacement of Non-Raptor Bird Species

Studies concerning displacement of non-raptor species have concentrated on grassland passerines and waterfowl/waterbirds (Larsen and Madsen 2000; Mabey and Paul 2007; Winkelman 1990). Wind-energy facility operation appears to cause small scale local displacement of grassland passerines and is likely due to the birds avoiding turbine noise and maintenance activities.

Construction also reduces habitat effectiveness because of the presence of access roads and large gravel pads surrounding turbines (Johnson et al. 2000a; Leddy 1996). Leddy et al. (1999) surveyed bird densities in Conservation Reserve Program (CRP) grasslands at the Buffalo Ridge wind-energy facility in Minnesota, and found mean densities of 10 grassland bird species were four times higher at areas located 591 ft (180 m) from turbines than they were at grasslands nearer turbines. Johnson et al. (2000a) found reduced use of habitat by seven of 22 grassland-breeding birds following construction of the Buffalo Ridge wind energy facility in Minnesota. Results from the Stateline wind-energy facility in Oregon and Washington (Erickson et al. 2004), and the Combine Hills wind-energy facility in Oregon (Young et al. 2005), suggest a relatively small impact of the wind-energy facilities on grassland nesting passerines. Transect surveys conducted prior to and after construction of the wind-energy facilities found that grassland passerine use was significantly reduced within approximately 164 ft (50 m) of turbine strings, but areas further away from turbine strings did not have reduced bird use. Displacement of grassland passerines may be reduced by siting turbines away from grassland or natural habitats. Turbines sited within agricultural land, similar to the surrounding area, should minimize displacement impacts.

Displacement effects of wind-energy facilities on waterfowl and shorebirds appear to be mixed. Studies from the Netherlands and Denmark suggest that densities of these types of species near turbines were lower compared to densities in similar habitats away from turbines (Pedersen and Poulsen 1991; Winkelman 1990). However, a study from a facility in England, found no effect of wind turbines on populations of cormorant (*Phalacrcorax xarbo*), purple sandpipers (*Calidris maritima*), eiders (*Somateria mollissima*), or gulls, although the cormorants were temporarily displaced during construction (Lawrence et al. 2007). At the Buffalo Ridge wind-energy facility in Minnesota, the abundance of several bird types, including shorebirds and waterfowl, were found to be significantly lower at survey plots with turbines than at reference plots without turbines (Johnson et al. 2000a). The report concluded that the area of reduced use was limited primarily to those areas within 328 ft (100 m) of the turbines. Disturbance tends to be greatest for migrating birds while feeding and resting (Crockford 1992; NRC 2007). The majority of waterfowl use at the BRWRA included migrating snow geese and the majority of waterbird use was accounted for by the American white pelican. Migrating snow geese require water areas and feeding areas, which in the Midwest usually consist of agricultural fields. The presence of similar habitat surrounding the BRWRA means that any displacement of snow geese is unlikely to impact the population. The American white pelican is primarily a water bird that nests on islands or cut-off peninsulas. Siting turbines and construction away from these types of habitat will decrease any impact to the population.

Sensitive Species Observed

All sensitive species observed at the BRWRA are summarized in Table 5. Of the two species that were designated "special concern" by the Minnesota Department of Natural Resources, the American white pelican was the species that was observed during fixed-point surveys, transect surveys, and incidentally. The loggerhead shrike was only observed during fixed-point surveys. All other species listed in Table 5 were considered "species in greatest conservation need" by Bird Conservation Minnesota. No federal threatened, endangered, proposed, or candidate species were observed at the BRWRA.

Bats and Potential Impacts

Assessing the potential impacts of wind energy development to bats at the BRWRA is complicated by our current lack of understanding regarding why bats collide with wind turbines (Baerwald et al. et al. 2008; Kunz et al. et al. 2007b) combined with the inherent difficulties of monitoring elusive, night-flying animals (O'Shea et al. et al. 2003). To date, monitoring studies of wind projects suggest that a) migratory tree-roosting species (eastern red [*Lasiurus borealis*], hoary [*Lasiurus cinereus*], and silver-haired [*Lasionycteris noctivagans*] bats) comprise almost 75% of reported bats killed, b) the majority of fatalities occur during the post-breeding or fall migration season (roughly July, August, and September), and c) the highest reported fatalities occur at wind facilities located along forested ridge tops in the eastern US (Arnett et al. et al. 2008; Gruver 2002; Johnson et al. et al. 2003a, Kunzet al. et al. 2007b), although recent studies in agricultural regions of Iowa and Alberta, Canada, report relatively high fatalities as well (Baerwald 2006; Jain 2005).

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

Activity

Bat activity within the BRWRA (mean = 37.94 bat passes per detector-night) was high compared to that observed at facilities throughout the U.S (Table 11). Based on the presumed relationship between pre-construction bat activity and post-construction fatalities, we expect bat mortality rates at BRWRA to be approximately equal to or greater than the 10.2 bat fatalities/turbine/year reported at Top of Iowa, Iowa, but lower than the 38 fatalities/turbine/year reported at Mountaineer, West Virginia.

Spatial Variation

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

With only three bat call detecting locations, it is difficult to draw any conclusions about spatial variation in bat use at BRWRA. The main difference in variation observed was when unit 3597 was moved from ground based to being used in conjunction with a bat-hat system on the met tower. This movement was not a significant horizontal movement as the unit was very near (within feet) of the met tower location prior to construction of the met tower. The drop in call rates or use could be attributed to lower use at the higher elevation, lower use at that time period, or impacts on calls being recorded from use of the elevated microphone on the bat-hat. Slack et al. (2008) found that the use of a bat-hat result in an approximately 50% reduction in bat calls recorded compared to a configuration similar to what was used at BRWRA for ground based installations. This one study, however, did not look at more than one bat-hat or other deployment options at one time so it is possible that the one used during the Slack et al. study was not functioning properly (J. Gruver, WEST, pers. comm.). Additional investigations are needed to determine if and how bat-hats are impacting calls recorded compared to other deployment techniques. Further, another year of data collection, with more locations, and AnaBats located at both ground level and elevated at the same location, would greatly improve our understanding of bat use at the site.

Temporal Variation
The number of bat calls detected per night at the BRWRA was higher during late July through mid-August. Activity in July could correspond with the reproductive season, when pups are being weaned and foraging rates are high. August activity may represent movement of migrating bats through the area. While use rates are dropping at both locations (unit 1660 and 3597) during mid-August, the call rate drops very quickly at location 3597 in mid-August. As explained above, this drop also corresponds to when the unit was changed from ground based to being deployed with a bat-hat. The same issues that impact the evaluation on spatial variation related to temporal variation for this unit. Looking at just unit 1660, use does drop off significantly in late-August to late-September, which is consistent with bats concluding their migration through the region and local bats starting to hibernate.

Fatality studies of bats at wind projects in the US have shown a peak in mortality in August and September and generally lower mortality earlier in the summer (Arnett et al. 2008; Johnson 2005). While the survey effort varies among the different studies, the studies that combine AnaBat surveys and fatality surveys show a general association between the timing of increased bat call rates and timing of mortality, with both call rates and mortality peaking during the fall (Kunz et al. 2007b). Based on the available use data, it is likely that bat mortality at the BRWRA will be highest in August. This would correspond to finding at other wind facilities in the Midwest.

Species Composition
Of the six species of bat likely to occur in the study area, all of them are known fatalities at wind-energy facilities (Table 1). Acoustic bat surveys were unable to determine bat species present in the study area (except for hoary bats), but they were able to distinguish between high-frequency, mid-frequency, and low-frequency species. About 92 percent of passes were by low-frequency bats, suggesting higher relative abundance of species such as the big brown bat (*Eptesicus fuscus*), the silver haired bat, and the hoary bat.

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Table 1. Bat species determined from range-maps (BCI website; Harvey et al. 1999) as likely to occur within the Bitter Root Wind Resource Area, sorted by call frequency.

Common Name	Scientific Name
High-frequency (> 35 kHz)	
little brown bat†	*Myotis lucifugus*
eastern red bat*†	*Lasiurus borealis*
northern myotis†	*Myotis septentrionalis*
Low-frequency (< 35 kHz)	
big brown bat†	*Eptesicus fuscus*
silver-haired bat*†	*Lasionycteris noctivagans*
hoary bat*†	*Lasiurus cinereus*

*long-distance migrant; †species known to have been killed at wind-energy facilities

Table 2. Summary of mean bird use (birds/plot/20-min survey), species richness (number of species/survey), and sample size (number of visits) by season and overall during the fixed-point bird use surveys at the Bitter Root Wind Resource Area, March 25 –October 8, 2008.

Season	Number of Visits	Mean Use	Species Richness	# Unique Species	# Surveys Conducted
Spring	5	233.38	4.22	44	50
Summer	6	9.54	3.58	47	59
Fall	4	21.00	2.25	33	40
Overall	**15**	**97.20**	**3.40**	**68**	**149**

Table 3. Total number of individuals and groups for each bird type and species, by season and overall, during the fixed-point bird use surveys at the Bitter Root Wind Resource Area, March 25 – October 8, 2008.

		Spring		Summer		Fall		Total	
Species/Type	Scientific Name	# grps	# obs	# grps	# obs	# grps	# obs	# grps	# obs
Waterbirds		**16**	**40**	**23**	**66**	**4**	**7**	**43**	**113**
American white pelican	*Pelecanus erythrorhyncos*	9	29	14	44	1	1	24	74
black tern	*Chlidonias niger*	0	0	1	2	0	0	1	2
California gull	*Larus californicus*	0	0	0	0	1	1	1	1
double-crested cormorant	*Phalacrocorax auritus*	3	4	2	12	0	0	5	16
Franklin's gull	*Larus pipixcan*	1	2	0	0	0	0	1	2
great blue heron	*Ardea herodias*	0	0	2	2	0	0	2	2
great egret	*Ardea alba*	1	2	1	1	0	0	2	3
pied-billed grebe	*Podilymbus podiceps*	1	1	1	1	0	0	2	2
ring-billed gull	*Larus delawarensis*	0	0	1	2	0	0	1	2
unidentified gull		1	2	1	2	2	5	4	9
Waterfowl		**110**	**11,319**	**25**	**136**	**14**	**221**	**149**	**11,676**
blue-winged teal	*Anas discors*	0	0	2	3	1	4	3	7
Canada goose	*Branta canadensis*	45	641	7	68	8	141	60	850
canvasback	*Aythya valisineria*	1	15	0	0	0	0	1	15
gadwall	*Anas strepera*	0	0	1	2	0	0	1	2
greater white-fronted goose	*Anser albifrons*	3	65	0	0	0	0	3	65
mallard	*Anas platyrhynchos*	26	60	12	56	5	76	43	192
northern shoveler	*Anas clypeata*	2	2	0	0	0	0	2	2
redhead	*Aythya americana*	0	0	1	3	0	0	1	3
ruddy duck	*Oxyura jamaicensis*	0	0	1	2	0	0	1	2
snow goose	*Chen caerulescens*	30	10,435	0	0	0	0	30	10,435
unidentified duck		2	99	1	2	0	0	3	101
wood duck	*Aix sponsa*	1	2	0	0	0	0	1	2
Shorebirds		**15**	**19**	**10**	**12**	**8**	**12**	**33**	**43**
common snipe	*Gallinago gallinago*	3	3	2	2	0	0	5	5

Table 3. Total number of individuals and groups for each bird type and species, by season and overall, during the fixed-point bird use surveys at the Bitter Root Wind Resource Area, March 25 – October 8, 2008.

		Spring		Summer		Fall		Total	
Species/Type	Scientific Name	# grps	# obs	# grps	# obs	# grps	# obs	# grps	# obs
killdeer	*Charadrius vociferus*	10	13	7	9	8	12	25	34
lesser yellowlegs	*Tringa flavipes*	1	2	0	0	0	0	1	2
upland sandpiper	*Bartramia longicauda*	1	1	1	1	0	0	2	2
Rails/Coots		**4**	**75**	**4**	**81**	**2**	**135**	**10**	**291**
American coot	*Fulica americana*	4	75	4	81	2	135	10	291
Raptors		**12**	**12**	**11**	**11**	**14**	**14**	**37**	**37**
American kestrel	*Falco sparverius*	1	1	0	0	1	1	2	2
broad-winged hawk	*Buteo platypterus*	1	1	1	1	2	2	4	4
northern harrier	*Circus cyaneus*	7	7	1	1	4	4	12	12
red-tailed hawk	*Buteo jamaicensis*	1	1	9	9	4	4	14	14
Swainson's hawk	*Buteo swainsoni*	1	1	0	0	2	2	3	3
unidentified buteo		1	1	0	0	1	1	2	2
Vultures		**0**	**0**	**1**	**1**	**2**	**4**	**3**	**5**
turkey vulture	*Cathartes aura*	0	0	1	1	2	4	3	5
Upland Gamebirds		**51**	**58**	**29**	**31**	**9**	**18**	**89**	**107**
ring-necked pheasant	*Phasianus colchicus*	51	58	28	30	8	13	87	101
sharp-tailed grouse	*Tympanuchus phasianellus*	0	0	0	0	1	5	1	5
wild turkey	*Meleagris gallopavo*	0	0	1	1	0	0	1	1
Doves/Pigeons		**2**	**3**	**12**	**42**	**7**	**20**	**21**	**65**
mourning dove	*Zenaida macroura*	2	3	11	12	4	6	17	21
rock pigeon	*Columba livia*	0	0	1	30	3	14	4	44
Passerines		**85**	**144**	**138**	**381**	**59**	**1,786**	**282**	**2,311**
American crow	*Corvus brachyrhynchos*	2	3	0	0	1	2	3	5
American goldfinch	*Carduelis tristis*	0	0	1	1	0	0	1	1
American robin	*Turdus migratorius*	3	5	3	3	1	1	7	9
bank swallow	*Riparia riparia*	0	0	1	2	1	5	2	7
barn swallow	*Hirundo rustica*	8	9	31	44	15	46	54	99

Table 3. Total number of individuals and groups for each bird type and species, by season and overall, during the fixed-point bird use surveys at the Bitter Root Wind Resource Area, March 25 – October 8, 2008.

		Spring		Summer		Fall		Total	
Species/Type	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
blue jay	*Cyanocitta cristata*	1	1	0	0	0	0	1	1
bobolink	*Dolichonyx oryzivorus*	5	6	7	9	0	0	12	15
brown thrasher	*Toxostoma rufum*	0	0	3	3	0	0	3	3
brown-headed cowbird	*Molothrus ater*	0	0	5	6	0	0	5	6
cliff swallow	*Petrochelidon pyrrhonota*	0	0	3	4	0	0	3	4
common grackle	*Quiscalus quiscula*	4	9	7	11	6	115	17	135
common yellowthroat	*Geothlypis trichas*	2	2	7	7	0	0	9	9
dickcissel	*Spiza americana*	0	0	5	5	0	0	5	5
eastern kingbird	*Tyrannus tyrannus*	0	0	1	1	2	5	3	6
European starling	*Sturnus vulgaris*	0	0	0	0	2	76	2	76
field sparrow	*Spizella pusilla*	1	1	0	0	0	0	1	1
grasshopper sparrow	*Ammodramus savannarum*	0	0	2	2	0	0	2	2
horned lark	*Eremophila alpestris*	6	20	2	2	3	9	11	31
house sparrow	*Passer domesticus*	0	0	1	1	0	0	1	1
loggerhead shrike	*Lanius ludovicianus*	1	1	0	0	0	0	1	1
northern rough-winged swallow	*Stelgidopteryx serripennis*	1	1	1	1	1	5	3	7
red-winged blackbird	*Agelaius phoeniceus*	25	54	27	247	22	1,517	74	1,818
savannah sparrow	*Passerculus sandwichensis*	1	1	5	5	0	0	6	6
song sparrow	*Melospiza melodia*	3	3	8	8	0	0	11	11
tree swallow	*Tachycineta bicolor*	2	2	1	1	1	1	4	4
unidentified sparrow		2	3	0	0	1	1	3	4
western kingbird	*Tyrannus verticalis*	0	0	1	1	0	0	1	1
western meadowlark	*Sturnella neglecta*	14	16	11	11	3	3	28	30
yellow-headed blackbird	*Xanthocephalus xanthocephalus*	3	6	5	6	0	0	8	12
yellow-rumped warbler	*Dendroica coronata*	1	1	0	0	0	0	1	1

Table 3. Total number of individuals and groups for each bird type and species, by season and overall, during the fixed-point bird use surveys at the Bitter Root Wind Resource Area, March 25 – October 8, 2008.

		Spring		Summer		Fall		Total	
Species/Type	**Scientific Name**	# grps	# obs	# grps	# obs	# grps	# obs	# grps	# obs
Other Birds		**6**	**6**	**2**	**2**	**0**	**0**	**8**	**8**
common nighthawk	*Chordeiles minor*	0	0	1	1	0	0	1	1
northern flicker	*Colaptes auratus*	4	4	1	1	0	0	5	5
unidentified woodpecker		2	2	0	0	0	0	2	2
Overall		**301**	**11,676**	**255**	**763**	**119**	**2,217**	**675**	**14,656**

Table 4. Mean bird use (number/plot/20-min survey), percent of total composition (%), and frequency of occurrence (%) for each bird type and species by season during the fixed-point bird use surveys at the Bitter Root Wind Resource Area, March 25 – October 8, 2008.

	Use			% Composition			% Frequency		
Species/Type	Spring	Summer	Fall	Spring	Summer	Fall	Spring	Summer	Fall
Waterbirds	**0.80**	**1.11**	**0.18**	**0.3**	11.6	**0.8**	12.0	**30.4**	**7.5**
American white pelican	0.58	0.74	0.03	0.2	7.7	0.1	8.0	18.5	2.5
black tern	0	0.03	0	0	0.3	0	0	1.7	0
California gull	0	0	0.03	0	0	0.1	0	0	2.5
double-crested cormorant	0.08	0.20	0	<0.1	2.1	0	2.0	3.3	0
Franklin's gull	0.04	0	0	<0.1	0	0	2.0	0	0
great blue heron	0	0.03	0	0	0.3	0	0	3.3	0
great egret	0.04	0.02	0	<0.1	0.2	0	2.0	1.7	0
pied-billed grebe	0.02	0.02	0	<0.1	0.2	0	2.0	1.9	0
ring-billed gull	0	0.03	0	0	0.3	0	0	1.7	0
unidentified gull	0.04	0.04	0.13	<0.1	0.4	0.6	2.0	1.9	2.5
Waterfowl	**226.38**	**2.27**	**5.53**	**97.0**	**23.8**	**26.3**	**66.0**	**23.7**	**30.0**
blue-winged teal	0	0.05	0.10	0	0.5	0.5	0	3.3	2.5
Canada goose	12.82	1.13	3.53	5.5	11.9	16.8	46.0	6.7	15.0
canvasback	0.30	0	0	0.1	0	0	2.0	0	0
gadwall	0	0.03	0	0	0.3	0	0	1.7	0
greater white-fronted goose	1.30	0	0	0.6	0	0	6.0	0	0
mallard	1.20	0.94	1.90	0.5	9.8	9.0	34.0	17.0	12.5
northern shoveler	0.04	0	0	<0.1	0	0	4.0	0	0
redhead	0	0.05	0	0	0.5	0	0	1.7	0
ruddy duck	0	0.03	0	0	0.3	0	0	1.7	0
snow goose	208.70	0	0	89.4	0	0	24.0	0	0
unidentified duck	1.98	0.03	0	0.8	0.3	0	4.0	1.7	0
wood duck	0.04	0	0	<0.1	0	0	2.0	0	0
Shorebirds	**0.38**	**0.20**	**0.30**	**0.2**	**2.1**	**1.4**	**24.0**	**13.7**	**12.5**
common snipe	0.06	0.04	0	<0.1	0.4	0	6.0	3.5	0
killdeer	0.26	0.15	0.30	0.1	1.6	1.4	16.0	10.2	12.5

Table 4. Mean bird use (number/plot/20-min survey), percent of total composition (%), and frequency of occurrence (%) for each bird type and species by season during the fixed-point bird use surveys at the Bitter Root Wind Resource Area, March 25 – October 8, 2008.

	Use			% Composition			% Frequency		
Species/Type	Spring	Summer	Fall	Spring	Summer	Fall	Spring	Summer	Fall
lesser yellowlegs	0.04	0	0	<0.1	0	0	2.0	0	0
upland sandpiper	0.02	0.02	0	<0.1	0.2	0	2.0	1.7	0
Rails/Coots	**1.50**	**1.35**	**3.38**	**0.6**	**14.1**	**16.1**	**8.0**	**6.7**	**5.0**
American coot	1.50	1.35	3.38	0.6	14.1	16.1	8.0	6.7	5.0
Raptors	**0.24**	**0.19**	**0.35**	**0.1**	**2.0**	**1.7**	**20.0**	**13.5**	**25.0**
American kestrel	0.02	0	0.03	<0.1	0	0.1	2.0	0	2.5
broad-winged hawk	0.02	0.02	0.05	<0.1	0.2	0.2	2.0	1.7	5.0
northern harrier	0.14	0.02	0.10	0.1	0.2	0.5	14.0	1.9	7.5
red-tailed hawk	0.02	0.15	0.10	<0.1	1.6	0.5	2.0	11.9	10.0
Swainson's hawk	0.02	0	0.05	<0.1	0	0.2	2.0	0	5.0
unidentified buteo	0.02	0	0.03	<0.1	0	0.1	2.0	0	2.5
Vultures	**0**	**0.02**	**0.10**	**0**	**0.2**	**0.5**	**0**	**1.7**	**5.0**
turkey vulture	0	0.02	0.10	0	0.2	0.5	0	1.7	5.0
Upland Gamebirds	**1.16**	**0.54**	**0.45**	**0.5**	**5.6**	**2.1**	**68.0**	**36.3**	**20.0**
ring-necked pheasant	1.16	0.52	0.33	0.5	5.4	1.5	68.0	34.6	17.5
sharp-tailed grouse	0	0	0.13	0	0	0.6	0	0	2.5
wild turkey	0	0.02	0	0	0.2	0	0	1.7	0
Doves/Pigeons	**0.06**	**0.76**	**0.50**	**<0.1**	**8.0**	**2.4**	**4.0**	**17.0**	**15.0**
mourning dove	0.06	0.20	0.15	<0.1	2.1	0.7	4.0	17.0	10.0
rock pigeon	0	0.56	0.35	0	5.8	1.7	0	1.9	5.0
Passerines	**2.74**	**3.07**	**10.23**	**1.2**	**32.2**	**48.7**	**76.0**	**83.1**	**75.0**
American goldfinch	0	0.02	0	0	0.2	0	0	1.7	0
American robin	0.10	0.05	0.03	<0.1	0.5	0.1	4.0	3.3	2.5
bank swallow	0	0.03	0.13	0	0.3	0.6	0	1.7	2.5
barn swallow	0.18	0.74	1.15	0.1	7.8	5.5	14.0	33.7	30.0
bobolink	0.12	0.15	0	0.1	1.6	0	10.0	12.0	0
brown thrasher	0	0.05	0	0	0.5	0	0	3.3	0
brown-headed cowbird	0	0.11	0	0	1.1	0	0	8.9	0

Table 4. Mean bird use (number/plot/20-min survey), percent of total composition (%), and frequency of occurrence (%) for each bird type and species by season during the fixed-point bird use surveys at the Bitter Root Wind Resource Area, March 25 – October 8, 2008.

	Use			% Composition			% Frequency		
Species/Type	**Spring**	**Summer**	**Fall**	**Spring**	**Summer**	**Fall**	**Spring**	**Summer**	**Fall**
cliff swallow	0	0.07	0	0	0.7	0	0	3.3	0
common grackle	0.18	0.19	0.38	0.1	2.0	1.8	6.0	7.0	10.0
common yellowthroat	0.04	0.12	0	<0.1	1.2	0	4.0	11.9	0
dickcissel	0	0.09	0	0	0.9	0	0	6.9	0
eastern kingbird	0	0.02	0.13	0	0.2	0.6	0	1.7	2.5
European starling	0	0	0.03	0	0	0.1	0	0	2.5
field sparrow	0.02	0	0	<0.1	0	0	2.0	0	0
grasshopper sparrow	0	0.03	0	0	0.3	0	0	3.3	0
horned lark	0.40	0.03	0.23	0.2	0.3	1.1	10.0	3.3	7.5
house sparrow	0	0.02	0	0	0.2	0	0	1.7	0
loggerhead shrike	0.02	0	0	<0.1	0	0	2.0	0	0
northern rough-winged swallow	0.02	0.02	0.13	<0.1	0.2	0.6	2.0	1.7	2.5
red-winged blackbird	1.02	0.80	7.93	0.4	8.4	37.7	42.0	37.4	25.0
savannah sparrow	0.02	0.09	0	<0.1	0.9	0	2.0	8.7	0
song sparrow	0.06	0.14	0	<0.1	1.4	0	6.0	13.7	0
tree swallow	0.04	0.02	0.03	<0.1	0.2	0.1	4.0	1.7	2.5
unidentified sparrow	0.06	0	0.03	<0.1	0	0.1	4.0	0	2.5
western kingbird	0	0.02	0	0	0.2	0	0	1.7	0
western meadowlark	0.32	0.19	0.08	0.1	2.0	0.4	22.0	17.0	7.5
yellow-headed blackbird	0.12	0.10	0	0.1	1.0	0	4.0	6.7	0
yellow-rumped warbler	0.02	0	0	<0.1	0	0	2.0	0	0
Other Birds	**0.12**	**0.04**	**0**	**0.1**	**0.4**	**0**	**10.0**	**3.5**	**0**
common nighthawk	0	0.02	0	0	0.2	0	0	1.7	0
northern flicker	0.08	0.02	0	<0.1	0.2	0	8.0	1.9	0
unidentified woodpecker	0.04	0	0	<0.1	0	0	4.0	0	0
Overall	**233.38**	**9.54**	**21.00**	**100**	**100**	**100**			

Table 5. Sensitive species observed during fixed-point surveys, transect surveys, and incidentally at Bitter Root Wind Resource Area, March 25 – October 8, 2008.

Species	Scientific Name	Observation Occurred	Status
American white pelican	*Pelecanus erythrorhyncos*	fixed-point, transect, incidental	MN DNR Special Concern, Species in Greatest Conservation Need
loggerhead shrike	*Lanius ludovicianus*	fixed-point	MN DNR Special Concern, Species in Greatest Conservation Need
sharp-tailed grouse	*Tympanuchus phasianellus*	fixed-point	Species in Greatest Conservation Need
northern harrier	*Circus cyaneus*	fixed-point, transect, incidental	Species in Greatest Conservation Need
Swainson's hawk	*Buteo swainsoni*	fixed-point, incidental	Species in Greatest Conservation Need
upland sandpiper	*Bartramia longicauda*	fixed-point	Species in Greatest Conservation Need
Franklin's gull	*Larus pipixcan*	fixed-point	Species in Greatest Conservation Need
common nighthawk	*Chordeiles minor*	fixed-point	Species in Greatest Conservation Need
northern rough-winged swallow	*Stelgidopteryx serripennis*	fixed-point, incidental	Species in Greatest Conservation Need
field sparrow	*Spizella pusilla*	fixed-point	Species in Greatest Conservation Need
grasshopper sparrow	*Ammodramus savannarum*	fixed-point, transect, incidental	Species in Greatest Conservation Need
dickcissel	*Spiza americana*	fixed-point, transect, incidental	Species in Greatest Conservation Need
bobolink	*Dolichonyx oryzivorus*	fixed-point, transect, incidental	Species in Greatest Conservation Need
northern pintail	*Anas acuta*	transect	Species in Greatest Conservation Need
American bittern	*Botaurus lentiginosus*	transect, incidental	Species in Greatest Conservation Need
sedge wren	*Cistothorus platensis*	transect	Species in Greatest Conservation Need
lesser scaup	*Aythya affinis*	incidental	Species in Greatest Conservation Need
black-crowned night heron	*Nycticorax nycticorax*	incidental	Species in Greatest Conservation Need

Table 6. Summary of bird use, species richness, and sample size during transect bird use surveys at the Bitter Root Wind Resource Area, June 5 – July 2, 2008.

Season	Number of Visits	Mean Use	# Species/transect/ Survey	# Unique Species	# Surveys Conducted
Summer	3	20.83	5.85	41	32

Table 7. Total number of individuals and groups for each bird type and species during transect bird use surveys at the Bitter Root Wind Resource Area, June 5 – July 2, 2008.

Species/Type	Scientific Name	# grps	#obs
Waterbirds		**7**	**8**
American bittern	*Botaurus lentiginosus*	3	3
American white pelican	*Pelecanus erythrorhyncos*	1	1
black tern	*Chlidonias niger*	1	2
double-crested cormorant	*Phalacrocorax auritus*	1	1
pied-billed grebe	*Podilymbus podiceps*	1	1
Waterfowl		**41**	**112**
Canada goose	*Branta canadensis*	2	5
blue-winged teal	*Anas discors*	11	24
gadwall	*Anas strepera*	2	4
green-winged teal	*Anas crecca*	1	1
mallard	*Anas platyrhynchos*	24	66
northern pintail	*Anas acuta*	1	12
Shorebirds		**5**	**5**
common snipe	*Gallinago Gallinago*	2	2
killdeer	*Charadrius vociferus*	3	3
Rails/Coots		**7**	**12**
American coot	*Fulica americana*	4	9
sora	*Porzana carolina*	3	3
Raptors		**7**	**8**
red-tailed hawk	*Buteo jamaicensis*	4	5
northern harrier	*Circus cyaneus*	3	3
Upland Gamebirds		**38**	**42**
ring-necked pheasant	*Phasianus colchicus*	38	42
Doves/Pigeons		**12**	**21**
mourning dove	*Zenaida macroura*	11	19
rock pigeon	*Columba livia*	1	2
Passerines		**299**	**549**
Blackbirds/Orioles		*203*	*432*
Baltimore oriole	*Icterus galbula*	1	1
bobolink	*Dolichonyx oryzivorus*	87	120
brown-headed cowbird	*Molothrus ater*	5	6
common grackle	*Quiscalus quiscula*	17	51
red-winged blackbird	*Agelaius phoeniceus*	80	229
western meadowlark	*Sturnella neglecta*	10	10
yellow-headed blackbird	*Xanthocephalus xanthocephalus*	3	15
Finches		*3*	*3*
American goldfinch	*Carduelis tristis*	3	3
Flycatchers		*3*	*4*
eastern kingbird	*Tyrannus tyrannus*	3	4

Table 7. Total number of individuals and groups for each bird type and species during transect bird use surveys at the Bitter Root Wind Resource Area, June 5 – July 2, 2008.

Species/Type	Scientific Name	# grps	#obs
Grassland/Sparrows		*59*	*59*
dickcissel	*Spiza americana*	27	27
grasshopper sparrow	*Ammodramus savannarum*	12	12
savannah sparrow	*Passerculus sandwichensis*	18	18
song sparrow	*Melospiza melodia*	1	1
unidentified sparrow		1	1
Swallows		*10*	*30*
barn swallow	*Hirundo rustica*	4	7
cliff swallow	*Petrochelidon pyrrhonota*	6	23
Thrushes		*1*	*1*
American robin	*Turdus migratorius*	1	1
Warblers		*16*	*16*
black-and-white warbler	*Mniotilta varia*	1	1
common yellowthroat	*Geothlypis trichas*	14	14
yellow warbler	*Dendroica petechia*	1	1
Wrens		*4*	*4*
sedge wren	*Cistothorus platensis*	4	4
Other Birds		**1**	**1**
belted kingfisher	*Ceryle alcyon*	1	1
Overall		**417**	**758**

Table 8. Mean bird use (number/plot/20-min survey), percent of total composition (%), and frequency of occurrence (%) for each bird type and species during transect bird use surveys at the Bitter Root Wind Resource Area, June 5 – July 2, 2008.

Species/Type	Use	% Composition	% Frequency
Waterbirds	**0.18**	**0.9**	**13.1**
American bittern	0.08	0.4	8.3
American white pelican	0.02	0.1	2.4
black tern	0.05	0.2	2.4
pied-billed grebe	0.02	0.1	2.4
Waterfowl	**3.05**	**14.6**	**53.6**
blue-winged teal	0.93	4.5	34.5
Canada goose	0.02	0.1	2.4
gadwall	0.21	1.0	10.7
green-winged teal	0.02	0.1	2.4
mallard	1.57	7.5	38.1
northern pintail	0.29	1.4	2.4
Shorebirds	**0.05**	**0.2**	**2.4**
killdeer	0.05	0.2	2.4
Rails/Coots	**0.30**	**1.4**	**17.9**
American coot	0.21	1.0	9.5
sora	0.08	0.4	8.3
Raptors	**0.05**	**0.2**	**4.8**
northern harrier	0.05	0.2	4.8
Upland Gamebirds	**0.39**	**1.9**	**25.0**
ring-necked pheasant	0.39	1.9	25.0
Doves/Pigeons	**0.43**	**2.1**	**14.3**
mourning dove	0.38	1.8	11.9
rock pigeon	0.05	0.2	2.4
Passerines	**16.39**	**78.7**	**100**
Blackbirds/Orioles	*13.21*	*63.4*	*92.9*
Baltimore oriole	0.02	0.1	2.4
bobolink	4.82	23.1	76.2
brown-headed cowbird	0.14	0.7	7.1
common grackle	1.27	6.1	29.8
red-winged blackbird	6.52	31.3	88.1
western meadowlark	0.24	1.1	19.0
yellow-headed blackbird	0.19	0.9	4.8
Finches	*0.13*	*0.6*	*13.1*
American goldfinch	0.13	0.6	13.1
Flycatchers	*0.10*	*0.5*	*7.1*
eastern kingbird	0.10	0.5	7.1
Grassland/Sparrows	*1.58*	*7.6*	*67.9*
dickcissel	0.64	3.1	33.3
grasshopper sparrow	0.29	1.4	9.5

Table 8. Mean bird use (number/plot/20-min survey), percent of total composition (%), and frequency of occurrence (%) for each bird type and species during transect bird use surveys at the Bitter Root Wind Resource Area, June 5 – July 2, 2008.

Species/Type	Use	% Composition	% Frequency
savannah sparrow	0.55	2.6	40.5
song sparrow	0.02	0.1	2.4
unidentified sparrow	0.08	0.4	8.3
Swallows	*0.71*	*3.4*	*16.7*
barn swallow	0.17	0.8	9.5
cliff swallow	0.55	2.6	7.1
Warblers	*0.56*	*2.7*	*46.4*
black-and-white warbler	0.02	0.1	2.4
common yellowthroat	0.51	2.5	44.0
yellow warbler	0.02	0.1	2.4
Wrens	*0.10*	*0.5*	*7.1*
sedge wren	0.10	0.5	7.1
Overall	**20.83**		

Table 9. Results of bat acoustic surveys conducted at the Bitter Root Wind Resource Area, July 15, 2008 - September 23, 2008.

AnaBat Location	# of HF Bat Passes	# of MidF Bat Passes	# of LF Bat Passes	# of Hoary Bat Passes*	Total Bat Passes	Detector-Nights	Bat Passes/ Night
1660	95	132	2726	563	2953	71	41.59
3597 ground	130	78	1931	187	2139	32	66.84
3597 elevated	5	9	196	132	210	39	5.38
Total	**230**	**219**	**4853**	**882**	**5302**	**142**	**37.94**

*Data for hoary bat passes is included in LF bat passes

Table 10. Incidental wildlife observed while conducting all surveys at the Bitter Root Wind Resource Area, March 25 – October 8, 2008.

Species	Scientific Name	# grps	# obs
Canada goose	*Branta canadensis*	5	114
blue-winged teal	*Anas discors*	8	78
northern shoveler	*Anas clypeata*	6	44
mallard	*Anas platyrhynchos*	8	28
ring-necked duck	*Aythya collaris*	3	14
double-crested cormorant	*Phalacrocorax auritus*	4	11
gadwall	*Anas strepera*	2	11
American coot	*Fulica americana*	3	10
American white pelican	*Pelecanus erythrorhyncos*	4	10
northern harrier	*Circus cyaneus*	6	7
red-tailed hawk	*Buteo jamaicensis*	7	7
American wigeon	*Anas americana*	2	6
common yellowthroat	*Geothlypis trichas*	3	5
American kestrel	*Falco sparverius*	4	4
greater white-fronted goose	*Anser albifrons*	1	4
Swainson's hawk	*Buteo swainsoni*	2	3
broad-winged hawk	*Buteo platypterus*	2	2
common grackle	*Quiscalus quiscula*	2	2
dickcissel	*Spiza americana*	2	2
green-winged teal	*Anas crecca*	1	2
pied-billed grebe	*Podilymbus podiceps*	2	2
red-winged blackbird	*Agelaius phoeniceus*	2	2
savannah sparrow	*Passerculus sandwichensis*	2	2
unidentified bird		2	2
wild turkey	*Meleagris gallopavo*	1	2
American bittern	*Botaurus lentiginosus*	1	1
American goldfinch	*Carduelis tristis*	1	1
barn swallow	*Hirundo rustica*	1	1
belted kingfisher	*Ceryle alcyon*	1	1
black tern	*Chlidonias niger*	1	1
black-crowned night-heron	*Nycticorax nycticorax*	1	1
bobolink	*Dolichonyx oryzivorus*	1	1
canvasback	*Aythya valisineria*	1	1
common snipe	*Gallinago gallinago*	1	1
grasshopper sparrow	*Ammodramus savannarum*	1	1
gray partridge	*Perdix perdix*	1	1
lesser scaup	*Aythya affinis*	1	1
northern rough-winged swallow	*Stelgidopteryx serripennis*	1	1
redhead	*Aythya americana*	1	1
rough-legged hawk	*Buteo lagopus*	1	1
ruddy duck	*Oxyura jamaicensis*	1	1
snow goose	*Chen caerulescens*	1	1

Table 10. Incidental wildlife observed while conducting all surveys at the Bitter Root Wind Resource Area, March 25 – October 8, 2008.

Species	Scientific Name	# grps	# obs
turkey vulture	*Cathartes aura*	1	1
yellow-headed blackbird	*Xanthocephalus xanthocephalus*	1	1
Bird Subtotal	***43 species***	**103**	**393**
white-tailed deer	*Odocoileus virginianus*	7	30
striped skunk	*Mephitis mephitis*	1	1
Mammal Subtotal	***3 species***	**8**	**31**
garter snake		1	1
Reptile Subtotal	***1 species***	**1**	**1**

Table 11. Wind-energy facilities in the US with both pre-construction AnaBat sampling data and post-construction mortality data for bat species (adapted from Kunz et al. 2007b).

Wind-Energy Facility	Activity (#/detector night)	Mortality (bats/turbine/year)	Reference
Bitter Root, MN	37.9		This study
Foote Creek Rim, WY	2.2	1.3	Gruver 2002
Buffalo Ridge, MN	2.1	2.2	Johnson et al. 2004
Buffalo Mountain, TN	23.7	20.8	Fiedler 2004
Top of Iowa, IA	34.9	10.2	Jain 2005
Mountaineer, WV	38.3	38	Arnett et al. 2005

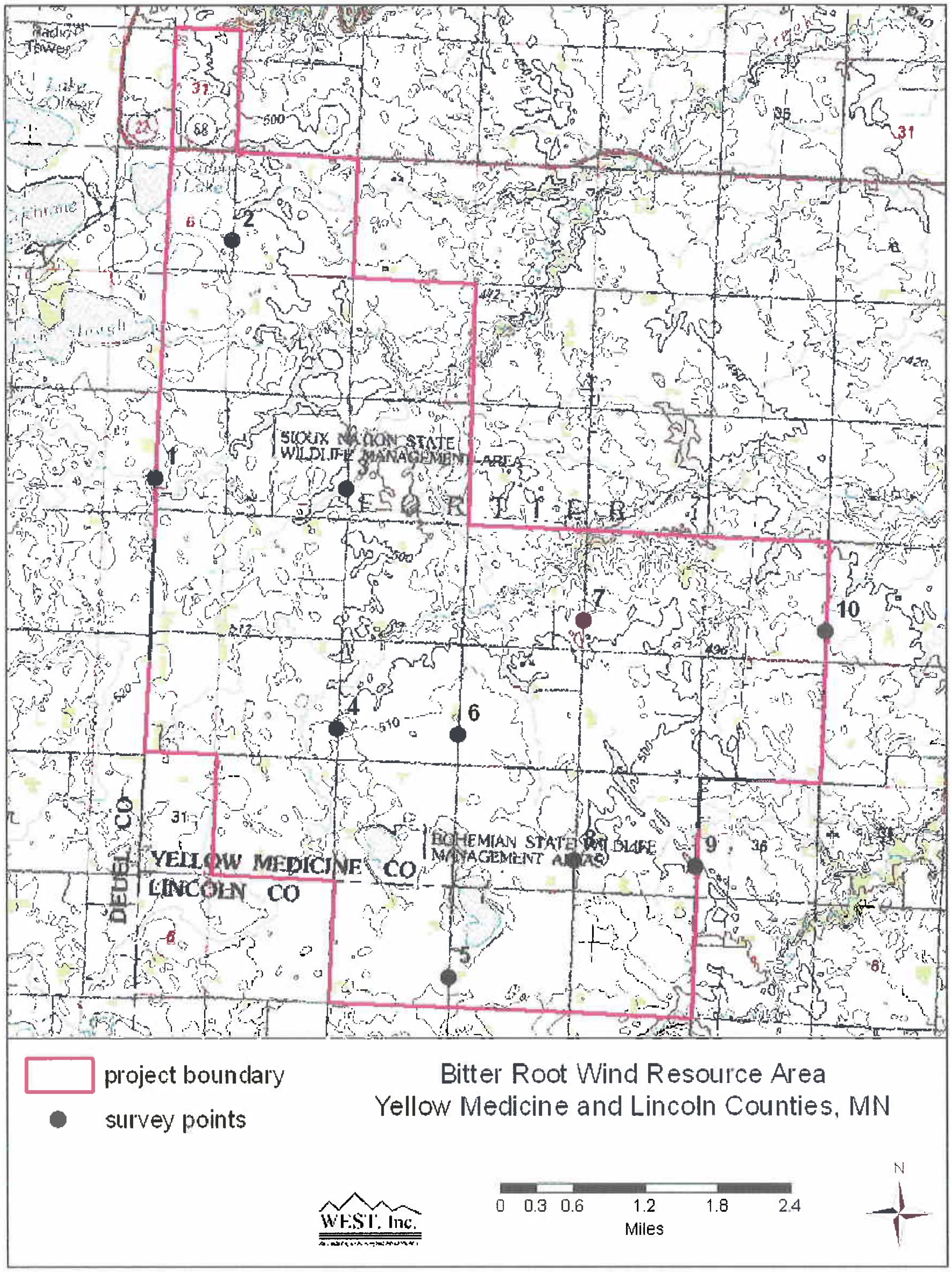


Figure 1. Fixed-points used for bird surveys in the proposed Bitter Root Wind Resource Area.

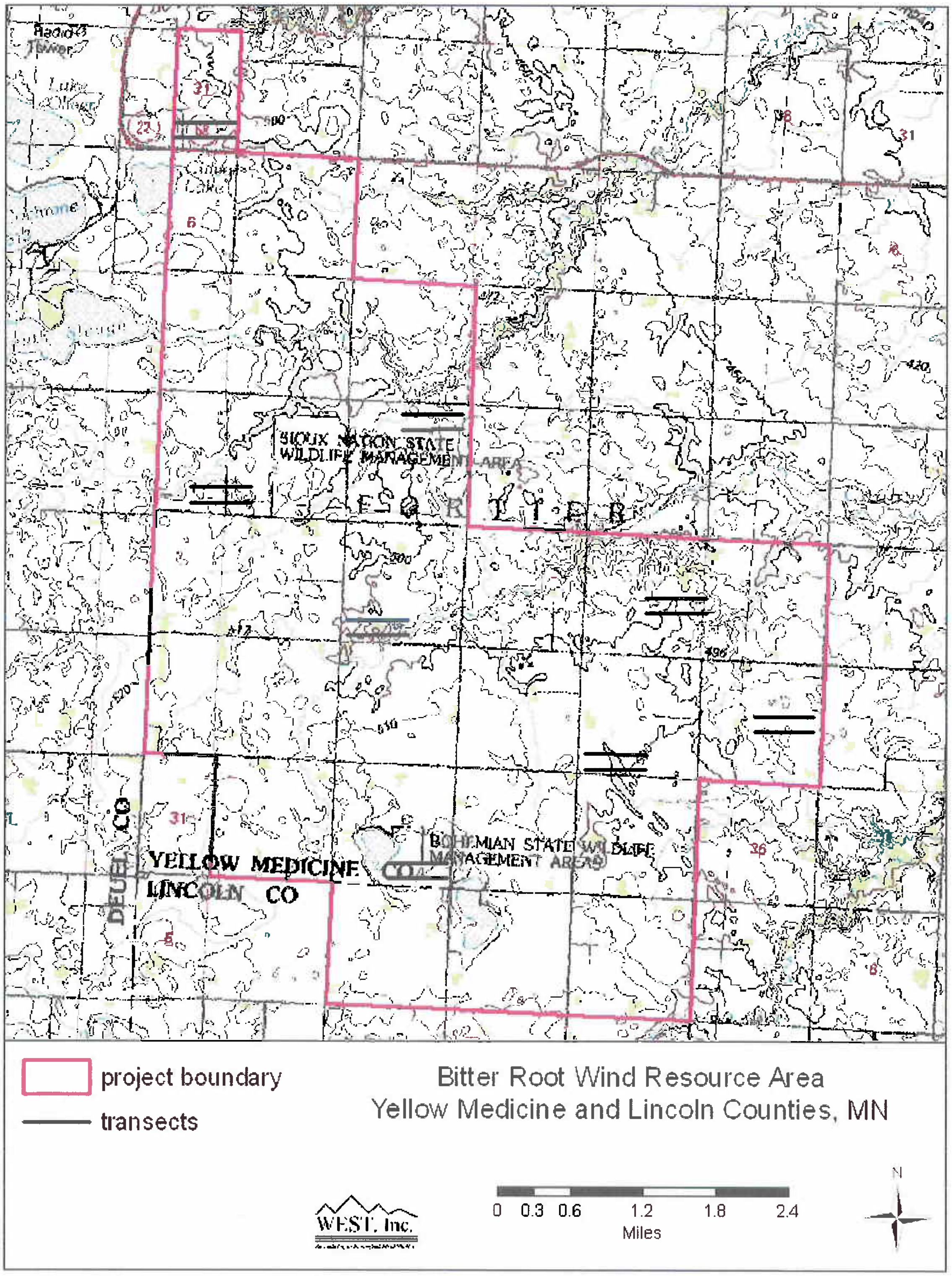


Figure 2. Transects used for bird surveys in the proposed Bitter Root Wind Resource Area.

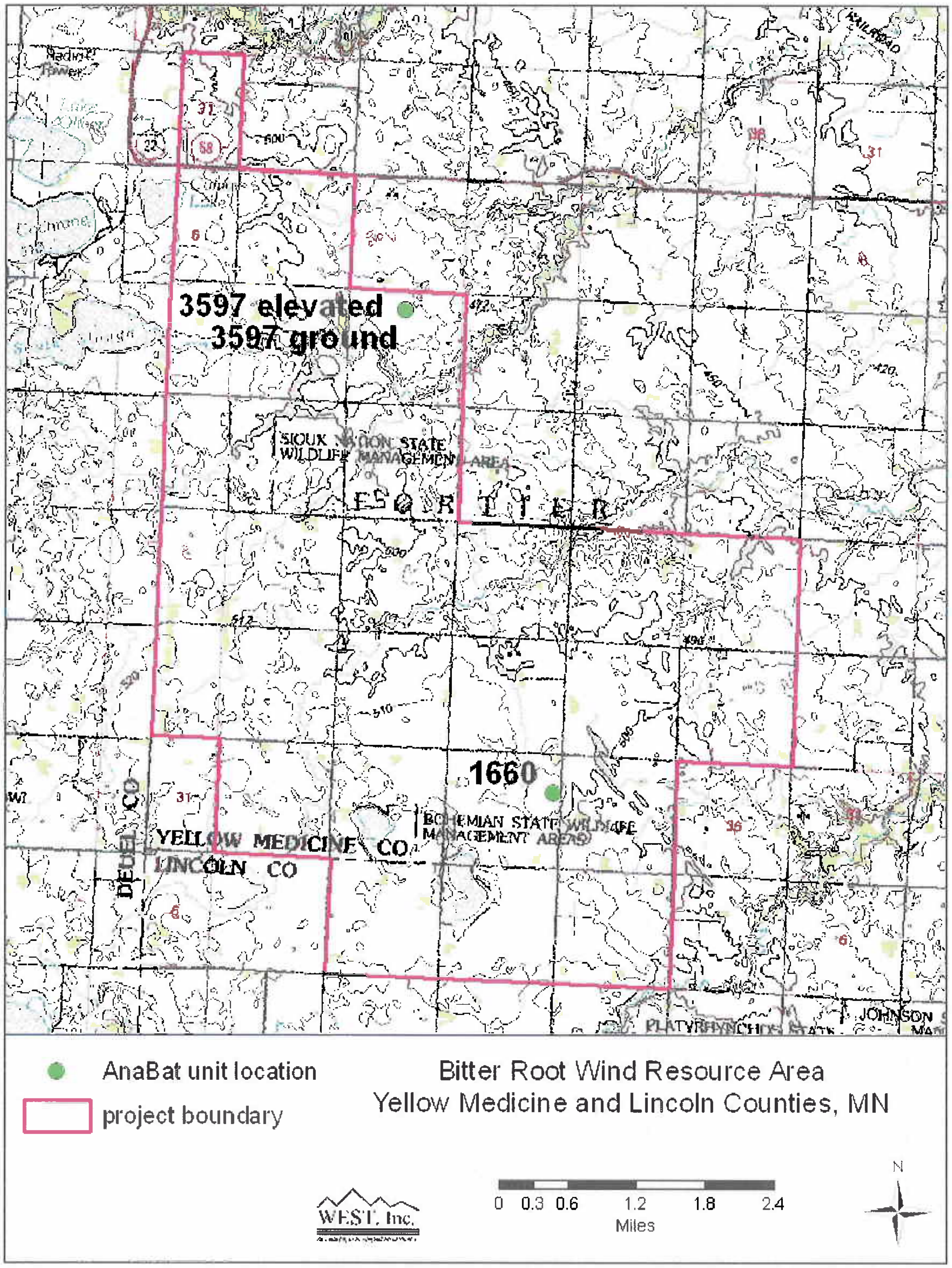


Figure 3. Locations of AnaBats in the proposed Bitter Root Wind Resource Area.

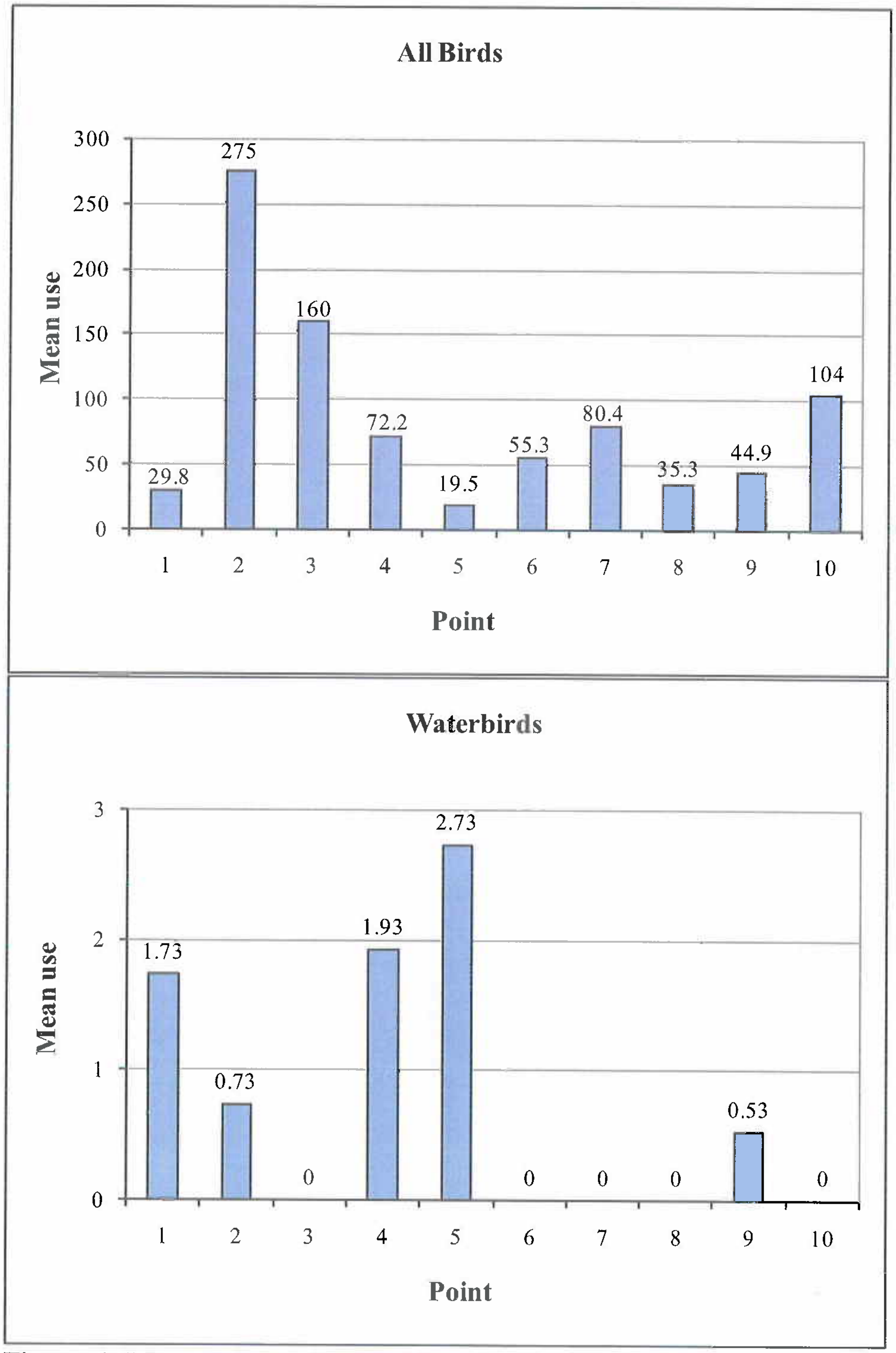


Figure 4. Mean use (birds/20-min survey) at each fixed-point bird use survey point for all birds major bird types at the Bitter Root Wind Resource Area.

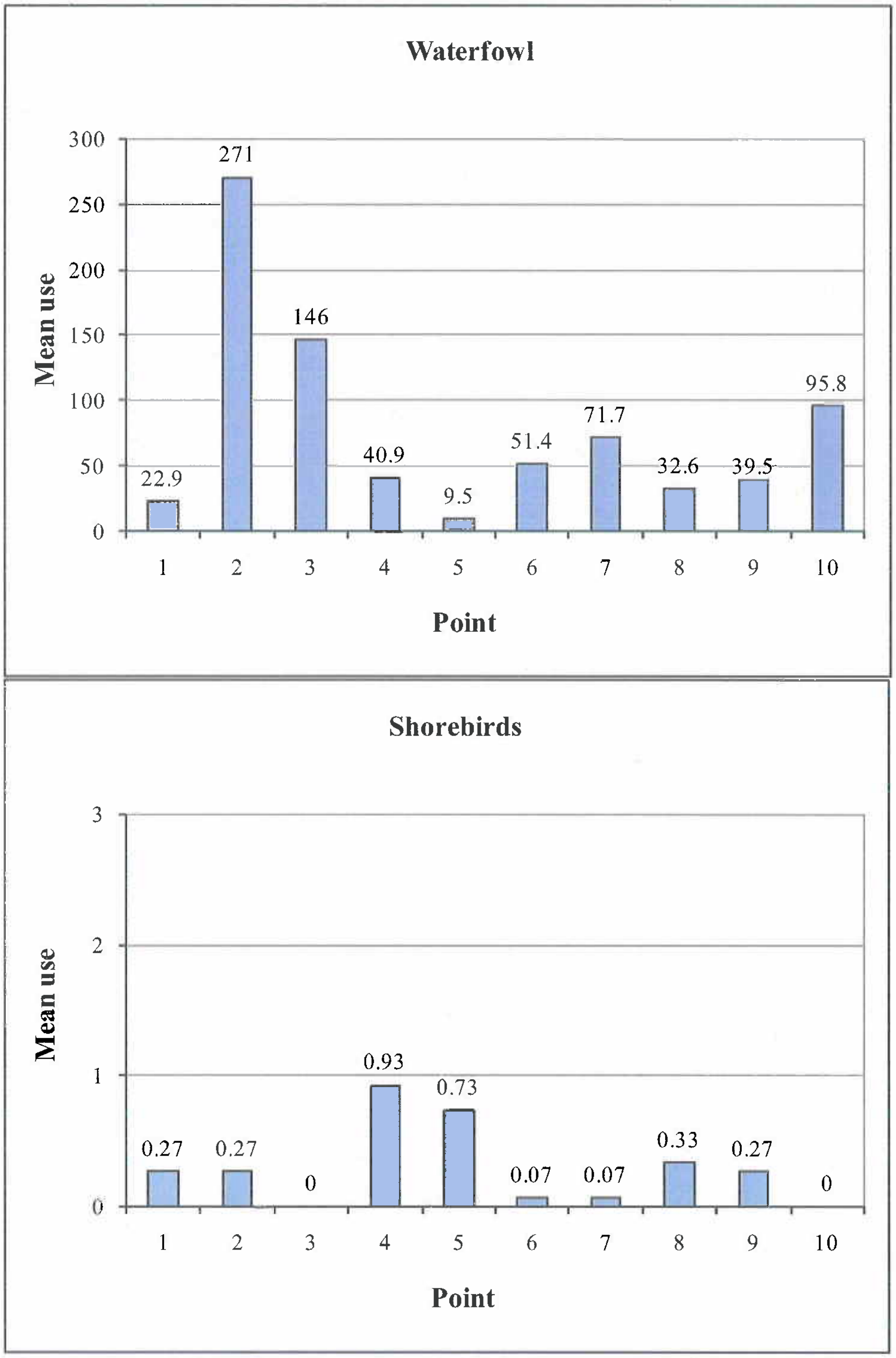
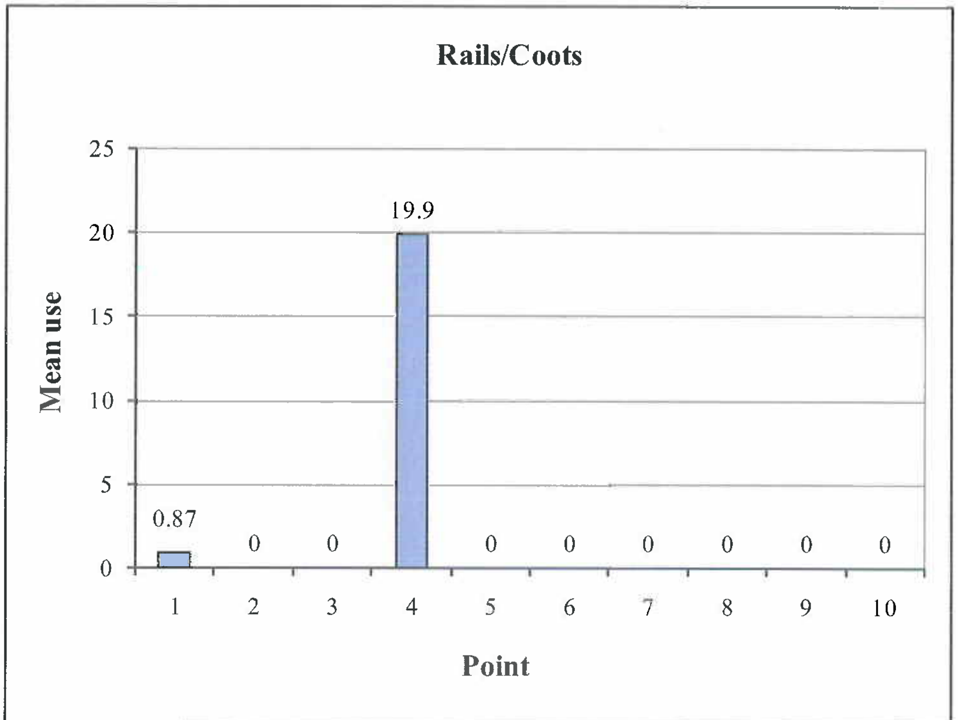


Figure 4. (*continued*). Mean use (birds/20-min survey) at each fixed-point bird use survey point for all birds and major bird types at the Bitter Root Wind Resource Area.



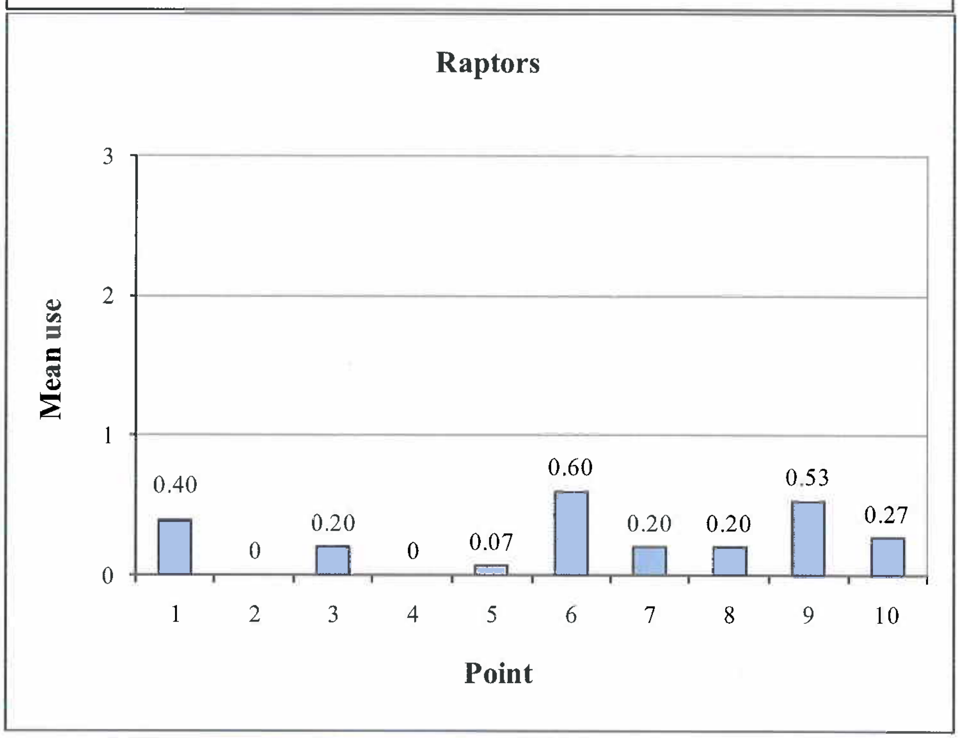
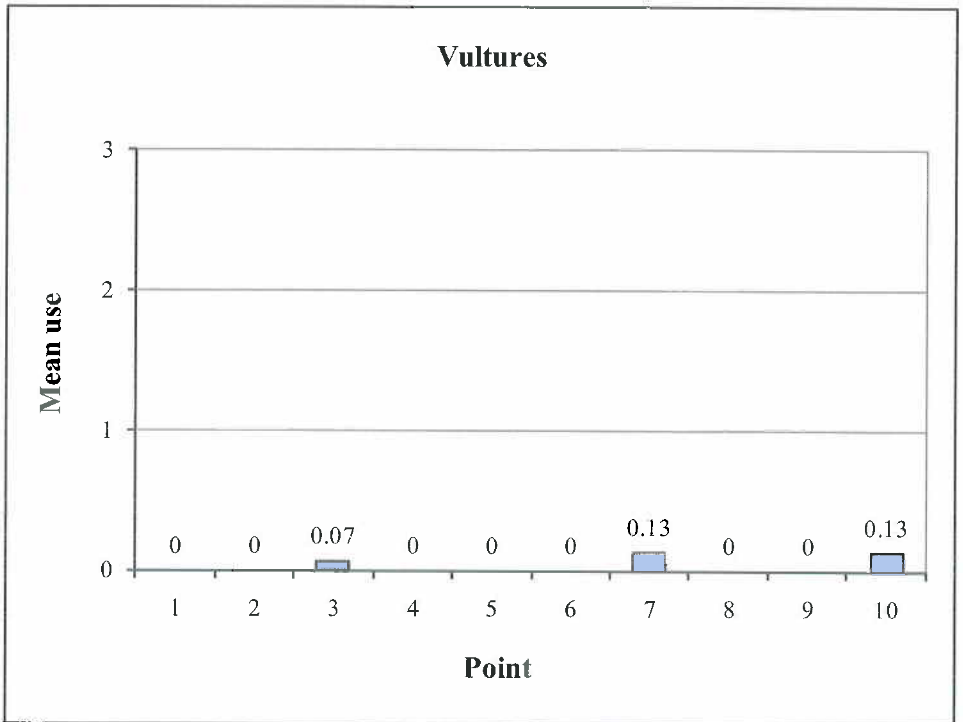


Figure 4. (*continued*). Mean use (birds/20-min survey) at each fixed-point bird use survey point for all birds and major bird types at the Bitter Root Wind Resource Area.



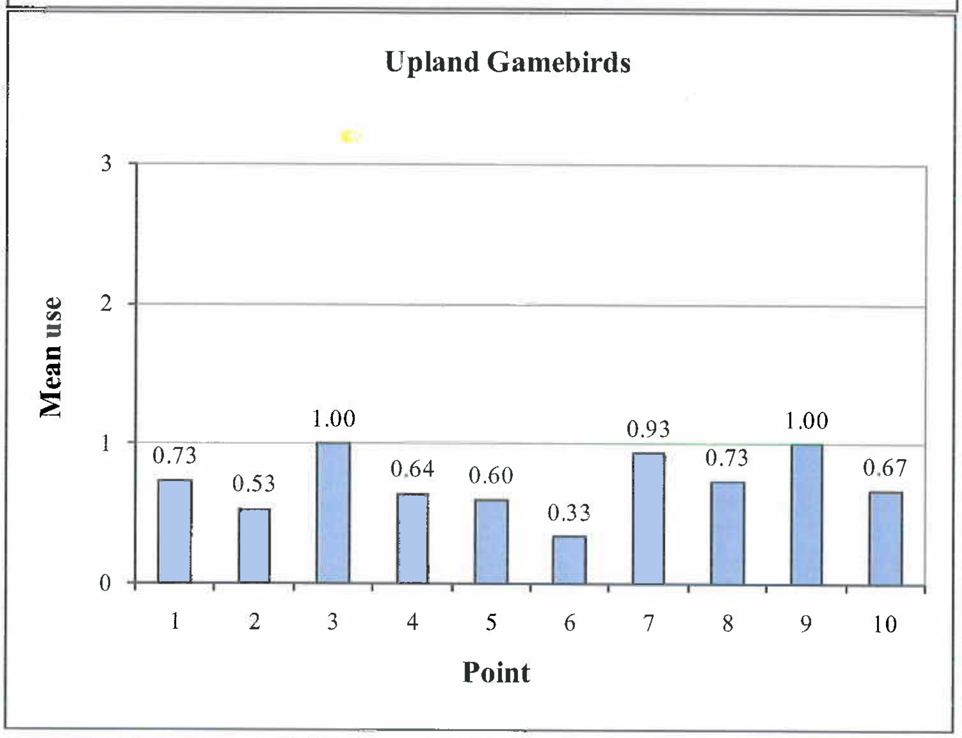
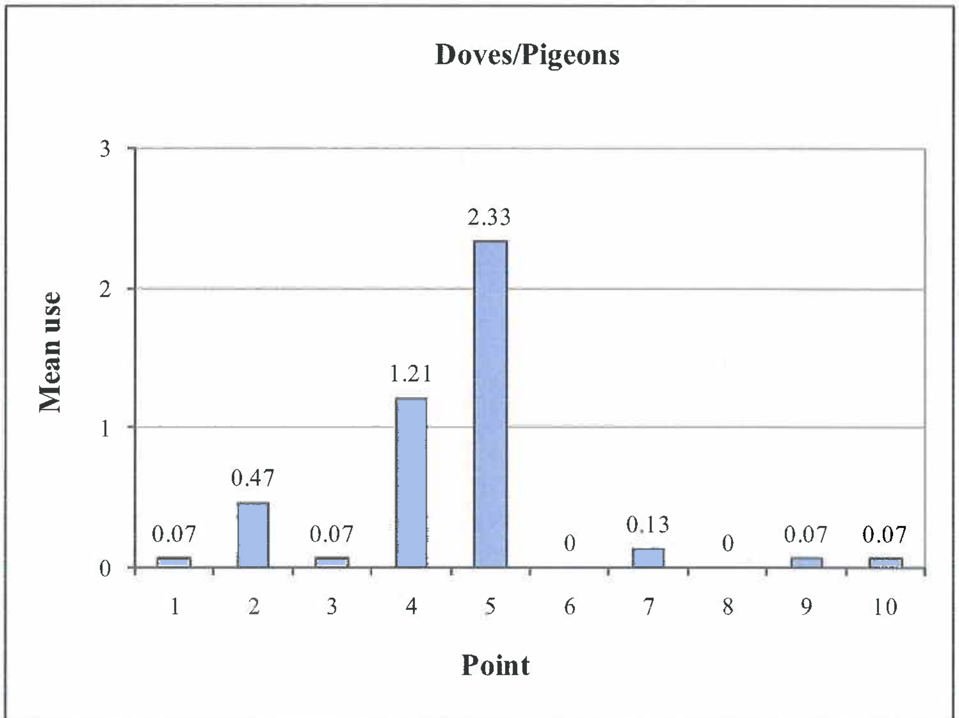


Figure 4. (*continued*). Mean use (birds/20-min survey) at each fixed-point bird use survey point for all birds and major bird types at the Bitter Root Wind Resource Area.



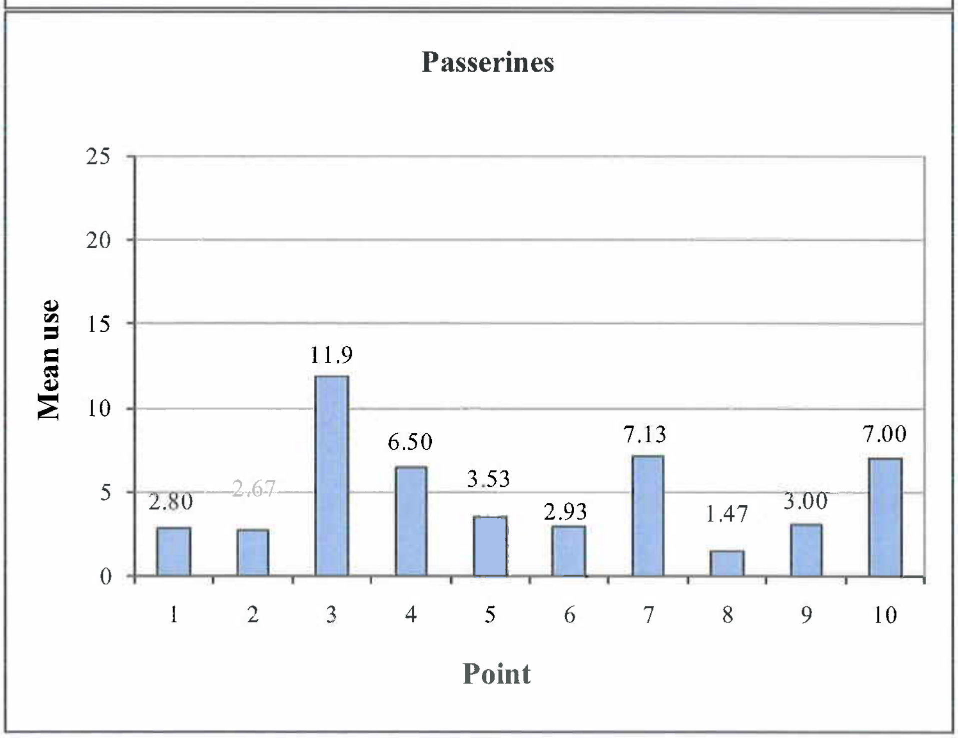


Figure 4. (*continued*). Mean use (birds/20-min survey) at each fixed-point bird use survey point for all birds and major bird types at the Bitter Root Wind Resource Area.

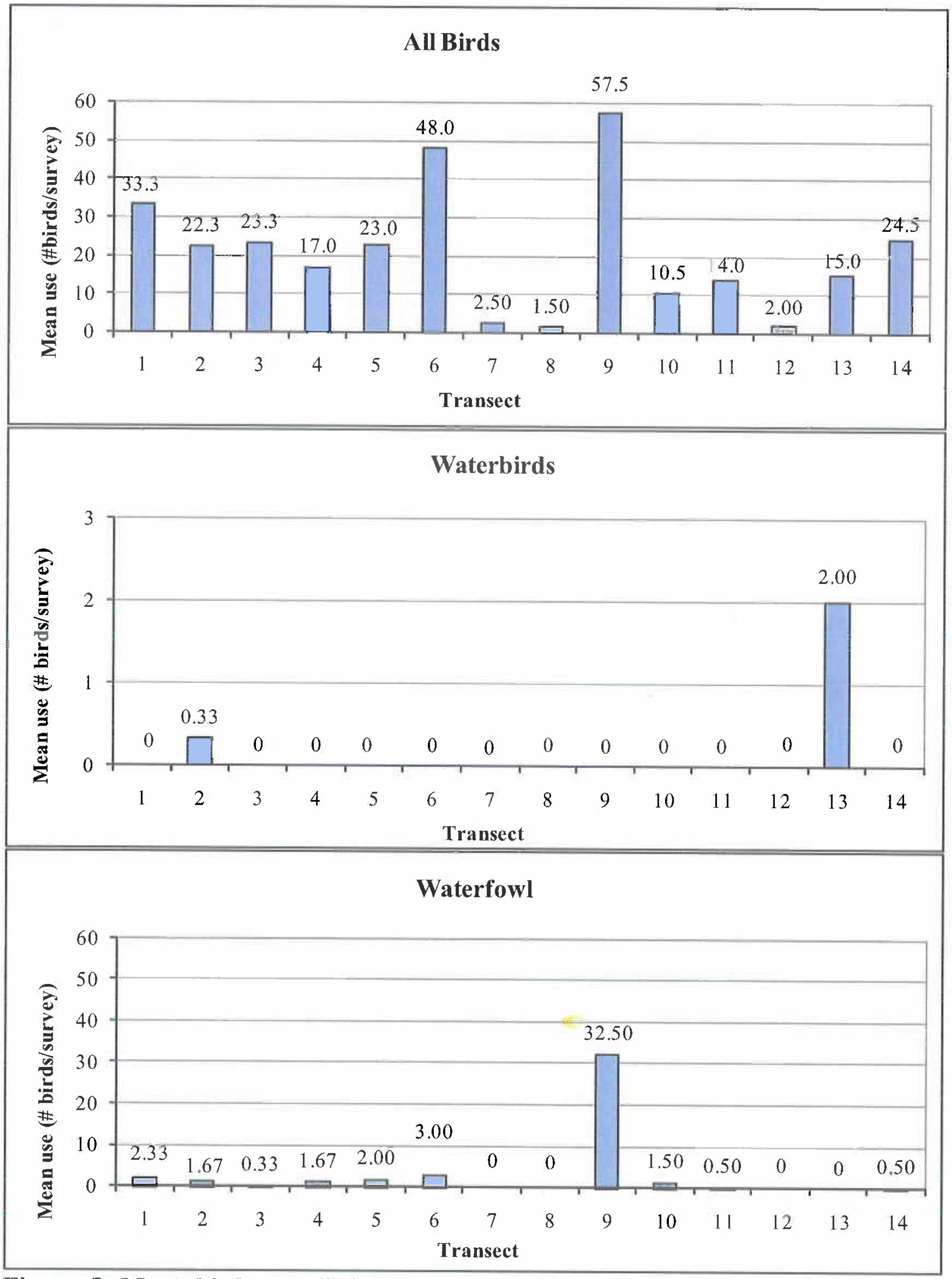


Figure 5. Mean birds use (#birds/survey) plotted by transect for bird types and passerine subtypes at the Bitter Root Wind Resource Area, June 5 – July 2, 2008.

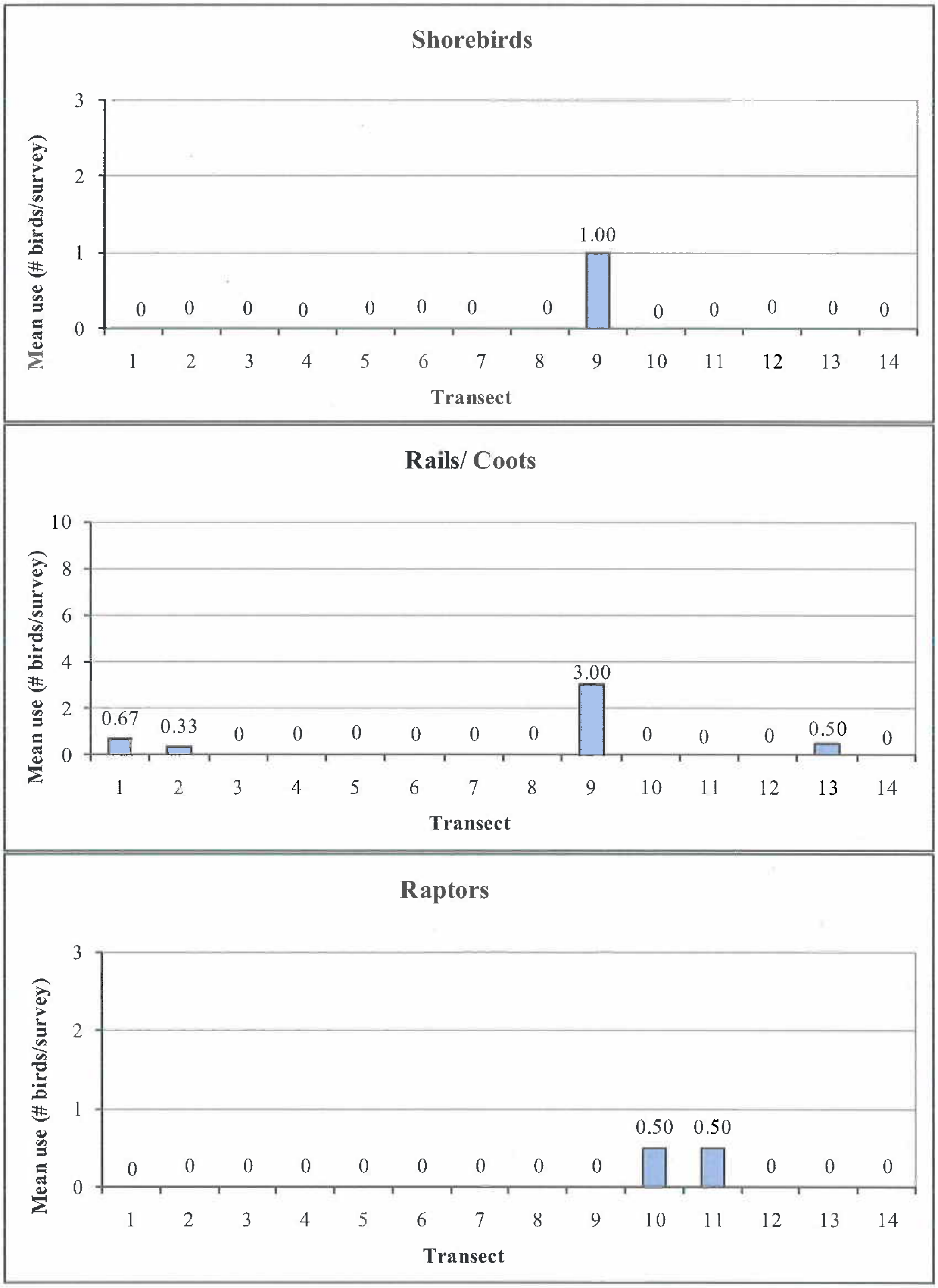


Figure 5 (*continued*). Mean birds use (#birds/survey) plotted by transect for bird types and passerine subtypes at the Bitter Root Wind Resource Area, June 5 – July 2, 2008.

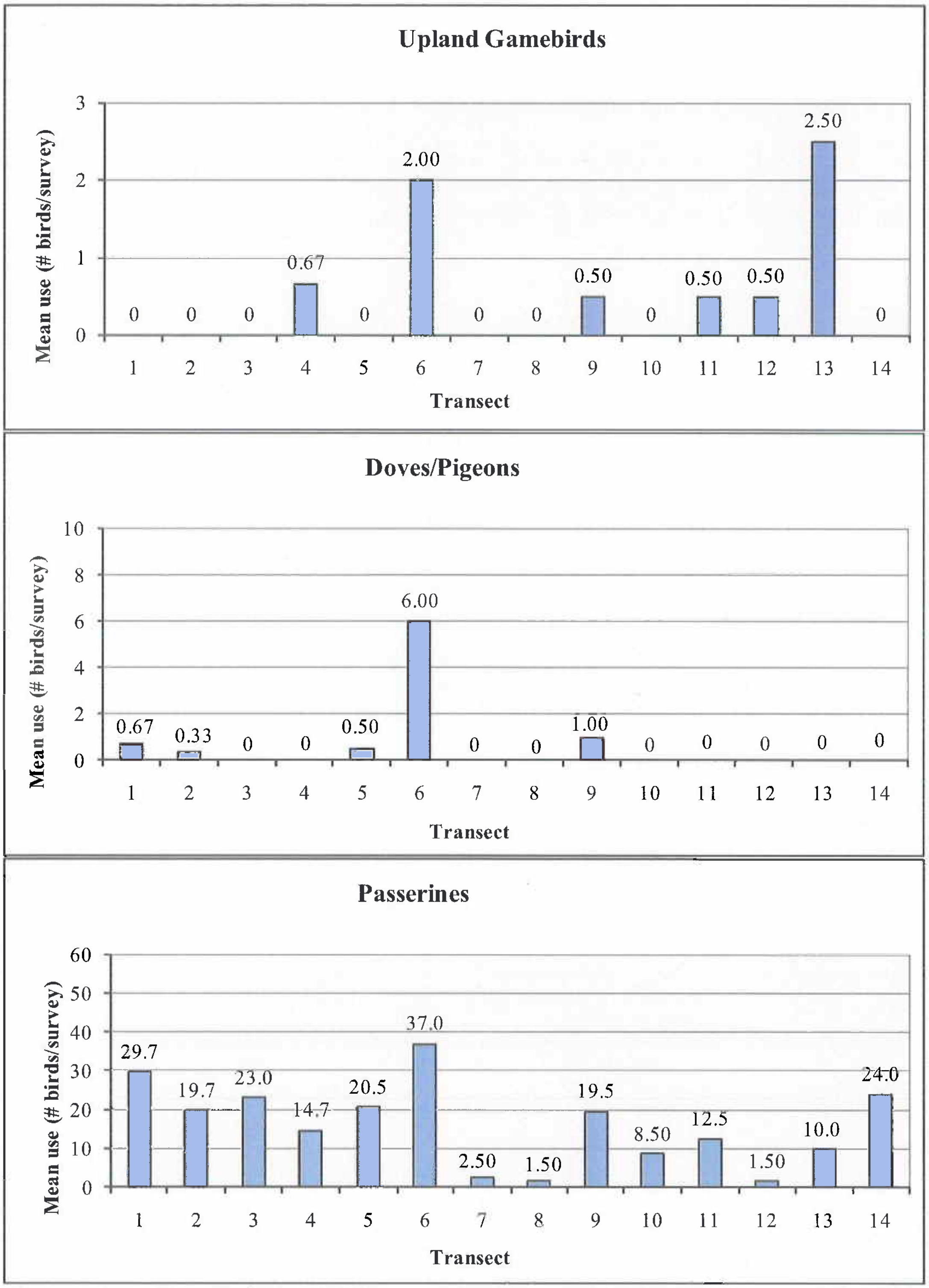


Figure 5 (*continued*). Mean birds use (#birds/survey) plotted by transect for bird types and passerine subtypes at the Bitter Root Wind Resource Area, June 5 – July 2, 2008.

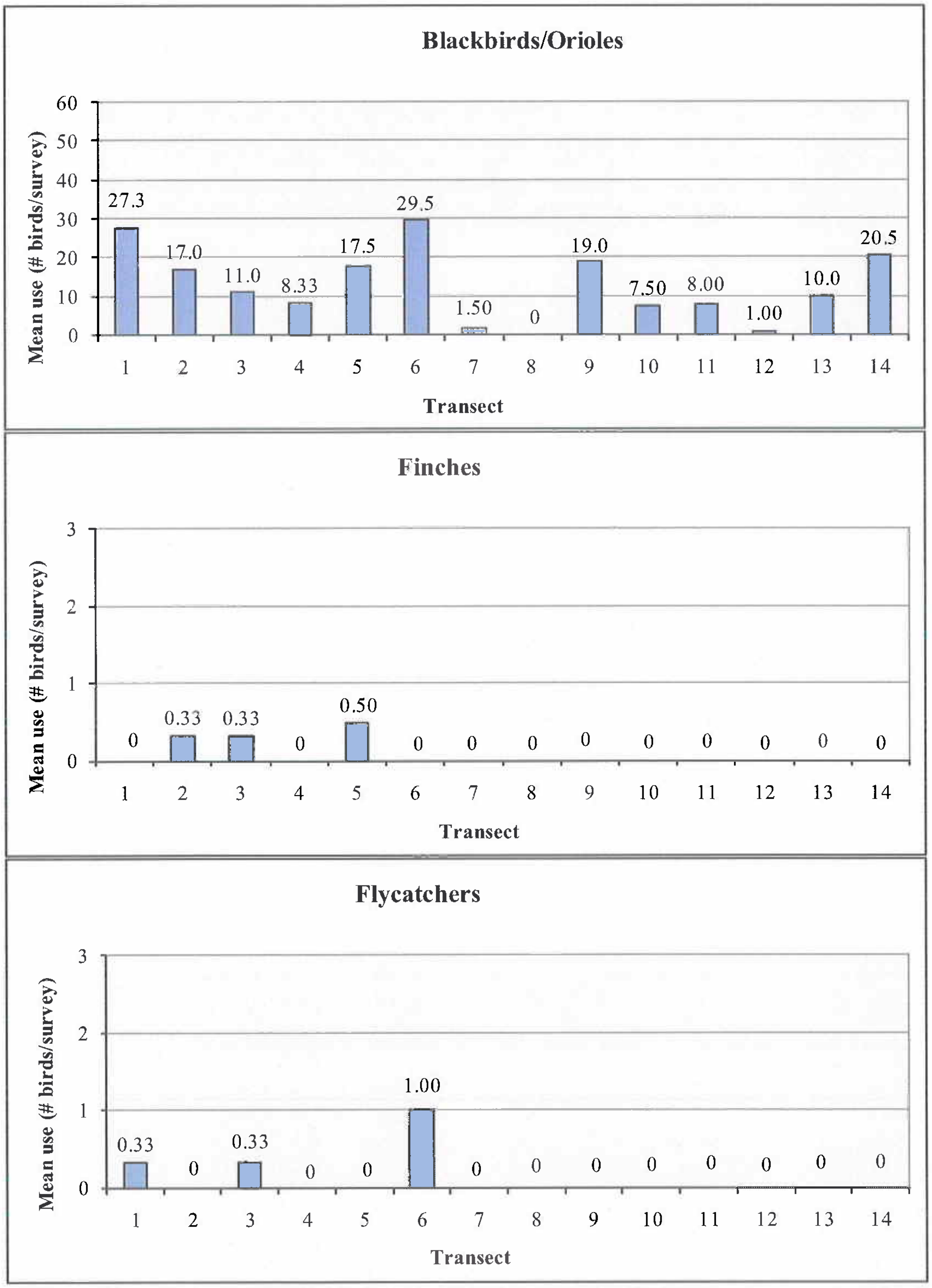


Figure 5 (*continued*). Mean birds use (#birds/survey) plotted by transect for bird types and passerine subtypes at the Bitter Root Wind Resource Area, June 5 – July 2, 2008.

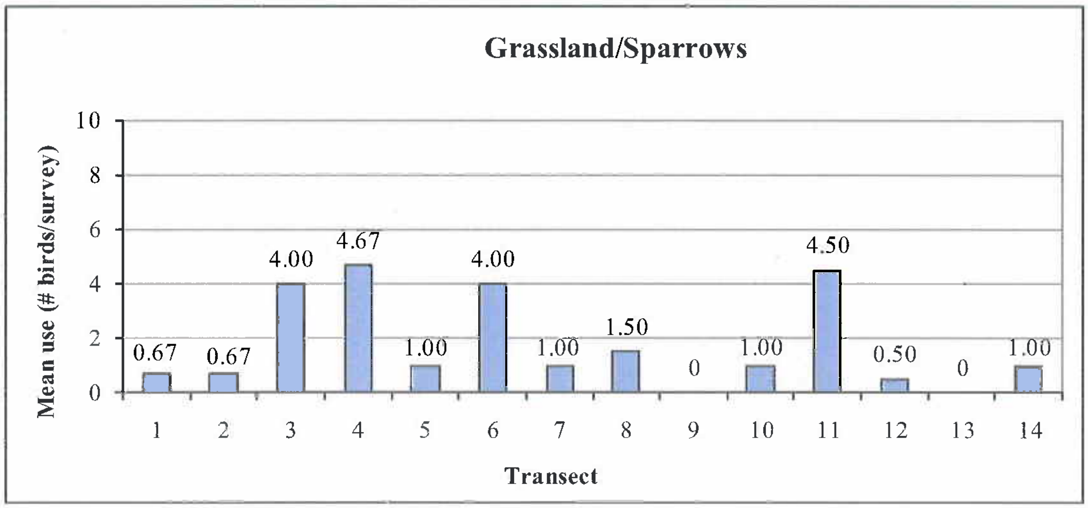


Figure 5 (*continued*). Mean birds use (#birds/survey) plotted by transect for bird types and passerine subtypes at the Bitter Root Wind Resource Area, June 5 – July 2, 2008.

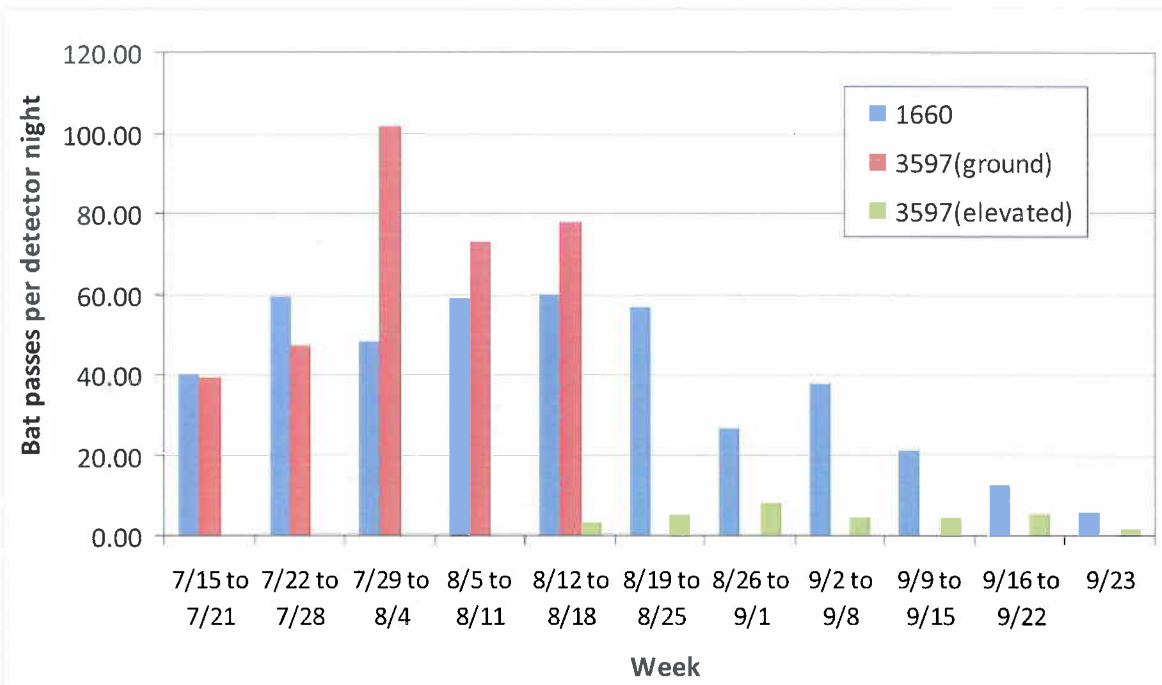


Figure 6. Total number of bat passes per detector night grouped by week for three locations in the proposed Bitter Root Wind Resource Area.

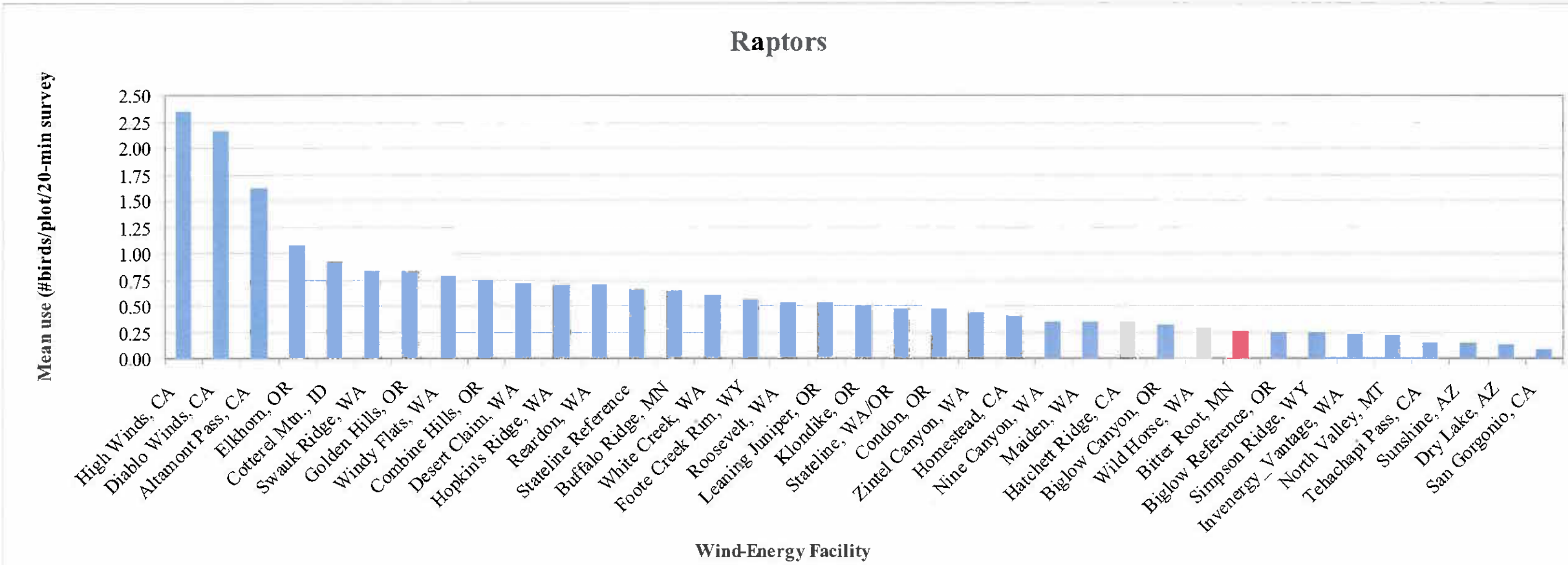
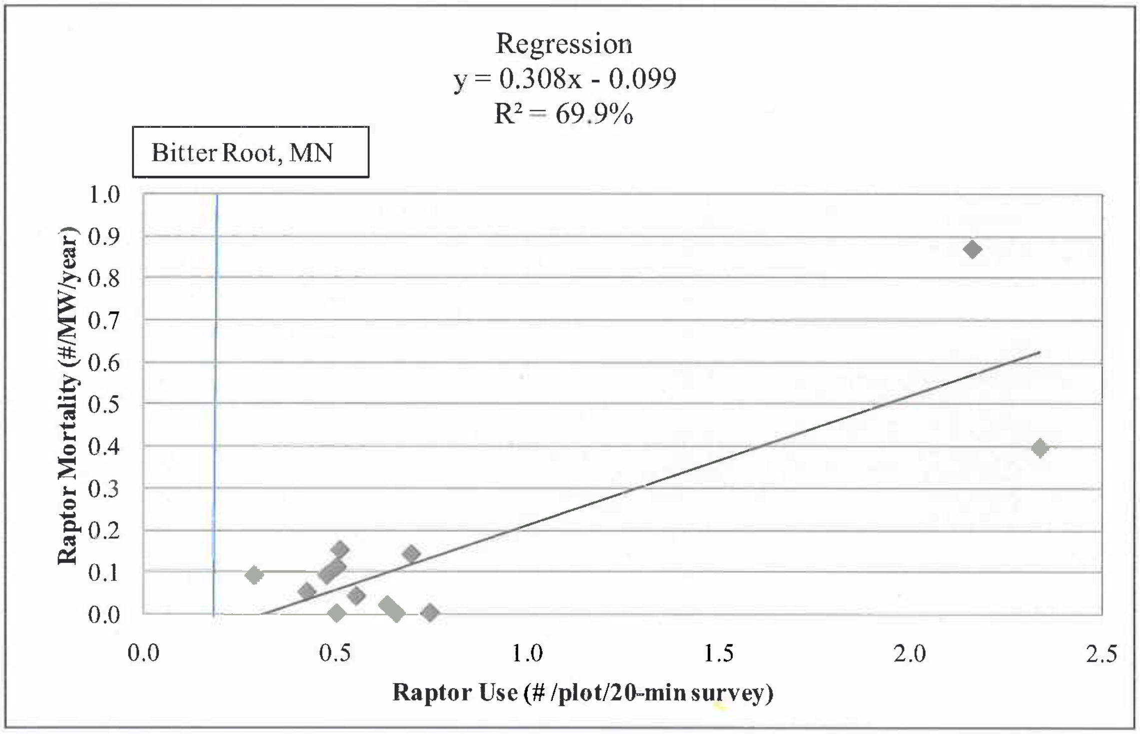


Figure 7. Comparison of annual raptor use between the Bitter Root Wind Resource Area and other US wind-energy facilities.
Data from the following sources:

Bitter Root, MN	This study.				
High Winds, CA	Kerlinger et al. 2005	Stateline Reference	URS et al. 2001	Maiden, WA	Erickson et al. 2002b
Diablo Winds, CA	WEST 2006a	Buffalo Ridge, MN	Erickson et al. 2002b	Hatchet Ridge, CA	Young et al. 2007b
Altamont Pass, CA	Erickson et al. 2002b	White Creek, WA	NWC and WEST 2005a	Biglow Canyon, OR	WEST 2005c
Elkhorn, OR	WEST 2005a	Foote Creek Rim, WY	Erickson et al. 2002b	Wild Horse, WA	Erickson et al. 2003b
Cotterel Mtn., ID	Cooper et al. 2004	Roosevelt, WA	NWC and WEST 2004	Biglow Reference, OR	WEST 2005c
Swauk Ridge, WA	Erickson et al. 2003a	Leaning Juniper, OR	NWC and WEST 2005b	Simpson Ridge, WY	Johnson et al. 2000b
Golden Hills, OR	Jeffrey et al. 2008	Klondike, OR	Johnson et al. 2002a	Invenergy_Vantage, WA	WEST 2007
Windy Flats, WA	Johnson et al. 2007	Stateline, WA/OR	Erickson et al. 2002b	North Valley, MT	WEST 2006b
Combine Hills, OR	Young et al. 2003d	Condon, OR	Erickson et al. 2002b	Tehachapi Pass, CA	Erickson et al. 2002b
Desert Claim, WA	Young et al. 2003b	Zintel Canyon, WA	Erickson et al. 2002a	Sunshine, AZ	WEST and the CPRS 2006
Hopkin's Ridge, WA	Young et al. 2003a	Homestead, CA	WEST et al. 2007	Dry Lake, AZ	Young et al. 2007c
Reardon, WA	WEST 2005b	Nine Canyon, WA	Erickson et al. 2001b	San Gorgonio, CA	Erickson et al. 2002b



Overall Raptor Use 0.259
Predicted Fatality Rate 0/MW/year
90.0% Prediction Interval (0, 0.24/MW/year)

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

Data from the following sources:

Study and Location	Raptor Use	Source	Raptor Mortality	Source
Buffalo Ridge, MN	0.64	Erickson et al. 2002b	0.02	Erickson et al. 2002b
Combine Hills, OR	0.75	Young et al. 2003d	0.00	Young et al. 2005
Diablo Winds, CA	2.161	WEST 2006a	0.87	WEST 2006a
Foote Creek Rim, WY	0.55	Erickson et al. 2002b	0.04	Erickson et al. 2002b
High Winds, CA	2.34	Kerlinger et al. 2005	0.39	Kerlinger et al. 2006
Hopkins Ridge	0.70	Young et al. 2003a	0.14	Young et al. 2007a
Klondike II, OR	0.50	Johnson 2004	0.11	NWC and WEST 2007
Klondike, OR	0.50	Johnson et al. 2002a	0.00	Johnson et al. 2003c
Stateline, WA/OR	0.48	Erickson et al. 2002b	0.09	Erickson et al. 2002b
Vansycle, OR	0.66	WCIA and WEST 1997	0.00	Erickson et al. 2002b
Wild Horse, WA	0.29	Erickson et al. 2003b	0.09	Erickson et al. 2008
Zintel, WA	0.43	Erickson et al. 2002a	0.05	Erickson et al. 2002b
Bighorn, WA	0.51	Johnson and Erickson 2004	0.15	Kronner et al. 2008