Wildlife Baseline Studies for the Buffalo Ridge II Wind Resource Area Brookings and Deuel Counties, South Dakota

Final Report
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Prepared for:

HDR Engineering, Inc.
701 Xenia Avenue South
Minneapolis, MN 55416

and

Iberdrola Renewables
2221 Riverwood Place
St. Paul, MN 55104

Prepared by:

Clayton Derby, Karen Seginak, Ann Dahl, and Kimberly Bay
Western **E**co**S**ystems **T**echnology**,** Inc.
4007 State Street, Suite 109
Bismarck, North Dakota

WEST, Inc.

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EXECUTIVE SUMMARY

Iberdrola Renewables has proposed a wind-energy facility in Brookings and Deuel Counties, South Dakota, near the towns of White and Astoria. Western Ecosystems Technology, Inc. (WEST) conducted baseline surveys and monitored wildlife resources in the Buffalo Ridge II Wind Resource Area (BRIIWRA) to estimate the impacts of wind-energy facility construction and operations on wildlife. The principal objectives of this wildlife monitoring study were to: 1) estimate the seasonal, spatial, and temporal use of the survey area by birds, particularly raptors, defined here as kites, accipiters, buteos, harriers, eagles, falcons, and owls; 2) identify the species and estimate the density of nesting raptors in the study area; 3) estimate the seasonal and spatial use of the study area by bats; 4) describe incidental observations; 5) estimate any potential impacts to birds and bats that could result from construction and operation of the proposed wind-energy facility; and 6) identify potential project modifications and/or mitigation measures that could reduce negative impacts. This report provides results of the baseline surveys at the BRIIWRA conducted from March 12, 2008 through November 5, 2008. Baseline surveys conducted at the BRIIWRA in 2008 included fixed-point bird use surveys, raptor nest surveys, acoustic bat surveys, and incidental wildlife observations.

The BRIIWRA, currently about 49,463 acres (20,017 hectares; ha), is located in northeast Brookings County and southern Deuel County in eastern South Dakota along the South Dakota/Minnesota border. The original project boundary covered a smaller area in Brookings County only; the current project boundary was adopted after the surveys were initiated. Topography in the current project area is flat to rolling. Approximately 60% of the WRA is composed of tilled agriculture. The next most common landcover is pasture, which comprises 20% of the BRIIWRA. The Buffalo Ridge Wind Project will have a nameplate capacity of up to 306 Megawatts (MW). Iberdrola has not selected the turbine model and size yet, but is considering turbines that range in size from 1.5 to 2.4 MW. The project will consist of up to 204 1.5-MW, 153 2.0-MW, 145 2.1-MW, or 127 2.4-MW wind turbines.

Fixed-point surveys (variable circular plots) were conducted approximately once every other week. Birds seen during each 20-minute (min) fixed-point survey were recorded. Nineteen points were selected to achieve optimal coverage of the study area and habitats within the study area. The project as initially described was limited to Brookings County and this area contained 15 points. In fall 2008, notice was given that the project area was expanding into Deuel County and an additional four points were added in this area. Each survey plot was a 2,625-ft (800-m) radius circle centered on the point for large birds and 328-ft (100-m) radius for small birds.

A total of 282 twenty-minute fixed-point surveys were conducted at the BRIIWRA. Fifty-six unique species were observed over the course of all fixed-point bird use surveys, with a mean number of species observed per survey of 2.14. More unique species were observed during the summer (43 species), followed by spring (40), and fall (21). The mean number of species per survey was higher in the spring (2.73 species/survey) and summer (2.67) compared to the fall (0.80). A total of 7,483 individual bird observations within 757 separate groups were recorded during the fixed-point surveys. A total of 39 individual raptors were recorded within the BRIIWRA, representing 8 identified species.

The highest overall bird use occurred in the spring (65.8 birds/plot/20-min survey), followed by fall (4.09), and summer (4.02). Waterfowl were the most abundant bird type overall due to large numbers of observations in the spring. Raptor use was relatively consistent through the seasons (0.14 birds/plot/20-min survey in the spring, 0.11 in the summer, and 0.15 in the fall. Northern harriers had the highest use of any raptor in spring (0.07) and red-tailed hawks had the highest use in summer (0.06) and fall (0.12). During the study, 347 single birds or groups totaling 6,676 individuals were observed flying during fixed-point bird use surveys. Overall, 77.1% of birds observed flying were recorded within the zone of risk (ZOR), 13.4% were below the ZOR, and 9.5% were flying above the ZOR. More than 70% of flying raptors were observed below the ZOR, 30.0% were within the ZOR, and no raptors were observed flying above the ZOR.

Based on data collected during this study, raptor and all bird use of the BRIIWRA is generally lower than most wind resource areas evaluated throughout the western and Midwestern United States using similar methods. Based on the results of the studies to date, bird mortality at the BRIIWRA would likely be similar to or lower than that documented at other wind energy facilities located in the western and Midwestern United States where bird collision mortality has been relatively low. Raptor fatality rates are expected to be lower than fatality rates observed at other facilities where raptor use levels are higher.

Given that there are grasslands and other potential nesting and use areas within the BRIIWRA, there will likely be some amount of displacement effects from the project. However, based on studies to date, the amount of these affects would appear to be small. Turbines placed on tilled agricultural lands would have even lower potential displacement impacts. Further, the presence of similar habitat surrounding the BRIIWRA means that any displacement of these species is unlikely to impact the population.

Raptor nest 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). No active or inactive raptor nests were observed in the BRIIWRA.

Bats were surveyed using AnaBat® II and AnaBat SD1 ultrasonic detectors (Titley Electronics Pty Ltd., NSW, Australia). Bat activity was surveyed using four detectors from July 1 to October 14, 2008. All units were programmed to turn on each night an approximate one half-hour before sunset and turn off an approximate one half-hour after sunrise.

The units of activity were number of bat passes. Bat calls were classified as either high-frequency calls (≥ 35 kHz) or low-frequency (< 35 kHz). The total number of bat passes per detector night was used as an index for bat. 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. AnaBat units recorded 685 bat passes on 391 detector-nights. Averaging bat passes per detector-night across locations, a mean of 1.75 bat passes per detector-night were recorded. Bat activity peaked in late July; bat passes per detector night were above 4.0 on four of six consecutive nights. Most bat calls detected during July were low frequency. There was another increase in activity in late August through mid-September. Calls detected during this period were mainly high frequency calls.

No federal or state listed threatened, endangered, proposed, candidate, or sensitive-status wildlife was observed at the BRIIWRA during fixed-point bird use surveys or incidentally. However, the BRIIWRA is just outside the eastern edge of the migration corridor of whooping cranes, and in comments on other project reviews, agencies have expressed concern over potential impacts to whooping cranes. No whooping or sandhill cranes were observed during the study.

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INTRODUCTION

Iberdrola Renewables (Iberdrola) has proposed a wind-energy facility in Brookings and Deuel Counties, South Dakota (Figure 1), near the towns of White and Astoria. HDR Engineering, Inc. (HDR) has been contracted to assist in the environmental permitting process. Under the direction of HDR, Western Ecosystems Technology, Inc. (WEST) conducted baseline surveys and monitored wildlife resources in the Buffalo Ridge II Wind Resource Area (BRIIWRA) to estimate the impacts of wind-energy facility construction and operations on wildlife.

The principal objectives of this wildlife monitoring study were to: 1) estimate the seasonal, spatial, and temporal use of the survey area by birds, particularly raptors, defined here as kites, accipiters, buteos, harriers, eagles, falcons, and owls; 2) identify the species and estimate the density of nesting raptors in the study area; 3) estimate the seasonal and spatial use of the study area by bats; 4) describe incidental observations; 5) estimate any potential impacts to birds and bats that could result from construction and operation of the proposed wind-energy facility; and 6) identify potential project modifications and/or mitigation measures that could reduce negative impacts.

This report provides results of the baseline surveys at the BRIIWRA conducted from March 12, 2008 through November 5, 2008. Baseline surveys conducted at the BRIIWRA in 2008 included fixed-point bird use surveys, raptor nest surveys, acoustic bat surveys, and incidental wildlife observations. In addition to site-specific data, this report presents existing information and results of studies conducted at other wind-energy facilities. The ability to estimate potential bird mortality at the proposed BRIIWRA is greatly enhanced by operational monitoring data collected at existing wind-energy facilities. For several wind-energy facilities, standardized data on fixed-point surveys were collected in association with standardized post-construction (operational) monitoring, allowing comparisons of bird use with bird mortality.

STUDY AREA

The BRIIWRA, currently about 49,463 acres (20,017 hectares; ha), is located in northeast Brookings County and southern Deuel County in eastern South Dakota along the South Dakota/Minnesota border (Figure 1). The original project boundary covered a smaller area in Brookings County only (Figure 1); the current project boundary was adopted after surveys were initiated. Topography in the current project area is flat to rolling, with elevations ranging from 1,719-1,991 feet (ft; 524-607 meters [m]) above sea level (Figure 2). Approximately 60% of the WRA is composed of tilled agriculture (Table 1). The next most common landcover is pasture, which comprises 20% of the BRIIWRA (Figure 3). Planted grasslands comprise 5% of the proposed BRIIWRA. Wetlands account for about 4% of landcover, hayland about 3% and farmsteads about 3%.

The BRIIWRA will have a nameplate capacity of up to 306 Megawatts (MW). Iberdrola has not selected the turbine model and size yet, but is considering turbines that range in size from 1.5 to 2.4 MW. The Project will consist of up to 204 1.5-MW, 153 2.0-MW, 145 2.1-MW, or 127 2.4-MW wind turbines. For the purposes of our analyses, a zone of risk (ZOR) of 114 to 427 ft (35 to 130 m) above ground level (AGL) was used. This range includes the rotor swept area of most modern wind turbines, but there may be types that have portions outside of this range; therefore, this is the most likely range and not the most extreme range for the rotor swept area.

METHODS

The study at the BRIIWRA consisted of the following research components: 1) fixed-point bird use surveys; 2) raptor nest surveys; 3) acoustic bat surveys; and 4) incidental wildlife observations.

Fixed-Point Bird Use Surveys

The objective of the fixed-point bird use surveys was to estimate the seasonal, spatial, and temporal use of the study area by birds, particularly raptors. 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. Birds seen during each 20-minute (min) fixed-point survey were recorded on data sheets.

Bird Use Survey Plots

Nineteen points were selected to achieve optimal coverage of the study area and habitats within the study area (Figure 4). The project as initially described was limited to Brookings County and this area contained 15 points. In late September 2008, the project study area was expanded into Deuel County and an additional four points were added in this area. Each survey plot was a 2,625-ft (800-m) radius circle centered on the point for large birds and 328-ft (100-m) radius for small birds.

Bird Survey Methods

All species of large birds observed during fixed-point surveys were recorded, and all large birds observed perched within or flying over the plot were recorded and mapped. Small birds (e.g., sparrows) observed within 328 ft (100 m) of the point were recorded, but not mapped. Observations of birds beyond the 2,625-ft (800-m) 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 to the nearest 16-ft (5-m) interval. Other information recorded about the observation included whether or not the observation was auditory only and the 10-min interval of the 20-min survey in which it was first observed.

Locations of raptors, other large birds, and species of concern 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. Fixed-point surveys were conducted from March 12, 2008, through November 5, 2008. Surveys were conducted approximately once every other week during the survey period (March 12 to November 5). 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. Also, the four points that were added in Deuel County were only surveyed three times in the fall of 2008.

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 or nests on the ground. 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). Universal Transverse Mercator (UTM) or global positioning system (GPS) coordinates, as well as nesting substrate and current status (inactive, active, incubating, young in nest), were recorded for each nest located.

Incidental Wildlife Observations

The objective of incidental wildlife observations was to provide a record of wildlife seen outside of the standardized surveys. All raptors, unusual or unique birds, sensitive species, mammals, reptiles, and amphibians 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 in UTM by GPS.

Bat Acoustic Surveys

The objective of the bat use surveys was to estimate the seasonal and spatial use of the BRIIWRA by bats. Bats were surveyed using AnaBat® II and AnaBat SD ultrasonic detectors (Titley Electronics Pty Ltd., NSW, Australia). 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). Bat activity was surveyed using four detectors from July 1 to October 14, 2008 (Figure 5).

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. The 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 off the ground to minimize echo interference and lift the unit above vegetation. All units were programmed to turn on each night an approximate one half-hour before sunset and turn off an approximate one half-hour after sunrise.

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

Bird Diversity and Species Richness

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 2,625-ft (800-m) radius plot for large birds and 328-ft (100-m) radius plot for small birds 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.

Bird Flight Height and Behavior

To calculate potential risk to bird species, the first flight height recorded was used to estimate the percentages of birds flying within the likely ZOR for potential collision with turbine blades for typical turbines. The likely zone of risk used for the analysis was 114 to 427 ft (35 to 130 m) AGL, which is the blade height range of many typical turbines that could be used at the BRIIWRA.

Bird Exposure Index

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

$$R = A*P_f*P_t$$

Where A equals mean relative use for species *i* (observations within 2,625 ft [800 m] of the observer) averaged across all surveys, P_f equals the proportion of all observations of species *i* where activity was recorded as flying (an index to the approximate percentage of time species *i* spends flying during the daylight period), and P_t equals the proportion of all initial flight height observations of species *i* within the likely ZOR.

Spatial Use

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

Bat Acoustic Surveys

The units of activity were number of bat passes (Hayes 1997). A pass was defined as a continuous series of greater than or equal to two 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 (≥ 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 2; BCI website 2008; Harvey et al. 1999).

The total number of bat passes per detector night was used as an index for bat use in the BRIIWRA. 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

Surveys were completed at the BRIIWRA from March 12, 2008 through November 5, 2008. Fifty-six bird species were identified during fixed-point bird use surveys. Four additional species were only observed as incidental observations, resulting in 60 unique bird species observed at the BRIIWRA. Six mammal species were also observed incidentally. Results of the fixed-point, raptor nest, and incidental surveys and the specific numbers of unique species per survey type are discussed in the sections below.

Fixed-point Bird Use Surveys

A total of 282 twenty-minute fixed-point surveys were conducted at the BRIIWRA (Table 3).

Bird Diversity and Species Richness
Fifty-six unique species were observed over the course of all fixed-point bird use surveys, with a mean number of species observed per survey of 2.14 (species/plot/20-min survey; Table 3). More unique species were observed during the summer (43 species), followed by spring (40), and fall (21; Table 3). The mean number of species per survey was higher in the spring (2.73 species/survey) and summer (2.67) compared to the fall (0.80; Table 3). A total of 7,483 individual bird observations within 757 separate groups were recorded during the fixed-point surveys (Table 4). Cumulatively, five species composed approximately 84% of the observations: snow goose (*Chen caerulescens*), Canada goose (*Branta canadensis*), horned lark (*Eremophila alpestris*), greater white-fronted goose (*Anser albifrons*), and red-winged blackbird (*Agelaius phoeniceus*). No other species comprised more than 5% of the observations (Table 4). A total of 39 individual raptors were recorded within the BRIIWRA, representing 8 identified species (Table 4).

Bird Use, Composition, and Frequency of Occurrence by Season
Mean bird use, percent composition, and frequency of occurrence for all species and bird types by season are shown in Table 5. The highest overall bird use occurred in the spring (65.8 birds/plot/20-min survey), followed by fall (4.09), and summer (4.02). Waterfowl were the most abundant bird type overall due to large numbers of observations in the spring. Passerines were the next most abundant birds, even with the smaller plots.

<u>Waterbirds</u>

Waterbirds had the highest use in spring (0.23 birds/plot/20-min survey), compared to other times of the year (summer 0.06 and fall 0.16; Table 5). Waterbirds comprised less than 4% of the overall bird use in all three seasons.

<u>Waterfowl</u>

Waterfowl had the highest use in spring (58.5 birds/plot/20-min survey), compared to other times of the year (summer 0.10 and fall 0.35; Table 5). High waterfowl use in spring was due to many large groups of snow geese and Canada geese that together made up 80% of the overall spring bird use. Otherwise, waterfowl comprised less than 8.5% of the overall bird use in the other seasons. Waterfowl were observed more frequently in spring (37.8%) compared to summer (6.7%) and fall (2.0%).

<u>Shorebirds</u>

Shorebirds had the highest use in spring (0.30 birds/plot/20-min survey) and summer 0.30, compared to fall (0.09; Table 5). Shorebirds comprised less than 8% of the overall bird use for all three seasons. Shorebirds were observed during 18.1% of the surveys in the summer, 17.8% in the spring and less often (2.7%) in the fall.

<u>Raptors</u>

Raptor use was relatively consistent through the seasons at 0.14 birds/plot/20-min survey in the spring, 0.11 in the summer, and 0.15 in the fall (Table 5). Northern harriers (*Circus cyaneus*) had the highest use of any raptor in spring (0.07) and red-tailed hawks (*Buteo jamaicensis*) had the highest use in summer (0.06) and fall (0.12). Raptors comprised less than 4% of the overall bird use during the study. Raptors were observed during 12.7% of surveys in the fall and 12.2% in the spring, compared to 9.5% of the surveys in the summer.

<u>Upland Gamebirds</u>

Upland gamebirds had relatively higher use in the spring (0.84 birds/plot/20-min survey), than in summer (0.39) and fall (0.29; Table 5). High use in the spring was primarily due to many observations of ring-necked pheasants (*Phasianus colchicus*). Upland gamebirds comprised less than 10% of overall bird use during all three seasons. Upland gamebirds were observed during 53.3% of surveys in the spring compared to 33.3% in the summer and 9.3% in the fall.

<u>Passerines</u>

Passerine use was highest in spring (5.47 birds/plot/20-min survey), compared to summer (2.55) and fall (2.74; Table 5). The horned lark had the highest use by any one species in spring (3.88 birds/plot/20-min survey) and fall (1.83). The red-winged blackbird had the highest use in summer (0.39). Passerines made up more than 63% of use in summer and fall and were observed during 28% or more of the surveys in all three seasons.

Bird Flight Height and Behavior

Flight height characteristics were estimated for both bird types and bird species (Tables 6 and 7). During the study, 347 single birds or groups totaling 6,676 individuals were observed flying during fixed-point bird use surveys (Table 6). Overall, 77.1% of birds observed flying were recorded within the ZOR, 13.4% were below the ZOR, and 9.5% were flying above the ZOR

(Table 6). More than 70% of flying raptors were observed below the ZOR, 30.0% were within the ZOR, and no raptors were observed flying above the ZOR. Waterfowl had the highest percentage of flying birds within the ZOR (87.5%) followed by waterbirds with 68.1% within the ZOR. Passerines had the third highest percentage of birds within the ZOR.

Seven species had at least 20 groups observed flying and three of those species were observed flying within the likely ZOR during at least 80% of the observations (52.8%; Table 7). Three species were always observed flying within the likely ZOR; however these were only based on one or two group observations.

Bird Exposure Index
A relative exposure index was calculated for each species (Table 7). This index is only based on initial flight height observations and relative abundance (defined as the use estimate) and does not account for other possible collision risk factors such as foraging or courtship behavior. Snow geese had an exposure index higher than any other species with 11.62; Canada geese (4.85) and greater white-fronted geese (1.51) had the next highest exposure indices. Exposure indices for all other species were less than 1.0. The raptor species with the highest exposure index was the red-tailed hawk (0.03); all other raptor species had an exposure index of <0.01 (Table 7).

Spatial Use
For all bird species combined, use was highest at point #3 (110.0 birds/20-min survey). Bird use at other points ranged from 5.06 to 43.9 (Figure 6). The high mean use estimate for point #3 was largely due to high waterfowl use (108). Waterfowl use at the other points ranged from 0.06 – 39.8 birds/20-min survey. Passerine use was highest at point #8, with 14.4 birds/20-min survey. Other points had passerine use ranging from 1.33 to 5.78 birds/20-min survey. Raptor use was highest at point #4 (0.44) and ranged from 0 to 0.33 birds/20-min survey at other points. Buteo use was highest at point #4 and point #11 (both 0.28) and northern harrier use was highest at point #4 and point #15.

Raptor Nest Surveys

No active or inactive raptor nests were observed in the BRIIWRA.

Incidental Wildlife Observations

Thirteen identified bird species and six mammal species were observed incidentally at the BRIIWRA. All incidental wildlife observations are presented in Table 8.

Bird Observations
The most abundant bird species recorded as an incidental wildlife observation was the Canada goose (1 group of 100 individuals). Thirteen unique bird species were observed and identified, with a total of 146 individuals in 29 groups (Table 8). Four species were only seen incidentally at the BRIIWRA.

Mammal Observations
White-tailed deer (*Odocoileus virginianus*) were observed in seven groups (18 individuals) incidentally during the fixed-point surveys at the BRIIWRA (Table 8). Other species observations consisted of only 1 or 2 individuals.

Bat Acoustic Surveys

Bat activity was monitored at four sampling locations on a total of 424 nights during the period July 1 to October 14, 2008. AnaBat units were operable for 92% of the sampling period because data cards reached capacity and were unable to record data on several nights. AnaBat units recorded 685 bat passes on 391 detector-nights (Table 9). Averaging bat passes per detector-night across locations, a mean of 1.75 bat passes per detector-night were recorded.

Spatial Variation
Bat activity was highest at the location of AnaBat unit #1546 in the BRIIWRA (mean = 2.25 bat passes per detector-night; Figures 7) and lowest at Unit #3791 (1.26).

Temporal Variation
Bat activity peaked in late July; bat passes per detection night were above 4.0 on four of six consecutive nights (Figure 8). Most bat calls detected during July were low frequency. There was another increase in activity in late August through mid-September. Calls detected during this period were mainly high frequency calls.

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. Most of the low frequency bat calls were made by hoary bats.

DISCUSSION AND IMPACT ASSESSMENT

Bird Impacts

Direct Effects
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. 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, but some risk from vehicle collision also exists.

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 pigeons (*Columba livia*) comprised 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 comprised only 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 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 and Exposure Risk

The annual mean raptor use at the BRIIWRA (0.14 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. 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 (Figure 9). 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). Under this ranking, mean raptor use at BRIIWRA is considered to be low; only 2 sites have a lower mean use (Figure 9).

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 (Falco sparverius), red-tailed hawks, and golden eagles (Aquila chrysaetos) 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.

An exposure index analysis may also provide insight into what species might be the most likely turbine casualties. The index considers relative probability of exposure based on abundance, proportion of activity spent flying, and proportion of flight height of each species within the ZOR for turbines likely to be used at the wind-energy facility. For the BRIIWRA, the raptor species with the highest exposure index was the red-tailed hawk, which was ranked eighth of all species; its exposure index was only 0.03 (Table 7). The relatively high exposure index for red-tailed hawk was due to the flight height data showing that 57.1% of flying observations were within the ZOR. The exposure index analysis is based on observations of birds during the daylight period and does not take into consideration flight behavior (e.g. during foraging or courtship) or abundance of nocturnal migrants. It also does not take into consideration habitat selection, the ability to detect and avoid turbines, and other factors that may vary among species and influence likelihood for turbine collision. For these reasons, the actual risk for some species may be lower or higher than indicated by this index.

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 ($R^2 = 70.5\%$; Figure 10). Using this regression to predict raptor collision mortality at the BRIIWRA, based on a mean raptor use of 0.14 birds/20-min survey, yields an estimated fatality rate of zero raptors/MW/year, or zero raptor fatalities per year for each 100-MW of wind-energy development. A 90% prediction interval around this estimate is zero to 0.21 raptors/MW/year.

No active raptor nests were observed in the BRIIWRA in 2008. This is low in comparison to ten other WRAs evaluated in the western United States, where active raptor nest density ranged from 0.03 to 0.30/mile^2 (0.01 to 0.12/ kilometer^2) and averaged 0.15/mile^2 (0.06/kilometer^2). Because few raptor species targeted during nest surveys 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, 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. 2000a), but no red-tailed hawk fatalities have been documented at this site (Young et al. 2003).

Non-raptor Use and Exposure Risk

Most bird species in the United States are protected by the Migratory Bird Treaty Act (MBTA 1918). Passerines (primarily perching birds) have been the most abundant avian fatality at wind energy facilities outside California (Erickson et al. 2001a, 2002b), often comprising more than 80% of the avian fatalities. Both migrant and resident passerine fatalities have been observed. Given that passerines made up a substantial proportion of the birds observed during the baseline study, we would expect passerines to make up a large proportion of fatalities at the BRIIWRA. Exposure indices indicate that red-winged blackbird is the most likely passerine to be exposed to collision from wind turbines at the BRIIWRA. Most passerines had relatively low exposure indices due to the majority of individuals flying below the likely zone of risk. Due to the low exposure risks at BRIIWRA, it is unlikely that passerine populations will be adversely affected by direct mortality from the operation of the wind-energy facility.

Waterfowl were the most abundant bird type overall due to large numbers of observations in the spring. Eighty-seven percent of flying waterfowl were observed flying within the ZOR and the three species with the highest exposure indices were waterfowl. Based on these results, it would appear that waterfowl are the most likely bird group to be negatively affected by direct mortality with wind turbines in the BRIIWRA. However, 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 farms, waterbirds comprised 2%, waterfowl comprised 3%, and shorebirds comprised <1% (Erickson et al. 2002b). At the Klondike, Oregon wind farm, 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 1 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 (Anas platyrhynchos) were the most common waterfowl observed. Three of the 55 fatalities observed during the fatality monitoring studies were waterfowl, including 2 mallards and 1 blue-winged teal (Anas discors). Two American coots (Fulica americana), 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 significant impacts are not likely. Post-construction monitoring will confirm that waterfowl mortality will not be a significant issue for this project area.

Sensitive Species Use and Exposure Risk

No federal or state listed threatened, endangered, proposed, candidate, or sensitive-status wildlife was observed at the BRIIWRA during fixed-point bird use surveys or incidentally. However, the BRIIWRA is just outside the eastern edge of the migration corridor of whooping cranes (*Grus americana*) and in comments regarding other project reviews, the South Dakota Game, Fish, and Parks and U.S. Fish & Wildlife Service have expressed concern over potential impacts to whooping cranes. Because whooping and sandhill (*Grus canadensis*) cranes show similar habitat use and behavior during migration, the presence of sandhill cranes may indicate suitability of a site for whooping cranes. No whooping or sandhill cranes were observed during the study. However, surveys were not conducted daily so movements of cranes through the project area may have gone undetected. In a 4-year study on a WRA just over the state line in Minnesota, sandhill cranes were observed in two of the four years (145 in 1996 and one in 1998) so there is the potential for sandhill cranes to utilize the BRIIWRA (Johnson et al. 2000a). No whooping cranes were observed during the 4-year Minnesota study. Limited or no mortality of common cranes (G*rus grus*) has been documented at large wind-energy facilities located in western Europe, where common cranes are abundant (Hartwig Prange, pers. comm., 2003 North American Crane Working Group Meeting). Erickson et al. (2001a) did not identify any studies that documented cranes being killed or injured at wind-energy facilities in the United States in their review of bird collisions with wind turbines. The low rate of crane collisions with turbines makes it unlikely that whooping or sandhill cranes will be affected by the proposed BRIIWRA. However, as cranes ascend and descend during landing, or migrate during inclement weather and as thermal lift decreases, they may fly at lower altitudes, and may be at risk for collision with turbine blades.

Indirect Effects
The presence of wind turbines may alter the landscape so that wildlife use patterns are affected, displacing wildlife away from the project facilities and suitable habitat. Some studies from wind-energy facilities in Europe consider displacement effects to have a greater impact on birds than collision mortality (Gill et al. 2006). The greatest concern with displacement impacts for wind-energy facilities in the United States has been where these facilities have been constructed in grassland or other native habitats (Leddy et al. 1999, Mabey and Paul 2007). Although Crockford (1992) suggests that disturbance appears to impact feeding, resting, and migrating birds, rather than breeding birds, results from studies at the Stateline wind-energy facility in Washington and Oregon (Erickson et al. 2004) and the Buffalo Ridge wind-energy facility in Minnesota (Johnson et al. 2000a) suggest that breeding birds are also affected by wind-facility operations.

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. No active raptor nests were observed within the BRIIWRA in 2008, which is low compared to most other regional wind-energy facilities, thereby minimizing the potential impact on nesting raptors. There is potential nesting habitat in the area in the form of scattered tree and shelter belts so raptors may nest in the area in future years. Birds displaced from wind-energy facilities might move to areas with fewer disturbances, but lower quality, with an overall effect of reducing breeding success. Most studies on raptor displacement at wind-energy facilities, however, indicate effects to be negligible (Howell and Noone 1992; Johnson et al. 2000b, 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 (Bubo virginianus), and one golden eagle nests located within one mile of the wind farm successfully fledged young (Johnson et al. 2000b). The golden eagle pair successfully nested 0.5 mile from the wind farm for three different years after it became operational. A Swainson's hawk (Buteo swainsoni) 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, along with the no or very limited nesting of raptors in the BRIIWRA, suggest that there will be limited nesting displacement of raptors at the BRIIWRA (if any nest in the area in the future).

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 facilities appear to cause small scale local displacement of grassland passerines, which is likely due to the birds avoiding turbine noise and maintenance activities. Facilities also reduce grassland habitat effectiveness because of the presence of access roads and 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 to 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).

A recent study conducted in England to assess displacement of wintering farmland birds by wind turbines located in an agricultural landscape found that common pheasants (*Phasianus colchicus*) apparently avoided turbines at close distances, but the overall effects were small. The other species/bird groups examined, including granivores, red-legged partridge (*Alectoris rufa*), Eurasian skylark (*Alauda arvensis*) and corvids, showed no displacement from wind turbines. In fact, Eurasian skylarks and corvids showed increased use of areas close to turbines, possibly due to increased food resources associated with disturbed areas (Devereux et al. 2008).

Given that there are grasslands and other potential nesting and use areas within the BRIIWRA, there will likely be some amount of displacement effects from the project. However, based on studies to date, the amount of these affects would appear to be small. Turbines placed on tilled agricultural lands (which are the predominate land cover type) would have even lower potential displacement impacts. Further, the presence of similar habitat surrounding the BRIIWRA means that any displacement of these species is unlikely to impact the population.

Bats--Potential Impacts

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

Some studies of wind projects have recorded both AnaBat detections per night and bat mortality (Table 3). 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 BRIIWRA (mean = 1.75 bat passes per detector-night) was low compared to that observed at other wind facilities (Table 10). Thus, based on the presumed relationship between pre-construction bat activity and post-construction fatalities, we expect bat mortality rates at BRIIWRA to be less than the 2.2 bat fatalities/turbine/year reported at Buffalo Ridge, Minnesota (Johnson et al. 2003c), and much lower than the 20.8 fatalities/turbine/year reported at Buffalo Mountain, Tennessee (Fiedler 2004).

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 BRIIWRA does not contain topographic features that may funnel migrating bats and is lacking large tracts of forest cover, unlike high-mortality sites in the eastern United States. 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 BRIIWRA and relatively even numbers of bat calls detected at the recording stations, we expect that any bat mortalities would be relatively evenly distributed across the project and not focused on one or more areas.

Temporal Variation
The number of bat calls detected per night at the BRIIWRA was relatively high during late July and again in September. Activity in July likely corresponds with the reproductive season, when pups are being weaned and foraging rates are high. September activity may represent movement of migrating bats through the area. In this part of the United States many species of bats conduct short to very long distance migrations. The majority of calls being high-frequency during this time period is contrary to most studies in which low-frequency calls are in the majority as they represent species such as hoary bats. At the BRIIWRA, some of the high frequency calls observed in September could be attributed to red bats (which are also a tree roosting, long distance migrant similar to the hoary bat) based on their frequency, but others were apparently myotis species.

Fatality studies of bats at wind projects in the United States 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 data, it is expected that bat mortality at the BRIIWRA will be highest in September.

Species Composition
Of the seven species of bat likely to occur in the study area, six are known fatalities at wind-energy facilities (Table 2). Acoustic bat surveys were unable to determine bat species present in the study area (except for hoary bats), but they were able to distinguish high-frequency from low-frequency species. Sixty-three percent of all passes were by low-frequency bats, suggesting higher relative abundance of species such as hoary bats and big brown bats during the course of the year. Many of the low-frequency species likely to be present at the BRIIWRA (e.g., hoary, silver-haired, and big brown bat) tend to forage at higher altitudes than most high-frequency species due to their wing morphology and echolocation call structure (Norberg and Rayner 1987). However, the number of high-frequency calls recorded in September would translate into red bats, eastern pipstrelles (Perimyotis subflavus), and little brown bats (Myotis lucifugus). This increase in high frequency species later in the year is something that is not often observed at projects in the Midwest. Some studies have found that individual bats can have varying degrees

of calls when foraging near wooded or broken landscapes, and this could explain some of the difficulties in narrowing the potential species use for the BRIIWRA.

CONCLUSIONS AND RECOMMENDATIONS

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

Currently, few published studies are available from the Midwest that compare bird use to bird mortality rates. Based on research conducted at wind projects throughout the United States, raptor use at the BRIIWRA is generally lower than use levels recorded at other wind-energy facilities. Raptor fatality rates are expected to be lower than fatality rates observed at other facilities where raptor use levels are higher. To date, no relationships have been observed between overall use by other bird types, and fatality rates of those bird groups at wind-energy facilities. However, the flight characteristics and foraging habits of some species may result in increased exposure for these species at the BRIIWRA. The surveys conducted for this project also do not address the impacts of the proposed facility to nocturnal migrants. To date, overall fatality rates for birds (including nocturnal migrants) at wind-energy facilities have been relatively low and consistent in the Midwest. The range of overall bird fatality estimates at three Midwest project areas has ranged from 0.7 to 3.4 birds/MW/year (Howe et al. 2002; Johnson et al. 2002b; Koford et al. 2005). As more research is conducted at projects in the Midwest, more information regarding the potential direct impacts of wind-energy facilities to bird species will be obtained.

The proposed wind-energy facility contains a diversity of habitats; approximately 60% of the BRIIWRA contains tilled agriculture, while the remaining areas are comprised of pastures, planted grasslands, and hayland (Table 1, Figure 3). No species considered to be state or federally threatened or endangered were observed within the BRIIWRA. Some potential exists for wind turbines to displace birds within non-cropland habitats. Research concerning displacement impacts to songbirds, waterfowl and waterbirds and wind-energy facilities is limited, but some studies show the potential for small scale (591 ft [180 m] or less) displacement, while impacts to densities of birds at larger scales has not been shown.

REFERENCES

Arnett, E. 2007. Report from BWEC on Collaborative Work and Plans. Presentation at the NWCC Wildlife Workgroup Meeting, Boulder Colorado. Conservation International. November 14th, 2007. Information available at www.nationwind.org

Arnett, E.B., K. Brown, W.P. Erickson, J. Fiedler, B.L. Hamilton, T.H. Henry, A. Jain, G.D. Johnson, J. Kerns, R.R. Kolford, C.P. Nicholson, T. O'Connell, M. Piorkowski, and R. Tankersley, Jr. 2008. Patterns of Fatality of Bats at Wind Energy Facilities in North America. Journal of Wildlife Management 72: 61-78.

Arnett, E.B., W.P. Erickson, J. Kerns, and J. Horn. 2005. Relationships between Bats and Wind Turbines in Pennsylvania and West Virginia: An Assessment of Fatality Search Protocols, Patterns of Fatality, and Behavioral Interactions with Wind Turbines. Prepared for the Bats and Wind Energy Cooperative. March 2005.

Baerwald, E. 2006. Bat Fatalities in Southern Alberta. Presented at the Wildlife Research Meeting VI, San Antonio, Texas. National Wind Coordinating Collaborative. November 2006.

Baerwald, E.F., G.H. D'Amours, B.J. Klug, and R.M.R. Barclay. 2008. Barotrauma Is a Significant Cause of Bat Fatalities at Wind Turbines. Current Biology 18(16): R695-R696.

Bat Conservation International (BCI). Website. Bat Species: US Bats. Bat Conservation International, Inc., Austin, Texas. Accessed 2008. Homepage: http://www.batcon.org Species Profiles: http://www.batcon.org/SPprofiles/index.asp

Cooper, B.A., R.J. Blaha, T.J. Mabee, and J.H. Plissner. 2004. A Radar Study of Nocturnal Bird Migration at the Proposed Cotterel Mountain Wind Energy Facility, Idaho, Fall 2003. Technical report prepared for Windland, Inc., Boise, Idaho, by ABR, Inc., Forest Grove, Oregon. January 2004.

Crockford, N.J. 1992. A Review of the Possible Impacts of Wind Farms on Birds and Other Wildlife. JNCC Report No. 27. Joint Nature Conservancy Committee, Peterborough, United Kingdom. 60 pp.

Demastes, J.W. and J.M. Trainer. 2000. Avian Risk, Fatality, and Disturbance at the IDWGP Wind Farm, Algona, Iowa. Final Report Submitted by the University of Northern Iowa, Cedar Falls, Iowa. 21 pp.

Devereux, C.L., M.J.H. Denny, and M.J. Whittingham. 2008. Minimal Effects of Wind Turbines on the Distribution of Wintering Farmland Birds. Journal of Applied Ecology Windfarms and Farmland Birds: 1365-2664.

Erickson, W.P., J. Jeffrey, K. Kronner, and K. Bay. 2004. Stateline Wind Project Wildlife Monitoring Final Report: July 2001 - December 2003. Technical report for and peer-reviewed by FPL Energy, Stateline Technical Advisory Committee, and the Oregon Energy Facility Siting Council, by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming, and Walla Walla, Washington, and Northwest Wildlife Consultants (NWC), Pendelton, Oregon. December 2004. http://www.west-inc.com

Erickson, W.P., J. Jeffrey, and V.K. Poulton. 2008. Avian and Bat Monitoring: Year 1 Report. Puget Sound Energy Wild Horse Wind Project, Kittitas County, Washington. Prepared for Puget Sound Energy, Ellensburg, Washington, by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming. January 2008.

Erickson, W.P., J. Jeffrey, D. Young, K. Bay, R. Good, K. Sernka, and K. Kronner. 2003a. Wildlife Baseline Study for the Kittitas Valley Wind Project: Summary of Results from 2002 Wildlife Surveys. Final Report February 2002– November 2002. Prepared for Zilkha Renewable Energy, Portland, Oregon, by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming, and Northwest Wildlife Consultants, Inc. (NWC), Pendleton, Oregon. January 2003.

Erickson, W.P., G.D. Johnson, K. Bay, and K. Kronner. 2002a. Ecological Baseline Study for the Zintel Canyon Wind Project. Final Report April 2001 – June 2002. Technical report prepared for Energy Northwest. Prepared for Energy Northwest by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming, and Northwest Wildlife Consultants, Inc. (NWC), Pendleton, Oregon. June 2002.

Erickson, W.P., G.D. Johnson, M.D. Strickland, D.P. Young, Jr. , K.J. Sernka, and R.E. Good. 2001a. Avian Collisions with Wind Turbines: A Summary of Existing Studies and Comparisons to Other Sources of Bird Collision Mortality in the United States. National Wind Coordinating Committee (NWCC) Publication and Resource Document. Prepared for the NWCC by WEST, Inc., Cheyenne, Wyoming. August 2001. http://www.nationalwind.org/publications/default.htm and http://www.west-inc.com

Erickson, W.P., G.D. Johnson, D. Young, D. Strickland, R. Good, M. Bourassa, K. Bay, and K. Sernka. 2002b. Synthesis and Comparison of Baseline Avian and Bat Use, Raptor Nesting and Mortality Information from Proposed and Existing Wind Developments. Technical report prepared for Bonneville Power Administration, Portland, Oregon by WEST, Inc., Cheyenne, Wyoming. December 2002. http://www.bpa.gov/Power/pgc/wind/Avian_and_Bat_Study_12-2002.pdf

Erickson, W.P., E. Lack, M. Bourassa, K. Sernka, and K. Kronner. 2001b. Wildlife Baseline Study for the Nine Canyon Wind Project, Final Report May 2000-October 2001 Technical report prepared for Energy Northwest, Richland, Washington.

Erickson, W.P., D. Young, G. Johnson, J. Jeffrey, K. Bay, R. Good, and H. Sawyer. 2003b. Wildlife Baseline Study for the Wild Horse Wind Project. Summary of Results from 2002-2003 Wildlife Surveys May 10, 2002- May 22, 2003. Draft report prepared for

Zilkha Renewable Energy, Portland, Oregon. Prepared by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming. November 2003.

Fiedler, J.K. 2004. Assessment of Bat Mortality and Activity at Buffalo Mountain Windfarm, Eastern Tennessee. M.S. Thesis. University of Tennessee, Knoxville, Tennessee.

Gannon, W.L., R.E. Sherwin, and S. Haymond. 2003. On the Importance of Articulating Assumptions When Conducting Acoustic Studies of Habitat Use by Bats. Wildlife Society Bulletin 31: 45-61.

Gill, J.P., M. Townsley, and G.P. Mudge. 1996. Review of the Impacts of Wind Farms and Other Aerial Structures Upon Birds. Scottish Natural Heritage Review No. 21. Scottish Natural Heritage. Battleby, United Kingdom.

Gruver, J.C. 2002. Assessment of Bat Community Structure and Roosting Habitat Preferences for the Hoary Bat (*Lasiurus cinereus*) near Foote Creek Rim, Wyoming. M.S. Thesis. University of Wyoming, Laramie, Wyoming.

Harvey, M.J., J.S. Altenbach, and T.L. Best. 1999. Bats of the United States. Arkansas Game and Fish Commission and US Fish and Wildlife Service, Arkansas.

Hayes, J.P. 1997. Temporal Variation in Activity of Bats and the Design of Echolocation-Monitoring Studies. Journal of Mammalogy 78: 514-524.

Howe, R.W., W. Evans, and A.T. Wolf. 2002. Effects of Wind Turbines on Birds and Bats in Northeastern Wisconsin. Prepared by University of Wisconsin-Green Bay, for Wisconsin Public Service Corporation and Madison Gas and Electric Company, Madison, Wisconsin. November 21, 2002. 104 pp.

Howell, J.A. and J. Noone. 1992. Examination of Avian Use and Mortality at a U.S. Windpower Wind Energy Development Site, Montezuma Hills, Solano County, California. Final Report to Solano County Department of Environmental Management, Fairfield, California. 41pp.

Jain, A. 2005. Bird and Bat Behavior and Mortality at a Northern Iowa Windfarm. M.S. Thesis. Iowa State University, Ames, Iowa. http://www.fws.gov/midwest/eco_serv/wind/references/Windfarmstudy.pdf

Jeffrey, J.D., W.P. Erickson, K.J. Bay, V.K. Poulton, W.L. Tidhar, and J.E. Baker. 2008. Wildlife Baseline Studies for the Golden Hills Wind Resource Area, Sherman County, Oregon. Final Report May 2006 – October 2007. Prepared for BP Alternative Energy North America Inc., Houston, Texas, by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming.

Johnson, G.D. 2004. Analysis of Potential Wildlife and Habitat Impacts from the Klondike II Project, Sherman County, Oregon. Technical report prepared by WEST, Inc., for CH2M HILL and PPM Energy.

Johnson, G.D. 2005. A Review of Bat Mortality at Wind-Energy Developments in the United States. Bat Research News 46(2): 45-49.

Johnson, G.D., W.P. Erickson, K. Bay, and K. Kronner. 2002a. Baseline Ecological Studies for the Klondike Wind Project, Sherman County, Oregon. Final report prepared for Northwestern Wind Power, Goldendale, Washington, by Western EcoSystems Technology, Inc. (WEST) Cheyenne, Wyoming, and Northwest Wildlife Consultants, Inc. (NWC), Pendleton, Oregon. May 29, 2002.

Johnson, G.D., W.P. Erickson, M.D. Strickland, M.F. Shepherd, and D.A. Shepherd. 2000a. Avian Monitoring Studies at the Buffalo Ridge Wind Resource Area, Minnesota: Results of a 4-Year Study. Final report prepared for Northern States Power Company, Minneapolis, Minnesota, by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming. September 22, 2000. 212 pp. http://www.west-inc.com

Johnson, G.D., W.P. Erickson, M.D. Strickland, M.F. Shepherd, D.A. Shepherd, and S.A. Sarappo. 2002b. Collision Mortality of Local and Migrant Birds at a Large-Scale Wind-Power Development on Buffalo Ridge, Minnesota. Wildlife Society Bulletin 30(3): 879-887.

Johnson, G.D., W.P. Erickson, M.D. Strickland, M.F. Shepherd, D.A. Shepherd, and S.A. Sarappo. 2003a. Mortality of Bats at a Large-Scale Wind Power Development at Buffalo Ridge, Minnesota. The American Midland Naturalist 150: 332-342.

Johnson, G.D., W.P. Erickson, and J. White. 2003b. Avian and Bat Mortality During the First Year of Operation at the Klondike Phase I Wind Project, Sherman County, Oregon. March 2003. Western EcoSystems Technology, Inc. (WEST).

Johnson, G.D., J. Jeffrey, J. Baker, and K. Bay. 2007. Baseline Avian Studies for the Windy Flats Wind Energy Project, Klickitat County, Washington. Prepared for Windy Point Partners, LLC., by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming. May 29, 2007.

Johnson, G.D., M.K. Perlik, W.P. Erickson, M.D. Strickland, D.A. Shepherd, and P. Sutherland, Jr. 2003c. Bat Interactions with Wind Turbines at the Buffalo Ridge, Minnesota Wind Resource Area: An Assessment of Bat Activity, Species Composition, and Collision Mortality. Electric Power Research Institute, Palo Alto, California and Xcel Energy, Minneapolis, Minnesota. In press. EPRI report # 1009178.

Johnson, G.D., Young, D. P. Jr., W.P. Erickson, C.E. Derby, M.D. Strickland, and R.E. Good. 2000b. Wildlife Monitoring Studies, SeaWest Windpower Plant, Carbon County, Wyoming, 1995-1999. Final report prepared for SeaWest Energy Corporation, San

Diego, California, and the Bureau of Land Management, Rawlins, Wyoming, by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming. August 9, 2000. http://www.west-inc.com

Kerlinger, P. 1997. A Study of Avian Fatalities at the Green Mountain Power Corporation's Searsburg, Vermont Windpower Facility - 1997. Prepared for Vermont Department of Public Service, Green Mountain Power Corporation, National Renewable Energy Laboratory and Vermont Environmental Research Associates. 12 pp.

Kerlinger, P., L. Culp, and R. Curry. 2005. Post-Construction Avian Monitoring Study for the High Winds Wind Power Project, Solano County, California. Year One Report. Prepared for High Winds, LLC and FPL Energy.

Kerlinger, P., R. Curry, L. Culp, A. Jain, C. Wilkerson, B. Fischer, and A. Hasch. 2006. Post-Construction Avian and Bat Fatality Monitoring for the High Winds Wind Power Project, Solano County, California: Two Year Report. Prepared for High Winds LLC, FPL Energy by Curry and Kerlinger, LLC. April 2006.

Koford, R., A. Jain, G. Zenner, and A. Hancock. 2005. Avian Mortality Associated with the Top of Iowa Wind Farm. Progress Report, Calendar Year 2004. February 2005. Iowa Cooperative Fish and Wildlife Research Unit, Iowa State University. Ames, Iowa. 12 pp. http://www.horizonwind.com/images_projects/what_were_doing/TOI_Avian_Annual_Interim_Report_2004_020205.pdf

Kronner, K., B. Gritski, and S. Downes. 2008. Big Horn Wind Power Project Wildlife Fatality Monitoring Study: 2006–2007. Final report prepared for PPM Energy and the Big Horn Wind Project Technical Advisory Committee by Northwest Wildlife Consultants, Inc.(NWC), Mid-Columbia Field Office,Goldendale, Washington. June 1, 2008.

Kunz, T.H., E.B. Arnett, B.M. Cooper, W.P. Erickson, A.R. Hoar, G.D. Johnson, R.P. Larkin, M.D. Strickland, R.W. Thresher, and M.D. Tuttle. 2007a. Ecological Impacts of Wind Energy Development on Bats: Questions, Research Needs, and Hypotheses. Frontiers in Ecology and the Environment 5(6): 315-324.

Kunz, T.H., E.B. Arnett, B.M. Cooper, W.P. Erickson, R.P. Larkin, T. Mabee, M.L. Morrison, M.D. Strickland, and J.M. Szewczak. 2007b. Assessing Impacts of Wind-Energy Development on Nocturnally Active Birds and Bats: A Guidance Document. Journal of Wildlife Management 71(8): 2449-2486.

Larsen, J.K. and J. Madsen. 2000. Effects of Wind Turbines and Other Physical Elements on Field Utilization by Pink-Footed Geese (*Anser brachyrhynchus*): A Landscape Perspective. Landscape Ecology 15: 755-764.

Lawrence, E.S., S. Painter, and B. Little. 2007. Responses of Birds to the Wind Farm at Blyth Harbour, Northumberland, UK. *In*: Birds and Wind Farms: Risk Assessment and Mitigation. M. De Lucas, G. F. E. Janss, and M. Ferrer, eds. Quercus, Pp. 47-69.

Leddy, K.L. 1996. Effects of Wind Turbines on Nongame Birds in Conservation Reserve Program Grasslands in Southwestern Minnesota. M.S. Thesis. South Dakota State University, Brookings. 61 pp.

Leddy, K.L., K.F. Higgins, and D.E. Naugle. 1999. Effects of Wind Turbines on Upland Nesting Birds in Conservation Reserve Program Grasslands. Wilson Bulletin 111(1): 100-104.

Mabey, S. and E. Paul. 2007. Impact of Wind Energy and Related Human Activities on Grassland and Shrub-Steppe Birds. A Critical Literature Review Prepared for the National Wind Coordinating Committee (NWCC) and The Ornithological Council. 183 pp. http://www.nationalwind.org/pdf/IMPACTOFWINDENERGYANDRELATEDHUMANACTIVITIESONGRASSLANDANDSHRUB-STEPPEBIRDS.pdf

Madders, M. and D.P. Whitfield. 2006. Upland Raptors and the Assessment of Wind Farm Impacts. Ibis 148: 43-56.

Migratory Bird Treaty Act (MBTA). 1918. 16 United States Code § 703-712. July 13, 1918.

National Research Council (NRC). 2007. Environmental Impacts of Wind-Energy Projects. National Academies Press. Washington, D.C.

National Wind Coordinating Committee (NWCC). 2004. Wind Turbine Interactions with Birds and Bats: A Summary of Research Results and Remaining Questions. Fact Sheet, Second Edition. November 2004. http://www.nationalwind.org/publications/default.htm

Nicholson, C.P. 2003. Buffalo Mountain Windfarm Bird and Bat Mortality Monitoring Report: October 2001 - September 2002. Tennessee Valley Authority, Knoxville, Tennessee. February 2003.

Northwest Wildlife Consultants, Inc. (NWC) and Western Ecosystems Technology, Inc. (WEST). 2004. Ecological Baseline Studies for the Roosevelt Wind Project, Klickitat County, Washington. Final Report. Prepared by NWC, Pendelton, Oregon, and WEST, Inc., Cheyenne, Wyoming. September 2004.

Northwest Wildlife Consultants, Inc. (NWC) and Western Ecosystems Technology, Inc. (WEST). 2005a. Ecological Baseline Studies and Wildlife Impact Assessment for the White Creek Wind Power Project, Klickitat County, Washington. Prepared for Last Mile Electric Cooperative, Goldendale, Washington, by Northwest Wildlife Consultants, Inc., Goldendale, Washington, and Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming. January 12, 2005.

Northwest Wildlife Consultants, Inc. (NWC) and Western Ecosystems Technology, Inc. (WEST). 2005b. Wildlife Baseline Study for the Leaning Juniper Wind Power Project, Gilliam County, Oregon. Prepared for PPM Energy, Portland, Oregon and CH2M HILL, Portland, Oregon by NWC, Pendelton, Oregon, and WEST, Inc., Cheyenne, Wyoming. November 3, 2005.

Northwest Wildlife Consultants, Inc. (NWC) and Western EcoSystems Technology, Inc. (WEST). 2007. Avian and Bat Monitoring Report for the Klondike II Wind Power Project. Sherman County, Oregon. Prepared for PPM Energy, Portland, Oregon. Managed and conducted by NWC, Pendleton, Oregon. Analysis conducted by WEST, Cheyenne, Wyoming. July 17, 2007.

O'Shea, T.J., M.A. Bogan, and L.E. Ellison. 2003. Monitoring Trends in Bat Populations of the U.S. And Territories: Status of the Science and Recommendations for the Future. Wildlife Society Bulletin 31: 16-29.

Orloff, S. and A. Flannery. 1992. Wind Turbine Effects on Avian Activity, Habitat Use, and Mortality in Altamont Pass and Solano County Wind Resource Areas, 1989-1991. Final Report P700-92-001 to Alameda, Costra Costa, and Solano Counties, and the California Energy Commission, Sacramento, California, by Biosystems Analysis, Inc., Tiburon, California. March 1992.

Pedersen, M.B. and E. Poulsen. 1991. Impact of a 90m/2mw Wind Turbine on Birds - Avian Responses to the Implementation of the Tjaereborg Wind Turbine at the Danish Wadden Sea. Dansek Vildundersogelser 47: 1-44. Miljoministeriet & Danmarks Miljoundersogelser.

Reynolds, R.T., J.M. Scott, and R.A. Nussbaum. 1980. A Variable Circular-Plot Method for Estimating Bird Numbers. Condor 82(3): 309-313.

URS Corporation, Western EcoSystems Technology, Inc. (WEST), and Northwest Wildlife Consultants, Inc. (NWC). 2001. Avian Baseline Study for the Stateline Project. Prepared for FPL Energy Vansycle, LLC, Juno Beach, Florida.

Usgaard, R.E., D.E. Naugle, R.G. Osborn, and K.F. Higgins. 1997. Effects of Wind Turbines on Nesting Raptors at Buffalo Ridge in Southwestern Minnesota. Proceedings of the South Dakota Academy of Science 76: 113-117.

Walker, D., M. McGrady, A. McCluskie, M. Madders, and D.R.A. McLeod. 2005. Resident Golden Eagle Ranging Behaviour Before and After Construction of a Windfarm in Argyll. Scottish Birds 25: 24-40. http://www.natural-research.org/projects/documents/SB25-EAGLESDOC.pdf

Western Ecosystems Technology, Inc. (WEST). 2005a. Ecological Baseline Study at the Elkhorn Wind Power Project. Exhibit A. Final report prepared for Zilkha Renewable Energy, LLC., Portland, Oregon, by WEST, Cheyenne, Wyoming. June 2005.

Western EcoSystems Technology, Inc. (WEST). 2005b. Ecological Baseline Study for the Proposed Reardon Wind Project, Lincoln County, Washington. Draft Final Report.

Prepared for Energy Northwest, Richland, Washington, by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming. June 2005.

Western EcoSystems Technology, Inc. (WEST). 2005c. Wildlife and Habitat Baseline Study for the Proposed Biglow Canyon Wind Power Project, Sherman County, Oregon. March 2004 - August 2005. Prepared for Orion Energy LLC., Oakland, California. October, 2005. WEST. Cheyenne, Wyoming.

Western EcoSystems Technology, Inc. (WEST). 2006a. Diablo Winds Wildlife Monitoring Progress Report, March 2005 - February 2006. Technical report submitted to FPL Energy and Alameda County California. WEST. Cheyenne, Wyoming.

Western EcoSystems Technology, Inc. (WEST). 2006b. Wildlife Baseline Study for the North Valley County Wind Project: Summary of Results from 2006 Wildlife Surveys. Prepared for POWER Engineers, Boise, Idaho, and Wind Hunter, LLC., Grapevine, Texas. Prepared by Western EcoSystems Technology, Inc. (WEST), Bismarck, North Dakota. December 8, 2006.

Western EcoSystems Technology, Inc. (WEST). 2007. Wildlife and Habitat Baseline Study for the Vantage Wind Power Project, Kittitas County, Washington. Draft report prepared for Invenergy by Western EcoSystems Technology, Inc. (WEST), Cheyenne Wyoming and Walla Walla, Washington. June 2007.

Western EcoSystems Technology, Inc. (WEST) and Colorado Plateau Research Station (CPRS). 2006. Avian Studies for the Proposed Sunshine Wind Park, Coconino County, Arizona. Prepared for Sunshine Arizona Wind Energy, LLC., Flagstaff, Arizona, by WEST, Cheyenne, Wyoming, and the CPRS, Northern Arizona University, Flagstaff, Arizona. May 2006.

Western EcoSystems Technology, Inc. (WEST), EDAW, Inc., and Bloom Biological, Inc. 2007. Baseline Avian Use and Risk Assessment for the Homestead Wind Energy Project, Kern County, California. 2005 – 2006. Prepared for Horizon Wind Energy by Western EcoSystems Technology, Inc. (WEST), EDAW, Inc., San Diego, California, and Bloom Biological, Inc., Santa Anna, California. April 19, 2007.

White, E.P. and S.D. Gehrt. 2001. Effects of Recording Media on Echolocation Data from Broadband Bat Detectors. Wildlife Society Bulletin 29: 974-978.

Whitfield, D.P. and M. Madders. 2006. A Review of the Impacts of Wind Farms on Hen Harriers *Circus cyaneus* and an Estimation of Collision Avoidance Rates. Natural Research Information Note 1 (revised). Natural Research Ltd., Banchory, UK.

Winkelman, E. 1990. Impact of the Wind Park near Urk, Netherlands, on Birds: Bird Collision Victims and Disturbance of Wintering Fowl. International Ornithological Congress 20: 402-403.

Woodward-Clyde International-Americas, (WCIA) and Western EcoSystems Technology, Inc. (WEST). 1997. Avian Baseline Study for the Vansycle Ridge Project - Vansycle Ridge, Oregon and Wildlife Mortality Studies, Vansycle Wind Project, Washington. Prepared for Esi Vansycle Partners, L.P., North Palm Beach, Florida.

Young, D.P. Jr., W.P. Erickson, K. Bay, J. Jeffrey, E.G. Lack, R.E. Good, and H.H. Sawyer. 2003a. Baseline Avian Studies for the Proposed Hopkins Ridge Wind Project, Columbia County, Washington. Final Report, March 2002 - March 2003. Prepared for RES North America, LLC., Portland, Oregon, by Western EcoSystems Technology, Inc.(WEST), Cheyenne, Wyoming. April 30, 2003.

Young, D.P. Jr., W.P. Erickson, K. Bay, J. Jeffrey, E.G. Lack, and H.H. Sawyer. 2003b. Baseline Avian Studies for the Proposed Desert Claim Wind Power Project, Kittitas County, Washington. Final Report. Prepared for Desert Claim Wind Power, LLC, Ellensburg, Washington, by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming. July 2003.

Young, D.P. Jr., W.P. Erickson, R.E. Good, M.D. Strickland, and G.D. Johnson. 2003c. Avian and Bat Mortality Associated with the Initial Phase of the Foote Creek Rim Windpower Project, Carbon County, Wyoming, Final Report, November 1998 - June 2002. Prepared for Pacificorp, Inc. Portland, Oregon, SeaWest Windpower Inc. San Diego, California, and Bureau of Land Management, Rawlins District Office, Rawlins, Wyoming.

Young, D.P. Jr., W.P. Erickson, J. Jeffrey, K. Bay, and M. Bourassa. 2005. Eurus Combine Hills Turbine Ranch. Phase 1 Post Construction Wildlife Monitoring Final Report February 2004 February 2005. Technical report for Eurus Energy America Corporation and the Combine Hills Technical Advisory Committee, Umatilla County, Oregon. Prepared by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming, and Northwest Wildlife Consultants, Inc. (NWC), Pendleton, Oregon.

Young, D.P. Jr., W.P. Erickson, J. Jeffrey, K. Bay, R.E. Good, and E.G. Lack. 2003d. Avian and Sensitive Species Baseline Study Plan and Final Report. Eurus Combine Hills Turbine Ranch, Umatilla County, Oregon. Technical report prepared for Eurus Energy America Corporation, San Diego, California and Aeropower Services, Inc., Portland, Oregon, by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming. March 10, 2003.

Young, D.P. Jr., W.P. Erickson, J. Jeffrey, and V.K. Poulton. 2007a. Puget Sound Energy, Hopkins Ridge Wind Project Phase 1, Post-Construction Avian and Bat Monitoring, First Annual Report, January - December 2006. Technical report prepared by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming, for Puget Sound Energy.

Young, D.P. Jr., G.D. Johnson, V.K. Poulton, and K. Bay. 2007b. Ecological Baseline Studies for the Hatchet Ridge Wind Energy Project, Shasta County, California. Prepared for Hatchet Ridge Wind, LLC, Portland, Oregon by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming. August 31, 2007.

Young, D.P. Jr., V.K. Poulton, and K. Bay. 2007c. Ecological Baseline Studies Report. Proposed Dry Lake Wind Project, Navajo County, Arizona. Prepared for PPM Energy, Portland, Oregon, by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming. July 1, 2007.

Table 1. The landcover types, coverage, and composition within the Buffalo Ridge II Wind Resource Area

Landcover	Acres	% Composition
tilled agriculture	29842.8	60.4
pasture	9969.9	20.2
planted grassland	2475.6	5.0
wetland	2113.2	4.3
hayland	1715.9	3.5
farmstead	1376.1	2.8
woodland	854.5	1.7
rangeland	679.6	1.4
residential	172.7	0.3
gravel pit	70.7	0.1
lake	46.6	0.1
stock pond	45.7	0.1
road	29.0	0.1
industrial	27.6	0.1
utility	27.3	0.1
cemetary	0.7	<0.1

Data collected by HDR in 2008.

Table 2. Bat species determined from range-maps (Harvey et al. 1999; BCI website) as likely to occur within the BRIIWRA, sorted by call frequency.

High-frequency (≥ 35 kHz)		Low-frequency (< 35 kHz)	
northern long-eared bat	*Myotis septentrionalis*	big brown bat†	*Eptesicus fuscus*
little brown bat†	*Myotis lucifugus*	silver-haired bat*†	*Lasionycteris noctivagans*
eastern red bat*†	*Lasiurus borealis*	hoary bat*†	*Lasiurus cinereus*
eastern pipstrelle†	*Parastrellus subflavus*		

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

Table 3. Summary of bird use, species richness, and sample size by season and overall during the fixed-point bird use surveys at the Buffalo Ridge II Wind Resource Area, March 12, 2008 – November 5, 2008.

Season	Number of Visits	Bird Use	Species Richness	# Species	# Surveys Conducted
Spring	6	65.8	2.73	40	90
Summer	7	4.02	2.67	43	105
Fall	5	4.09	0.80	21	87
Overall	**18**	**25.9**	**2.14**	**56**	**282**

Table 4. 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 Buffalo Ridge II Wind Resource Area, March 12, 2008 – November 5, 2008.

		Spring		Summer		Fall		Total	
Species/Type	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Waterbirds		**4**	**21**	**6**	**6**	**8**	**20**	**18**	**47**
double-crested cormorant	*Phalacrocorax auritus*	1	15	3	3	0	0	4	18
Franklin's gull	*Larus pipixcan*	1	3	0	0	3	4	4	7
great egret	*Ardea alba*	1	1	2	2	0	0	3	3
herring gull	*Larus argentatus*	1	2	0	0	0	0	1	2
unidentified gull		0	0	1	1	5	16	6	17
Waterfowl		**82**	**5,269**	**7**	**11**	**2**	**51**	**91**	**5,331**
blue-winged teal	*Anas discors*	1	4	1	2	1	1	3	7
Canada goose	*Branta canadensis*	41	1,363	0	0	1	50	42	1,413
greater white-fronted goose	*Anser albifrons*	4	443	0	0	0	0	4	443
mallard	*Anas platyrhynchos*	15	50	6	9	0	0	21	59
snow goose	*Chen caerulescens*	21	3,409	0	0	0	0	21	3,409
Shorebirds		**25**	**27**	**29**	**32**	**4**	**7**	**58**	**66**
killdeer	*Charadrius vociferus*	17	19	16	19	4	7	37	45
upland sandpiper	*Bartramia longicauda*	6	6	7	7	0	0	13	13
Wilson's snipe	*Gallinago Gallinago*	2	2	6	6	0	0	8	8
Raptors		**14**	**14**	**10**	**12**	**11**	**13**	**35**	**39**
Accipiters		*1*	*1*	*0*	*0*	*0*	*0*	*1*	*1*
sharp-shinned hawk	*Accipter striatus*	1	1	0	0	0	0	1	1
Buteos		*6*	*6*	*6*	*7*	*9*	*11*	*21*	*24*
broad-winged hawk	*Buteo platypterus*	1	1	1	1	1	1	3	3
red-tailed hawk	*Buteo jamaicensis*	2	2	5	6	8	10	15	18
unidentified buteo		3	3	0	0	0	0	3	3
Northern Harrier		*6*	*6*	*1*	*1*	*2*	*2*	*9*	*9*
northern harrier	*Circus cyaneus*	6	6	1	1	2	2	9	9

Table 4. 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 Buffalo Ridge II Wind Resource Area, March 12, 2008 – November 5, 2008.

		Spring		Summer		Fall		Total	
Species/Type	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Falcons		*1*	*1*	*2*	*3*	*0*	*0*	*3*	*4*
American kestrel	*Falco sparverius*	0	0	2	3	0	0	2	3
prairie falcon	*Falco mexicanus*	1	1	0	0	0	0	1	1
Owls		*0*	*0*	*1*	*1*	*0*	*0*	*1*	*1*
great-horned owl	*Bubo virginianus*	0	0	1	1	0	0	1	1
Vultures		**1**	**1**	**2**	**2**	**0**	**0**	**3**	**3**
turkey vulture	*Cathartes aura*	1	1	2	2	0	0	3	3
Upland Gamebirds		**71**	**76**	**41**	**41**	**8**	**22**	**120**	**139**
gray partridge	*Perdix perdix*	1	2	0	0	0	0	1	2
ring-necked pheasant	*Phasianus colchicus*	70	74	41	41	7	7	118	122
wild turkey	*Meleagris gallopavo*	0	0	0	0	1	15	1	15
Doves/Pigeons		**9**	**15**	**33**	**48**	**6**	**20**	**48**	**83**
mourning dove	*Zenaida macroura*	7	8	33	48	6	20	46	76
rock pigeon	*Columba livia*	2	7	0	0	0	0	2	7
Passerines		**138**	**831**	**201**	**595**	**34**	**337**	**373**	**1,763**
American crow	*Corvus brachyrhynchos*	6	7	9	34	6	18	21	59
American goldfinch	*Carduelis tristis*	0	0	4	4	1	1	5	5
American robin	*Turdus migratorius*	4	5	2	2	0	0	6	7
bank swallow	*Riparia riparia*	0	0	4	15	0	0	4	15
barn swallow	*Hirundo rustica*	2	5	25	35	2	11	29	51
blue grosbeak	*Guiraca caerulea*	0	0	1	1	0	0	1	1
blue jay	*Cyanocitta cristata*	2	2	1	1	0	0	3	3
bobolink	*Dolichonyx oryzivorus*	4	6	10	19	0	0	14	25
Brewer's blackbird	*Euphagus cyanocephalus*	1	20	0	0	0	0	1	20
brown thrasher	*Toxostoma rufum*	1	1	0	0	0	0	1	1
brown-headed cowbird	*Molothrus ater*	6	8	8	21	0	0	14	29

Table 4. 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 Buffalo Ridge II Wind Resource Area, March 12, 2008 – November 5, 2008.

		Spring		Summer		Fall		Total	
Species/Type	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
clay-colored sparrow	*Spizella pallida*	0	0	1	1	0	0	1	1
cliff swallow	*Petrochelidon pyrrhonota*	0	0	4	6	0	0	4	6
common grackle	*Quiscalus quiscula*	6	312	12	22	2	8	20	342
common yellowthroat	*Geothlypis trichas*	0	0	3	3	0	0	3	3
dickcissel	*Spiza americana*	0	0	8	8	0	0	8	8
eastern bluebird	*Sialia sialis*	0	0	1	1	0	0	1	1
eastern kingbird	*Tyrannus tyrannus*	2	2	6	6	0	0	8	8
European starling	*Sturnus vulgaris*	0	0	0	0	1	30	1	30
field sparrow	*Spizella pusilla*	0	0	2	2	1	3	3	5
grasshopper sparrow	*Ammodramus savannarum*	1	1	4	4	0	0	5	5
horned lark	*Eremophila alpestris*	21	350	4	5	11	216	36	571
northern rough-winged swallow	*Stelgidopteryx serripennis*	0	0	3	4	0	0	3	4
red-winged blackbird	*Agelaius phoeniceus*	31	52	32	341	5	44	68	437
savannah sparrow	*Passerculus sandwichensis*	1	1	2	2	0	0	3	3
song sparrow	*Melospiza melodia*	1	1	16	16	0	0	17	17
tree swallow	*Tachycineta bicolor*	6	12	8	9	0	0	14	21
unidentified sparrow		3	3	1	1	1	1	5	5
western kingbird	*Tyrannus verticalis*	0	0	5	7	0	0	5	7
western meadowlark	*Sturnella neglecta*	40	43	25	25	4	5	69	73
Other Birds		**6**	**7**	**2**	**2**	**3**	**3**	**11**	**12**
belted kingfisher	*Ceryle alcyon*	0	0	0	0	1	1	1	1
northern flicker	*Colaptes auratus*	5	6	2	2	2	2	9	10
unidentified woodpecker		1	1	0	0	0	0	1	1
Overall		**350**	**6,261**	**331**	**749**	**76**	**473**	**757**	**7,483**

Table 5. 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 Buffalo Ridge II Wind Resource Area, March 12, 2008 – November 5, 2008.

	Use			% Composition			% Frequency		
Species/Type	**Spring**	**Summer**	**Fall**	**Spring**	**Summer**	**Fall**	**Spring**	**Summer**	**Fall**
Waterbirds	**0.23**	**0.06**	**0.16**	**0.4**	**1.4**	**3.9**	**2.2**	**3.8**	**2.7**
double-crested cormorant	0.17	0.03	0	0.3	0.7	0	1.1	1.9	0
Franklin's gull	0.03	0	0.03	0.1	0	0.7	1.1	0	0.7
great egret	0.01	0.02	0	<0.1	0.5	0	1.1	1.9	0
herring gull	0.02	0	0	<0.1	0	0	1.1	0	0
unidentified gull	0	0.01	0.13	0	0.2	3.3	0	1.0	2.0
Waterfowl	**58.5**	**0.10**	**0.35**	**89.0**	**2.6**	**8.5**	**37.8**	**6.7**	**2.0**
blue-winged teal	0.04	0.02	0.01	0.1	0.5	0.3	1.1	1.0	1.3
Canada goose	**15.1**	**0**	**0.33**	**23.0**	**0**	**8.2**	**21.1**	**0**	**0.7**
greater white-fronted goose	4.92	0	0	7.5	0	0	4.4	0	0
mallard	0.56	0.09	0	0.8	2.1	0	12.2	5.7	0
snow goose	37.88	0	0	57.6	0	0	13.3	0	0
Shorebirds	**0.30**	**0.30**	**0.09**	**0.5**	**7.6**	**2.3**	**17.8**	**18.1**	**2.7**
killdeer	*0.21*	*0.18*	*0.09*	*0.3*	*4.5*	*2.3*	*14.4*	*13.3*	*2.7*
upland sandpiper	0.07	0.07	0	0.1	1.7	0	4.4	6.7	0
Wilson's snipe	0.02	0.06	0	<0.1	1.4	0	2.2	4.8	0
Raptors	**0.14**	**0.11**	**0.15**	**0.2**	**2.8**	**3.8**	**12.2**	**9.5**	**12.7**
Accipiters	*0.01*	*0*	*0*	*<0.1*	*0*	*0*	*1.1*	*0*	*0*
sharp-shinned hawk	0.01	0	0	<0.1	0	0	1.1	0	0
Buteos	*0.06*	*0.07*	*0.13*	*0.1*	*1.7*	*3.1*	*5.6*	*5.7*	*10.0*
broad-winged hawk	0.01	0.01	0.01	<0.1	0.2	0.2	1.1	1.0	0.7
red-tailed hawk	0.02	0.06	0.12	<0.1	1.4	2.9	2.2	4.8	9.3
unidentified buteo	*0.02*	*0*	*0*	*<0.1*	*0*	*0*	*2.2*	*0*	*0*
Northern Harrier	*0.07*	*0.01*	*0.03*	*0.1*	*0.2*	*0.7*	*6.7*	*1.0*	*2.7*
northern harrier	0.07	0.01	0.03	0.1	0.2	0.7	6.7	1.0	2.7

Table 5. 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 Buffalo Ridge II Wind Resource Area, March 12, 2008 – November 5, 2008.

	Use			% Composition			% Frequency		
Species/Type	**Spring**	**Summer**	**Fall**	**Spring**	**Summer**	**Fall**	**Spring**	**Summer**	**Fall**
Falcons	*0.01*	*0.03*	*0*	*<0.1*	*0.7*	*0*	*1.1*	*1.9*	*0*
American kestrel	0	0.03	0	0	0.7	0	0	1.9	0
prairie falcon	0.01	0	0	<0.1	0	0	1.1	0	0
Owls	*0*	*0.01*	*0*	*0*	*0.2*	*0*	*0*	*1.0*	*0*
great-horned owl	0	0.01	0	0	0.2	0	0	1.0	0
Vultures	**0.01**	**0.02**	**0**	**<0.1**	**0.5**	**0**	**1.1**	**1.0**	**0**
turkey vulture	0.01	0.02	0	<0.1	0.5	0	1.1	1.0	0
Upland Gamebirds	**0.84**	**0.39**	**0.29**	**1.3**	**9.7**	**7.2**	**53.3**	**33.3**	**9.3**
gray partridge	0.02	0	0	<0.1	0	0	1.1	0	0
ring-necked pheasant	0.82	0.39	0.09	1.2	9.7	2.3	53.3	33.3	8.0
wild turkey	0	0	0.20	0	0	4.9	0	0	1.3
Doves/Pigeons	**0.17**	**0.46**	**0.27**	**0.3**	**11.4**	**6.5**	**7.8**	**24.8**	**8.0**
mourning dove	0.09	0.46	0.27	0.1	11.4	6.5	5.6	24.8	8.0
rock pigeon	0.08	0	0	0.1	0	0	2.2	0	0
Passerines	**5.47**	**2.55**	**2.74**	**8.3**	**63.5**	**67.0**	**68.9**	**74.3**	**27.3**
American crow	0	0.16	0.01	0	4.0	0.2	0	2.9	0.7
American goldfinch	0	0.04	0.01	0	0.9	0.3	0	3.8	1.3
American robin	0.06	0.02	0	0.1	0.5	0	3.3	1.9	0
bank swallow	0	0.05	0	0	1.2	0	0	2.9	0
barn swallow	0.06	0.33	0.08	0.1	8.3	2.0	2.2	20.0	2.0
blue grosbeak	0	0.01	0	0	0.2	0	0	1.0	0
blue jay	0.01	0.01	0	<0.1	0.2	0	1.1	1.0	0
bobolink	0.07	0.18	0	0.1	4.5	0	3.3	7.6	0
brown thrasher	0.01	0	0	<0.1	0	0	1.1	0	0
brown-headed cowbird	0.09	0.20	0	0.1	5.0	0	6.7	6.7	0
cliff swallow	0	0.06	0	0	1.4	0	0	2.9	0
common grackle	0.13	0.21	0.11	0.2	5.2	2.6	3.3	7.6	2.7
common yellowthroat	0	0.03	0	0	0.7	0	0	2.9	0

Table 5. 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 Buffalo Ridge II Wind Resource Area, March 12, 2008 – November 5, 2008.

	Use			% Composition			% Frequency		
Species/Type	**Spring**	**Summer**	**Fall**	**Spring**	**Summer**	**Fall**	**Spring**	**Summer**	**Fall**
dickcissel	0	0.08	0	0	1.9	0	0	5.7	0
eastern bluebird	0	0.01	0	0	0.2	0	0	1.0	0
eastern kingbird	0.02	0.06	0	<0.1	1.4	0	2.2	5.7	0
European starling	0	0	0.20	0	0	4.9	0	0	0.7
field sparrow	0	0.02	0.04	0	0.5	1.0	0	1.9	1.3
grasshopper sparrow	0.01	0.04	0	<0.1	0.9	0	1.1	3.8	0
horned lark	3.88	0.05	1.83	5.9	1.2	44.9	20.0	3.8	9.3
northern rough-winged swallow	0	0.04	0	0	0.9	0	0	2.9	0
red-winged blackbird	0.57	0.39	0.38	0.9	9.7	9.3	26.7	24.8	5.3
savannah sparrow	0.01	0.02	0	<0.1	0.5	0	1.1	1.9	0
song sparrow	0	0.15	0	0	3.8	0	0	14.3	0
tree swallow	0.13	0.09	0	0.2	2.1	0	6.7	6.7	0
unidentified sparrow	0.03	0.01	0.01	0.1	0.2	0.3	3.3	1.0	1.3
western kingbird	0	0.07	0	0	1.7	0	0	3.8	0
western meadowlark	0.39	0.24	0.07	0.6	5.9	1.6	31.1	21.0	5.3
belted kingfisher	0	0	0.01	0	0	0.3	0	0	1.3
Other Birds	**0.08**	**0.02**	**0.03**	**0.1**	**0.5**	**0.8**	**4.4**	**1.9**	**3.3**
northern flicker	0.07	0.02	0.02	0.1	0.5	0.5	3.3	1.9	2.0
unidentified woodpecker	0.01	0	0	<0.1	0	0	1.1	0	0
Overall	**65.8**	**4.02**	**4.09**	**100**	**100**	**100**			

Table 6. Flight height characteristics by bird type during fixed-point bird use surveys at the Buffalo Ridge II Wind Resource Area, March 12, 2008 – November 5, 2008.

Bird Type	# Groups Flying	# Obs Flying	Mean Flight Height	% Obs Flying	% within Flight Height Categories		
					0-114 ft	114-427 ft	> 427 ft
Waterbirds	18	47	33.3	100	31.9	68.1	0
Waterfowl	76	5,296	69.9	99.3	0.5	87.5	12.0
Shorebirds	27	35	12.4	53.0	94.3	5.7	0
Raptors	27	30	23.4	78.9	70.0	30.0	0
Accipiters	*1*	*1*	*2.00*	*100*	*100*	*0*	*0*
Buteos	*15*	*17*	*35.27*	*73.9*	*52.9*	*47.1*	*0*
Northern Harrier	*8*	*8*	*9.25*	*88.9*	*87.5*	*12.5*	*0*
Falcons	*3*	*4*	*9.00*	*100*	*100*	*0*	*0*
Doves/Pigeons	29	47	13.9	56.6	83.0	17.0	0
Passerines	166	1,217	9.23	69.0	62.0	38.0	0
Other Birds	4	4	13.3	33.3	100	0	0
Overall	**347**	**6,676**	**25.56**	**89.2**	**13.4**	**77.1**	**9.5**

Table 7. Relative exposure index and flight characteristics by species during the fixed-point bird use surveys at the Buffalo Ridge II Wind Resource Area, March 12, 2008 – November 5, 2008.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within ZOR based on initial obs	Exposure Index	% Within ZOR at anytime
snow goose	21	13.4	100	86.7	11.62	86.7
Canada goose	32	5.46	98.3	90.4	4.85	90.4
greater white-fronted goose	4	1.74	100	86.5	1.51	86.5
red-winged blackbird	38	0.45	91.5	82.5	0.34	82.5
horned lark	27	1.92	98.2	17.8	0.34	17.8
mallard	18	0.23	89.8	75.5	0.15	75.5
double-crested cormorant	4	0.07	100	94.4	0.07	94.4
red-tailed hawk	12	0.06	77.8	57.1	0.03	57.1
rock pigeon	2	0.03	100	100	0.03	100
unidentified gull	6	0.04	100	58.8	0.02	70.6
Franklin's gull	4	0.02	100	57.1	0.01	57.1
tree swallow	11	0.08	71.4	20.0	0.01	20.0
mourning dove	27	0.27	52.6	2.5	<0.01	2.5
killdeer	26	0.17	75.6	2.9	<0.01	2.9
barn swallow	28	0.16	98.0	2.0	<0.01	26.0
common grackle	15	0.15	25.1	8.1	<0.01	8.1
American crow	9	0.06	35.6	4.8	<0.01	4.8
northern harrier	8	0.03	88.9	12.5	<0.01	12.5
Wilson's snipe	1	0.03	12.5	100	<0.01	100
great egret	3	0.01	100	33.3	<0.01	33.3
ring-necked pheasant	0	0.46	0	0	0	0
western meadowlark	8	0.24	15.1	0	0	0
brown-headed cowbird	4	0.10	41.4	0	0	0
bobolink	3	0.09	16.0	0	0	0
European starling	0	0.06	0	0	0	0
wild turkey	0	0.06	0	0	0	0

Table 7. Relative exposure index and flight characteristics by species during the fixed-point bird use surveys at the Buffalo Ridge II Wind Resource Area, March 12, 2008 – November 5, 2008.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within ZOR based on initial obs	Exposure Index	% Within ZOR at anytime
song sparrow	0	0.05	0	0	0	0
upland sandpiper	0	0.05	0	0	0	0
northern flicker	4	0.04	40.0	0	0	0
eastern kingbird	3	0.03	37.5	0	0	0
dickcissel	0	0.03	0	0	0	0
American robin	1	0.03	28.6	0	0	0
blue-winged teal	1	0.03	28.6	0	0	0
western kingbird	1	0.02	14.3	0	0	0
cliff swallow	4	0.02	100	0	0	0
unidentified sparrow	1	0.02	20.0	0	0	0
field sparrow	0	0.02	0	0	0	0
grasshopper sparrow	0	0.02	0	0	0	0
American goldfinch	3	0.02	60.0	0	0	0
bank swallow	4	0.02	100	0	0	0
northern rough-winged swallow	3	0.01	100	0	0	0
savannah sparrow	0	0.01	0	0	0	0
turkey vulture	0	0.01	0	0	0	0
American kestrel	2	0.01	100	0	0	0
common yellowthroat	0	0.01	0	0	0	0
broad-winged hawk	2	0.01	66.7	0	0	0
gray partridge	0	0.01	0	0	0	0
herring gull	1	0.01	100	0	0	0
unidentified buteo	1	0.01	50.0	0	0	0
blue jay	0	0.01	0	0	0	0
belted kingfisher	0	<0.01	0	0	0	0
blue grosbeak	1	<0.01	100	0	0	0
brown thrasher	1	<0.01	100	0	0	0

Table 7. Relative exposure index and flight characteristics by species during the fixed-point bird use surveys at the Buffalo Ridge II Wind Resource Area, March 12, 2008 – November 5, 2008.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within ZOR based on initial obs	Exposure Index	% Within ZOR at anytime
clay-colored sparrow	0	<0.01	0	0	0	0
eastern bluebird	0	<0.01	0	0	0	0
great-horned owl	0	<0.01	0	0	0	0
prairie falcon	1	<0.01	100	0	0	0
sharp-shinned hawk	1	<0.01	100	0	0	0
unidentified woodpecker	0	<0.01	0	0	0	0
Brewer's blackbird	1	0	100	100	0	100

ZOR: The likely "zone of risk" for potential collision with a turbine blade, or 114-427 ft (35-130 m) above ground level (AGL).

Table 8. Incidental wildlife observed while conducting all surveys at the Buffalo Ridge II Wind Resource Area, March 27, 2007 - April 27, 2008.

Species	Scientific Name	#grps	# obs
Canada goose	*Branta canadensis*	1	100
wild turkey	*Meleagris gallopavo*	1	15
red-tailed hawk	*Buteo jamaicensis*	7	7
mallard	*Anas platyrhynchos*	3	5
broad-winged hawk	*Buteo platypterus*	3	4
northern harrier	*Circus cyaneus*	3	3
wood duck*	*Aix sponsa*	2	3
American kestrel	*Falco sparverius*	2	2
unidentified bird		2	2
belted kingfisher	*Ceryle alcyon*	1	1
great blue heron*	*Ardea herodias*	1	1
red-headed woodpecker*	*Melanerpes erythrocephalus*	1	1
rough-legged hawk*	*Buteo lagopus*	1	1
turkey vulture	*Cathartes aura*	1	1
Bird Subtotal		**29**	**146**
white-tailed deer	*Odocoileus virginianus*	7	18
eastern cottontail	*Sylvilagus floridanus*	1	2
coyote	*Canis latrans*	1	1
raccoon	*Procyon lotor*	1	1
striped skunk	*Mephitis mephitis*	1	1
thirteen-lined ground squirrel	*Spermophilus tridecemlineatus*	1	1
Mammal Subtotal		**12**	**24**

*bird species observed only during incidental observations

Table 9. Results of acoustic bat surveys conducted at the BRIIWRA, July 1 – October 14, 2008.

AnaBat Units	# of HF Bat Passes	# of LF Bat Passes	# of Hoary Bat Passes*	Total Bat Passes	Detector-Nights	Bat Passes/ Night
1546	110	126	33	236	105	2.25
1659	27	102	19	129	78	1.65
3592	48	138	38	186	102	1.82
3791	66	68	2	134	106	1.26
Total	**251**	**434**	**92**	**685**	**391**	**1.75**

*Passes by hoary bats included in low-frequency (LF) numbers.

Table 10. 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
Buffalo Ridge II, SD	1.75		This study
Foote Creek Rim, WY	2.2	1.3	Gruver 2002
Buffalo Ridge, MN	2.1	2.2	Johnson et al 2004
Buffalo Mountain, TN	23.7	20.8	Fiedler 2004
Top of Iowa, IA	34.9	10.2	Koford et al. 2005
Mountaineer, WV	38.3	38	Arnett et al. 2005

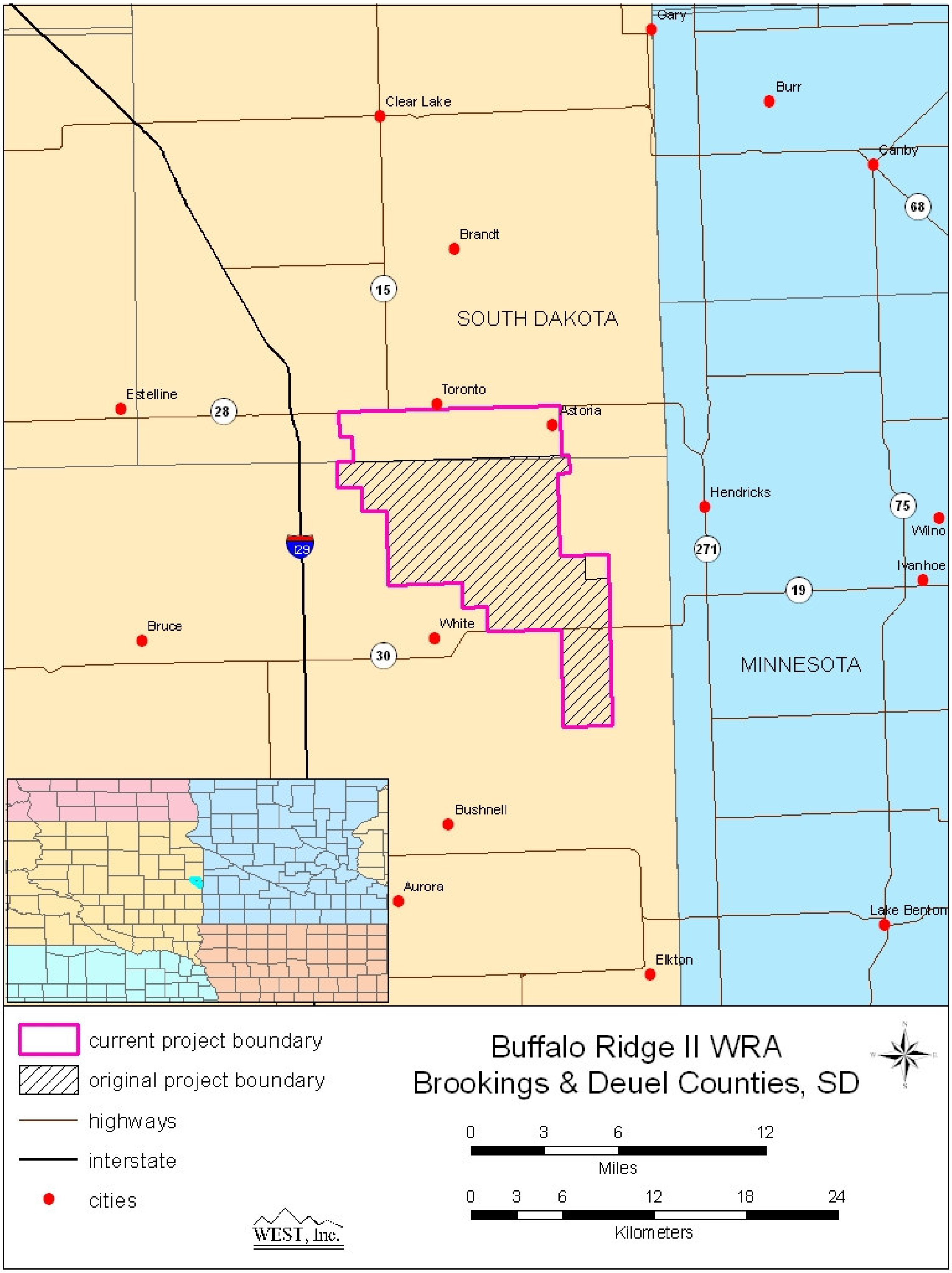


Figure 1. Location of the Buffalo Ridge II Wind Resource Area.

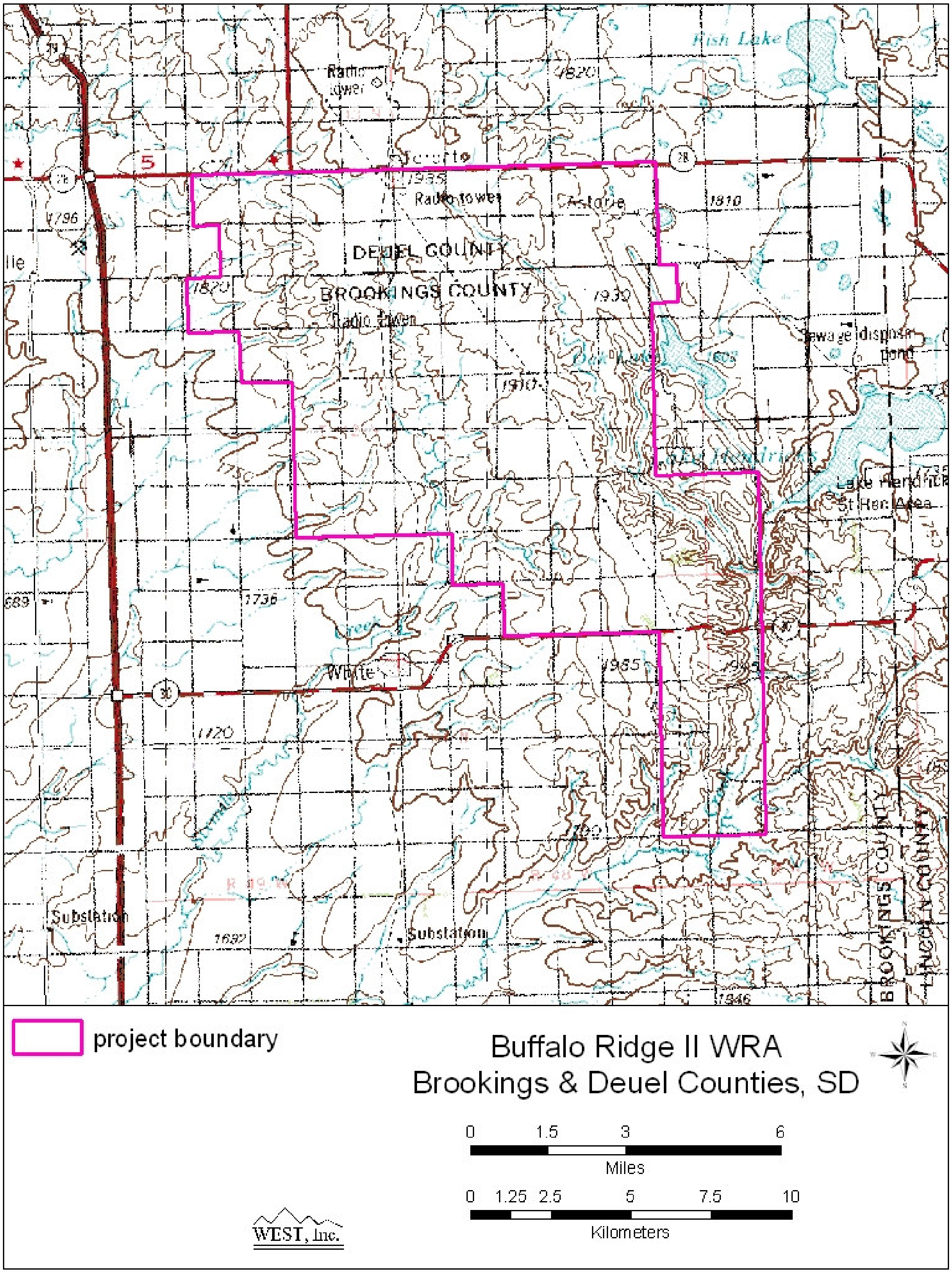


Figure 2. Topographic map of the Buffalo Ridge II Wind Resource Area.

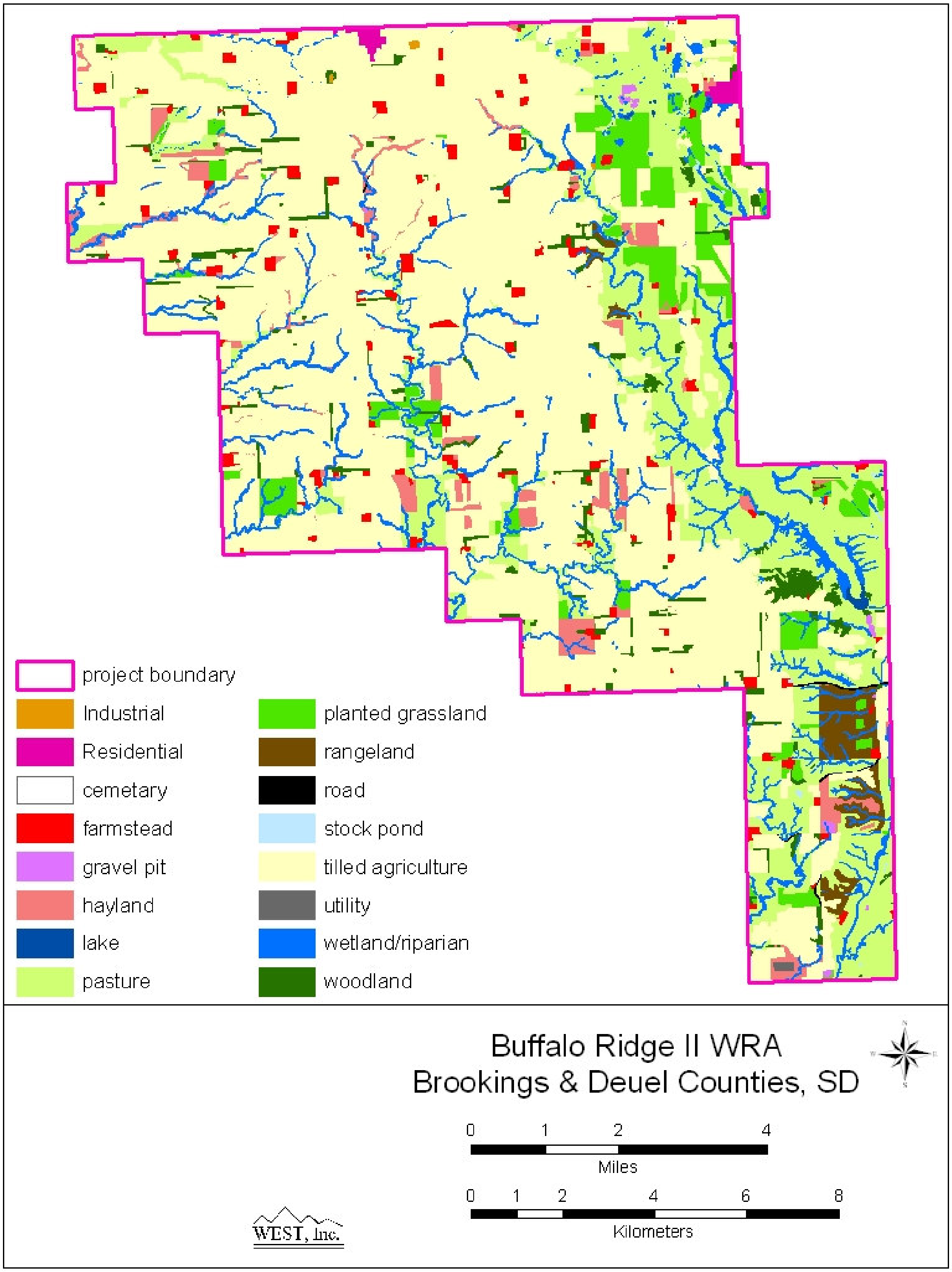


Figure 3. The landcover types and coverage within the Buffalo Ridge II Wind Resource Area.

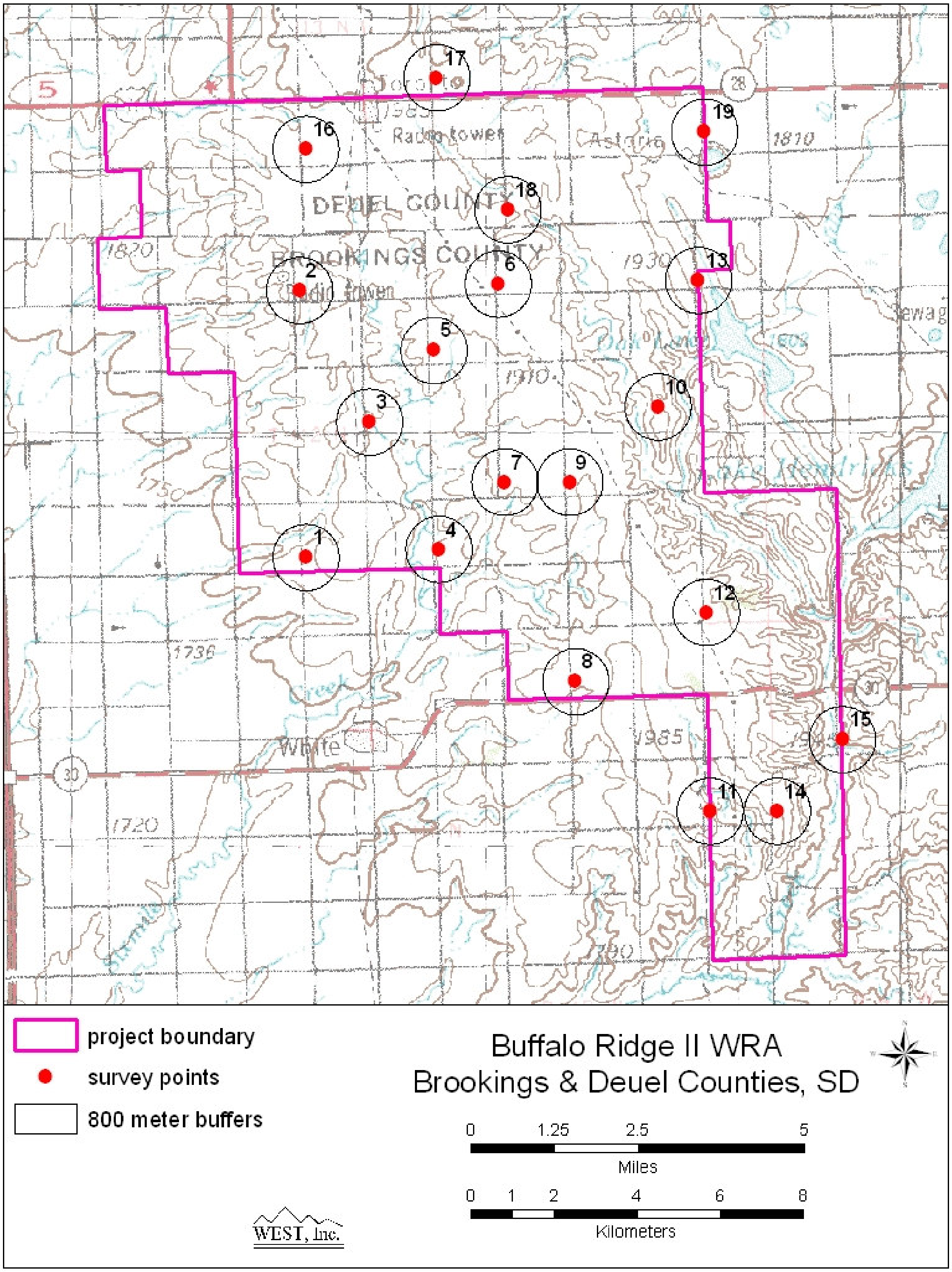


Figure 4. Fixed-point bird use survey points at the Buffalo Ridge II Wind Resource Area.

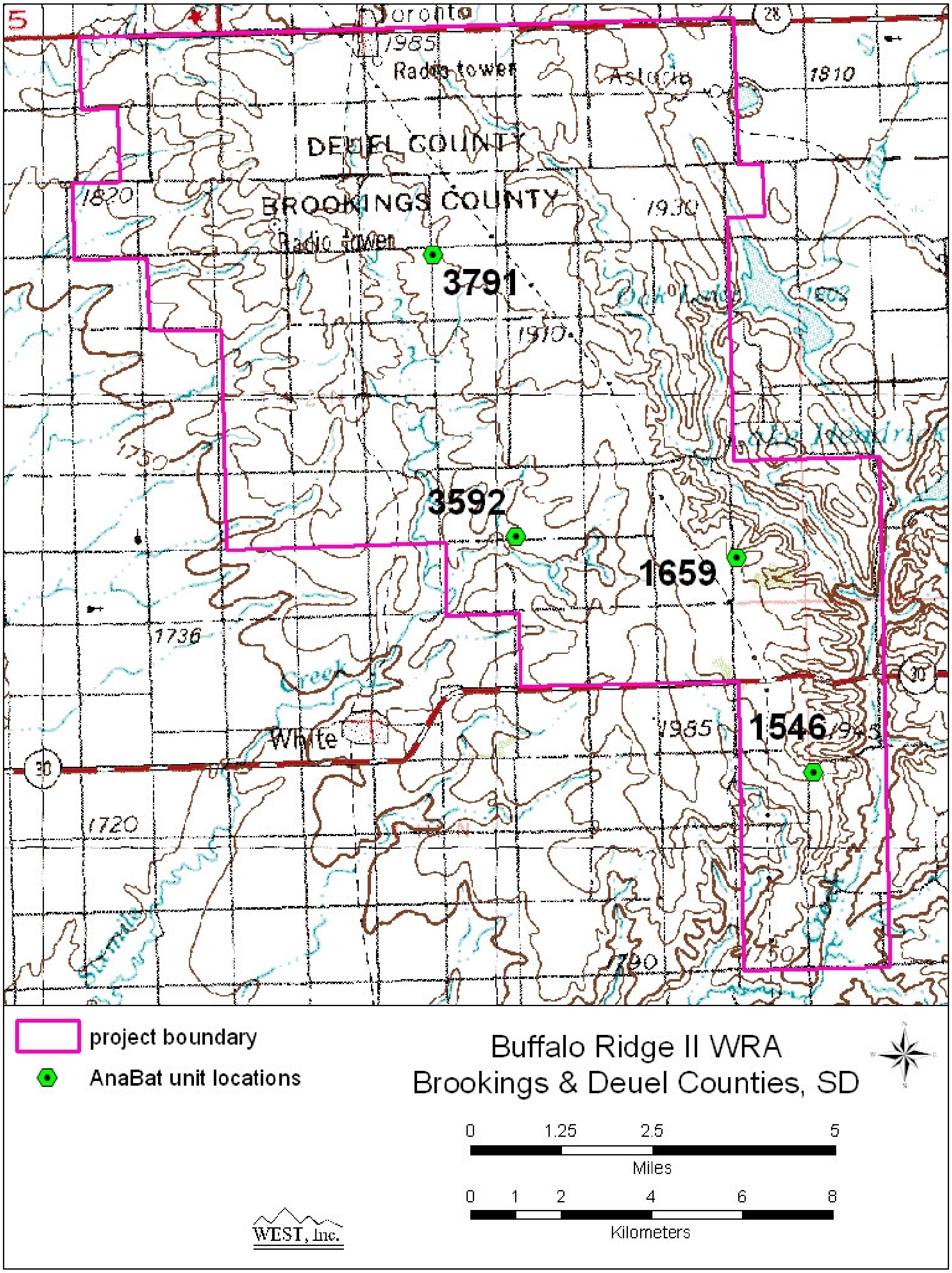


Figure 5. Study area map and AnaBat sampling locations at the Buffalo Ridge II Wind Resource Area.

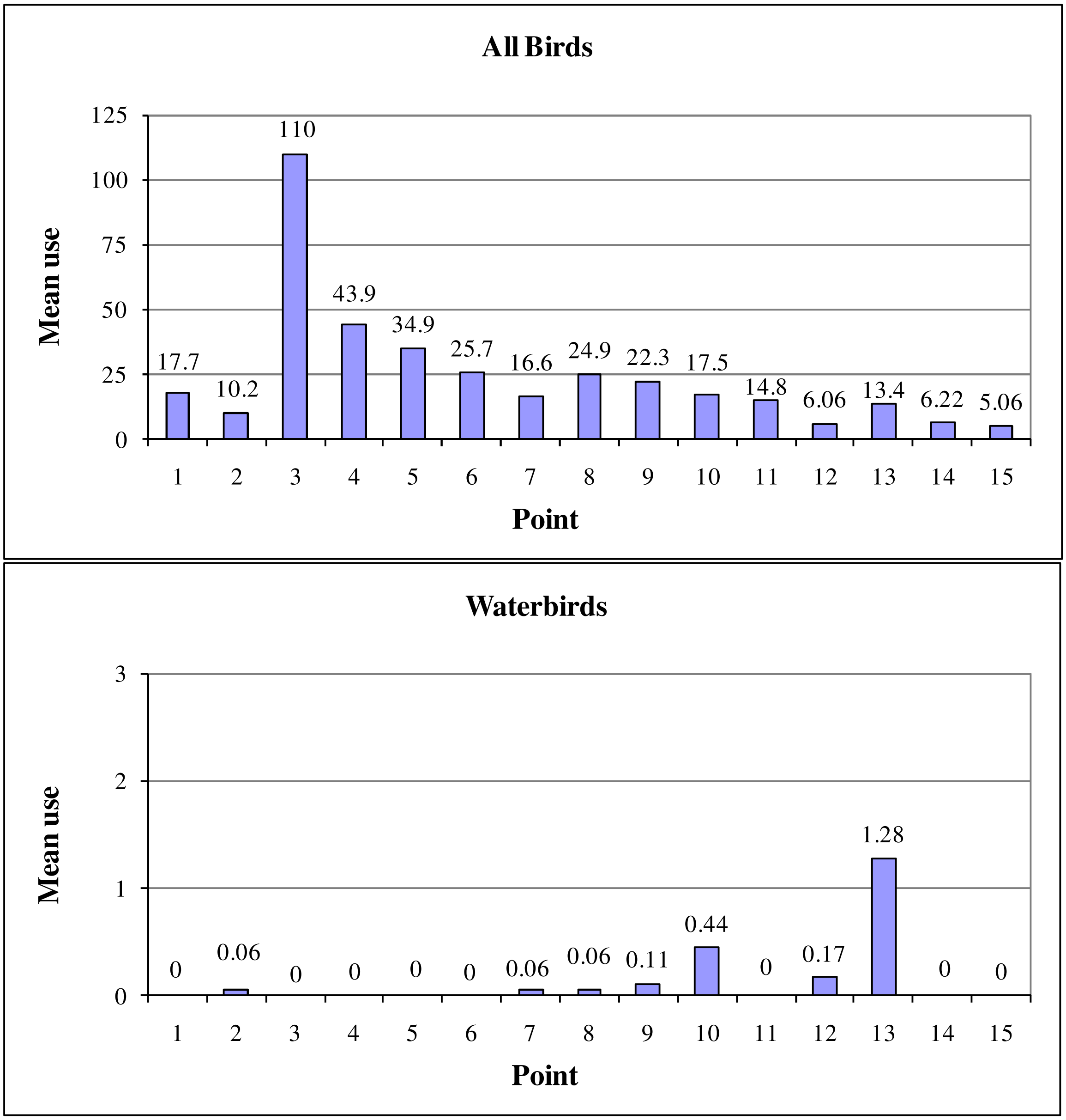


Figure 6. Mean use (birds/20-min survey) at each fixed-point bird use survey point for all birds, major bird types, and raptor subtypes at the Buffalo Ridge II Wind Resource Area.

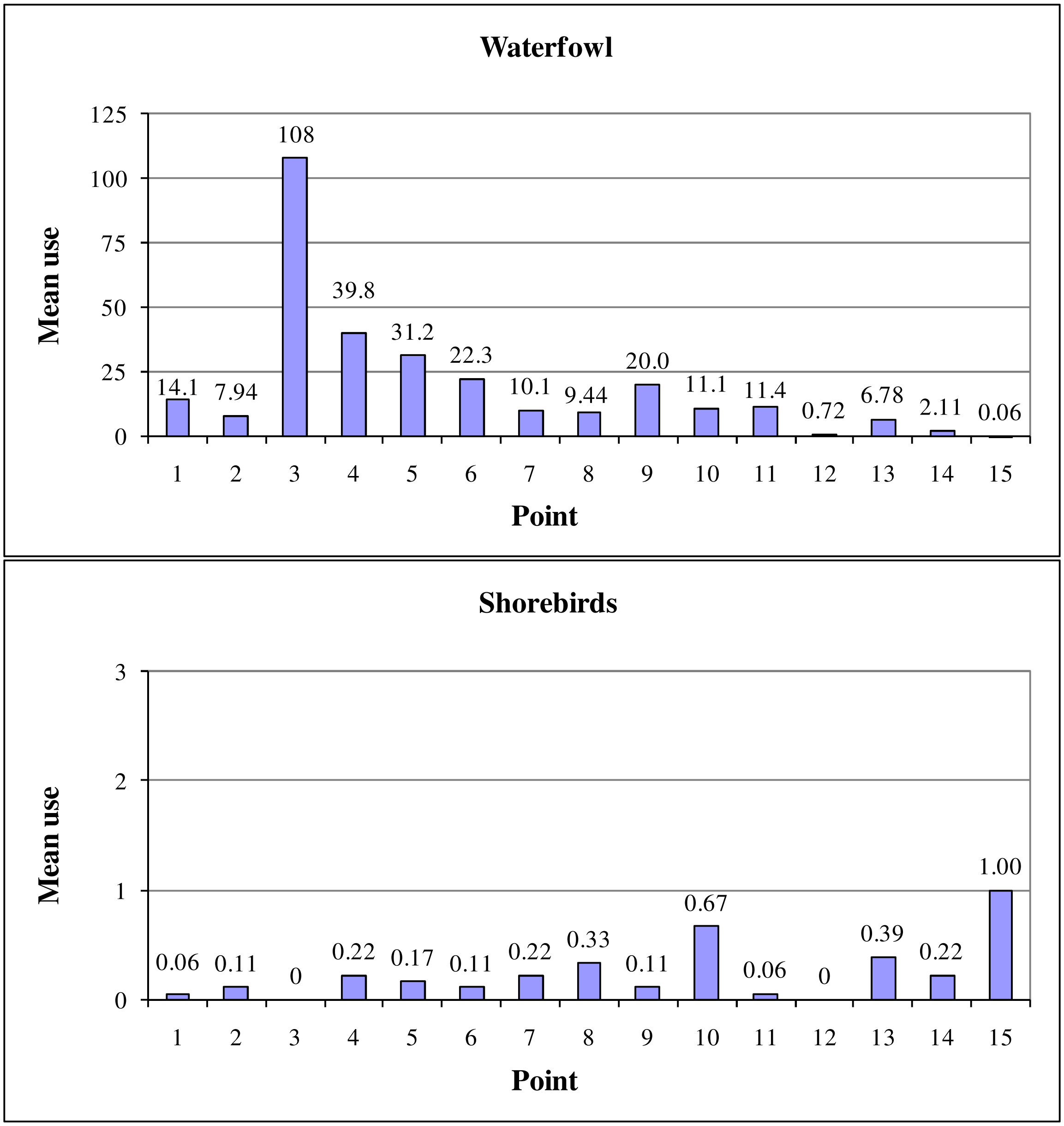
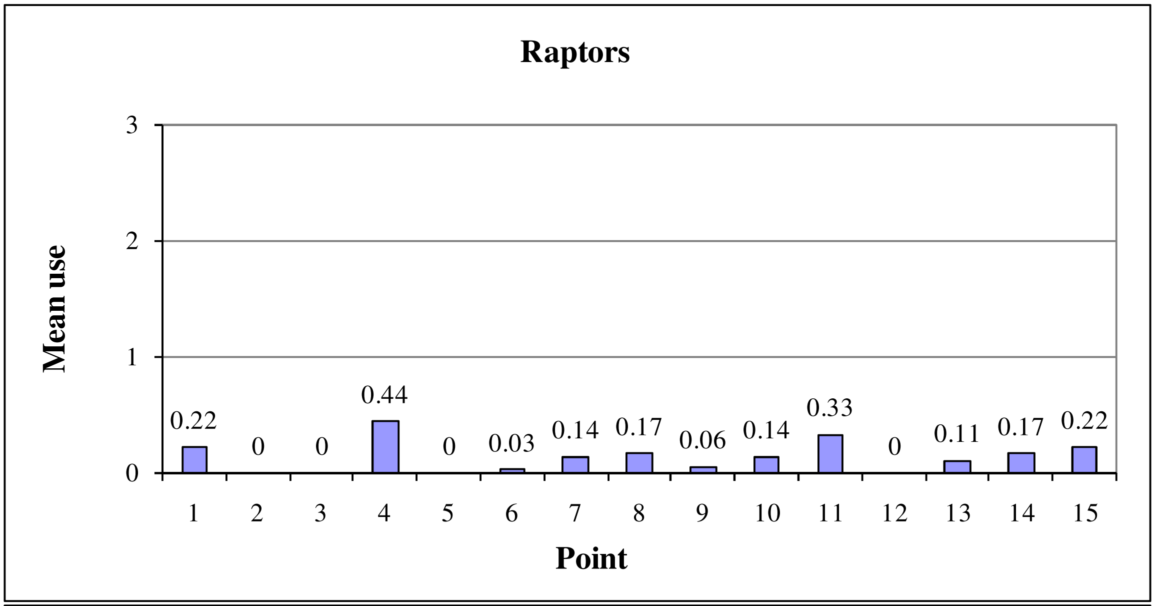


Figure 6 (*continued*). Mean use (birds/20-min survey) at each fixed-point bird use survey point for all birds, major bird types, and raptor subtypes at the Buffalo Ridge II Wind Resource Area.



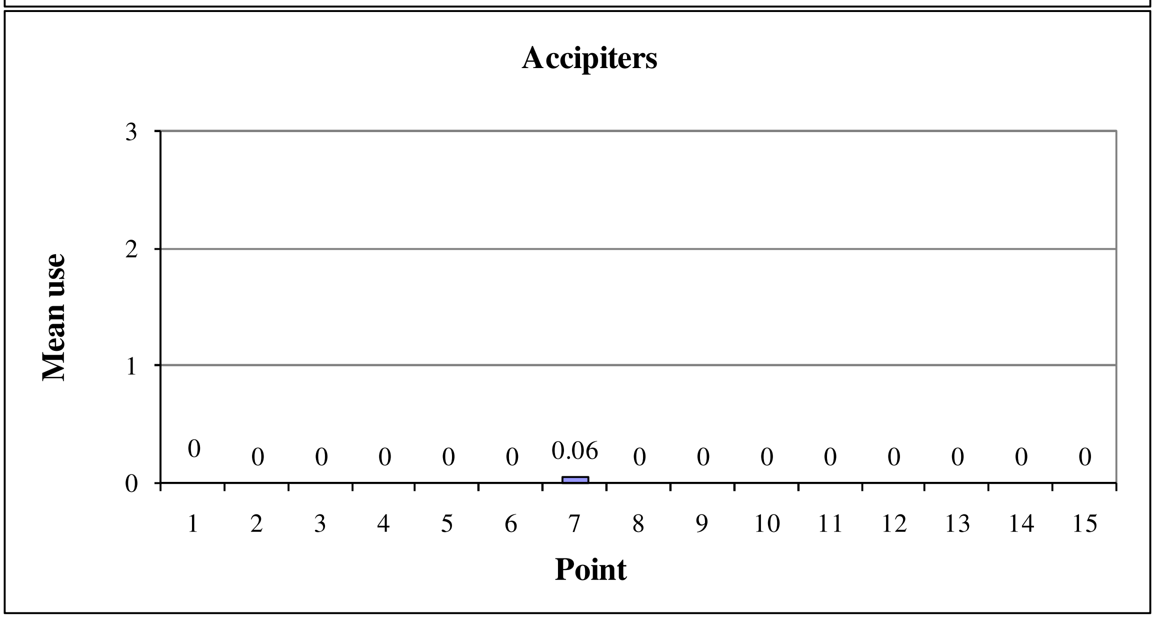


Figure 6 (*continued*). Mean use (birds/20-min survey) at each fixed-point bird use survey point for all birds, major bird types, and raptor subtypes at the Buffalo Ridge II Wind Resource Area.

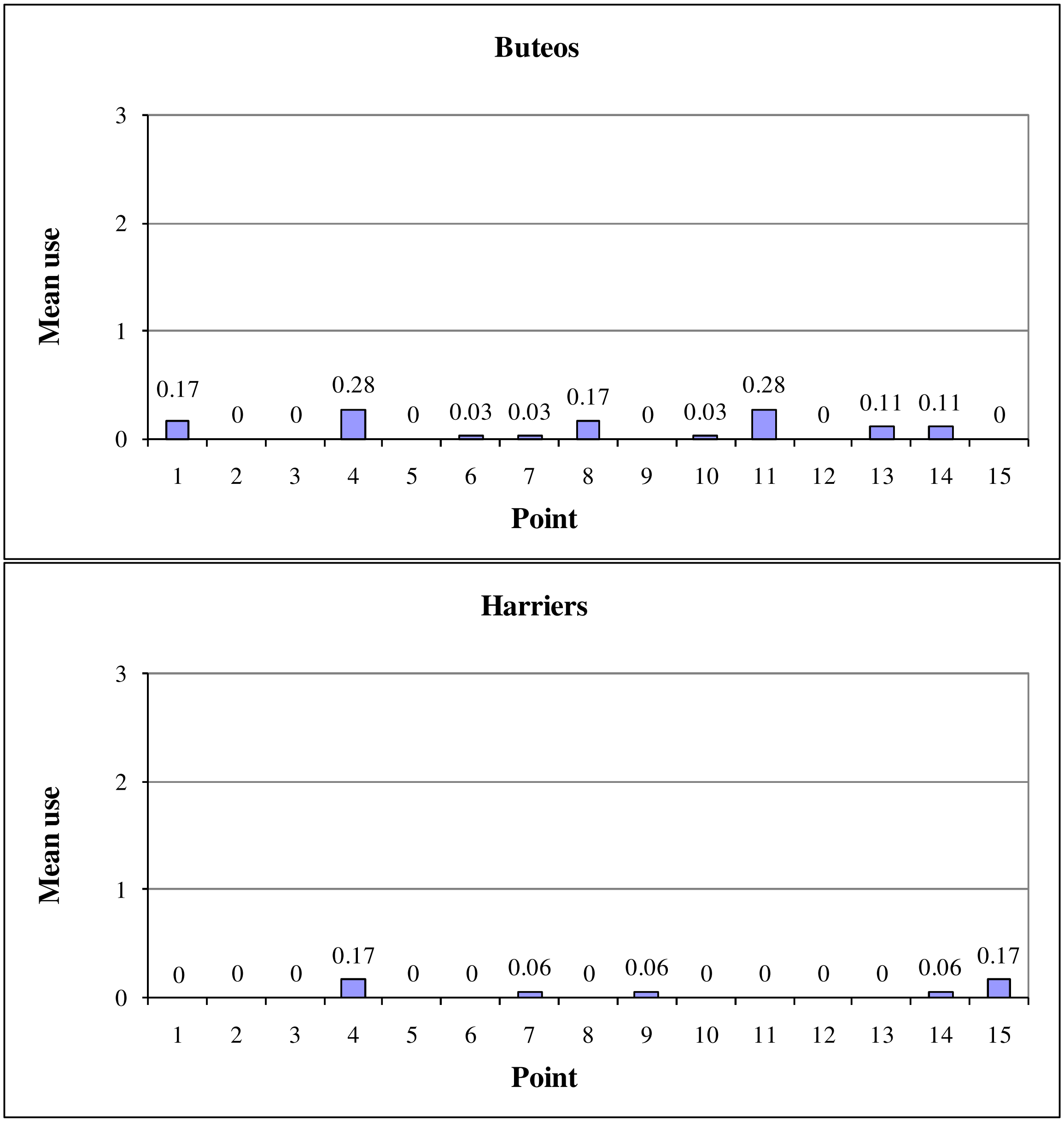
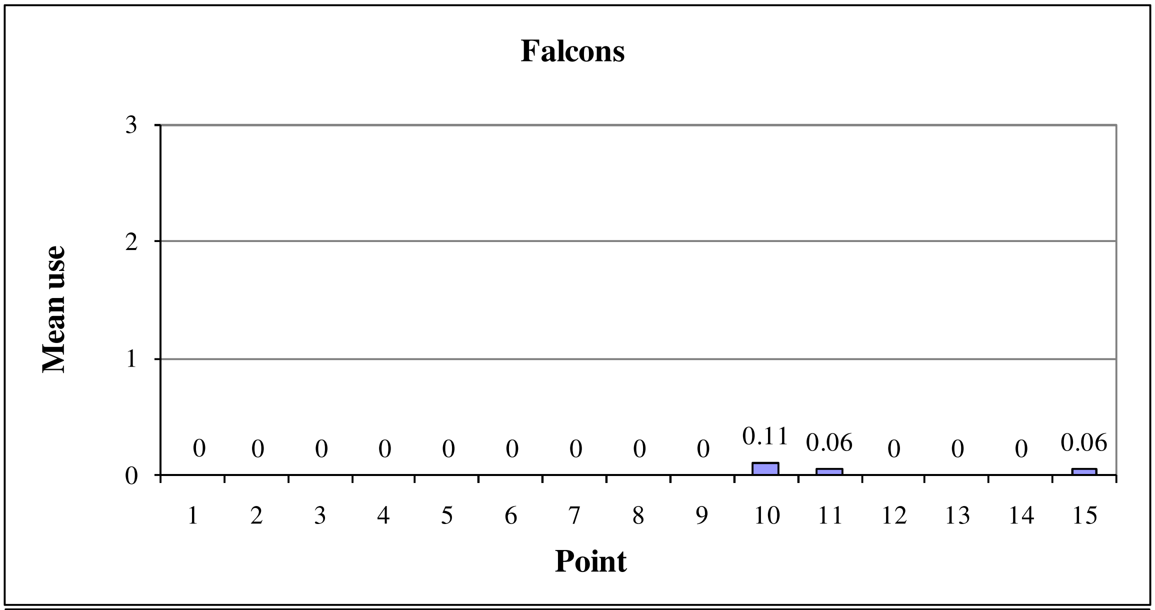


Figure 6 (*continued*). Mean use (birds/20-min survey) at each fixed-point bird use survey point for all birds, major bird types, and raptor subtypes at the Buffalo Ridge II Wind Resource Area.



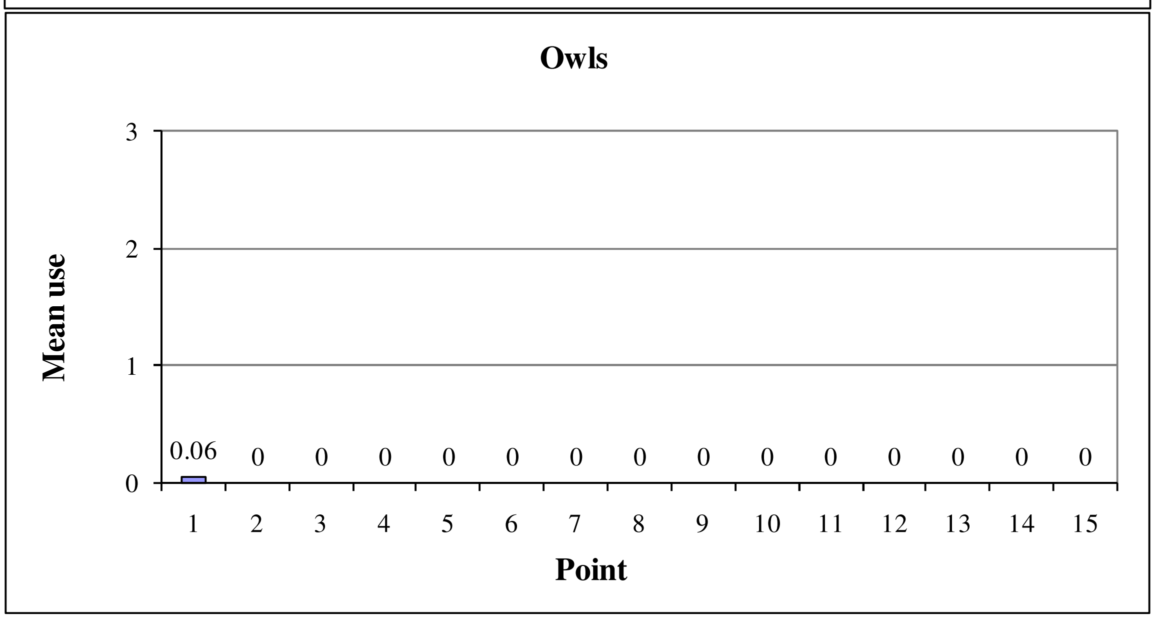
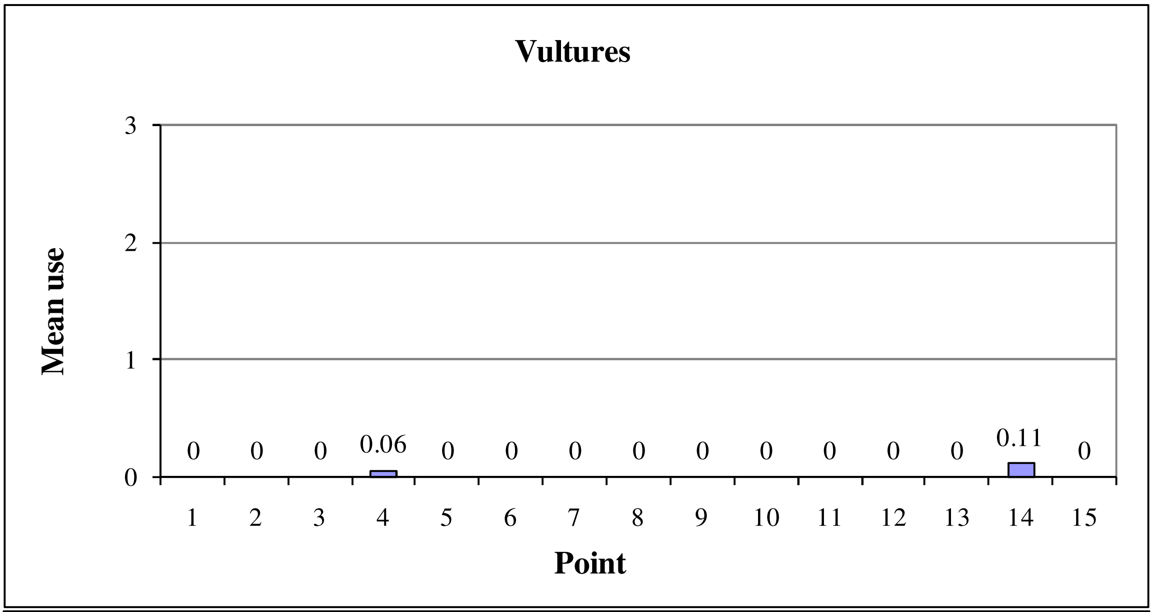


Figure 6 (*continued*). Mean use (birds/20-min survey) at each fixed-point bird use survey point for all birds, major bird types, and raptor subtypes at the Buffalo Ridge II Wind Resource Area.



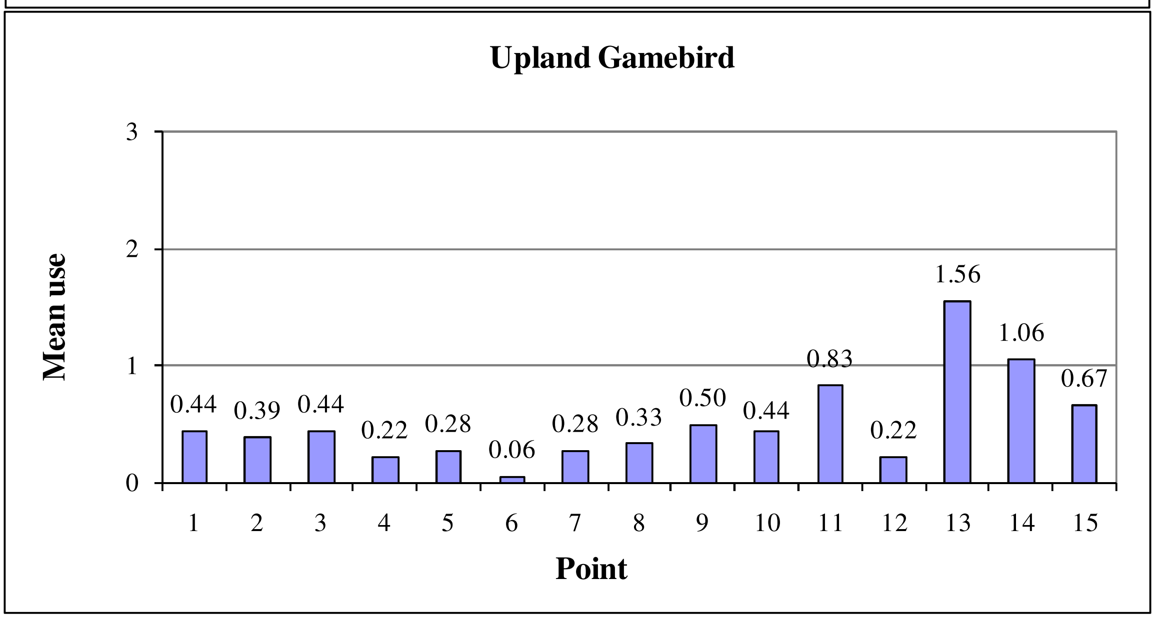
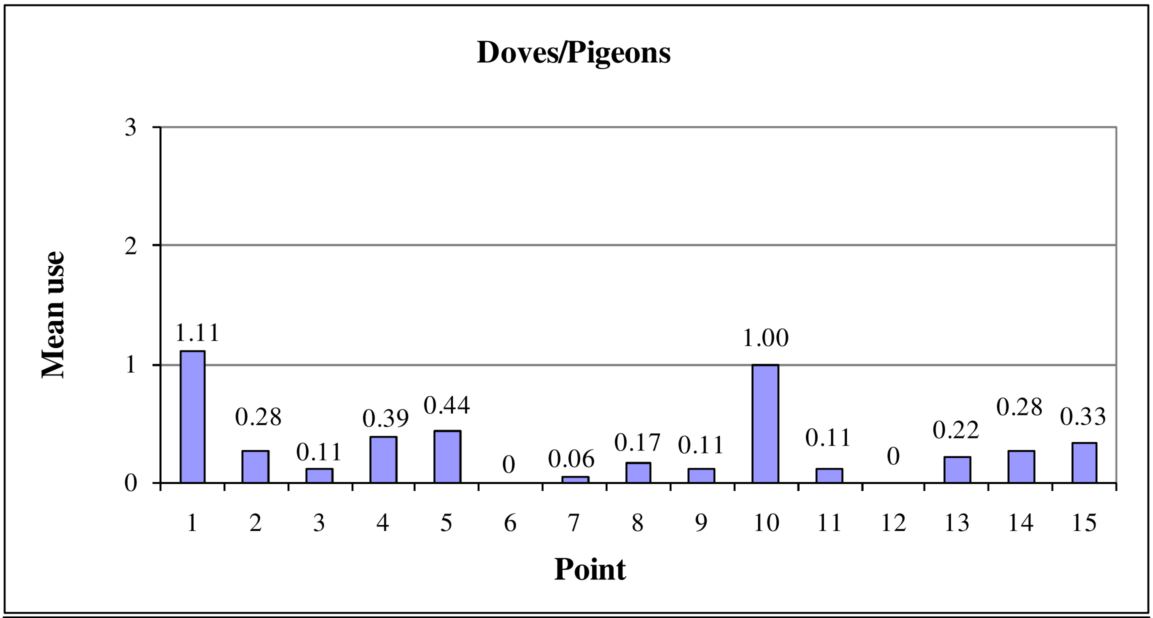


Figure 6 (*continued*). Mean use (birds/20-min survey) at each fixed-point bird use survey point for all birds, major bird types, and raptor subtypes at the Buffalo Ridge II Wind Resource Area.



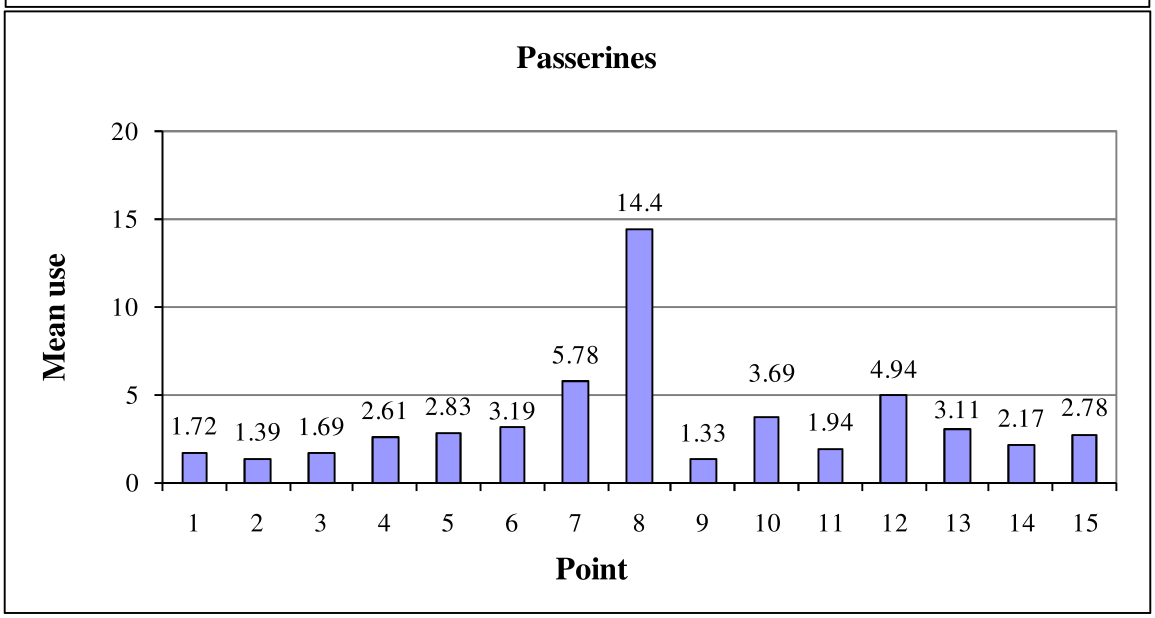


Figure 6 (*continued*). Mean use (birds/20-min survey) at each fixed-point bird use survey point for all birds, major bird types, and raptor subtypes at the Buffalo Ridge II Wind Resource Area.

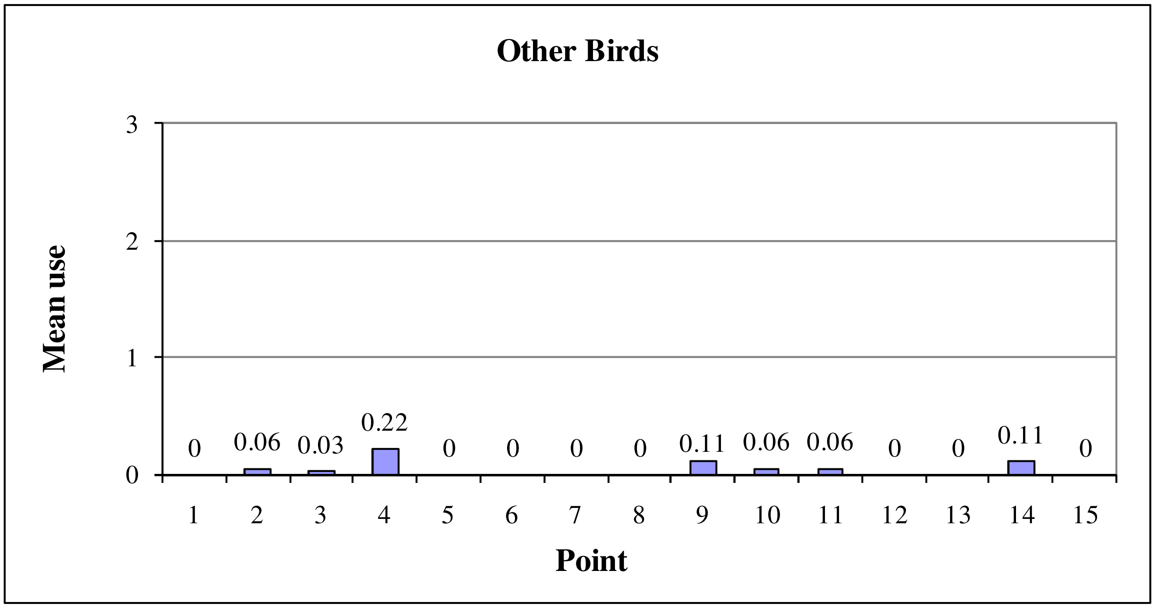


Figure 6 (*continued*). Mean use (birds/20-min survey) at each fixed-point bird use survey point for all birds, major bird types, and raptor subtypes at the Buffalo Ridge II Wind Resource Area.

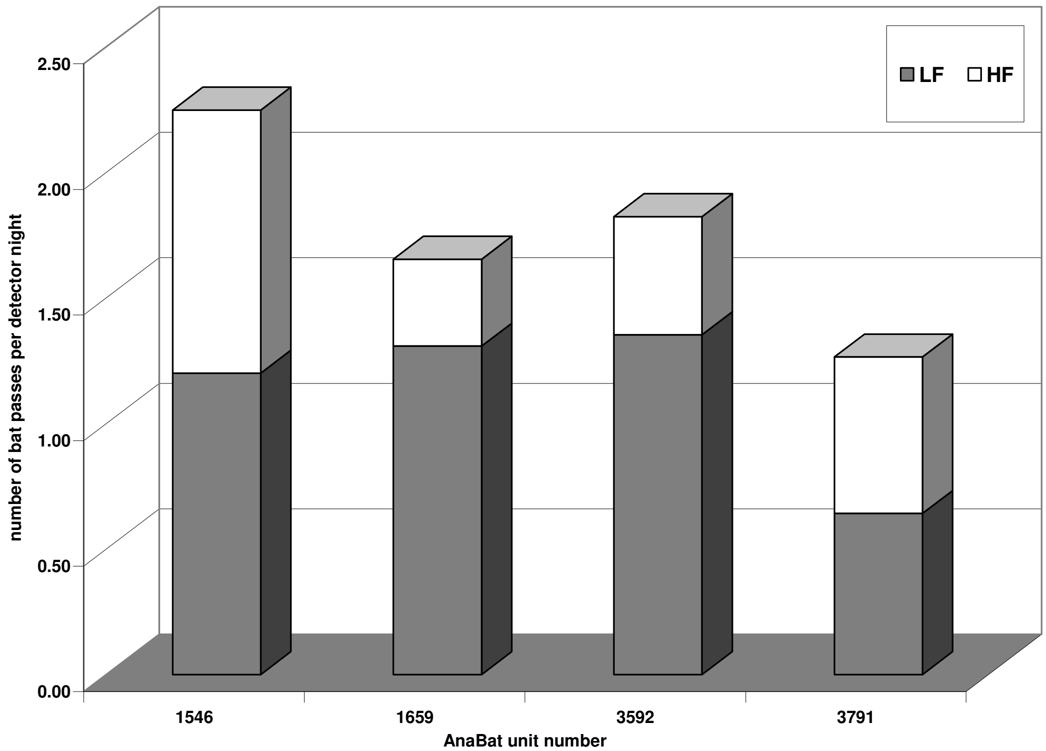


Figure 7. Number of bat passes per detector-night by high-frequency (HF) and low-frequency (LF) bats for each AnaBat location at the BRIIWRA for the study period July 1 – October 14, 2008.

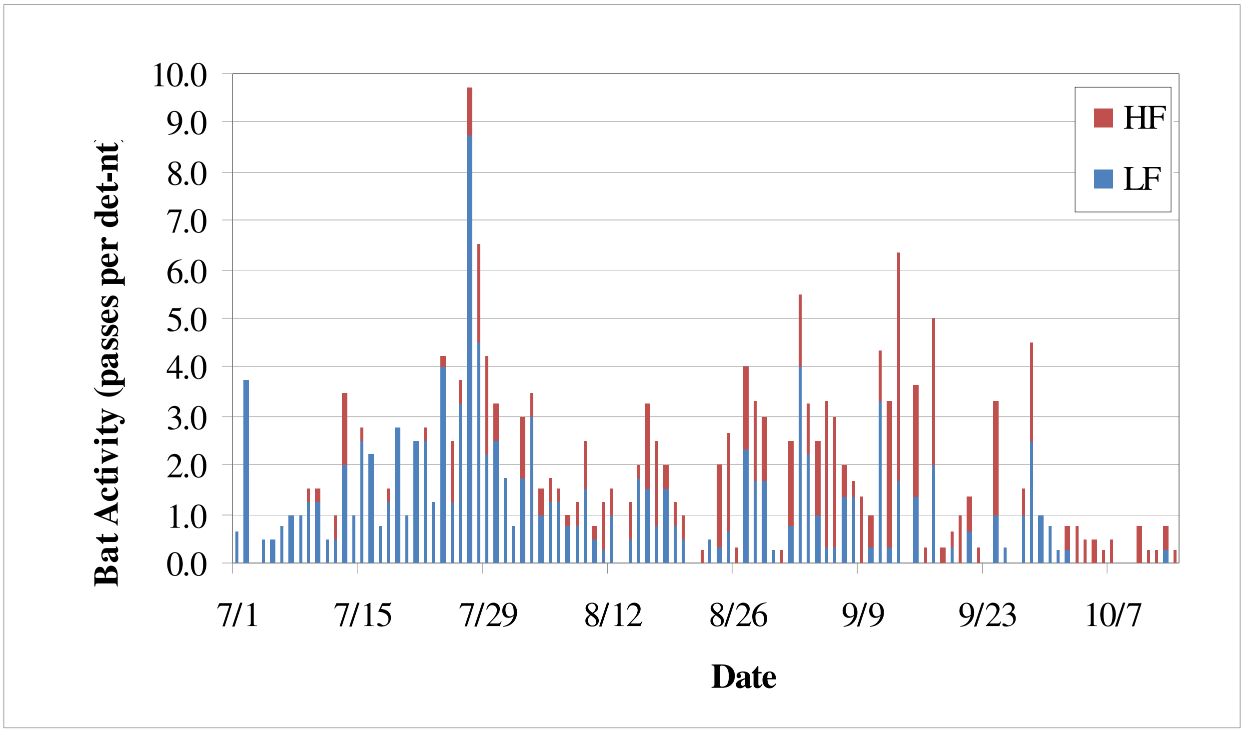


Figure 8. Nightly activity by high-frequency (HF) and low-frequency (LF) bats at the BRIIWRA for the study period July 1 – October 14, 2008.

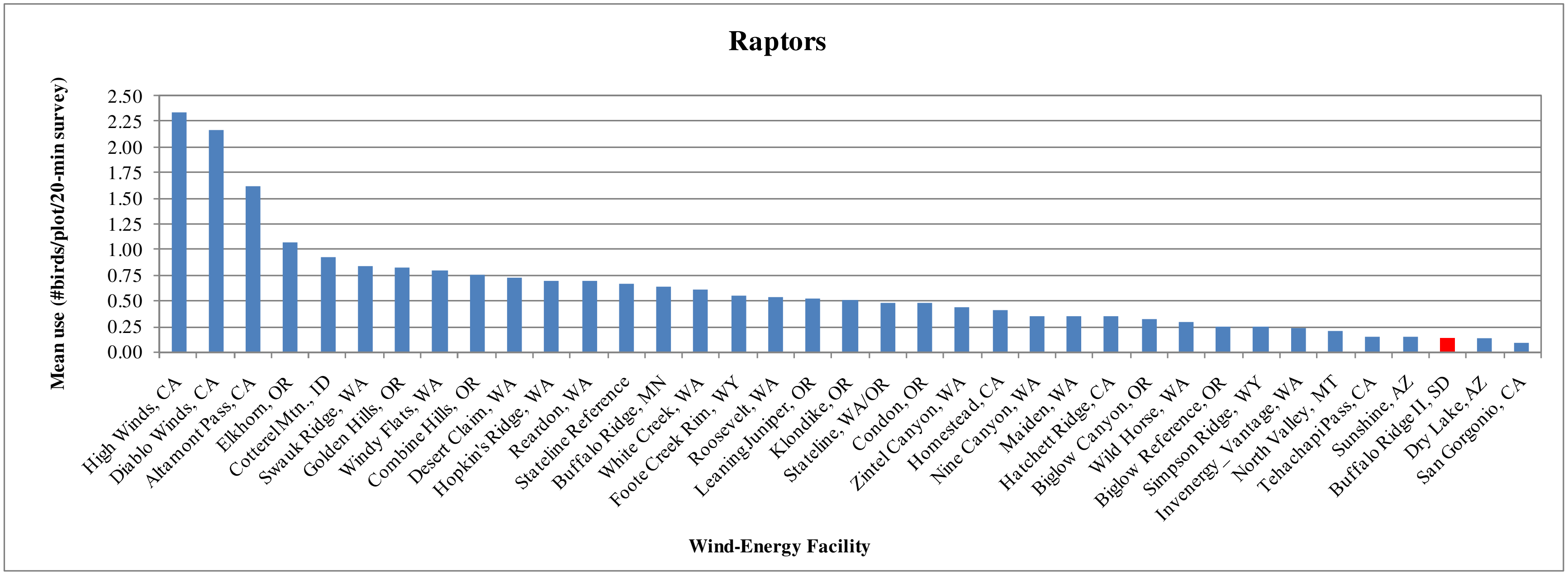
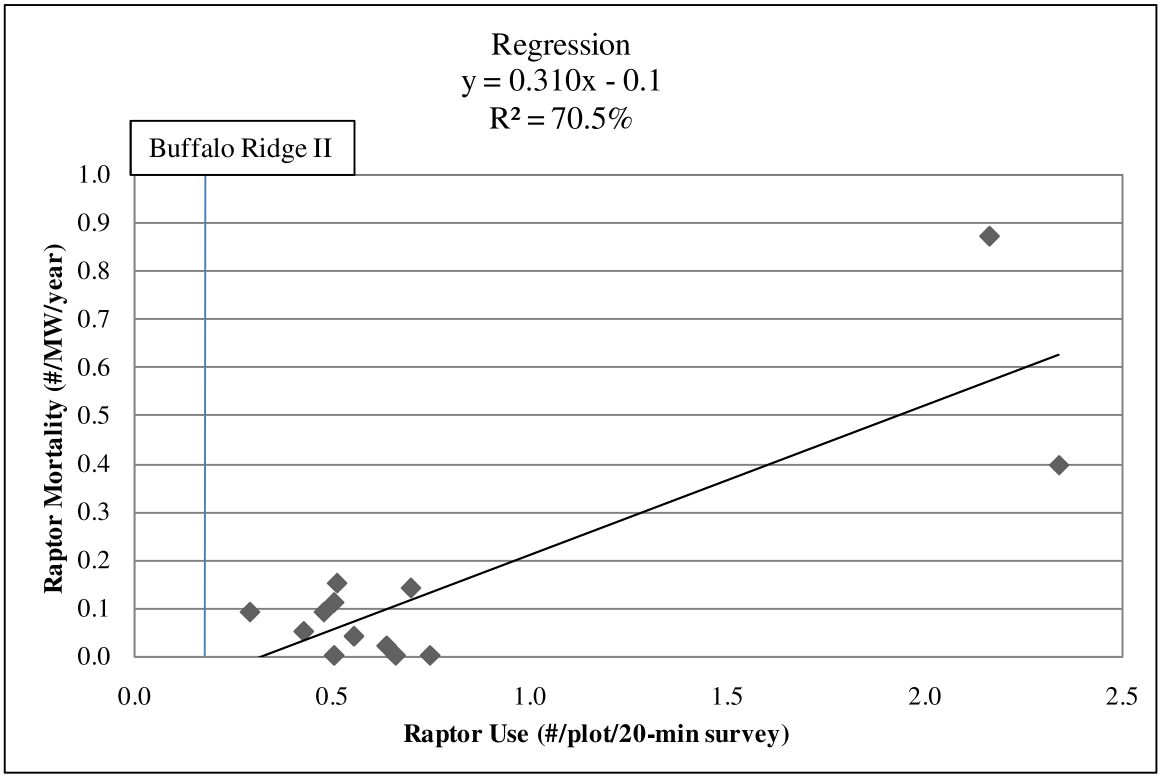


Figure 9. Comparison of overall raptor use annually between the Buffalo Ridge II Wind Resource Area and other US wind-energy facilities.

Data from the following sources:

Buffalo Ridge II, SD	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 0.14
Predicted Fatality Rate 0.00/MW/year
90.0% Prediction Interval (0, 0.21/MW/year)

Figure 10. 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	2.16	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, WA	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. 2003b
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