APPENDIX E

Avian Baseline Studies for the Chokecherry-Sierra Madre Wind Resource Area Carbon County, Wyoming

Final Report
June 26, 2008 – June 16, 2009

Prepared for:

AECOM
1726 Cole Blvd.
Building 22, Suite 150
Golden, Colorado 80401

Prepared by:

Greg Johnson, Troy Rintz, Dale Strickland, and Kimberly Bay

Western **E**co**S**ystems **T**echnology**,** Inc.

2003 Central Avenue
Cheyenne, Wyoming

WEST, Inc.

September 8, 2009

EXECUTIVE SUMMARY

The Power Company of Wyoming has proposed a wind-energy facility in Carbon County, Wyoming, capable of producing 2,000 megawatts of energy with 1,000 wind turbines. To assist with preparing an Environmental Impact Statement for the proposed facility, AECOM contracted Western Ecosystems Technology, Inc. to conduct surveys and monitor wildlife resources in the Chokecherry-Sierra Madre Wind Resource Area to estimate the impacts of project construction and operations on wildlife. The following document contains results for fixed-point bird use surveys and incidental wildlife observations.

The principal objectives of the study were to (1) provide site specific bird use data that would be useful in evaluating potential impacts from the proposed wind-energy facility; (2) provide information that could be used in project planning and design of the facility to minimize impacts to birds; and (3) recommend further studies or potential mitigation measures, if warranted.

The proposed wind-energy facility is composed primarily (77%) of scrub-scrub habitat dominated by big sagebrush. The remaining areas are covered by grassland (19.3%), evergreen forest (1.4%) deciduous forest (0.7%), and emergent wetlands (0.6%), with smaller patches of open water, developed space, barren habitat, mixed forest, woody wetlands, and pastures.

The study used fixed-point bird use surveys to estimate the seasonal, spatial, and temporal use of the study area by birds, particularly raptors. Fixed-point surveys were conducted from June 26, 2008 through June 16, 2009 at nineteen points established throughout the Chokecherry-Sierra Madre Wind Resource Area. A total of 433 20-minute fixed-point surveys were completed and 50 bird species were identified.

A total of 2,005 individual bird observations within 1,301 separate groups were recorded during the fixed-point surveys. The most abundant large bird species recorded was the common raven (175 observations) and the most abundant small bird species was horned lark (805). A total of 230 individual raptors were recorded within the Chokecherry-Sierra Madre Wind Resource Area, representing 12 species. The most abundant raptor observed was golden eagle (69 observations).

Use by waterbirds and shorebirds was relatively low (0.10 and 0.01 birds/plot/20-minute survey, respectively) and these bird types were only observed during the spring season. Raptor use was highest during the fall (0.62 birds/plot/20-min survey) and lowest during the winter (0.17). Vultures were only recorded during the fall and spring (0.01 birds/plot/20-minute survey for both seasons). Upland gamebird use, limited to greater sage-grouse, ranged from 0.09 birds/plot/20-minute survey in the winter to zero in the summer. Large corvids had the highest use in the fall (0.73 birds/plot/20-minute survey) and the lowest use in the winter (0.34). Passerine use ranged from 0.02 birds/plot/20-minute survey in winter to 5.00 in spring; however, the focus for small birds was within a 100 meter viewshed and passerine use is not directly comparable to the other bird types, which were recorded out to 800 m.

During the study, 311 single or groups of large birds totaling 467 individuals were observed flying during fixed-point bird use surveys. For all large bird species combined, 67.0% of birds were observed flying below the likely zone of risk, 29.3% were within the zone of risk, and 3.6%

were observed flying above the zone of risk for typical turbines that could be used in the Chokecherry-Sierra Madre Wind Resource Area. Bird types with at least 20 individuals observed flying most often observed flying within the turbine zone of risk were raptors (30.4%) and large corvids (24.8%). A total of 1,046 passerines and other small birds in 596 groups were recorded flying within 100 meters of the survey plots in the proposed wind resource area, with 99.8% flying below the zone of risk, 0.2% within the zone of risk, and none observed above the zone of risk.

For large bird species with at least 25 separate groups of flying birds, golden eagles were observed most often within the zone of risk (45.0%) based on initial observations. Based on the use (measure of abundance) of the study area by each species and the flight characteristics observed for that species, the common raven had the highest probability of turbine exposure, with an exposure index of 0.09. The raptor species with the highest exposure index was the golden eagle, which was ranked second of all species at 0.06. All other raptor species had an exposure index of 0.02 or less. For passerines and other small birds, the species with the highest exposure index was horned lark, though its exposure index was less than 0.01.

Levels of bird use varied within the study area by point. For all large bird species combined, use was highest at point 12, with 3.18 birds/20-minute survey. The higher mean use at point 12 was due mostly to high use by large corvids at this point (2.50 birds/20-minute survey). Use at the other points ranged from 0.32 to 2.55 birds/20-minute survey for large bird species. Waterbird use was highest at point 16, with 0.67 birds/20-minute survey, and mean shorebird use was only recorded at point 17, with 0.17 birds/20-minute survey. Raptor use was highest at point four (0.93 birds/20-minute survey), and ranged from 0.10 to 0.83 birds/20-minute survey at other points. Vultures were only seen at points six and eleven (0.03 and 0.04 birds/20-minute survey, respectively) and upland gamebird use was highest at point 13 (0.14 birds/20-minute survey). Passerine use, limited to birds observed within 100 meters of the survey point, was highest at point 13, with 5.10 birds/20-minute survey, and ranged from 1.81 to 4.70 at the other points.

No obvious flyways or concentration areas were observed. No strong association with topographic features within the study area was noted for raptors or other large birds. Although some differences in bird use were detected among survey points, the differences are not large enough to suggest that any portions of the Chokecherry-Sierra Madre Wind Resource Area should be avoided when siting turbines due to very high bird use.

The objective of incidental wildlife observations was to provide a record of wildlife seen outside of the standardized surveys. There were 12 bird species observed incidentally, totaling 270 individuals within 157 separate groups during the study. The most abundant large bird species recorded incidentally were greater sage-grouse (123 individuals), golden eagle (52 observations), and northern harrier (38 observations). Three bird species were only observed incidentally and were not observed during fixed-point surveys. Four mammal species totaling 3,083 individuals in 304 groups were also observed incidentally at the CSMWRA. The most commonly recorded mammal species was pronghorn antelope with 2,879 observations in 285 groups.

Based on fixed-point bird use data collected for the Chokecherry-Sierra Madre Wind Resource Area, mean annual raptor use was 0.46 raptors/plot/20-minute survey. The annual rate was low relative to raptor use at 36 other wind-energy facilities that implemented similar protocols to the present study and had data for three or four different seasons. Mean raptor use in the Chokecherry-Sierra Madre Wind Resource Area was low compared to the other wind resource areas, ranking twenty-second among the 36 studies.

A regression analysis of raptor use and mortality for 13 new-generation wind-energy facilities, where similar methods were used to estimate raptor use and mortality, found that there was a significant correlation between use and mortality ($R^2 = 69.9\%$; Figure 8). Using this regression to predict raptor collision mortality at the CSMWRA, based on an adjusted mean raptor use of 0.46 raptors/plot/20-min survey, yields an estimated fatality rate of 0.04 fatalities/MW/year, or four raptor fatalities per year for each 100-MW of wind-energy development, which would equate to an estimate of 80 raptors per year for a 2,000-MW development. A 90% prediction interval around this estimate is zero to 0.30 fatalities/MW/year. Based on species composition of the most common raptor fatalities at other western wind-energy facilities and species composition of raptors observed at the Chokecherry-Sierra Madre Wind Resource Area during the surveys, the majority of the fatalities of diurnal raptors will likely consist of red-tailed hawk, American kestrel and golden eagle. Based on the seasonal use estimates, it is expected that risk to raptors would be unequal across seasons, with the lowest risk in the winter, and highest risk during the fall. However, the winter use estimates were only based on three surveys that were completed prior to the area becoming inaccessible due to snow. Therefore, winter use as based on these three surveys may not be representative of actual use throughout the entire winter, but is the best data available for predicting winter use of the study area by raptors.

Some species considered to be sensitive or of conservation concern were observed within the Chokecherry-Sierra Madre Wind Resource Area. During all surveys and incidental observations, one petitioned species, the greater sage-grouse, was recorded within the proposed wind resource area. Furthermore, 10 other bird species and one mammal species classified by the Wyoming Game and Fish Department as Native Species Status 2, 3, or 4 were also recorded during fixed-point bird use surveys or as incidental wildlife observations. A total of 538 individual birds in 293 groups, representing 11 sensitive bird species, and five white-tailed prairie dogs in one group were recorded. This is a tally that in some cases may represent repeated observations of the same individual. Some potential exists for wind turbines to displace these species within the study area. Research concerning displacement impacts of wind-energy facilities is limited, but some show the potential for small scale displacement of 180 meters (591 feet) or less for small birds, while impacts to densities of small birds at larger scales have not been shown.

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INTRODUCTION

The Power Company of Wyoming has proposed a wind-energy facility in Carbon County, Wyoming (Figures 1 and 2), capable of producing 2,000 megawatts (MW) of energy with 1,000 wind turbines. To assist with preparing an Environmental Impact Statement for the proposed facility, AECOM contracted Western Ecosystems Technology, Inc. to conduct surveys and monitor wildlife resources in the Chokecherry-Sierra Madre Wind Resource Area (CSMWRA) to estimate the impacts of project construction and operations on wildlife.

The principal objectives of the study were to (1) provide site specific bird use data that would be useful in evaluating potential impacts from the proposed wind-energy facility; (2) provide information that could be used in project planning and design of the facility to minimize impacts to birds; and (3) recommend further studies or potential mitigation measures, if warranted. The protocols for the baseline studies are similar to those used at other wind-energy facilities across the nation, and follow the guidance of the National Wind Coordinating Collaborative (Anderson et al. 1999). The protocols have been developed based on WEST's experience studying wildlife at proposed wind-energy facilities throughout the US; and were designed to help predict potential impacts to bird species (particularly raptors).

Baseline surveys, conducted from June 26, 2008 through June 16, 2009 at the CSMWRA, included fixed-point bird use surveys and incidental observations. Sensitive species of wildlife observed during either the fixed-point surveys or observed incidentally were also recorded. 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 CSMWRA 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. Where possible, comparisons with regional and local studies were made.

STUDY AREA

The proposed CSMWRA is located in Carbon County (Figure 1) approximately four miles (6.4 kilometers [km]) south of Rawlins, Wyoming, within T 16 N – T 18N, R 88 W – R 89W and T 19 N – T21N, R 85 W – R 88W. The CSMWRA is comprised of two portions, the Chokecherry Wind Resource Area (WRA) to the north and the Sierra Madre WRA to the south. Approximately 77% of the study area is covered by scrub-scrub habitat, which is dominated primarily by big sagebrush (*Artemisia tridentata*). The remaining areas are covered by grassland (19.3%), evergreen forest (1.4%) deciduous forest (0.7%), and emergent wetlands (0.6%), with smaller patches of open water, developed space, barren habitat, mixed forest, woody wetlands, and pastures (Table 1; Figure 3).

Topography in the Chokecherry WRA is rolling hills throughout much of the Chokecherry WRA, with topography becoming more varied in the southern portion (Figure 2). A distinct rim with a steep cliff face dominates the southern boundary of the Chokecherry WRA. The general land practice is cattle grazing.

The Sierra Madre WRA is dominated by sagebrush steppe with pockets of quaking aspen (*Populus tremuloides*). Topography in the Sierra Madre WRA ranges from gently rolling plains in the northern portion to rolling hills in the southern portion (Figure 2). The escarpment of Miller Hill dominates the northern boundary of the Sierra Madre WRA. Drainages in the southern portion are dominated by willow (*Salix* spp.) and the general land practice is also cattle grazing.

METHODS

Fixed-Point Bird Use Surveys

Fixed-point bird use surveys were used to estimate the seasonal, spatial, and temporal use of the study area by birds, particularly raptors, defined here as kites, accipiters, buteos, harriers, eagles, falcons, and owls. 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 providing relatively even coverage. All birds seen during each 20-minute (min) fixed-point survey were recorded.

Bird Use Survey Plots

At the start of the study, 16 points were selected to achieve relatively even coverage of the study area and survey representative habitats and topography within the study area. Due to snow conditions which prevented access to much of the study area, three additional points were added north of the Sierra Madre WRA in the spring, for a total of 19 points (Figure 4). Each survey plot was a variable circular plot, and all birds seen during each survey were recorded. Using this method, all birds that are seen or heard are recorded and later analysis can truncate observations to set distances (Reynolds et al. 1980).

Bird Survey Methods

All species of birds observed during fixed-point surveys were recorded. Observations of large birds beyond 800 m (2,625 feet [ft]) were recorded, but were not included in the statistical analyses; for small birds observations beyond a 100-m (328 ft) radius were excluded. 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 5-m (16-ft) interval. Other information recorded included whether or not the observation was auditory only and in which of the two 10-min intervals of the 20-min survey 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. Flight paths and perch locations were digitized using ArcGIS 9.3. Any comments were recorded in the comments section of the data sheet. Any wildlife observations were recorded on the incidental datasheets.

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 June 26, 2008, through June 16, 2009. Surveys were conducted approximately once a week during spring (March 16 to May 31) and fall (September 1 to November 15), once every two weeks during summer (June 1 to August 31), and three times during the winter (November 16 to December 31). Only three surveys were completed in winter before snow conditions made the area inaccessible. Surveys were conducted during daylight hours and survey periods were varied to approximately cover all daylight hours during a season. To the extent practical, each point was surveyed about the same number of times each season. The three additional points (points 17, 18, and 19) were added during spring surveys because winter snows made much of the CCWRA inaccessible. The purpose of surveying at these three points was to capture south to north migration through the study area.

Incidental Wildlife Observations

Incidental wildlife observations provided 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 Universal Transverse Mercator (UTM) location was recorded with a global positioning system (GPS) unit.

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 used 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). Bird diversity and species 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 large birds detected within the 800-m radius plot were used; small bird observations were limited to 100 m. Estimates of mean 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. Two different viewsheds were utilized when calculating the various statistics such as species richness, use, percent composition, percent frequency, and exposure index; a circle with a radius of 800 m for large birds and 100 m for small birds.

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

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 “zone of risk” (ZOR) for collision with turbine blades of 35 m to 130 m (114 – 427 ft) above ground level (AGL), which is the blade height of typical turbines that could be used at the CSMWRA.

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* (large bird observations within 800 m of the observer or 100 m for small birds) 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.

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.

Spatial Use

Data were analyzed by comparing use among plots. Mapped flight paths were qualitatively compared to study area features such as topographic features. The objective of mapping observed bird locations and flight paths was to look for areas of concentrated use by raptors and other large birds and/or consistent flight patterns within the study area. This information can be useful in turbine layout design or adjustments of individual turbines for micro-siting.

RESULTS

Fifty-three bird species and four mammal species were identified during surveys completed at the CSMWRA. Results of the fixed-point surveys and incidental wildlife observations, and the specific numbers of unique species for each survey type, are discussed in the sections below.

Fixed-Point Bird Use Surveys

Bird Diversity and Species Richness

A total of 433 20-minute fixed-point surveys were conducted at the CSMWRA (Table 2). Fifty unique species were observed over the course of all fixed-point bird use surveys. More unique species were observed during the spring (36 species) and summer (32) than in the fall (25) and winter (six). Mean use was 0.63 birds/plot/20-min survey for large bird species and 1.19 birds/100-m plot/20-min survey for small bird species (Table 2). The mean number of species per plot per survey for large birds was higher in the fall (0.81 species/800-m plot/20-min survey) compared to spring (0.61), summer (0.60), and winter (0.40). For small birds, the mean number of species per plot per survey was higher in the summer (2.05 species/100-m plot/20-min survey) and spring (1.62), compared to the fall (0.43) and winter (0.02; Table 2).

A total of 2,005 individual bird observations within 1,301 separate groups were recorded during the fixed-point surveys (Table 3). One species, horned lark (*Eremophila alpestris*), composed 40.1% of all bird observations. All other species comprised less than 10% of the total observations. The most abundant large bird species recorded was the common raven (*Corvus corax;* 175 observations). A total of 230 individual raptors were recorded within the CSMWRA, representing 12 species (Table 3). The most abundant raptor observed was golden eagle (*Aquila chrysaetos*; 69 observations).

Bird Use, Composition, and Frequency of Occurrence by Season

Mean bird use, percent composition, and frequency of occurrence by season were calculated (Tables 4a and 4b). The highest overall large bird use occurred in the fall (1.37 birds/plot/20-min survey), followed by the summer (1.08), spring (0.98), and winter (0.60; Table 4a). For all small birds, use was highest in the spring (5.00 birds/plot/20-min survey), followed by the summer (4.18), fall (1.57), and winter (0.02; Table 4b).

Waterbirds
Waterbirds were only observed during the spring season (Table 4a), with a mean use of 0.10 birds/plot/20-min survey. Waterbirds accounted for 10.5% of all bird use during the spring and the frequency of occurrence was relatively low (1.4% of spring surveys; Table 4a). The only waterbird species observed were American white pelican (*Pelecanus erythrorhyncos*) and great blue heron (*Ardea herodias*).

Shorebirds
Shorebirds were also only observed during the spring season (Table 4a), with a use of 0.01 birds/plot/20-min survey. Shorebirds accounted for less than 1% of overall bird composition during the spring, and were recorded during less than 1% of spring surveys (Table 4a). The only shorebird species observed was killdeer (*Charadrius vociferous*).

Raptors
Raptor use was highest in the fall (0.62 birds/plot/20-min survey), followed by summer (0.58), spring (0.35) and winter (0.17; Table 4a). Higher use in the summer and spring was primarily due to high use of the area by American kestrels (*Falco sparverius*; 0.18 and 0.12 birds/plot/20-min survey, respectively). Higher use in the fall and winter was primarily due to use of the area by golden eagles (0.25 and 0.14 birds/plot/20-min survey, respectively). Raptors comprised 53.1% of overall bird use during the summer, 45.2% during the fall, 36.1% during the spring, and 27.9% during the winter. Raptors were observed during 37.2% of summer surveys, 36.8% of fall surveys, 28.6% of spring surveys, and 16.7% of winter surveys (Table 4a).

Vultures
Vultures, limited to turkey vulture (*Cathartes aura*), were only recorded during the fall and spring (0.01 birds/plot/20-min survey for both seasons; Table 4a). Vultures accounted for less than 1% of overall bird use and were recorded during less than 1% of all surveys during both seasons (Table 4a).

Upland Gamebirds
Upland gamebird use, limited to greater sage-grouse (*Centrocercus urophasianus*) was highest during the winter (0.09 birds/plot/20-min survey) compared to the spring (0.06), fall (0.01), and summer (0; Table 4a). Greater sage-grouse accounted for 15.1% of all bird use during the winter, 5.9% in the spring, and 1.1% in the fall. Greater sage-grouse were recorded during 5.8% of spring surveys, 4.9% winter surveys, and less than 1% of fall surveys (Table 4a).

Large Corvids
Large corvids, consisting of American crow (*Corvus brachyrhynchos*), black-billed magpie (*Pica pica*), and common raven, had the highest use in the fall (0.73 birds/plot/20-min survey), followed by spring (0.45), summer (0.44) and winter (0.34; Table 4a). Large corvids accounted for 57.0% of all bird use during the winter, 53.2% in the fall, 45.9% in the spring, and 40.5% in the summer. Large corvids were recorded during 29.7% of fall surveys, 20.5% of spring surveys, 16.0% of winter surveys, and 7.7% of summer surveys (Table 4a).

Passerines

A 100-m radius viewshed was used for small bird data analysis, therefore, results are not directly comparable to the other large bird types, which were recorded out to 800 m. Passerine use was highest in spring (4.97 birds/plot/20-min survey), compared to summer (4.04), winter (1.57), and fall (0.02; Table 4b). Horned lark had the highest use by any one species in all seasons (spring 3.38 birds/plot/20-min survey; summer 1.83; fall 1.15; winter 0.02). Passerines were observed during more than 80% of the surveys in the summer and spring, 29.4% of fall surveys, and only 2.1% of winter surveys (Table 4b). After horned lark (805 observations; Table 3), the most common small passerine species recorded were: vesper sparrow (*Pooecetes gramineus*; 121), Brewer's sparrow (*Euphagus cyanocephalus*: 80), western meadowlark (*Sturnella neglecta*; 69), and sage thrasher (*Oreoscoptes montanus*; 65).

Bird Flight Height and Behavior

Flight height characteristics were estimated for both bird types and bird species (Tables 5 and 6). During the study, 311 single large birds or groups totaling 467 individuals were observed flying within the 800-m radius plot (Table 5). Overall, 29.3% of large birds observed flying were recorded within the ZOR for collision with turbine blades (35 to 135 m AGL), 67.0% were below the ZOR, and 3.6% were flying above the ZOR (Table 5). More than half (61.8%) of flying raptors were observed below the ZOR, 30.4% were within the ZOR, and only 7.7% were above the ZOR. Waterbirds had the highest percentage of flying birds within the ZOR (100%), although this was only based on two groups totaling 16 individuals. Fifty percent of turkey vultures were observed flying within the ZOR, but this percentage was based on only two vultures observed flying. Raptors had the third highest percentage of birds within the ZOR, primarily due to 45.2% of eagle observations and 43.6% of buteo observations recorded at this height. Shorebirds, doves/pigeons, large corvids, and upland gamebirds were typically observed flying below the ZOR (Table 5). The majority of passerines within the 100-m plot were observed below the ZOR (99.8%), while 0.2% were recorded within the ZOR and none were recorded above the ZOR (Table 5).

Of all large bird species, five species had at least 25 groups observed flying; golden eagle was the most commonly observed species flying within the likely ZOR based on initial observations (45.0%; Table 6a). Three species were always seen flying within the likely ZOR based on initial; observations; however, these were based on only one or two observations. Of all passerine and small bird species, four species had at least 30 groups observed flying, with only one species, horned lark, recorded flying within the ZOR based on initial observations (Table 6b).

Bird Exposure Index

A relative exposure index was calculated for each bird species (Tables 6a and 6b). Common raven (0.09) and golden eagle (0.06) had exposure indices higher than any other species. All other raptor species had an exposure index of 0.02 or less (Table 6a). The passerine species with the highest exposure index was horned lark, with an index of less than 0.01 (Table 6b). All identified small birds had exposure indices of zero because they were not observed flying within the ZOR based on initial observations.

Spatial Use

For all large bird species combined, use was highest at point 12 (3.18 birds/20-min survey). Bird use at other points ranged from 0.32 to 2.55 birds/20-min survey (Figure 5). The high mean use estimate for point 12 was largely due to high use at this point by large corvids (2.50 birds/20-min survey), and use by large corvids at the remaining points ranged from zero to 1.05 birds/20-min survey. Waterbird use was highest at point 16, with 0.67 birds/20-min survey, and were only observed at one other point (point one; 0.07 birds/20-min survey). Mean shorebird use was only recorded at point 17, with 0.17 birds/20-min survey at this point. Raptor use was highest at point four (0.93 birds/20-min survey), and ranged from 0.10 to 0.83 birds/20-min survey at other points. Vultures were only seen at points six and eleven (0.03 and 0.04 birds/20-min survey, respectively). Upland gamebird use was highest at point 13 (0.14 birds/20-min survey), and ranged from zero to 0.09 bird/20-min survey at other points. Passerine use was highest at point 13 (5.10 birds/20-min survey), and ranged from 1.81 to 4.70 at other points (Figure 5).

Flight paths for waterbirds, waterfowl, shorebirds, raptors, and vultures were digitized and mapped (Figures 6a-f). No obvious flyways or concentration areas were observed for any species. The available data do not indicate that any portions of the study area warrant being excluded from development due to very high bird use.

Sensitive Species Observations

Ten sensitive bird species totaling 269 individuals in 215 groups were observed during fixed-point bird use surveys (Tables 3 and 7). As with all avian surveys, this is a tally that in some cases may represent repeated observations of the same individual. The greater sage-grouse has been petitioned for listing as a federal threatened species (ECOS 2009). A total of 28 greater sage-grouse were recorded during fixed-point bird use surveys within the CSMWRA (Table 7). The greater sage-grouse is also a Wyoming Native Species Status (NSS) 2 species. Nine other NSS2, NSS3, or NSS4 species (WGFD 2005; WYNDD 2009) were also recorded during fixed-point surveys. The most abundant sensitive species recorded during fixed-point surveys were Brewer's sparrow (80 observations), sage thrasher (65), and sage sparrow (*Amphispiza belli*; 59).

Incidental Wildlife Observations

There were 12 bird species observed incidentally, totaling 270 individuals within 157 separate groups during the study (Table 8). Four mammal species totaling 3,083 individuals in 304 groups were also observed incidentally at the CSMWRA.

Bird Observations

The most abundant bird species recorded as an incidental wildlife observation were greater sage-grouse (123 observations), golden eagle (52 observations), and northern harrier (*Circus cyaneus*; 38 observations). All other bird species recorded incidentally had less than 20 observations (Table 8). Three bird species, American goldfinch (*Carduelis tristis*), burrowing owl (*Athene cunicularia*), and snow bunting (*Plectrophenax nivalis*), were only observed incidentally and were not observed during fixed-point surveys.

Mammal Observations
The most commonly recorded mammal species in the CSMWRA was pronghorn antelope (*Antilocapra americana*) with 2,879 observations in 285 groups (Table 8). Three additional mammal species were also recorded incidentally: elk (*Cervus elephus*; 189 observations), mule deer (*Odocoileus hemionus*; 10), and white-tailed prairie dog (*Cynomys leucurus*; five).

Sensitive Species Observations
Six sensitive species totaling 146 individuals in 49 groups were recorded during incidental observations (Table 7; WGFD 2005; ECOS 2009; WYNDD 2009). A total of 123 greater sage-grouse in 29 groups were recorded incidentally within the CSMWRA. All other sensitive bird species, classified as NSS2, NSS3, or NSS4 species, had ten or fewer observations recorded. One sensitive mammal species, the white-tailed prairie dog (NSS4), was also observed incidentally, with a total of five individuals observed in one group.

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 study area or with migrant birds seasonally moving through the study area. Project construction could affect birds through loss of habitat, or potential fatalities from construction equipment. Impacts from the decommissioning of the facility are anticipated to be similar to construction in terms of noise, disturbance, and equipment. Potential mortality from construction equipment is expected to be very low. Equipment used in wind-energy facility construction generally moves at slow rates or is stationary for long periods (e.g., cranes). The risk of direct mortality to birds from construction is most likely potential destruction of a nest for ground- and shrub-nesting species during initial site clearing.

Substantial data on bird mortality at wind-energy facilities are available from studies in California and throughout the West and Midwest. Of 841 bird fatalities reported from California studies (>70% from the Altamont Pass facility in California), about 39% were diurnal raptors, about 19% were passerines (excluding house sparrows [*Passer domesticus*] and European starlings [*Sturnus vulgaris*]), and about 12% were owls. Non-protected birds, including house sparrows, European starlings, and rock pigeons (*Columba livia*) comprised about 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 about 2% of the wind-energy facility-related fatalities and raptor mortality averaged 0.03 fatalities/turbine/year. Passerines (excluding house sparrows and European starlings) were the most common collision victims, comprising about 82% of the 225 fatalities documented. For all bird species combined, estimates of the number of bird fatalities per turbine per year from individual studies ranged from zero at the Searsburg wind-energy facility in Vermont (Kerlinger 1997) and the Algona facility in Iowa (Demastes and Trainer 2000), to 7.7 at the Buffalo Mountain facility in Tennessee (Nicholson 2003). Using mortality data from a 10-year period from wind-energy facilities throughout the entire United States, the average number of bird collision fatalities is 3.1 fatalities/MW/year, or 2.3 fatalities/turbine/year (NWCC 2004).

<u>Raptor Use and Exposure Risk</u>

The annual mean raptor use at the CSMWRA (0.46 raptors/plot/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 to 2.34 raptors/plot/20-min survey (Figure 7). Based on the results from these wind-energy facilities, a ranking of seasonal raptor mean use was developed as: low (0 – 0.5 raptors/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 (number of raptors divided by the number of 800-m plots and the total number of surveys) at the CSMWRA is considered to be low, with the CSMWRA ranking twenty-second when compared with the 36 other wind-energy facilities (Figure 7).

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

Exposure indices analysis may also provide insight into what species have a higher likelihood of turbine casualties. The index considers relative probability of exposure based on abundance, proportion of daily 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 CSMWRA, the raptor species with the highest exposure index was the golden eagle, which was ranked second of all species, at 0.06 (Table 6a). The relatively higher exposure index for golden eagle was due to flight height data showing that 45.0% of flying observations were within the ZOR based on initial observations. 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. Based on species composition of the most common raptor fatalities at other western wind-energy facilities and species composition of raptors observed at the Chokecherry-Sierra Madre Wind Resource Area during the surveys, the majority of the fatalities of diurnal raptors will likely consist of red-tailed hawk, American kestrel, and golden eagle. Based on the seasonal use estimates, it is expected that risk to raptors would be unequal across seasons, with the lowest risk in the winter and the highest risk during the fall. However, the winter use estimates were only based on three surveys that were completed prior to the area becoming inaccessible due to snow. Therefore, winter use as based on these three surveys may not be representative of actual use throughout the entire winter, but is the best data available for predicting winter use of the study area by raptors.

A regression analysis of raptor use and mortality for 13 new-generation wind-energy facilities, where similar methods were used to estimate raptor use and mortality, found that there was a significant correlation between use and mortality (R^2 = 69.9%; Figure 8). Using this regression to predict raptor collision mortality at the CSMWRA, based on an adjusted mean raptor use of 0.46 raptors/plot/20-min survey, yields an estimated fatality rate of 0.04 fatalities/MW/year. A 90% prediction interval around this estimate is zero to 0.30 fatalities/MW/year. The estimate of 0.04 raptor fatalities/MW/year would equate to an estimate of 80 raptor fatalities per year for a 2,000-MW development. These fatalities would be spread over several species, seasons, and between resident and migrant birds. Nevertheless, this level of fatality might result in a measurable adverse effect on the demographics of the local population of golden eagles.

Non-Raptor Use and Exposure Risk

Most bird species in the US are protected by the Migratory Bird Treaty Act (MBTA 1918). Passerines (primarily perching birds) have been the most abundant bird fatality at wind energy facilities outside California (Erickson et al. 2001a, 2002b), often comprising more than 80% of the bird fatalities. Both migrant and resident passerine fatalities have been observed. Given that passerines made up a large proportion of the birds observed during the baseline study, passerines would be expected to make up the largest proportion of fatalities at the CSMWRA. Exposure indices, based on observations within 100 m, indicate that horned lark is the most likely passerine to be exposed to collision from wind turbines at the CSMWRA (Table 6b). Most non-raptors 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 CSMWRA, it is unlikely that non-raptor populations will be adversely affected by direct mortality from the operation of the wind-energy facility.

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 facilities by these groups. Of 1,033 bird carcasses collected at US wind-energy facilities, waterbirds comprised about 2%, waterfowl comprised about 3%, and shorebirds comprised less than 1% (Erickson et al. 2002b). At the Klondike, Oregon wind-energy facility, only two Canada goose (*Branta canadensis*) fatalities were documented (Johnson et al. 2003) even though 43 groups totaling 4,845 individual Canada geese were observed during pre-construction surveys (Johnson et al. 2002a). The recently constructed Top of Iowa wind-energy facility is located in cropland between three Wildlife Management Areas (WMAs) with historically high bird use, including migrant and resident waterfowl. During a recent study, approximately one million goose-use days and 120,000 duck-use days were recorded in the WMAs during the fall and early winter, and no waterfowl fatalities were documented during concurrent and standardized wind-energy facility fatality studies (Jain 2005). Similar findings were observed at the Buffalo Ridge wind-energy facility in southwestern Minnesota, which is located in an area with relatively high waterfowl/waterbird use and some shorebird use. Snow geese (*Chen caerulescens*), 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 two mallards and one 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, waterbirds and shorebirds do not seem especially vulnerable to turbine collisions and significant impacts are not likely.

<u>Sensitive Species Use and Exposure Risk</u>
No federally-listed threatened or endangered species were observed in the CSMWRA during fixed-point bird use surveys (Table 3) or incidentally (Table 8). Thirty-five groups totaling 151 greater sage-grouse were observed (Table 7). This species has been petitioned for listing under the Endangered Species Act (ESA 1973), with a determination expected in February 2010; the greater sage-grouse is also classified by the Wyoming Game and Fish Department (WGFD) as NSS2. Ten other bird species considered sensitive (NSS) by the WGFD were also observed within the CSMWRA. Wyoming sensitive species of most concern are those classified as NSS1 or NSS2. No NSS1 bird species were observed and the only NSS2 species observed was bald eagle (*Haliaeetus leucocephalus*), with a total of six individuals recorded (Table 7). Due to very low use of the CSMWRA by bald eagle, it is unlikely that significant collision mortality would occur. Of those species classified as NSS3 or NSS4, the most frequently observed bird species were Brewer's sparrow (80 individuals), sage thrasher (65), and sage sparrow (59). As with all of the avian surveys, these are tallies that in some cases represent repeated observations of the same individuals. Brewer's sparrows, sage thrashers, and sage sparrows were never observed flying within the turbine ZOR. Therefore, significant risk of collision mortality is not expected for these species. Use of the CSMWRA by the other sensitive species recorded was relatively low and no significant direct impacts are likely to occur.

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. 1996). However, one study conducted in England to assess displacement of wintering farmland birds by wind turbines located in an agricultural landscape found that only common (ring-necked) pheasants (*Phasianus colchicus*) apparently avoided turbines. 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).

The greatest concern with displacement impacts for wind-energy facilities in the US has been where these facilities have been constructed in grassland or other native habitats (Leddy et al. 1999; Mabey and Paul 2007), While 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. Birds displaced from wind-energy facilities might move to areas with fewer disturbances, but with lower quality habitat, 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. 2000a, 2003; 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 (less than 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 square miles (mi^2; 262 km^2) of land surrounding a wind-energy facility was 5.94 nests/39 mi^2 (5.94 nests/101 km^2), yet no nests were present in the 12 mi^2 (31 km^2) 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 nests 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 study area at approximately the same levels after construction, and several nests were located within 0.5 miles (0.8 km) 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 miles (0.5 km) of the turbine strings, and seven red-tailed hawk nests, one great horned owl (*Bubo virginianus*) nest, and one golden eagle nest were located within one mile (1.6 km) of the wind-energy facility successfully fledged young (Johnson et al. 2000b). The golden eagle pair successfully nested 0.5 mile from the facility for three different years after it became operational. A Swainson's hawk also nested within 0.25 mile (0.4 km) of a turbine string at the Klondike I wind-energy facility in Oregon after the facility was operational (Johnson et al. 2003). These observations suggest that there will be limited nesting displacement of raptors at the CSMWRA, although the creation of a buffer surrounding known nests when siting turbines will further reduce any potential disturbance impact, and perhaps reduce the risk of collisions with turbines.

Displacement of Non-Raptor Bird Species

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

Construction also reduces habitat effectiveness because of the presence of access roads and large gravel pads surrounding turbines (Leddy 1996; Johnson et al. 2000a). 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 180 m (591 feet) 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 50 m (164 feet) of turbine strings, but areas further away from turbine strings did not have reduced bird use.

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 (Winkelman 1990; Pedersen and Poulsen 1991). 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 100 m of the turbines. Disturbance tends to be greatest for migrating birds while feeding and resting (Crockford 1992; NRC 2007).

Much debate has occurred recently regarding the potential impacts of wind-energy facilities on prairie grouse, including greater sage-grouse. Under a set of voluntary guidelines, the US Fish and Wildlife Service (USFWS) has taken a precautionary approach and recommends wind turbines be placed at least five miles (eight km) from known prairie grouse lek locations (USFWS 2003). The USFWS argues that because prairie grouse evolved in habitats with little vertical structure, placement of tall man-made structures, such as wind turbines, in occupied prairie grouse habitat may result in a decrease in habitat suitability (USFWS 2004). While the potential exists for wind turbines to displace greater sage-grouse from occupied habitat, well-designed studies examining the potential impacts of wind turbines on prairie grouse are currently lacking. Ongoing research conducted by Kansas State University to examine response of greater prairie-chickens (*Tympanuchus cupido*) to wind-energy development in Kansas, and by WEST, Inc. to examine response of greater sage-grouse to wind-energy development in Wyoming, will help address the potential for impacts to prairie grouse.

CONCLUSIONS AND RECOMMENDATIONS

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

Currently, few published studies are available from the western US that compare bird use to bird mortality rates. Based on research conducted at wind-energy facilities throughout the US, raptor use at the CSMWRA is generally lower than levels recorded at other wind-energy facilities. Raptor fatality rates are expected to be within the range of fatality rates observed at other facilities where raptor use levels are lower. To date, no relationships have been observed between overall use by other bird types, and fatality rates of those bird types at wind-energy facilities. However, the flight characteristics and foraging habits of some species may result in increased exposure for these species at the CSMWRA. The surveys conducted for the proposed CSMWRA also do not address the impacts of the proposed facility to nocturnal migrants, such as passerines. To date, overall fatality rates for birds (including nocturnal migrants) at wind-energy facilities have been relatively low and consistent in the West. As more research is conducted at facilities in the West, more information regarding the potential direct impacts of wind-energy facilities to bird species will be obtained.

The proposed wind-energy facility is comprised of native habitats such as scrub-shrub and grasslands (Table 1, Figure 3). Several species considered to be sensitive were observed breeding within these habitats at the CSMWRA, and some potential exists for wind turbines to displace breeding birds. Research concerning displacement impacts to passerines, waterfowl, and waterbirds associated with wind-energy facilities is limited, but some studies show the potential for small scale (200 m [656 ft] or less) displacement, while impacts to densities of birds at larger scales have not been shown.

REFERENCES

Anderson, R., M. Morrison, K. Sinclair, and D. Strickland. 1999. Studying Wind Energy/Bird Interactions: A Guidance Document. Metrics and Methods for Determining or Monitoring Potential Impacts on Birds at Existing and Proposed Wind Energy Sites. Prepared for the Avian Subcommittee and National Wind Coordinating Committee (NWCC). December 1999. National Wind Coordinating Committee/RESOLVE. Washington, D.C. 87 pp. http://www.nationalwind.org/publications/wildlife/avian99/Avian_booklet.pdf

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. Joint Nature Conservancy Committee (JNCC) Report No. 27. JNCC. 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.

Endangered Species Act (ESA). 1973. 16 United States Code § 1531-1544. December 28, 1973.

Environmental Conservation Online System (ECOS). 2009. US Fish and Wildlife Service (USFWS) Threatened and Endangered Species System (TESS). USFWS Endangered Species Program Homepage: http://www.fws.gov/endangered/ ECOS: http://ecos.fws.gov/tess_public

Erickson, W.P., D.P. Young, Jr., G. Johnson, J. Jeffrey, K. Bay, R. Good, and H. Sawyer. 2003a. 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.

Erickson, W.P., J. Jeffrey, D.P. Young, Jr., K. Bay, R. Good, K. Sernka, and K. Kronner. 2003b. 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., 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), Pendleton, 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., 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, D.P. Young, Jr., 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., 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., 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.

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.

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.

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. and W.P. Erickson. 2004. Analysis of Potential Wildlife/Wind Plant Interactions, Bighorn Site, Klickitat County, Washington. Prepared for CH2M HILL, Portland, Oregon by WEST, Inc., Cheyenne, Wyoming. August 2004.

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, and J. White. 2003. Avian and Bat Mortality During the First Year of Operation at the Klondike Phase I Wind Project, Sherman County, Oregon. March 2003. Technical report prepared for Northwestern Wind Power, Goldendale, Washington, by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming. http://www.west-inc.com

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., D.P. Young, 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 and http://www.west-inc.com/reports/fcr_final_baseline.pdf

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. 2005. Summary of Bird Studies and Collision Rates at Wind Power Projects. Rebuttal testimony of Paul Kerlinger for the East Haven Windfarm. February 9, 2005. http://easthavenwindfarm.com/filing/feb/ehwf-pk-reb1.pdf

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.

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.

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 Windfarm at Blyth Harbour, Northumberland, UK. *In*: Birds and Windfarms: Risk Assessment and Mitigation. M. J. de Lucas, G. F. E. Janss, and M. Ferrer, eds. Quercus, Madrid, Spain. 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. www.nap.edu

National Wind Coordinating Committee (NWCC). 2004. Wind Turbine Interactions with Birds and Bats: A Summary of Research Results and Remaining Questions. Fact Sheet. 2nd 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, Pendleton, 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, Pendleton, 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.

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, Contra 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.

US Fish and Wildlife Service (USFWS). 2003. Interim Guidelines to Avoid and Minimize Wildlife Impacts from Wind Turbines. May 13, 2003. USFWS. Washington, D.C. http://www.fws.gov/habitatconservation/wind.pdf

US Fish and Wildlife Service (USFWS). 2004. Prairie Grouse Leks and Wind Turbines: US Fish and Wildlife Service Justification for a 5-Mile Buffer from Leks; Additional Grassland Songbird Recommendations. An unpublished briefing paper.

US Geological Survey (USGS) National Land Cover Database (NLCD). 2001. Land Use/Land Cover NLCD Data. USGS Headquarters, USGS National Center. Reston, Virginia.

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.

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, United Kingdom.

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.

Wyoming Game and Fish Department (WGFD). 2005. Avian Species of Special Concern in Wyoming. WGFD Nongame Species of Special Concern (SSC)-Native Status Species (NSS). January 2005. WGFD. Cheyenne, Wyoming. http://gf.state.wy.us/wildlife/nongame/SpeciesofSpecialConcern/index.asp

Wyoming Natural Diversity Database (WYNND). 2009. Codes and Definitions. Last updated January 22, 2009. Homepage: http://uwadmnweb.uwyo.edu/wyndd/ Codes and Definitions: http://uwadmnweb.uwyo.edu/wyndd/infoprint.asp?p=2656

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, 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. 2003c. 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. http://www.co.shasta.ca.us/Departments/Resourcemgmt/drm/Hatchet%20Ridge/DEIR/App_C-1.pdf

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 land cover types, coverage, and composition within the Chokecherry-Sierra Madre Wind Resource Area.

Habitat	Acres	% Composition
Scrub-Shrub	171,092.00	76.9
Grassland	42,948.20	19.3
Evergreen Forest	3,067.66	1.4
Deciduous Forest	1,607.75	0.7
Emergent Wetlands	1,222.09	0.6
Barren	948.87	0.4
Woody Wetlands	386.59	0.2
Developed, Open Space	385.12	0.2
Open Water	383.29	0.2
Pasture/Hay	332.81	0.2
Developed, Low Intensity	154.4	0.1
Mixed Forest	44.33	<0.1
Developed, Medium Intensity	25.25	<0.1
Developed, High Intensity	4.88	<0.1
Total	**222,603.24**	**100**

Data from the National Landcover Database (USGS NLCD 2001).

Table 2. Summary of species richness (species/plot[a]/20-min survey), and sample size by season and overall during the fixed-point bird use surveys at the Chokecherry-Sierra Madre Wind Resource Area, June 26, 2008 – June 16, 2009.

Season	Number of Visits	# Surveys Conducted	# Unique Species	Species Richness	
				Large Birds	Small Birds
Summer	9	142	32	0.60	2.05
Fall	9	142	25	0.81	0.43
Winter	3	31	6	0.40	0.02
Spring	10	118	36	0.61	1.62
Overall	**31**	**433**	**50**	**0.63**	**1.19**

[a] 800-m radius for large birds and 100-m radius for small birds.

Table 3. Total number of individuals and groups for each bird type and species[a], by season and overall, during the fixed-point bird use surveys at the Chokecherry-Sierra Madre Wind Resource Area[a] , June 26, 2008 – June 16, 2009.

		Summer		Fall		Winter		Spring		Total	
Species/Type	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Waterbirds		**0**	**0**	**0**	**0**	**0**	**0**	**2**	**16**	**2**	**16**
American white pelican	*Pelecanus erythrorhyncos*	0	0	0	0	0	0	1	14	1	14
great blue heron	*Ardea herodias*	0	0	0	0	0	0	1	2	1	2
Shorebirds		**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**
killdeer	*Charadrius vociferus*	0	0	0	0	0	0	1	1	1	1
Raptors		**77**	**86**	**80**	**88**	**3**	**3**	**51**	**53**	**211**	**230**
Accipiters		*0*	*0*	*5*	*5*	*0*	*0*	*1*	*1*	*6*	*6*
Cooper's hawk	*Accipiter cooperii*	0	0	2	2	0	0	0	0	2	2
sharp-shinned hawk	*Accipter striatus*	0	0	1	1	0	0	1	1	2	2
unidentified accipiter		0	0	2	2	0	0	0	0	2	2
Buteos		*23*	*26*	*20*	*21*	*1*	*1*	*11*	*12*	*55*	*60*
ferruginous hawk	*Buteo regalis*	1	1	2	2	1	1	1	1	5	5
red-tailed hawk	*Buteo jamaicensis*	14	16	6	6	0	0	7	8	27	30
rough-legged hawk	*Buteo lagopus*	0	0	9	9	0	0	2	2	11	11
Swainson's hawk	*Buteo swainsoni*	7	8	0	0	0	0	1	1	8	9
unidentified buteo		1	1	3	4	0	0	0	0	4	5
Northern Harrier		*15*	*15*	*19*	*22*	*0*	*0*	*5*	*5*	*39*	*42*
northern harrier	*Circus cyaneus*	15	15	19	22	0	0	5	5	39	42
Eagles		*17*	*19*	*33*	*37*	*2*	*2*	*13*	*14*	*65*	*72*
bald eagle	*Haliaeetus leucocephalus*	0	0	0	0	0	0	2	2	2	2
golden eagle	*Aquila chrysaetos*	17	19	32	36	2	2	11	12	62	69
unidentified eagle		0	0	1	1	0	0	0	0	1	1
Falcons		*22*	*26*	*3*	*3*	*0*	*0*	*20*	*20*	*45*	*49*
American kestrel	*Falco sparverius*	21	25	2	2	0	0	16	16	39	43
prairie falcon	*Falco mexicanus*	1	1	1	1	0	0	4	4	6	6
Other Raptors		*0*	*0*	*0*	*0*	*0*	*0*	*1*	*1*	*1*	*1*
osprey	*Pandion haliaetus*	0	0	0	0	0	0	1	1	1	1

Table 3. Total number of individuals and groups for each bird type and species[a], by season and overall, during the fixed-point bird use surveys at the Chokecherry-Sierra Madre Wind Resource Area[a] , June 26, 2008 – June 16, 2009.

		Summer		Fall		Winter		Spring		Total	
Species/Type	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Vultures		**0**	**0**	**1**	**1**	**0**	**0**	**1**	**1**	**2**	**2**
turkey vulture	*Cathartes aura*	0	0	1	1	0	0	1	1	2	2
Upland Gamebirds		**0**	**0**	**1**	**2**	**3**	**24**	**2**	**2**	**6**	**28**
greater sage grouse	*Centrocercus urophasianus*	0	0	1	2	3	24	2	2	6	28
Doves/Pigeons		**8**	**10**	**0**	**0**	**0**	**0**	**0**	**0**	**8**	**10**
mourning dove	*Zenaida macroura*	8	10	0	0	0	0	0	0	8	10
Large Corvids		**14**	**65**	**62**	**105**	**9**	**15**	**30**	**60**	**115**	**245**
American crow	*Corvus brachyrhynchos*	4	49	0	0	0	0	2	16	6	65
black-billed magpie	*Pica pica*	0	0	2	3	2	2	0	0	4	5
common raven	*Corvus corax*	10	16	60	102	7	13	28	44	105	175
Passerines		**467**	**600**	**95**	**255**	**2**	**4**	**379**	**588**	**943**	**1,447**
American robin	*Turdus migratorius*	1	1	0	0	0	0	0	0	1	1
barn swallow	*Hirundo rustica*	0	0	0	0	0	0	2	2	2	2
Brewer's blackbird	*Euphagus cyanocephalus*	8	9	0	0	0	0	2	26	10	35
Brewer's sparrow	*Spizella breweri*	51	57	5	5	0	0	14	18	70	80
Clark's nutcracker	*Nucifraga columbiana*	1	1	0	0	0	0	0	0	1	1
cliff swallow	*Petrochelidon pyrrhonota*	0	0	0	0	0	0	1	1	1	1
grasshopper sparrow	*Ammodramus savannarum*	0	0	0	0	0	0	4	4	4	4
green-tailed towhee	*Pipilo chlorurus*	1	1	0	0	0	0	0	0	1	1
horned lark	*Eremophila alpestris*	177	264	48	172	1	1	224	368	450	805
house wren	*Troglodytes aedon*	8	13	3	3	0	0	0	0	11	16
lark bunting	*Calamospiza melanocorys*	3	3	0	0	0	0	1	12	4	15
lark sparrow	*Chondestes grammacus*	0	0	2	2	0	0	0	0	2	2
Lincoln's sparrow	*Melospiza lincolnii*	0	0	0	0	0	0	2	2	2	2
loggerhead shrike	*Lanius ludovicianus*	2	2	0	0	0	0	2	2	4	4
mountain bluebird	*Sialia currucoides*	3	4	4	16	0	0	7	14	14	34
rock wren	*Salpinctes obsoletus*	7	7	0	0	0	0	4	6	11	13
sage sparrow	*Amphispiza belli*	7	7	0	0	0	0	48	52	55	59

Table 3. Total number of individuals and groups for each bird type and species[a], by season and overall, during the fixed-point bird use surveys at the Chokecherry-Sierra Madre Wind Resource Area[a] , June 26, 2008 – June 16, 2009.

		Summer		Fall		Winter		Spring		Total	
Species/Type	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
sage thrasher	*Oreoscoptes montanus*	52	55	2	2	0	0	6	8	60	65
Say's phoebe	*Sayornis saya*	1	1	0	0	0	0	1	1	2	2
song sparrow	*Melospiza melodia*	0	0	2	3	0	0	0	0	2	3
Townsend's solitaire	*Myadestes townsendi*	0	0	1	1	0	0	0	0	1	1
tree swallow	*Tachycineta bicolor*	3	3	0	0	0	0	0	0	3	3
unidentified blackbird		0	0	1	4	0	0	0	0	1	4
unidentified passerine		28	43	16	30	1	3	1	6	46	82
unidentified sparrow		9	9	3	5	0	0	0	0	12	14
unidentified swallow		4	4	0	0	0	0	0	0	4	4
unidentified wren		2	2	0	0	0	0	0	0	2	2
vesper sparrow	*Pooecetes gramineus*	65	79	3	4	0	0	32	38	100	121
western kingbird	*Tyrannus verticalis*	1	1	1	1	0	0	0	0	2	2
western meadowlark	*Sturnella neglecta*	33	34	4	7	0	0	28	28	65	69
Other Birds		**10**	**22**	**0**	**0**	**0**	**0**	**3**	**4**	**13**	**26**
common nighthawk	*Chordeiles minor*	5	6	0	0	0	0	0	0	5	6
northern flicker	*Colaptes auratus*	1	1	0	0	0	0	1	1	2	2
unidentified hummingbird		2	2	0	0	0	0	0	0	2	2
white-throated swift	*Aeronautes saxatalis*	2	13	0	0	0	0	2	3	4	16
Overall		**576**	**783**	**239**	**451**	**17**	**46**	**469**	**725**	**1,301**	**2,005**

[a] Regardless of distance from observer.

Table 4a. Mean bird use (number of birds/800-plot/20-min survey), percent of total composition (%), and frequency of occurrence (%) for each large bird type and species by season during the fixed-point bird use surveys at the Chokecherry-Sierra Madre Wind Resource Area, June 26, 2008 – June 16, 2009.

	Use				% Composition				% Frequency			
Species/Type	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**
Waterbirds	**0**	**0**	**0**	**0.10**	**0**	**0**	**0**	**10.5**	**0**	**0**	**0**	**1.4**
American white pelican	0	0	0	0.09	0	0	0	9.0	0	0	0	0.6
great blue heron	0	0	0	0.02	0	0	0	1.6	0	0	0	0.8
Shorebirds	**0**	**0**	**0**	**0.01**	**0**	**0**	**0**	**0.8**	**0**	**0**	**0**	**0.8**
killdeer	0	0	0	0.01	0	0	0	0.8	0	0	0	0.8
Raptors	**0.58**	**0.62**	**0.17**	**0.35**	**53.1**	**45.2**	**27.9**	**36.1**	**37.2**	**36.8**	**16.7**	**28.6**
Accipiters	*0*	*0.03*	*0*	*0.01*	*0*	*2.3*	*0*	*0.6*	*0*	*2.4*	*0*	*0.6*
Cooper's hawk	0	0.01	0	0	0	0.8	0	0	0	1.0	0	0
sharp-shinned hawk	0	0.01	0	0.01	0	0.5	0	0.6	0	0.7	0	0.6
unidentified accipiter	0	0.01	0	0	0	1.0	0	0	0	1.4	0	0
Buteos	*0.18*	*0.15*	*0.03*	*0.08*	*16.8*	*11.1*	*4.7*	*8.0*	*14.1*	*8.7*	*2.8*	*7.3*
ferruginous hawk	0.01	0.01	0.03	0.01	0.7	1.0	4.7	1.5	0.7	1.4	2.8	1.4
red-tailed hawk	0.11	0.04	0	0.04	10.3	3.1	0	3.9	8.4	2.9	0	3.8
rough-legged hawk	0	0.07	0	0.02	0	4.8	0	2.0	0	5.1	0	2.0
Swainson's hawk	0.06	0	0	0.01	5.2	0	0	0.6	4.9	0	0	0.6
unidentified buteo	0.01	0.03	0	0	0.6	2.2	0	0	0.7	2.2	0	0
Northern Harrier	*0.10*	*0.16*	*0*	*0.03*	*9.0*	*11.5*	*0*	*3.3*	*8.3*	*10.1*	*0*	*2.4*
northern harrier	0.10	0.16	0	0.03	9.0	11.5	0	3.3	8.3	10.1	0	2.4
Eagles	*0.11*	*0.26*	*0.14*	*0.08*	*10.4*	*19.1*	*23.3*	*8.3*	*9.6*	*20.3*	*13.9*	*6.1*
bald eagle	0	0	0	0.01	0	0	0	1.3	0	0	0	1.3
golden eagle	0.11	0.25	0.14	0.07	10.4	18.5	23.3	7.0	9.6	19.6	13.9	5.4
unidentified eagle	0	0.01	0	0	0	0.5	0	0	0	0.7	0	0
Falcons	*0.18*	*0.02*	*0*	*0.15*	*16.8*	*1.3*	*0*	*15.2*	*14.0*	*1.8*	*0*	*13.4*
American kestrel	0.18	0.01	0	0.12	16.2	0.8	0	12.1	13.3	1.1	0	11.1
prairie falcon	0.01	0.01	0	0.03	0.6	0.5	0	3.1	0.7	0.7	0	3.0
Other Raptors	*0*	*0*	*0*	*0.01*	*0*	*0*	*0*	*0.6*	*0*	*0*	*0*	*0.6*
osprey	0	0	0	0.01	0	0	0	0.6	0	0	0	0.6

Table 4a. Mean bird use (number of birds/800-plot/20-min survey), percent of total composition (%), and frequency of occurrence (%) for each large bird type and species by season during the fixed-point bird use surveys at the Chokecherry-Sierra Madre Wind Resource Area, June 26, 2008 – June 16, 2009.

	Use				% Composition				% Frequency			
Species/Type	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**
Vultures	**0**	**0.01**	**0**	**0.01**	**0**	**0.5**	**0**	**0.8**	**0**	**0.7**	**0**	**0.8**
turkey vulture	0	0.01	0	0.01	0	0.5	0	0.8	0	0.7	0	0.8
Upland Gamebirds	**0**	**0.01**	**0.09**	**0.06**	**0**	**1.1**	**15.1**	**5.9**	**0**	**0.7**	**4.9**	**5.8**
greater sage grouse	0	0.01	0.09	0.06	0	1.1	15.1	5.9	0	0.7	4.9	5.8
Doves/Pigeons	**0.07**	**0**	**0**	**0**	**6.4**	**0**	**0**	**0**	**4.9**	**0**	**0**	**0**
mourning dove	0.07	0	0	0	6.4	0	0	0	4.9	0	0	0
Large Corvids	**0.44**	**0.73**	**0.34**	**0.45**	**40.5**	**53.2**	**57.0**	**45.9**	**7.7**	**29.7**	**16.0**	**20.5**
black-billed magpie	0	0.02	0.05	0	0	1.7	8.1	0	0	1.5	4.9	0
common raven	0.10	0.71	0.29	0.34	9.1	51.5	48.8	35.1	5.7	29.0	13.9	19.1
American crow	0.34	0	0	0.11	31.4	0	0	10.8	2.1	0	0	1.4
Overall	**1.08**	**1.37**	**0.60**	**0.98**	**100**	**100**	**100**	**100**				

Table 4b. Mean use (number of birds/100-m plot/20-min survey), percent of total composition (%), and frequency of occurrence (%) for each small bird type and species by season during the fixed-point bird use surveys at the Chokecherry-Sierra Madre Wind Resource Area, June 26, 2008 – June 16, 2009.

	Use				% Composition				% Frequency			
Species/Type	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring
Passerines	**4.04**	**1.57**	**0.02**	**4.97**	**96.8**	**100.0**	**100.0**	**99.5**	**83.4**	**29.4**	**2.1**	**89.2**
American robin	0.01	0	0	0	0.2	0	0	0	0.7	0	0	0
barn swallow	0	0	0	0.02	0	0	0	0.3	0	0	0	1.6
Brewer's blackbird	0.06	0	0	0.14	1.4	0	0	2.7	4.3	0	0	1.1
Brewer's sparrow	0.39	0.03	0	0.12	9.4	1.8	0	2.4	24.1	1.7	0	7.6
Clark's nutcracker	0	0	0	0	0	0	0	0	0	0	0	0
cliff swallow	0	0	0	0.01	0	0	0	0.1	0	0	0	0.5
grasshopper sparrow	0	0	0	0.03	0	0	0	0.5	0	0	0	1.9
green-tailed towhee	0.01	0	0	0	0.2	0	0	0	0.7	0	0	0
horned lark	1.83	1.15	0.02	3.38	43.7	73.1	100.0	67.6	55.6	19.8	2.1	79.2
house wren	0.09	0.02	0	0	2.2	1.3	0	0	4.2	1.4	0	0
lark bunting	0.02	0	0	0.12	0.5	0	0	2.4	2.1	0	0	1.0
lark sparrow	0	0.01	0	0	0	0.9	0	0	0	0.7	0	0
Lincoln's sparrow	0	0	0	0.01	0	0	0	0.3	0	0	0	1.3
loggerhead shrike	0.01	0	0	0.01	0.2	0	0	0.3	0.7	0	0	0.6
mountain bluebird	0.01	0.11	0	0.19	0.4	6.7	0	3.8	1.5	2.5	0	9.4
rock wren	0.05	0	0	0.05	1.2	0	0	1.1	3.6	0	0	2.6
sage sparrow	0.05	0	0	0.37	1.2	0	0	7.5	4.4	0	0	20.6
sage thrasher	0.32	0.01	0	0.06	7.6	0.9	0	1.2	27.0	1.4	0	3.9
Say's phoebe	0.01	0	0	0.01	0.2	0	0	0.2	0.7	0	0	1.0
song sparrow	0	0.02	0	0	0	1.4	0	0	0	1.4	0	0
Townsend's solitaire	0	0.01	0	0	0	0.4	0	0	0	0.7	0	0
tree swallow	0.02	0	0	0	0.5	0	0	0	2.2	0	0	0
unidentified blackbird	0	0	0	0	0	0	0	0	0	0	0	0
unidentified passerine	0.29	0.10	0	0.03	6.8	6.3	0	0.6	14.8	6.4	0	0.5
unidentified sparrow	0.06	0.04	0	0	1.4	2.2	0	0	5.7	2.1	0	0
unidentified swallow	0.03	0	0	0	0.7	0	0	0	2.8	0	0	0

Table 4b. Mean use (number of birds/100-m plot/20-min survey), percent of total composition (%), and frequency of occurrence (%) for each small bird type and species by season during the fixed-point bird use surveys at the Chokecherry-Sierra Madre Wind Resource Area, June 26, 2008 – June 16, 2009.

	Use				% Composition				% Frequency			
Species/Type	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**
unidentified wren	0.01	0	0	0	0.2	0	0	0	0.7	0	0	0
vesper sparrow	0.56	0.03	0	0.23	13.4	1.8	0	4.6	26.2	2.1	0	11.5
western kingbird	0.01	0	0	0	0.2	0	0	0	0.7	0	0	0
western meadowlark	0.23	0.05	0	0.19	5.4	3.2	0	3.9	17.5	2.2	0	15.4
Other Birds	**0.13**	**0**	**0**	**0.03**	**3.2**	**0**	**0**	**0.5**	**4.4**	**0**	**0**	**2.0**
common nighthawk	0.01	0	0	0	0.3	0	0	0	1.4	0	0	0
northern flicker	0.01	0	0	0.01	0.2	0	0	0.2	0.8	0	0	0.8
unidentified hummingbird	0.01	0	0	0	0.3	0	0	0	0.7	0	0	0
white-throated swift	0.10	0	0	0.02	2.3	0	0	0.4	1.5	0	0	1.3
Overall	**4.18**	**1.57**	**0.02**	**5.00**	**100**	**100**	**100**	**100**				

Table 5. Flight height characteristics by bird type during fixed-point bird use surveys at the Chokecherry-Sierra Madre Wind Resource Area, June 26, 2008 – June 16, 2009. Large bird observations were limited to within 800 m and small birds were limited to within 100 m.

Bird Type	# Groups Flying	# Obs Flying	Mean Flight Height (m)	% Obs Flying	% within Flight Height Categories 0-35 m	35-130 m	> 130 m
Waterbirds	2	16	87.50	100	0	100	0
Shorebirds	1	1	10.00	100	100	0	0
Raptors	192	207	52.65	92.8	61.8	30.4	7.7
Accipiters	*6*	*6*	*23.33*	*100*	*66.7*	*33.3*	*0*
Buteos	*51*	*55*	*51.39*	*94.8*	*50.9*	*43.6*	*5.5*
Northern Harrier	*37*	*40*	*12.97*	*97.6*	*90.0*	*10.0*	*0*
Eagles	*57*	*62*	*106.75*	*91.2*	*35.5*	*45.2*	*19.4*
Falcons	*40*	*43*	*19.05*	*87.8*	*86.0*	*11.6*	*2.3*
Other Raptors	*1*	*1*	*20.00*	*100*	*100*	*0*	*0*
Vultures	2	2	27.50	100	50.0	50.0	0
Upland Gamebirds	4	6	2.25	75.0	100	0	0
Doves/Pigeons	4	5	4.25	50.0	100	0	0
Large Corvids	106	230	23.49	95.8	74.8	24.8	0.4
Large Birds Overall	**311**	**467**	**41.36**	**93.4**	**67.0**	**29.3**	**3.6**
Passerines	586	1,023	4.25	71.0	99.8	0.2	0
Other Birds	10	23	13.30	95.8	100	0	0
Small Birds Overall	**596**	**1,046**	**4.40**	**71.4**	**99.8**	**0.2**	**0**

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

Table 6a. Relative exposure index and flight characteristics by large bird species during the fixed-point bird use surveys at the Chokecherry-Sierra Madre Wind Resource Area, June 26, 2008 – June 16, 2009.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within ZOR based on initial obs	Exposure Index	% Within ZOR at anytime
common raven	98	0.35	95.9	27.6	0.09	42.9
golden eagle	55	0.14	92.3	45.0	0.06	68.3
American crow	5	0.14	98.5	18.8	0.03	18.8
American white pelican	1	0.02	100	100	0.02	100
red-tailed hawk	25	0.06	96.4	29.6	0.02	55.6
rough-legged hawk	11	0.02	100	72.7	0.02	100
Swainson's hawk	8	0.02	100	66.7	0.01	88.9
northern harrier	37	0.08	97.6	10.0	0.01	22.5
American kestrel	34	0.09	86.0	8.1	0.01	16.2
great blue heron	1	<0.01	100	100	<0.01	100
prairie falcon	6	0.01	100	33.3	<0.01	66.7
unidentified accipiter	2	<0.01	100	100	<0.01	100
ferruginous hawk	5	0.01	100	20.0	<0.01	20.0
unidentified buteo	2	0.01	60.0	33.3	<0.01	100
turkey vulture	2	<0.01	100	50.0	<0.01	50.0
bald eagle	2	<0.01	100	50.0	<0.01	50.0
greater sage grouse	4	0.03	75.0	0	0	0
mourning dove	4	0.02	50.0	0	0	0
black-billed magpie	3	0.01	60.0	0	0	0
sharp-shinned hawk	2	<0.01	100	0	0	0
Cooper's hawk	2	<0.01	100	0	0	0
killdeer	1	<0.01	100	0	0	0
unidentified eagle	0	<0.01	0	0	0	0
osprey	1	<0.01	100	0	0	100

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

Table 6b. Relative exposure index and flight characteristics for small birds during the fixed-point bird use surveys at the Chokecherry-Sierra Madre Wind Resource Area, June 26, 2008 – June 16, 2009.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within ZOR based on initial obs	Exposure Index	% Within ZOR at anytime
horned lark	381	1.78	89.1	0.1	<0.01	1.3
unidentified passerine	38	0.12	87.8	1.4	<0.01	1.4
vesper sparrow	39	0.25	38.8	0	0	2.1
Brewer's sparrow	39	0.16	55.0	0	0	0
western meadowlark	8	0.14	13.0	0	0	0
sage thrasher	10	0.12	15.4	0	0	0
sage sparrow	12	0.12	23.7	0	0	0
mountain bluebird	10	0.08	55.9	0	0	0
Brewer's blackbird	10	0.05	100	0	0	0
lark bunting	3	0.04	93.3	0	0	0
white-throated swift	4	0.04	100	0	0	87.5
house wren	2	0.03	31.3	0	0	0
rock wren	3	0.03	30.8	0	0	0
unidentified sparrow	11	0.03	92.9	0	0	0
unidentified swallow	4	0.01	100	0	0	25.0
tree swallow	3	0.01	100	0	0	0
grasshopper sparrow	0	0.01	0	0	0	0
song sparrow	1	0.01	33.3	0	0	0
loggerhead shrike	3	0.01	100	0	0	0
Say's phoebe	2	<0.01	100	0	0	0
northern flicker	1	<0.01	50.0	0	0	0
common nighthawk	3	<0.01	100	0	0	50.0
unidentified hummingbird	2	<0.01	100	0	0	0
barn swallow	2	<0.01	100	0	0	0
lark sparrow	1	<0.01	50.0	0	0	0
Lincoln's sparrow	1	<0.01	50.0	0	0	0
American robin	1	<0.01	100	0	0	0

Table 6b. Relative exposure index and flight characteristics for small birds during the fixed-point bird use surveys at the Chokecherry-Sierra Madre Wind Resource Area, June 26, 2008 – June 16, 2009.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within ZOR based on initial obs	Exposure Index	% Within ZOR at anytime
green-tailed towhee	0	<0.01	0	0	0	0
unidentified wren	0	<0.01	0	0	0	0
western kingbird	1	<0.01	50.0	0	0	0
Townsend's solitaire	0	<0.01	0	0	0	0
cliff swallow	1	<0.01	100	0	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 7. Summary of sensitive species observed at the Chokecherry-Sierra Madre Wind Resource Area during fixed-point bird use surveys (FP) and as incidental wildlife observations (Inc.), June 26, 2008 – June 16, 2009.

			FP		Inc.		Total	
Species	**Scientific Name**	**Status**	**# of grps**	**# of obs**	**# of grps**	**# of obs**	**# of grps**	**# of obs**
greater sage-grouse	*Centrocercus urophasianus*	NSS2, P	6	28	29	123	35	151
Brewer's sparrow	*Spizella breweri*	NSS4	70	80	0	0	70	80
sage thrasher	*Oreoscoptes montanus*	NSS4	60	65	0	0	60	65
sage sparrow	*Amphispiza belli*	NSS4	55	59	0	0	55	59
Swainson's hawk	*Buteo swainsoni*	NSS4	8	9	7	10	15	19
lark bunting	*Calamospiza melanocorys*	NSS4	4	15	0	0	4	15
ferruginous hawk	*Buteo regalis*	NSS3	5	5	8	8	13	13
bald eagle	*Haliaeetus leucocephalus*	NSS2	2	2	4	4	6	6
grasshopper sparrow	*Ammodramus savannarum*	NSS4	4	4	0	0	4	4
great blue heron	*Ardea herodias*	NSS4	1	2	0	0	1	2
burrowing owl	*Athene cunicularia*	NSS4	0	0	1	1	1	1
Bird Subtotal	**11 species**		**215**	**269**	**49**	**146**	**293**	**538**
white-tailed prairie dog	*Cynomys leucurus*	NSS4	0	0	1	5	1	5
Total	**12 species**		**215**	**269**	**50**	**151**	**294**	**543**

P= petitioned for Federal listing.
NSS1= Populations greatly restricted or declining, extirpation possible OR ongoing significant loss of habitat.
NSS2= Populations declining, extirpation possible; habitat restricted or vulnerable but no recent or ongoing significant loss; species likely sensitive to human disturbance OR populations declining or restricted in numbers or distribution, extirpation not imminent; ongoing significant loss of habitat.
NSS3= Populations greatly restricted or declining, extirpation possible; habitat not restricted, vulnerable but no loss; species not sensitive to human disturbance OR populations declining or restricted in numbers or distribution, extirpation not imminent; habitat restricted or vulnerable but no recent or ongoing significant loss; species likely sensitive to human disturbance OR species widely distributed; population status or trends unknown but suspected to be stable; on-going significant loss of habitat.
NSS4= Populations greatly restricted or declining, extirpation possible; habitat stable and not restricted OR populations declining or restricted in numbers or distribution, extirpation not imminent; habitat not restricted, vulnerable but no loss; species not sensitive to human disturbance OR species widely distributed, population status or trends unknown but suspected to be stable; habitat restricted or vulnerable but no recent or on-going significant loss; species likely sensitive to human disturbance OR populations stable or increasing and not restricted in numbers or distribution; on-going significant loss of habitat
(From Wyoming Game and Fish Department [WGFD 2005] and Wyoming's Natural Diversity Database [WYNDD 2009]).

Table 8. Incidental wildlife observed while conducting all surveys at the Chokecherry-Sierra Madre Wind Resource Area, June 26, 2008 – June 16, 2009.

Species	Scientific Name	#grps	# obs
American goldfinch	*Carduelis tristis*	1	1
bald eagle	*Haliaeetus leucocephalus*	4	4
burrowing owl	*Athene cunicularia*	1	1
ferruginous hawk	*Buteo regalis*	8	8
golden eagle	*Aquila chrysaetos*	44	52
greater sage-grouse	*Centrocercus urophasianus*	29	123
northern harrier	*Circus cyaneus*	34	38
prairie falcon	*Falco mexicanus*	8	8
red-tailed hawk	*Buteo jamaicensis*	14	18
rough-legged hawk	*Buteo lagopus*	6	6
snow bunting	*Plectrophenax nivalis*	1	1
Swainson's hawk	*Buteo swainsoni*	7	10
Bird Subtotal	**12 species**	**157**	**270**
elk	*Cervus elephus*	14	189
white-tailed prairie dog	*Cynomys leucurus*	1	5
mule deer	*Odocoileus hemionus*	4	10
pronghorn	*Antilocapra americana*	285	2,879
Mammal Subtotal	**4 species**	**304**	**3,083**

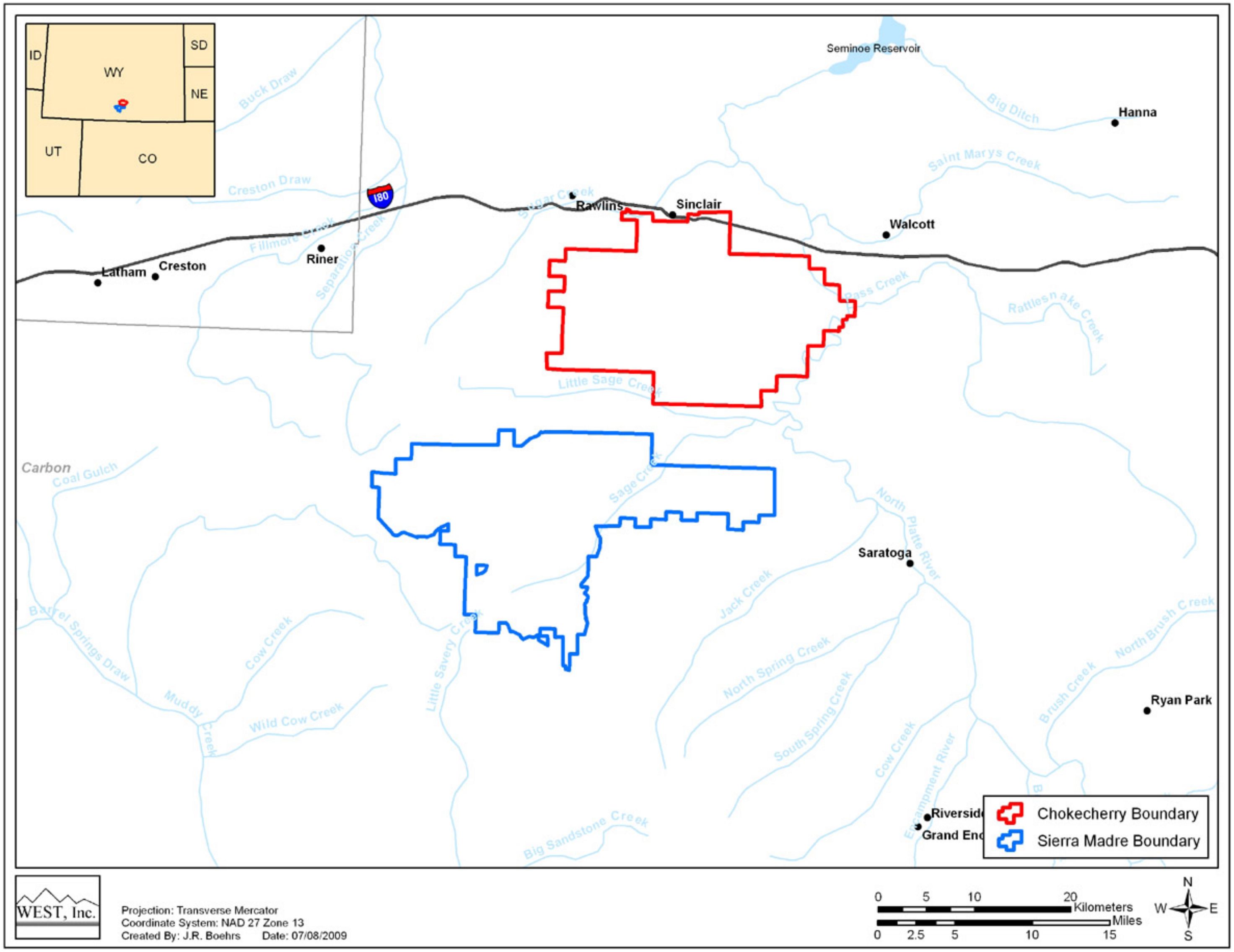


Figure 1. Location of the Chokecherry-Sierra Madre Wind Resource Areas.

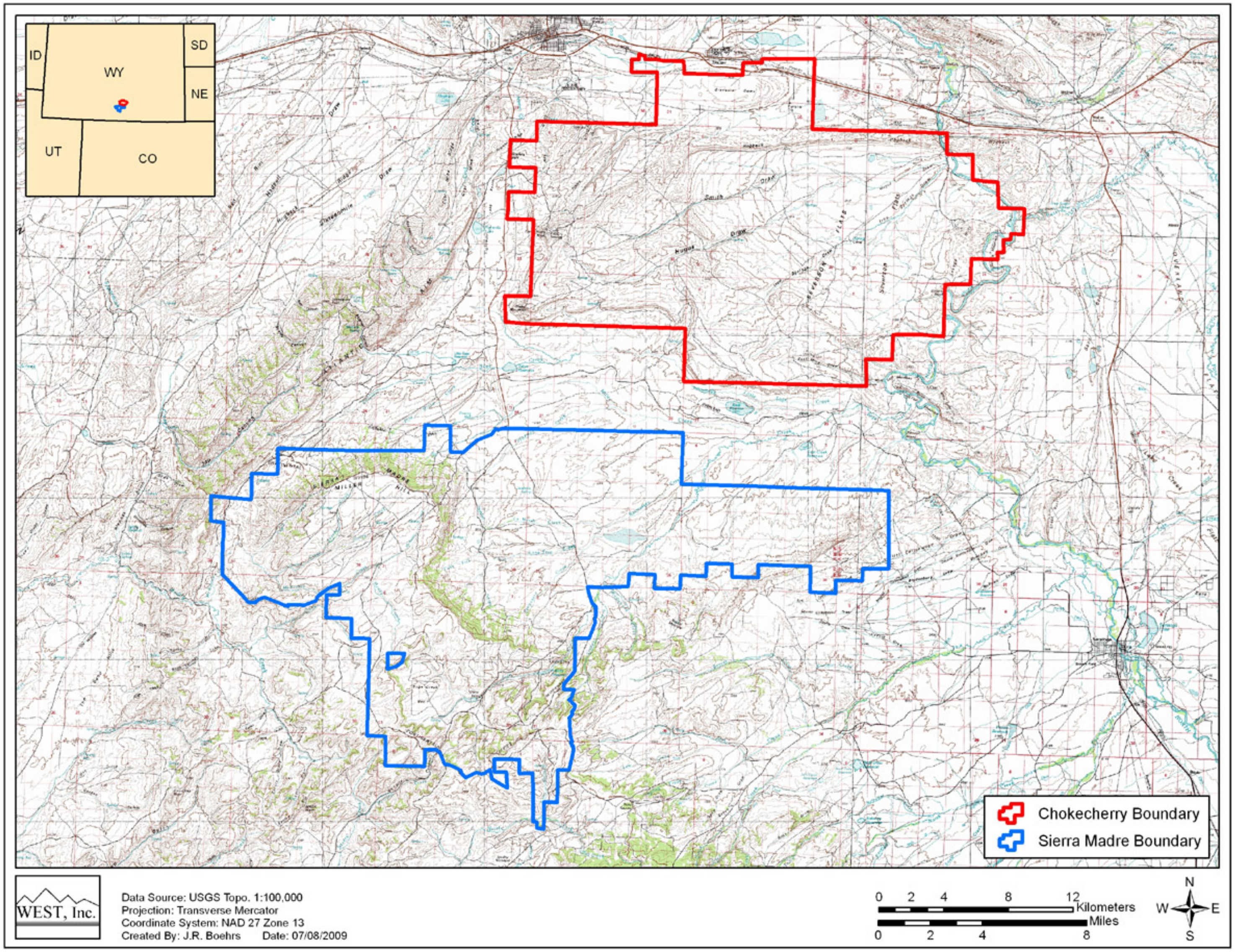


Figure 2. Elevation and topography of the Chokecherry-Sierra Madre Wind Resource Areas.

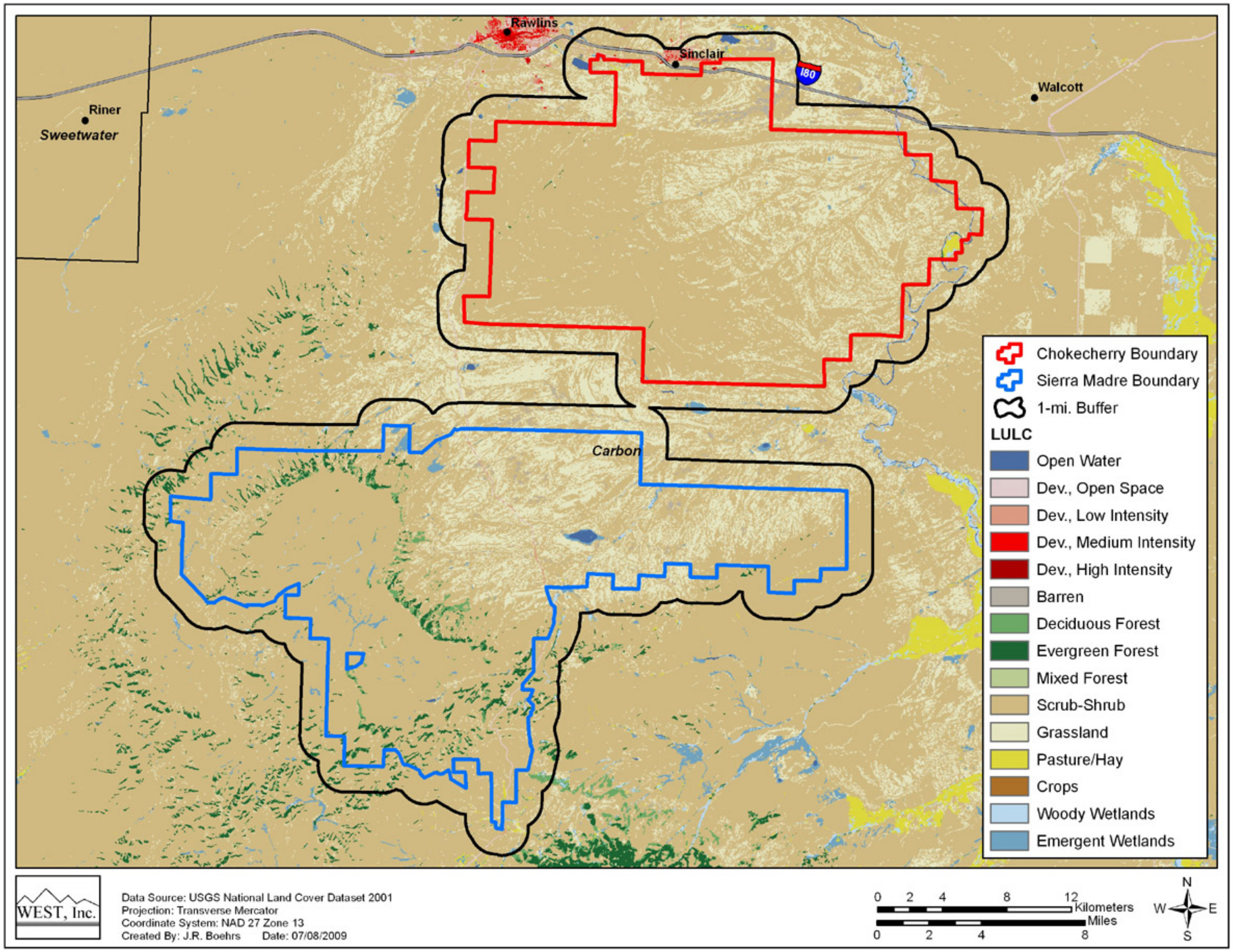


Figure 3. The land cover types and coverage within the Chokecherry-Sierra Madre Wind Resource Areas (USGS NLCD 2001).

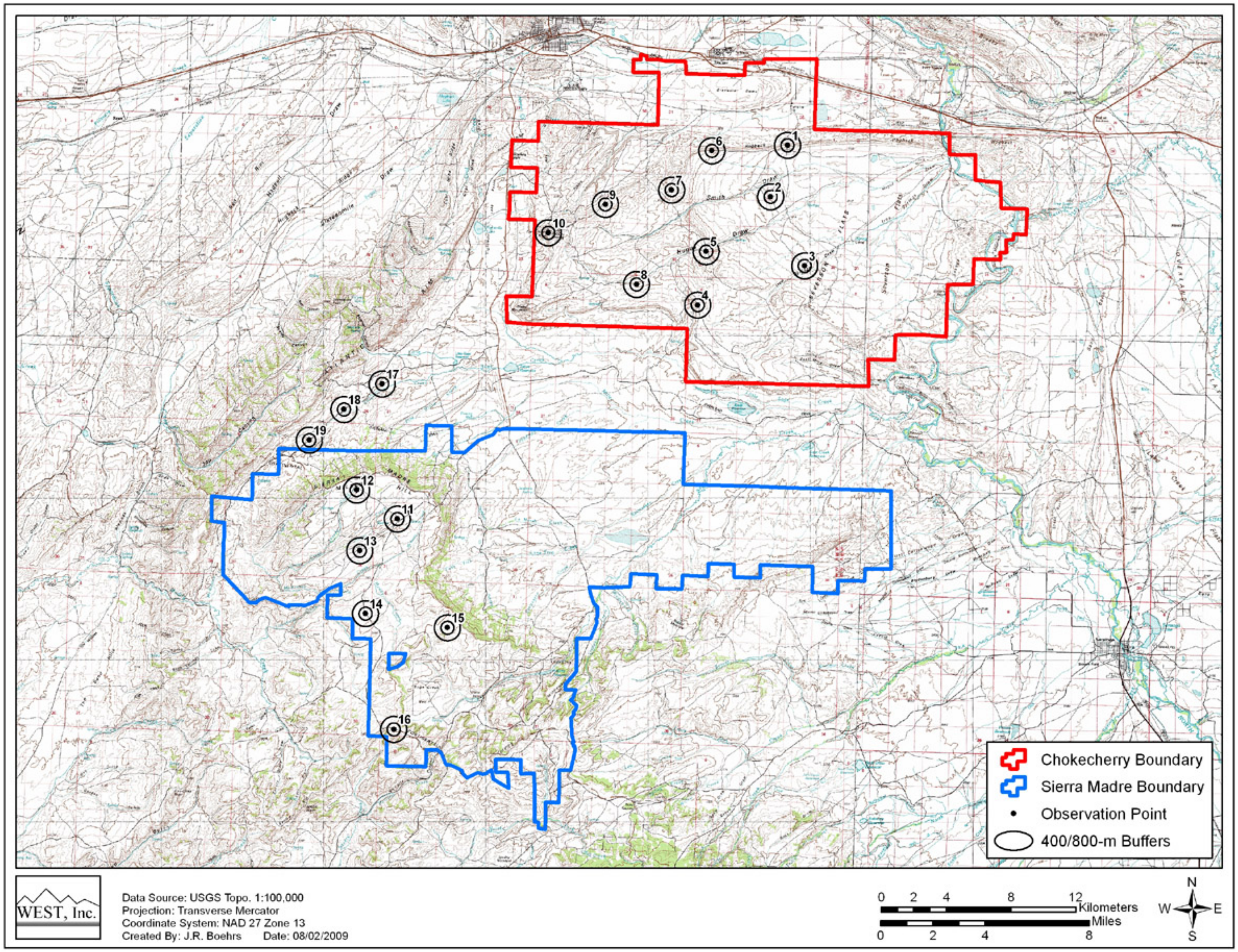


Figure 4. Fixed-point bird use survey points at the Chokecherry-Sierra Madre Wind Resource Areas.

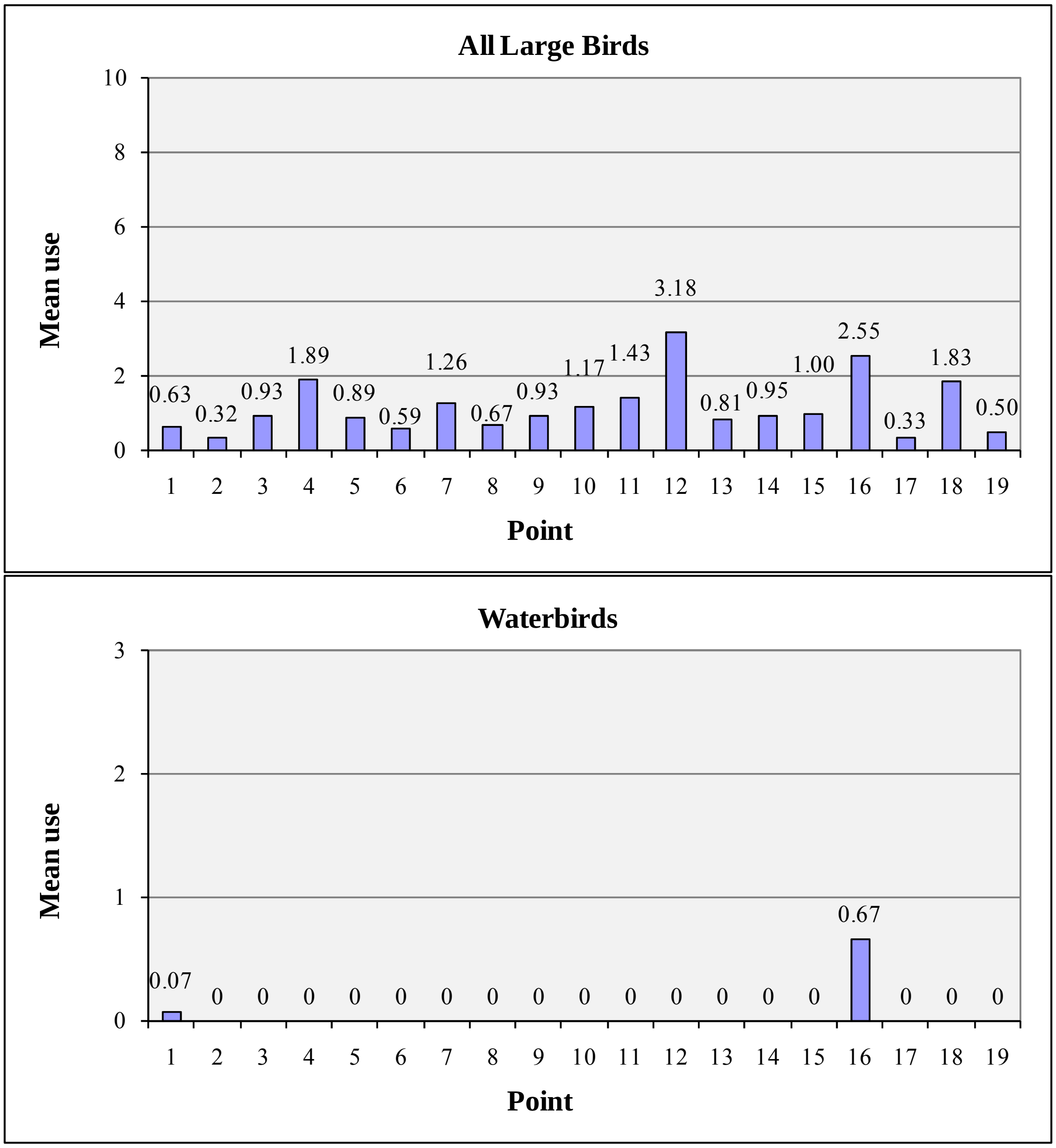


Figure 5. Mean use (number of birds/20-min survey) at each fixed-point bird use survey point for all birds and major bird types at the Chokecherry-Sierra Madre Wind Resource Area.

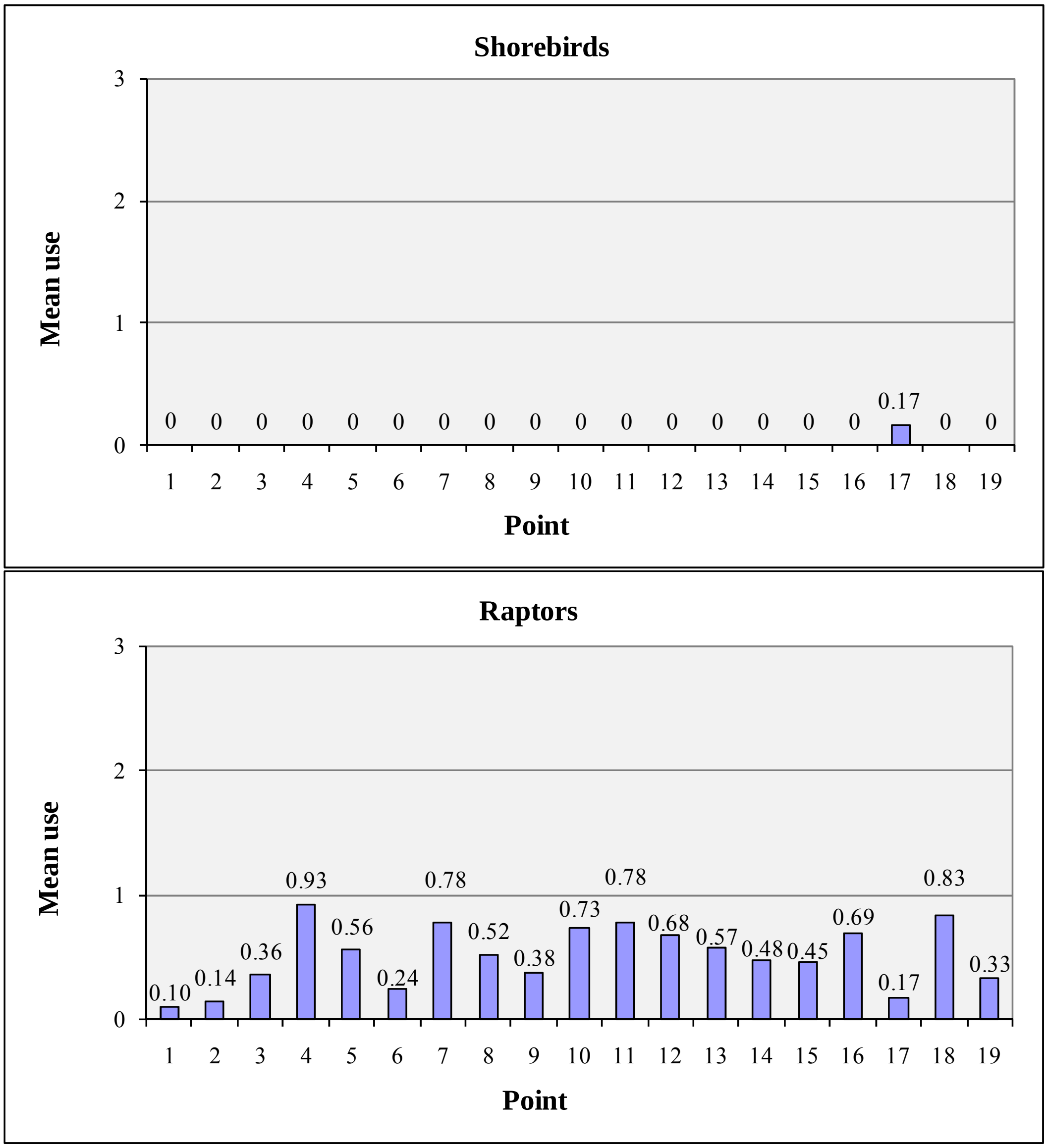
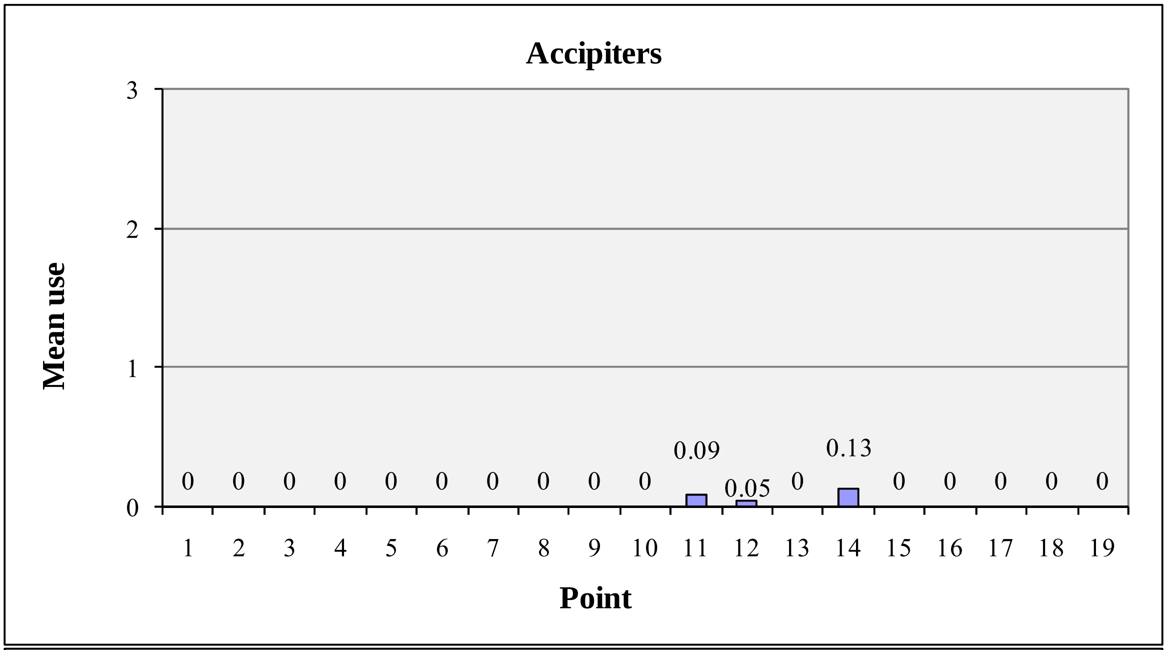


Figure 5 (*continued*). Mean use (number of birds/20-min survey) at each fixed-point bird use survey point for all birds and major bird types at the Chokecherry-Sierra Madre Wind Resource Area.



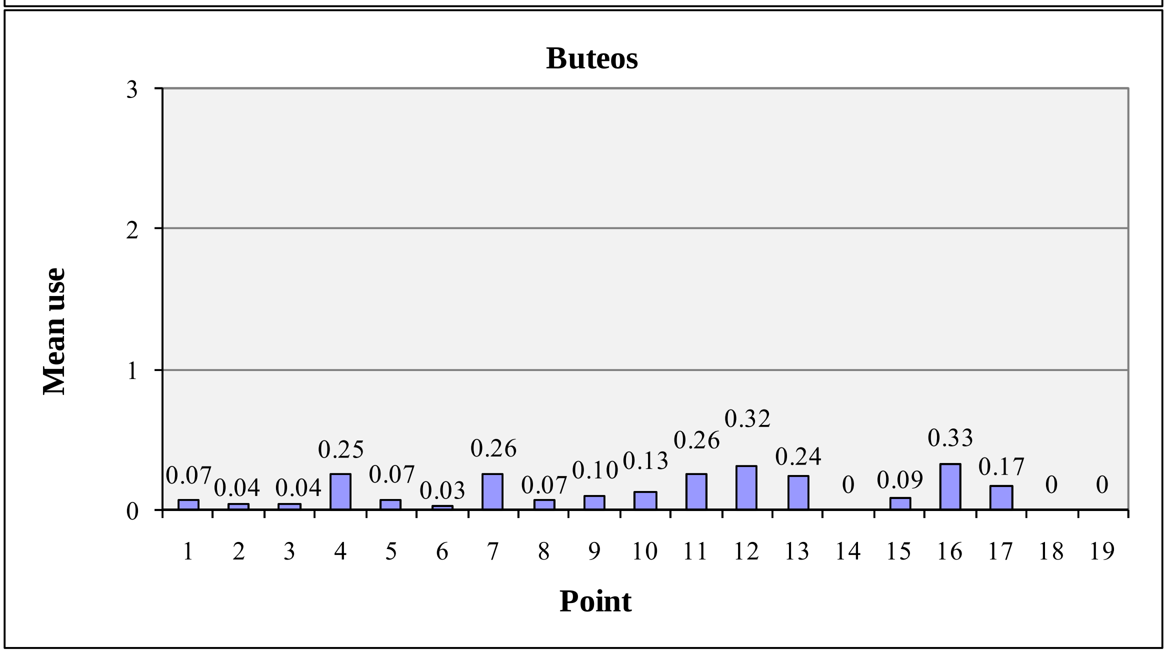
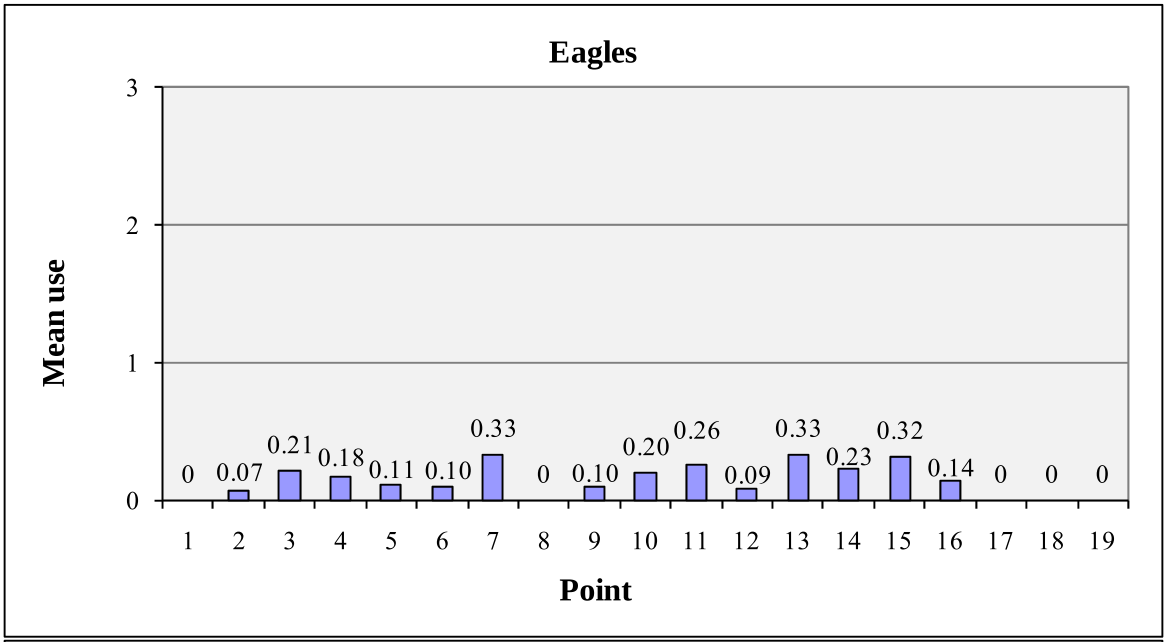


Figure 5 (*continued*). Mean use (number of birds/20-min survey) at each fixed-point bird use survey point for all birds and major bird types at the Chokecherry-Sierra Madre Wind Resource Area.



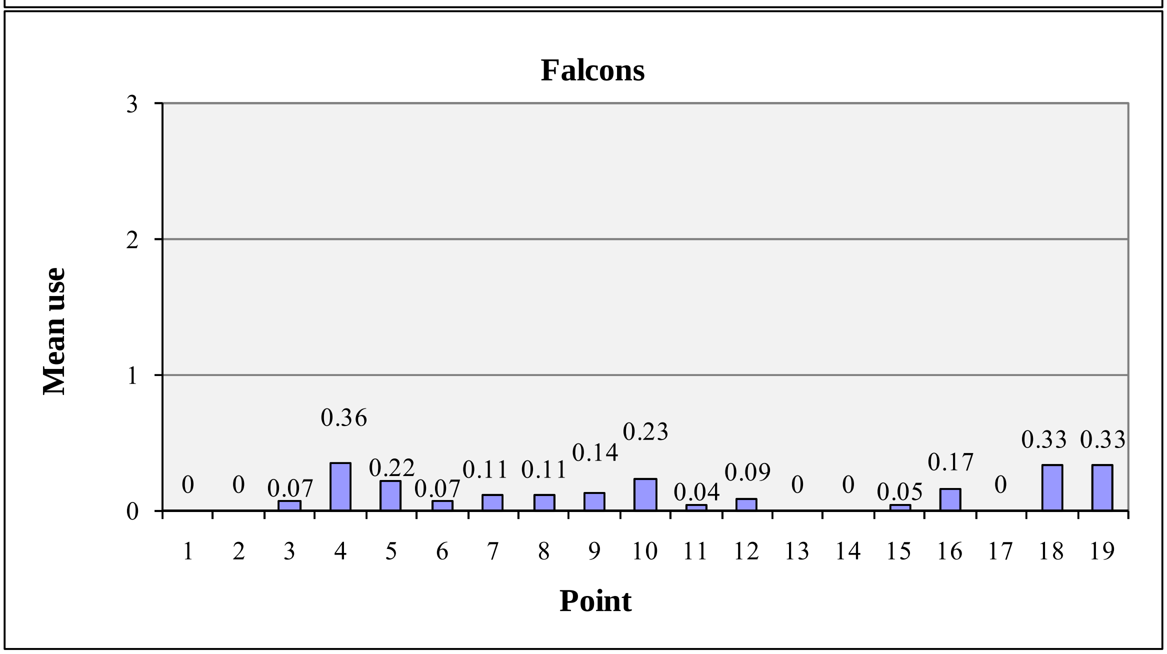
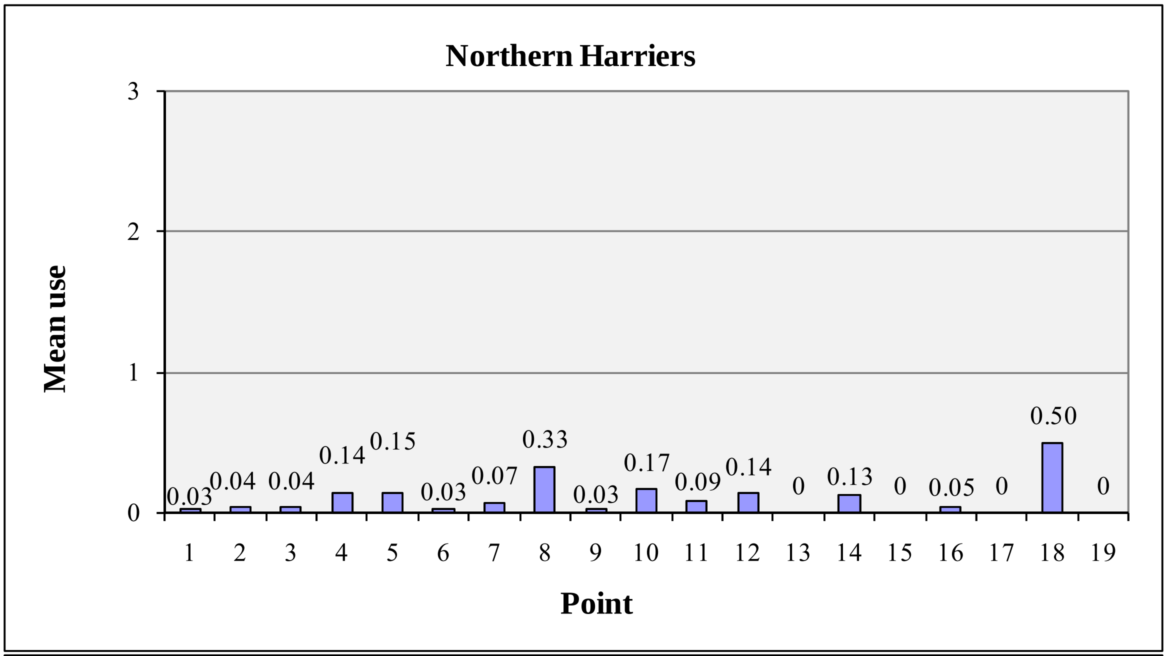


Figure 5 (*continued*). Mean use (number of birds/20-min survey) at each fixed-point bird use survey point for all birds and major bird types at the Chokecherry-Sierra Madre Wind Resource Area.



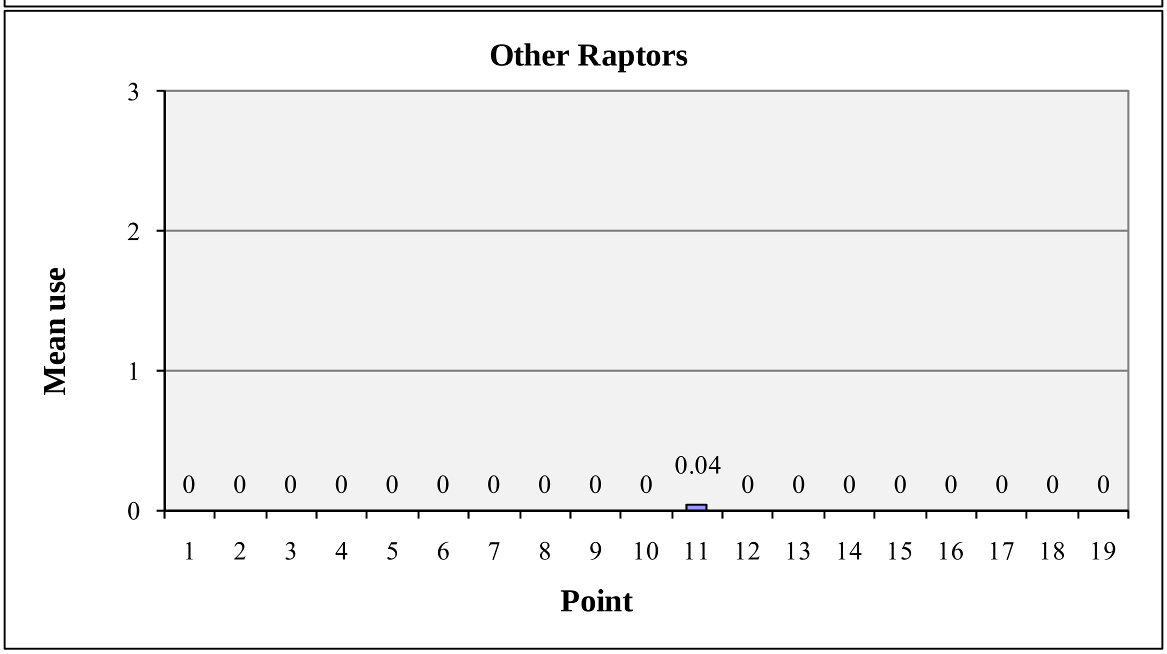
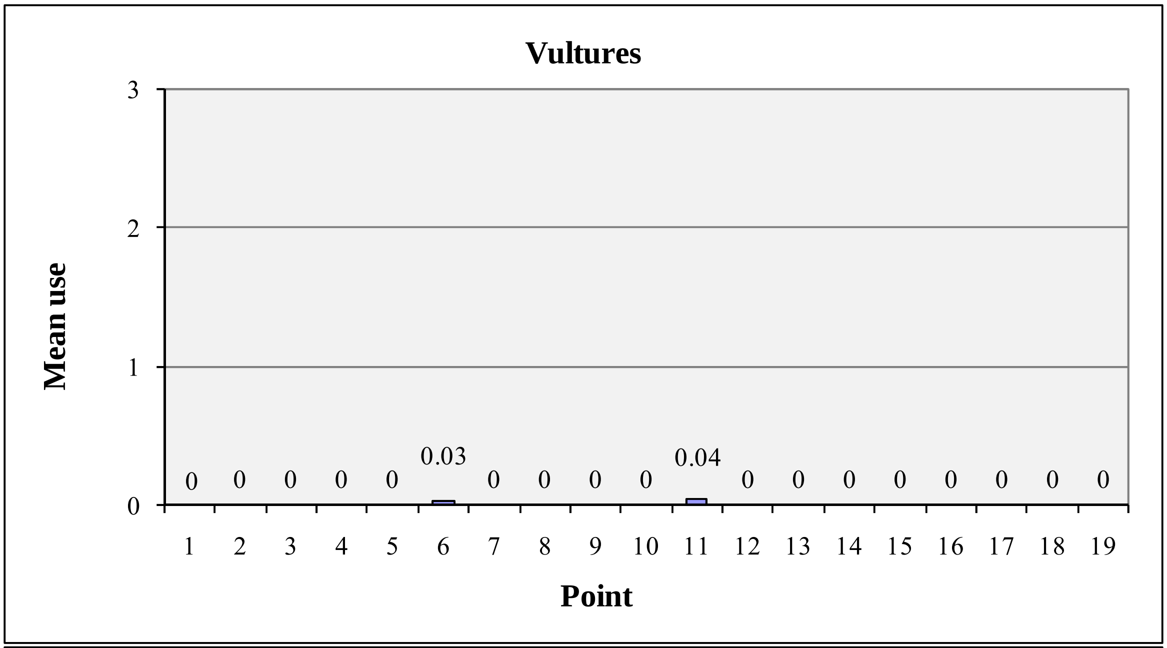


Figure 5 (*continued*). Mean use (number of birds/20-min survey) at each fixed-point bird use survey point for all birds and major bird types at the Chokecherry-Sierra Madre Wind Resource Area.



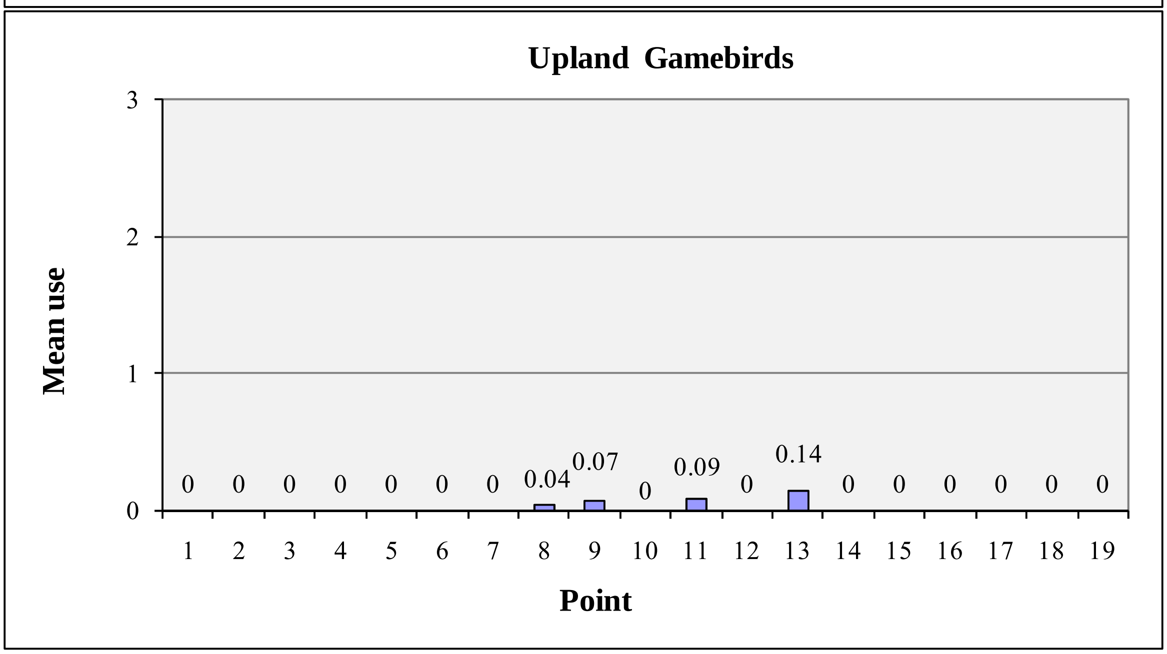
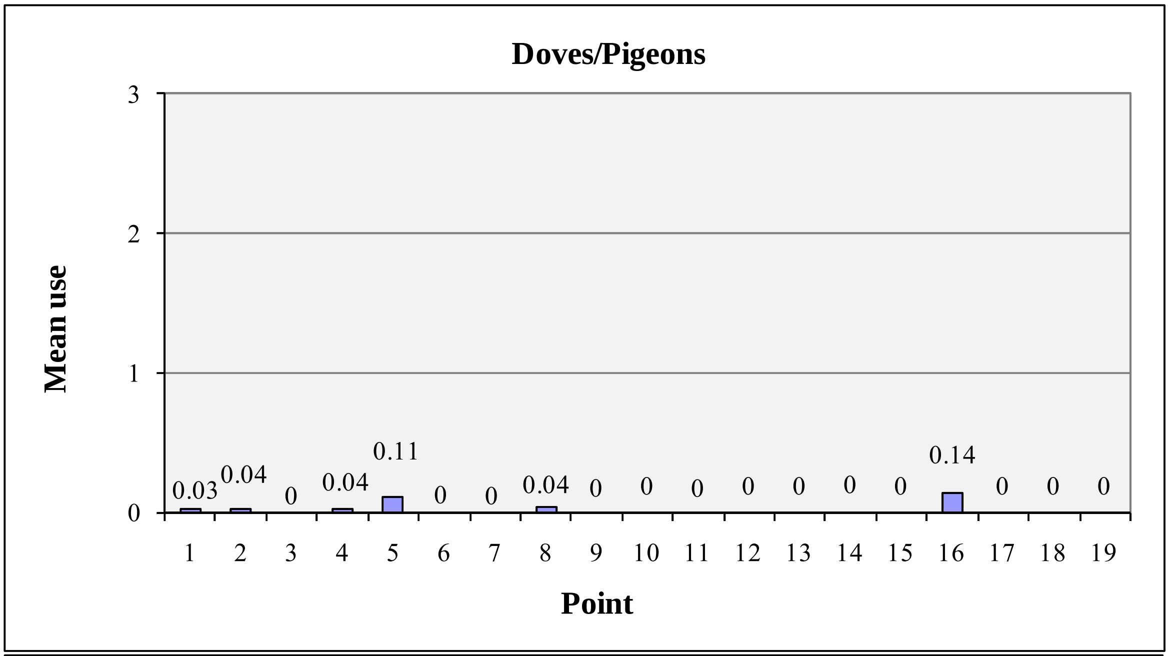


Figure 5 (*continued*). Mean use (number of birds/20-min survey) at each fixed-point bird use survey point for all birds and major bird types at the Chokecherry-Sierra Madre Wind Resource Area.



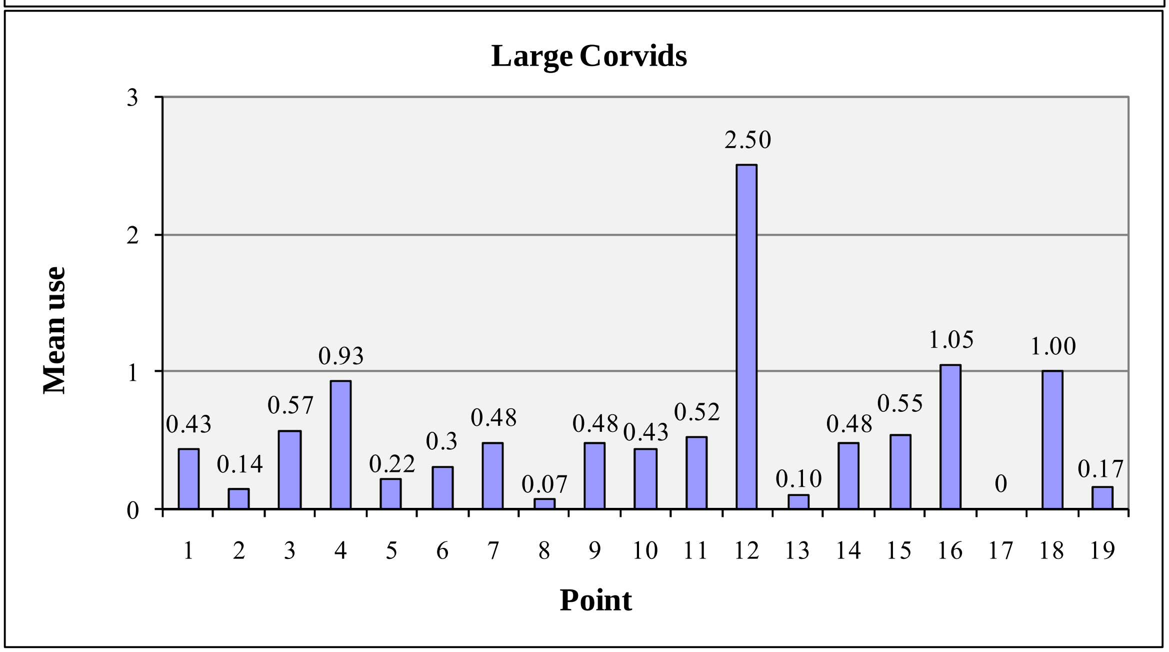
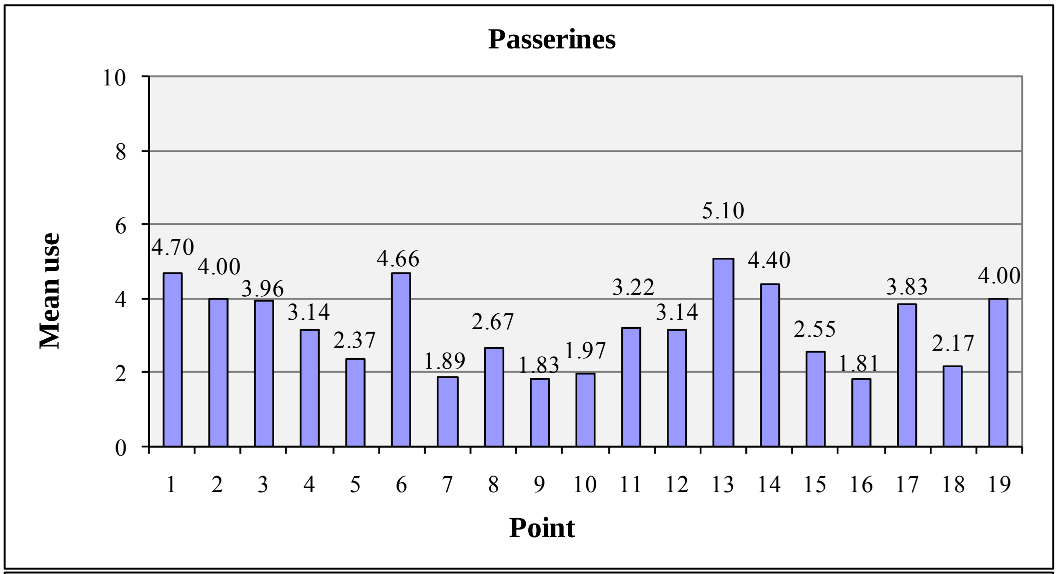


Figure 5 (*continued*). Mean use (number of birds/20-min survey) at each fixed-point bird use survey point for all birds and major bird types at the Chokecherry-Sierra Madre Wind Resource Area.



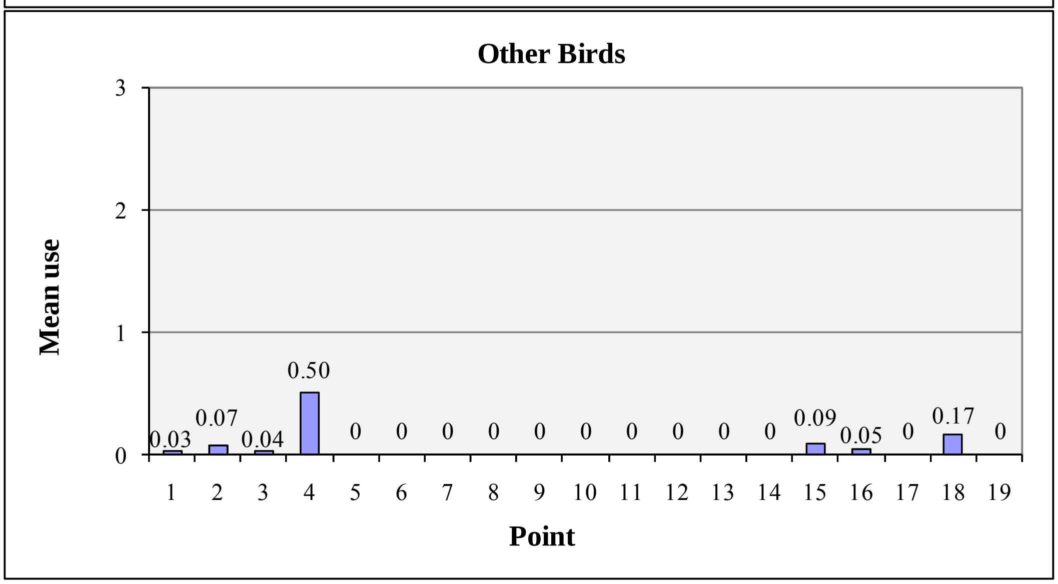


Figure 5 (*continued*). Mean use (number of birds/20-min survey) at each fixed-point bird use survey point for all birds and major bird types at the Chokecherry-Sierra Madre Wind Resource Area. Passerine and other bird observations were focused within 100-m viewsheds.

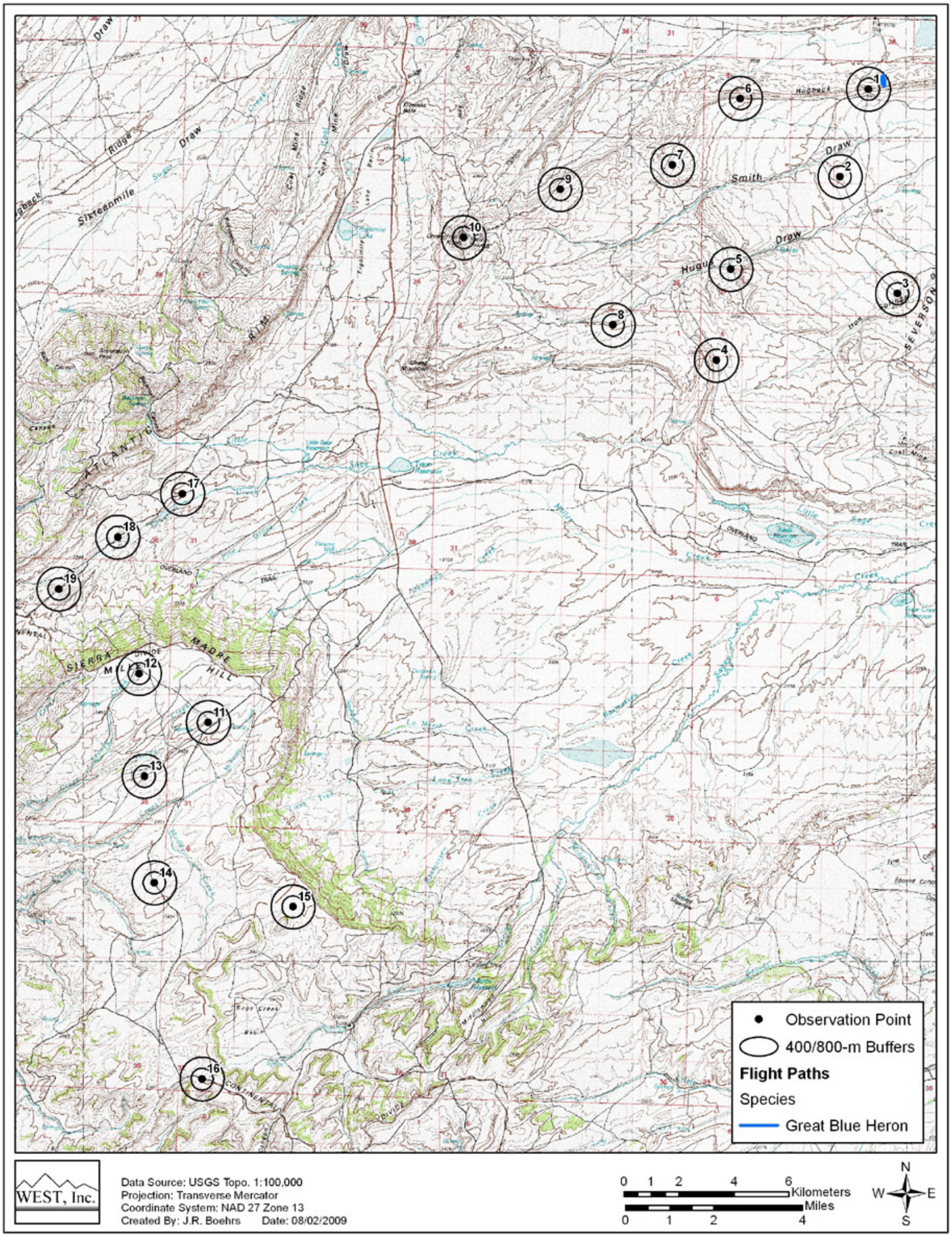


Figure 6a. Flight paths of waterbirds at the Chokecherry-Sierra Madre Wind Resource Area.

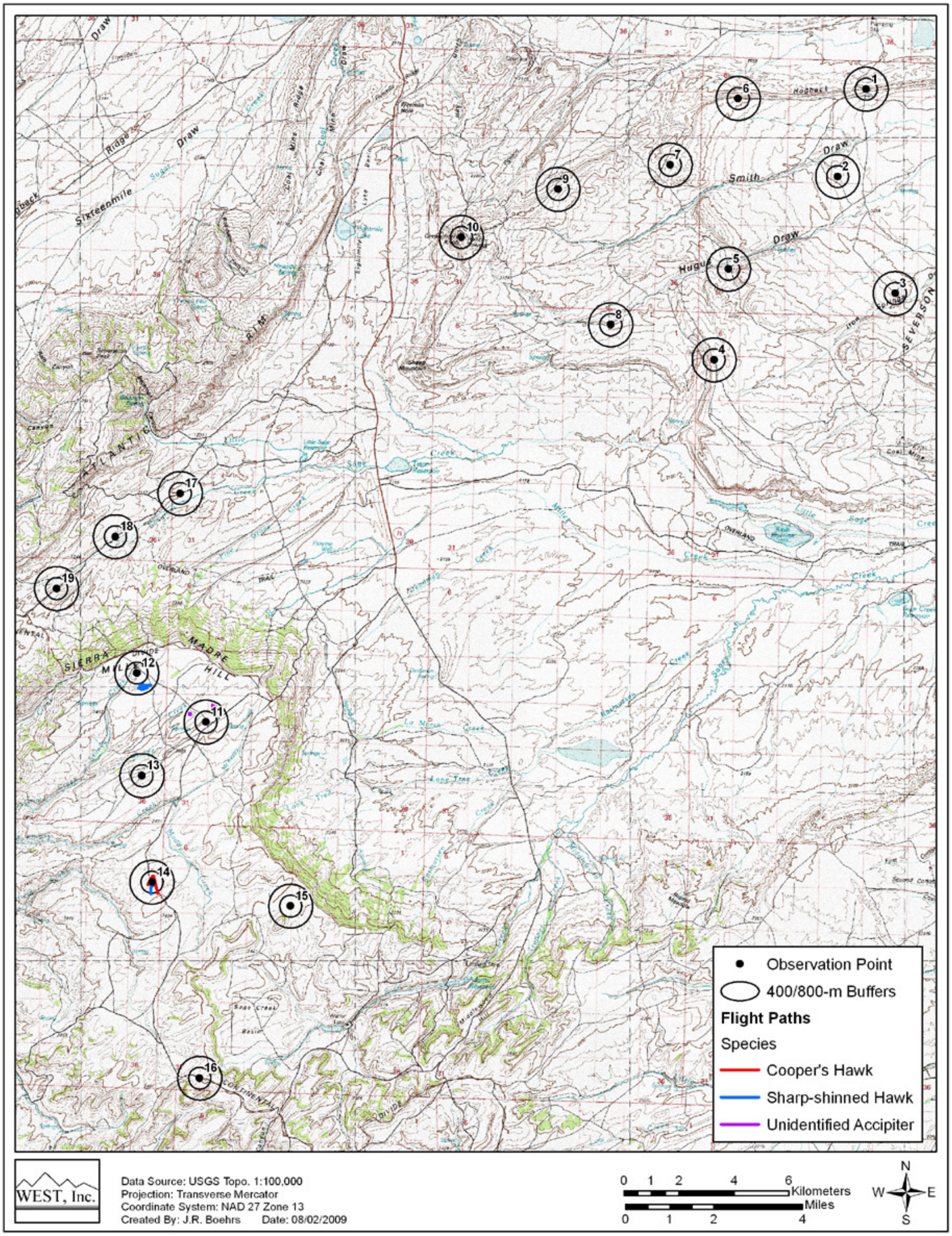


Figure 6b. Flight paths of accipiters at the Chokecherry-Sierra Madre Wind Resource Area.

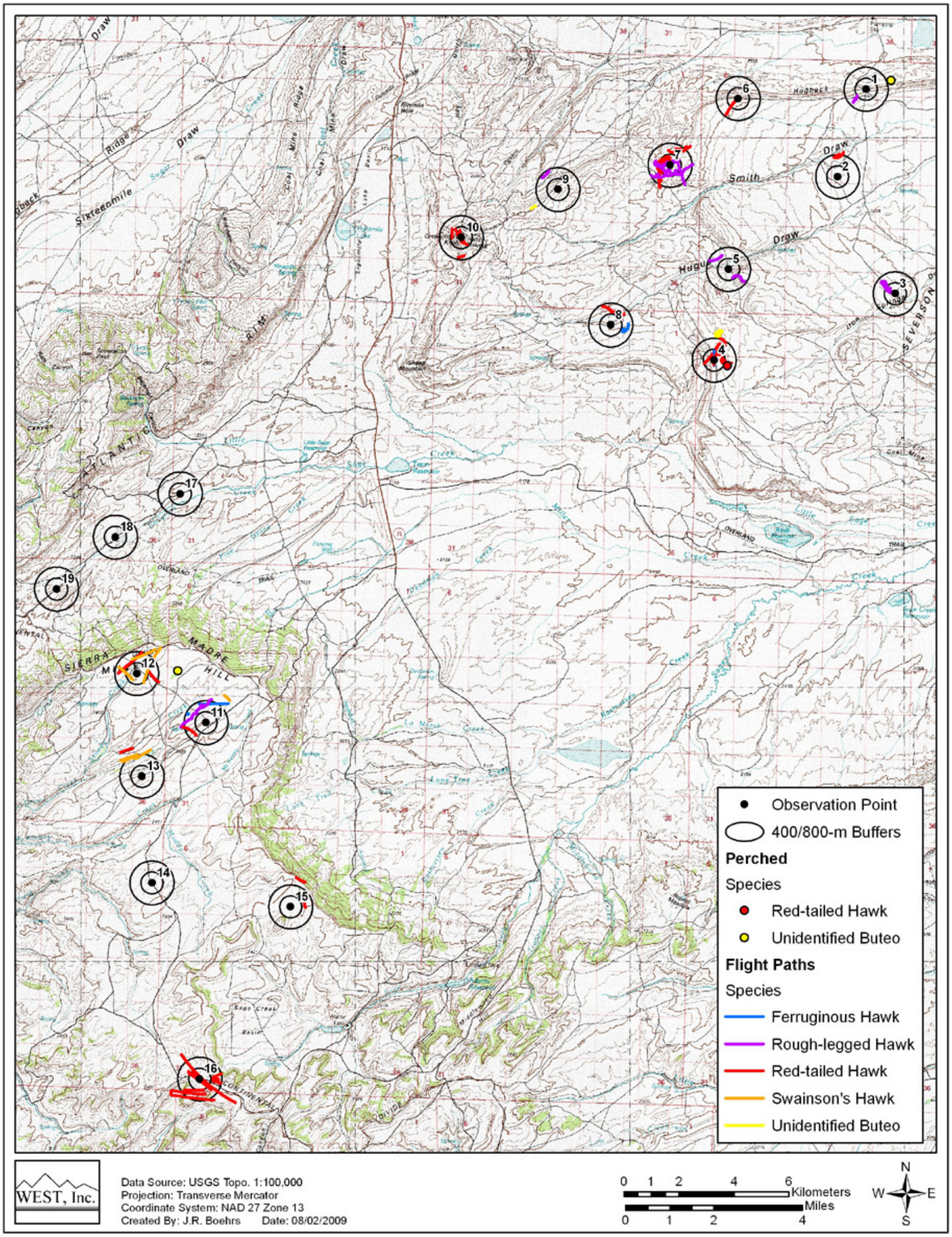


Figure 6c. Flight paths of buteos at the Chokecherry-Sierra Madre Wind Resource Area.

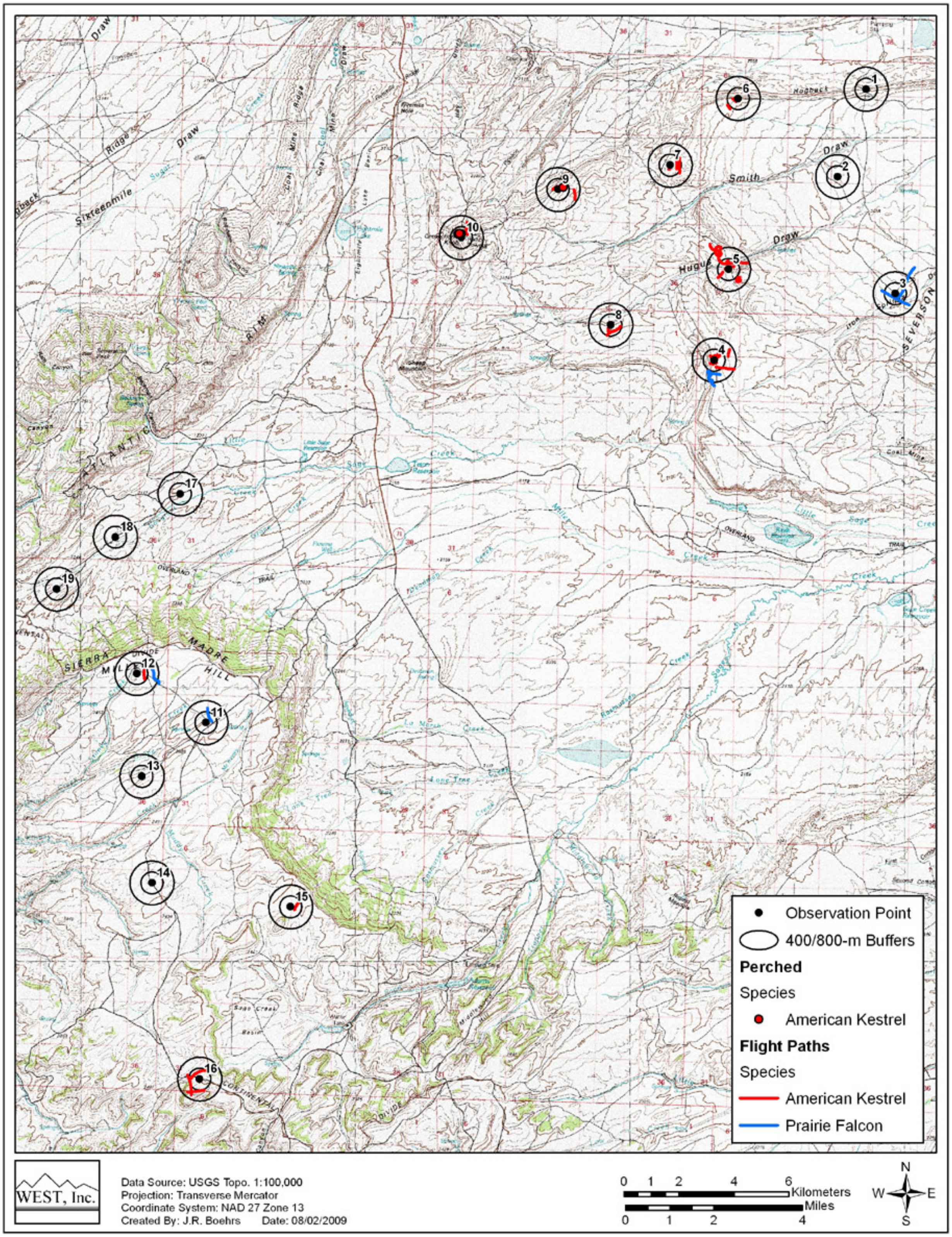


Figure 6d. Flight paths of falcons at the Chokecherry-Sierra Madre Wind Resource Area.

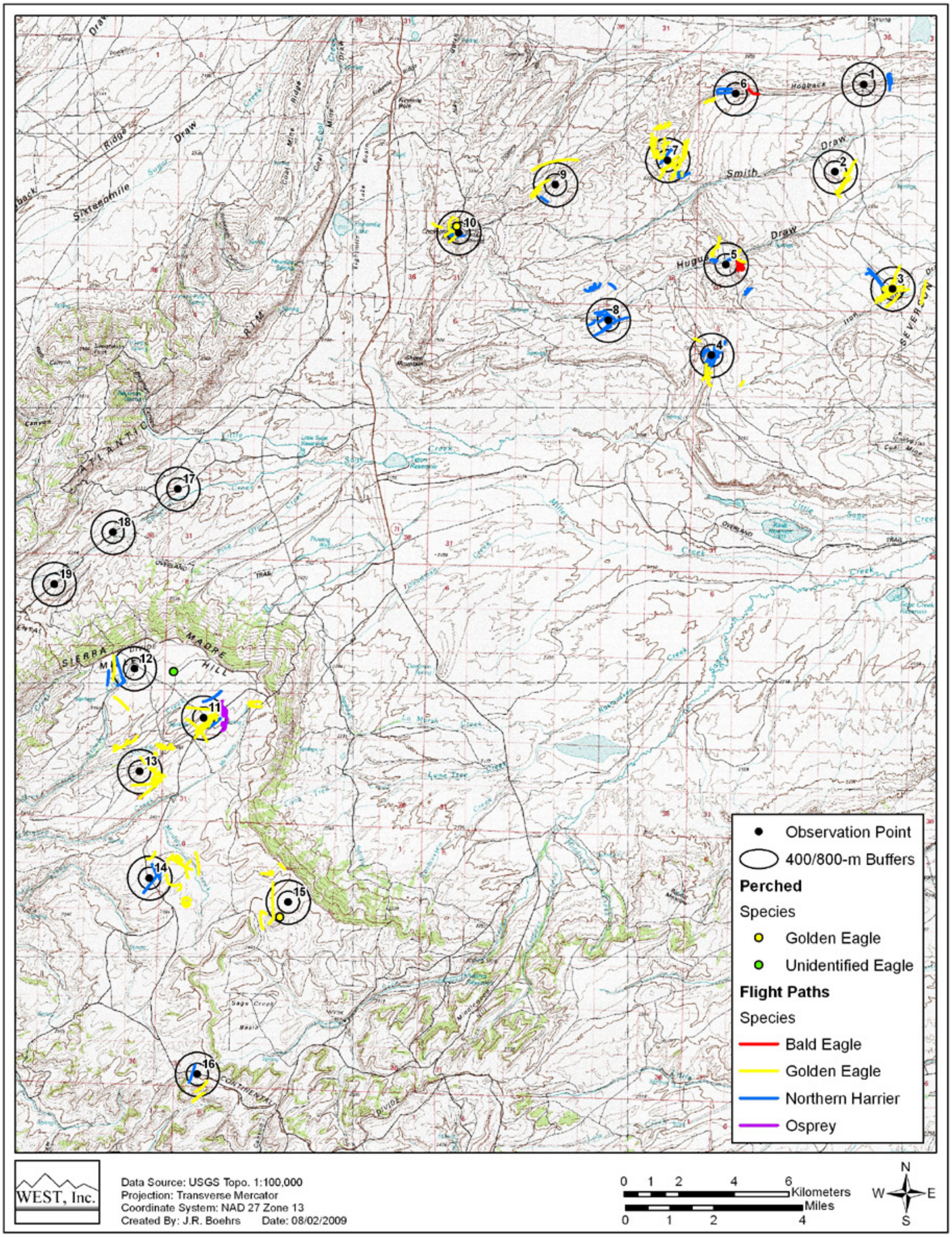


Figure 6e. Flight paths of eagles, northern harriers, and other raptors at the Chokecherry-Sierra Madre Wind Resource Area.

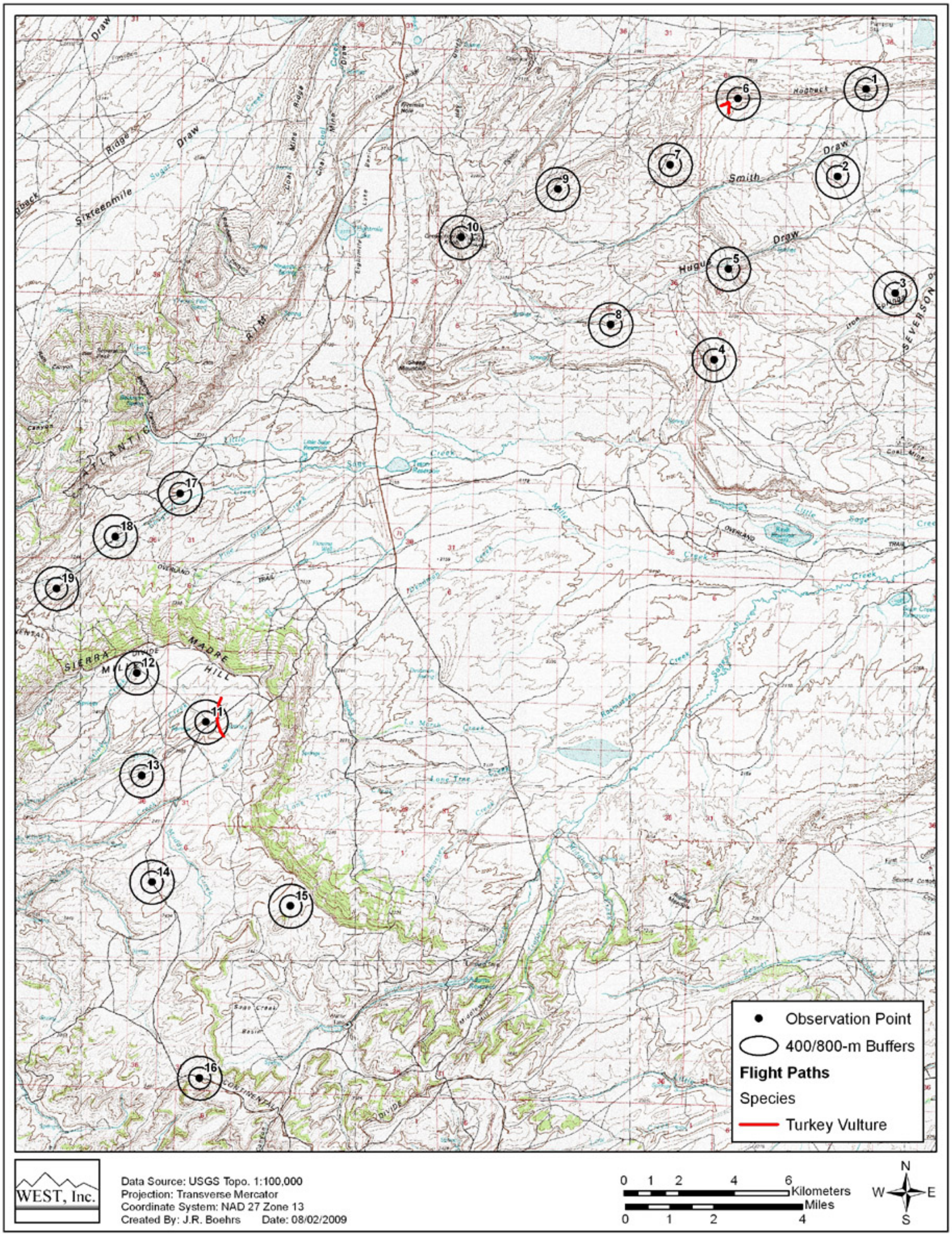


Figure 6f. Flight paths of vultures at the Chokecherry-Sierra Madre Wind Resource Area.

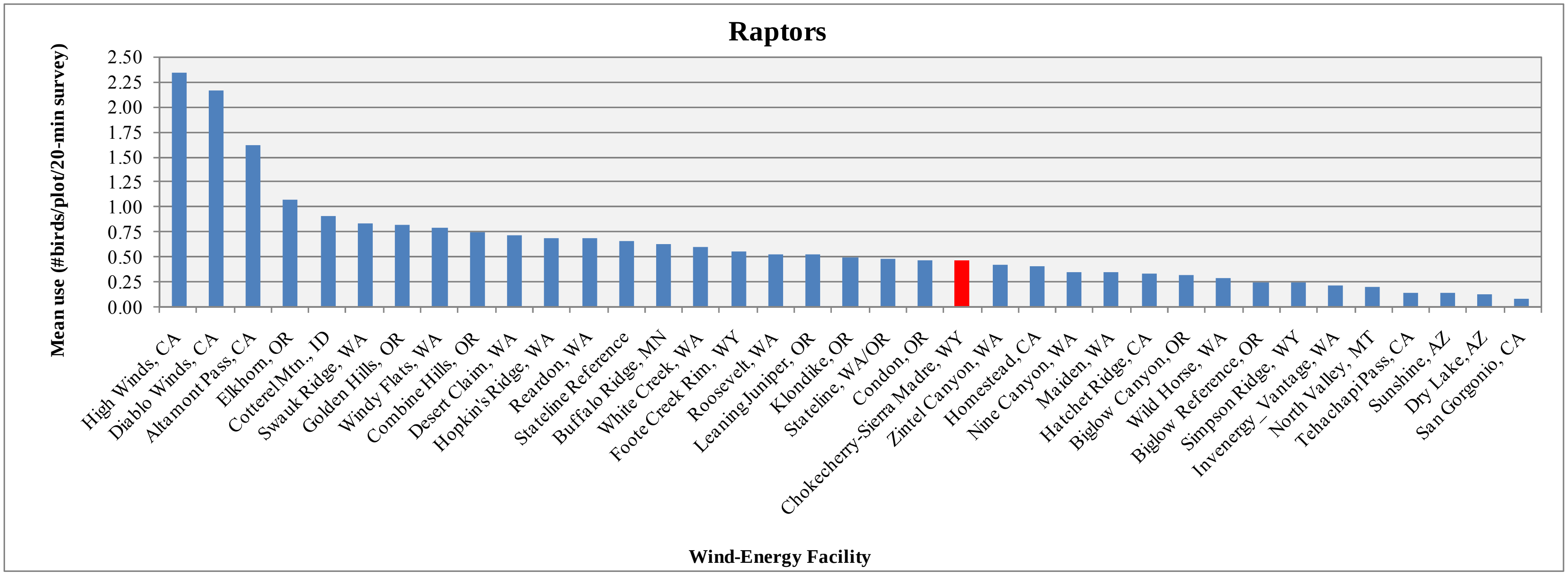
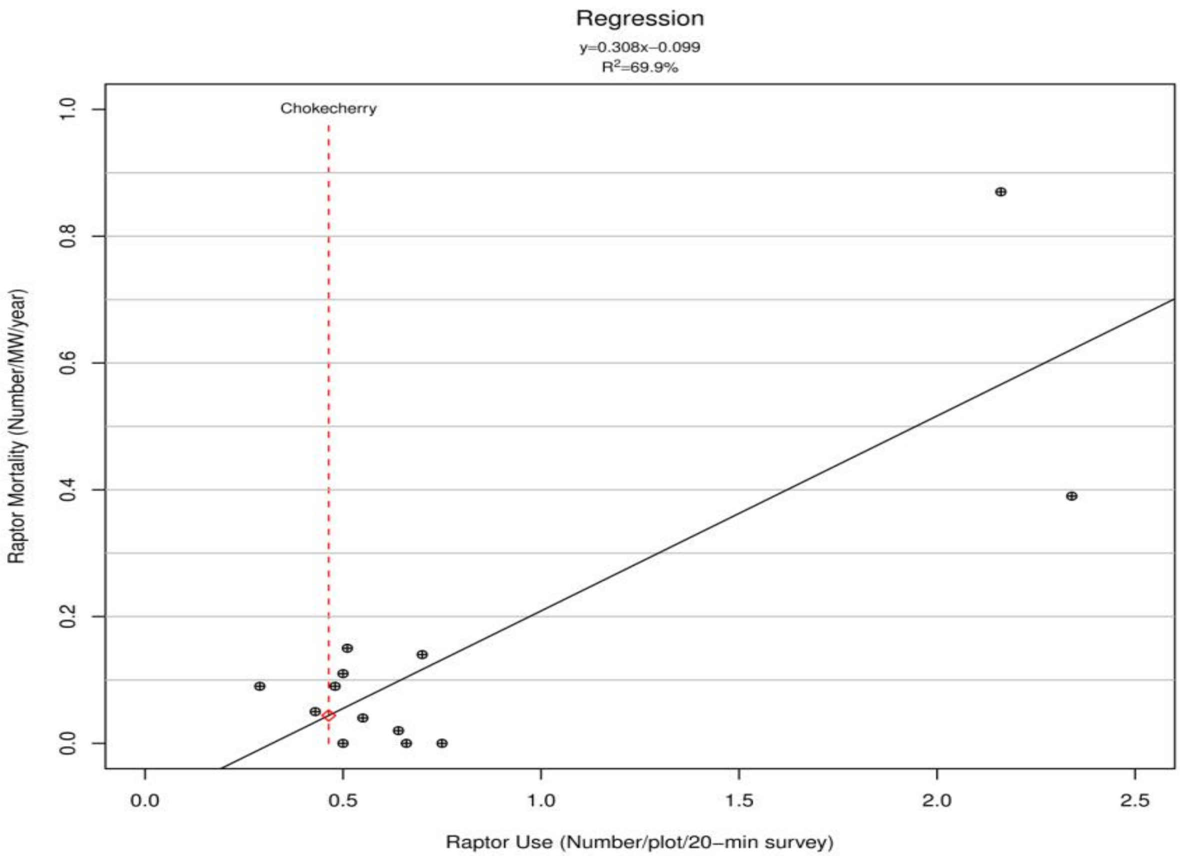


Figure 9. Comparison of annual raptor use between the Chokecherry-Sierra Madre Wind Resource Area and other US wind-energy facilities.

Data from the following sources:

Chokecherry-Sierra Madre, WY	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. 2003a
Cotterel Mtn., ID	Cooper et al. 2004	Roosevelt, WA	NWC and WEST 2004	Biglow Reference, OR	WEST 2005c
Swauk Ridge, WA	Erickson et al. 2003b	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. 2003c	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 0.46
Predicted Fatality Rate 0.04 fatalities/MW/year
90.0% Prediction Interval (0, 0.30 fatalities/MW/year)

Figure 10. Regression analysis comparing raptor use estimates versus estimated raptor mortality.

Data from the following sources:

Study and Location	Raptor Use (birds/plot /20-min survey)	Source	Raptor Mortality (fatalities/MW/yr)	Source
Buffalo Ridge, MN	0.64	Erickson et al. 2002b	0.02	Erickson et al. 2002b
Combine Hills, OR	0.75	Young et al. 2003c	0.00	Young et al. 2005
Diablo Winds, CA	2.161	WEST 2006a	0.87	WEST 2006a
Foote Creek Rim, WY	0.55	Erickson et al. 2002b	0.04	Erickson et al. 2002b
High Winds, CA	2.34	Kerlinger et al. 2005	0.39	Kerlinger et al. 2006
Hopkins Ridge, 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. 2003
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. 2003a	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

April 2011–March 2012 Supplemental Wildlife Report
Chokecherry and Sierra Madre Wind Energy Project

Prepared for:

Power Company of Wyoming, LLC
555 17th Street, Suite 2400
Denver, CO 80202

Prepared by:

SWCA Environmental Consultants
295 Interlocken Blvd., Suite 300
Broomfield, CO 80021
(303) 487-1183 / Fax (303) 487-1245

October 2012

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INTRODUCTION

Between April 2011 and March 2012, SWCA Environmental Consultants (SWCA) performed a second year of avian and bat surveys for the Power Company of Wyoming, LLC (PCW) within the Chokecherry and Sierra Madre Wind Energy Project (Project) site. These Year Two survey efforts included long-watch raptor surveys, aerial raptor nest surveys within 5-miles of the Project, migratory bird point counts, breeding bird grid surveys, waterbird surveys, greater sage-grouse monitoring, and acoustic bat monitoring. Year One surveys were conducted between June 2008 and June 2009 with the primary intent of collecting data for the development of an Environmental Impact Statement (EIS) for the Project. Year One surveys consisted primarily of 20-minute avian point counts, aerial raptor nest surveys within 1-mile of the Project, greater sage-grouse monitoring, and acoustic bat monitoring.

All protocols and survey methodologies used to assess wildlife in the Project site during Year Two surveys were developed in consultation with the U.S. Fish and Wildlife Service (Service), and are in accordance with recommendations made by the Service, the Bureau of Land Management (BLM), and the Wyoming Game and Fish Department (WGFD). Many of the Year Two data pertaining to eagles, raptors, nests, and greater sage-grouse have been previously analyzed and presented in the Project Eagle Conservation Plan (ECP), Bird and Bat Conservation Strategy (BBCS), 2011 and 2012 Summary Nest Reports, and Sage-grouse Conservation Plan, respectively. More detailed summaries of data from other survey efforts are contained herein.

RAPTOR SURVEYS

Bi-weekly long-watch raptor surveys were completed at 15 sites between April 4 and November 16, 2011. Monthly surveys were completed between December 2011 and March 2012. Long-watch raptor surveys were conducted at 4,000-meter (m) radius plots strategically distributed across the Chokecherry and Sierra Madre Wind Development Areas (WDAs). Fixed-point surveys were conducted in a 4,000-m radius to maximize areal coverage for the purposes of identifying high-use areas while maintaining observer confidence in species identification. For the purposes of this report, only a brief summary is presented for raptor surveys; more detailed summaries and analyses for eagles and raptors are provided in the Project ECP and BBCS, respectively.

Year Two surveys were conducted for a total of 129,750 minutes, or 49.4% of the total 262,800 daylight minutes in the year. During Year Two, 324 long-watch raptor surveys were conducted between April 2011 and March 2012. Of the 324 total surveys, 109 were conducted in the spring, 45 in the summer, 110 in the fall, and 60 during the winter (Table 1). The total 129,750 minutes of survey conducted during all Year Two long-watch surveys were evenly distributed between sites and between spring and fall; however, summer and winter survey minutes were lower because the survey effort was scaled down between July 2 and August 14, and between November 17 and March 31.

Table 1. Summary of Observations from Year Two Long-watch Surveys.

Season	Surveys	Raptor Observations
Spring	109	486
Summer	45	94
Fall	110	341
Winter	60	102
Total	**324**	**1,023**

In total, 178 surveys were conducted in the Chokecherry WDA, while 146 surveys were conducted in the Sierra Madre WDA. Across all seasons, 1,023 raptor observations were made at all long-watch locations; however, most of the observations were likely the same birds being observed multiple times per survey date. This is often detailed in observational notes taken by field personnel during raptor surveys, and is further exemplified by the raptor use calculations presented in the Project BBCS, as well as information presented in the 2011 and 2012 Summary Nest Reports. The Raptor use calculations presented in the BBCS show relatively consistent use between all seasons during Year Two, which indicates there are not large influxes of migrant raptors moving into the Project during the spring and fall months. Additionally, the results presented in the 2011 and 2012 Summary Nest Reports show relatively low numbers of nesting raptors occurring in the Project site and immediate surrounding area. These data indicate that the majority of the 1,023 raptor observations are likely repeat observations of the same resident individuals as there does not appear to be strong raptor migration through the area, nor are there high numbers of nesting raptors occurring in the Project.

MIGRATORY BIRD SURVEYS

Migratory bird point count surveys were completed in conjunction with the long-watch raptor surveys, and therefore the number of sites as well as the weekly scheduling was identical to the raptor surveys. Each migratory bird survey point was established in representative habitat near each raptor monitoring site at sufficient distance to ensure that the observer for the raptor surveys would not likely impact migratory bird species behavior at the point count location.

Point count surveys were conducted across all daylight hours to account for time-of-day effects. For any individual point, surveys were conducted between 7:30 am and 6:30 pm on a pre-determined, systematic schedule. All birds detected within a 200-m radius were recorded during the point count surveys. The data collected during these counts included species, number of individuals, radial distance from observer, behavior, and general demographic data. Standard survey and environmental data (e.g., time, date, wind speed, temperature) were also collected.

The metrics used to characterize avian use are number of species, number of individuals, number of flocks, species frequency (the percentage of 20-minute surveys on which a species was observed), occurrence frequency (percentage of surveys with at least one bird detection), and mean use (average number of individuals per 20-minute survey).

Vegetation data collected across 500 transect surveys conducted by SWCA in 2009 was used to characterize major habitat types at each point. Table 2 summarizes the percentage of major habitat types (minimum 5% of total acreage) within the 200-m radius survey area (31.03 acres) of each location center.

Table 2. Percentage of Major Habitat Categories within 200-m Radius of Migratory Bird Survey Points (Minimum 5%).

Survey Site	Habitat Category							
	Aspen-Mixed Conifer	Dense Sagebrush	Sagebrush Steppe	Salt Desert Shrub	Upland Grassland	Sparsely Vegetated	Lowland Mesic Zone	Montane Shrubland
1		18	74		6			
2				95				
3	39		54					
4	23		30		30	5		6
5			62	6	30			
6			67		31			
7			52		43			
8		16	69		14			
9			75	9	11			
10			89	7				
11		11	75		9			
12			45		51			
13		17	70				8	
14			16	63		18		
15		13	45	37				

Note: Due to rounding error and minimum requirement of 5% coverage, total habitat coverage may not equal 100%.

Sagebrush steppe comprised a substantial portion (≥30%) of 13 survey sites. Salt desert shrub dominated at survey sites 2 and 14 (95% and 63%, respectively). Aspen-mixed conifer was well-represented at survey sites 3 and 4 (39% and 23%, respectively), as was upland grassland with ≥30% coverage at survey sites 4, 5, 6, 7, and 12. Dense sagebrush, sparsely vegetated, lowland mesic zone, and montane shrubland were also identified with >5% coverage at several survey sites. Barren ground was the only major habitat category to not register at least 5% coverage on any site.

Between April 4, 2011, and March 27, 2012, 295 migratory bird surveys were conducted. Point count locations were each surveyed 16 to 23 times, with the variation in number of surveys due to safety and accessibility concerns arising from inclement weather. These same factors are also the cause of differences in the overall number of migratory bird surveys relative to long-watch raptor surveys.

In sum, 1,518 individuals in 969 flocks representing 43 species were recorded during all surveys combined in the 12-month survey period (Table 3). Of the 295 surveys completed, no birds were recorded on 74 of the surveys for an occurrence frequency of 75% (221 of 295 surveys). Mean use was 5.1 individuals/survey. Horned lark (*Eremophila alpestris*) dominated the number of observations, accounting for 951 (62%) individuals with a mean use of 3.2 individuals/survey. Horned lark was also the most frequently encountered species on surveys, with the species recorded on 67% of surveys.

Table 3. The Number of Individuals, Flocks, Species Frequency, and Mean Use for All Migratory Bird Survey Point Locations Combined, April 2011–March 2012.

Species	# of Individuals	# of Flocks	Species Frequency (as %) (n = 295)	Mean Use
Horned Lark	935	530	67	3.2
Brewer's Sparrow	70	65	13	0.2
Vesper Sparrow	68	67	15	0.2
American Crow	55	2	<1	0.2
Rock Wren	43	40	11	0.1
Sage Thrasher	41	39	11	0.1
Sage Sparrow	42	34	6	0.1
Common Raven	34	27	8	0.1
Western Meadowlark	29	25	6	0.1
Sparrow sp.	29	19	6	0.1
American Robin	18	10	3	0.1
Greater Sage-grouse	18	3	1	0.1
Mountain Bluebird	16	11	4	0.1
Common Nighthawk	12	9	2	0.0
Undetermined sp.	12	11	3	0.0
Passerine sp.	9	6	2	0.0
American Kestrel	8	7	2	0.0
Green-tailed Towhee	7	7	3	0.0
White-throated Swift	6	1	<1	0.0
Barn Swallow	5	3	1	0.0
Black-billed Magpie	5	3	1	0.0
Tree Swallow	5	4	1	0.0
American Goldfinch	4	4	2	0.0
Song Sparrow	4	4	2	0.0
Violet-green Swallow	4	4	1	0.0
Warbler sp.	4	2	1	0.0
Chipping Sparrow	3	3	1	0.0
Evening Grosbeak	3	3	<1	0.0
Mourning Dove	3	2	1	0.0
Savannah Sparrow	3	3	1	0.0
Brown-headed Cowbird	2	2	1	0.0
Dark-eyed Junco	2	2	1	0.0
Northern Flicker	2	2	1	0.0
Gray-crowned Rosy-Finch	2	1	<1	0.0
Turkey Vulture	2	1	<1	0.0
Brewer's Blackbird	1	1	1	0.0
Golden Eagle	1	1	<1	0.0
House Finch	1	1	<1	0.0
House Wren	1	1	1	0.0
Killdeer	1	1	<1	0.0

Species	# of Individuals	# of Flocks	Species Frequency (as %) (n = 295)	Mean Use
Loggerhead Shrike	1	1	<1	0.0
Northern Harrier	1	1	<1	0.0
Red-tailed Hawk	1	1	<1	0.0
Rufous Hummingbird	1	1	<1	0.0
Sharp-shinned Hawk	1	1	<1	0.0
Swallow sp.	1	1	<1	0.0
Western Kingbird	1	1	<1	0.0
Woodpecker sp.	1	1	<1	0.0
Total (43)	**1,518**	**969**	**75***	**5.1**

* Seventy-four surveys resulted in zero bird detections; therefore, percentage of surveys with at least one bird detection was 75%.

Note: Because of rounding error, mean use values may not equal total shown.

Summary results for individual point count locations are presented in Table 4. Values for number of species (range = 6–18), number of individuals (range = 26–168), number of flocks (range = 23–94), and mean use (range = 1.3–8.1) varied between sites.

Table 4. Summary of Key Metrics for Individual Migratory Bird Point Count Locations, April–November 2011.

Survey Site	# of Surveys	# of Species	# of Individuals	# of Flocks	% of Surveys w/ Bird Detections	Mean Use[1]
1	20	6	86	60	60	4.3
2	20	6	26	23	70	1.3
3	16	17	120	57	81	7.5
4	19	11	76	50	84	4.0
5	20	9	113	76	70	5.7
6	20	10	111	94	70	5.6
7	20	7	67	41	70	3.4
8	21	11	118	93	81	5.6
9	19	6	94	64	79	4.9
10	20	12	161	72	80	8.1
11	20	10	88	71	75	4.4
12	19	10	99	70	74	5.2
13	23	18	168	91	74	7.3
14	19	8	116	50	79	6.1
15	19	9	75	57	79	3.9
Total	**295**	**43[2]**	**1,518**	**969**	**75%[3]**	**5.1**

[1] Because of rounding error, mean use values may not equal total shown.

[2] The same species were observed at multiple sites; therefore, this total represents the number of individual species observed at all sites.

[3] Seventy-four surveys resulted in zero bird detections; therefore, percentage of surveys with at least one bird detection was 75%.

Survey site 2 had relatively few birds (26 individuals; mean use = 1.3) recorded on the 20 surveys conducted at that site. Survey sites 10 and 13 had the highest number of individuals (161 and 168, respectively), and sites 3 and 10 had the highest mean use (7.5 and 8.1, respectively). All sites had at least three surveys when no birds were recorded.

BREEDING BIRD SURVEYS

SWCA established and conducted 15 breeding bird survey grids in the Project site following protocols established in Rocky Mountain Bird Observatory's *Field Protocol for Spatially Balanced Sampling of Landbird Populations* (Hanni et al. 2010). This study design allows for analyses of population trends for diurnal, regular-breeding landbird species. Its application in the Project site would allow for integration into and comparison with Rocky Mountain Bird Observatory's similar efforts in the Atlantic Rim Natural Gas Development Project Area (Van Lanen et al. 2011), as well those across broader landscapes where similar studies are conducted (see White et al. 2011).

Survey areas for each grid were selected using generalized random-tessellation stratification (GRTS), a spatially balanced sampling algorithm (Stevens and Olsen 2004), without sample weighting (i.e., not accounting for any factor expected to influence a species' distribution [e.g., habitat type]). By using GRTS, data-embedded information on spatial autocorrelation can increase density estimate precision. This spatially balanced sampling design also allows for adjustment of sampling effort among years while preserving a random sampling design (Hanni et al. 2010).

Each survey site consisted of 16 point count locations in a 4 × 4 grid, with 250 m spacing between points. Each grid was surveyed once in June 2011. Surveys were initiated within 30 minutes of local sunrise and were completed by 10:00 am. Habitat information was collected at each point count location prior to conducting the avian count to allow birds time to adjust to the presence of field personnel. Habitat data collected included proximity to human-made structures (e.g., roads, fences) and variables used to describe overstory, shrub layer, and groundcover components. Standard weather (e.g., wind speed, cloud cover) variables were also collected prior to starting the avian survey. Upon completion of the habitat data collection, biologists conducted an avian survey at each point for 6 minutes. All bird detections were recorded regardless of distance. Data for each detection included species, number of individuals, horizontal distance from observer, age, sex, and how detected.

The 15 grids of 16 point counts were surveyed in June 2011 for a total of 240 individual sampling points. For all sites combined, 1,944 individuals representing 63 species were recorded (Table 5). The most prevalent species, based on total number of individuals recorded and frequency of detection (on grids and individual points), was horned lark (411 individuals, 100% occurrence on the 15 grids, and on 73% of the 240 point counts). Following horned lark, in order of prevalence, were Brewer's sparrow (*Spizella breweri*; 283, 100%, 65%), vesper sparrow (*Pooecetes gramineus*; 216, 93%, 55%), and sage thrasher (*Oreoscoptes montanus*; 138, 80%, 46%), all species closely associated with sagebrush communities. These four species combined for 1,048 individuals or 54% of all detections.

Table 5. Summary Statistics for Grid-based Breeding Bird Surveys, June 2011.

Species	# of Individuals	% Frequency on Grids (n = 15)	% Frequency on Individual Points (n = 240)
Horned Lark	411	100	73
Brewer's Sparrow	283	100	65
Vesper Sparrow	216	93	55
Sage Thrasher	138	80	46
Green-tailed Towhee	116	87	35
Rock Wren	104	67	31
Sage Sparrow	89	47	25
Western Meadowlark	58	60	15
Brown-headed Cowbird	49	60	13
American Robin	47	40	16
Common Raven	41	73	13
Sparrow sp.	32	93	10
Common Nighthawk	28	53	10
Greater Sage-grouse	23	13	<0.5
Warbling Vireo	23	27	8
House Wren	22	20	6
American Goldfinch	21	27	5
Yellow Warbler	21	20	6
Red-winged Blackbird	17	13	5
MacGillivray's Warbler	16	27	5
Mountain Bluebird	15	33	4
Chipping Sparrow	14	20	3
Dusky Flycatcher	11	7	3
Sora	10	13	3
Orange-crowned Warbler	9	13	3
Brewer's Blackbird	8	7	3
Killdeer	8	20	2
Mourning Dove	8	20	2
Savannah Sparrow	8	13	3
Northern Flicker	7	20	3
N. Rough-winged Swallow	7	20	1
Red-tailed Hawk	7	27	2
Undetermined sp.	7	27	3
Song Sparrow	6	20	2
Broad-tailed Hummingbird	5	20	2
Common Yellowthroat	4	7	1
Say's Phoebe	4	13	1
Tree Swallow	4	20	2
Wilson's Snipe	4	7	1
Ruby-crowned Kinglet	3	7	1
Western Wood-Pewee	3	7	1
American Kestrel	2	13	<0.5
Bald Eagle	2	7	1

Species	# of Individuals	% Frequency on Grids (n = 15)	% Frequency on Individual Points (n = 240)
Black-capped Chickadee	2	7	1
Black-crowned Night Heron	2	7	<0.5
Common Merganser	2	7	<0.5
Common Poorwill	2	13	1
Dark-eyed Junco	2	13	<0.5
Hermit Thrush	2	13	1
Lark Sparrow	2	7	<0.5
Northern Harrier	2	7	<0.5
Yellow-rumped Warbler	2	7	<0.5
Barn Swallow	1	7	<0.5
Bewick's Wren	1	7	<0.5
Black-billed Magpie	1	7	<0.5
Blackbird sp.	1	7	<0.5
Blue-gray Gnatcatcher	1	7	<0.5
Cliff Swallow	1	7	<0.5
Empidonax sp.	1	7	<0.5
Hammond's Flycatcher	1	7	<0.5
Loggerhead Shrike	1	7	<0.5
Mountain Chickadee	1	7	<0.5
Oriole sp.	1	7	<0.5
Swainson's Thrush	1	7	<0.5
Violet-green Swallow	1	7	<0.5
Wilson's Warbler	1	7	<0.5
Yellow-breasted Chat	1	7	<0.5
Total (63)	**1,944**	**100**	**99***

* One point count survey resulted in zero bird detections; although rounding to the nearest whole number would result in a 100% frequency (239 of 240 = 99.58%); this table shows 99% to recognize the single point count with no birds.

The number of species and number of individuals varied between survey grid sites (Table 6). The mean number of species per grid was 16 (range of 9–30), while the mean number of individuals was 130 (range of 58–182). Although the number of species at four survey locations (sites 42, 49, 94, and 263) differed from the mean by more than 50%, only one site (163) differed by 50% from the mean in the number of individuals recorded.

Table 6. The Number of Species and Number of Individuals per Grid-based Breeding Bird Survey Site, June 2011.

Grid Identifier	# of Species	# of Individuals
42	30	182
49	29	131
94	30	157
151	10	113
163	11	58
208	10	92
224	9	121
263	28	169
321	15	143
335	15	173
358	13	155
470	12	119
482	12	121
575	12	123
605	10	87
Total	**63**[1]	**1,944**

[1] The same species were observed at multiple sites; therefore, this total represents the number of individual species observed at all sites.

WATERBIRD SURVEYS

Waterbird surveys were conducted in 2011 during spring (April 26–May 4), summer (August 23–24), and fall (October 20–21) at each of the four major reservoirs (Kindt, Rasmussen, Sage Creek, and Teton) occurring within the Project site and surrounding area. These surveys were conducted to help build a baseline of potential prey species and assess their spatiotemporal abundance in the Project site at locations with the potential to attract and/or concentrate eagles and other raptor species. Surveys were conducted using spotting scopes to maximize coverage from a minimal number of viewing locations, as well as to facilitate species identification. Along with standard survey information (i.e., date, location, observer, time, weather conditions), species-specific data collected included species, age, sex, and number of individuals.

SPRING SURVEYS

Spring waterbird surveys were conducted between April 26 and May 4, 2011. These surveys resulted in a total count of 1,415 individuals representing 35 species (Table 7). American coot (*Fulica americana*) was the most abundant species accounting for 364 individuals (26% of total count). Scaup (*Aythya* sp.), *Aechmophorus* grebes (i.e., western and Clark's), and eared grebe (*Podiceps nigricollis*) were the next most abundant species with 351, 209, and 113 individuals, respectively. Collectively, those four groups accounted for 1,037 individuals or 73% of all birds detected.

Table 7. Species, Number of Individuals, and Spring Survey Dates of Waterbird Surveys at Four Major Reservoirs within the Chokecherry-Sierra Madre Wind Resource Area, 2011.

Species	Kindt 5/2/11	Rasmussen 5/4/11	Sage Creek 4/26/11	Teton 5/4/11	Total Count
Aechmophorus sp.		71			**71**
American Avocet	2	4	2		**8**
American Coot	198	5	100	61	**364**
American White Pelican	2	1		3	**6**
American Wigeon	5	1			**6**
Bufflehead	6	2	1	1	**10**
Calidris sp.	3				**3**
Canada Goose				5	**5**
Canvasback	4				**4**
Cinnamon Teal				3	**3**
Clark's Grebe				1	**1**
Common Loon		4	1		**5**
Common Merganser	53		7	14	**74**
Double-crested Cormorant				6	**6**
Eared Grebe	59	31	6	17	**113**
Gadwall	8	8	5	11	**32**
Greater Scaup	4				**4**
Greater Yellowlegs	2				**2**
Green-winged Teal	2	6		6	**14**
Horned Grebe			1		**1**
Killdeer	16		5	1	**22**
Least Sandpiper	1				**1**
Lesser Scaup	84	19			**103**
Lesser Yellowlegs	1				**1**
Mallard	4			2	**6**
Marbled Godwit	7	1			**8**
Northern Pintail	2			1	**3**
Northern Shoveler		2		6	**8**
Pied-billed Grebe			1		**1**
Redhead	69	11		5	**85**
Ring-billed Gull		1		1	**2**
Ring-necked Duck	8	2		16	**26**
Ruddy Duck	9				**9**
Scaup sp.	200	44			**244**
Western Grebe	39	50	34	14	**137**
White-faced Ibis		3			**3**
Willet	17	2	2		**21**
Wilson's Phalarope	3				**3**
Total	**808**	**268**	**165**	**174**	**1,415**
Number of Species	**25**	**18**	**12**	**19**	**35**

More species and individuals were counted at Kindt Reservoir (25 species, 808 individuals) than the other three reservoirs (Table 7). The fewest species and number of individuals (12 species, 165 individuals) were recorded at Sage Creek Reservoir during spring surveys.

SUMMER SURVEYS

A total of 1,708 individuals representing 29 species were recorded on summer waterbird surveys conducted on August 23 and 24, 2011 (Table 8). Redhead (*Aythya americana*) had the highest number of individuals (815) accounting for 48% of all birds detected during summer surveys. Lesser scaup (*Aythya affinis*), mallard (*Anas platyrhynchos*), and American coot were the next most abundant species with 157, 149, and 99 individuals, respectively. Collectively, those four species accounted for 1,221 individuals or 71% of all birds detected.

The highest number of individuals (920) was recorded at Rasmussen Reservoir, where 89% (780 individuals) were redheads (Table 8). Nearly all of the season's redheads (780 of 815) were recorded at Rasmussen Reservoir. Despite the high number of birds recorded at Rasmussen Reservoir, biologists recorded the fewest number of species (12) at that location.

Table 8. Species, Number of Individuals, and Summer Survey Dates of Waterbird Surveys at Four Major Reservoirs within the Chokecherry-Sierra Madre Wind Resource Area, 2011.

Species	Kindt 8/23/11	Rasmussen 8/24/11	Sage Creek 8/23/11	Teton 8/24/11	Total Count
American Avocet	10	4	5	6	**25**
American Coot	30		45	24	**99**
American White Pelican	10		12	2	**24**
American Wigeon	2		4	5	**11**
Black-crowned Night Heron			4	3	**7**
Blue-winged Teal		14	6		**20**
California Gull				2	**2**
Canada Goose	16	12			**28**
Common Loon		2			**2**
Common Merganser	1	16			**17**
Double-crested Cormorant			5	6	**11**
Eared Grebe	27	9	7	7	**50**
Gadwall	26			10	**36**
Great Blue Heron			1	1	**2**
Green-winged Teal	26			42	**68**
Herring Gull	3				**3**
Killdeer	1	5	1	3	**10**
Lesser Scaup	80	18	59		**157**
Mallard	102	13	25	9	**149**
Northern Pintail	4		6		**10**
Pied-billed Grebe	3			7	**10**
Redhead		780	35		**815**
Ring-billed Gull		4	2		**6**
Ruddy Duck			9		**9**

Species	Kindt 8/23/11	Rasmussen 8/24/11	Sage Creek 8/23/11	Teton 8/24/11	Total Count
Snowy Egret			1		**1**
Spotted Sandpiper	2		2		**4**
Unknown dabbling duck			35	12	**47**
Unknown gull		13		1	**14**
Western Grebe	3	30	24	10	**67**
Willet	1				**1**
Wilson's Phalarope				3	**3**
Total	**347**	**920**	**288**	**153**	**1,708**
Number of Species	**18**	**12**	**19**	**16**	**29**

FALL SURVEYS

Surveys during the fall migration period on October 20 and 21, 2011, resulted in a total of 11,473 individuals of 29 species recorded (Table 9). Similar to spring, in the fall American coot accounted for the majority of individuals (8,024, 70% of total individuals). A total of 1,692 American wigeon (*Anas americana*) were also recorded. Combined, American coot and American wigeon accounted for 9,716 individuals (85% of all individuals).

More individuals (8,773) and species (22) were recorded at Kindt Reservoir during fall surveys than at other reservoirs (Table 9). Of the 8,024 American coots and 1,692 American wigeons recorded at all reservoirs combined, the survey at Kindt Reservoir accounted for 5,810 coots (66%) and 1,690 wigeon (99%).

Table 9. Species, Number of Individuals, and Fall Survey Dates of Waterbird Surveys at Four Major Reservoirs within the Chokecherry-Sierra Madre Wind Resource Area, 2011.

Species	Kindt 10/21/11	Rasmussen 10/21/11	Sage Creek 10/20/11	Teton 10/20/11	Total Count
American Avocet			8		**8**
American Coot	5,810	2,088		126	**8,024**
American Wigeon	1,690	1	1		**1,692**
Bufflehead	2			1	**3**
Canada Goose	38		5		**43**
Canvasback	5		1		**6**
Common Loon		2			**2**
Common Merganser			64	6	**70**
Eared Grebe	3	98	9		**110**
Gadwall	554	20	3		**577**
Greater Yellowlegs	4				**4**
Green-winged Teal	10	33	44		**87**
Herring Gull		1		2	**3**
Hooded Merganser			3		**3**
Horned Grebe	16	13	5		**34**
Lesser Scaup	24				**24**

Species	Kindt 10/21/11	Rasmussen 10/21/11	Sage Creek 10/20/11	Teton 10/20/11	Total Count
Long-billed Dowitcher	4				**4**
Mallard	121	20	8	3	**152**
Northern Pintail	50	4	3		**57**
Northern Shoveler	1	1	11		**13**
Pectoral Sandpiper	1				**1**
Pied-billed Grebe	6	3			**9**
Redhead	328	27	4		**359**
Ring-billed Gull	1	7	11	9	**28**
Ring-necked Duck	84				**84**
Ruddy Duck	17	13	4		**34**
Surf Scoter		6			**6**
Western Grebe	4	25	3	1	**33**
White-winged Scoter		3			**3**
Total	**8,773**	**2,365**	**187**	**148**	**11,473**
Number of Species	**22**	**18**	**17**	**7**	**29**

ACOUSTIC BAT MONITORING

Anabat (Titley Electronics, Australia) is a bat detection system that uses a broadband microphone that can detect ultrasonic sounds and record them onto a compact flash data card. This system uses a frequency division technique called Zero-Crossings Analysis to produce sonograms that can be viewed on a PDA or computer screen using the AnalookW program. These sonograms display the shape of individual pulses on a frequency graph plotted against time. Bat species produce echolocation vocalizations based on their ecological niche requirements, which may demand different frequency bandwidth, pulse duration, and other characteristics discernible in the sonograms. Sonograms produced through Zero-Crossings Analysis generally have enough information to label a pulse sequence as belonging to a group of bats with similar acoustic characteristics (e.g., 25-kilohertz [kHz] bats) and even allow for identification of acoustically distinctive species (e.g., hoary bat [*Lasiurus cinereus*]) (Kunz et al. 2007). In North America, *Myotis* bat species are generally recognized as being the most difficult to differentiate due to similarities in vocalization characteristics and pulses are often placed within a frequency group (e.g., 40-kHz Myotis).

An index of bat activity was calculated by counting the number of bat passes per detector-hour past sunset (Kunz et al. 2007) for data collected in 2011. The number of detector-hours per night was calculated by summing the number of minutes surveyed between sunset and sunrise and dividing by 60 for each night surveyed. A bat pass was defined as a pulse sequence (commonly referred to as a “call”) consisting of at least one individual pulse that was separated by >1 second from the next pulse (White and Gehrt 2001). An index of activity is used because the number of bats cannot be quantified from acoustic data (Kunz et al. 2007). Individual bats are not identifiable in an acoustical dataset as pulses may have been produced by the same or different individuals over the course of a single night survey period (Hayes 2000 in Kunz et al. 2007). All bat passes were categorized through assessment of both qualitative (e.g., shape) and quantitative (e.g., characteristic frequency) qualities (Weller and

Baldwin 2012). Individual passes were labeled by characteristic frequency type (e.g., 25 kHz, 30 kHz, 40 kHz), then grouped into low (<25 kHz), mid- (30–40 kHz), and high (>50 kHz) characteristic frequency groups. Diagnostic call sequences were labeled by species. For reporting purposes, except where indicated, species-specific passes were combined with the appropriate frequency group.

In 2011, four locations (sites 2-1, 3-1, 3-2, and 4-1) were surveyed for nightly bat activity. Table 10 provides the level of effort (number of nights and number of survey-hours), the total number of bat passes, and the number of passes per survey-hour.

Table 10. Level of Effort and Bat Pass Summary for Locations Surveyed in 2011.

Site	Date Span	# of Survey Nights	# of Survey-Hours	Total # of Bat Passes	# of Bat Passes per Survey-Hour
2-1	Jun 15–27	13	114.4	19	0.2
3-1	Jun 30–Jul 26	27	244.9	79	0.3
3-2	Jul 27–Aug 22	27	267.1	33	0.1
4-1	Sep 23–Oct 20	28	349.7	7	0.0
Total	**Jun 15–Oct 20**	**95**	**976.1**	**138**	**0.1**

The average number of bat passes per survey-hour across a season may be beneficial to delineate approximate dates of local bat activity, including arrival of spring migrants and departure of fall migrants. Furthermore, variation in the number of bat passes per night at an individual site may be useful in identifying migratory pulses.

Activity levels were inconsistent during the survey period (Figure 1). This inconsistency is likely due to lack of recognizable foraging areas (e.g., slow-moving streams, ponds, wooded sites) at the survey locations and the seemingly random occurrence of a bat traveling between roost and foraging sites being detected by the Anabat. The steep increase in the number of bat passes on July 24 (26 bat passes in 9.3 survey-hours = 2.8 bat passes/survey-hour) is four times higher than the next highest average count at that site. Activity levels decreased in mid-August. No survey data were collected from August 23 to September 22 due to system error. Activity levels were low during the September 23 to October 20 survey period with no more than 0.1 bat pass per survey-hour on any given night.

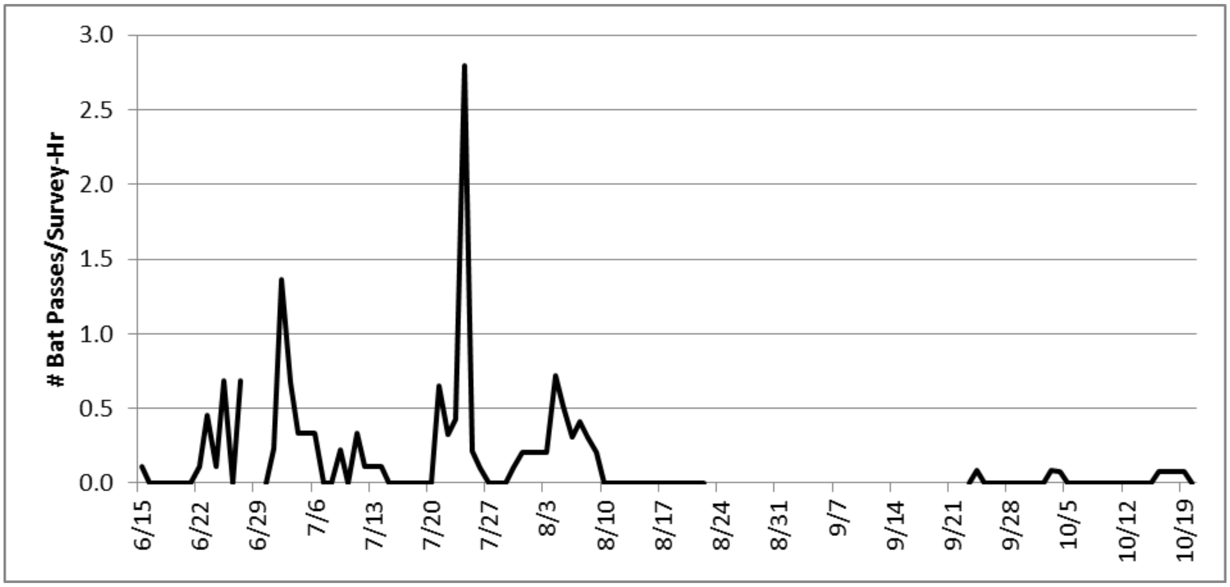

Figure 1. Average number of bat passes per survey-hour, June 15–October 20, 2011.

REFERENCES

Hanni, D.J., C.M. White, R.A. Sparks, J.A. Blakesley, G.J. Levandoski, and J.J. Birek. 2010. Field Protocol for Spatially Balanced Sampling of Landbird Populations. Unpublished report. Rocky Mountain Bird Observatory, Brighton, CO.

Hayes, J.P. 2000. Assumptions and practical considerations in the design and interpretation of echolocation-monitoring studies. Acta Chiropterologica 2:225–236.

Kunz, T.H., E.B. Arnett, B.A. Cooper, W.I.P. Erickson, R.P. Larkin, T. Mabee, M.L. Morrison, J.D. Strickland, and J.M. Szewczak. 2007. Assessing impacts of wind energy development on nocturnally active birds and bats: a guidance document. Journal of Wildlife Management 71:2449–2486.

Stevens, D.L., and A.R. Olsen. 2004. Spatially balanced sampling of natural resources. Journal of American Statistical Association 99:262–278.

Van Lanen, N.J., D.C. Pavlacky Jr., and D.J. Hanni. 2011. Monitoring Birds in the Atlantic Rim Natural Gas Development Project Area; 2010 Report. Technical Report #SC-ARIM-01. Rocky Mountain Bird Observatory, Brighton, CO.

Weller, T.J., and J.A. Baldwin. 2011. Using echolocation monitoring to model bat occupancy and inform mitigations at wind energy facilities. Journal of Wildlife Management 76:619–631.

White, C.M., N.J. Van Lanen, D.C. Pavlacky Jr., J.A. Blakesley, R.A. Sparks, J.M. Stenger, J.A. Rehm-Lorber, M.F. McLaren, F. Cardone, J.J. Birek, and D.J. Hanni. 2011. Integrated Monitoring of Bird Conservation Regions (IMBCR): 2010 Annual Report. Rocky Mountain Bird Observatory, Brighton, CO.

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.

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Bat Survey Report

Chokecherry and Sierra Madre Wind Energy Project

Prepared for

Power Company of Wyoming, LLC

Prepared by

SWCA Environmental Consultants

May 2015

Bat Survey Report
Chokecherry and Sierra Madre Wind Energy Project

Prepared for:

Power Company of Wyoming, LLC
555 17th Street, Suite 2400
Denver, CO 80202

Prepared by:

SWCA Environmental Consultants
295 Interlocken Blvd., Suite 300
Broomfield, CO 80021
(303) 487-1183 / Fax (303) 487-1245

May 2015

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INTRODUCTION

Power Company of Wyoming LLC (PCW) proposes to construct, operate, maintain and decommission the Chokecherry and Sierra Madre Wind Energy Project (CCSM Project), located in Carbon County, Wyoming. The CCSM Project will consist of 1,000 wind turbines capable of generating up to 3,000 megawatts (MW) of clean, renewable wind energy. PCW is developing the CCSM Project in two phases (Figure 1). Phase I will include 500 wind turbine generators located in the western portions of two Wind Development Areas (WDAs) referred to as "Chokecherry" and "Sierra Madre" and associated infrastructure including the Road Rock Quarry, West Sinclair Rail Facility and Phase I Haul Road and Facilities. Phase II will include 500 wind turbine generators and associated infrastructure located in the eastern portions of the Chokecherry and Sierra Madre WDAs.

This Bat Survey Report (Report) describes surveys conducted by PCW to characterize bat use across the CCSM Project for purposes of informing siting decisions and reducing potential impacts on bats and their habitats. In 2012, the U.S. Fish and Wildlife Service (USFWS) issued its Land-Based Wind Energy Guidelines (USFWS 2012). The guidelines seek to assist developers in identifying species of concern that may potentially be affected by a proposed project and recommend a "tiered approach" for assessing potential adverse effects to those species and their habitats. The tiered approach is an iterative decision-making process for collecting information in increasing detail; quantifying the possible risks of proposed wind energy projects to species of concern and their habitats; and evaluating those risks to make siting, construction, and operation decisions (USFWS 2012). To identify potential risks to bats from the CCSM Project, PCW collected baseline data for bat use across the CCSM Project Site. Specifically, PCW conducted monitoring for bats in 2008, 2011, 2012, and 2013 through the use of AnaBat passive acoustic monitors and a DeTect Merlin radar system.

ENVIRONMENTAL SETTING

The CCSM Project is located south of the city of Rawlins, primarily within the bounds of the Overland Trail Ranch (Ranch). Current land use across the Ranch consists of agricultural operations, including cattle grazing and hay production. The Ranch, including the CCSM Project Site, is dominated by three topographic features, Chokecherry Plateau, Miller Hill, and Sage Creek Rim, separated by the Sage Creek Basin (Figure 1). Chokecherry Plateau is the most topographically varied, consisting of ridges and rolling hills that generally slope northeasterly towards the North Platte River. Miller Hill and Sage Creek Rim are relatively level and gently sloped in a southwesterly direction. The Sage Creek Basin is a flat, high desert basin.

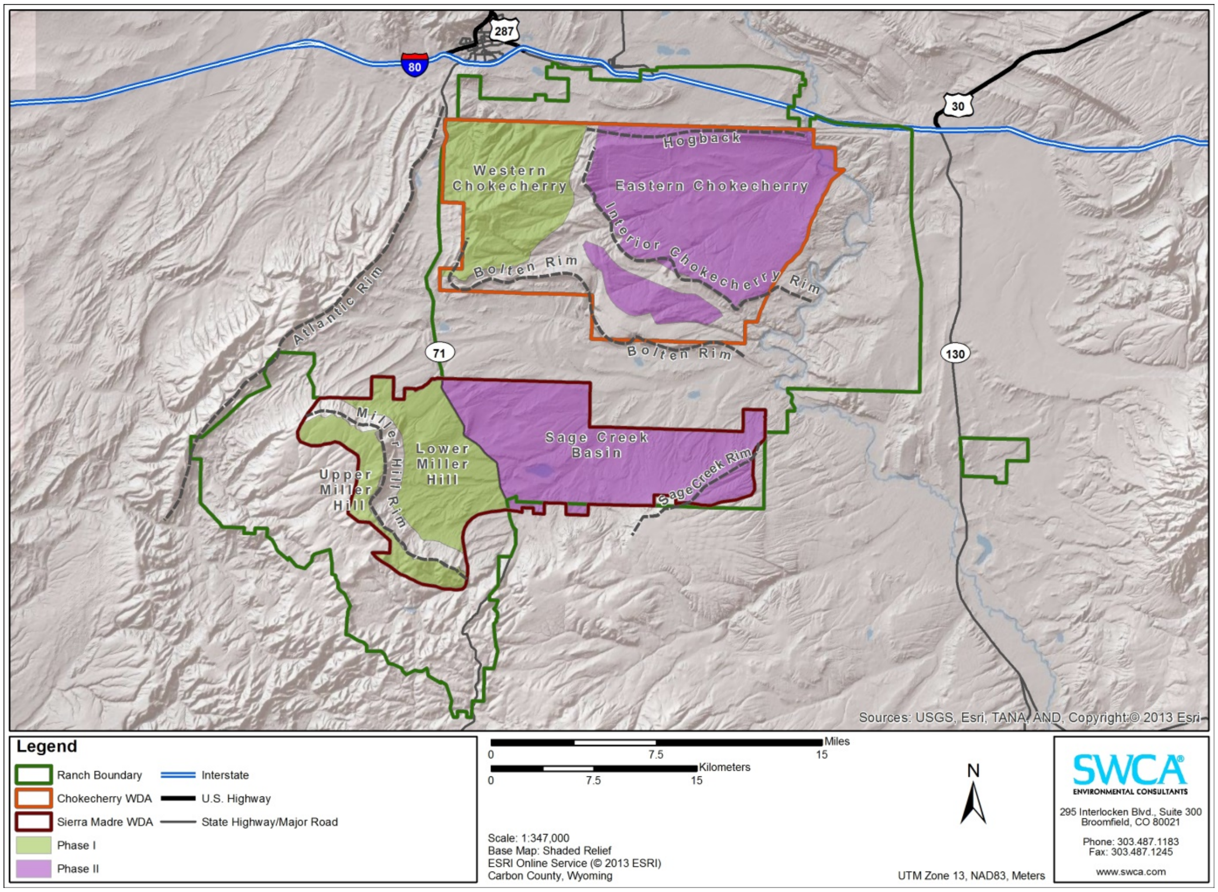

Figure 1. CCSM Project overview.

Vegetation cover in the CCSM Project Site is typical of Wyoming Basin and Southern Rockies ecoregions, defined by rolling sagebrush steppe, salt desert shrub basins, and foothill shrublands (Chapman et al. 2004). Sagebrush steppe communities are interspersed with bunchgrass/rhizomatous grass communities and allied shrubs, and generally have relatively low forb cover. Surface water sources on the Ranch include the North Platte River and several small tributaries. In addition, several small ephemeral streams and a few isolated springs are located throughout the Ranch. There are also reservoirs located within Sage Creek Basin, including Kindt, Rasmussen, Sage Creek, and Teton Reservoirs.

Of the eight bat species or subspecies in the contiguous U.S. currently listed or proposed for listing under the Endangered Species Act (USFWS 2014), none are expected to occur in the vicinity of the CCSM Project. The Bureau of Land Management (BLM 2010) lists fringed myotis, long-eared myotis, spotted bat (*Euderma maculatum*), and Townsend's big-eared bat as Sensitive Species. According to Orabona et al. (2012), bat species that have been observed or acoustically detected in the general vicinity of the CCSM Project (Latilong 25 in Orabona et al. 2012) include, California myotis (*Myotis californicus*), western small-footed myotis (*M. ciliolabrum*), long-eared myotis (*M. evotis*), little brown myotis (*M. lucifugus*), fringed myotis (*M. thysanodes*), long-legged myotis (*M. volans*), Yuma myotis (*M. yumanensis*), eastern red bat (*Lasiurus borealis*), hoary bat (*L. cinereus*), silver-haired bat (*Lasionycteris noctivagans*), big brown bat (*Eptesicus fuscus*), Townsend's big-eared bat (*Corynorhinus townsendii*), and pallid bat (*Antrozous pallidus*). In fact, a recent survey conducted in southern Wyoming, including areas near the CCSM Project, found all of these species, except California myotis (Griscom et al. 2012).

METHODS

Acoustic Survey

AnaBat detection systems manufactured by Titley Electronics were used for acoustic bat surveys conducted on the CCSM Project Site. Bat species produce echolocation vocalizations based on their ecological niche requirements, which may demand different frequency bandwidth, pulse duration, and other characteristics discernible in sonograms. AnaBat systems are capable of detecting and recording these ultrasonic sounds and producing sonograms, individual pulses on a frequency graph plotted against time. AnaBat sonograms generally have enough information to label a pulse sequence to a group of bats with similar acoustic characteristics (e.g., 25-kilohertz [kHz] bats) and even allow for identification of acoustically distinctive species (e.g., hoary bat) (Kunz et al. 2007). In North America, *Myotis* bat species are generally recognized as being the most difficult to differentiate due to similarities in vocalization characteristics; therefore these pulses are often placed within a frequency group (e.g., 40-kHz Myotis).

For acoustic bat surveys conducted on the CCSM Project Site, a standard index of bat activity was generated by counting the number of bat passes per detector-night at each survey location (Hayes 1997; Kunz et al. 2007). A bat pass is defined as a pulse sequence (commonly referred to as a "call") consisting of at least one individual pulse that was separated by more than 1 second from the next pulse (White and Gehrt 2001). Individual bats are not identifiable in an acoustical dataset since pulses may have been produced by the same or different individuals over the course of a single night survey period (Hayes 2000 in Kunz et al. 2007); therefore, an index of activity is used because the exact number of bats cannot be quantified from acoustic data (Kunz et al. 2007).

All bat passes were categorized through assessment of both qualitative (e.g., shape) and quantitative (e.g., characteristic frequency) qualities as demonstrated by Weller and Baldwin (2012). Bat passes were classified as pertaining to low (<35 kilohertz [kHz]) or high (>35 kHz) characteristic frequency groups in 2008, and further subdivided into low (≤25 kHz), mid (~30-40 kHz), and high (≥40 kHz) frequency groups for subsequent surveys. Further refinement in the dataset was intended to provide more differentiation as to what species may be represented in the low frequency group. The low frequency category in the 2008 dataset may also have included some bat species with a characteristic frequency around 30 kHz, such as long-eared myotis, fringed myotis, Townsend's big-eared bat, and pallid bat (Griscom et al. 2012; Keinath undated). Diagnostic call sequences in the datasets were labeled only for hoary bat as that species has a unique call pattern easily distinguished from other bat species.

Radar Survey

A DeTect Merlin radar system was used to map avian and bat use from March 2011 through March 2013 at multiple locations within the CCSM Project Site. The radar is a trailer-mounted system with a 200-watt horizontal solid-state S-band radar and a 10-kilowatt (kW) vertically operating X-band open array radar. The horizontal scanning radar (HSR) has a range of up 4.6 miles in a 360-degree pattern around the unit. The HSR is able to record how targets use topographic features within the CCSM Project Site by collecting accurate location data for each target as it moves through the radar scanning area. The vertical scanning radar (VSR) has a 24-degree beam width and detects flight paths heights to 2.0 miles or more above the unit. The HSR does not collect altitudinal data for biological targets; however, the elevation of targets may be collected if they pass through the footprint of the VSR. These data are useful for determining the relative percentage of targets passing through the rotor swept zone (RSZ) versus those flying above and below the RSZ. The radar ran continuously, collecting data for movements of birds throughout the day, and birds and bats at night.

Current avian radar technology and software are not able to distinguish between taxonomic groups (e.g., bird or bat). Rather, data for each target is recorded in a series of more than 60 variables based on different measures of recorded pixel size and shape. These variables can differ greatly within species and even for a single individual. It is not possible to determine a target's specific identity from the dataset recorded by the radar system. Targets could be grouped based upon their relative size, but this is also problematic due to variance in the size of individuals and overlap in variable values between small bird and bat species. Though the radar dataset did not help in quantifying species-specific use on the CCSM Project Site, it did prove useful for analysis of nocturnal broad-front migratory patterns and flight heights.

RESULTS AND DISCUSSION

2008 Acoustic Survey Results

Passive acoustic bat surveys were conducted from July 13 to October 13, 2008 (Solick et al. 2008). Six sites were surveyed with eight AnaBat units (Figure 1), two of which were placed on meteorological towers approximately 45 meters above the ground, with the remaining six AnaBat units being ground-based. The study resulted in 3,021 bat passes across 669 detector-nights for an average of 4.52 bat passes/detector-night. However, this mean value is heavily influenced by site A3 located in Hugus Draw (Figure 2) which comprised 63% of all bat passes recorded during 2008 (average 20.62 passes/detector-night). Site A3 is located near a wetland/stock pond within a defined Turbine No-Build Area[1]. As no impacts to bats will occur at site A3 because of its location within a Turbine No-Build Area, it was removed from the dataset as an outlier. After removal of site A3, the remaining seven AnaBat sites demonstrated more consistent bat use with an average of 1.9 bat passes per detector-night (Table 1).

Bat activity in 2008 was highest from July 13 through the end of August, with activity peaks on July 27 and August 22. Very low activity was recorded in September and October. Temporal variation was similar among AnaBat sites across the CCSM Project.

Approximately 63% of all bat passes recorded were of high-frequency bats. Ground-based AnaBat units recorded similar ratios of low- and high-frequency bats, though there was variation between sites and across the survey period. However, elevated units deployed on meteorological towers consistently recorded disproportionately high numbers of low-frequency bat passes than high-frequency, with hoary bat comprising 7% of all bat passes. Trends in activity for hoary bat were concordant with patterns observed for all bat frequency groups, including a peak in activity on August 22.

Table 1. Number of bat passes per detector night for 2008, 2010, and 2011 passive acoustic bat surveys.

Year	Mid and High Frequency Bat Passes	Low Frequency Bat Passes	Hoary Bat Passes	Total Bat Passes	Detector Nights	Bat Passes/ Night
2008[2]	1909	895	217	1124	577	1.9
2011	156	22	7	185	95	1.9
2012	115	9	10	134	62	2.2
Total	**2180**	**926**	**234**	**1443**	**734**	**2.0**

[1] Designated areas where turbines would not be constructed or overhang (PCW 2015).

[2] 2008 data do not include bat passer or detector nights for bat monitoring site A3

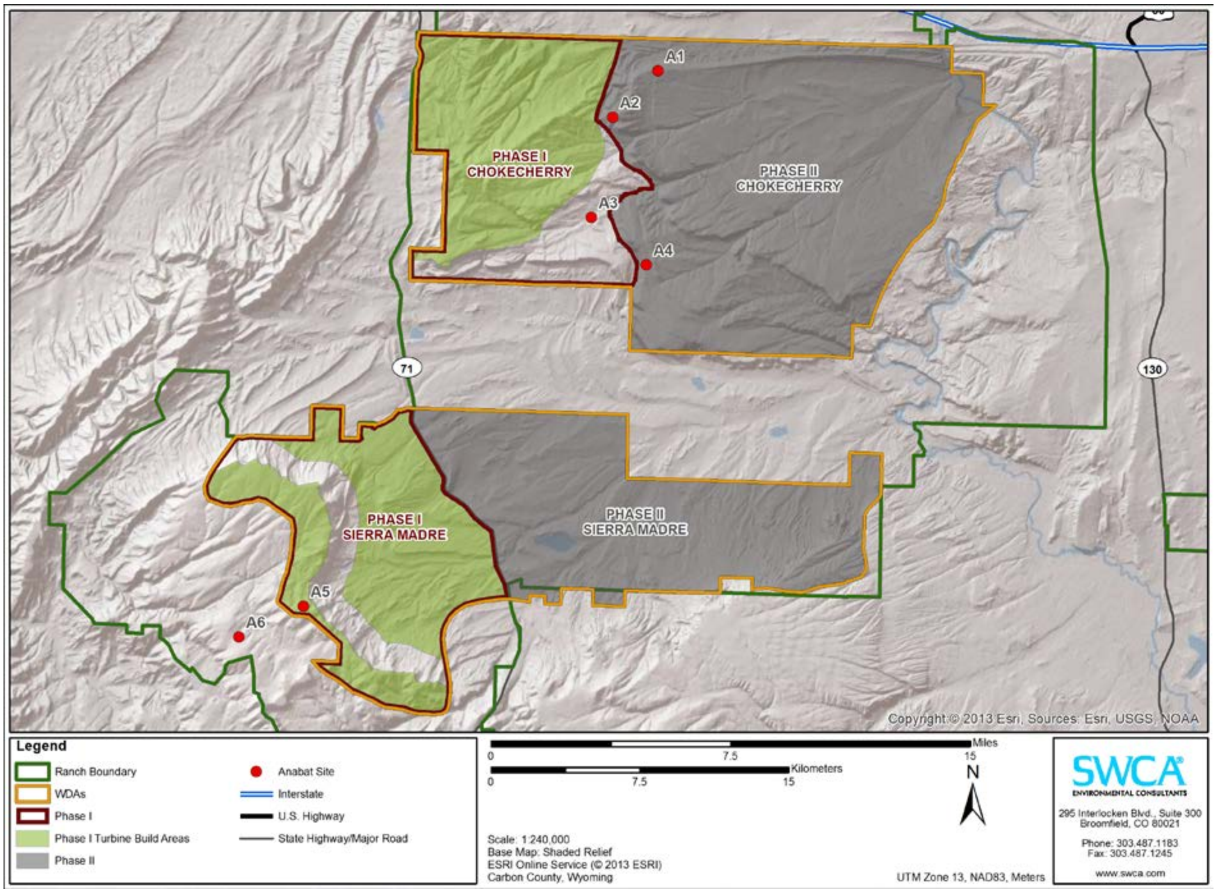

Figure 2. AnaBat sites surveyed in 2008.

2011 and 2012 Acoustic Survey Results

Bat surveys in 2011 and 2012 consisted of passive acoustic monitoring with ground-based AnaBats conducted in coordination with radar surveys. To complement data collected by the radar, acoustic bat monitoring was conducted at five locations collocated with the radar system (Chokecherry Bench, Smith Draw, Upper Iron Springs, McKinney Creek, and Pine Grove) (Figure 3) to characterize nightly bat activity during periods from June 15 to October 20, 2011, and June 27 to August 29, 2012. Collectively, sites were surveyed for 95 detector-nights in 2011 and 62 detector-nights in 2012. In total, 185 and 134 bat passes were recorded in 2011 and 2012, respectively, for an average of 2.0 bat passes/detector-night across years, nearly identical to the 1.9 bat passes/detector-night (after removal of the A3 site located in Hugus Draw) documented in 2008 (Table 1).

Activity levels were variable during the 2011 and 2012 survey periods. There was a spike in the number of bat passes on July 24, 2011 (26 total bat passes) and over the nights of July 11, 2012 (17 bat passes) and July 12, 2012 (15 bat passes). These peaks in activity are similar in timing to a spike in activity on July 27, 2008 (Solick et al. 2008).

In 2011, activity levels decreased in mid-August and remained low from September 23 to October 20, averaging less than 1 bat pass/detector-night. This low activity is similar to that reported for the September to October period in 2008. The 2011 surveys recorded more mid- and high-frequency (156; 84% of all bat passes) than low-frequency (29; 16%) bat passes. Hoary bat comprised 4% of all bat passes and was specifically identified in the data on four nights (July 30, and August 12–14). Surveys in 2012 had trends similar to the 2011 surveys with mid- and high-frequency bat passes accounting for 115 (86%) of the 134 total bat passes. Ten bat passes were attributable to hoary bat (7% of all bat passes) evenly spaced across seven nights between July 26 and August 29, 2012.

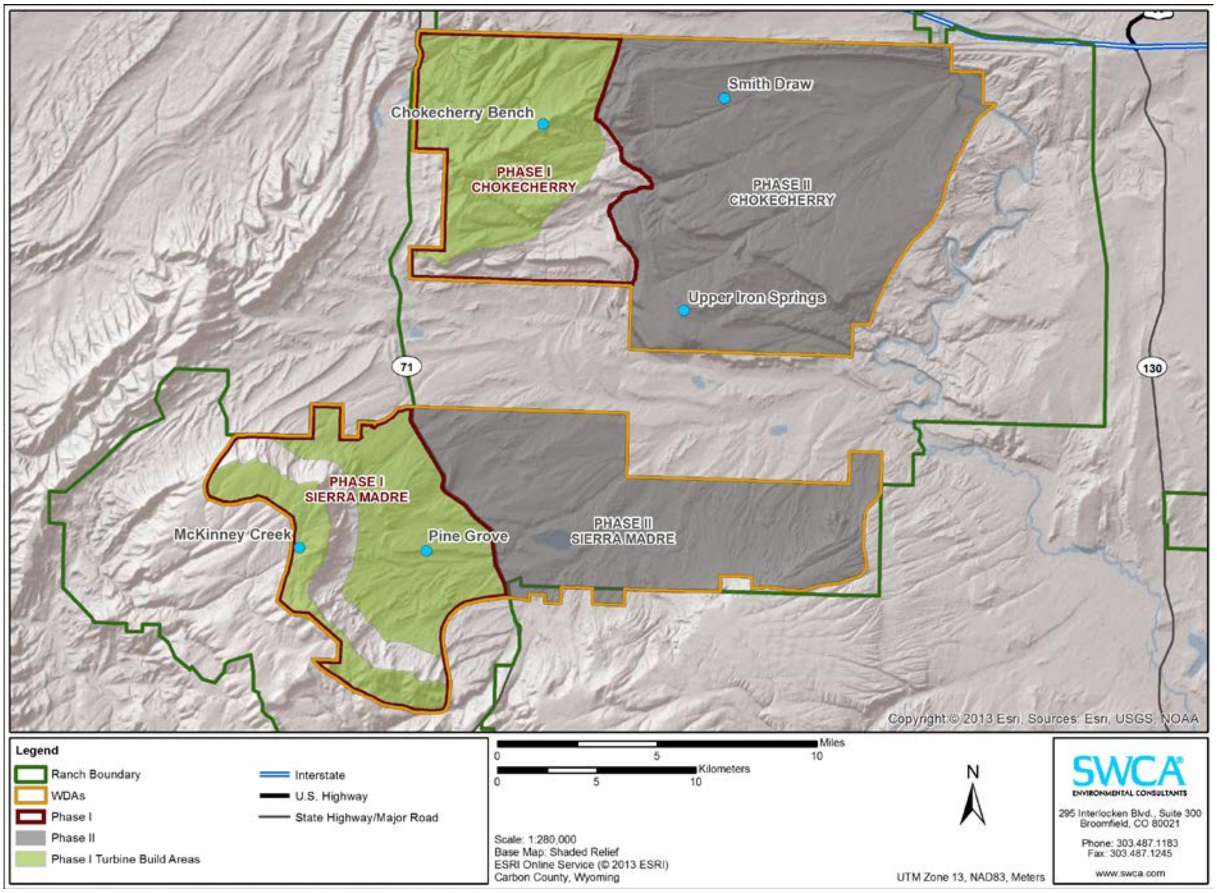

Figure 3. AnaBat sites surveyed in 2011 and 2012.

2011 through 2013 Radar Surveys

Bird and bat activity detected by the radar system does not correlate to the ground-based bat activity detected by the AnaBat unit. In fact, radar data collected during periods of increased AnaBat activity show a trend towards a period of low activity (DeTect 2013). However, the radar dataset is useful for analysis of broad-front migratory patterns of avian and bat species. The radar data consistently demonstrate that the highest average number of targets detected per hour on the CCSM Project Site occur at night during the spring and fall seasons. The summer seasons showed lower numbers of targets per hour distributed more evenly during the day and night, while the winter seasons showed a large decrease in the number of targets recorded per hour. This is consistent with expected avian and bat migratory events passing over the area. Further, the radar data show that 90% to 95% of all targets detected by the radar, which includes both birds and bats, were flying above the wind turbine rotor swept zone at altitudes where there is no risk of collision.

SUMMARY

Acoustic bat surveys were conducted for the CCSM Project during the summer and fall seasons in 2008, 2011, and 2012. The average number of bat passes per night was consistent between survey years at 1.9 in 2008 (after removal of the A3 site outlier), 1.9 in 2011 and 2.2 in 2012. These bat passage rates are consistent with the 2.2 bat passes per night observed at the nearby Foote Creek Rim wind project (Gruver 2002). All three years of acoustic survey show the highest bat activity occurred in July and August during favorable weather conditions. Further, the surveys show that bat activity was relatively low in September and October indicating that resident bat activity as well as bat migration is tapering off during that period. In addition, data collected by the radar between 2011 and 2013 for all biological targets, including avian and bat species, showed that 90% to 95% of the flight paths occur above the wind turbine rotor swept zone; demonstrating that these targets would not be at risk of collision. Therefore, because ground level bat activity measured using passive acoustic monitoring on the CCSM Project site is relatively low and the recorded flight heights of any potential migrating bats or avian species are well above the rotor swept zone, impacts to bat species are expected to be minimal for the CCSM Project.

REFERENCES

Bureau of Land Management. 2010. BLM Wyoming Sensitive Species Policy and List. USDI Bureau of Land Management, Wyoming State Office, Cheyenne, WY.

Chapman, S.S., S.A. Bryce, J.M. Omernik, D.G. Despain, J. ZumBerge, and M. Conrad. 2004. Ecoregions of Wyoming (color poster with map, descriptive text, summary tables, and photographs): Reston, Virginia, U.S. Geological Survey (map scale 1:1,400,000).

DeTect. 2012. MERLIN Avian Radar Survey for the Power Company of Wyoming: Graphical Data Report for March – November, 2011. Prepared for Power Company of Wyoming, Denver, CO. Prepared by DeTect, Inc., Panama City, FL.

------. 2013. MERLIN Avian Radar Survey for the Chokecherry and Sierra Madre Wind Energy Project: Graphical Data Report for November, 2011 – March, 2013. Prepared for Power Company of Wyoming, Denver, CO. Prepared by DeTect, Inc., Panama City, FL.

Ellison, L.E. 2012. Bats and wind energy—A literature synthesis and annotated bibliography. U.S. Geological Survey Open-File Report 2012-1110.

Griscom, H.R., M.D. Andersen, and D.A. Keinath. 2012. Bats of southern Wyoming: distribution and migration, year 1 report. Prepared for the USDI Bureau of Land Management, Cheyenne, WY. Prepared by Wyoming Natural Diversity Database, University of Wyoming, Laramie, WY.

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. 149 pp.

Hayes, J.P. 1997. Temporal variation in activity of bats and the design of echolocation-monitoring studies. Journal of Mammalogy 78:514-524.

------. 2000. Assumptions and practical considerations in the design and interpretation of echolocation-monitoring studies. Acta Chiropterologica 2:225–236.

Keinath, D.A. Undated. AnaBat call key for the Greater Yellowstone Ecosystem. Wyoming Natural Diversity Database.

Kunz, T.H., E.B. Arnett, B.A. Cooper, W.I.P. Erickson, R.P. Larkin, T. Mabee, M.L. Morrison, J.D. Strickland, and J.M. Szewczak. 2007. Assessing impacts of wind energy development on nocturnally active birds and bats: a guidance document. Journal of Wildlife Management 71:2449–2486.

Orabona, A., C. Rudd, M. Grenier, Z. Walker, S. Patla, and B. Oakleaf. 2012. Atlas of Birds, Mammals, Amphibians, and Reptiles in Wyoming. Wyoming Game and Fish Department Nongame Program, Lander.

Power Company of Wyoming. 2015. Phase I Eagle Conservation Plan, Chokecherry and Sierra Madre Wind Energy Project. Power Company of Wyoming LLC, Denver, Colorado.

Solick, D., G. Johnson, T. Rintz, D. Strickland. 2008. Bat Surveys for the Chokecherry and Sierra Madre Wind Resource Areas. Carbon County, Wyoming. Final Report November 29, 2008. Prepared by Western EcoSystems Technology, Inc.

U.S. Fish and Wildlife Service (USFWS). 2012. Land Based Wind Energy Guidelines. Wind Turbine Guidelines Advisory Committee. U.S. Fish and Wildlife Service, Department of the Interior, Washington D.C.

------. 2014. Endangered Species. Available online at: www.fws.gov/endangered. Accessed December 2014.

Weller, T.J., and J.A. Baldwin. 2011. Using echolocation monitoring to model bat occupancy and inform mitigations at wind energy facilities. Journal of Wildlife Management 76:619–631.

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.