Appendix D-3

Avian Baseline Studies 2010

Avian Baseline Studies at the Sun Creek Wind Resource Area Kern County, California

Final Report
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EXECUTIVE SUMMARY

Alta Windpower Development, LLC has proposed a wind-energy facility in Kern County, California, known as the Sun Creek Wind Resource Area. CH2M HILL contracted Western EcoSystems Technology, Inc. to conduct surveys and monitor avian resources in the Sun Creek Wind Resource Area to estimate the impacts of facility construction and operation on birds. The following document presents results of fixed-point bird use surveys, raptor nest surveys, and incidental wildlife observations.

The principal objectives of the study were to: 1) provide site-specific avian resource and 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 objective of the fixed-point bird use surveys was to estimate the seasonal, spatial, and temporal use of the Sun Creek Wind Resource Area by birds, particularly raptors. Bird use surveys were conducted from May 11, 2009, through May 6, 2010, at six points established throughout the Sun Creek Wind Resource Area. Sixty-one unique bird species were identified over the course of 311 30-minute surveys, representing 2,581 individuals within 1,044 groups. A total of 43 raptors were observed, representing six species.

Bird use by species was calculated as the mean number of birds per 30-minute survey. Among large birds, common raven had the highest use of any other species across all seasons (spring 1.56 birds/plot/30-minute survey; summer, 0.44; fall, 1.29; and winter, 0.89). Waterbird use was recorded only during spring (0.73 birds/plot/30-minute survey), while vultures use was recorded during spring (1.04) and fall (0.23). Raptor use was highest during the winter (0.20 birds/plot/30-minute survey) and lowest during the summer (0.10). A total of 43 individual raptors, representing six unique species, were observed during surveys, with red-tailed hawk and golden eagle being the most commonly observed raptor species. Use by passerines was higher in winter (7.26 birds/plot/30-minute survey) and spring (7.07), compared to fall (5.23) and summer (2.28). However small bird observations were limited to a 100-m viewshed, thus use estimates for small birds are not directly comparable to use estimates for large bird types.

During the study, 220 groups of large birds totaling 559 individuals were observed flying during fixed-point bird use surveys. For all large bird species combined, 57.6% of flying birds were observed below the likely rotor-swept height, 22.7% were flying within the rotor-swept height, and 19.7% were above the rotor-swept height for typical turbines that could be used in the Sun Creek Wind Resource Area. Bird types most often observed flying within the turbine rotor-swept height were vultures (58.3%) and raptors (23.1%). For small birds, 423 groups totaling 1,339 individuals were recorded flying within the 100-m viewsheds. The majority of flying passerines (94.4%) were observed below the rotor-swept heights, and the remaining 5.6% were observed flying within the rotor-swept height.

A relative exposure index was calculated for each bird species based on initial flight height observations and relative abundance (defined as the use estimate). Turkey vulture and common raven had the highest exposure indices of any large bird species (0.19 and 0.16, respectively). All other large bird species had an exposure index of 0.02 or less. The only raptor species with exposure indices greater than zero were golden eagle (0.02) and red-tailed hawk (0.01). Of the small bird species, house finch has the highest exposure index (0.12), followed by horned lark (0.08). All other small bird species had exposure indices of 0.01 or less.

Levels of bird use varied within the study area by point. For all large bird species combined, use was highest at point three (2.98 birds/30-minute survey), with use ranging from 1.27 to 2.41 at other points. Relatively high large bird use at point three was primarily due to higher use by vultures (1.98 birds/30-minute survey) at this point. Raptor use was highest at points four, five, and six, and was comprised primarily of use by buteos and eagles. Passerine use was highest at point one (9.40 birds/30-minute survey), with use ranging from 3.38 to 7.15 at the remaining points.

The annual mean raptor use estimate (number of raptors divided by the number of plots and the total number of surveys) in the Sun Creek Wind Resource Area was compared to mean raptor use estimates from 39 other studies that implemented similar protocols to the present study and had data for three or four different seasons. Based on fixed-point bird use data collected at the Sun Creek Wind Resource Area, mean annual raptor use was 0.09 raptors/plot/20-minute survey, ranking second lowest compared to raptor use at the other wind resource areas.

A regression analysis of raptor use and raptor collision mortality for 13 new-generation wind-energy facilities where similar methods were used to obtain raptor use estimates showed a significant (R^2 = 69.9%) correlation between raptor use and raptor collision mortality. Using this regression to predict raptor collision mortality the Sun Creek Wind Resource Area yields an estimated fatality rate of less than 0.01 fatalities/megawatt/year, or less than one raptor per year for each 100-megawatt of wind-energy development. However, the 90% prediction interval may provide a more realistic estimate of potential raptor mortality. Based on this prediction interval, up to 19 raptor fatalities per 100 megawatts per year could occur within the Sun Creek Wind Resource Area. Based on species composition of the most common raptor fatalities at other western wind-energy facilities and species composition of raptors observed at the Sun Creek Wind Resource Area during the surveys, the majority of the fatalities of diurnal raptors will likely consist of red-tailed hawks. Based on the seasonal use estimates, it is expected that risk to raptors would be unequal across seasons, with higher risk during the winter and relatively low risk during other times of the year.

Aerial raptor nest surveys were conducted via helicopter on April 13 and May 24, 2010 at the Sun Creek Wind Resource Area. The survey area for golden eagle nests included all eagle nesting habitat within a 10-mile buffer of the Sun Creek Wind Resource Area, while the survey area for all other raptor and large bird nests included a two-mile buffer. One active golden eagle nest was observed on a cliff ledge approximately three miles from the northwestern boundary of the Sun Creek Wind Resource Area, and a second active golden eagle nest was observed in a gray pine approximately one mile outside of the western edge of the 10-mile buffer. No active raptor nests were located within the boundary of the Sun Creek Wind Resource Area, or within

the surrounding two-mile buffer of the study area. However, nine inactive nests, and a single active common raven nests were identified within two miles of the study area. While conducting surveys for golden eagles within the 10-mile buffer of the Sun Creek Wind Resource Area, and over the course of other fieldwork conducted during the spring of 2010, a number of active raptor nests were identified in the region including two active red-tailed hawk nests, and three active great horned owl nests. Additionally, seven active common raven nests and 23 inactive nests were identified within 10-miles of the Sun Creek Wind Resource Area.

Some species considered to be sensitive or of conservation concern were observed within the Sun Creek Wind Resource Area. During all surveys and incidental observations, one state and federal threatened species, desert tortoise (one individual), was observed incidentally in the study area. Five additional state sensitive bird species were recorded including four California species of special concern (loggerhead shrike, Vaux's swift, northern harrier, and burrowing owl) and one state fully-protected species (golden eagle). This is a tally that in some cases represents repeated observations of the same individual. Loggerhead shrikes and burrowing owls are also considered federal species of concern, golden eagles are further protected under the Federal Bald and Golden Eagle Protection Act, and the others are protected under the Migratory Bird Treaty Act.

STUDY PARTICIPANTS

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INTRODUCTION

Alta Windpower Development, LLC has proposed a wind-energy facility in Kern County, California (Figures 1 and 2). CH2M HILL contracted Western EcoSystems Technology, Inc. (WEST) to conduct surveys and monitor avian resources in the Sun Creek Wind Resource Area (SCWRA) to estimate the impacts of wind-energy facility construction and operation on birds.

The principal objectives of the study were to: 1) provide site-specific avian resource and 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 study are similar to those used at other studies in California and throughout the western US with modifications to accommodate site-specific characteristics of the SCWRA. Additionally, the protocols follow guidance of the California Wind Energy Guidelines (CEC and CDFG 2007) and the National Wind Coordinating Collaborative (NWCC; Anderson et al. 1999), and are based on WEST's experience studying wildlife at proposed wind-energy facilities throughout the US.

Baseline surveys were conducted from May 11, 2009, through May 6, 2010, at the SCWRA, and consisted of fixed-point bird use surveys, aerial raptor nest surveys, and incidental wildlife observations. Acoustic bat surveys were also conducted at the SCWRA, and will be presented in a separate report. 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 avian mortality at the proposed SCWRA is greatly enhanced by operational monitoring data collected at existing facilities. For several wind-energy facilities, standardized data on fixed-point bird use 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 SCWRA is located in southeastern Kern County, approximately two miles (3.2 kilometers [km]) north-northwest of the unincorporated city of Mojave and 10 miles (16 km) east of the city of Tehachapi (Figure 1). The study area is comprised of undeveloped rangeland on a combination of privately-owned land and land administered by the Bureau of Land Management (BLM). The SCWRA falls within the high desert plains and hills on the western edge of the Mojave Desert. The existing natural conditions of the region are complex as the Tehachapi Mountains to the north and west transition into Mojave Desert to the south and east. Elevations within the study area range from approximately 3,100 – 4,200 feet (ft; 940 – 1,280 meters [m]) above sea level, with the highest elevations occurring in the northwestern portion of the study area (Figure 1). The habitat ranges from lowland creosote (*Larrea tridentata*) scrub and Joshua tree (*Yucca brevifolia*) woodland in the southeast to juniper (*Juniperus* spp.) shrubland on the steeper, rocky slopes in the north and west. Wetlands within the SCWRA are limited to a network of ephemeral drainages; there are no perennial water sources within the study area. Highway 58 bisects the SCWRA, an underground portion of the Los Angeles Aqueduct runs

along the southeast corner of the study area, and a network of dirt roads and off-highway vehicle (OHV) trails run throughout the study area.

According to the National Land Cover Dataset (USGS NLCD 2001), the dominant cover type within the SCWRA is scrub-shrub, which comprises 96.7% of the study area (Table 1; Figure 3). Grasslands and low intensity developed areas comprise a further 1.3% and 1.0% of the study area, respectively. The remaining land cover types, developed open space, evergreen forest, and barren land, comprise just over one percent of the SCWRA, combined.

METHODS

Baseline avian studies at the SCWRA consisted of the following components: 1) fixed-point bird use surveys, 2) raptor nest surveys, and 3) incidental wildlife observations.

Fixed-Point Bird Use Surveys

The objective of the fixed-point bird use surveys was to estimate the seasonal and spatial use of the study area by birds, particularly raptors (defined here as kites, accipiters, buteos, harriers, eagles, osprey, and falcons). Fixed-point bird surveys (variable circular plots) were conducted using methods described by Reynolds et al. (1980).

Survey Plots

Six points were selected to survey representative habitats and topography within the SCWRA, while achieving relatively even coverage of the study area (Figure 4). After the initial establishment of the six survey points, the SCWRA boundary was adjusted such that points four and five no longer fell within the proposed project boundary; however these points continued to be surveyed for the duration of the study (see Figure 4). Each survey plot was a 2,625-ft (800-m) radius circle centered on the point.

Survey Methods

All species of birds observed during each 30-minute (min) fixed-point bird use survey were recorded. Observations of large birds beyond the 800-m radius were recorded, but were not included in the statistical analyses; for small birds, observations beyond a 328-ft (100-m) 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 (e.g., 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 distance from plot center at first observation were recorded to the nearest 16-ft (5-m) interval. Other information recorded about the observation included whether or not the observation was auditory only and the 10-min interval of the 30-min survey in which it was initially noted.

The location of species of interest (e.g., raptors, species of concern, and other large birds) seen during the fixed-point bird use surveys were recorded on field maps by unique observation number. Flight paths and perched locations were digitized using ArcGIS 9.3. Any comments were recorded in the comments section of the data sheet.

Observation Schedule

Sampling intensity was designed to document bird use and behavior by habitat and season within the SCWRA. Fixed-point bird use surveys were conducted from May 11, 2009, through May 6, 2010, with surveys conducted approximately once per week during each season: spring (March 1 to May 31), summer (June 1 to August 31), fall (September 1 to November 15), and winter (November 16 to February 28). Surveys were carried out during daylight hours, and survey periods varied to approximately cover all daylight hours during a season. To the extent practical, each point was surveyed about the same number of times.

Raptor Nest Survey

A raptor nest survey was conducted throughout the SCWRA during the spring of 2010. The objective of the survey was to locate nests that may be subject to disturbance and/or displacement effects from the wind-energy facility construction and/or operation. While active and inactive nests of all raptor species were recorded, the survey specifically targeted golden eagles and was consistent with the USFWS *Interim Golden Eagle Technical Guidance: Inventory and Monitoring Protocols; and other Recommendations in Support of Golden Eagle Management and Permit Issuance* (Pagel et al. 2010). Golden eagles (*Aquila chrysaetos*) are protected by the Bald and Golden Eagle Protection Act (BGEPA 1940) and are also a fully-protected species in California (CDFG, Fish and Game Code, Section 3511).

Survey Methods

Two aerial surveys were conducted via helicopter by two observers during the spring breeding period. The first aerial survey was flown on April 13, and the second survey was flown on May 24. Surveys for golden eagles included all suitable eagle nesting habitat within the study area, as well as the area within an approximate 10-mile buffer of the study area. For all other raptor and other large bird species (e.g., hawks, falcons, owls, and ravens), the survey area included all potential nesting habitat within two miles of the study area.

Aerial survey methods involved a comprehensive search of suitable nesting areas and substrate (e.g., isolated trees, open woodland and savanna, rocky outcrops, cliffs, and other nest platforms such as power poles and transmission towers). During surveys, the helicopter was flown at an altitude of tree-top level to approximately 250 ft (76 m) above ground level. If a nest was observed, the helicopter was moved to a position where nest status and species present could be determined. Efforts were made to minimize disturbance to breeding raptors, including keeping the helicopter a maximum distance from the nest at which the species could be identified, with distances varying depending upon nest location and wind conditions. Data recorded for each nest location included species occupying the nest, nest status (i.e., inactive, bird incubating, young present, eggs present, adult present, or unknown), nest substrate (e.g., pine, cottonwood, rocky outcrop, cliff or power line), number of young present, time and date of observation. All raptor and other large bird nests regardless of nest status were recorded with a Trimble Geo XH global positioning system (GPS) unit with sub-meter accuracy and mapped on a GIS ArcView project

utilizing USGS topographic maps (1:24000 scale) as the base. Locations of inactive nests were recorded as they could be occupied during subsequent years.

Ground-based surveys were also conducted in conjunction with fixed-point bird use surveys during the peak of the breeding season (March – June), when target species would be actively incubating eggs or attending young. If nesting species, status, or outcome could not be determined from aerial surveys, ground-based follow-up visits were made provided the nest site could be accessed from the ground.

Incidental Wildlife Observations

The objective of incidental wildlife observations was to record wildlife seen outside of the standardized surveys. All unusual or unique birds and sensitive species were recorded. A unique observation number and the date, time, species, number of individuals, sex and age class, distance from observer, activity, height above ground (for bird species), and habitat were recorded for each incidental observation. The location of any sensitive species or other species of interest was recorded by UTM coordinates collected using a hand-held 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 were made in all affected steps.

Data Compilation and Storage

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

Fixed-Point Bird Use Surveys

<u>Bird Diversity and Species Richness</u>
Bird diversity was illustrated by the total number of unique species observed. Species lists (with the number of observations and the number of groups) were generated by season and included all observations of birds detected, regardless of their distance from the observer. Species richness was calculated as the mean number of species observed per plot per survey (number of species/plot/30-min survey). Species diversity and richness were compared among seasons for fixed-point bird use surveys.

Bird Use, Percent Composition, and Frequency of Occurrence

For the standardized fixed-point bird use estimates, only observations of large birds detected within the 2,625-ft (800-m) radius plot were used; small bird observations were limited to 328 ft (100 m). Estimates of mean bird use (number of birds/plot/30-min survey) were used to compare and contrast among bird types, seasons, and other wind-energy facilities.

Percent composition was calculated as the proportion of the overall mean use for a particular bird type or species, and the frequency of occurrence was calculated as the percent of surveys in which a particular bird type or species was observed. Frequency of occurrence and percent composition provide relative estimates of species exposure to the proposed wind-energy facility. For example, a particular species might have high use estimates for the study area based on just a few observations of large groups. However, the frequency of occurrence would indicate that the species only occurred during a few of the surveys, therefore the species would be less likely to be affected by the wind-energy facility or transmission corridor.

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 RSH for collision with turbine blades of 115 to 427 ft (35 to 130 m) above ground level, which is the blade height of typical turbines that could be used at the SCWRA.

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 2,625 ft [800 m] of the observer or 328 ft [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 RSH.

Spatial Use

To determine spatial use within the SCWRA, data were analyzed by comparing use among plots. Mapped flight paths were qualitatively compared to study area features (e.g., 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

Surveys were conducted at the SCWRA from May 11, 2009, through May 6, 2010, during which 62 bird species and one reptile species were identified. Results of the fixed-point surveys, raptor nest surveys, and incidental wildlife observations are discussed in the sections below.

Fixed-Point Bird Use Surveys

A total of 311 30-minute (min) fixed-point bird use surveys were conducted at the SCWRA during 52 site visits (Table 2). Two different viewsheds were utilized when calculating the different statistics (species richness, use, percent composition, percent frequency, and exposure index): 800 m for large birds and 100 m for small birds.

Bird Diversity and Species Richness

Sixty-one unique species were observed during the fixed-point bird use surveys, with a mean of 0.66 large bird species/800-m plot/30-min survey and 1.95 small bird species/100-m plot/30-min survey (Table 2). Bird diversity (number of unique species) was much greater in the spring (50 species) than in the winter (30), fall (28), and summer (22; Table 2). Large bird species richness (mean number of species per survey) was highest in the spring (0.90 species/survey, respectively), followed by fall (0.70), winter (057), and summer (0.50; Table 2). For small birds, higher species richness was observed in the fall and spring (2.42 and 2.37 species/survey), compared to winter (1.73) and summer (1.39; Table 2). A total of 2,581 individual bird observations within 1,044 separate groups were recorded during the fixed-point bird surveys (Table 3). Cumulatively, regardless of bird size, six species (9.8% of all species) composed 70.6% of the observations: white-crowned sparrow (*Zonotrichia leucophrys*), house finch (*Carpodacus mexicanus*), common raven (*Corvus corax*), horned lark (*Eremophila alpestris*), sage sparrow (*Amphispiza belli*), and turkey vulture (*Cathartes aura*). Individually, all other species comprised less than four percent of the observations. A total of 43 individual raptors were recorded within the SCWRA, representing six species: Cooper's hawk (*Accipiter cooperii*), sharp-shined hawk (*Accipiter striatus*), red-tailed hawk (*Buteo jamaicensis*), northern harrier (*Circus cyaneus*), golden eagle, and American kestrel (*Falco sparverius*; Table 3).

Bird Use, Percent Composition, and Frequency of Occurrence

Mean bird use, percent composition, and frequency of occurrence were calculated by season for each bird type and species (Tables 4a and 4b). Large bird use (within 800-m plot) was much higher in the spring (3.64 birds/plot/30-min survey) than in other seasons (fall 1.86, winter 1.43, and summer 1.08; Table 4a). For small birds (i.e., passerines, swifts/hummingbirds, and woodpeckers), use (within 100-m plot) was highest in the winter and spring (7.27 and 7.25 birds/plot/30-min survey, respectively), and lower in fall (5.30) and summer (2.39; Table 4b). Because different viewsheds were used in the analyses for large and small birds, use estimates calculated for the two groups are not directly comparable.

<u>Waterbirds</u>

Waterbirds were observed only during spring surveys, with a use estimate of 0.73 birds/800-m plot/30-min survey during this period (Table 4a). Waterbird use at the SCWRA was attributable to a single group of California gulls (*Larus californicus*) comprising 60 individuals, and a single great egret (*Ardea alba*). Although waterbirds comprised 19.9% of the overall large bird use in spring, they were observed during only 2.4% of spring surveys (Table 4a).

<u>Raptors</u>

Raptor use was highest during the winter (0.20 birds/800-m plot/30-min survey), with relatively similar use in other seasons (spring 0.13, fall 0.11, and summer 0.10; Table 4a). Higher use in

the winter was primarily due to higher use of the area by red-tailed hawks (0.08 birds/plot/30-min survey) and golden eagles (0.07), and these species also comprised the majority of raptor use in the fall (0.05 for each). Red-tailed hawk had the highest use of any raptor species in summer (0.07), while use in spring was attributable to low use by Cooper's hawk, red-tailed hawk, golden eagle, and American kestrel, each with 0.01 birds/ plot/30-min survey. Raptors comprised 14.0% of overall large bird use in winter, 9.0% in summer, 5.7% in fall, and 3.6% in spring. Raptors were observed more frequently during winter and spring (13.3% and 13.1% of surveys, respectively) than during summer and fall (9.7% and 7.6% of surveys, respectively; Table 4a).

Vultures

Vultures were observed only in spring and winter with use estimates of 1.04 and 0.23 birds/800-m plot/30-min survey during those seasons, respectively (Table 4a). Turkey vulture was the only vulture species observed during surveys. Vultures comprised 28.4% of overall large bird use in spring and 16.4% in winter. Vultures were observed during 7.1% of spring surveys and 1.1% of winter surveys (Table 4a).

Upland Game Birds

Use by upland game birds was higher in the summer and fall (0.38 birds/800-m plot/30-min survey during each) than in the winter (0.10) and spring (0.06; Table 4a). Chukar (*Alectoris chukar*) comprised all upland game bird use in summer, fall, and winter, while California quail (*Callipepla californica*) comprised the majority of upland game bird use in the spring (0.05 birds/plot/30-min survey). Upland game birds comprised 34.6% of overall large bird use in summer, 20.3% in fall, 7.0% in winter, and 1.6% in spring. Upland game birds were observed during 6.1% of fall surveys, and less than five percent of surveys during other seasons (Table 4a).

Large Corvids

Use by large corvids was higher in the spring and fall (1.54 and 1.29 bird/800-m plot/30-min survey, respectively), compared to winter and summer (0.89 and 0.44, respectively; Table 4a). Common raven was the only large corvid species observed. Across all seasons large corvids comprised a greater proportion of the overall large bird use than any other bird type: 69.1% of use in fall, 62.6% in winter, 42.8% in spring, and 41.0% in summer. Large corvids were observed during 54.8% of spring surveys, 47.0% of fall surveys, 40.2% of winter surveys, and 25.0% of summer surveys (Table 4a).

Greater Roadrunners

Greater roadrunners (*Geococcyx californianus*) were observed only during summer and fall surveys with use estimates of 0.04 and 0.02 birds/800-m plot/30-min survey during these periods, respectively (Table 4a). Greater roadrunners comprised 3.8% of overall large bird use in summer and less than one percent in fall. Greater roadrunners were observed during 2.8% of surveys in summer and 1.5% in fall (Table 4a).

Passerines

Use by passerines was highest in winter (7.26 birds/100-m plot/30-min survey) and spring (7.07), within intermediate use in fall (5.23) and low use in summer (2.28; Table 4b). House finch had the highest use of any passerine species in the fall and winter (1.85 and 2.44 birds/plot/30-min

survey, respectively), while white-crowned sparrow had the highest use in spring (2.62), and horned lark had the highest use in summer (0.50). Passerines comprised over 95% of overall small birds use in any given season and were observed during more than 70% of the surveys during each season (Table 4b).

Swifts and Hummingbirds

Use by swifts and hummingbirds was highest in spring (0.15 birds/100-m plot/30-min survey) followed by summer (0.08), and fall (0.06); no swifts or hummingbirds were observed in winter (Table 4b). Swifts and hummingbirds comprised less than four percent of overall small bird use in any given season, and were observed during 6.0% of spring surveys, 4.2% of summer surveys, and 3.0% of fall surveys (Table 4b).

Woodpeckers

Woodpecker use was low throughout the year (0.03 birds/100-m plot/survey in summer, spring 0.02, fall 0.02, and winter 0.01; Table 4b). Woodpeckers comprised less than two percent of overall small bird use during each season and were observed during less than three percent of surveys in any given season (Table 4b).

Bird Flight Height and Behavior

Flight height characteristics were estimated for both bird types and species (Tables 5 and 6). During fixed-point bird use surveys, 220 groups of flying large birds totaling 559 individuals were observed within 800-m plots (Table 5). Overall, 22.7% of flying large birds were observed within the RSH for collision with turbine blades of 115 to 427 feet (35 to 130 m) above ground level, 57.6% were observed below the RSH, and 19.7% were above the RSH (Table 5). Most (53.8%) flying raptors were observed below the RSH, 23.1% were within the RSH, and 23.1% were flying above the RSH. Nearly all flying waterbirds (98.4%) were observed above the RSH; the remaining 1.6% were below the RSH. Vultures had the highest percentage of flying birds within the RSH (58.3%). Raptors had the second highest percentage of birds within the RSH, primarily due to 50.0% of eagle observations and 20.0% buteo observations recorded at this height. Large corvids, doves and pigeons, upland game birds, and greater roadrunners were generally observed flying below the RSH (Table 5). A total of 423 groups of small birds totaling 1,339 individuals were observed flying within the 100-m plots (Table 5). Overall, 5.6% of small birds were observed flying within the estimated RSH. The majority of passerines and swifts/hummingbirds (94.4% and 91.3%, respectively), and all of the woodpeckers were observed flying below the RSH. No small birds were recorded flying above the RSH (Table 5).

Only three large bird species (turkey vulture, common raven and red-tailed hawk) had at least 10 groups observed flying. Of these, only turkey vulture and common raven were recorded flying within the RSH during at least 50% of the observations (84.3% and 51.7%, respectively; Table 6a). Three other species (golden eagle, rock pigeon [*Columba livia*], and sharp-shined hawk) were recorded flying within the likely RSH during at least 50% of the observations (70.0%, 71.4%, and 100%, respectively). However this is based on only a small number of observations (one to six individuals; Table 6a). Of all small bird species, 11 species had at least 10 groups observed flying. However, none of these species were observed within the RSH during greater than 50% of observations (Table 6b).

Bird Exposure Index

A relative exposure index was calculated for each bird species based on initial flight height observations and relative abundance (defined as the use estimate; Tables 6a and 6b). This index does not account for other possible collision risk factors (e.g., foraging or courtship behavior). Turkey vulture and common raven had the highest exposure indices of any large bird species (0.19 and 0.16, respectively). All other large bird species had an exposure index of 0.02 or less. The only raptor species with exposure indices greater than zero were golden eagle (0.02) and red-tailed hawk (0.01; Table 6a). Of the small bird species, house finch has the highest exposure index (0.12), followed by horned lark (0.08). All other small bird species had exposure indices of 0.01 or less (Table 6b).

Spatial Use

For all large bird species combined, use was highest at point three (2.98 birds/30-min survey); large bird use ranged from 1.27 to 2.41 birds/30-min survey at other points (Figure 5). The high mean use estimate for point three was largely due to high vulture use at this point (1.98 birds/30-min survey). Vultures were also observed at points two and four (0.06 and 0.04, respectively). Waterbird use was recorded only at points two (1.15 birds/30-min survey) and one (0.02). Raptor use was highest at point four (0.27 birds/30-min survey), largely due to higher use by buteos, eagles, and northern harriers at this point. Raptor use at other points ranged from 0.02 to 0.19 birds/30-min survey. Upland game bird use was much higher at point four (1.12 birds/30-min survey), and ranged from zero to 0.12 birds/30-min survey at other points. Use by large corvids (common ravens) was highest at point six (1.73 birds/30-min survey), and ranged from 0.71 to 1.10 birds/30-min survey at other points. Greater roadrunners were recorded only at points four, five, and six, with use ranging from 0.02 to 0.04 birds/30-min survey at these points. Passerine use was highest at point one (9.40 birds/30-min survey), and ranged from 3.38 to 7.15 at other points. Swifts/hummingbird use ranged from 0.012 to 0.15 birds/30-min survey, while woodpecker use ranged from zero to 0.06 across points (Figure 5).

Flight paths for waterbirds, raptors, and vultures were digitized and mapped (Figures 6a-e). A qualitative comparison of mapped flight paths across survey points indicate higher use for some raptor species (buteos, eagles, and falcons) at points four, five, and six, in the areas of greater topographic relief. This is particularly evident for golden eagles and can be explained by the proximity of these points to an active golden eagle nest identified during raptor nest surveys (see discussion of raptor nest surveys below). Observations of waterbirds and other raptor species (accipiters and harriers) were too few to make inferences on spatial use of the study area by these species.

Sensitive Species Observations

Four state sensitive bird species (CDFG 2009) were recorded during fixed-point bird use surveys at the SCWRA including three California species of special concern (loggerhead shrike [*Lanius ludovicianus*; 46 observations], Vaux's swift [*Chaetura vauxi*; 13 observations], and northern harrier [two observations]) and one state fully-protected species (golden eagle [11 observations]). Loggerhead shrike is also considered a federal species of concern, and golden eagle is further protected under the BGEPA (1940).

Raptor Nest Surveys

Aerial raptor nest surveys were conducted by two observers via helicopter on April 13 and May 24, 2010. The survey area for golden eagles included all eagle nesting habitat within a 10-mile buffer of the proposed SCWRA, while the survey area for all other raptors and common ravens included a two-mile buffer of the SCWRA.

Golden Eagle Nests

One active golden eagle nest was observed on a cliff ledge approximately three miles from the northwestern boundary of the SCWRA (Figure 7). Two nestlings were observed in the nest on May 24th. A second active golden eagle nest was observed in a live gray pine (*Pinus sabineana*) approximately 1.0 mile outside of the western edge of the 10-mile buffer (Figure 7). During the first survey on April 13, an adult was observed on this nest. On the May 24th flight, both adults were observed perched in the area, but the nest was empty and it was concluded that the nest had failed. Single adult golden eagles were observed at two additional locations within the 10-mile buffer: approximately 7.0 miles northeast of the SCWRA, and approximately 7.5 miles to the south of the SCWRA (Figure 7). Both locations contained evidence of previous golden eagle nesting (old nests) and, based on information provided by the Bureau of Land Management (BLM; Dr. Larry LaPre, pers. comm.) both areas have records of historical nesting. However, no active nests were located during either survey.

Other Raptor Nests

No active raptor nests were located within the boundary of the SCWRA, or within the surrounding two-mile buffer. However, nine inactive nests and a single active common raven nests were identified within two miles of the SCWRA (Figure 7). While conducting surveys for golden eagles within the 10-mile buffer of the SCWRA, and over the course of fieldwork conducted during the spring of 2010, a number of active raptor nests were identified in the region: two active red-tailed hawk nests (one along the transmission line approximately 6.0 miles from the SCWRA, and the other on a rock ledge approximately 8.0 miles from SCWRA), and three active great horned owl nests (two nests in cottonwood [*Populus sp.*] trees approximately 4.5 and 8.0 miles from the SCWRA, and one in a Joshua tree approximately 5.0 miles from the SCWRA; Figure 7). Additionally, seven active common raven nests were identified within the 10-mile buffer and 23 inactive nests were identified. It should be noted that only the area encompassed by a 2-mile buffer of the SCWRA was systematically searched for raptor nests and nests of other large birds. Outside of this area, the survey effort focused on golden eagle nesting habitat; however, any raptor or raven nest encountered was recorded as an incidental observation.

Incidental Wildlife Observations

One desert tortoise (*Gopherus agassizii*), a state and federal threatened species (CDFG 2009, USFWS 2010), and one burrowing owl (*Athene cunicularia*), a California species of special concern (CDFG 2009), were recorded incidentally at the SCWRA (Figure 8).

DISCUSSION AND IMPACT ASSESSMENT

Bird Impacts

Direct Effects

The most probable direct impact to birds from wind-energy facilities is 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. Facility 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, as 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. During 12 fatality monitoring studies conducted outside of California, diurnal raptor fatalities comprised approximately 2% of the wind-energy facility-related fatalities and raptor mortality averaged 0.03 fatalities per turbine per year. Passerines (excluding house sparrows [*Passer domesticus*] and European starlings [*Sturnus vulgaris*]) were the most common collision victims, comprising about 82% of the 225 fatalities documented. Of 841 bird fatalities reported from California studies (more than 70% from the Altamont Pass facility in California), about 39% were diurnal raptors, about 19% were passerines (excluding house sparrows and European starlings), and approximately 12% were owls (Erickson et al. 2002b). Non-protected birds (house sparrows, European starlings, and rock pigeons) comprised about 15% of the fatalities. Other bird types generally made up less than 10% of the fatalities (Erickson et al. 2002b). Using mortality data collected during a 10-year period from wind-energy facilities throughout the entire United States, the average number of bird collision fatalities is 3.1 per megawatt (MW) per year, or 2.3 fatalities per turbine per year (NWCC 2004).

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

Annual mean raptor use (number of raptors divided by the number of 800-m plots and the total number of surveys) at the SCWRA was compared with 39 other wind-energy facilities that implemented similar protocols and had data for three or four seasons. The annual mean raptor use at these wind-energy facilities ranged from 0.09 to 2.34 raptors/plot/20-min survey (Figure 9). 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 (more than 3.0). Under this ranking, mean raptor use at the SCWRA (0.09 raptors/plot/20-min survey) is considered to be low, ranking second lowest compared to the other wind-energy facilities (Figure 9).

Although high numbers of raptor fatalities have been documented at some wind-energy facilities (e.g., Altamont Pass), a review of studies at wind-energy facilities across the United States reported that only 3.2% of casualties were raptors (Erickson et al. 2001a). Indeed, although

raptors occur in most areas with the potential for wind-energy development, individual species appear to differ from one another in their susceptibility to collision (NRC 2007). Results from Altamont Pass in California suggest that mortality for some species is not necessarily related to abundance (Orloff and Flannery 1992). American kestrels, red-tailed hawks, and golden eagles were killed more often than predicted based on abundance. Thus far, few northern harrier fatalities at existing wind-energy facilities have been reported in publicly available documents, despite the fact they are commonly observed during fixed-point bird 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. Additionally, relative use by American kestrels at the High Winds facility is almost six times the use of American kestrels at the Altamont Pass facility, but the fatality rate of American kestrels was lower at the High Winds facility (Erickson et al. 2001a, Kerlinger et al. 2005). It is likely that many factors, in addition to abundance, are important in predicting raptor mortality.

Exposure indices analysis may provide insight into which species might be the most likely turbine casualties. However, the index only considers relative probability of exposure based on abundance, proportion of birds observed flying, and proportion of flight height of each species within the RSH for turbines likely to be used at the wind-energy facility. This analysis is based on observations of birds during the surveys and does not take into consideration behavior (e.g., foraging, courtship), habitat selection, the ability to detect and avoid turbines, and other factors that may vary among species and influence the likelihood of turbine collision. For these reasons, the index is only a relative index among species observed during the surveys and within the SCWRA, and actual risk for some species may be lower or higher than indicated by these data. At the SCWRA, the raptor species with the highest exposure indices were golden eagle (which was influenced by the relatively high proportion of individuals observed within the RSH) and the red-tailed hawk (which was influenced by relatively high use of the SCWRA). Other raptor species ranked much lower, primarily due to the lower use estimates by these species and relatively low proportions of flight heights observed within the RSH.

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 10). Using this regression to predict raptor collision mortality at the SCWRA (based on an adjusted mean raptor use of 0.09 raptors/20-min survey) yields an estimated fatality rate of < 0.01 fatalities/MW/year or less than one raptor fatality per year for each 100-MW of wind-energy development. A 90% prediction interval around this estimate is zero to 0.19 raptor fatalities per MW per year.

Overall bird use at the SCWRA was compared to other wind-energy facilities in the same geographic region (Western), many of which also had data for raptor mortality (Table 8). Use values at these facilities ranged from 2.34 raptors/plot/20-min survey at the High Winds wind-energy facility in California to 0.21 raptors/plot/20-min survey recorded in 2003 at the Stateline wind-energy facility in Washington and Oregon. Raptor fatality estimates were available at many of these sites, and ranged from 0.87 raptors/MW/year at the Diablo Winds facility to zero raptors/MW/year at the Combine Hills, Vansycle, and Klondike wind-energy facilities in Oregon (Table 8). Assuming a correlation between use and fatality rates exists, fatality rates at the

SCWRA are expected to be much lower than the fatality rates observed at other sites in California, and more similar to fatality rates observed at sites in the Pacific Northwest (Table 8).

Non-Raptor Use and Exposure Risk

Most bird species in the United States are protected by the Migratory Bird Treaty Act (MBTA 1918). Passerines (primarily perching birds) have been the most abundant 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 SCWRA. The SCWRA does not appear to provide important stopover habitat for migrant songbirds based on the results of the fixed point bird use surveys. Based on observations within 100 m of the survey point, exposure indices indicate that house finch is the most likely passerine to be exposed to collision from wind turbines at the SCWRA. Other passerine species more at risk based on abundance and flight behavior include horned lark, lesser goldfinch (*Carduelis psaltria*), and Brewer's blackbird (*Euphagus cyanocephalus*; Table 6b).

The project area appears to receive very little use by waterfowl, waterbirds, or shorebirds (only one group of 60 California gulls and a single great egret were observed during surveys), and mortality involving these groups is expected to be inconsequential. The area does receive some use by upland gamebirds (mainly chukar), but these species are not expected to be highly susceptible to turbine collisions because they spend most of their time on the ground and were never observed flying at turbine rotor-swept heights during this study. Despite the high use estimates and high exposure indices calculated for common ravens, which comprised approximately 13% of the individual large birds observed during fixed-point surveys, post-construction fatality studies at other wind resource areas (WRAs) in the Western US reveal relatively low fatality for common ravens, suggesting this species is also not very susceptible to collisions.

Of the large bird species observed flying, turkey vulture had the highest exposure index (0.19). Post-construction avian fatality monitoring studies at WRAs in California have documented very few vulture fatalities, and Orloff and Flannery (1992) suggest that turkey vultures are killed less often than predicted based on abundance at older-generation wind-energy facilities. Out of 127 fatalities at the Tehachapi Pass WRA (Anderson et al. 2004), and 439 fatalities at Altamont Pass WRA (Thelander et al. 2003), there were no documented vulture fatalities. During a two-year study at the new-generation High Winds WRA, only four vultures were found among 301 total fatalities (Kerlinger et al. 2006). While fatality data for new-generation WRAs is limited, Tierney (2007) suggests that turkey vultures may show higher susceptibility to collision at the new-generation facilities than previously believed.

With the exception of turkey vultures and ravens, most non-raptors had relatively low exposure indices due to low use estimates and/or the majority of individuals flying below the RSH. Due to the relatively low exposure risks at SCWRA, it is unlikely that non-raptor populations will be adversely affected by direct mortality from the operation of the wind-energy facility.

Sensitive Species Use and Exposure Risk

Sensitive species observed at the SCWRA are summarized in Table 7. One state and federal threatened species, desert tortoise (one individual; CDFG 2009, USFWS 2010), was observed incidentally in the SCWRA. Six additional state sensitive bird species were recorded within the SCWRA including four California species of special concern (loggerhead shrike, Vaux's swift, northern harrier, Le Conte's thrasher, and burrowing owl; CDFG 2009) and one state fully-protected species (golden eagle; (CDFG 2009). Loggerhead shrikes and burrowing owls are also considered federal species of concern, golden eagles are further protected under the BGEPA (1940), and the others are protected under the MBTA (1918).

The only sensitive bird species with an exposure index greater than zero were golden eagle, which ranked third among large bird species with an index of 0.06, and Vaux's swift, which ranked sixth among small birds with an index of <0.01. While golden eagles are year-round residents of the area, Vaux's swifts were only observed during spring and fall and are likely migrants through the region. With the possible exception of golden eagles, impacts to sensitive avian species are expected to be inconsequential. Golden eagle use of the study area was highest at points four (0.12 birds/30-min survey), five (0.04), and six (0.06; Figures 5 and 6d). While point four lies near the northwest boundary of the SCWRA, points five and six both fall outside of the current project boundary (Figure 4). Furthermore, golden eagle use at point four occurred primarily in the hills to the north of the point, outside of the current project boundary (Figure 6d). No golden eagles were observed at the remaining three points.

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). The greatest concern with displacement impacts for wind-energy facilities in the United States has been where these facilities have been constructed in grassland or other native habitats (Leddy et al. 1999, Mabey and Paul 2007). Although Crockford (1992) suggests that disturbance appears to impact feeding, resting, and migrating birds, rather than breeding birds, the 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-energy facility operations. Studies on habitat displacement caused by wind-energy facilities have primarily concentrated on raptors, grassland passerines, and waterfowl (NRC 2007).

There have been few studies of raptor displacement at wind-energy facilities, and most of these have suggested indirect effects to be negligible or difficult to measure (Howell and Noone 1992; Johnson et al. 2000b, 2003; Madders and Whitfield 2006). Information concerning potential nesting displacement on specific species is limited. A Swainson's hawk (*Buteo swainsonii*) was reported to have nested within 0.25 mile (0.8 km) of the turbine string at a wind-energy facility in Oregon, suggesting little disturbance to this species (Johnson et al. 2003). At the Foote Creek Rim wind-energy facility in southern Wyoming, construction and operation of the facility did not affect density of raptor nests or nest success for three focal species (Young et al. 2003c). At Foote Creek Rim, a pair of red-tailed hawks nested within 0.3 mile (~0.5 km) and a golden eagle pair successfully nested 0.5 mile (800 m) from the wind-energy facility. In addition, seven red-

tailed hawks and one great horned owl nested within one mile (~1.6 km) of the facility (Johnson et al. 2000b). Studies at the Stateline wind-energy facility in Oregon and Washington have not shown any measurable short-term effects to nesting raptors (Erickson et al. 2004). While the nest locations for some species changed, the number of active nests was not significantly different over a three year period from pre-to post-construction (Erickson et al. 2004). These types of observations suggest that there is limited potential for displacement of nesting raptors and, in particular, at the SCWRA where no active raptor nests were located within 2-miles of the proposed development area.

While some displacement effects for non-raptor species could occur at SCWRA, they will likely be immeasurable given the very low relative bird use, and the lack of unique habitats within the SCWRA relative to the surrounding landscape.

CONCLUSIONS AND RECOMMENDATIONS

While higher use by some raptor species, particularly golden eagles, was observed in the northwestern portions of the SCWRA, overall raptor use was lower than nearly all other WRAs evaluated throughout the western and Midwestern US. Additionally, golden eagles recorded during the surveys, were primarily observed outside of the current project boundary. The data collected during this study suggest that the SCWRA is not within a high bird use area or major spring migration pathway. The habitat and features of the SCWRA are not unique to the surrounding landscape, nor are they particularly preferred or critical to migrants. No active raptor nests were located within the boundary of the SCWRA, or within the surrounding two-mile buffer, indicating a very low raptor nest density. This is consistent with other proposed wind-energy sites in the region (Erickson et al. 2009). Use of the area by sensitive species, especially state and federal listed species, appears to be very low as well.

Currently, few published studies are available from California that compare bird use to bird mortality rates at modern wind-energy facilities. Based on research conducted at wind-energy facilities throughout the US, raptor use at the SCWRA is generally lower than use levels recorded at other wind-energy facilities. Bird use and fatality data collected at other sites within the Tehachapi Wind Resource Area by Anderson et al. (2004), while not directly comparable to those collected at the majority of modern wind-energy facilities in the US, also suggest relatively low numbers of raptors and birds use the area. To date, no relationships have been observed between overall use by other bird types, and fatality rates of those bird groups at wind-energy facilities. However, the flight characteristics and foraging habits of some species may result in increased exposure for these species at the SCWRA.

Overall, results of the studies to date do not suggest that a wind development at the SCWRA would have significant impacts to most avian species. The relatively high use of the area by golden eagles and the proximity to golden eagle nests in the surrounding landscape is a concern; however, it appears that the majority of use by golden eagles is occurring to the north and west of the current project boundary. To help address this concern, a second year of avian use studies is ongoing at the SCWRA and scheduled to continue through June of 2011. As more research, including post-construction fatality monitoring, is conducted at facilities in this region of

California, more information regarding the potential direct impacts of wind-energy facilities to bird species will be obtained.

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Table 1. The land cover types, coverage, and composition within the Sun Creek Wind Resource Area.

Habitat	Acres	% Composition
Developed, Open Space	14.80	0.6
Developed, Low Intensity	22.85	1.0
Barren	1.57	0.1
Evergreen Forest	8.67	0.4
Scrub-shrub	2,252.49	96.7
Grassland	30.12	1.3
Total	**2,330.51**	**100**

Data from the National Land Cover Database (USGS NLCD 2001).

Table 2. Summary of species richness (species/plot[a]/30-min survey) and sample size, by season and overall, during the fixed-point bird use surveys at the Sun Creek Wind Resource Area, May 11, 2009, to May 6, 2010.

Season	Number of Visits	# Surveys Conducted	# Unique Species	Species Richness	
				Large Birds	Small Birds
Spring	14	84	50	0.90	2.37
Summer	12	72	22	0.50	1.39
Fall	11	66	28	0.70	2.42
Winter	15	89	30	0.57	1.73
Overall	**52**	**311**	**61**	**0.66**	**1.95**

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

Table 3. Summary of individuals (# obs) and group observations (# grps), by bird type or species, for fixed-point bird use surveys at the Sun Creek Wind Resource Area[a], May 11, 2009, to May 6, 2010.

		Spring		Summer		Fall		Winter		Total	
Bird Type or Species	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Waterbirds		**2**	**61**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**61**
California gull	*Larus californicus*	1	60	0	0	0	0	0	0	1	60
great egret	*Ardea alba*	1	1	0	0	0	0	0	0	1	1
Raptors		**11**	**11**	**7**	**7**	**6**	**7**	**14**	**18**	**38**	**43**
Accipiters		*1*	*1*	*0*	*0*	*0*	*0*	*2*	*2*	*3*	*3*
Cooper's hawk	*Accipiter cooperii*	1	1	0	0	0	0	0	0	1	1
sharp-shinned hawk	*Accipiter striatus*	0	0	0	0	0	0	1	1	1	1
unidentified accipiter		0	0	0	0	0	0	1	1	1	1
Buteos		*8*	*8*	*5*	*5*	*3*	*3*	*6*	*7*	*22*	*23*
red-tailed hawk	*Buteo jamaicensis*	8	8	5	5	3	3	6	7	22	23
Northern Harrier		*0*	*0*	*0*	*0*	*0*	*0*	*2*	*2*	*2*	*2*
northern harrier	*Circus cyaneus*	0	0	0	0	0	0	2	2	2	2
Eagles		*1*	*1*	*1*	*1*	*2*	*3*	*3*	*6*	*7*	*11*
golden eagle	*Aquila chrysaetos*	1	1	1	1	2	3	3	6	7	11
Falcons		*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*4*	*4*
American kestrel	*Falco sparverius*	1	1	1	1	1	1	1	1	4	4
Vultures		**9**	**87**	**0**	**0**	**0**	**0**	**2**	**21**	**11**	**108**
turkey vulture	*Cathartes aura*	9	87	0	0	0	0	2	21	11	108
Upland Game Birds		**4**	**5**	**3**	**27**	**6**	**25**	**1**	**9**	**14**	**66**
California quail	*Callipepla californica*	3	4	0	0	0	0	0	0	3	4
chukar	*Alectoris chukar*	1	1	3	27	6	25	1	9	11	62
Doves/Pigeons		**7**	**11**	**6**	**9**	**4**	**5**	**0**	**0**	**17**	**25**
mourning dove	*Zenaida macroura*	3	3	6	9	4	5	0	0	13	17
rock pigeon	*Columba livia*	4	8	0	0	0	0	0	0	4	8
Large Corvids		**64**	**131**	**23**	**32**	**45**	**85**	**48**	**80**	**180**	**328**
common raven	*Corvus corax*	64	131	23	32	45	85	48	80	180	328

Table 3. Summary of individuals (# obs) and group observations (# grps), by bird type or species, for fixed-point bird use surveys at the Sun Creek Wind Resource Area[a], May 11, 2009, to May 6, 2010.

		Spring		Summer		Fall		Winter		Total	
Bird Type or Species	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Greater Roadrunners		**0**	**0**	**2**	**3**	**1**	**1**	**0**	**0**	**3**	**4**
greater roadrunner	*Geococcyx californianus*	0	0	2	3	1	1	0	0	3	4
Passerines		**222**	**706**	**103**	**164**	**211**	**345**	**223**	**700**	**759**	**1,915**
ash-throated flycatcher	*Myiarchus cinerascens*	4	4	4	4	0	0	0	0	8	8
Bewick's wren	*Thryomanes bewickii*	4	4	0	0	5	7	7	8	16	19
black-throated sparrow	*Amphispiza bilineata*	7	9	18	24	2	2	4	16	31	51
blue-gray gnatcatcher	*Polioptila caerulea*	0	0	0	0	1	1	0	0	1	1
Brewer's blackbird	*Euphagus cyanocephalus*	5	23	0	0	2	7	0	0	7	30
Brewer's sparrow	*Spizella breweri*	3	6	0	0	0	0	0	0	3	6
cactus wren	*Campylorhynchus brunneicapillus*	4	4	12	16	3	5	11	16	30	41
California towhee	*Pipilo crissalis*	0	0	0	0	0	0	2	2	2	2
Cassin's vireo	*Vireo cassinii*	1	1	0	0	0	0	0	0	1	1
chipping sparrow	*Spizella passerina*	1	10	0	0	0	0	0	0	1	10
dark-eyed junco	*Junco hyemalis*	1	1	0	0	0	0	3	41	4	42
dusky flycatcher	*Empidonax oberholseri*	1	1	0	0	0	0	0	0	1	1
European starling	*Sturnus vulgaris*	4	6	0	0	1	2	3	4	8	12
fox sparrow	*Passerella iliaca*	1	1	0	0	0	0	0	0	1	1
horned lark	*Eremophila alpestris*	28	63	7	36	27	43	37	122	99	264
house finch	*Carpodacus mexicanus*	40	107	16	27	67	122	71	220	194	476
house wren	*Troglodytes aedon*	1	1	0	0	0	0	0	0	1	1
lark sparrow	*Chondestes grammacus*	8	10	0	0	0	0	0	0	8	10
Le Conte's thrasher	*Toxostoma lecontei*	0	0	0	0	0	0	1	1	1	1
lesser goldfinch	*Carduelis psaltria*	1	5	0	0	3	6	1	1	5	12
Lincoln's sparrow	*Melospiza lincolnii*	1	1	0	0	0	0	0	0	1	1
loggerhead shrike	*Lanius ludovicianus*	6	8	16	18	9	9	11	11	42	46
northern mockingbird	*Mimus polyglottos*	15	20	5	8	1	1	1	1	22	30
rock wren	*Salpinctes obsoletus*	8	11	9	9	34	43	15	20	66	83
ruby-crowned kinglet	*Regulus calendula*	0	0	0	0	0	0	2	2	2	2

Table 3. Summary of individuals (# obs) and group observations (# grps), by bird type or species, for fixed-point bird use surveys at the Sun Creek Wind Resource Area[a], May 11, 2009, to May 6, 2010.

		Spring		Summer		Fall		Winter		Total	
Bird Type or Species	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
sage sparrow	*Amphispiza belli*	26	40	8	13	26	39	30	53	90	145
savannah sparrow	*Passerculus sandwichensis*	0	0	0	0	2	2	0	0	2	2
Say's phoebe	*Sayornis saya*	2	2	0	0	0	0	2	2	4	4
Scott's oriole	*Icterus parisorum*	0	0	1	1	0	0	0	0	1	1
Townsend's warbler	*Dendroica townsendi*	1	1	0	0	0	0	0	0	1	1
tree swallow	*Tachycineta bicolor*	1	2	0	0	0	0	0	0	1	2
unidentified sparrow		1	1	0	0	0	0	0	0	1	1
unidentified swallow		1	1	0	0	1	1	0	0	2	2
verdin	*Auriparus flaviceps*	1	1	0	0	0	0	1	1	2	2
violet-green swallow	*Tachycineta thalassina*	1	1	0	0	1	5	0	0	2	6
western bluebird	*Sialia mexicana*	0	0	0	0	1	1	1	8	2	9
western kingbird	*Tyrannus verticalis*	5	10	4	4	0	0	0	0	9	14
western meadowlark	*Sturnella neglecta*	8	10	0	0	4	9	4	6	16	25
western scrub-jay	*Aphelocoma californica*	3	4	3	4	0	0	0	0	6	8
western tanager	*Piranga ludoviciana*	2	2	0	0	0	0	0	0	2	2
white-crowned sparrow	*Zonotrichia leucophrys*	15	323	0	0	4	12	16	165	35	500
Wilson's warbler	*Wilsonia pusilla*	2	2	0	0	0	0	0	0	2	2
yellow-rumped warbler	*Dendroica coronata*	9	10	0	0	17	28	0	0	26	38
Swifts/Hummingbirds		**7**	**14**	**4**	**6**	**2**	**4**	**1**	**1**	**14**	**25**
Costa's hummingbird	*Calypte costae*	1	1	1	1	0	0	0	0	2	2
unidentified hummingbird		1	1	1	1	0	0	0	0	2	2
Vaux's swift	*Chaetura vauxi*	3	9	0	0	2	4	0	0	5	13
white-throated swift	*Aeronautes saxatalis*	2	3	2	4	0	0	1	1	5	8
Woodpeckers		**2**	**2**	**2**	**2**	**1**	**1**	**1**	**1**	**6**	**6**
ladder-backed woodpecker	*Picoides scalaris*	2	2	2	2	0	0	0	0	4	4
northern flicker	*Colaptes auratus*	0	0	0	0	1	1	1	1	2	2
Overall		**328**	**1,028**	**150**	**250**	**276**	**473**	**290**	**830**	**1,044**	**2,581**

[a] Regardless of distance from observer.

Table 4a. Mean bird use (number of birds/800-meter plot/30-minunte 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 Sun Creek Wind Resource Area, May 11, 2009, to May 6, 2010.

	Mean Use				Percent Composition				Frequency of Occurrence			
Bird Type or Species	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
Waterbirds	**0.73**	**0**	**0**	**0**	**19.9**	**0**	**0**	**0**	**2.4**	**0**	**0**	**0**
California gull	0.71	0	0	0	19.6	0	0	0	1.2	0	0	0
great egret	0.01	0	0	0	0.3	0	0	0	1.2	0	0	0
Raptors	**0.13**	**0.10**	**0.11**	**0.20**	**3.6**	**9.0**	**5.7**	**14.0**	**13.1**	**9.7**	**7.6**	**13.3**
Accipiters	*0.01*	*0*	*0*	*0.02*	*0.3*	*0*	*0*	*1.6*	*1.2*	*0*	*0*	*2.2*
Cooper's hawk	0.01	0	0	0	0.3	0	0	0	1.2	0	0	0
sharp-shinned hawk	0	0	0	0.01	0	0	0	0.8	0	0	0	1.1
unidentified accipiter	0	0	0	0.01	0	0	0	0.8	0	0	0	1.1
Buteos	*0.10*	*0.07*	*0.05*	*0.08*	*2.6*	*6.4*	*2.4*	*5.5*	*9.5*	*6.9*	*4.5*	*5.6*
red-tailed hawk	0.10	0.07	0.05	0.08	2.6	6.4	2.4	5.5	9.5	6.9	4.5	5.6
Northern Harrier	*0*	*0*	*0*	*0.02*	*0*	*0*	*0*	*1.6*	*0*	*0*	*0*	*2.2*
northern harrier	0	0	0	0.02	0	0	0	1.6	0	0	0	2.2
Eagles	*0.01*	*0.01*	*0.05*	*0.07*	*0.3*	*1.3*	*2.4*	*4.7*	*1.2*	*1.4*	*3.0*	*3.3*
golden eagle	0.01	0.01	0.05	0.07	0.3	1.3	2.4	4.7	1.2	1.4	3.0	3.3
Falcons	*0.01*	*0.01*	*0.02*	*0.01*	*0.3*	*1.3*	*0.8*	*0.8*	*1.2*	*1.4*	*1.5*	*1.1*
American kestrel	0.01	0.01	0.02	0.01	0.3	1.3	0.8	0.8	1.2	1.4	1.5	1.1
Vultures	**1.04**	**0**	**0**	**0.23**	**28.4**	**0**	**0**	**16.4**	**7.1**	**0**	**0**	**1.1**
turkey vulture	1.04	0	0	0.23	28.4	0	0	16.4	7.1	0	0	1.1
Upland Game Birds	**0.06**	**0.38**	**0.38**	**0.10**	**1.6**	**34.6**	**20.3**	**7.0**	**4.8**	**4.2**	**6.1**	**1.1**
California quail	0.05	0	0	0	1.3	0	0	0	3.6	0	0	0
chukar	0.01	0.38	0.38	0.10	0.3	34.6	20.3	7.0	1.2	4.2	6.1	1.1
Doves/Pigeons	**0.13**	**0.12**	**0.08**	**0**	**3.6**	**11.5**	**4.1**	**0**	**8.3**	**8.3**	**6.1**	**0**
mourning dove	0.04	0.12	0.08	0	1.0	11.5	4.1	0	3.6	8.3	6.1	0
rock pigeon	0.10	0	0	0	2.6	0	0	0	4.8	0	0	0
Large Corvids	**1.56**	**0.44**	**1.29**	**0.89**	**42.8**	**41.0**	**69.1**	**62.6**	**54.8**	**25.0**	**47.0**	**40.2**
common raven	1.56	0.44	1.29	0.89	42.8	41.0	69.1	62.6	54.8	25.0	47.0	40.2

Table 4a. Mean bird use (number of birds/800-meter plot/30-minunte 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 Sun Creek Wind Resource Area, May 11, 2009, to May 6, 2010.

	Mean Use				Percent Composition				Frequency of Occurrence			
Bird Type or Species	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
Greater Roadrunners	**0**	**0.04**	**0.02**	**0**	**0**	**3.8**	**0.8**	**0**	**0**	**2.8**	**1.5**	**0**
greater roadrunner	0	0.04	0.02	0	0	3.8	0.8	0	0	2.8	1.5	0
Overall	**3.64**	**1.08**	**1.86**	**1.43**	**100**	**100**	**100**	**100**				

Table 4b. Mean bird use (number of birds/100-meter plot/30-minute 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 Sun Creek Wind Resource Area, May 11, 2009, to May 6, 2010.

	Mean Use				Percent Composition				Frequency of Occurrence			
Bird Type or Species	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
Passerines	**7.07**	**2.28**	**5.23**	**7.26**	**97.5**	**95.3**	**98.6**	**99.8**	**77.4**	**70.8**	**93.9**	**83.1**
ash-throated flycatcher	0.04	0.06	0	0	0.5	2.3	0	0	3.6	5.6	0	0
Bewick's wren	0.05	0	0.11	0.09	0.7	0	2.0	1.2	3.6	0	6.1	6.7
black-throated sparrow	0.11	0.33	0.03	0.18	1.5	14.0	0.6	2.4	7.1	19.4	3.0	4.4
blue-gray gnatcatcher	0	0	0.02	0	0	0	0.3	0	0	0	1.5	0
Brewer's blackbird	0.27	0	0.11	0	3.8	0	2.0	0	6.0	0	1.5	0
Brewer's sparrow	0.07	0	0	0	1.0	0	0	0	3.6	0	0	0
cactus wren	0.04	0.22	0.08	0.11	0.5	9.3	1.4	1.6	3.6	16.7	4.5	6.9
California towhee	0	0	0	0.01	0	0	0	0.2	0	0	0	1.1
Cassin's vireo	0.01	0	0	0	0.2	0	0	0	1.2	0	0	0
chipping sparrow	0.12	0	0	0	1.6	0	0	0	1.2	0	0	0
dark-eyed junco	0.01	0	0	0.46	0.2	0	0	6.3	1.2	0	0	2.2
dusky flycatcher	0.01	0	0	0	0.2	0	0	0	1.2	0	0	0
European starling	0.07	0	0.03	0.03	1.0	0	0.6	0.5	4.8	0	1.5	2.2
fox sparrow	0.01	0	0	0	0.2	0	0	0	1.2	0	0	0
horned lark	0.75	0.50	0.65	1.31	10.3	20.9	12.3	18.0	25.0	9.7	34.8	30.4
house finch	1.27	0.38	1.85	2.44	17.6	15.7	34.9	33.5	42.9	20.8	65.2	51.6
lark sparrow	0.12	0	0	0	1.6	0	0	0	9.5	0	0	0
lesser goldfinch	0.06	0	0.09	0.01	0.8	0	1.7	0.2	1.2	0	4.5	1.1
Lincoln's sparrow	0.01	0	0	0	0.2	0	0	0	1.2	0	0	0
loggerhead shrike	0.08	0.25	0.14	0.07	1.1	10.5	2.6	1.0	6.0	22.2	10.6	7.3
northern mockingbird	0.23	0.11	0.02	0	3.1	4.7	0.3	0	15.5	5.6	1.5	0
rock wren	0.11	0.12	0.65	0.22	1.5	5.2	12.3	3.1	8.3	11.1	40.9	13.3
ruby-crowned kinglet	0	0	0	0.02	0	0	0	0.3	0	0	0	2.2
sage sparrow	0.48	0.18	0.59	0.44	6.6	7.6	11.1	6.0	25.0	8.3	25.8	23.8
savannah sparrow	0	0	0.03	0	0	0	0.6	0	0	0	3.0	0
Say's phoebe	0.02	0	0	0.01	0.3	0	0	0.2	2.4	0	0	1.1

Table 4b. Mean bird use (number of birds/100-meter plot/30-minute 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 Sun Creek Wind Resource Area, May 11, 2009, to May 6, 2010.

	Mean Use				Percent Composition				Frequency of Occurrence			
Bird Type or Species	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
Scott's oriole	0	0.01	0	0	0	0.6	0	0	0	1.4	0	0
Townsend's warbler	0.01	0	0	0	0.2	0	0	0	1.2	0	0	0
tree swallow	0.02	0	0	0	0.3	0	0	0	1.2	0	0	0
unidentified sparrow	0.01	0	0	0	0.2	0	0	0	1.2	0	0	0
unidentified swallow	0.01	0	0.02	0	0.2	0	0.3	0	1.2	0	1.5	0
verdin	0.01	0	0	0	0.2	0	0	0	1.2	0	0	0
violet-green swallow	0.01	0	0.08	0	0.2	0	1.4	0	1.2	0	1.5	0
western bluebird	0	0	0.02	0	0	0	0.3	0	0	0	1.5	0
western kingbird	0.12	0.06	0	0	1.6	2.3	0	0	6.0	5.6	0	0
western meadowlark	0.12	0	0.14	0.02	1.6	0	2.6	0.3	9.5	0	3.0	2.2
western scrub-jay	0.02	0.06	0	0	0.3	2.3	0	0	2.4	4.2	0	0
western tanager	0.02	0	0	0	0.3	0	0	0	2.4	0	0	0
white-crowned sparrow	2.62	0	0.18	1.83	36.1	0	3.4	25.2	13.1	0	6.1	15.6
Wilson's warbler	0.02	0	0	0	0.3	0	0	0	2.4	0	0	0
yellow-rumped warbler	0.12	0	0.42	0	1.6	0	8.0	0	10.7	0	19.7	0
Swifts/Hummingbirds	**0.15**	**0.08**	**0.06**	**0**	**2.1**	**3.5**	**1.1**	**0**	**6.0**	**4.2**	**3.0**	**0**
Costa's hummingbird	0.01	0.01	0	0	0.2	0.6	0	0	1.2	1.4	0	0
unidentified hummingbird	0.01	0.01	0	0	0.2	0.6	0	0	1.2	1.4	0	0
Vaux's swift	0.11	0	0.06	0	1.5	0	1.1	0	2.4	0	3.0	0
white-throated swift	0.02	0.06	0	0	0.3	2.3	0	0	1.2	2.8	0	0
Woodpeckers	**0.02**	**0.03**	**0.02**	**0.01**	**0.3**	**1.2**	**0.3**	**0.2**	**2.4**	**2.8**	**1.5**	**1.1**
ladder-backed woodpecker	0.02	0.03	0	0	0.3	1.2	0	0	2.4	2.8	0	0
northern flicker	0	0	0.02	0.01	0	0	0.3	0.2	0	0	1.5	1.1
Overall	**7.25**	**2.39**	**5.30**	**7.27**	**100**	**100**	**100**	**100**				

Table 5. Flight height characteristics by bird type during fixed-point bird use surveys at the Sun Creek Wind Resource Area, May 11, 2009, to May 6, 2010. Large bird observations were limited to within an 800-meter (m) radius and small bird observations were limited to within a 100-m radius.

Bird Type	# Groups Flying	# Obs Flying	Mean Flight Height (m)	% Obs Flying	% Within Flight Height Categories		
					0 - 35 m	35 - 130 m[a]	> 130 m
Waterbirds	2	61	255.00	100	1.6	0	98.4
Raptors	34	39	73.82	90.7	53.8	23.1	23.1
Accipiters	*3*	*3*	*80.00*	*100*	*66.7*	*0*	*33.3*
Buteos	*19*	*20*	*49.47*	*87.0*	*70.0*	*20.0*	*10.0*
Northern Harrier	*2*	*2*	*6.50*	*100*	*100*	*0*	*0*
Eagles	*6*	*10*	*179.17*	*90.9*	*0*	*50.0*	*50.0*
Falcons	*4*	*4*	*60.50*	*100*	*75.0*	*0*	*25.0*
Vultures	11	108	82.27	100	28.7	58.3	13.0
Upland Game Birds	3	31	2.67	47.0	100	0	0
Doves/Pigeons	16	24	10.69	96.0	83.3	16.7	0
Large Corvids	153	294	45.30	89.6	73.5	17.3	9.2
Greater Roadrunners	1	2	0	50.0	100	0	0
Large Birds Overall	**220**	**559**	**50.16**	**88.0**	**57.6**	**22.7**	**19.7**
Passerines	408	1,313	11.53	75.1	94.4	5.6	0
Swifts/Hummingbirds	12	23	14.33	100	91.3	8.7	0
Woodpeckers	3	3	4.00	50.0	100	0	0
Small Birds Overall	**423**	**1,339**	**11.55**	**75.3**	**94.4**	**5.6**	**0**

[a] the likely rotor-swept heights for potential collision with a turbine blade or 115 - 427 feet (35 – 130 m) above ground level.

Table 6a. Relative exposure index and flight characteristics for large bird species during the fixed-point bird use surveys at the Sun Creek Wind Resource Area, May 11, 2009, to May 6, 2010.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying Within RSH[a] Based on Initial Obs	Exposure Index	% Flying Within RSH at Anytime
turkey vulture	11	0.33	100	58.3	0.19	84.3
common raven	153	1.03	89.6	17.3	0.16	51.7
golden eagle	6	0.04	90.9	50.0	0.02	70.0
red-tailed hawk	19	0.07	87.0	20.0	0.01	45.0
rock pigeon	3	0.02	87.5	57.1	0.01	71.4
chukar	2	0.21	46.8	0	0	0
California gull	1	0.18	100	0	0	0
mourning dove	13	0.06	100	0	0	5.9
greater roadrunner	1	0.01	50.0	0	0	0
American kestrel	4	0.01	100	0	0	25.0
California quail	1	0.01	50.0	0	0	0
northern harrier	2	<0.01	100	0	0	50.0
sharp-shinned hawk	1	<0.01	100	0	0	100
unidentified accipiter	1	<0.01	100	0	0	0
Cooper's hawk	1	<0.01	100	0	0	0
great egret	1	<0.01	100	0	0	0

[a] RSH - The likely rotor-swept heights for potential collision with a turbine blade or 115 - 427 feet (35 - 130 meters) above ground level.

Table 6b. Relative exposure index and flight characteristics for small bird species during the fixed-point bird use surveys at the Sun Creek Wind Resource Area, May 11, 2009, to May 6, 2010.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying Within RSH[a] Based on Initial Obs	Exposure Index	% Flying Within RSH at Anytime
house finch	144	1.50	83.9	9.6	0.12	31.7
horned lark	53	0.83	72.3	13.5	0.08	45.4
lesser goldfinch	2	0.04	75.0	44.4	0.01	44.4
Brewer's blackbird	6	0.09	50.0	26.7	0.01	26.7
European starling	6	0.03	81.8	22.2	<0.01	22.2
Vaux's swift	5	0.04	100	15.4	<0.01	30.8
white-crowned sparrow	18	1.23	93.7	0	0	0
sage sparrow	39	0.41	49.6	0	0	0
rock wren	11	0.26	17.3	0	0	0
black-throated sparrow	17	0.17	70.6	0	0	0
dark-eyed junco	2	0.13	95.2	0	0	0
loggerhead shrike	15	0.13	47.5	0	0	0
yellow-rumped warbler	17	0.12	71.1	0	0	3.7
cactus wren	10	0.11	58.8	0	0	0
northern mockingbird	14	0.09	78.6	0	0	0
western meadowlark	6	0.06	57.1	0	0	0
Bewick's wren	10	0.06	63.2	0	0	0
western kingbird	7	0.04	85.7	0	0	0
chipping sparrow	1	0.03	100	0	0	0
lark sparrow	5	0.03	60.0	0	0	0
ash-throated flycatcher	3	0.02	42.9	0	0	0
western scrub-jay	3	0.02	66.7	0	0	0
white-throated swift	3	0.02	100	0	0	0
violet-green swallow	2	0.02	100	0	0	0
Brewer's sparrow	0	0.02	0	0	0	0
ladder-backed woodpecker	1	0.01	25.0	0	0	0
Say's phoebe	1	<0.01	33.3	0	0	100

Table 6b. Relative exposure index and flight characteristics for small bird species during the fixed-point bird use surveys at the Sun Creek Wind Resource Area, May 11, 2009, to May 6, 2010.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying Within RSH[a] Based on Initial Obs	Exposure Index	% Flying Within RSH at Anytime
Costa's hummingbird	2	<0.01	100	0	0	0
unidentified hummingbird	2	<0.01	100	0	0	0
ruby-crowned kinglet	2	<0.01	100	0	0	0
northern flicker	2	<0.01	100	0	0	0
savannah sparrow	2	<0.01	100	0	0	50.0
unidentified swallow	2	<0.01	100	0	0	50.0
tree swallow	1	<0.01	100	0	0	0
western tanager	2	<0.01	100	0	0	0
Wilson's warbler	0	<0.01	0	0	0	0
Scott's oriole	0	<0.01	0	0	0	0
California towhee	0	<0.01	0	0	0	0
blue-gray gnatcatcher	1	<0.01	100	0	0	0
western bluebird	0	<0.01	0	0	0	0
Cassin's vireo	1	<0.01	100	0	0	0
dusky flycatcher	1	<0.01	100	0	0	0
fox sparrow	0	<0.01	0	0	0	0
Lincoln's sparrow	1	<0.01	100	0	0	0
Townsend's warbler	1	<0.01	100	0	0	0
unidentified sparrow	1	<0.01	100	0	0	0
verdin	1	<0.01	100	0	0	0

[a] RSH - The likely rotor-swept heights for potential collision with a turbine blade or 115 - 427 feet (35 - 130 meters) above ground level.

Table 7. Summary of sensitive species observed at the Sun Creek Wind Resource Area during fixed-point bird use surveys (FP) and as incidental wildlife observations (Inc.) from May 11, 2009, to May 6, 2010.

			FP		Inc.		Total	
Species	**Scientific Name**	**Status**	**# of grps**	**# of obs**	**# of grps**	**# of obs**	**# of grps**	**# of obs**
loggerhead shrike	*Lanius ludovicianus*	SSC; FSOC	42	46	0	0	**42**	**46**
Vaux's swift	*Chaetura vauxi*	SSC	5	13	0	0	**5**	**13**
golden eagle	*Aquila chrysaetos*	EA	7	11	0	0	**7**	**11**
northern harrier	*Circus cyaneus*	SSC	2	2	0	0	**2**	**2**
burrowing owl	*Athene cunicularia*	SSC; FSOC	0	0	1	1	**1**	**1**
Bird Subtotal	**5 Species**		**57**	**73**	**1**	**1**	**57**	**73**
desert tortoise	*Gopherus agassizii*	ST; FT	0	0	1	1	**1**	**1**
Total	**7 Species**		**57**	**73**	**2**	**2**	**58**	**74**

FSOC - federal species of concern (USFWS 2010);
FT - federal threatened (USFWS 2010);
ST - state threatened (CDFG 2009);
SSC - state species of concern (CDFG 2009);
EA - Bald and Golden Eagle Protection Act (BGEPA 1940).

Table 8. Comparison of raptor use estimates and raptor mortality between the Sun Creek Wind Resource Area and other wind-energy facilities in North America.

Wind-Energy Facility	Use Estimate[a]	Raptor Mortality[b]	# of Turbines	Total Megawatts (MW)
Sun Creek, CA	0.09			
Western				
Diablo Winds, CA	2.16	0.87	31	20
SMUD, CA		0.53		15
High Winds, CA	2.34	0.39	90	162
Leaning Juniper, OR	0.52	0.21	67	100.5
Big Horn, WA	0.51	0.15	133	199.5
Hopkins Ridge, WA	0.70	0.14	83	150
Klondike II, OR	0.50	0.11	50	75
Stateline, OR/WA (2002)	0.23	0.09	454	300
Stateline, OR/WA (2003)	0.21	0.09	454	300
Wild Horse, WA	0.29	0.09	127	229
Klondike III, OR		0.06	122	375
Zintel, WA	0.43	0.05	38	50
Nine Canyon, WA	0.35	0.05	37	48
Combine Hills, OR	0.75	0	41	41
Vansycle, OR	0.66	0	38	24.9
Klondike, OR	0.50	0	16	24
Dillon, CA		0	45	45
Rocky Mountains				
Summerview, Alb. (2005/2006)		0.11	39	70.2
Judith Gap, MT		0.09	90	135
Foote Creek Rim, WY (Phase I; 1999)		0.08	69	41.4
Foote Creek Rim, WY (Phase I; 2000)		0.05	69	41.4
Foote Creek Rim, WY (Phase I; 2001/2002)		0	69	41.4
Midwest				
NPPD Ainsworth, NE		0.06	36	59.4
Wolfe Island, Ont.		0.04	86	197.8
Buffalo Ridge, MN	0.64	0.02	281	210.75
Southern Plains				
Buffalo Gap, TX		0.10	67	134

Table 8. Comparison of raptor use estimates and raptor mortality between the Sun Creek Wind Resource Area and other wind-energy facilities in North America.

Northeastern			
Noble Ellenburg, NY (2009)	0.49	54	80
Noble Ellenburg, NY (2008)	0.32	54	80
Noble Clinton, NY (2008)	0.29	67	100.5
Maple Ridge, NY (2007)	0.25	195	321.75
Noble Clinton, NY (2009)	0.24	67	100
Noble Bliss, NY (2008)	0.19	67	100
Noble Bliss, NY (2009)	0.18	67	100
Maple Ridge, NY (2006)	0.04	120	198
Buffalo Mountain, TN (2006)	0	18	29
Buffalo Mountain, TN (2000-2003)	0	3	1.98
Mount Storm, WV (2008)	0	82	164

[a] = number of raptors/800-meter plot/20-minute survey
[b] = number of fatalities/MW/year
Data from the following sources:

Diablo Winds, CA	WEST 2006	WEST 2008a	Foote Creek Rim, WY (Phase I; 99)		Young et al. 2003c
SMUD, CA		URS et al. 2005	Foote Creek Rim, WY (Phase I; 00)		Young et al. 2003c
High Winds, CA	Kerlinger et al. 2005	Kerlinger et al. 2006	Foote Creek Rim, WY (Phase I; 01/02)		Young et al. 2003c
Leaning Juniper, OR	Kronner et al. 2005	Gritski et al. 2008	NPPD Ainsworth, NE		Derby et al. 2007
Big Horn, WA	Johnson and Erickson 2004	Kronner et al. 2008	Wolfe Island, Ont.		Stantec Ltd. 2010
Hopkins Ridge, WA	Young et al. 2003a	Young et al. 2007a	Buffalo Ridge, MN	Erickson et al. 2002b	Erickson et al. 2002b
Klondike II, OR	Johnson 2004	NWC and WEST 2007	Buffalo Gap, TX		Tierney 2007
Stateline, OR/WA (02)	Erickson et al. 2002b	Erickson et al. 2004	Noble Ellensburg, NY (09)		Jain et al. 2010c
Stateline, OR/WA (03)	Erickson et al. 2003b	Erickson et al. 2004	Noble Ellensburg, NY (08)		Jain et al. 2009a
Wild Horse, CA	Erickson et al. 2003d	Erickson et al. 2008	Noble Clinton, NY (2008)		Jain et al. 2009b
Klondike III, OR		Gritski et al. 2009	Maple Ridge, NY (07)		Jain et al. 2008
Zintel, WA	Erickson et al. 2002a	Erickson et al. 2008	Noble Clinton, NY (09)		Jain et al. 2010b
Nine Canyon, WA	Erickson et al. 2001b	Erickson et al. 2003c	Noble Bliss, NY (08)		Jain et al. 2009c
Combine Hills, OR	Young et al. 2003d	Young et al. 2006	Noble Bliss, NY (09)		Jain et al. 2010a
Vansycle, OR	WCIA and WEST 1997	Erickson et al. 2000	Maple Ridge, NY (06)		Jain et al. 2007
Klondike, OR	Johnson et al. 2002	Johnson et al. 2003	Buffalo Mountain, TN (06)		Fiedler et al. 2007
Dillon, CA		Chatfield et al. 2009	Buffalo Mountain, TN (00-03)		Nicholson 2003, 2005
Summerview, Alb. (05/06)		Brown and Hamilton 2006	Mount Storm, WV (08)		Young et al. 2009
Judith Gap, MT		TRC 2008			

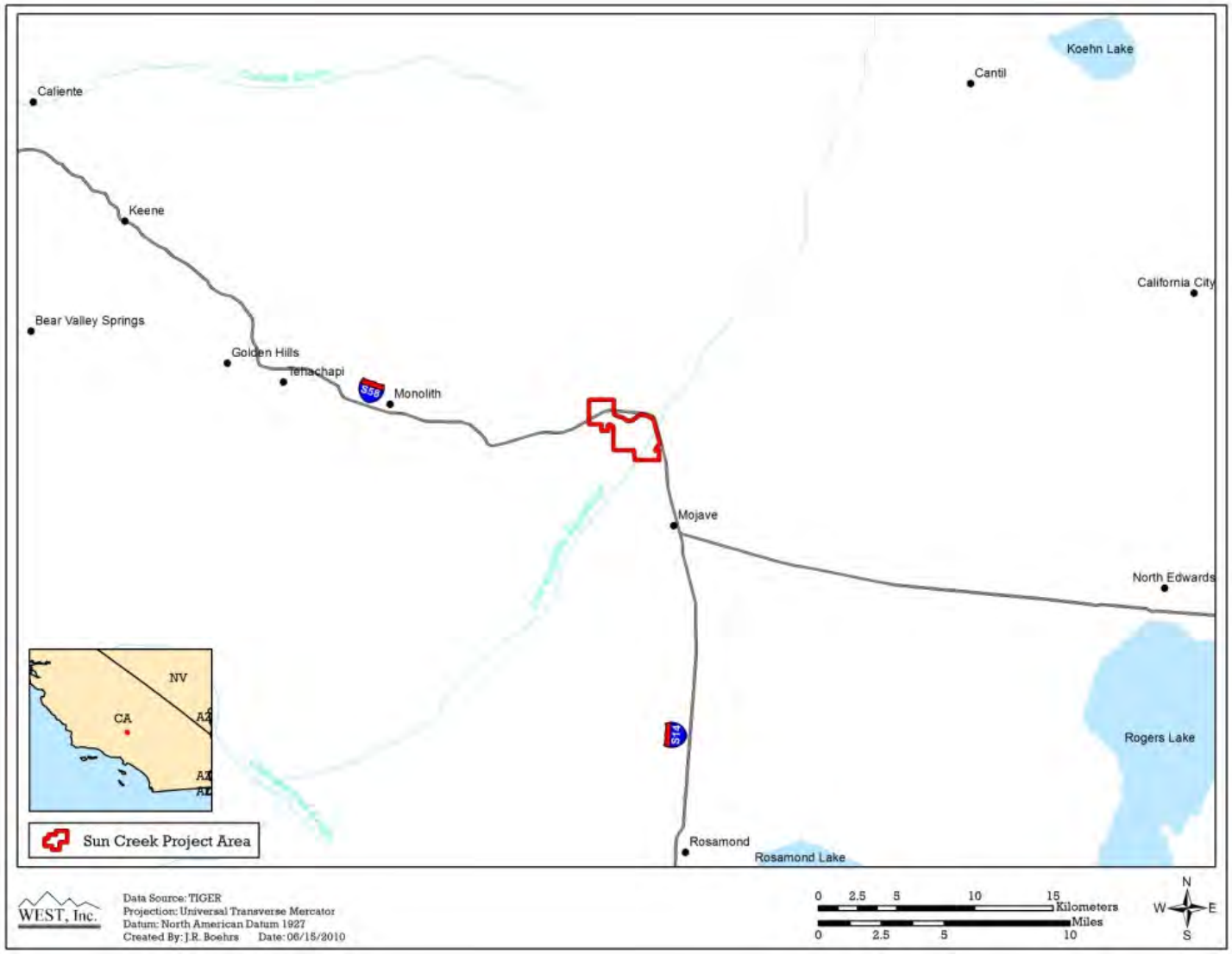


Figure 1. Overview of the Sun Creek Wind Resource Area.

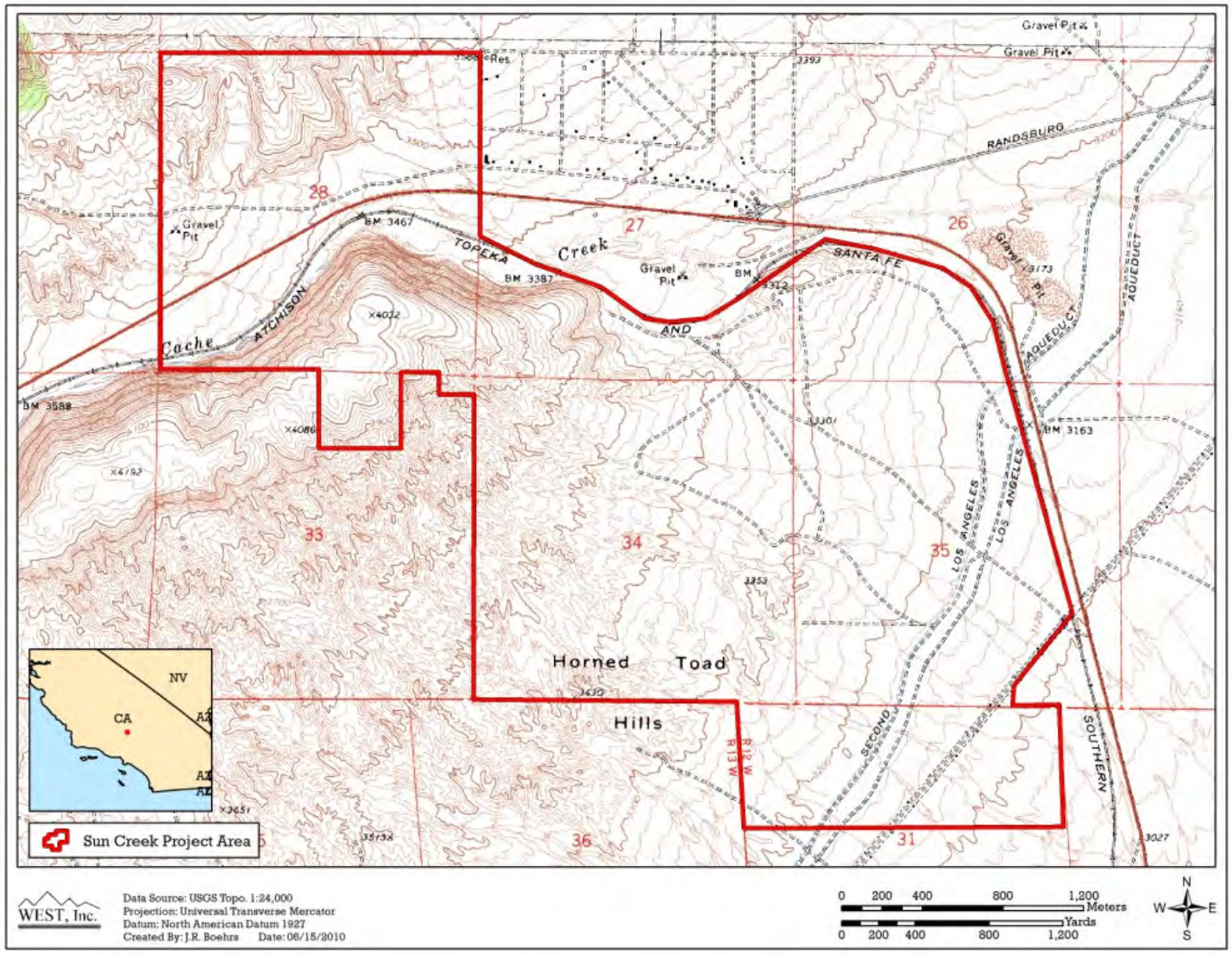


Figure 2. Location of the Sun Creek Wind Resource Area.

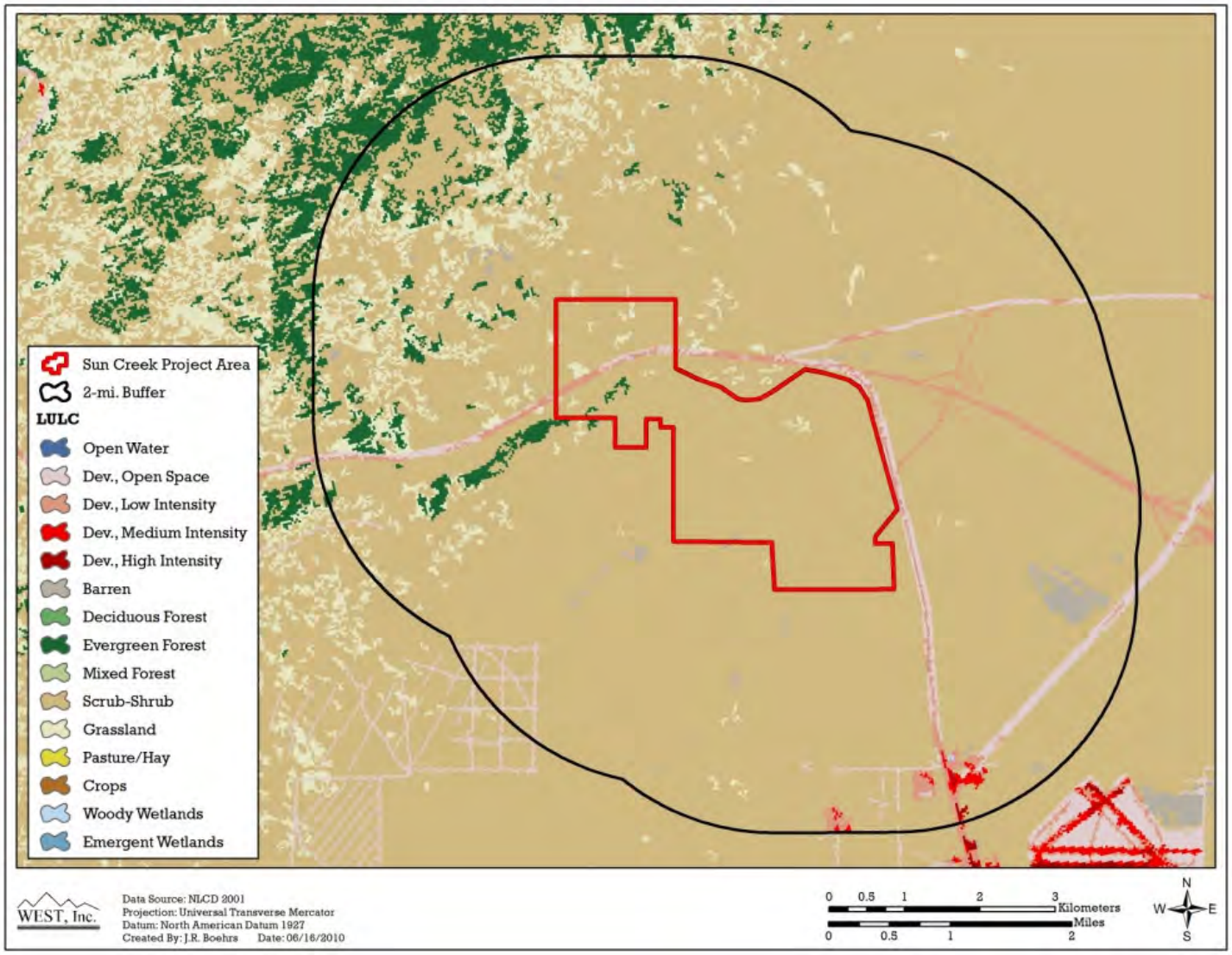


Figure 3. The land cover types and coverage within the Sun Creek Wind Resource Area (USGS NLCD 2001).

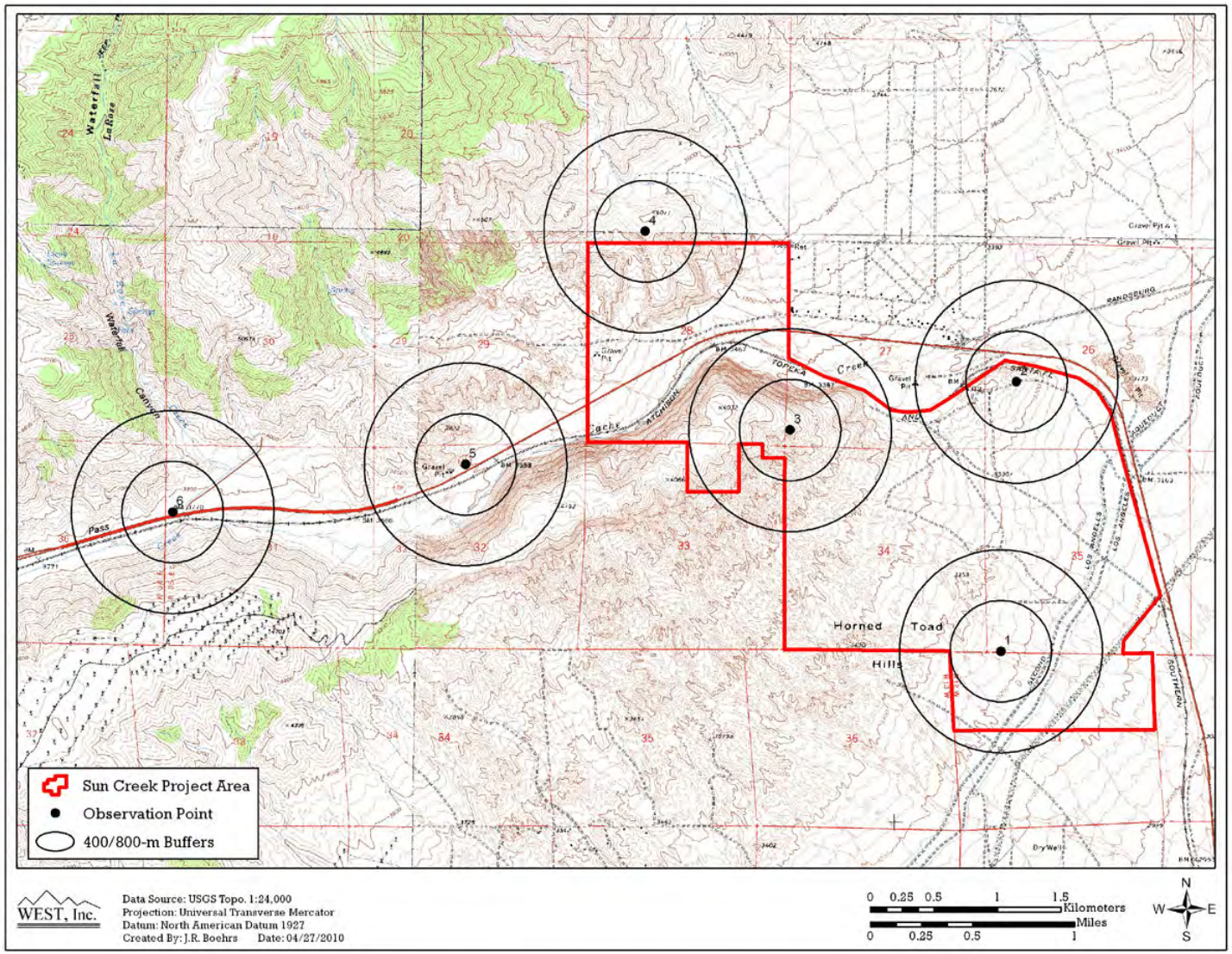


Figure 4. Fixed-point bird use survey points at the Sun Creek Wind Resource Area.

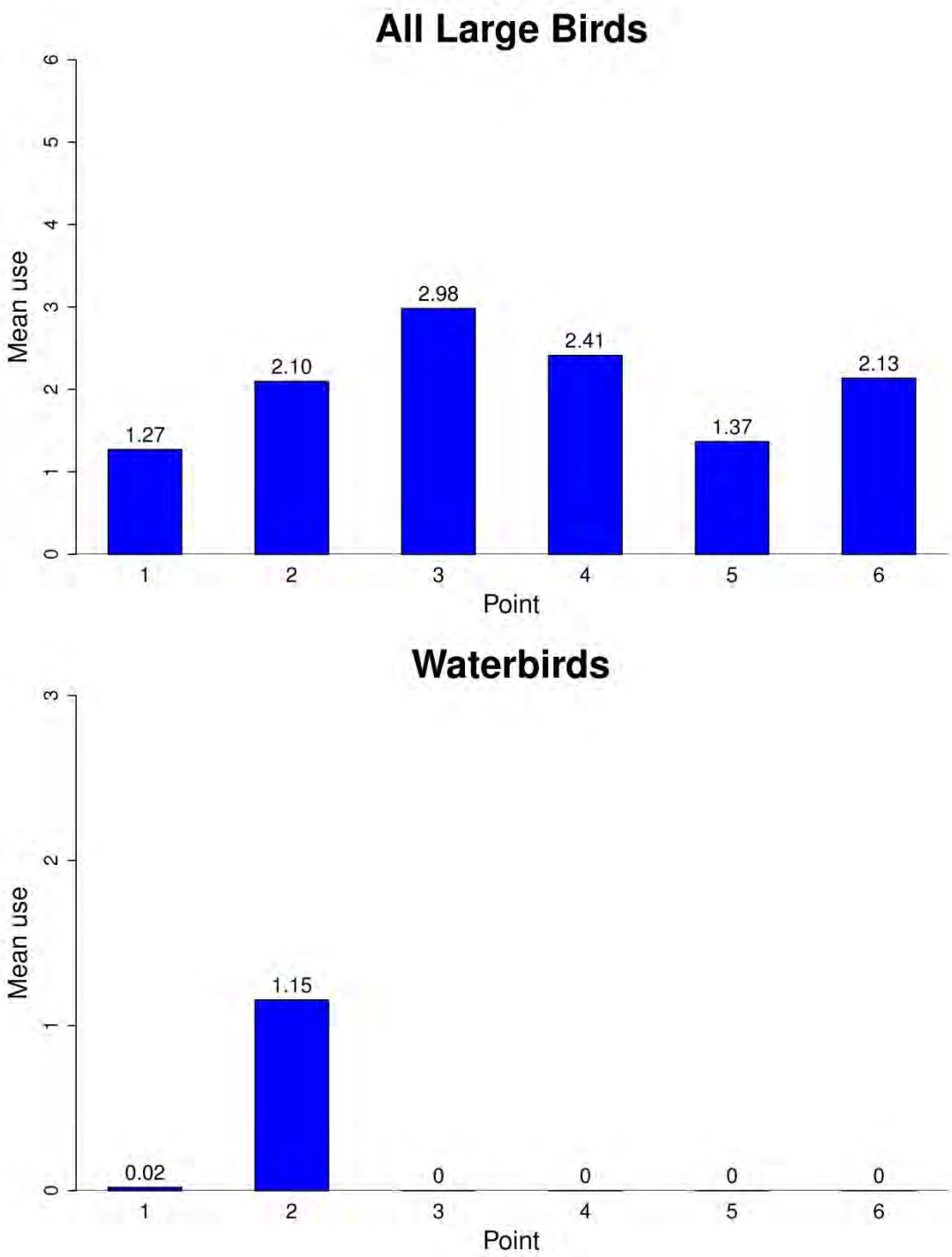


Figure 5. Mean bird use (number of birds/30-minute survey) at each fixed-point bird use point for all birds, major bird types, and raptor subtypes at the Sun Creek Wind Resource Area.

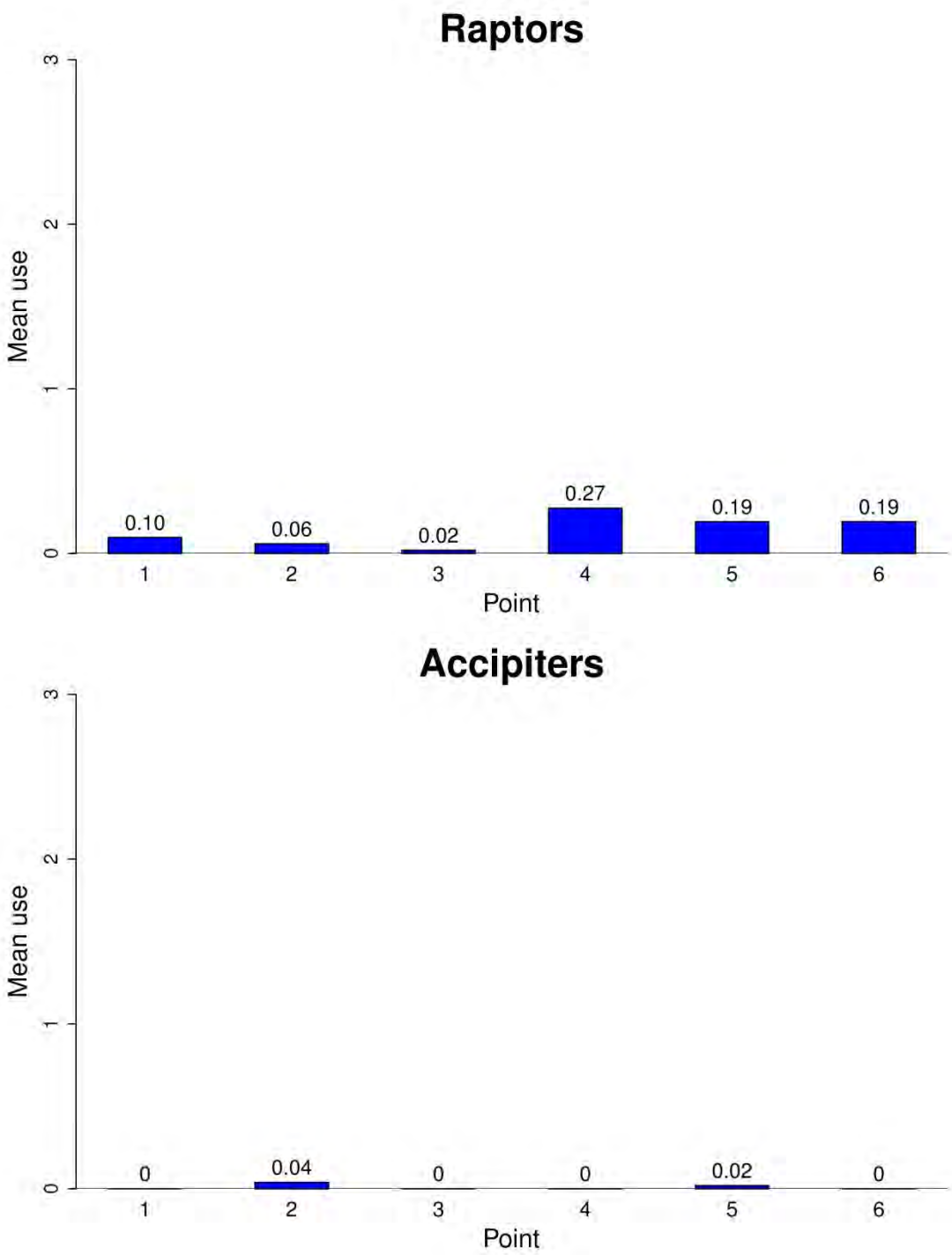


Figure 5 (*continued*). Mean bird use (number of birds/30-minute survey) at each fixed-point bird use point for all birds, major bird types, and raptor subtypes at the Sun Creek Wind Resource Area.

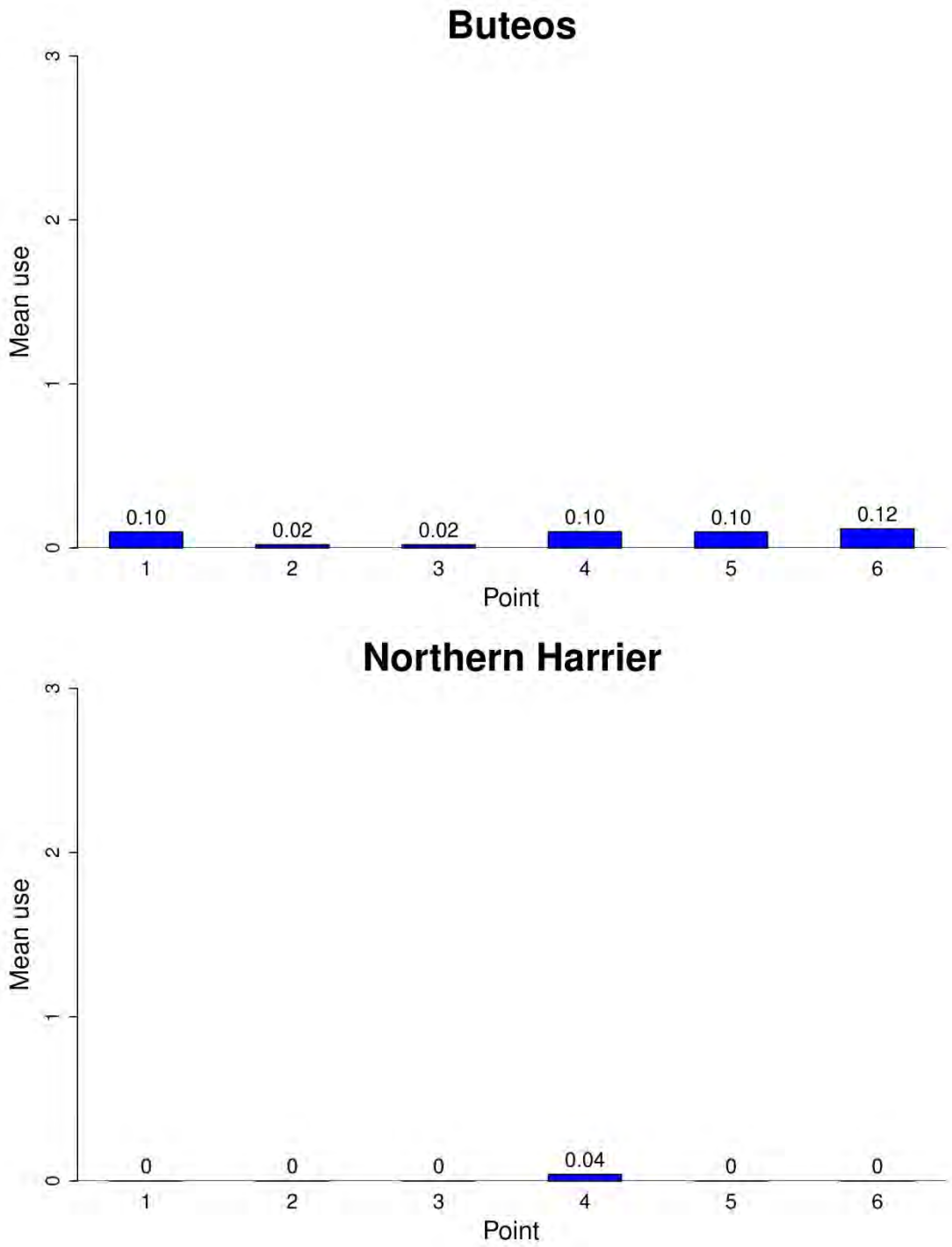


Figure 5 (*continued*). Mean bird use (number of birds/30-minute survey) at each fixed-point bird use point for all birds, major bird types, and raptor subtypes at the Sun Creek Wind Resource Area.

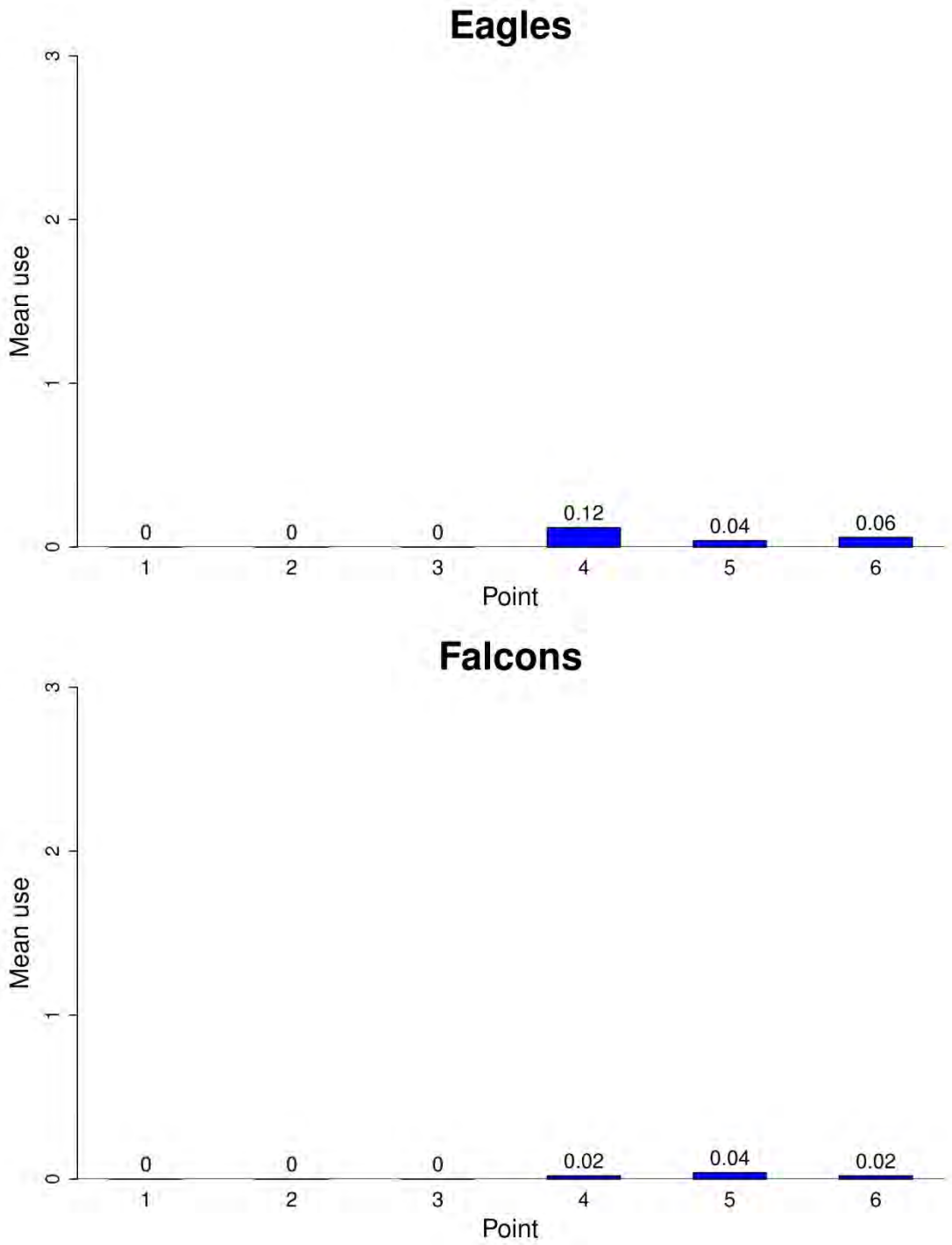


Figure 5 (*continued*). Mean bird use (number of birds/30-minute survey) at each fixed-point bird use point for all birds, major bird types, raptor subtypes at the Sun Creek Wind Resource Area.

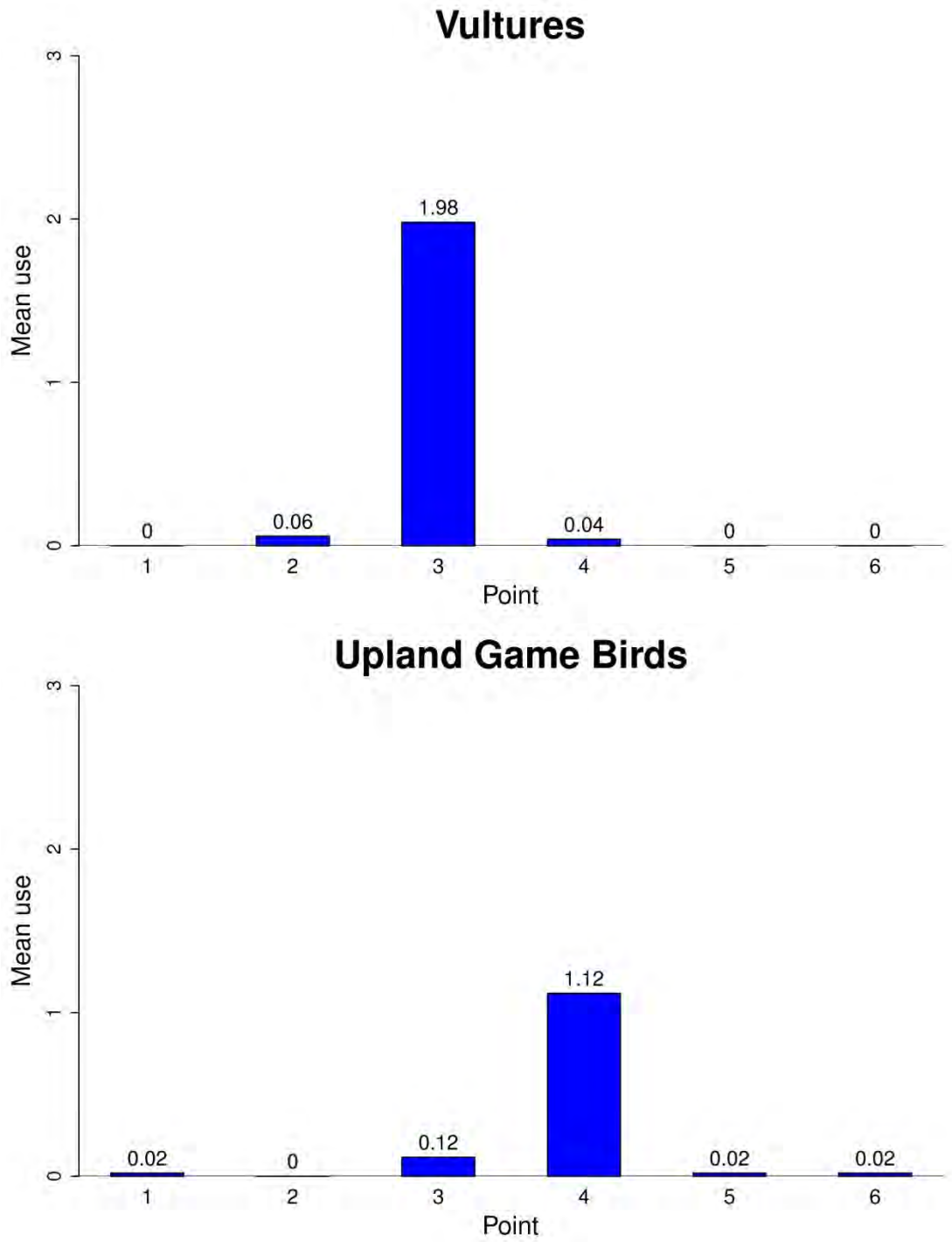


Figure 5 (*continued*). Mean bird use (number of birds/30-minute survey) at each fixed-point bird use point for all birds, major bird types, and raptor subtypes at the Sun Creek Wind Resource Area. Observations of passerines and other small birds were focused within 100-m viewsheds.

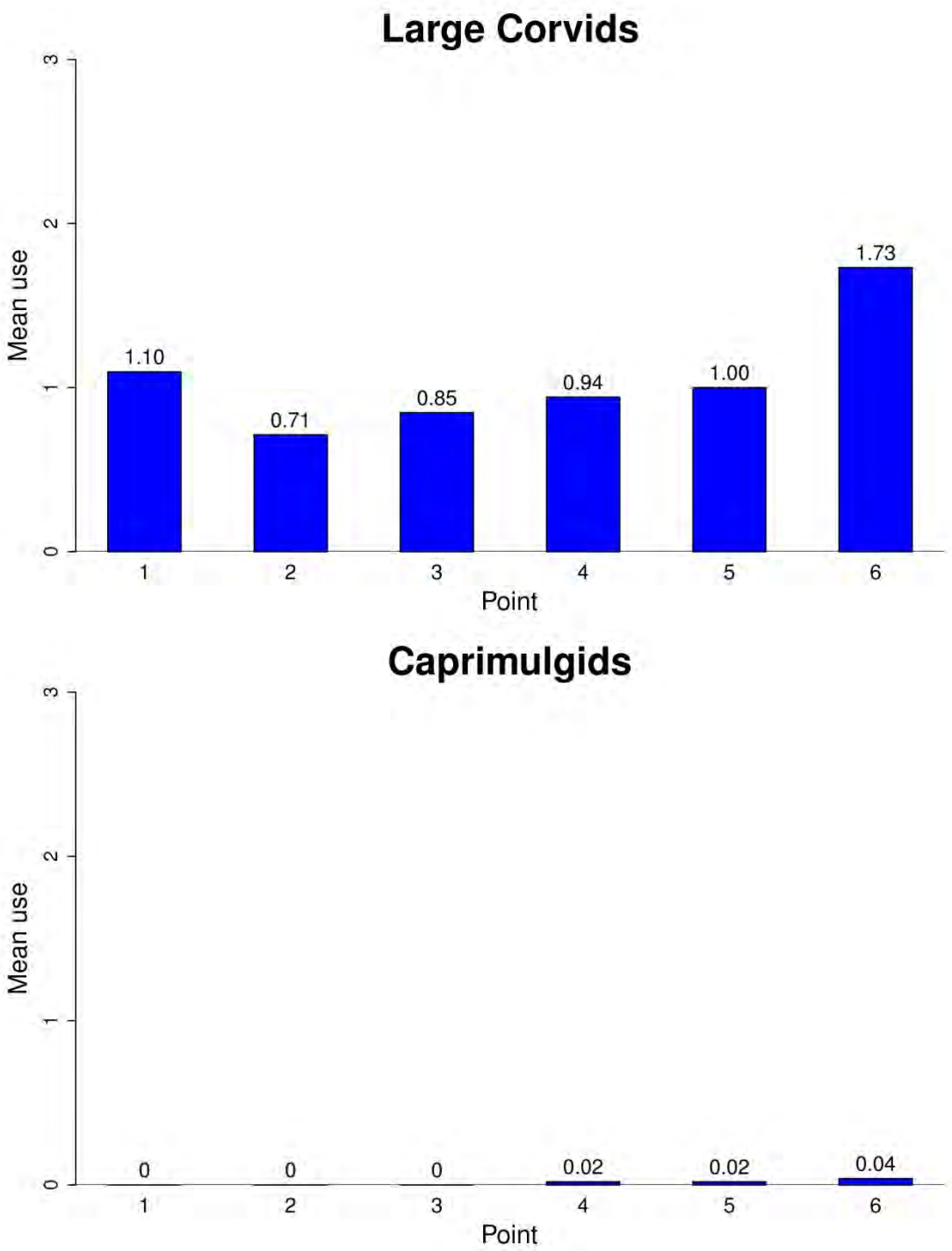


Figure 5 (*continued*). Mean bird use (number of birds/30-minute survey) at each fixed-point bird use point for all birds, major bird types, and raptor subtypes at the Sun Creek Wind Resource Area.

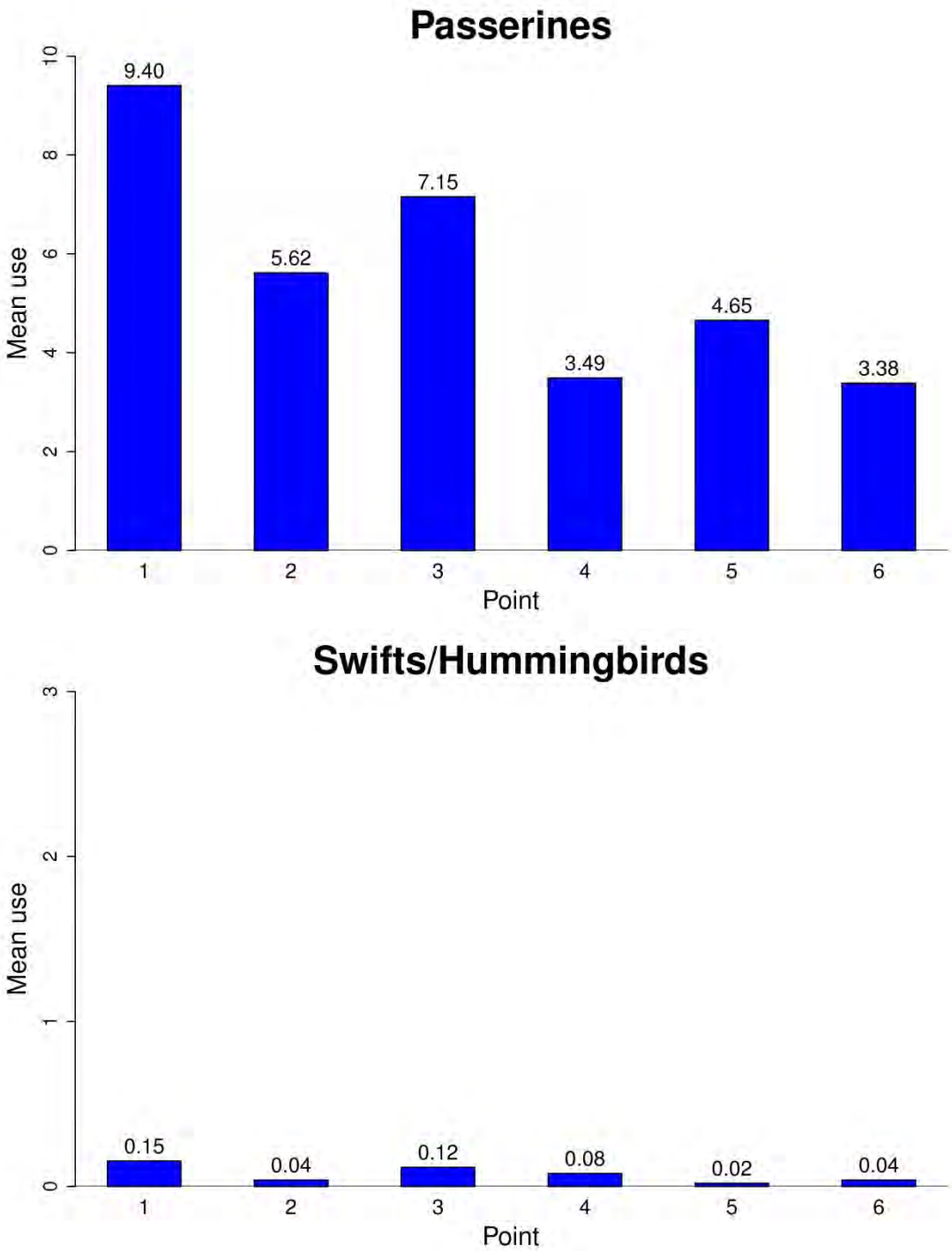


Figure 5 (*continued*). Mean bird use (number of birds/30-minute survey) at each fixed-point bird use point for all birds, major bird types, and raptor subtypes at the Sun Creek Wind Resource Area. Small bird observations were focused within 100-meter viewsheds.

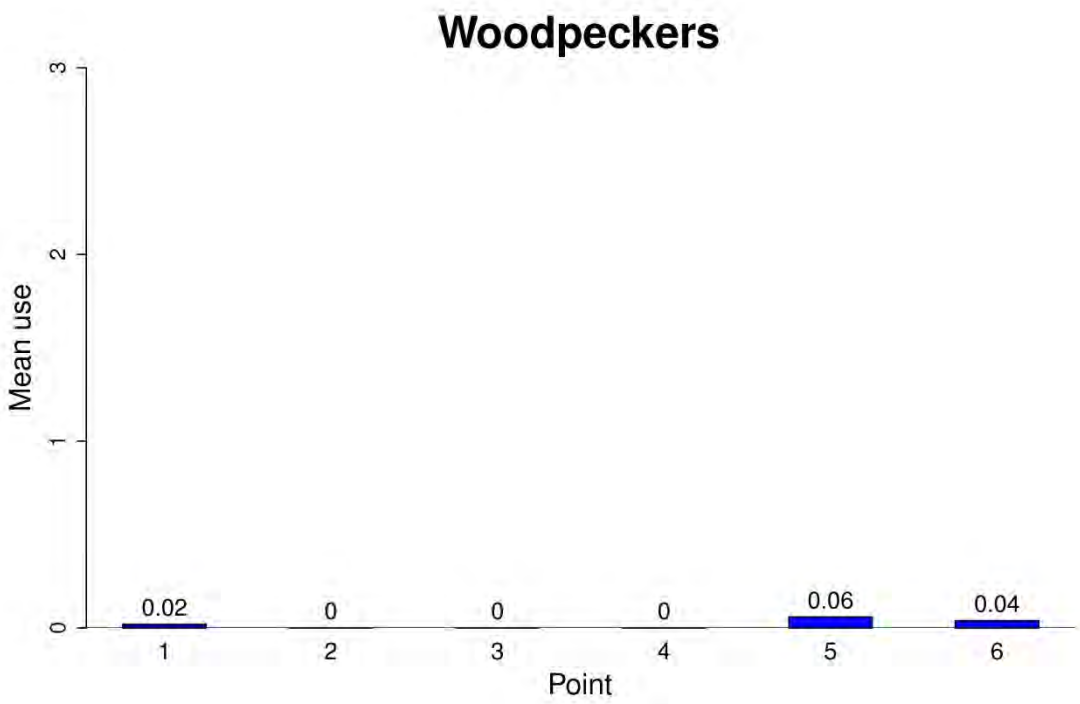


Figure 5 (*continued*). Mean bird use (number of birds/30-minute survey) at each fixed-point bird use point for all birds, major bird types, and raptor subtypes at the Sun Creek Wind Resource Area. Small bird observations were focused within 100-meter viewsheds.

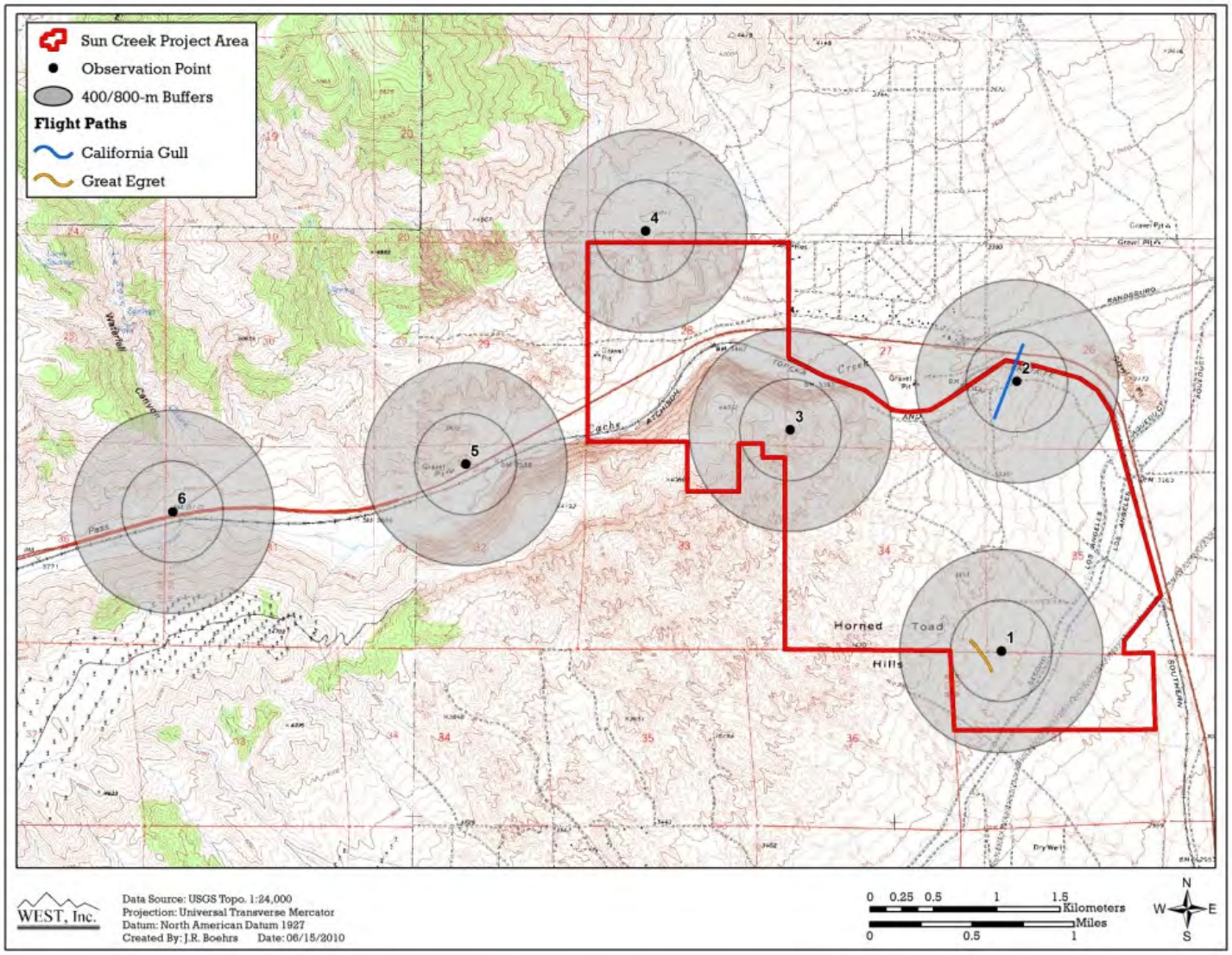


Figure 6a. Spatial use by flight paths of waterbirds at the Sun Creek Wind Resource Area.

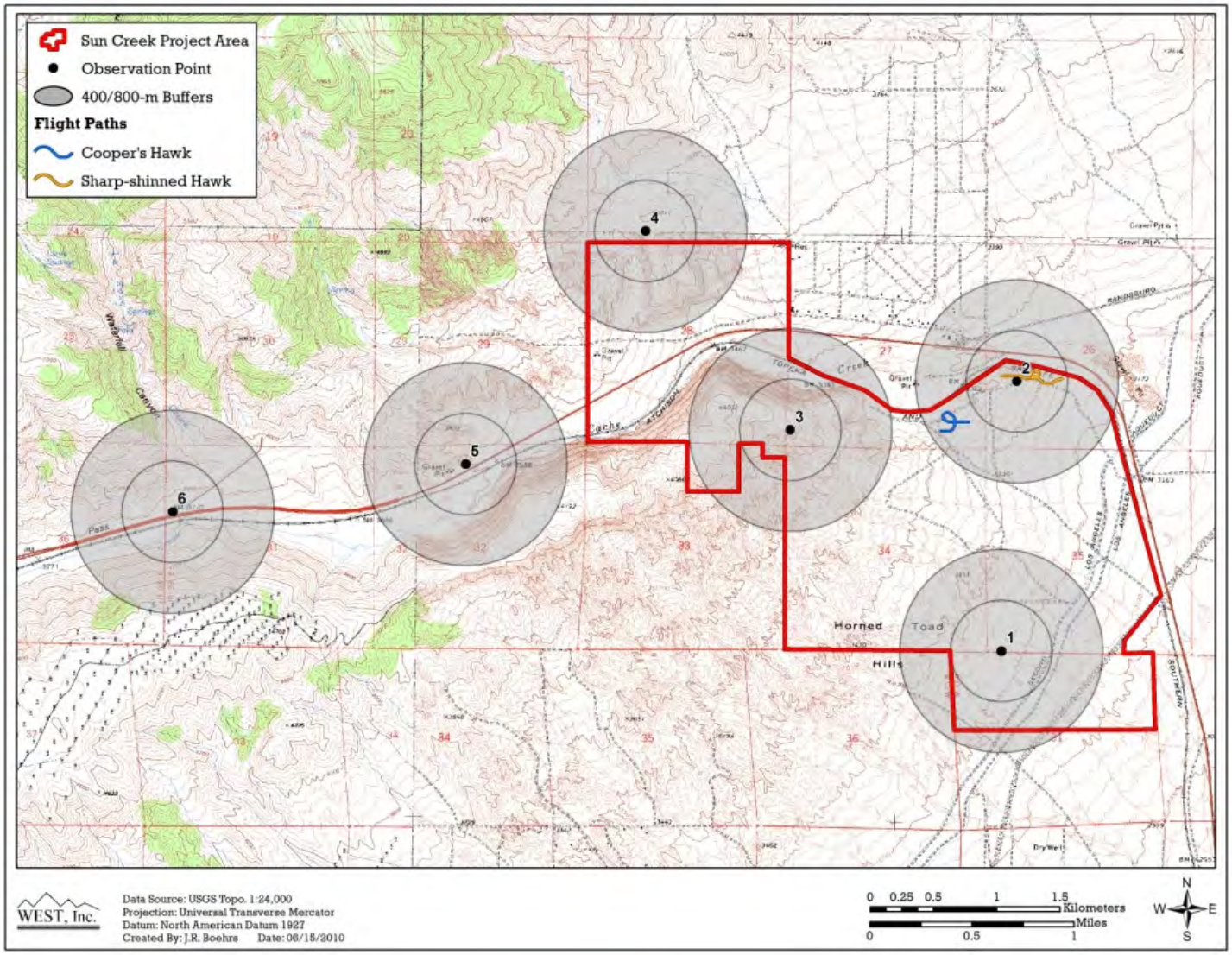


Figure 6b. Spatial use by flight paths of accipiters at the Sun Creek Wind Resource Area.

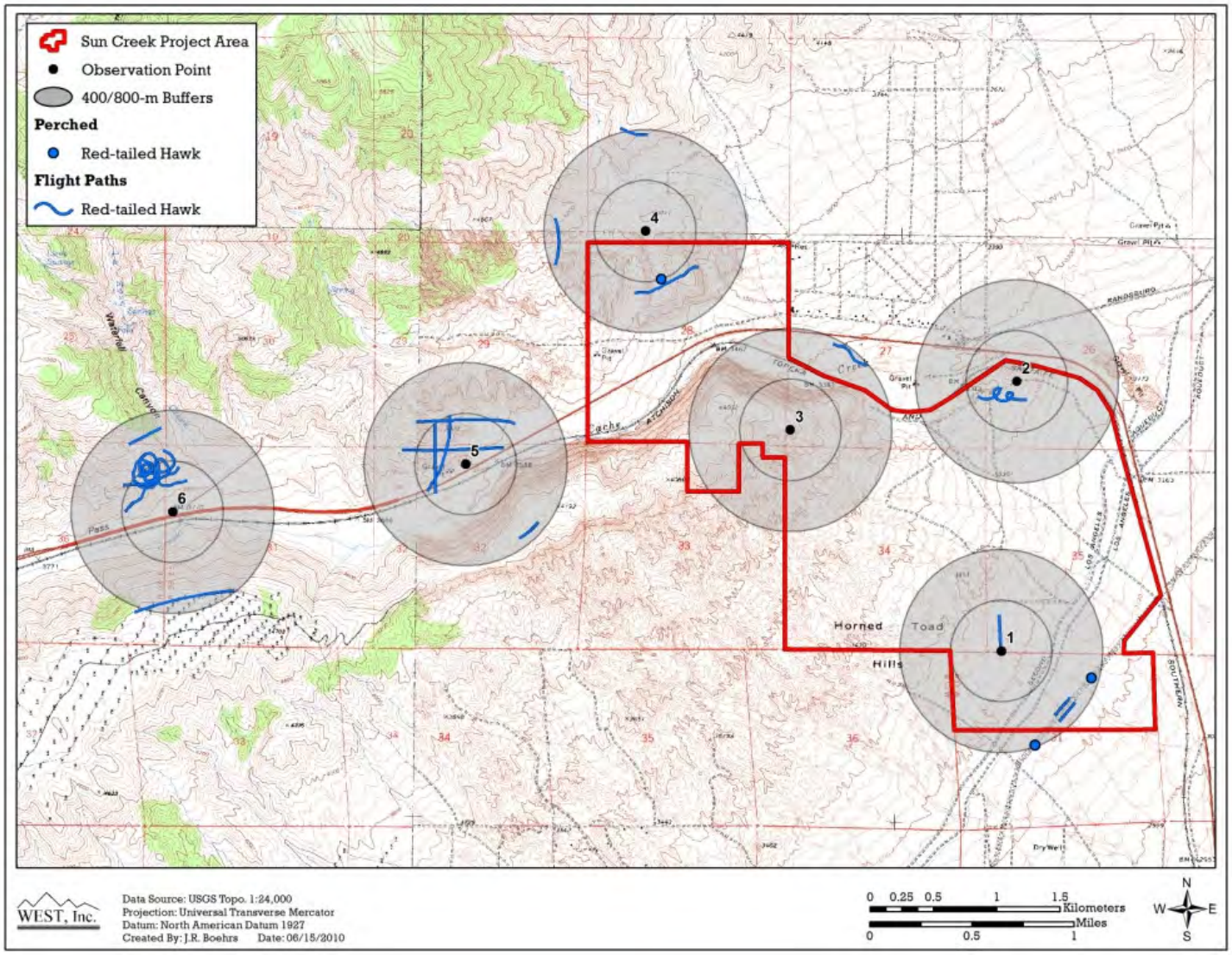


Figure 6c. Spatial use by flight paths of buteos at the Sun Creek Wind Resource Area.

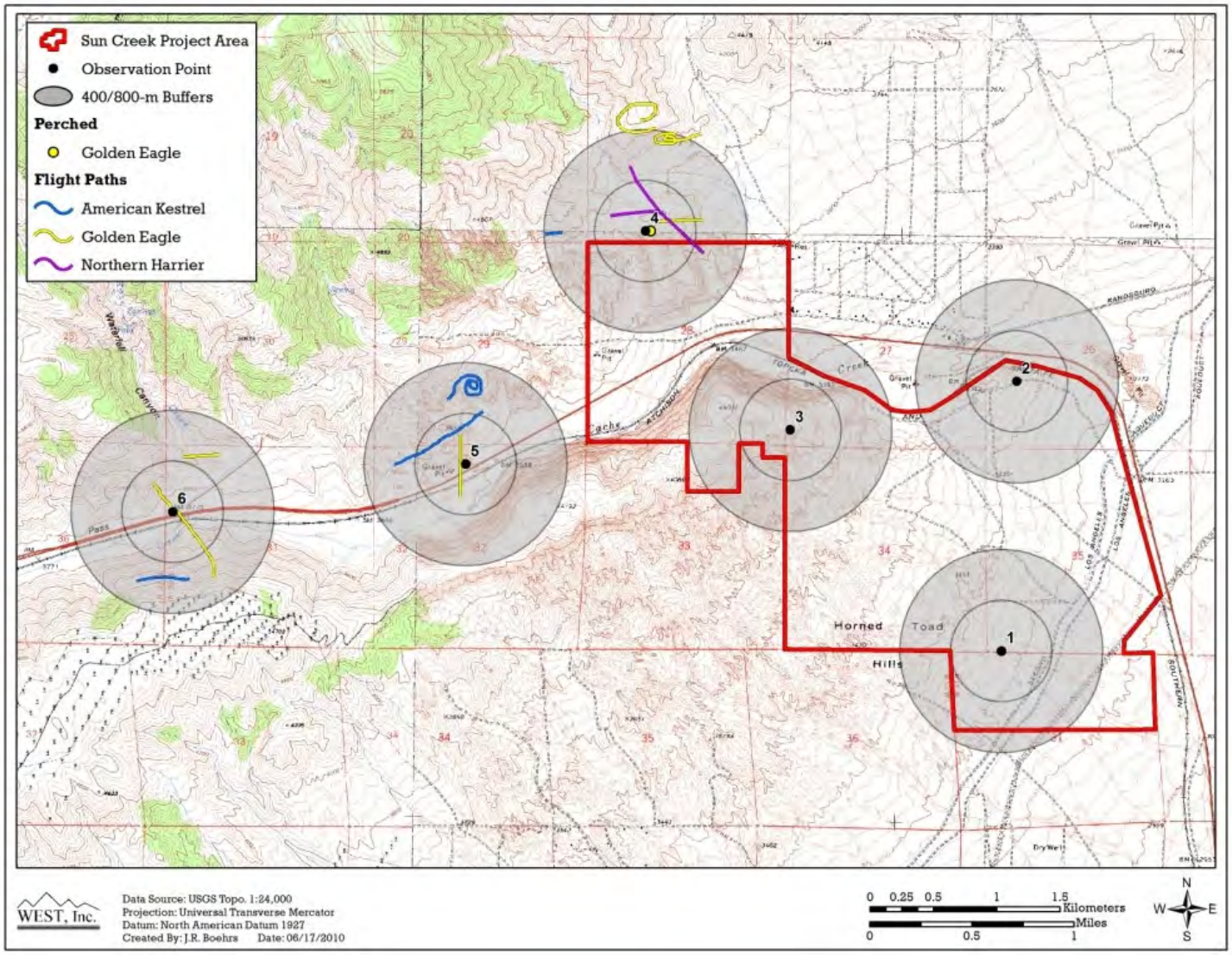


Figure 6d. Spatial use by flight paths of miscellaneous raptors at the Sun Creek Wind Resource Area.

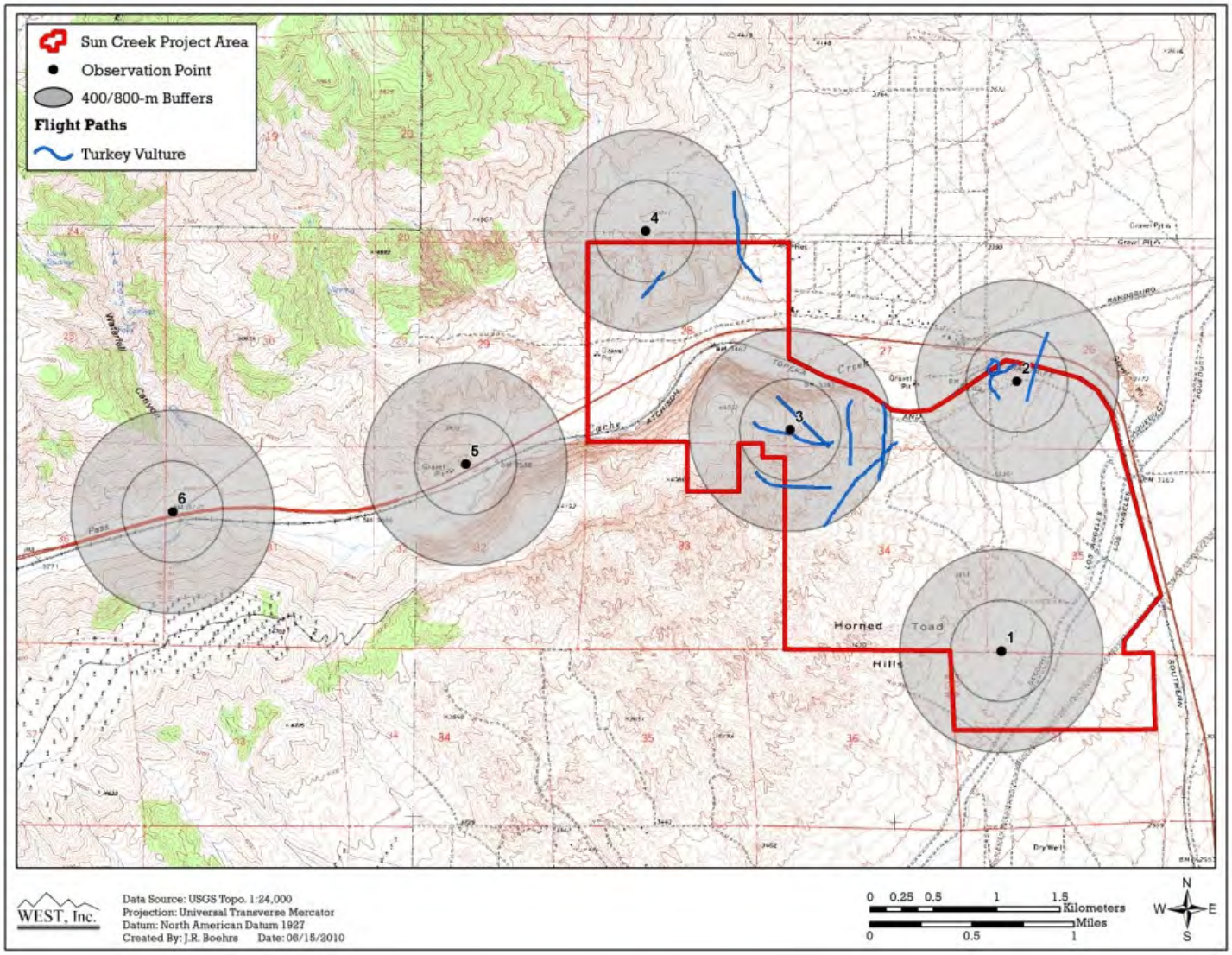


Figure 6e. Spatial use by flight paths of vultures at the Sun Creek Wind Resource Area.

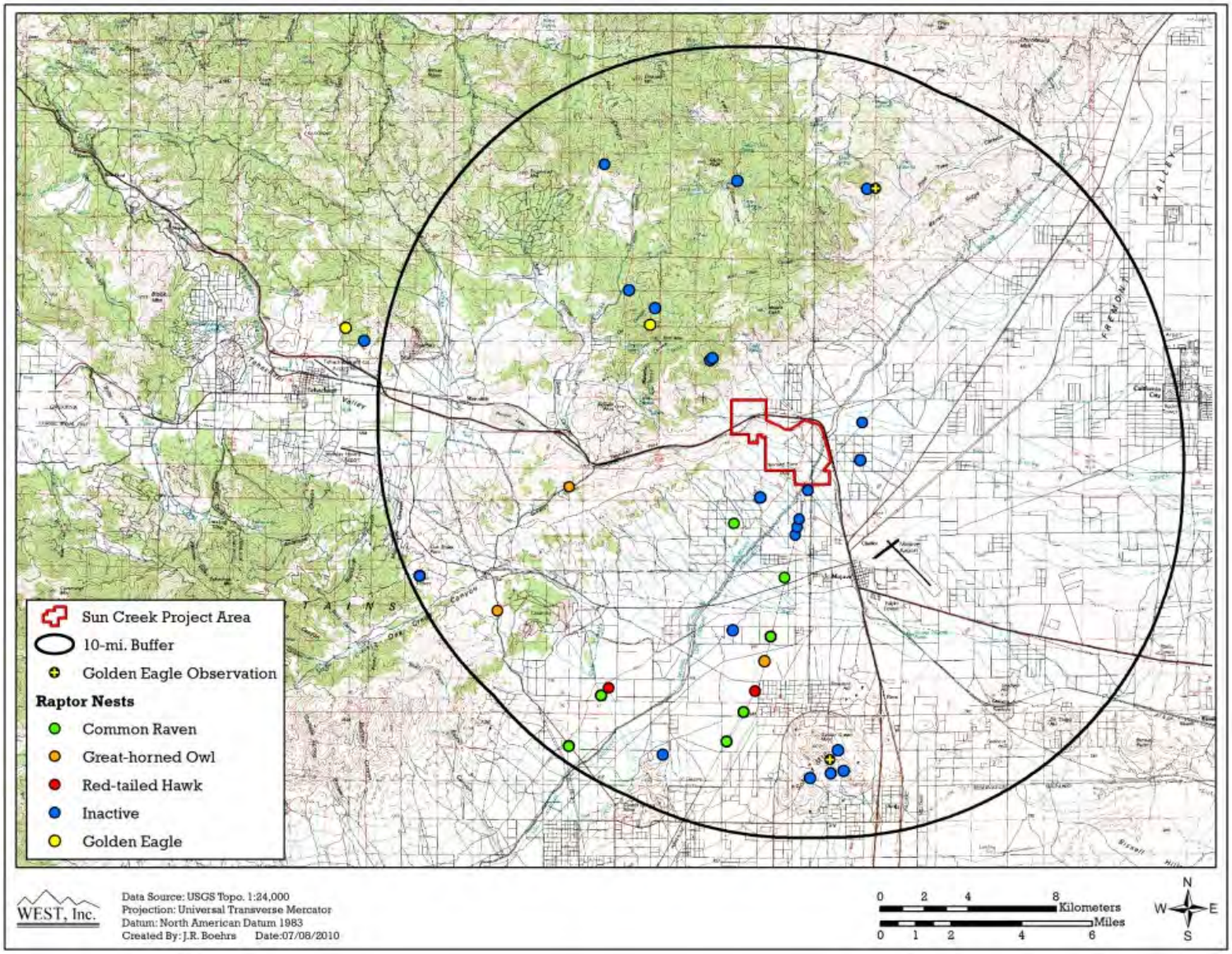


Figure 7. Location of raptor nests at the Sun Creek Wind Resource Area.

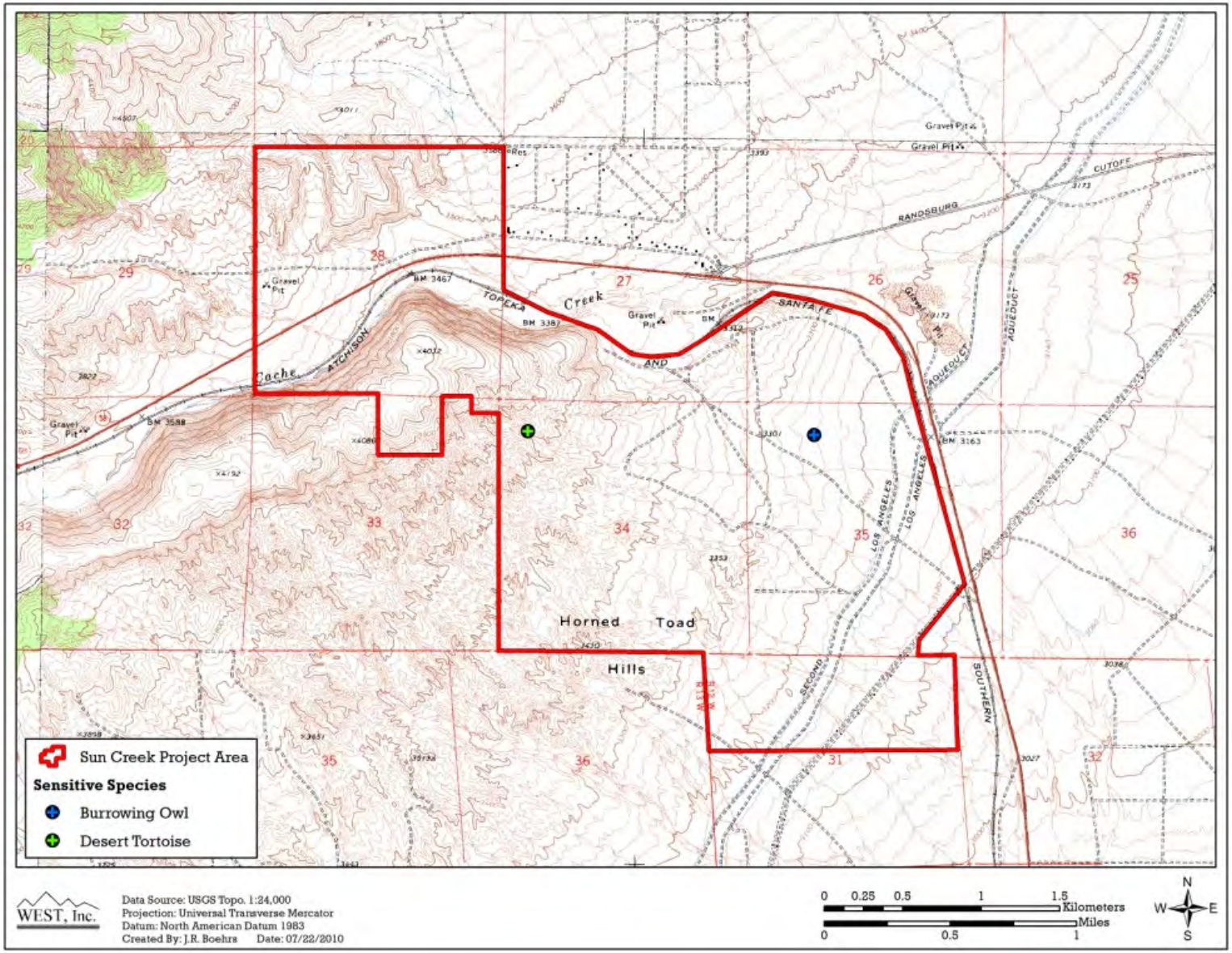


Figure 8. Locations of sensitive species observed incidentally within the Sun Creek Wind Resource Area.

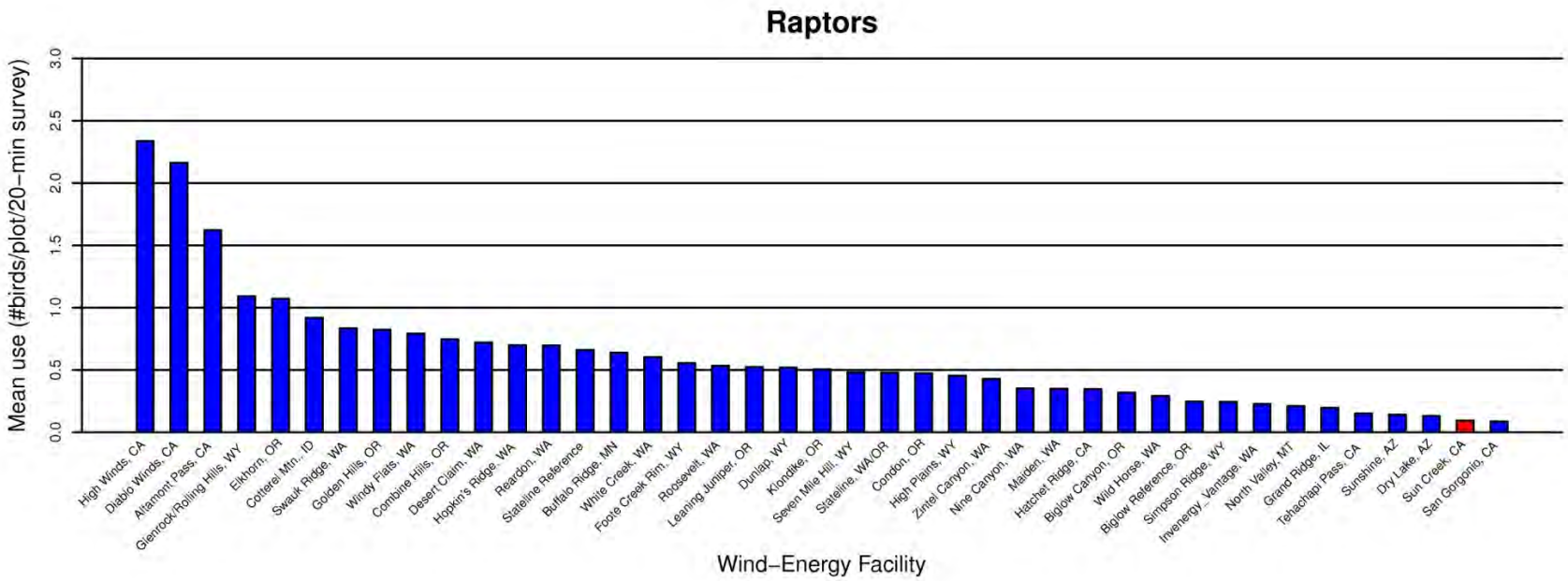
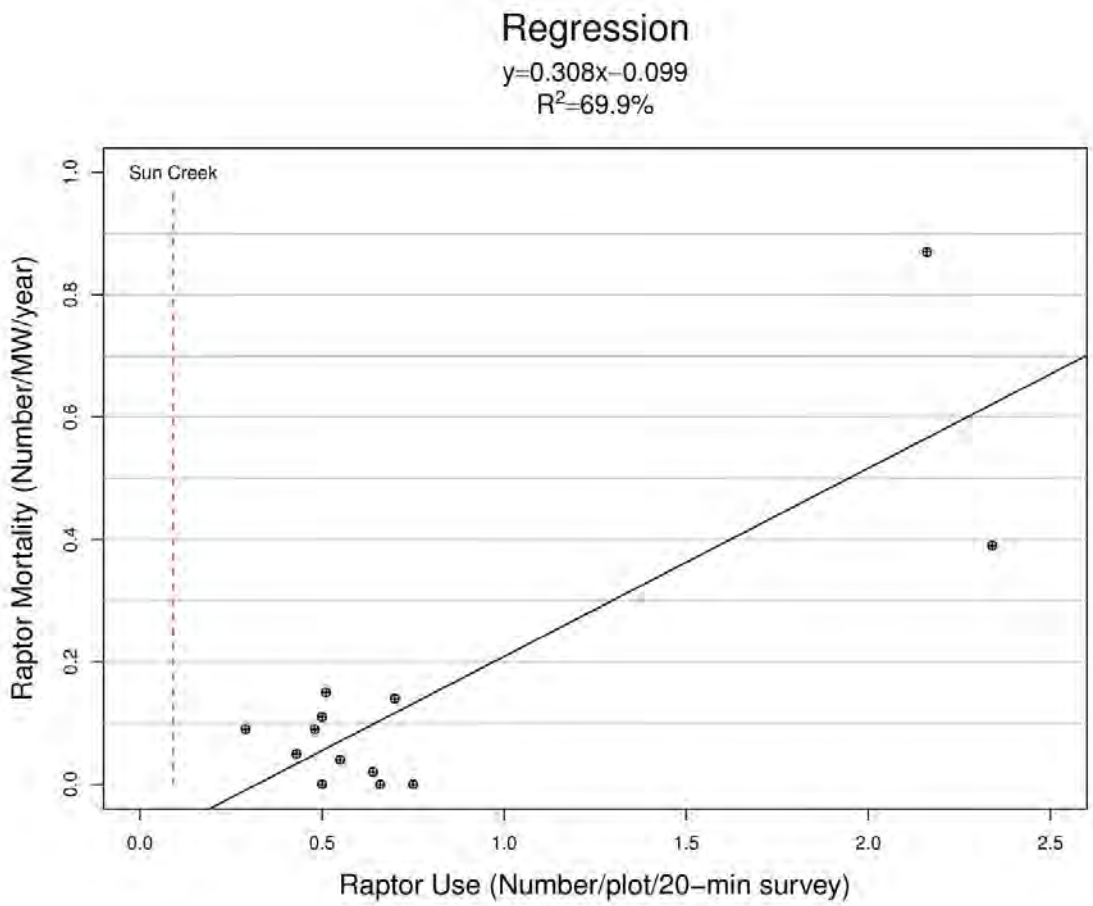


Figure 9. Comparison of annual raptor use between the Sun Creek Wind Resource Area and other wind-energy facilities in the United States.

Data from the following sources:

Wind-Energy Facility	Reference	Wind-Energy Facility	Reference	Wind-Energy Facility	Reference
Sun Creek, CA	This study.				
High Winds, CA	Kerlinger et al. 2005	Stateline Reference	URS et al. 2001	Nine Canyon, WA	Erickson et al. 2001b
Diablo Winds, CA	WEST 2006	Buffalo Ridge, MN	Erickson et al. 2002b	Maiden, WA	Erickson et al. 2002b
Altamont Pass, CA	Erickson et al. 2002b	White Creek, WA	NWC and WEST 2005	Hatchet Ridge, CA	Young et al. 2007b
Glenrock/Rolling Hills, WY	Johnson et al. 2008a	Foote Creek Rim, WY	Erickson et al. 2002b	Biglow Canyon, OR	WEST 2005c
Elkhorn, OR	WEST 2005a	Roosevelt, WA	NWC and WEST 2004	Wild Horse, WA	Erickson et al. 2003d
Cotterel Mtn., ID	BLM 2006	Leaning Juniper, OR	Kronner et al. 2005	Biglow Reference, OR	WEST 2005c
Swauk Ridge, WA	Erickson et al. 2003a	Dunlap, WY	Johnson et al. 2009a	Simpson Ridge, WY	Johnson et al. 2000b
Golden Hills, OR	Jeffrey et al. 2008	Klondike, OR	Johnson et al. 2002	Invenergy_Vantage, WA	WEST 2007
Windy Flats, WA	Johnson et al. 2007	Seven Mile Hill, WY	Johnson et al. 2008b	Grand Ridge, IL	Derby et al. 2009
Combine Hills, OR	Young et al. 2003d	Stateline, WA/OR	Erickson et al. 2002b	Tehachapi Pass, CA	Erickson et al. 2002b
Desert Claim, WA	Young et al. 2003b	Condon, OR	Erickson et al. 2002b	Sunshine, AZ	WEST and the CPRS 2006
Hopkin's Ridge, WA	Young et al. 2003a	High Plains, WY	Johnson et al. 2009b	Dry Lake, AZ	Young et al. 2007c
Reardon, WA	WEST 2005b	Zintel Canyon, WA	Erickson et al. 2002a	San Gorgonio, CA	Erickson et al. 2002b



Overall Raptor Use 0.09
Predicted Fatality Rate < 0.01 fatalities/MW/year
90.0% Prediction Interval (0, 0.20 fatalities/MW/year)

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

Data from the following sources:

Wind-Energy Facility	Raptor Use (birds/plot /20-min survey)	Reference	Raptor Mortality (fatalities/MW/yr)	Reference
Buffalo Ridge, MN	0.64	Erickson et al. 2002b	0.02	Erickson et al. 2002b
Combine Hills, OR	0.75	Young et al. 2003d	0.00	Young et al. 2006
Diablo Winds, CA	2.161	WEST 2006	0.87	WEST 2008b
Foote Creek Rim, WY	0.55	Johnson et al. 2000b	0.04	Young et al. 2003c
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. 2002	0.00	Johnson et al. 2003
Stateline, WA/OR	0.48	Erickson et al. 2004	0.09	Erickson et al. 2002b
Vansycle, OR	0.66	WCIA and WEST 1997	0.00	Erickson et al. 2000
Wild Horse, WA	0.29	Erickson et al. 2003d	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