Wildlife Baseline Studies for the Oak Glen Wind Resource Area Steele County, Minnesota

Final Report
April 1 – November 13, 2009

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EXECUTIVE SUMMARY

Oak Glen Wind Farm, LLC proposes development of a wind-energy facility in the Oak Glen Wind Resource Area (OGWRA), located in Steele County, Minnesota. Merjent, Inc is assisting Oak Glen Wind Farm, LLC with permitting this project and requested that Western EcoSystems Technology, Inc. develop and implement a standardized protocol for baseline wildlife studies in the study area. The principal objectives of the study were to (1) provide site-specific bird resource and use data that would be useful in evaluating potential impacts from the proposed wind-energy facility and (2) provide information that could be used in project planning and design of the facility to minimize impacts to birds. The following document contains results for fixed-point bird use surveys and incidental wildlife observations.

The OGWRA, currently about 5,225 hectares (12,911 acres), is located in southeast Steele County in southern Minnesota. Topography is gently rolling, with elevations ranging from 364 to 409 meters (1,194 to 1,342 feet) above sea level. About 74% of the OGWRA is cropland, with the next most common land use being grassland (21.5%). Oak Glen Lake and Rickert Lake are two relatively large bodies of water within OGWRA. Ownership within the OGWRA is mostly private. There are three state Wildlife Management Areas located within or partially within the study area: Aurora, Oak Glen, and Pogones Wildlife Management Areas; Rickert Lake is also state-owned. There is also a United States Fish and Wildlife Service Waterfowl Production Area in the southwest corner of the study area.

Fixed-point surveys were conducted from April 1 through November 13, 2009 at 10 points established throughout the OGWRA. A total of 239 20-minute fixed-point surveys were completed and 66 bird species were identified. Observations of large birds beyond an 800-meter (2,625 foot) radius were recorded but were not included in the statistical analyses; small bird observations recorded beyond a 100-meter (328-foot) radius were also excluded from analysis. Species richness for large bird species was 2.48 species/800-meter plot/20-minute survey and for small bird species was 3.21species/100-meter plot/20-minute survey. Species richness for large birds was highest in spring (3.43 species/survey); for small birds, the species richness was highest in the summer (4.61 species/survey).

A total of 22,273 individual bird observations within 1,295 separate groups were recorded during the fixed-point surveys. Three species (4.5% of all species) accounted for approximately 75.6% of the observations: common grackle, European starling, and unidentified gulls. The most abundant large bird recorded was the unidentified gull group (5,287 individuals in 31 groups).

A total of 129 individual raptors were recorded within the OGWRA, representing seven species. The red-tailed hawk was observed most often (52 individuals in 46 groups); the American kestrel was the next most commonly observed raptor (37 individuals in 24 groups)

The highest overall large bird use occurred in fall (52.92 birds/plot/20-minute survey), followed by spring (15.14), and summer (7.65). For small birds, use was highest in spring (22.33), followed by summer (18.83), and fall (18.10).

For large bird species, 315 groups totaling 6,201 individuals were observed flying within the 800-meter plot. Overall, 9.6% of large birds observed flying were recorded within the zone of risk for collision with turbine blades of 35 to 130 meters (114 – 427 feet) above ground level, 90.0% were below the zone of risk, and 0.4% were flying above the zone of risk. Two-hundred seventy-three groups of small bird species totaling 2,803 individuals were observed flying within the 100-meter plot. About 60% of all small bird species observed were flying and approximately 33% of those birds flew within the zone of risk.

For all large bird species combined, use was highest at point 3 (176 birds/20-minute survey) and bird use was second highest at point 2 (46.3). Use at other points ranged from 4.40 to 13.3 birds/20-minute survey. The high mean use estimates at these points was largely due to gulls, but use by corvids, raptors, and vultures was also relatively high at these points. Most of the gull use appeared to be centered around the Steele County Landfill as gulls flew to and from the landfill. Small bird species and passerine use was highest at point 3 (33.2 birds/20-minute survey), and ranged from 7.28 to 27.7 birds/20-minute survey at other points.

Incidental wildlife observations included 17 bird species totaling 44 birds within 22 separate groups. The most abundant bird species recorded incidentally were lesser scaup and mallard, both with 10 individuals recorded. Lesser scaup was only observed incidentally. Mammal observations consisted of 26 unidentified ground squirrels in two groups.

Two Minnesota state species of concern, American white pelican and bald eagle, were recorded during fixed-point surveys. Additionally, the bald eagle is also federally protected under the Bald and Golden Eagle Protection Act.

The annual mean raptor use at the OGWRA (0.54 raptors/plot/20-minute survey) was compared with 37 other wind-energy facilities that implemented similar protocols and had data for three or four seasons. Based on the results from these wind-energy facilities, mean raptor use (number of raptors divided by the number of 800-meter plots and the total number of surveys) at the OGWRA is considered to be low to moderate.

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%). Using this regression to predict raptor collision mortality at the OGWRA yields an estimated fatality rate of 0.07 fatalities per megawatt per year or seven raptor fatalities per year for each 100 megawatts of wind-energy development. Based on the relative abundance of red-tailed hawks throughout the year and a higher risk exposure index than other raptor species, there is a higher potential for red-tailed hawk fatalities compared to other species.

STUDY PARTICIPANTS

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INTRODUCTION

Oak Glen Wind Farm, LLC proposes development of a wind-energy facility in the Oak Glen Wind Resource Area (OGWRA), located in Steele County, Minnesota (Figures 1 and 2). Merjent, Inc is assisting Oak Glen Wind Farm, LLC with environmental permitting and contracted Western Ecosystems Technology, Inc. (WEST) to conduct surveys and monitor wildlife resources in the Oak Glen Wind Resource Area (OGWRA) to estimate the impacts of project construction and operations on wildlife.

The principal objectives of the study were to (1) provide site-specific bird use information that could be useful in evaluating potential impacts from the proposed wind-energy facility and (2) provide information that could be used in project planning and design of the facility to minimize impacts to birds. The methods used for the baseline studies follow the guidance of the National Wind Coordinating Collaborative (Anderson et al. 1999) and were designed to help predict potential impacts to bird species (particularly raptors).

Baseline surveys, conducted from April 1 through November 13, 2009 at the OGWRA, included fixed-point bird use surveys and incidental wildlife observations. In addition to site-specific data, this report presents existing information and results of studies conducted at other wind-energy facilities. For several wind-energy facilities, bird use data were collected in association with 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 OGWRA, currently about 5,225 hectares (12,911 acres), is located in southeast Steele County in southern Minnesota (Figure 1). Oak Glen Lake is a relatively large lake located within the study area on the eastern boundary (Figure 2). A smaller lake, Rickert Lake, is located in the southeast portion of OGWRA. The rest of the landscape within the study area has a limited number of wetlands. Topography is gently rolling, with elevations ranging from 364 to 409 meters (m; 1,194 to 1,342 feet [ft]) above sea level (reference needed). Ownership within the OGWRA is mostly private (Minnesota Gap Analysis 2009a). There are three state Wildlife Management Areas (WMA) located within or partially within the study area: Aurora WMA, Oak Glen WMA, and Pogones WMA. Rickert Lake is also state-owned. There is also a United States Fish and Wildlife Service (USFWS) Waterfowl Production Area in the southwest corner of the study area.

About 74% of the OGWRA is cropland, with the next most common land use being grassland (21.5%; Table 1). The land classification that WEST obtained from the Minnesota Gap Analysis (2009b) grouped native grass, pasture, planted cover, and hayland into one category called “grassland”. Therefore, we have only general information about the amount of native grasslands in the study area. During the study, very few areas were observed that were obviously native grasslands. All other land use types accounted for less than 2% of the area individually.

METHODS

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, falcons, and owls. Fixed-point surveys (variable circular plots) were conducted using methods described by Reynolds et al. (1980). The points were selected to survey representative habitats and topography of the study area, while also providing relatively even coverage. All birds seen during each 20-minute (min) fixed-point survey were recorded.

Bird Use Survey Plots

From April 1 through July 14, 2009, nine points were surveyed in the OGWRA. The study area was then expanded and an additional survey point was added. For the remainder of the study, 10 points were surveyed (Figure 3). Points were selected to achieve relatively even coverage of the study area and survey representative habitats and topography within the study area. Each survey plot was an 800-m (2,625-ft) radius circle centered on the point.

Bird Survey Methods

All species of birds observed during fixed-point surveys 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 recorded beyond a 100-m (328-ft) radius were excluded from analysis.

The date, start, and end time of the survey period, and weather information such as temperature, wind speed, wind direction, and cloud cover were recorded for each survey. Species or best possible identification, number of individuals, sex and age class (if possible), distance from plot center when first observed, closest distance, altitude above ground, activity (behavior), and habitat(s) were recorded for each observation. The behavior of each bird observed, and the vegetation type in which or over which the bird occurred, were recorded based on the point of first observation. Approximate flight height and flight direction at first observation were recorded to the nearest 5-m (16-ft) interval. Other information recorded about the observation included whether or not the observation was auditory only and the 10-min interval of the 20-min survey in which it was first observed. Locations of raptors, other large birds, and species of concern observed during fixed-point bird use surveys were recorded on field maps by observation number.

Observation Schedule

Sampling intensity was designed to document bird use and behavior by habitat and season within the study area. Fixed-point surveys were conducted from April 1 through November 13, 2009. Once initiated, surveys were conducted approximately once a week during spring (March 15 to May 15) and fall (September 1 to November 14) and bi-monthly during summer (May 16 to August 31).

Surveys were conducted during daylight hours and survey periods varied to approximately cover all daylight hours during a season. To the extent practical, each point was surveyed about the same number of times.

Incidental Wildlife Observations

The objective of incidental wildlife observations was to provide record of wildlife seen outside of the standardized surveys. All observations of raptors or their nests, unusual or unique birds, sensitive species, mammals, reptiles, and amphibians were recorded. The observation number, date, time, species, number of individuals, sex/age class, distance from observer, activity, height above ground (for bird species), habitat, and, in the case of sensitive species and raptor nests, the location was recorded.

Statistical Analysis

Quality Assurance and Quality Control

Quality assurance and quality control (QA/QC) measures were implemented at all stages of the study. A sample of records from an electronic database was compared to the raw data forms and any errors detected were corrected. Irregular codes or data suspected as questionable were discussed with the observer and/or project manager. Errors, omissions, or problems identified in later stages of analysis were traced back to the raw data forms and appropriate changes in all steps were made.

Data Compilation and Storage

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

Fixed-Point Bird Use Surveys

Two different viewsheds (800 m for large birds and 100 m for small birds) were utilized when calculating the different statistics: species richness, use, percent composition, percent frequency, and risk exposure index.

Species Diversity and Species Richness

Species diversity is defined as the total number of unique species observed. Species lists, with the number of observations and the number of groups, were generated by season, including all observations of birds detected regardless of their distance from the observer. Species richness was calculated as the mean number of species observed per plot per survey (i.e., number of species/plot/20-min survey). Species diversity and richness were compared between seasons.

Bird Use, Composition, and Frequency of Occurrence

For the standardized fixed-point bird use estimates, only observations of large birds detected within the 800-m radius plot were used in the analysis. For small birds, only observations within a 100-m radius were used. Estimates of mean bird use (i.e., number of birds/plot/20-min survey) were used to compare differences between bird types, seasons, survey points, and other wind-energy facilities. Mean use is calculated by determining the number of birds observed within

each 800-m plot (or 100-m plot for small birds) for each given visit and then averaging by the number of plots surveyed during that visit. A second averaging occurs across the number of visits during the season and entire study period. A visit is defined as the required length of time to survey all of the plots once within the study area.

The frequency of occurrence was calculated as the percent of surveys in which a particular bird type or species was observed. Percent composition was calculated as the proportion of the overall mean use for a particular species/bird type. Frequency of occurrence and percent composition provide relative estimates of species exposure to the 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 making it less likely to be affected by the wind-energy facility or the transmission corridor.

Bird Flight Height and Behavior

To calculate potential risk to bird species, the first flight height recorded was used to estimate the percentage of birds flying within the likely zone of risk (ZOR) for collision with turbine blades of 35 m to 130 m (114 – 427 ft) above ground level (AGL), which is the blade height of typical turbines that could be used at the OGWRA.

Bird Collision Risk Exposure Index

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

$$R = A*P_f*P_t$$

Where A equals mean relative use for species *i* (large bird observations within 800 m of the observer or 100 m for small birds) averaged across all surveys, P_f equals the proportion of all observations of species *i* where activity was recorded as flying (an index to the approximate percentage of time species *i* spends flying during the daylight period), and P_t equals the proportion of all initial flight height observations of species *i* within the likely ZOR.

Spatial Use

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

RESULTS

Surveys were completed at the OGWRA from April 1 through November 13, 2009. Sixty-seven bird species were identified during surveys completed at the OGWRA.

Fixed-Point Bird Use Surveys

A total of 239 20 min fixed-point surveys were conducted during 25 visits at the OGWRA (Table 2).

Species Diversity and Species Richness

Sixty-six unique species were observed during all fixed-point bird use surveys. Species richness for large bird species was 2.48 species/plot/20-min survey and 3.21 for small bird species/100-m plot/20-min survey (Table 2). Species richness for large birds was highest in spring (3.43 species/survey); for small birds, the species richness was highest in the summer (4.61 species/survey; Table 2).

A total of 22,273 individual bird observations within 1,295 separate groups were recorded during the fixed-point surveys (Table 3). Two species, common grackle (*Quiscalus quiscula*) and European starling (*Sturnis vulgaris*), and unidentified gulls accounted for approximately 75.6% of the observations and 4.5% of all species. All other species accounted for less than 5% of the observations individually. The most abundant large bird species was the unidentified gull group (5,287 individuals in 31 groups). The common grackle was the most common small bird species (7,077 individuals in 101 groups).

A total of 129 individual raptors were recorded within the OGWRA, representing seven species (Table 3). The red-tailed hawk (*Buteo jamaicensis*) was the raptor species observed most often (52 individuals in 46 groups), followed by American kestrel (*Falco sparverius*; 37 individuals in 24 groups).

Bird Use, Composition, and Frequency of Occurrence by Season

The highest overall large bird use occurred in fall (52.92 birds/plot/20-min survey), followed by spring (15.14), and summer (7.65; Table 4a). For small birds, use was highest in spring (22.33), followed by summer (18.83), and fall (18.10; Table 4b).

Waterbirds

Waterbirds had the highest use in fall (46.48 birds/plot/20-min survey), compared to other times of the year (spring 7.16, and summer 1.48; Table 4a). Relatively high waterbird use in fall was largely due to 4,783 unidentified gulls in 20 groups. Waterbirds accounted for 87.8% of the overall bird use in fall, 47.3% in spring, and 19.3% in summer. Waterbirds were observed during 22.7% of fall surveys, 14.3% of spring surveys and 8.9% of summer surveys (Table 4a).

Waterfowl

Waterfowl had the highest use in spring (2.06 birds/plot/20-min survey), compared to other times of the year (fall 1.78 and summer 0.48; Table 4a). Canada geese (*Branta canadensis*) had the highest use of any waterfowl during all three seasons (spring 1.63, summer 0.48, fall 1.72). Waterfowl accounted for 13.6% of the overall bird use during spring, 6.2% during summer and 3.4% during fall. Waterfowl were observed more frequently in spring (38.1%) and in fall (10.0%), compared to in summer (1.6%; Table 4a).

Shorebirds

Shorebirds had the highest use in spring (0.67 birds/plot/20-min survey), compared to other times of the year (summer 0.36 and fall 0.09; Table 4a). Shorebirds accounted for less than 5% of the overall bird use for all three seasons. Shorebirds were observed during 49.2% of the surveys in the spring, compared to 31.1% in the summer, and 8.2% in the fall.

Raptors

Raptor use was highest in spring (0.60 birds/plot/20-min survey), followed by summer (0.53), and fall (0.51; Table 4a). Higher use in the spring was primarily due to use by red-tailed hawks (0.25 birds/plot/20-min survey) and northern harriers (*Circus cyaneus*; 0.22). Red-tailed hawks had the highest use of any raptor in summer (0.31), while American kestrels had the highest use in fall (0.25). Raptors accounted for 6.9% of the overall bird use in summer, 4.0% during spring and 1.0% during fall. Raptors were observed during 42.9% of surveys in the spring, 36.2% in the summer, and 30.9% of surveys in the fall (Table 4a).

Vultures

Vultures had the highest use in summer (1.56 birds/plot/20-min survey), compared to fall (0.65) and spring (0.29; Table 4a). The only vulture species observed was turkey vulture (*Cathartes aura*). Vultures accounted for 20.4% of the overall bird use in summer, compared to less than 2% of the overall bird use in spring and fall. Vultures were observed during 31.6% of the surveys in the summer, compared to 19.0% in the spring and 15.5% in the fall.

Upland Gamebirds

Upland gamebirds had the highest use in spring (0.90 birds/plot/20-min survey), followed by fall (0.52) and summer (0.24; Table 4a). Higher use in the spring and fall was primarily due to use by wild turkey (*Meleagris gallopavo*; 0.52 and 0.46 birds/plot/20-min survey, respectively), while use during summer was mostly due to use by ring-necked pheasants (*Phasianus colchicus*; 0.22). Upland gamebirds accounted for 6.0% of the overall bird use during spring, 3.1% during summer and 1.0% during fall. Upland gamebirds were observed during 39.7% of surveys in the spring, 23.7% in the summer, and 9.1% in the fall (Table 4a).

Dove/Pigeons

Doves and pigeons had the highest use in spring (2.24 birds/plot/20-min survey), compared to summer (1.63) and fall (1.52; Table 4a). Doves and pigeons accounted for 21.4% of the overall bird use in summer, compared to 14.8% of the overall bird use in spring and 2.9% in fall. Doves and pigeons were observed during 57.6% of the surveys in the summer, compared to 39.7% in the spring and 21.8% in the fall.

Large Corvids

Large corvids had similar use during summer and fall (1.38 and 1.37 birds/plot/20-min survey, respectively), and slightly lower use during spring (1.22; Table 4a). The only large corvid species observed was American crow (*Corvus brachyrhynchos*). Large corvids accounted for 18.0% of the overall bird use in summer, 8.1% in spring, and 2.6% in fall. Large corvids were observed during 58.7% of spring surveys, 52.7% of fall surveys, and 39.7% of summer surveys (Table 4a).

Passerines

Passerine use was highest in the spring (22.32 birds/plot/20-min survey), and relatively similar between summer (18.82) and fall (18.08; Table 4b). Common grackle had the highest use by any one species in spring (7.60), followed by red-winged blackbird (*Agelaius phoeniceus*; 7.03). European starling had the highest use of any passerine in summer and fall (4.26 and 5.29,

respectively). Passerines were observed during 77.3% or more of the surveys in all seasons (Table 4b).

Bird Flight Height and Behavior

Flight height characteristics were estimated for both bird types and bird species (Tables 5 and 6).

For large bird species, 315 groups totaling 6,201 individuals were observed flying within the 800-m plot (Table 5). Overall, 9.6% of large birds observed flying were recorded within the ZOR for collision with turbine blades, 90.0% were below the ZOR, and 0.4% were flying above the ZOR (Table 5).

Approximately two-thirds (67.9%) of flying raptors were observed below the ZOR, 21.8% were within the ZOR, and 10.3% were above the ZOR. Vultures had the highest percentage of flying birds within the ZOR (39.5%), followed by doves/pigeons at 25.7%. Raptors had the third highest percentage of birds within the ZOR, with raptors occurring within the ZOR 21.8% of the time. Within the raptor subtypes, only falcons occurred in the ZOR less than 20% of the time (8.3%). Waterbirds, waterfowl, shorebirds, upland gamebirds, and large corvids were typically observed flying below the ZOR (Table 5). Small bird species totaling 2,803 individuals in 273 groups were observed flying within the 100-m plot. The majority of passerines within the 100-m plot were observed below the estimated ZOR (66.9%), 33.0% were recorded within the ZOR, and 0.1% were observed above the ZOR (Table 5).

Of all large bird species, six species had at least 20 groups observed flying. Of these, three species were observed flying within the likely ZOR during at least 20% of the observations: turkey vulture (39.5%; Table 6a), rock pigeon (*Columba livia*; 28.4), and red-tailed hawk (23.7%). The other species were always observed flying and always flew within the likely ZOR; however, these were only based on single observations of one or two birds.

Of all small bird species, five species had at least 20 groups observed flying. Of those species, the common grackle and European starling were recorded flying within the ZOR at least 40% of the time (41.2% and 42.9%, respectively; Table 6b). Seven species were always observed flying but none of those observations were made within the ZOR.

Bird Collision Risk Exposure Index

Unidentified gulls had a higher risk exposure index (0.96) than any other large bird, followed by turkey vulture (0.38) and rock pigeon (0.28; Table 6a). The raptor with the highest risk exposure index was red-tailed hawk (0.04); all other raptor species had a risk exposure index of 0.01 or less (Table 6a).

The small bird species with the highest risk exposure indices were common grackle (1.34), red-winged blackbird (1.25), and European starling (1.13; Table 6b). All other small bird species had risk exposure indices of 0.08 or less.

Spatial Use

For all large bird species combined, use was highest at point 3 (176 birds/20-min survey). Bird use was second highest at point 2 (46.3). Use for all large birds at the other points ranged from

4.40 to 13.3 birds/20-min survey (Figure 4). The relatively high mean use estimate for point 3 was largely due to relatively high waterbird use (161 birds/20-min survey). Waterbird use (37.2) also accounted for most of the large bird use at point 2. Use by waterbirds at the other points ranged from 0.08 to 10.2 birds/20-min survey. Waterfowl use was highest at point 10, with 9.43 birds/20-min survey. Waterfowl use ranged from zero to 4.44 birds/20-min survey at the remaining points. Mean shorebird use was fairly uniform between points, ranging from zero at point 10 to 0.48 birds/20-min survey at points 1, 4, and 8.

Raptor use was highest at point three (0.76 birds/20-min survey) and ranged from 0.07 to 0.72 birds/20-min survey at other points (Figure 4). The relatively high use by raptors at point 3 was largely due to use by buteos (0.28 birds/20-min survey).

Vulture use was also highest at point three (2.92 birds/20-min survey), and ranged from 0.08 to 01.84 birds/20-min survey at other points. Upland gamebird use was highest at point eight (3.00 birds/20-min survey), and ranged from 0.04 to 0.92 at other points. Use by doves/pigeons was highest at point five (5.12) and use ranged from 0.43 to 2.80 at other points. Use by large corvids was highest at point 3 (3.88 birds/20-min survey) and ranged from 0.24 to 2.36 at other points.

Small bird species and passerine use was highest at point 3 (33.2 birds/20-min survey), and ranged from 7.28 to 27.7 at other points (Figure 4).

Sensitive Species Observations

Sensitive species were recorded during fixed-point bird use surveys (Table 7). Two Minnesota state species of concern (MDNR 2007), American white pelican (*Pelecanus erythrorhyncos*; 356 individuals) and bald eagle (*Haliaeetus leucocephalus*; six individuals) were recorded during fixed-point surveys. Additionally, the bald eagle is also federally protected under the Bald and Golden Eagle Protection Act (BGEPA; BGEPA 1940).

Incidental Wildlife Observations

Bird Observations

Seventeen bird species were observed incidentally, totaling 44 birds within 22 separate groups (Table 8). The most abundant bird species recorded incidentally were lesser scaup (*Aythya affinis*) and mallard (*Anas platyrhynchos*), both with 10 individuals recorded. Lesser scaup was only seen incidentally at the OGWRA. No raptor nests were observed incidentally.

Mammal Observations

Twenty-six unidentified ground squirrels in two groups were observed incidentally at the OGWRA (Table 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 towers. Collisions may occur with resident birds foraging and flying within the study area or with migrant birds seasonally moving through the study area. Project construction could affect birds through loss of habitat or potential fatalities caused by construction equipment. Potential mortality from construction equipment is expected to be very low. Equipment used in wind-energy facility construction generally moves at slow rates or is stationary for long periods (e.g., cranes). The risk of direct mortality to birds from construction is most likely potential destruction of a nest for ground- and shrub-nesting species during initial site clearing. Impacts from the decommissioning of the facility are anticipated to be similar to construction in terms of noise, disturbance, and equipment.

Substantial data on bird mortality at wind-energy facilities are available from studies in California and throughout the West and Midwest. Of 841 bird fatalities reported from California studies (>70% from the Altamont Pass facility in California; Erickson et al. 2002b), approximately 39% were diurnal raptors, about 19% were passerines (excluding house sparrows [*Passer domesticus*] and European starlings), and about 12% were owls. Non-protected birds (e.g., birds not protected by the Migratory Bird Treaty Act [MBTA; MBTA 1918] or the Endangered Species Act [ESA 1973]), including house sparrows, European starlings, and rock pigeons, accounted for about 15% of the fatalities. Other bird types generally made up less than 10% of the fatalities (Erickson et al. 2002b).

During 12 fatality monitoring studies conducted outside of California, diurnal raptor fatalities accounted for approximately 2% of the wind-energy facility-related fatalities and raptor mortality averaged 0.03 fatalities/turbine/year (Erickson et al. 2002b). Passerines (excluding house sparrows and European starlings) were the most common collision victims, accounting for about 82% of the 225 fatalities documented. For all bird species combined, estimates of the number of bird fatalities per turbine per year from individual studies ranged from zero at the Searsburg wind-energy facility in Vermont (Kerlinger 1997) and the Algona facility in Iowa (Demastes and Trainer 2000) to 7.7 at the Buffalo Mountain facility in Tennessee (Nicholson 2003). Using mortality data from a 10-year period from wind-energy facilities throughout the entire United States, the average number of bird collision fatalities was 3.1 fatalities per megawatt (MW) per year, or 2.3 fatalities per turbine per year (NWCC 2004).

To date, overall fatality rates for birds at wind-energy facilities have been relatively low and consistent in the Midwest. The range of overall bird fatality estimates at three Midwest wind-energy facilities has ranged from 0.7 to 3.4 fatalities/MW/year (Howe et al. 2002; Johnson et al. 2002b, 2003a; Jain 2005). Given that nearly all facilities have documented some level of direct mortality to birds, it is reasonable to assume that the OGWRA will have some direct impact on birds migrating through the area, as well as on those birds residing in the area. The level of this anticipated impact is discussed below.

Raptor Use and Collision Risk Exposure

Although high numbers of raptor fatalities have been documented at some wind-energy facilities (e.g., the Altamont Pass facility), a review of studies at wind-energy facilities across the United States reported that only 3.2% of fatalities were raptors (Erickson et al. 2001a). 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 the Altamont Pass facility 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 (*Aquila chrysaetos*) were killed more often than predicted based on abundance. Thus far, only three northern harrier fatalities at existing wind-energy facilities have been reported in publicly available documents, despite the fact that northern harriers are commonly observed during point counts at these facilities (Erickson et al. 2001a, Whitfield and Madders 2006). Because northern harriers often forage close to the ground, risk of collision with turbine blades is considered low for this species. It is likely that many factors, in addition to abundance, are important in predicting raptor mortality.

Collision risk exposure indices analysis may also provide insight into which species might be the most likely turbine casualties; however, the index only considers relative probability of collision exposure based on abundance, proportion of observations flying, and proportion of flight height of each species within the ZOR 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 varying ability among species to detect and avoid turbines, and other factors that may vary among species and influence likelihood for turbine collision. For these reasons, the index is only a relative index among species (i.e., comparison between species) observed during the surveys and within the study area and cannot be compared to other wind resource areas. Actual risk for some species may be lower or higher than indicated by these data. At the OGWRA, the raptor species with the highest risk exposure indices were red-tailed hawk and northern harrier; the risk exposure indices were influenced by the relatively high use estimates by these species. Cooper's hawk (*Accipiter cooperii*), American kestrel, bald eagle, and merlin (*Falco columbarius*) ranked much lower comparatively, primarily due to lower use estimates or a low proportion of flight heights observed in the ZOR by these species.

The annual mean raptor use at the OGWRA (0.54 raptors/plot/20-min survey) was compared with 37 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 5). Based on the results from these studies, a ranking of seasonal raptor mean use was developed as: low (0 – 0.5 raptors/plot/20-min survey); low to moderate (0.5 – 1.0); moderate (1.0 – 2.0); high (2.0 – 3.0); and very high (> 3.0). Under this ranking, mean raptor use (number of raptors divided by the number of 800-m plots and the total number of surveys) at the OGWRA is considered to be low to moderate. Raptor use at the OGWRA ranked seventeenth when compared to the other wind-energy facilities (Figure 5).

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 6). Using this regression to

predict raptor collision mortality at the OGWRA, based on an adjusted mean raptor use of 0.54 raptors/20-min survey, yields an estimated fatality rate of 0.07 fatalities/MW/year, or seven raptor fatalities per year for each 100-MW of wind-energy development. A 90% prediction interval around this estimate is zero to 0.33 fatalities/MW/year. Based on the relative abundance of red-tailed hawks throughout the year and a higher risk exposure index than other raptor species, there is higher potential for red-tailed hawk fatalities at the OGWRA compared to other species.

Raptor mortality data has been reported from 28 wind-energy facilities in the United States, many of which also had data for raptor use (Table 9). Raptor use estimates at the facilities ranged from 2.16 raptors/20min survey at the Diablo Winds facility in California to 0.29 raptors/20min survey at the State Line facility in Washington and Oregon. Raptor mortality estimates from these 28 facilities ranged from 0.87 raptors/MW/year at the Diablo Winds facility to zero raptors/MW/year at several of the facilities. Assuming a correlation between use and fatality rates, fatality rates at the OGWRA would be much lower than the fatality rate at the Diable Winds facility site in California and would be similar to the rates seen at facilities in Oregon and Washington where fatality rates have been relatively low (Table 9).

Non-Raptor Use and Collision Risk Exposure

Passerines (primarily perching birds) have been the most abundant bird fatality at wind-energy facilities, excluding facilities in California (Erickson et al. 2001a, 2002b), often accounting for 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 this baseline study, passerines would be expected to make up the largest proportion of fatalities at the OGWRA; however, there has not been a clearly demonstrated correlation between high passerine use and high mortality as there appears to be with raptors. Collision risk exposure indices, based on observations within 100 m of the point, indicate that the common grackle is the most likely passerine to be exposed to collision from wind turbines at the OGWRA. Other passerine species likely most at risk based on abundance and flight behavior would include red-winged blackbird, European starling, northern rough-winged swallow (*Stelgidopteryx serripennis*), and horned lark (*Eremophila alpestris*; Table 6b). Most non-raptors had relatively low risk exposure indices due to the majority of individuals flying below the likely ZOR.

Wind-energy facilities with year-round use by water-dependent species have shown the highest mortality by these groups, although the levels of mortality are very small compared to the use of the facilities by these groups. Of 1,033 bird fatalities recovered at United States wind-energy facilities, waterbirds accounted for about 2% of the fatalities, waterfowl about 3%, and shorebirds less than 1% (Erickson et al. 2002b). At the Klondike, wind-energy facility in Oregon, only two Canada goose fatalities were documented (Johnson et al. 2003b) even though 43 groups totaling 4,845 individual Canada geese were observed during pre-construction surveys (Johnson et al. 2002a). The recently constructed Top of Iowa wind-energy facility is located in cropland between three WMAs with historically high bird use, including migrant and resident waterfowl. During a recent study, approximately one million goose-use days and 120,000 duck-use days were recorded in the WMAs during the fall and early winter but no waterfowl fatalities were documented during concurrent and standardized wind-energy facility fatality studies (Jain 2005). Similar findings were observed at the Buffalo Ridge wind-energy facility in southwestern

Minnesota, which is located in an area with relatively high waterfowl/waterbird use and some shorebird use. Snow geese (*Chen caerulescens*), Canada geese, and mallards were the most common waterfowl observed. Three of the 55 fatalities observed during the fatality monitoring studies were waterfowl, including two mallards and one blue-winged teal (*Anas discors*). Two American coots (*Fulica americana*), one grebe, and one shorebird fatality were also found (Johnson et al. 2002b). Based on available evidence, waterfowl do not seem especially vulnerable to turbine collisions and significant impacts are not likely.

The OGWRA had relatively high use by gulls. This use was particularly high at points 2 and 3 (Figure 4), which occur on either side of the Steele County Landfill (Figure 3). About 93% of unidentified gulls were observed at points 2 and 3 and were observed flying to and from the landfill. Identification of the flying gulls was difficult but the gulls have tentatively been identified as ring-billed (*Larus delawarensis*) or California gulls (*Larus californicus*). American crow, raptor, and vulture use was also relatively high at these points. The landfill likely provides a foraging opportunity for gulls and large corvids. This opportunity may extend to the vultures and raptors observed in the area as well, if these species are foraging on small mammals and birds that are concentrated at the landfill. This area does appear to constitute a forage concentration area for gulls and large corvids, putting the birds of these species at risk of a turbine strike. The USFWS Interim Guidelines (USFWS 2003) recommends avoiding turbine placement in areas where birds will be concentrated, such as at a landfill.

Sensitive Species Use and Collision Risk Exposure

Federal-listed threatened and endangered species known to occur in Steele County, Minnesota were not observed in the OGWRA during fixed-point bird use surveys. Two state-designated species of special concern (MDNR 2010), the bald eagle and American white pelican, were observed during fixed-point surveys (Table 7). Additionally, the bald eagle is also protected under the BGEPA (1940), while the American white pelican is protected under the MBTA (1918). Based on occurrence of these species in the OGWRA, it is possible that individuals of one or both species may be directly impacted by the proposed wind-energy facility. However, both the bald eagle and American white pelican had relatively low exposure indices, indicating that use was relatively low and/or flight characteristics of these species in the OGWRA were above or below the typical ZOR.

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 facilities have been constructed in grasslands or other native habitats (Leddy et al. 1999, Mabey and Paul 2007); Crockford (1992) suggests that disturbance appears to impact feeding, resting, and migrating birds rather than breeding birds. Results from studies at the Stateline wind-energy facility in Washington and Oregon (Erickson et al. 2004) and the Buffalo Ridge wind-energy facility in Minnesota (Johnson et al. 2000a) suggest that breeding birds are also affected by wind-facility operations.

Raptor Displacement

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

The only published report of avoidance of wind turbines by nesting raptors occurred at the Buffalo Ridge wind-energy facility, where raptor nest density on 101 square mile (mi^2; 262 square kilometer [km^2]) of land surrounding a wind-energy facility was 5.94 nests/39 mi^2 (5.94 nests/101 km^2), yet no nests were present in the 12 mi^2 (31 km^2) facility itself, even though habitat was similar (Usgaard et al. 1997). However, this analysis assumes that raptor nests are uniformly distributed across the landscape, an unlikely event, and even though no nests were found, only two nests would be expected for an area 12 mi^2 in size if the nests were distributed uniformly. At a wind-energy facility in eastern Washington, based on extensive monitoring using helicopter flights and ground observations, raptors still nested in the study area at approximately the same levels after construction, and several nests were located within a half-mile (0.8 km) of turbines (Erickson et al. 2004). At the Foote Creek Rim wind-energy facility in southern Wyoming, one pair of red-tailed hawks nested within 0.3 miles (0.5 km) of the turbine strings, and seven red-tailed hawk nests, one great horned owl (*Bubo virginianus*) nest, and one golden eagle nest located within one mile of the facility successfully fledged young (Johnson et al. 2000b). The golden eagle pair successfully nested a half-mile from the facility for three different years after it became operational. A Swainson's hawk (*Buteo swainsoni*) also nested within a quarter-mile (0.4 km) of a turbine string at the Klondike I wind-energy facility in Oregon after the facility was operational (Johnson et al. 2003b). These observations suggest that there may be limited displacement of nesting raptors at the OGWRA. A buffer around active nests during construction could be one means to further limit potential displacement impacts.

The red-tailed hawk was the most commonly observed raptor at the OGWRA. These hawks typically build a large stick nest near the top of deciduous trees; farm and suburban woodlots in Minnesota are common nesting areas for the hawk (The Raptor Center 2009). In the OGWRA, there are potential nesting sites located around farmsteads and in natural wooded areas which are sometimes associated with lakes, ponds, and streams. Raptor nests were not observed during the course of this study but specific surveys for raptor nests did not take place.

Displacement of Non-Raptor Bird Species

Studies concerning displacement of non-raptor species have concentrated on grassland passerines and waterfowl/waterbirds (Winkelman 1990, Larsen and Madsen 2000, Mabey and Paul 2007).

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

A study conducted in England to assess displacement of wintering farmland birds by wind turbines located in an agricultural landscape found that only common pheasants (referred to as the ring-necked pheasant in the United States) apparently avoided turbines. The other species/bird groups examined, including granivores, red-legged partridge (*Alectoris rufa*), Eurasian skylark (*Alauda arvensis*), and corvids, showed no displacement from wind turbines. In fact, Eurasian skylarks and corvids showed increased use of areas close to turbines, possibly due to increased food resources associated with disturbed areas (Devereux et al. 2008). Displacement impacts on upland gamebirds at the OGWRA are expected to be minimal.

Displacement effects of wind-energy facilities on waterfowl and shorebirds appear to be mixed. Studies from the Netherlands and Denmark suggest that densities of these types of species near turbines were lower compared to densities in similar habitats away from turbines (Winkelman 1990, Pedersen and Poulsen 1991). However, a study from a facility in England found no effect of wind turbines on populations of cormorants (*Phalacrocorax carbo*), purple sandpipers (*Calidris maritima*), common eiders (*Somateria mollissima*), or gulls, although the cormorants were temporarily displaced during construction (Lawrence et al. 2007). At the Buffalo Ridge facility, the abundance of several bird types, including shorebirds and waterfowl, were found to be significantly lower at survey plots with turbines than at reference plots without turbines (Johnson et al. 2000a). The report concluded that the area of reduced use was limited primarily to those areas within 100 m (328 ft) of the turbines. Disturbance tends to be greatest for migrating birds during feeding and resting activities (Crockford 1992, NRC 2007). The majority of waterfowl/waterbirds use at the OGWRA included 31 groups of 5,287 unidentified gulls, five groups of 590 unidentified ducks, five groups of 356 American white pelican and 323 Canada geese in 37 groups, totaling of 6,556 individuals (99.2% of waterfowl/waterbird observations). It appears from the literature that any displacement of these groups would be minimal and given the presence of similar habitat surrounding the OGWRA, any displacement of these groups is unlikely to significantly impact the populations.

CONCLUSIONS

Surveys at the OGWRA documented significant use by waterbirds (i.e., gulls) and most of these observations were in the vicinity of the Steele County Landfill. In addition to high use of this area by gulls, there was also higher use at observation points near the landfill by large corvids, raptors, vultures, and passerines. It appears that gulls and American crows are utilizing the landfill as a foraging area. In addition to the active landfill itself, the reclaimed portion of the landfill is planted with grass and there is a wildlife area to the west of the landfill; these factors may influence the higher use rates as well. Consideration of this relatively high use should be included when deciding to place turbines in the vicinity of the landfill.

A total of 129 individual raptors were recorded within the OGWRA, representing seven species. The red-tailed hawk was observed most often (52 individuals in 46 groups); the American kestrel was the next most commonly observed raptor (37 individuals in 24 groups). Based on findings from other wind-energy facilities, it is estimated that 0.07 raptor fatalities/MW/year, or seven raptor fatalities per year for each 100-MW of wind-energy development, could be expected at the OGWRA. Based on the relative abundance of red-tailed hawks throughout the year and a higher risk exposure index than other raptor species, there is higher potential for red-tailed hawk fatalities compared to other species.

While the area is predominately tilled agriculture (approximately 75%), there are areas of grasslands and wetlands both within and adjacent to the OGWRA. Minimizing impacts to the grassland and wetland areas should lower potential displacement impacts to breeding birds.

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Table 1. Land cover and land use present within the Oak Glen Wind Resource Area.

Habitat	Acres	% Composition
Cropland	9504.5	73.6
Grassland	2772.1	21.5
Water	245.9	1.9
Lowland Deciduous Shrub	121.7	0.9
Sedge Meadow	92.8	0.7
Transportation	81.2	0.6
Bur/White Oak	71.6	0.6
Maple/Basswood	8.2	0.1
Lowland Deciduous	7.1	0.1
Red Oak	3.1	<0.1
Upland Deciduous	2.9	<0.1
Total	**12,911**	**100**

Data from the Minnesota Gap Analysis (2009).

Table 2. Number of visits, number of surveys conducted, number of unique species, and summary of species richness (species/plot[a]/20-min survey) by season and overall during the fixed-point bird use surveys at the Oak Glen Wind Resource Area, April 1 - November 13, 2009.

Season	Number of Visits	# Surveys Conducted	# Unique Species	Species Richness	
				Large Birds	Small Birds
Spring	7	63	43	3.43	2.54
Summer	7	66	45	2.42	4.61
Fall	11	110	37	1.79	1.75
Overall	**25**	**239**	**66**	**2.48**	**3.21**

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

Table 3. Total number of individuals (# obs) and groups (# grps) for each bird type and species, by season and overall, during the fixed-point bird use surveys at the Oak Glen Wind Resource Area , April 1 - November 13, 2009.

		Spring		Summer		Fall		Total	
Species/Type	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Waterbirds		**15**	**453**	**6**	**100**	**25**	**5,113**	**46**	**5,666**
American white pelican	*Pelecanus erythrorhyncos*	0	0	2	31	3	325	5	356
California gull	*Larus californicus*	4	4	0	0	0	0	4	4
great blue heron	*Ardea herodias*	1	1	0	0	1	1	2	2
great egret	*Ardea alba*	0	0	1	1	0	0	1	1
ring-billed gull	*Larus delawarensis*	0	0	0	0	1	4	1	4
sandhill crane	*Grus canadensis*	1	5	1	7	0	0	2	12
unidentified gull		9	443	2	61	20	4,783	31	5,287
Waterfowl		**40**	**716**	**1**	**30**	**11**	**196**	**52**	**942**
Canada goose	*Branta canadensis*	26	104	1	30	10	189	37	323
mallard	*Anas platyrhynchos*	6	13	0	0	0	0	6	13
northern shoveler	*Anas clypeata*	1	2	0	0	0	0	1	2
ring-necked duck	*Aythya collaris*	0	0	0	0	1	7	1	7
unidentified duck		5	590	0	0	0	0	5	590
unidentified goose		1	3	0	0	0	0	1	3
wood duck	*Aix sponsa*	1	4	0	0	0	0	1	4
Shorebirds		**32**	**42**	**20**	**23**	**9**	**10**	**61**	**75**
Baird's sandpiper	*Calidris bairdii*	1	1	0	0	0	0	1	1
killdeer	*Charadrius vociferus*	30	39	20	23	9	10	59	72
stilt sandpiper	*Calidris himantopus*	1	2	0	0	0	0	1	2
Raptors		**36**	**38**	**28**	**35**	**40**	**56**	**104**	**129**
Accipiters		*1*	*1*	*0*	*0*	*0*	*0*	*1*	*1*
Cooper's hawk	*Accipiter cooperii*	1	1	0	0	0	0	1	1
Buteos		*15*	*16*	*17*	*20*	*17*	*19*	*49*	*55*
red-tailed hawk	*Buteo jamaicensis*	15	16	17	20	14	16	46	52
rough-legged hawk	*Buteo lagopus*	0	0	0	0	3	3	3	3

Table 3. Total number of individuals (# obs) and groups (# grps) for each bird type and species, by season and overall, during the fixed-point bird use surveys at the Oak Glen Wind Resource Area , April 1 - November 13, 2009.

		Spring		Summer		Fall		Total	
Species/Type	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Northern Harrier		*13*	*14*	*1*	*1*	*0*	*0*	*14*	*15*
northern harrier	*Circus cyaneus*	13	14	1	1	0	0	14	15
Eagles		*0*	*0*	*1*	*1*	*4*	*5*	*5*	*6*
bald eagle	*Haliaeetus leucocephalus*	0	0	1	1	4	5	5	6
Falcons		*5*	*5*	*4*	*4*	*16*	*29*	*25*	*38*
American kestrel	*Falco sparverius*	5	5	4	4	15	28	24	37
merlin	*Falco columbarius*	0	0	0	0	1	1	1	1
Other Raptors		*2*	*2*	*5*	*9*	*3*	*3*	*10*	*14*
unidentified hawk		2	2	5	9	3	3	10	14
Vultures		**12**	**18**	**21**	**106**	**17**	**71**	**50**	**195**
turkey vulture	*Cathartes aura*	12	18	21	106	17	71	50	195
Upland Gamebirds		**27**	**57**	**15**	**15**	**11**	**57**	**53**	**129**
northern bobwhite	*Colinus virginianus*	0	0	1	1	0	0	1	1
ring-necked pheasant	*Phasianus colchicus*	24	24	14	14	6	6	44	44
wild turkey	*Meleagris gallopavo*	3	33	0	0	5	51	8	84
Doves/Pigeons		**30**	**141**	**42**	**110**	**26**	**167**	**98**	**418**
mourning dove	*Zenaida macroura*	13	18	33	51	20	97	66	166
rock pigeon	*Columba livia*	17	123	9	59	6	70	32	252
Large Corvids		**40**	**77**	**26**	**90**	**58**	**151**	**124**	**318**
American crow	*Corvus brachyrhynchos*	40	77	26	90	58	151	124	318
Passerines		**206**	**3,314**	**301**	**1,244**	**196**	**9,839**	**703**	**14,397**
American goldfinch	*Carduelis tristis*	0	0	5	8	13	22	18	30
American robin	*Turdus migratorius*	24	114	24	26	6	16	54	156
Baltimore oriole	*Icterus galbula*	1	1	0	0	0	0	1	1
bank swallow	*Riparia riparia*	1	2	21	213	7	53	29	268
barn swallow	*Hirundo rustica*	9	16	23	113	4	45	36	174
black-capped chickadee	*Poecile atricapillus*	4	4	5	5	2	2	11	11
blue jay	*Cyanocitta cristata*	6	6	19	30	53	69	78	105

Table 3. Total number of individuals (# obs) and groups (# grps) for each bird type and species, by season and overall, during the fixed-point bird use surveys at the Oak Glen Wind Resource Area , April 1 - November 13, 2009.

		Spring		Summer		Fall		Total	
Species/Type	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
bobolink	*Dolichonyx oryzivorus*	2	3	5	16	0	0	7	19
brown-headed cowbird	*Molothrus ater*	0	0	3	3	1	100	4	103
brown thrasher	*Toxostoma rufum*	0	0	1	1	2	11	3	12
cedar waxwing	*Bombycilla cedrorum*	0	0	1	7	0	0	1	7
chestnut-sided warbler	*Dendroica pensylvanica*	0	0	0	0	1	1	1	1
chipping sparrow	*Spizella passerina*	2	2	7	8	0	0	9	10
common grackle	*Quiscalus quiscula*	36	1,025	35	221	30	5,831	101	7,077
common yellowthroat	*Geothlypis trichas*	0	0	21	23	4	4	25	27
eastern bluebird	*Sialia sialis*	1	1	0	0	0	0	1	1
eastern kingbird	*Tyrannus tyrannus*	0	0	16	24	0	0	16	24
eastern meadowlark	*Sturnella magna*	0	0	1	1	0	0	1	1
eastern phoebe	*Sayornis phoebe*	3	3	0	0	0	0	3	3
eastern towhee	*Pipilo erythrophthalmus*	0	0	2	2	0	0	2	2
eastern wood-pewee	*Contopus virens*	0	0	1	1	0	0	1	1
European starling	*Sturnus vulgaris*	17	1,153	12	289	15	3,032	44	4,474
horned lark	*Eremophila alpestris*	8	12	14	17	2	9	24	38
house sparrow	*Passer domesticus*	0	0	0	0	29	359	29	359
indigo bunting	*Passerina cyanea*	1	2	14	14	1	1	16	17
northern cardinal	*Cardinalis cardinalis*	9	10	2	2	1	1	12	13
northern rough-winged swallow	*Stelgidopteryx serripennis*	0	0	2	10	0	0	2	10
red-eyed vireo	*Vireo olivaceus*	0	0	1	1	0	0	1	1
red-winged blackbird	*Agelaius phoeniceus*	55	757	28	117	0	0	83	874
savannah sparrow	*Passerculus sandwichensis*	1	1	0	0	0	0	1	1
scarlet tanager	*Piranga olivacea*	0	0	1	1	0	0	1	1
song sparrow	*Melospiza melodia*	2	2	32	37	0	0	34	39
tree swallow	*Tachycineta bicolor*	1	1	3	52	7	185	11	238
unidentified blackbird		1	150	0	0	0	0	1	150

Table 3. Total number of individuals (# obs) and groups (# grps) for each bird type and species, by season and overall, during the fixed-point bird use surveys at the Oak Glen Wind Resource Area , April 1 - November 13, 2009.

		Spring		Summer		Fall		Total	
Species/Type	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
unidentified chickadee		1	1	0	0	1	1	2	2
unidentified sparrow		1	25	0	0	3	58	4	83
unidentified swallow		0	0	0	0	1	5	1	5
unidentified warbler		0	0	1	1	1	2	2	3
vesper sparrow	*Pooecetes gramineus*	9	11	0	0	11	31	20	42
western meadowlark	*Sturnella neglecta*	9	9	1	1	1	1	11	11
yellow-headed blackbird	*Xanthocephalus xanthocephalus*	2	3	0	0	0	0	2	3
Other Birds		**1**	**1**	**1**	**1**	**2**	**2**	**4**	**4**
northern flicker	*Colaptes auratus*	0	0	0	0	2	2	2	2
unidentified hummingbird		0	0	1	1	0	0	1	1
unidentified woodpecker		1	1	0	0	0	0	1	1
Overall		**439**	**4,857**	**461**	**1,754**	**395**	**15,662**	**1,295**	**22,273**

Table 4a. Mean bird use (number of birds/plot/20-min survey), percent of total composition (%), and frequency of occurrence (%) for each large bird type and species by season during the fixed-point bird use surveys at the Oak Glen Wind Resource Area, April 1 - November 13, 2009.

	Use			% Composition			% Frequency		
Species/Type	**Spring**	**Summer**	**Fall**	**Spring**	**Summer**	**Fall**	**Spring**	**Summer**	**Fall**
Waterbirds	**7.16**	**1.48**	**46.48**	**47.3**	**19.3**	**87.8**	**14.3**	**8.9**	**22.7**
American white pelican	0	0.49	2.95	0	6.4	5.6	0	3.2	2.7
California gull	0.06	0	0	0.4	0	0	4.8	0	0
great blue heron	0.02	0	<0.01	0.1	0	<0.1	1.6	0	0.9
great egret	0	0.01	0	0	0.2	0	0	1.4	0
ring-billed gull	0	0	0.04	0	0	<0.1	0	0	0.9
sandhill crane	0.08	0.10	0	0.5	1.3	0	1.6	1.4	0
unidentified gull	7.00	0.87	43.48	46.2	11.4	82.2	7.9	2.9	18.2
Waterfowl	**2.06**	**0.48**	**1.78**	**13.6**	**6.2**	**3.4**	**38.1**	**1.6**	**10.0**
Canada goose	1.63	0.48	1.72	10.8	6.2	3.2	31.7	1.6	9.1
mallard	0.21	0	0	1.4	0	0	9.5	0	0
northern shoveler	0.03	0	0	0.2	0	0	1.6	0	0
ring-necked duck	**0**	**0**	**0.06**	**0**	**0**	**0.1**	**0**	**0**	**0.9**
unidentified duck	*0.08*	*0*	*0*	*0.5*	*0*	*0*	*4.8*	*0*	*0*
unidentified goose	0.05	0	0	0.3	0	0	1.6	0	0
wood duck	0.06	0	0	0.4	0	0	1.6	0	0
Shorebirds	**0.67**	**0.36**	**0.09**	**4.4**	**4.7**	**0.2**	**49.2**	**31.1**	**8.2**
Baird's sandpiper	*0.02*	*0*	*0*	*0.1*	*0*	*0*	*1.6*	*0*	*0*
killdeer	0.62	0.36	0.09	4.1	4.7	0.2	47.6	31.1	8.2
stilt sandpiper	0.03	0	0	0.2	0	0	1.6	0	0
Raptors	**0.60**	**0.53**	**0.51**	**4.0**	**6.9**	**1.0**	**42.9**	**36.2**	**30.9**
Accipiters	*0.02*	*0*	*0*	*0.1*	*0*	*0*	*1.6*	*0*	*0*
Cooper's hawk	*0.02*	*0*	*0*	*0.1*	*0*	*0*	*1.6*	*0*	*0*
Buteos	*0.25*	*0.31*	*0.17*	*1.7*	*4.0*	*0.3*	*23.8*	*25.9*	*14.5*
red-tailed hawk	0.25	0.31	0.15	1.7	4.0	0.3	23.8	25.9	12.7
rough-legged hawk	0	0	0.03	0	0	<0.1	0	0	2.7

Table 4a. Mean bird use (number of birds/plot/20-min survey), percent of total composition (%), and frequency of occurrence (%) for each large bird type and species by season during the fixed-point bird use surveys at the Oak Glen Wind Resource Area, April 1 - November 13, 2009.

	Use			% Composition			% Frequency		
Species/Type	**Spring**	**Summer**	**Fall**	**Spring**	**Summer**	**Fall**	**Spring**	**Summer**	**Fall**
Northern Harrier	*0.22*	*0.02*	*0*	*1.5*	*0.2*	*0*	*20.6*	*1.6*	*0*
northern harrier	0.22	0.02	0	1.5	0.2	0	20.6	1.6	0
Eagles	*0*	*0.02*	*0.05*	*0*	*0.2*	*<0.1*	*0*	*1.6*	*3.6*
bald eagle	0	0.02	0.05	0	0.2	<0.1	0	1.6	3.6
Falcons	*0.08*	*0.06*	*0.26*	*0.5*	*0.8*	*0.5*	*7.9*	*5.9*	*14.5*
American kestrel	0.08	0.06	0.25	0.5	0.8	0.5	7.9	5.9	13.6
merlin	0	0	<0.01	0	0	<0.1	0	0	0.9
Other Raptors	*0.03*	*0.13*	*0.03*	*0.2*	*1.7*	*<0.1*	*3.2*	*7.3*	*2.7*
unidentified hawk	0.03	0.13	0.03	0.2	1.7	<0.1	3.2	7.3	2.7
Vultures	**0.29**	**1.56**	**0.65**	**1.9**	**20.4**	**1.2**	**19.0**	**31.6**	**15.5**
turkey vulture	0.29	1.56	0.65	1.9	20.4	1.2	19.0	31.6	15.5
Upland Gamebirds	**0.90**	**0.24**	**0.52**	**6.0**	**3.1**	**1.0**	**39.7**	**23.7**	**9.1**
northern bobwhite	0	0.02	0	0	0.2	0	0	1.6	0
ring-necked pheasant	0.38	0.22	0.05	2.5	2.9	0.1	38.1	22.1	5.5
wild turkey	0.52	0	0.46	3.5	0	0.9	4.8	0	4.5
Doves/Pigeons	**2.24**	**1.63**	**1.52**	**14.8**	**21.4**	**2.9**	**39.7**	**57.6**	**21.8**
mourning dove	0.29	0.77	0.88	1.9	10.0	1.7	20.6	49.8	18.2
rock pigeon	1.95	0.87	0.64	12.9	11.3	1.2	27.0	13.8	5.5
Large Corvids	**1.22**	**1.38**	**1.37**	**8.1**	**18.0**	**2.6**	**58.7**	**39.7**	**52.7**
American crow	1.22	1.38	1.37	8.1	18.0	2.6	58.7	39.7	52.7
Overall	**15.14**	**7.65**	**52.92**	**100**	**100**	**100**			

Table 4b. Mean use (number of birds/100-m plot/20-min survey), percent of total composition (%), and frequency of occurrence (%) for each small bird type and species by season during the fixed-point bird use surveys at the Oak Glen Wind Resource Area, April 1 - November 13, 2009.

	Use			% Composition			% Frequency		
Species/Type	**Spring**	**Summer**	**Fall**	**Spring**	**Summer**	**Fall**	**Spring**	**Summer**	**Fall**
Passerines	**22.32**	**18.82**	**18.08**	**99.9**	**99.9**	**99.9**	**98.4**	**97.1**	**77.3**
American goldfinch	0	0.12	0.20	0	0.6	1.1	0	7.5	11.8
American robin	1.22	0.40	0.15	5.5	2.1	0.8	28.6	36.7	5.5
Baltimore oriole	0.02	0	0	<0.1	0	0	1.6	0	0
bank swallow	0.03	3.14	0.48	0.1	16.7	2.7	1.6	30.8	6.4
barn swallow	0.21	1.74	0.41	0.9	9.2	2.3	12.7	35.2	3.6
black-capped chickadee	0.06	0.07	0.02	0.3	0.4	0.1	6.3	7.5	1.8
blue jay	0.10	0.44	0.63	0.4	2.3	3.5	9.5	28.3	48.2
bobolink	0.05	0.25	0	0.2	1.3	0	3.2	7.9	0
brown-headed cowbird	0	0.05	0.91	0	0.2	5.0	0	4.6	0.9
brown thrasher	0	0.01	0.10	0	<0.1	0.6	0	1.4	1.8
cedar waxwing	0	0.11	0	0	0.6	0	0	1.6	0
chestnut-sided warbler	0	0	<0.01	0	0	<0.1	0	0	0.9
chipping sparrow	0.03	0.12	0	0.1	0.6	0	3.2	10.6	0
common grackle	7.60	3.37	4.83	34.0	17.9	26.7	33.3	54.0	25.5
common yellowthroat	0	0.35	0.04	0	1.9	0.2	0	31.9	3.6
eastern bluebird	0.02	0	0	<0.1	0	0	1.6	0	0
eastern kingbird	0	0.36	0	0	1.9	0	0	24.1	0
eastern meadowlark	0	0.02	0	0	<0.1	0	0	1.6	0
eastern phoebe	0.05	0	0	0.2	0	0	4.8	0	0
eastern towhee	0	0.03	0	0	0.2	0	0	3.2	0
eastern wood-pewee	0	0.01	0	0	<0.1	0	0	1.4	0
European starling	4.81	4.26	5.29	21.5	22.6	29.2	12.7	18.3	10.9
horned lark	0.14	0.27	0.08	0.6	1.4	0.5	9.5	22.1	1.8
house sparrow	0	0	3.26	0	0	18.0	0	0	26.4
indigo bunting	0	0.21	<0.01	0	1.1	<0.1	0	21.0	0.9
northern cardinal	0.16	0.03	<0.01	0.7	0.2	<0.1	14.3	3.0	0.9

Table 4b. Mean use (number of birds/100-m plot/20-min survey), percent of total composition (%), and frequency of occurrence (%) for each small bird type and species by season during the fixed-point bird use surveys at the Oak Glen Wind Resource Area, April 1 - November 13, 2009.

	Use			% Composition			% Frequency		
Species/Type	**Spring**	**Summer**	**Fall**	**Spring**	**Summer**	**Fall**	**Spring**	**Summer**	**Fall**
northern rough-winged swallow	0	0.16	0	0	0.8	0	0	3.2	0
red-eyed vireo	0	0.02	0	0	<0.1	0	0	1.6	0
red-winged blackbird	7.03	1.85	0	31.5	9.8	0	71.4	44.1	0
savannah sparrow	0.02	0	0	<0.1	0	0	1.6	0	0
scarlet tanager	0	0.02	0	0	<0.1	0	0	1.6	0
song sparrow	0.03	0.56	0	0.1	3.0	0	3.2	48.4	0
tree swallow	0.02	0.83	0.77	<0.1	4.4	4.3	1.6	4.8	5.5
unidentified chickadee	0.02	0	<0.01	<0.1	0	<0.1	1.6	0	0.9
unidentified sparrow	0.40	0	0.53	1.8	0	2.9	1.6	0	2.7
unidentified swallow	0	0	0.05	0	0	0.3	0	0	0.9
unidentified warbler	0	0.02	0.02	0	<0.1	0.1	0	1.6	0.9
vesper sparrow	0.13	0	0.28	0.6	0	1.6	11.1	0	10.0
western meadowlark	0.14	0.02	<0.01	0.6	<0.1	<0.1	14.3	1.6	0.9
yellow-headed blackbird	0.05	0	0	0.2	0	0	3.2	0	0
Other Birds	**0.02**	**0.02**	**0.02**	**<0.1**	**<0.1**	**0.1**	**1.6**	**1.6**	**1.8**
northern flicker	0	0	0.02	0	0	0.1	0	0	1.8
unidentified hummingbird	0	0.02	0	0	<0.1	0	0	1.6	0
unidentified woodpecker	0.02	0	0	<0.1	0	0	1.6	0	0
Overall	**22.33**	**18.83**	**18.10**	**100**	**100**	**100**			

Table 5. Flight height characteristics by bird type during fixed-point bird use surveys at the Oak Glen Wind Resource Area, April 1 - November 13, 2009. Large bird observations were limited to within 800-meters and small birds were limited to within 100-meters.

					% within Flight Height Categories		
Bird Type	**# Groups Flying**	**# Observed Flying**	**Mean Flight Height (m)**	**% Observed Flying**	**0-35 m**	**ZOR 35-130 m[a]**	**>130 m**
Waterbirds	41	5,133	38.66	90.6	92.8	7.1	0.1
Waterfowl	29	270	43.62	75.8	80.4	18.5	1.1
Shorebirds	24	37	16.29	49.3	91.9	8.1	0
Raptors	71	78	64.70	60.5	67.9	21.8	10.3
Accipiters	*1*	*1*	*40.00*	*100*	*0*	*100*	*0*
Buteos	*36*	*40*	*83.33*	*72.7*	*65.0*	*22.5*	*12.5*
Northern Harrier	*14*	*15*	*37.21*	*100*	*73.3*	*20.0*	*6.7*
Eagles	*4*	*4*	*102.50*	*66.7*	*50.0*	*25.0*	*25.0*
Falcons	*11*	*12*	*15.73*	*31.6*	*91.7*	*8.3*	*0*
Other Raptors	*5*	*6*	*90.00*	*42.9*	*50.0*	*33.3*	*16.7*
Vultures	50	195	72.40	100	57.9	39.5	2.6
Upland Gamebirds	1	1	2.00	0.8	100	0	0
Doves/Pigeons	43	265	32.30	63.4	73.6	25.7	0.8
Large Corvids	56	222	18.93	69.8	93.7	6.3	0
Large Birds Overall	**315**	**6,201**	**44.15**	**85.1**	**90.0**	**9.6**	**0.4**
Passerines	272	2,802	14.67	60.4	66.9	33.0	0.1
Other Birds	1	1	5.00	25.0	100	0	0
Small Birds Overall	**273**	**2,803**	**14.63**	**60.4**	**66.9**	**33.0**	**0.1**

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

Table 6a. Flight characteristics and relative collision risk exposure index by large bird species during the fixed-point bird use surveys at the Oak Glen Wind Resource Area, April 1 - November 13, 2009.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within ZOR based on initial obs	Exposure Index	% Within ZOR at anytime
unidentified gull	26	15.47	90.0	6.9	0.96	26.5
turkey vulture	50	0.96	100	39.5	0.38	66.7
rock pigeon	28	1.07	92.1	28.4	0.28	28.9
Canada goose	17	1.15	73.9	16.4	0.14	17.6
American white pelican	5	1.12	100	8.7	0.10	78.9
American crow	56	1.34	69.8	6.3	0.06	6.8
red-tailed hawk	34	0.24	73.1	23.7	0.04	60.5
sandhill crane	2	0.06	100	58.3	0.04	100
mallard	5	0.05	84.6	54.5	0.02	63.6
northern harrier	14	0.06	100	20.0	0.01	40.0
unidentified duck	3	0.02	100	60.0	0.01	80.0
unidentified hawk	5	0.07	42.9	33.3	0.01	50.0
mourning dove	15	0.68	19.9	6.1	<0.01	6.1
stilt sandpiper	1	<0.01	100	100	<0.01	100
northern shoveler	1	<0.01	100	100	<0.01	100
killdeer	22	0.34	47.2	2.9	<0.01	2.9
California gull	4	0.02	100	25.0	<0.01	25.0
Cooper's hawk	1	<0.01	100	100	<0.01	100
bald eagle	4	0.02	66.7	25.0	<0.01	25.0
American kestrel	10	0.12	29.7	9.1	<0.01	9.1
wild turkey	0	0.27	0	0	0	0
ring-necked pheasant	1	0.21	2.3	0	0	0
ring-necked duck	1	0.02	100	0	0	0
wood duck	1	0.02	100	0	0	0
unidentified goose	1	0.01	100	0	0	0
ring-billed gull	1	0.01	100	0	0	0
rough-legged hawk	2	<0.01	66.7	0	0	0

Table 6a. Flight characteristics and relative collision risk exposure index by large bird species during the fixed-point bird use surveys at the Oak Glen Wind Resource Area, April 1 - November 13, 2009.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within ZOR based on initial obs	Exposure Index	% Within ZOR at anytime
northern bobwhite	0	<0.01	0	0	0	0
great blue heron	2	<0.01	100	0	0	0
great egret	1	<0.01	100	0	0	0
Baird's sandpiper	1	<0.01	100	0	0	0
merlin	1	<0.01	100	0	0	0

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

Table 6b. Flight characteristics and relative collision risk exposure index for small birds during the fixed-point bird use surveys at the Oak Glen Wind Resource Area, April 1 - November 13, 2009.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within ZOR based on initial obs	Exposure Index	% Within ZOR at anytime
common grackle	68	4.89	66.4	41.2	1.34	41.2
red-winged blackbird	17	2.59	55.2	87.1	1.25	90.0
European starling	24	4.71	56.0	42.9	1.13	42.9
unidentified sparrow	3	0.26	97.6	30.9	0.08	30.9
northern rough-winged swallow	2	0.07	100	50.0	0.03	50.0
horned lark	2	0.18	14.3	80.0	0.02	80.0
bank swallow	28	1.54	98.9	0.4	<0.01	6.0
American robin	11	0.53	15.1	5.6	<0.01	5.6
vesper sparrow	10	0.12	74.4	3.4	<0.01	3.4
house sparrow	20	1.00	62.7	0	0	0
barn swallow	35	0.94	100	0	0	0
tree swallow	10	0.60	100	0	0	36.2
blue jay	1	0.41	1.9	0	0	0
brown-headed cowbird	0	0.30	0	0	0	0
song sparrow	2	0.26	5.1	0	0	0
common yellowthroat	1	0.17	3.7	0	0	0
eastern kingbird	7	0.16	45.8	0	0	0
bobolink	4	0.12	73.7	0	0	0
American goldfinch	16	0.11	93.3	0	0	0
indigo bunting	1	0.10	6.7	0	0	0
chipping sparrow	0	0.06	0	0	0	0
northern cardinal	0	0.06	0	0	0	0
black-capped chickadee	0	0.05	0	0	0	0
cedar waxwing	1	0.05	100	0	0	0
western meadowlark	2	0.05	18.2	0	0	0
brown thrasher	1	0.04	8.3	0	0	0
eastern towhee	0	0.01	0	0	0	0

Table 6b. Flight characteristics and relative collision risk exposure index for small birds during the fixed-point bird use surveys at the Oak Glen Wind Resource Area, April 1 - November 13, 2009.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within ZOR based on initial obs	Exposure Index	% Within ZOR at anytime
unidentified swallow	0	0.01	0	0	0	0
unidentified warbler	1	0.01	33.3	0	0	0
yellow-headed blackbird	1	0.01	66.7	0	0	0
eastern phoebe	1	0.01	33.3	0	0	0
unidentified hummingbird	1	<0.01	100	0	0	0
scarlet tanager	1	<0.01	100	0	0	0
red-eyed vireo	0	<0.01	0	0	0	0
eastern meadowlark	0	<0.01	0	0	0	0
unidentified chickadee	0	<0.01	0	0	0	0
eastern wood-pewee	0	<0.01	0	0	0	0
northern flicker	0	<0.01	0	0	0	0
unidentified woodpecker	0	<0.01	0	0	0	0
savannah sparrow	0	<0.01	0	0	0	0
eastern bluebird	0	<0.01	0	0	0	0
Baltimore oriole	1	<0.01	100	0	0	0
chestnut-sided warbler	1	<0.01	100	0	0	0

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

Table 7. Summary of sensitive species observed at the Oak Glen Wind Resource Area during fixed-point bird use surveys, April 1 – November 13, 2009.

Species	Scientific Name	Status	Total # of grps	Total # of obs
American white pelican	*Pelecanus erythrorhyncos*	SSC	5	356
bald eagle	*Haliaeetus leucocephalus*	SSC, EA	5	6
Total	**2 species**		**10**	**362**

SSC = MN species of special concern;
EA = protected under the BGEPA (1940)
(Data from MDNR 2007).

Table 8. Incidental wildlife, by number of groups (# grps) and number of observations (# obs), observed at the Oak Glen Wind Resource Area, April 1 - November 13, 2009.

Species	Scientific Name	# grps	# obs
lesser scaup	*Aythya affinis*	1	10
mallard	*Anas platyrhynchos*	1	10
American kestrel	*Falco sparverius*	4	4
common grackle	*Quiscalus quiscula*	1	3
European starling	*Sturnus vulgaris*	2	2
wild turkey	*Meleagris gallopavo*	2	2
American crow	*Corvus brachyrhynchos*	1	2
Canada goose	*Branta canadensis*	1	2
American robin	*Turdus migratorius*	1	1
mourning dove	*Zenaida macroura*	1	1
northern flicker	*Colaptes auratus*	1	1
northern harrier	*Circus cyaneus*	1	1
red-tailed hawk	*Buteo jamaicensis*	1	1
ring-necked pheasant	*Phasianus colchicus*	1	1
rock pigeon	*Columba livia*	1	1
turkey vulture	*Cathartes aura*	1	1
western meadowlark	*Sturnella neglecta*	1	1
Bird Subtotal	**17 Species**	**22**	**44**
unidentified ground squirrel		2	26

Table 9. Comparison of raptor use estimates and raptor mortality at wind-energy facilities in the United States.

Wind-Energy Facility	Use Estimate[A]	Raptor Mortality[B]	No. of Turbines	Total MW
Oak Glen, MN	0.54			
	Midwest			
NPPD Ainsworth, NE		0.06	36	59.4
	Northeastern			
Noble Ellensburg, NY		0.32	54	80
Noble Clinton, NY		0.29	67	100.5
Maple Ridge, NY (2007)		0.25	195	321.75
Noble Bliss, NY		0.19	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
Searsburg, VT		0	11	7
	Rocky Mountains			
Judith Gap, MT		0.09	90	135
Summerview, Alb. (2005/2006)		0.11	39	70.2
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
	Western			
Diablo Winds, CA	2.16	0.87	31	20
SMUD, CA		0.53		15
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)	0.29	0.09	454	300
Stateline, OR/WA (2003)		0.09	454	300
Wild Horse, WA		0.09	127	229
Nine Canyon, WA		0.05	37	48
Combine Hills, OR	0.75	0	41	41
Klondike, OR	0.50	0	16	24
Vansycle, OR	0.66	0	38	24.9
	Southern Plains			
Buffalo Gap, TX		0.10	67	134

A=number of raptors/plot/20min survey
B=number of fatalities/MW/year
Data from the following sources:

Facility	Use Estimate	Mortality Estimate	Facility	Use Estimate	Mortality Estimate
Diablo Winds, CA	WEST 2006a	WEST 2008	Judith Gap, MT		TRC 2008
SMUD, CA		URS et al. 2005	Summerview, Alb. (2005/2006)		Brown and Hamilton 2006
Big Horn, WA	Johnson and Erickson 2004	Kronner et al. 2008	Foote Creek Rim, WY (Phase I; 99)		Young et al. 2003c
Hopkins Ridge, WA	Young et al. 2003a	Young et al. 2007a	Foote Creek Rim, WY (Phase I; 00)		Young et al. 2003c
Klondike II, OR	Johnson 2004	NWC and WEST 2007	Foote Creek Rim, WY (Phase I; 01/02)		Young et al. 2003c
Stateline, OR/WA (02)	Erickson et al. 2002b	Erickson et al. 2004	Noble Ellensburg, NY		Jain et al. 2009a
Stateline, OR/WA (03)		Erickson et al. 2004	Noble Clinton, NY		Jain et al. 2009b
Wild Horse, WA		Erickson et al. 2008	Maple Ridge, NY (07)		Jain et al. 2008
Nine Canyon, WA		Erickson et al. 2003c	Noble Bliss, NY		Jain et al. 2009c
Combine Hills, OR	Young et al. 2003d	Young et al. 2006	Maple Ridge, NY (06)		Jain et al. 2007
Klondike, OR	Johnson et al. 2002a	Johnson et al. 2003b	Buffalo Mountain, TN (06)		Fiedler et al. 2007
Vansycle, OR	WICA and WEST 1997	Erickson et al. 2000	Buffalo Mountain, TN (00-03)		Nicholson 2003, Nicholson et al. 2005
NPPD Ainsworth, NE		Derby et al. 2007	Mount Storm, WV (08)		Young et al. 2009
Buffalo Gap, TX		Tierney 2007	Searsburg, VT		Kerlinger 2002

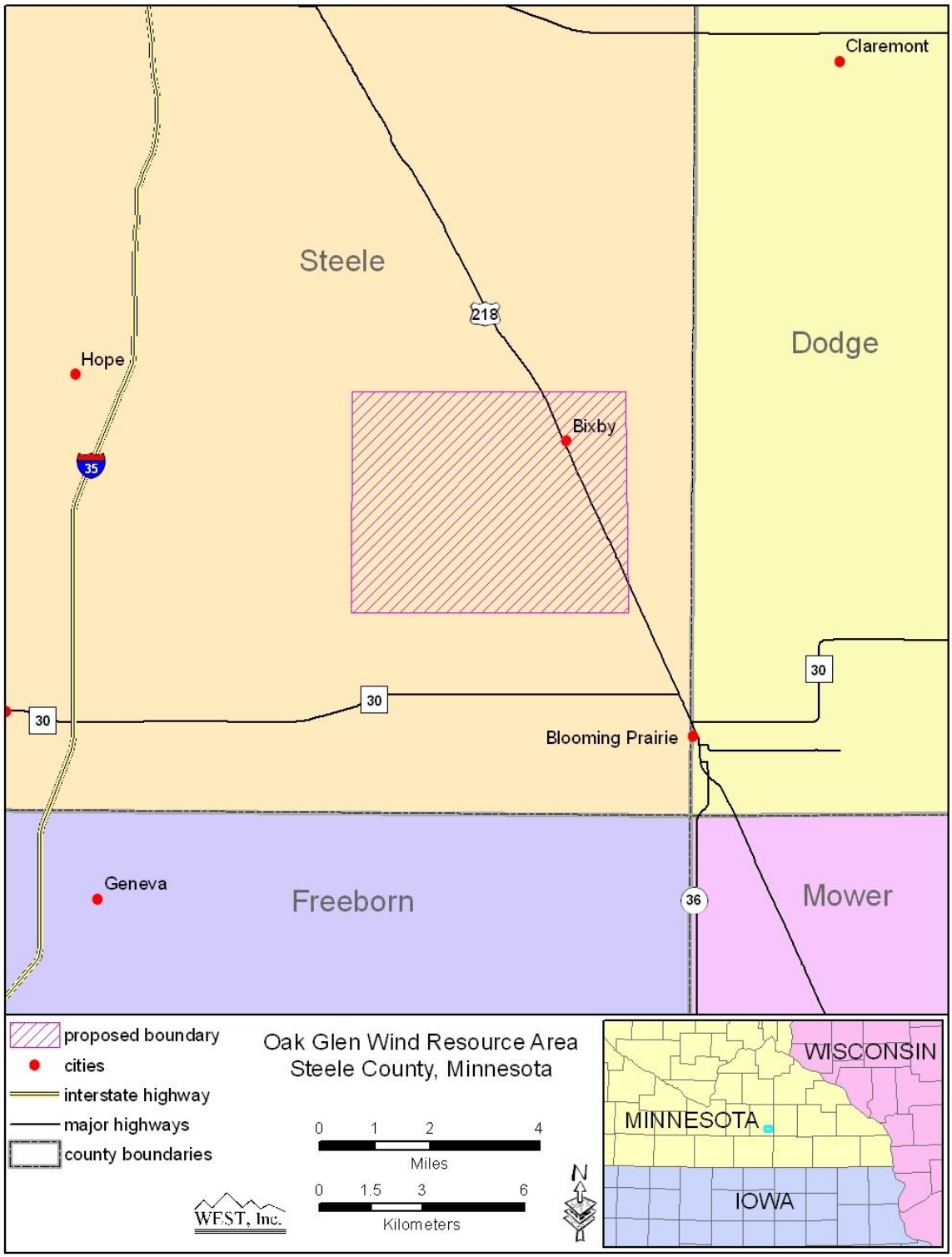


Figure 1. Location of the Oak Glen Wind Resource Area.

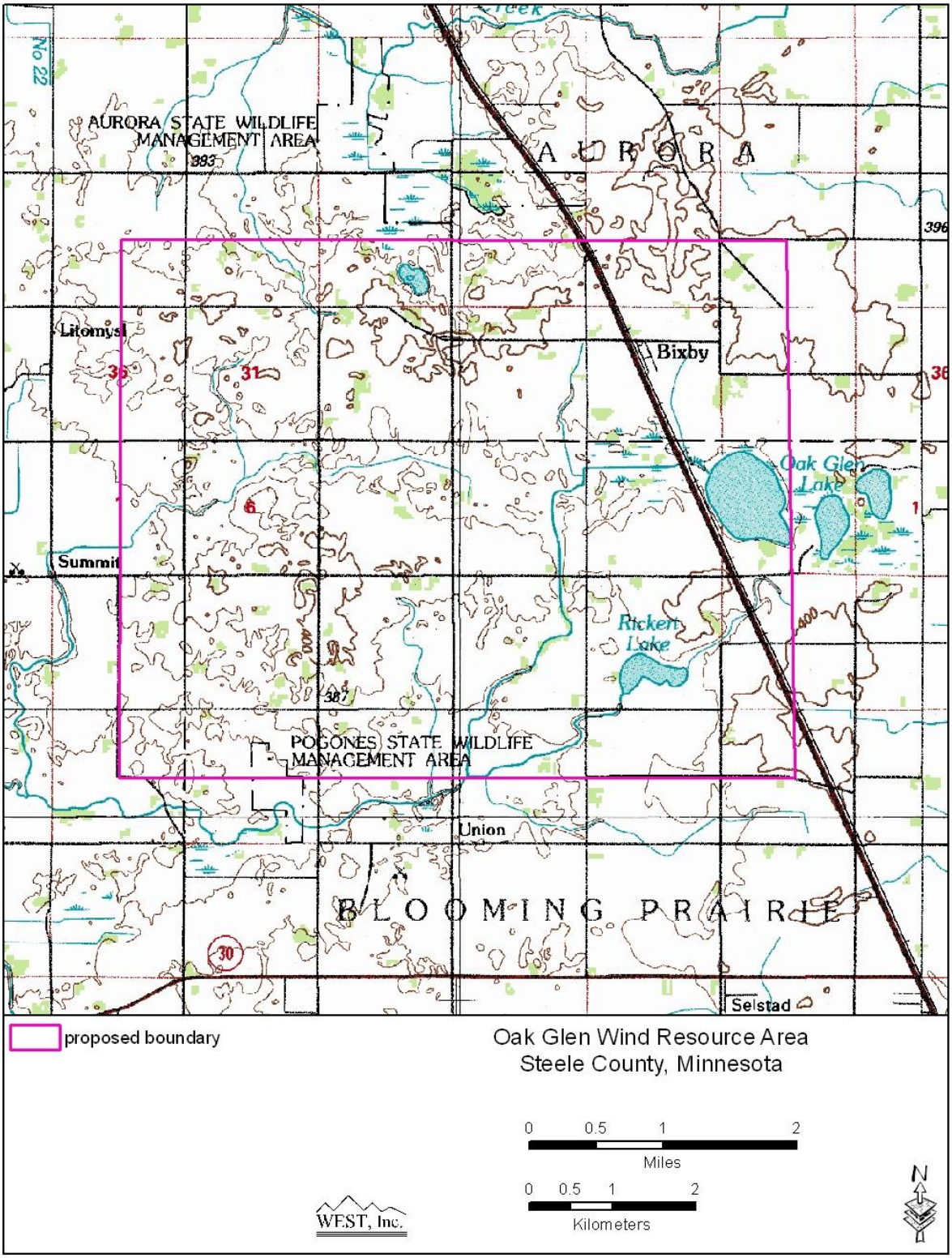


Figure 2. Overview of the Oak Glen Wind Resource Area.

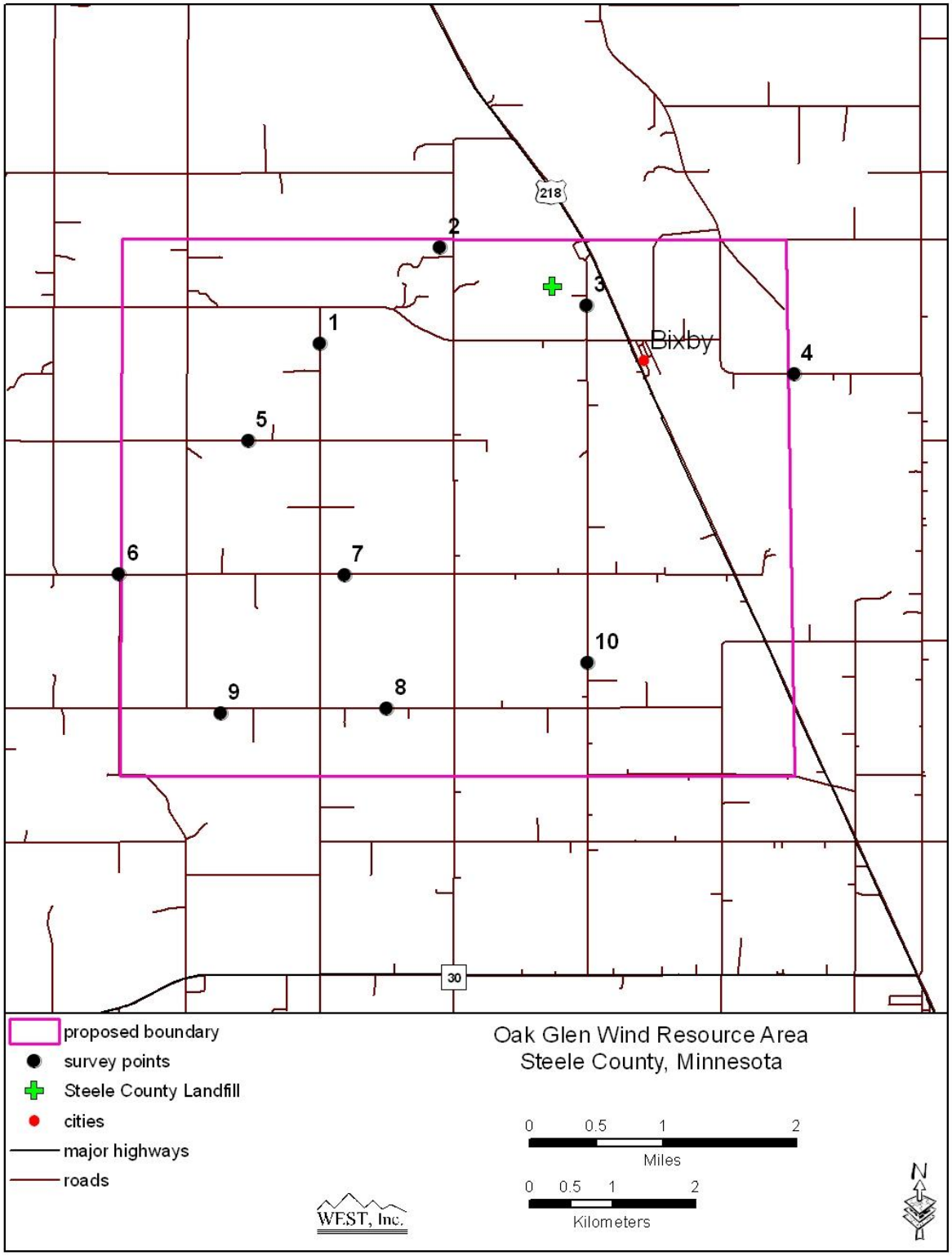


Figure 3. Fixed-point bird use survey points at the Oak Glen Wind Resource Area.

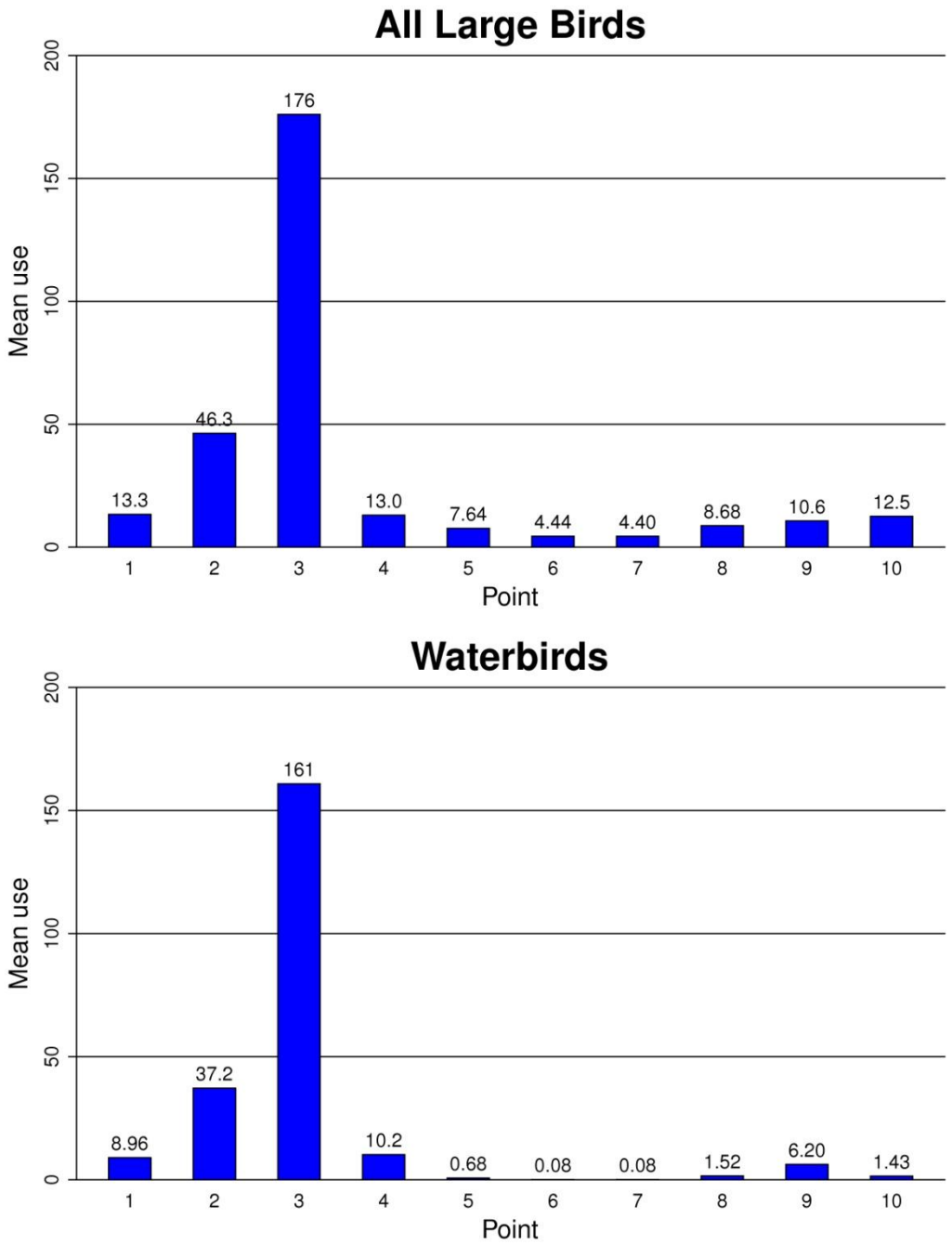


Figure 4. Mean use (number of birds/20-min survey) at each fixed-point bird use survey point for all birds major bird types at the Oak Glen Wind Resource Area, April 1 - November 13, 2009.

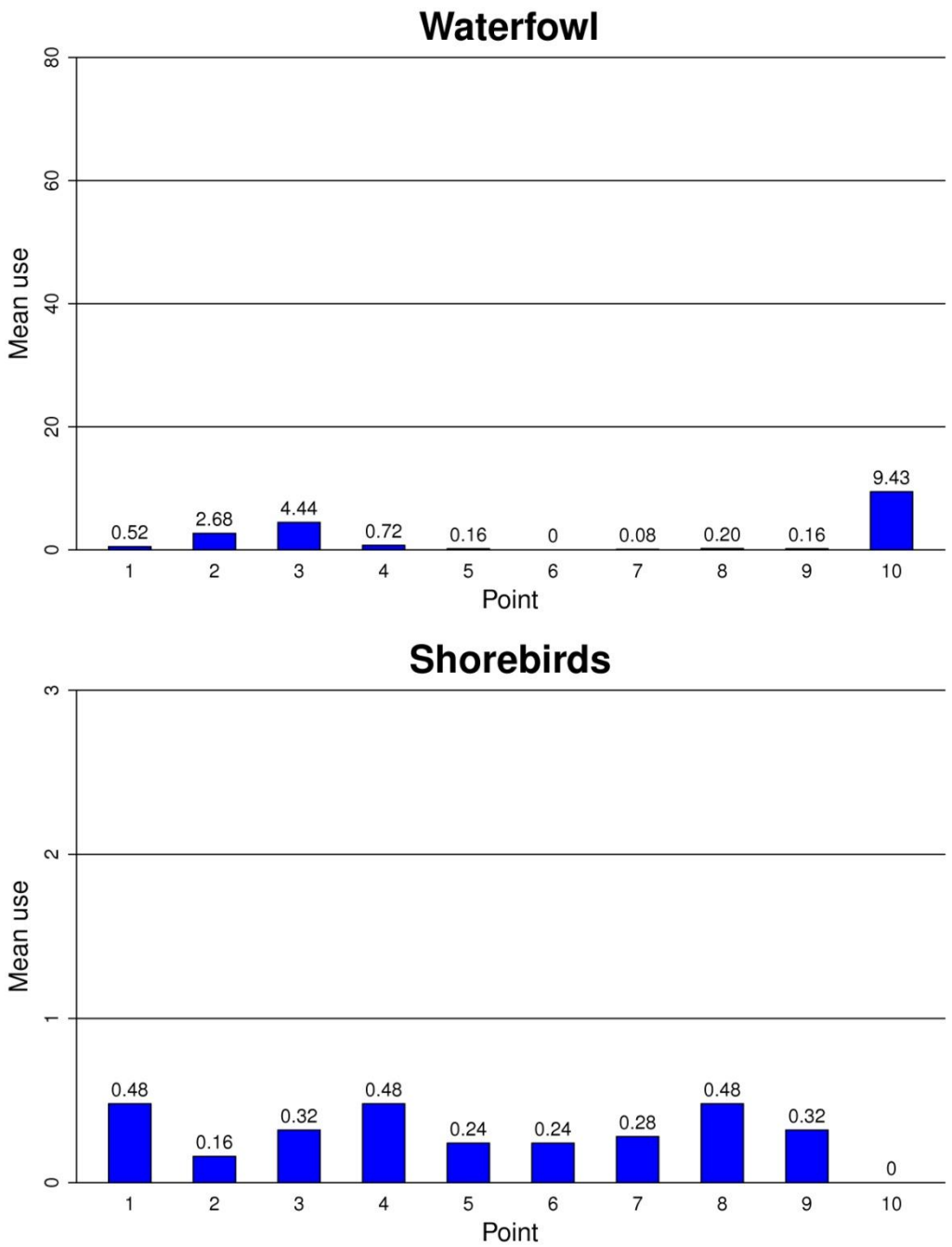
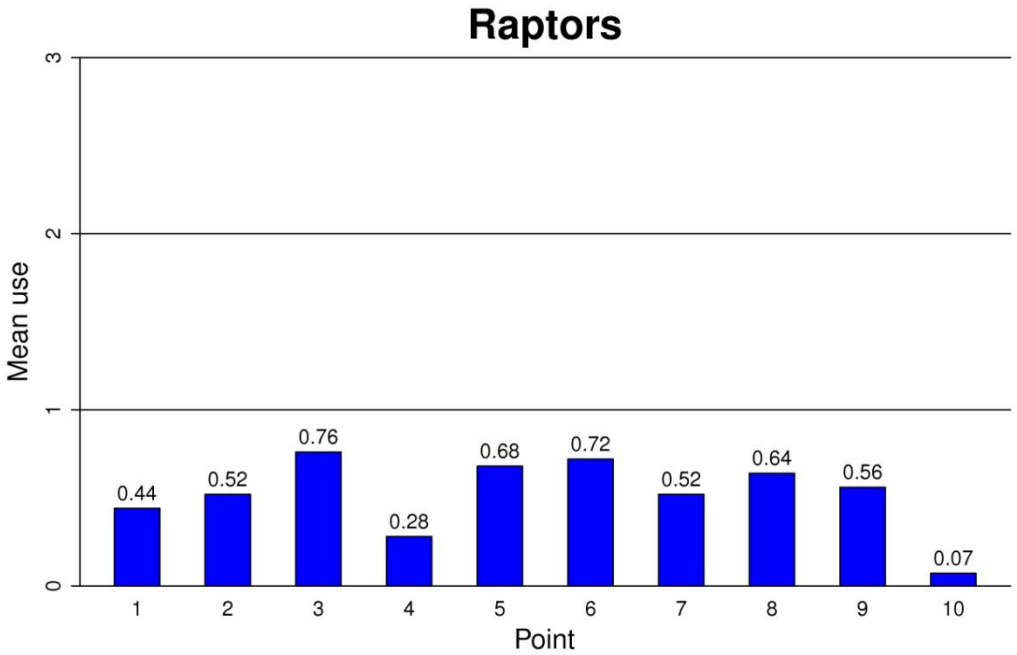


Figure 4 (continued). Mean use (number of birds/20-min survey) at each fixed-point bird use survey point for all birds major bird types at the Oak Glen Wind Resource Area, April 1 - November 13, 2009.



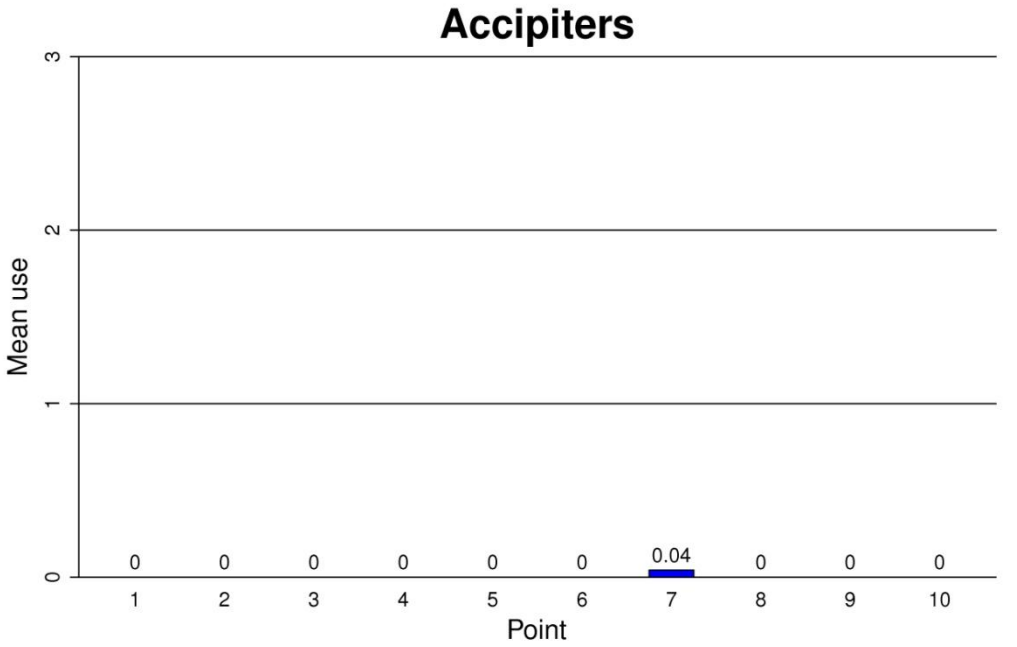
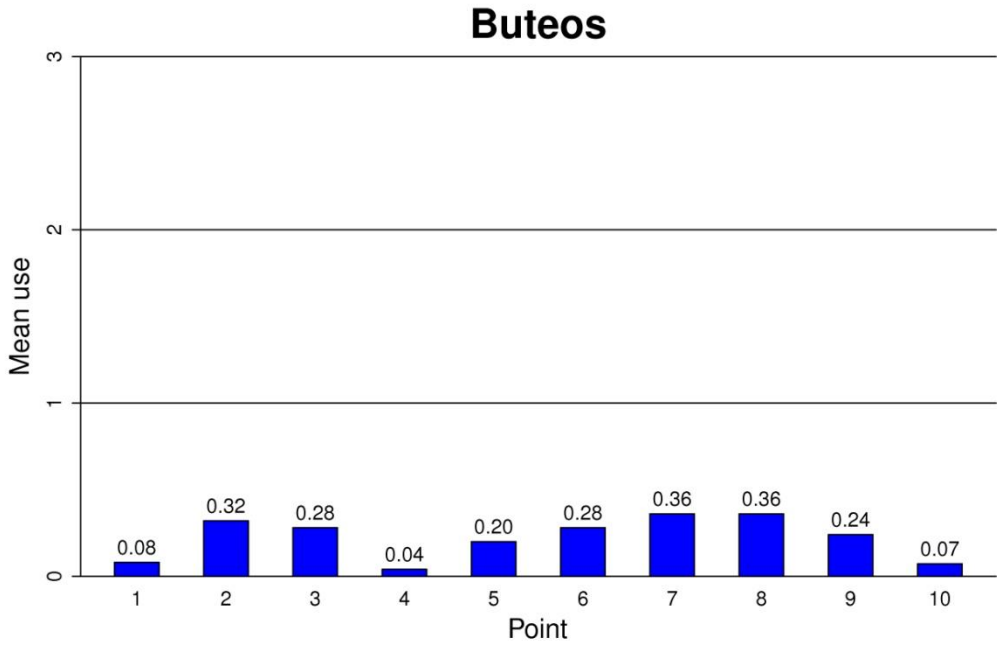


Figure 4 (*continued*). Mean use (number of birds/20-min survey) at each fixed-point bird use survey point for all birds and major bird types at the Oak Glen Wind Resource Area, April 1 - November 13, 2009.



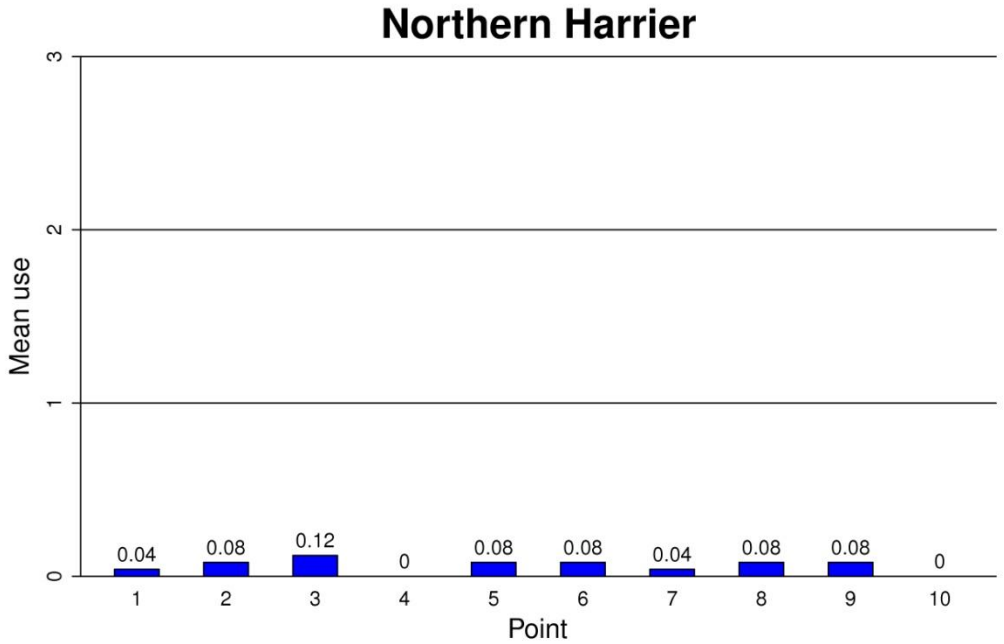
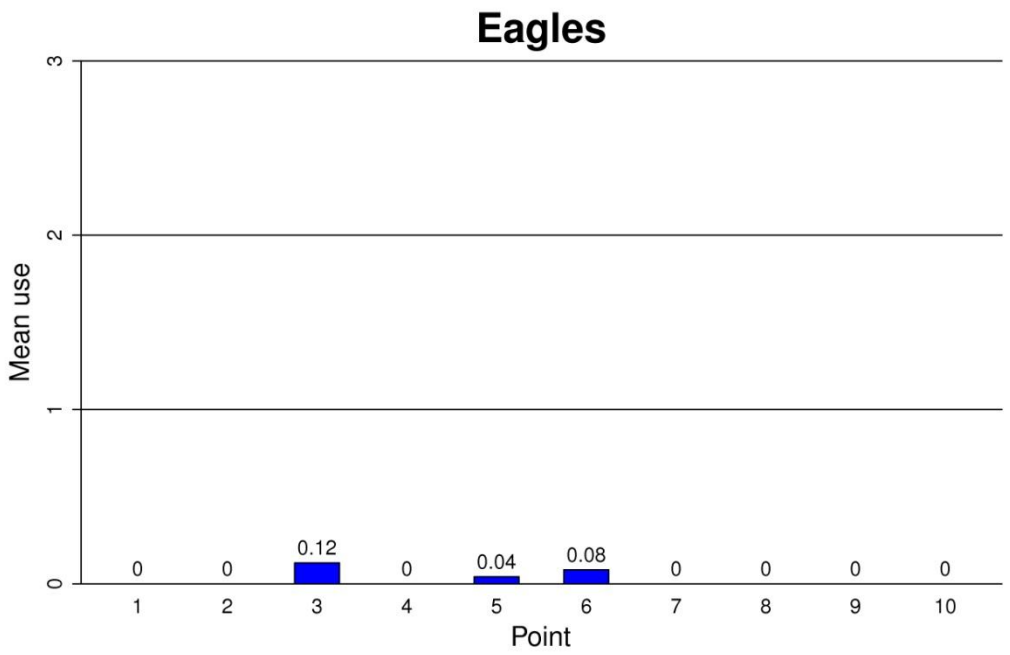


Figure 4 (continued). Mean use (number of birds/20-min survey) at each fixed-point bird use survey point for all birds and major bird types at the Oak Glen Wind Resource Area, April 1 - November 13, 2009.



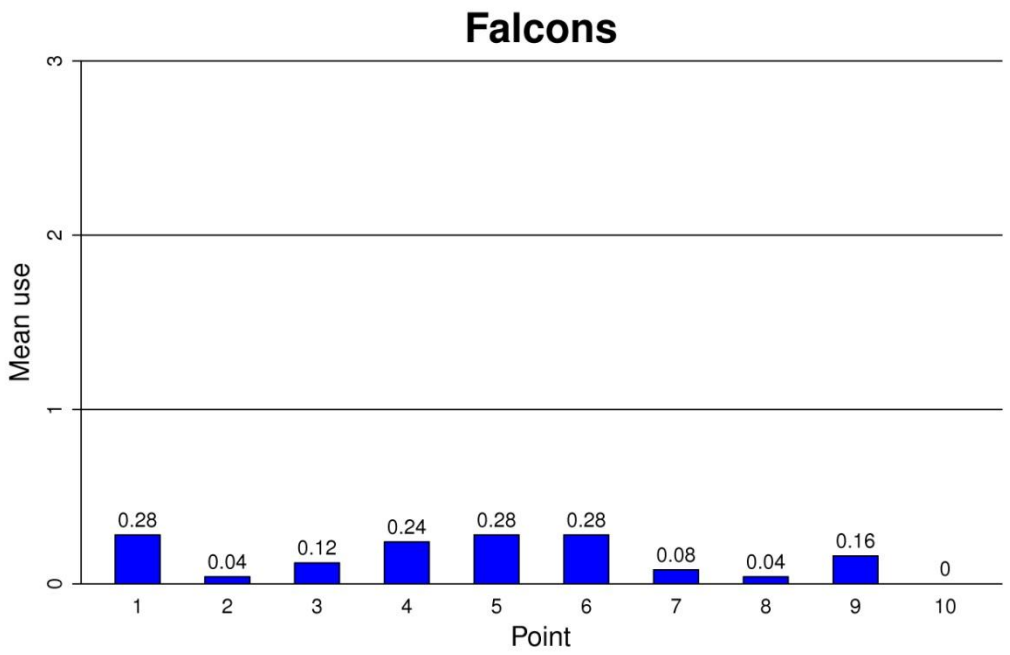


Figure 4 (*continued*). Mean use (number of birds/20-min survey) at each fixed-point bird use survey point for all birds and major bird types at the Oak Glen Wind Resource Area, April 1 - November 13, 2009.

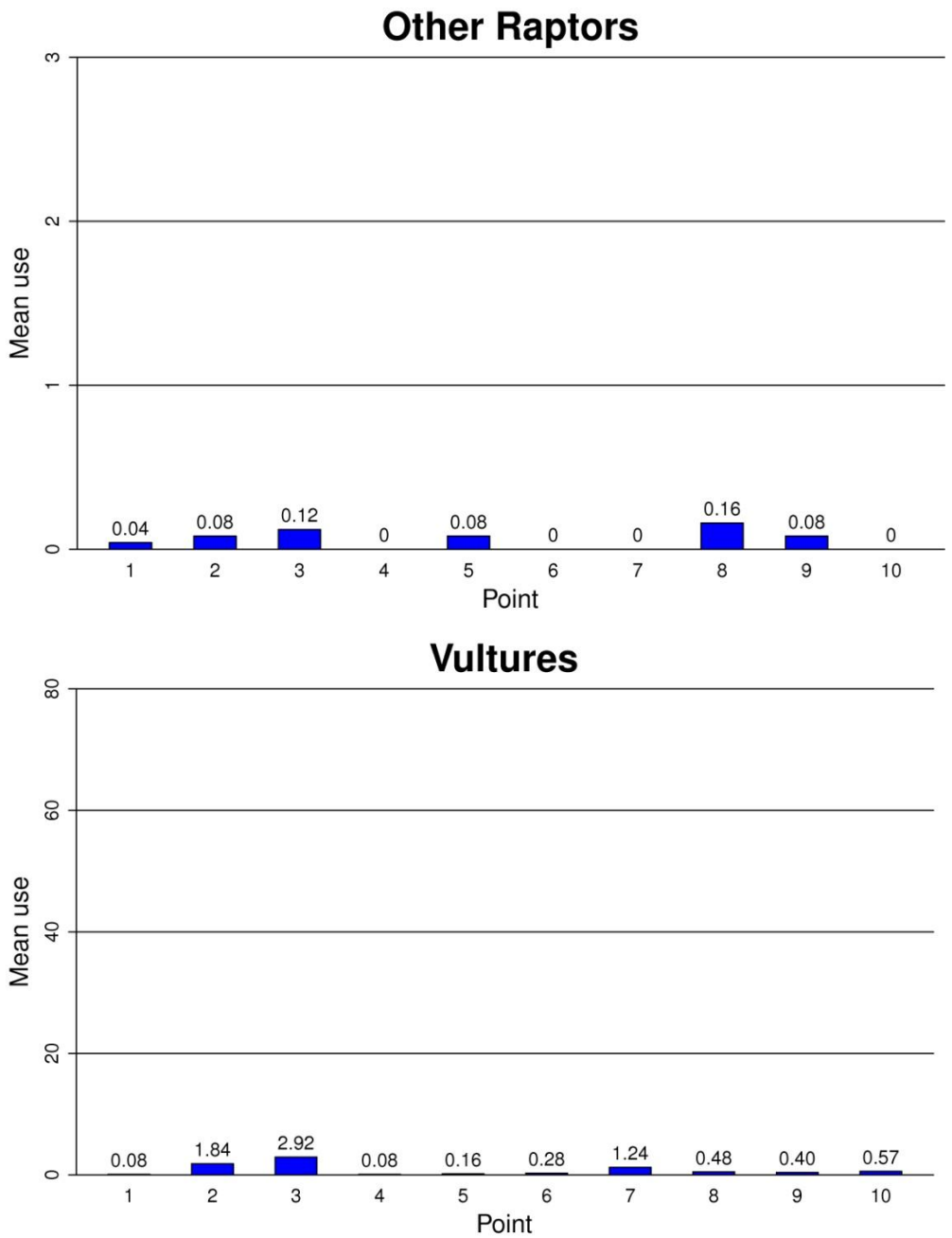
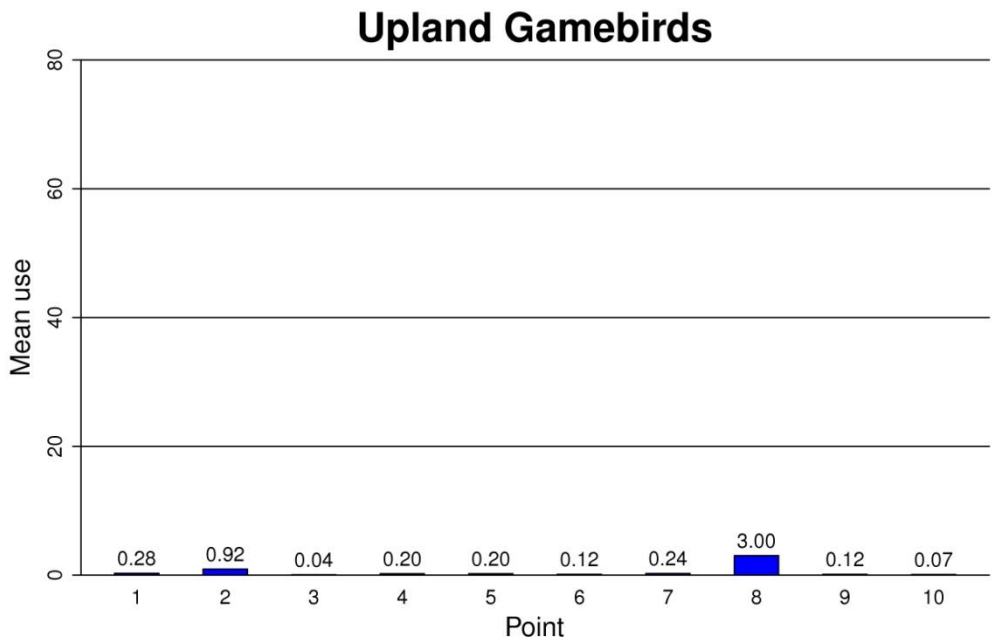


Figure 4 (*continued*). Mean use (number of birds/20-min survey) at each fixed-point bird use survey point for all birds and major bird types at the Oak Glen Wind Resource Area, April 1 - November 13, 2009.



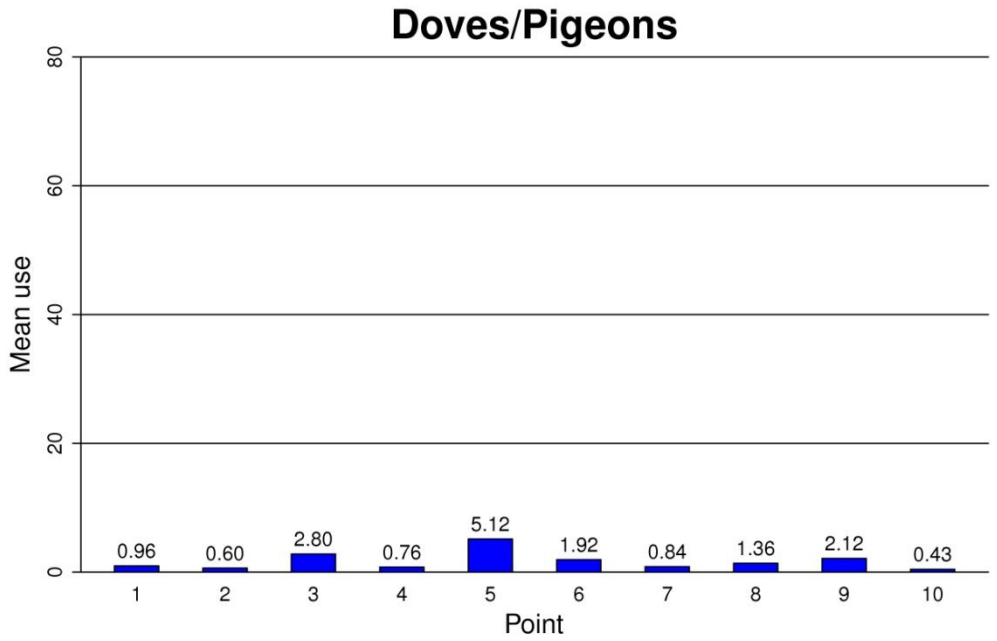
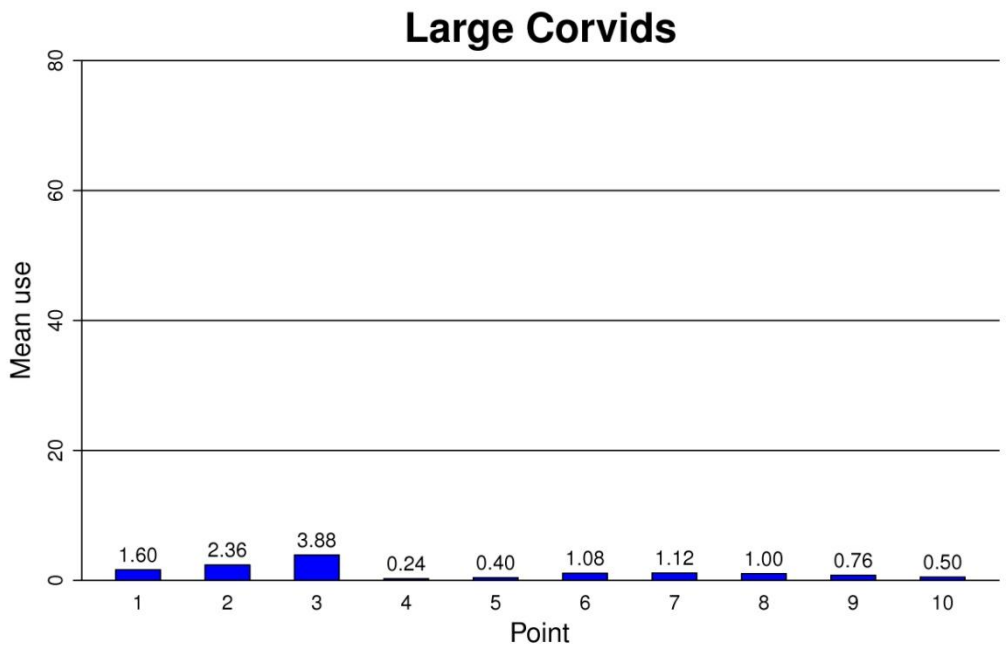
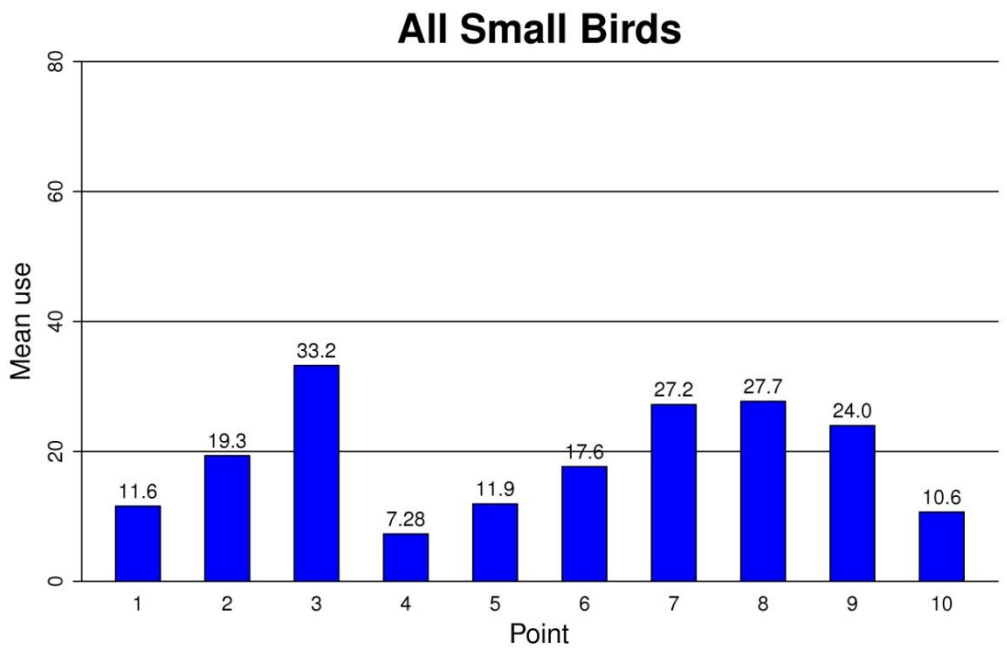


Figure 4 (*continued*). Mean use (number of birds/20-min survey) at each fixed-point bird use survey point for all birds and major bird types at the Oak Glen Wind Resource Area, April 1 - November 13, 2009.





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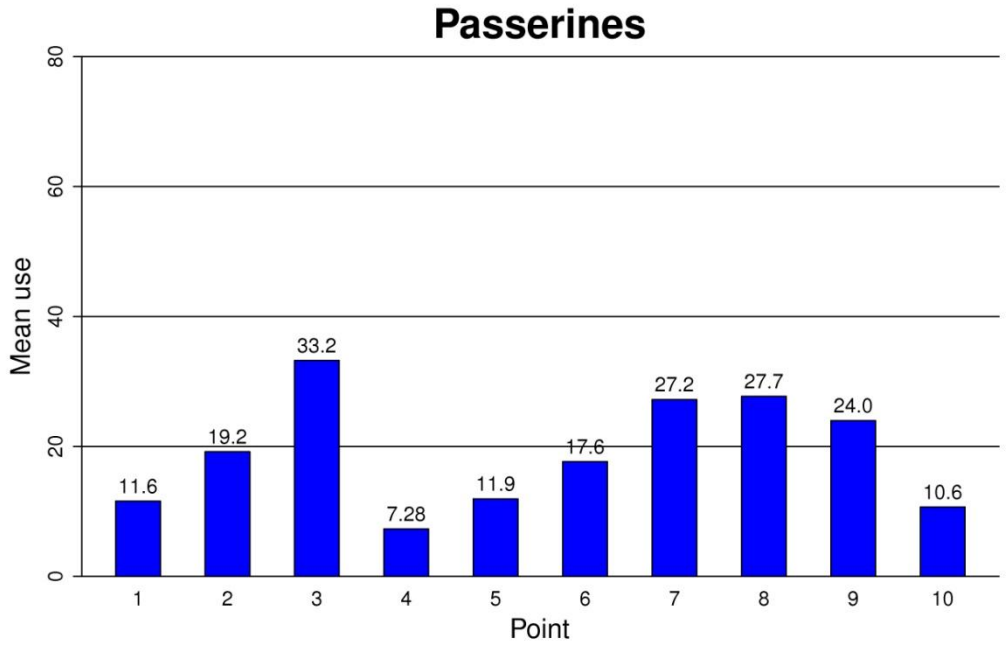


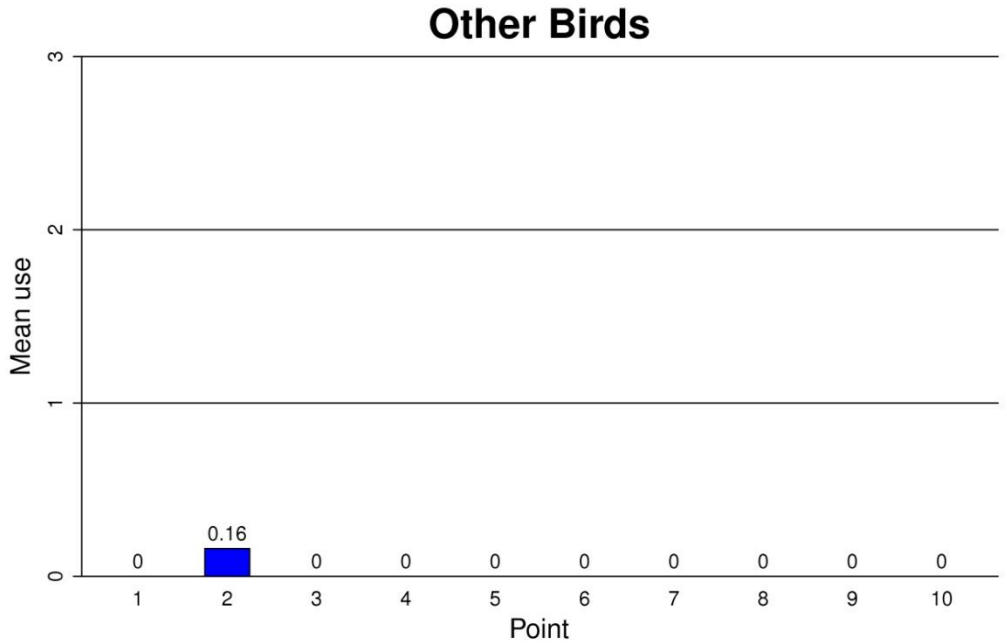


Figure 4 (*continued*). Mean use (number of birds/20-min survey) at each fixed-point bird use survey point for all birds and major bird types at the Oak Glen Wind Resource Area, April 1 - November 13, 2009.

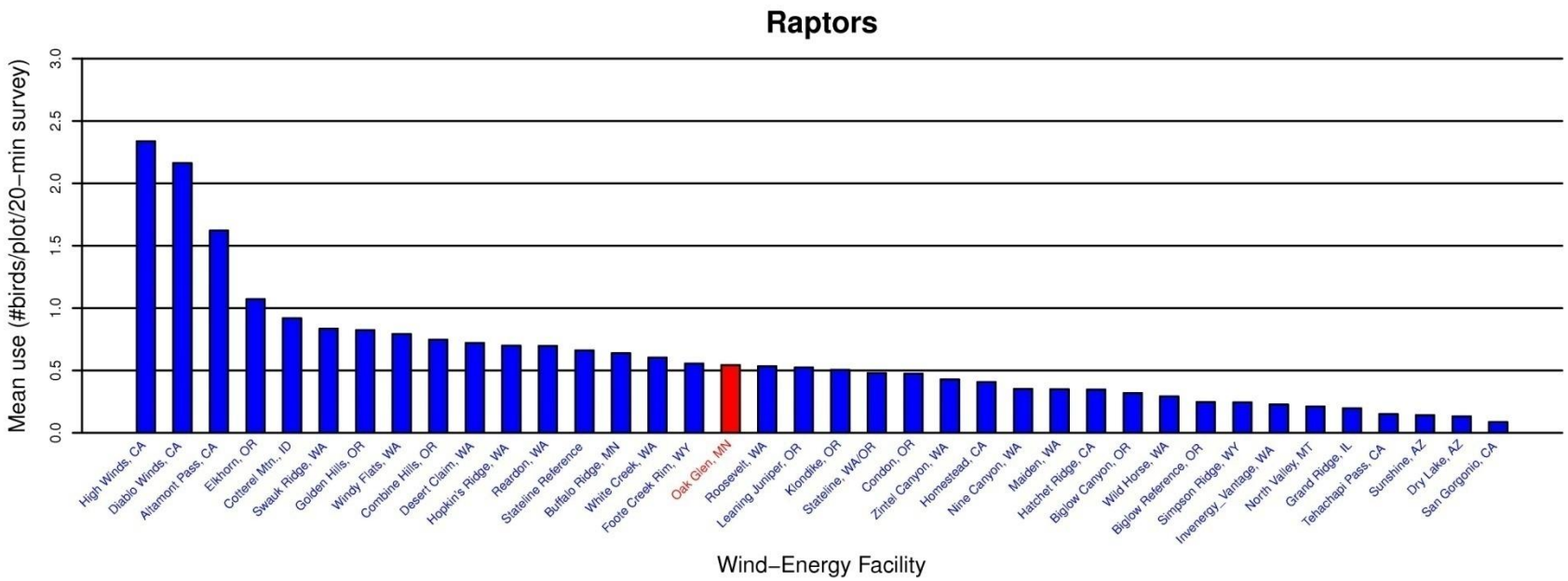
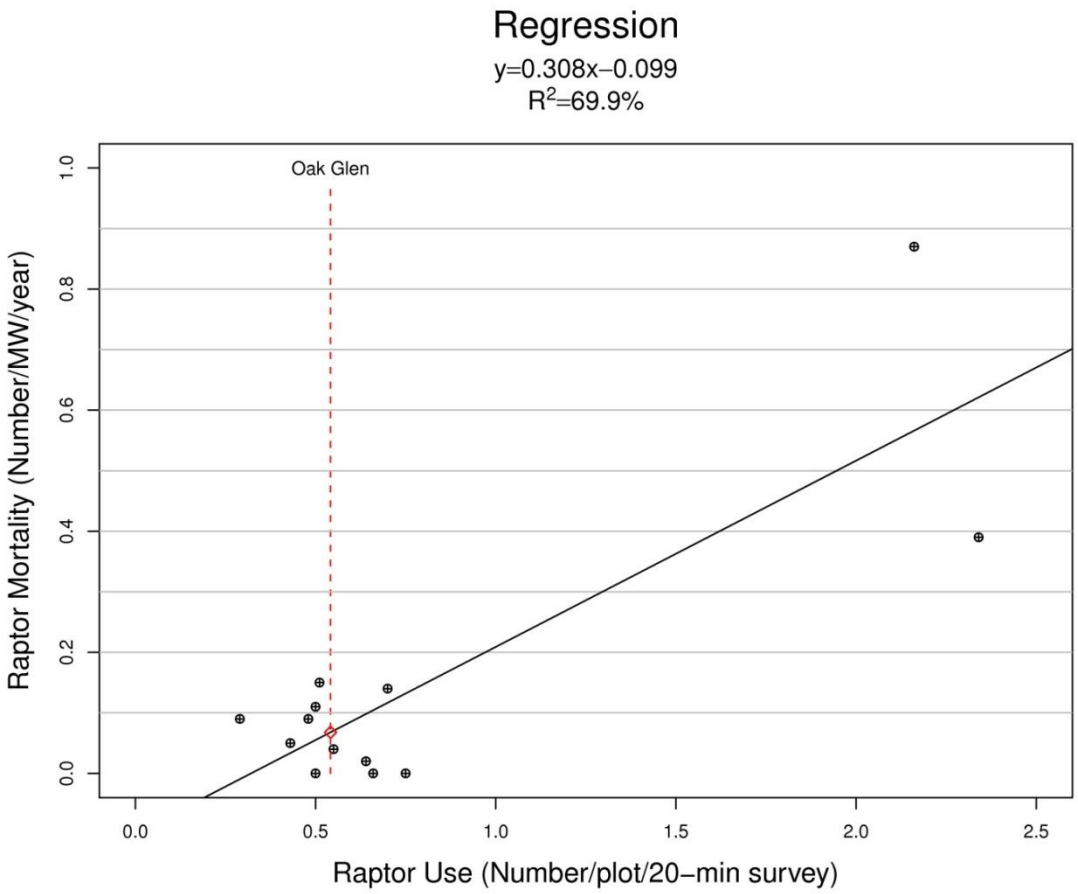


Figure 5. Comparison of annual raptor use between the Oak Glen Wind Resource Area and other United States wind-energy facilities.

Data from the following sources:

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



Overall Raptor Use 0.54
Predicted Fatality Rate 0.07 fatalities/MW/year
90.0% Prediction Interval (0, 0.33 fatalities/MW/year)

Figure 6. Regression analysis of raptor use estimations and estimated raptor mortality.

Data from the following sources:

Study and Location	Raptor Use (birds/plot /20-min survey)	Source	Raptor Mortality (fatalities/MW/yr)	Source
Buffalo Ridge, MN	0.64	Erickson et al. 2002b	0.02	Erickson et al. 2002b
Combine Hills, OR	0.75	Young et al. 2003d	0.00	Young et al. 2005
Diablo Winds, CA	2.161	WEST 2006a	0.87	WEST 2006a
Foote Creek Rim, WY	0.55	Erickson et al. 2002b	0.04	Erickson et al. 2002b
High Winds, CA	2.34	Kerlinger et al. 2005	0.39	Kerlinger et al. 2006
Hopkins Ridge, WA	0.70	Young et al. 2003a	0.14	Young et al. 2007b
Klondike II, OR	0.50	Johnson 2004	0.11	NWC and WEST 2007
Klondike, OR	0.50	Johnson et al. 2002a	0.00	Johnson et al. 2003b
Stateline, WA/OR	0.48	Erickson et al. 2002b	0.09	Erickson et al. 2002b
Vansycle, OR	0.66	WCIA and WEST 1997	0.00	Erickson et al. 2002b
Wild Horse, WA	0.29	Erickson et al. 2003a	0.09	Erickson et al. 2008
Zintel, WA	0.43	Erickson et al. 2002a	0.05	Erickson et al. 2002b
Bighorn, WA	0.51	Johnson and Erickson 2004	0.15	Kronner et al. 2008