DRAFT REPORT

Wildlife Baseline Studies for the Wilton Expansion Wind Resource Area Burleigh County, North Dakota

Final Report
September 2008 – June 2009

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August 22, 2009

EXECUTIVE SUMMARY

NextEra Energy Resources is constructing a wind-energy facility in Burleigh County, North Dakota, south and east of the city of Wilton. NextEra Energy Resources contracted Western Ecosystems Technology, Inc. to conduct surveys and monitor wildlife resources in the Wilton Expansion Wind Resource Area to estimate the impacts of project construction and operations on wildlife. The following document contains results for fixed-point bird use surveys, raptor nest surveys, and incidental wildlife observations. The principal objective of the study was to provide site specific bird resource and use data that would be useful in evaluating potential impacts from the wind-energy facility.

The objective of the fixed-point bird use surveys was to estimate the seasonal, spatial, and temporal use of the Wilton Expansion Wind Resource Area by birds, particularly raptors. Fixed-point surveys were conducted from September 17 through November 4, 2008, and March 18 through June 25, 2009 at 18 points established throughout the Wilton Expansion Wind Resource Area. A total of 414 twenty-minute fixed-point surveys were completed and 76 bird species were identified.

Waterfowl use was highest during the spring (3.33 birds/plot/20-min survey), primarily due to high use by Canada geese. Raptor use was highest during the summer (0.46 birds/plot/20-min survey) and lowest during the fall (0.20). The most common raptors observed in the Wilton Expansion Wind Resource Area were red-tailed hawk and northern harrier. Passerines had use ranging from 2.15 birds/plot/20-minute survey in summer to 0.66 in fall; although the focus was within a100-meter viewshed and is not directly comparable to the other bird types.

Levels of bird use varied within the Wilton Expansion Wind Resource Area by point. For all large bird species combined, use was highest at Point 15, with 25.5 birds/20-minute survey. The mean use at Point 15 was due mostly to high use by waterbirds and waterfowl at this point (7.74 and 16.1 birds/20-minute survey, respectively). Use at the other points ranged from 1.13 to 18.2 birds/20-minute survey for large bird species. Raptor use was highest at Point 2, comprised primarily of buteo use. Passerine use, within 100 meters, was relatively uniform with the highest use at Point nine (3.04 birds/20-minute surveys), and ranging from 0.74 to 2.65 at the other points.

The proposed wind-energy facility contains a diversity of habitats. Approximately 55% of the study area contains cropland habitats, while approximate 41% is grassland. While the various habitat types are found throughout the study area, there is somewhat more grasslands along the east and southeast boundary of the project area. No obvious flyways or concentration areas were observed. No strong association with topographic features within the study area was noted for raptors or other large birds. Although some differences in bird use were detected among survey points, the differences are not large enough to suggest that any portions of the Wilton Expansion Wind Resource Area should be avoided when siting turbines.

During the study, 237 single or groups of large birds totaling 1,774 individuals were observed flying during fixed-point bird use surveys. For all large bird species combined, 18.3% of birds were observed flying below the likely zone of risk, 48.9% were within the zone of risk, and

32.8% were observed flying above the zone of risk for typical turbines that could be used in the Wilton Expansion Wind Resource Area. Bird types most often observed flying within the turbine zone of risk were waterfowl (82.9%), large corvids (53.5%), and raptors (43.4%). A total of 297 passerines and other small birds in 134 groups were recorded flying within 100 meters of the survey plots in the proposed Wilton Expansion Wind Resource Area, with 99.0% below the zone of risk, 1.0% within the zone of risk, and none observed above the zone of risk.

Based on the use (measure of abundance) of the Wilton Expansion Wind Resource Area by each species and the flight characteristics observed for that species, the sandhill crane had the highest probability of turbine exposure, with an exposure index of 0.93. The raptor species with the highest exposure index was the red-tailed hawk, which was ranked fourth of all large bird species; although its exposure index was only 0.06. For passerines and other small birds, the bird with the highest exposure index within 100 meters was western meadowlark, with an exposure index of 0.01.

Based on fixed-point bird use data collected for the Wilton Expansion Wind Resource Area, mean annual raptor use was 0.28 raptors/plot/20-minute survey. The annual rate was low relative to raptor use at other wind-energy facilities that implemented similar protocols to the present study and had data for three or four different seasons.

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 Wilton Expansion Wind Resource Area yields an estimated fatality rate of 0.01 fatalities/megawatt/year, or one raptor fatality per year for each 100-megawatt of wind-energy development. Based on species composition of raptors observed at the Wilton Expansion 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 the lowest risk in the fall and spring, and highest risk during the summer.

The data collected during this study suggests that the Wilton Expansion Wind Resource Area may occasionally receive substantial use by waterfowl, but does not appear to be within a major migratory pathway for raptors. In addition, the study area does not appear to provide important stopover habitat for migrant songbirds based on fixed-point bird use surveys. Construction and operation of the wind-energy facility may displace some types of birds. Siting turbines within altered habitats (crop fields) to the extent possible will reduce potential impacts of bird displacement.

The objective of the raptor nest mapping was to record raptor nests that may be subject to disturbance and/or displacement by wind-energy facility construction and/or operation. Ground based surveys were conducted in conjunction with bird use surveys in March and April. The surveys were conducted prior to leaf-out to improve the chances of finding nests. A total of 16 raptor nests (five active) were recorded in or within 0.25 mi of the Wilton Expansion Wind Resource Area. One active nest was in the construction path and had a ¼ mi “no disturbance” buffer placed around it until it was no longer active.

The objective of incidental wildlife observations was to provide record of wildlife seen outside of the standardized surveys. The most abundant large bird species recorded incidentally was sandhill crane.

Some species considered to be sensitive or of conservation concern by the state of North Dakota were observed within the Wilton Expansion Wind Resource Area. During all surveys and incidental observations, 17 sensitive species were observed. This is a tally that in some cases represents repeated observations of the same individual. These species have greater potential to occur in non-cropland areas, such as grasslands. Some potential exists for wind turbines to displace these species within non-cropland habitats. Research concerning displacement impacts of wind-energy facilities are limited, but some show the potential for small scale displacement of 591 feet (180 meters) or less, while impacts to densities of birds at larger scales has not been shown. Two bird species of primary interest to wind energy development in the central and north-central United States are whooping cranes and sharp-tailed grouse. No whooping cranes or sharp-tailed grouse leks (individual grouse were observed) were recorded at the Wilton Expansion Wind Resource Area. However, the location, presence of suitable habitat, and presence of similar species at the Wilton Expansion Wind Resource Area indicates that both whooping cranes and sharp-tailed grouse leks could be found within the project area at some point.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

NextEra Energy Resources (NextEra) has proposed a wind-energy facility in Burleigh County, North Dakota, south and east of the city of Wilton (Figures 1 and 2). NextEra contracted Western Ecosystems Technology, Inc. (WEST) to conduct surveys and monitor wildlife resources in the Wilton Expansion Wind Resource Area (WEWRA) to estimate the impacts of wind-energy facility operations on wildlife.

The principal objectives of the study was to provide site specific bird resource and use data that would be useful in evaluating potential impacts from the proposed wind-energy facility. The methods for the baseline studies are similar to those used at other wind-energy facilities across the nation, and follow the guidance of the National Wind Coordinating Collaborative (Anderson et al. 1999). The protocols have been developed based on WEST's experience studying wildlife at proposed wind-energy facilities throughout the US; and were designed to help predict potential impacts to bird species (particularly raptors).

Baseline surveys, conducted September 17, 2008 through November 4, 2008 and again from March 18, 2009 through June 25, 2009 at the WEWRA, included fixed-point bird use surveys, ground based raptor nest surveys, and incidental wildlife observations. In addition to site-specific data, this report presents existing information and results of studies conducted at other wind-energy facilities. The ability to estimate potential bird mortality at the proposed WEWRA is greatly enhanced by operational monitoring data collected at existing wind-energy facilities. For several wind-energy facilities, standardized data on fixed-point surveys were collected in association with standardized post-construction (operational) monitoring, allowing comparisons of bird use with bird mortality. Where possible, comparisons with regional and local studies were made.

STUDY AREA

The WEWRA is located in Burleigh County, in central North Dakota and lies to the south and east of the city of Wilton (Figure 1). The WEWRA encompasses an existing 32 turbine, wind generating facility. The WEWRA has a flat to rolling topography, and consists mainly of cultivated agriculture and planted grasslands. Elevation within the WEWRA ranges from approximately 1,949 feet (ft; 594 meters [m]) to 2,254 ft (687 m) above mean sea level, with the higher elevations generally running in an east-west and northwest-southeast direction (Figure 2)..

Approximately 55% of the 47,739 acre (72.9 square mile [mi^2]; 188.8 square kilometers [km^2]) area is composed of cropland (Table 1). Small grains appear to be the most common crop. Other crops include corn, sunflowers, soy beans, and other edible beans. Grasslands, both planted and native, comprise another approximate 41% of the area. Wetlands/water cover another approximate 2% of the WEWRA and the remaining approximate 2% is comprised of other habitat types (Table 1). The various habitat types are dispersed throughout the WEWRA with grasslands being somewhat more dominate along the eastern and southeastern boundary (Figure 3).

METHODS

Surveys at the WEWRA consisted of the following components: 1) fixed-point bird use surveys; 2) ground 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, spatial, and temporal use of the WEWRA by birds, particularly raptors (defined 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).

Bird Use Survey Plots
Eighteen points were selected to include representative habitats and topography within the WEWRA, while achieving relatively even coverage of the study area (Figure 4). 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 20-minute (min) 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 beyond a 100-m radius were excluded.

The date, start, and end time of the survey period, and weather information such as temperature, wind speed, wind direction, precipitation, visibility, 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, flight direction when first observed, activity (behavior), and habitat(s) were recorded for each observation. A unique observation number was assigned to each observation. The behavior and 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 the plot center at first observation were recorded. 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. Any comments were recorded in the comments section of the data sheet. Locations and flight path, if appropriate, of raptors, other large birds, and species of concern seen during fixed-point bird use surveys were recorded on field maps by observation number. Any unusual animal observations were recorded on the incidental datasheets.

Observation Schedule
Sampling intensity was designed to document bird use and behavior by habitat and season within the WEWRA. Fixed-point bird use surveys were conducted from September 17 through November 4, 2008, and March 18 through June 25, 2009. Surveys were conducted approximately once a week during fall (September 17 to November 4), spring (March 18 to May 27), and summer (June 3 to June 25). Surveys were carried out during daylight hours and survey periods varied to approximately cover all daylight hours during a season.

Raptor Nest Surveys

The objective of the raptor nest surveys was to locate and record raptor nests that may be subject to disturbance and/or displacement effects by wind-energy facility construction and/or operation. Surveys were focused on large, stick nest structures, and did not include searches for cavity nests or nests on the ground. Surveys were completed by driving and walking along public roads and accessible private roads during leaf-off conditions and looking for raptor nest structures within areas of suitable habitat (trees, rock outcrops, etc). Potential raptor nests were recorded on aerial photo maps and digitized with GIS software. Other information recorded included nest status, nest height, and nest material.

Incidental Wildlife Observations

The objective of incidental wildlife observations was to provide a record of wildlife seen within the WEWRA outside of the standardized surveys. All raptors, unusual or unique birds, sensitive species, mammals, reptiles, and amphibians were recorded in a similar fashion to standardized surveys. The observation number, date, time, species, number of individuals, sex/age class, distance from observer, activity, height above ground (for bird species), habitat, and general 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, including in the field, during data entry and analysis, and report writing. Following field surveys, observers were responsible for inspecting data forms for completeness, accuracy, and legibility. A sample of records from an electronic database was compared to the raw data forms and any errors detected were corrected. Irregular codes or data suspected as questionable were discussed with the observer and/or project manager. Errors, omissions, or problems identified in later stages of analysis were traced back to the raw data forms, and appropriate changes in all steps were made.

Data Compilation and Storage

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

Fixed-Point Bird Use Surveys

<u>Bird Diversity and Species Richness</u>

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

Bird Use, Composition, and Frequency of Occurrence

When calculating standardized fixed-point bird use estimates, only observations of large birds detected within the 800-m radius plot were included, and small bird observations were limited to a 100-m radius. Estimates of mean bird use (i.e., number of birds/plot/20-min survey) were used to compare differences between bird types, seasons, and other wind-energy facilities.

Percent composition was calculated as the proportion of the overall mean use for a particular species or bird type. 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 flocks; however, the frequency of occurrence would indicate that it 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 a bird species, the flight height at which the bird was first recorded and used to estimate the percentage of birds flying within the likely zone of risk (ZOR) for collision with turbine blades. A height of 35 m to 130 m (114 – 427 ft) AGL was used for the ZOR.

Bird Exposure Index

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

$$R = A*P_f*P_t$$

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

The exposure index is one means to consider the relative use and flight height between different bird species within the WEWRA. It does not consider all factors related to exposure (e.g., avoidance behaviors, bird size, courtship, etc). Birds with high use rates and many birds in the ZOR would have the highest exposure index. The indices cannot be compared to other projects, but can be compared to different species of birds within this project.

RESULTS

Surveys were completed at the WEWRA from September 17, 2008 through June 25, 2009. Eighty-two bird species and five mammal species were recorded within the WEWRA. Results of the fixed-point bird use surveys are presented below, as well as incidental wildlife observations.

Fixed-Point Bird Use Surveys

Bird Diversity and Species Richness

A total of 414 twenty-minute fixed-point surveys were conducted at the WEWRA between September 17, 2008 and June 25, 2009 over the course of 23 visits (Table 2). Due to heavy snow fall and early spring snow storms, only 10 of the 18 survey points were accessible from 3/17/09 through 4/14/09. Sixteen of the 18 points were accessible on 4/22/09 and 17 of 18 on 04/28/09. All survey points were visited after that. Seventy-six unique species were recorded over the course of fixed-point bird use surveys, with an average of 1.21 large species/plot/20-min survey and 0.75 small species/100-m plot/20-min survey observed. More unique species were observed during the spring (62 species), followed by summer (45), and fall (25). The mean number of species per survey for large and small birds was higher in the summer (2.51 and 1.82 species/survey, respectively) and spring (1.39 and 0.93) compared to the fall (0.51 and 0.14). A total of 3,082 individual birds in 934 separate groups were recorded (Table 3). Cumulatively, regardless of bird size, three species (3.9% of all species) composed approximately 49% of the observations: sandhill crane (*Grus canadensis*), Canada goose (*Branta canadensis*), and red-winged blackbird (*Agelaius phoeniceus*). All other species comprised less than 10% of the observations. The most abundant large bird species were sandhill crane (999 individuals in 20 groups) and Canada goose (352 individuals in 14 groups). A total of 118 individual raptors were recorded within the WEWRA, representing eight species.

Bird Use, Composition, and Frequency of Occurrence by Season

Mean bird use, percent composition, and frequency of occurrence by season are presented in Tables 4a and 4b. The highest overall large bird use occurred in the spring (8.99 birds/plot/20-min survey), followed by summer (4.94), and fall (2.35). For small birds, use was highest in the summer (2.17 birds/plot/20-min survey), followed by the spring (1.79), and fall (0.67).

Waterbirds

Waterbirds had the highest use in spring (4.53 birds/plot/20-min survey), compared to other times of the year (fall 1.27, and summer 0.29; Table 4a). Higher use by waterbirds in spring was largely due to high use by sandhill crane (4.13). Waterbirds comprised more than half of overall bird use in fall and spring, but only 5.9% in summer.

Waterfowl

Waterfowl had the highest use in spring (3.33 birds/plot/20-min survey), compared to other times of the year (summer 2.49 and fall 0). High waterfowl use in spring was due to several large groups of Canada geese that made up 19.0% of the overall large bird use. Waterfowl comprised just over half (50.3%) of large bird use in summer and 37% in the spring. Waterfowl were observed more frequently in summer (27.8%) than in the spring (20.2%).

Shorebirds

Shorebirds had relatively consistent use through the three seasons (0.24 birds/plot/20-min survey in fall, 0.22 in summer, and 0.28 in winter). Shorebirds comprised less than six percent of large bird use for any single season. Shorebirds were observed during 22.2% of the surveys in the summer compared to 12.6% in spring and only 3.5% during fall.

Rails and Coots

American coot (*Fulica americana*) had a use of 0.18 birds/plot/20-min survey in summer, 0.01 in spring, and had no use of the WEWRA in the fall. Rails and coots comprised less than four percent of large bird use in any season. American coot was observed much more frequently in summer (8.3% of surveys) than in spring (one percent).

Raptors

Raptor use was highest in the summer (0.46 birds/plot/20-min survey), followed by spring (0.28), and fall (0.20). Higher use in the summer was primarily due to high use of the area by red-tailed hawks (*Buteo jamaicensis*; 0.26 birds/plot/20-min survey) and northern harrier (*Circus cyaneus*; 0.13). Red-tailed hawks had the highest use of any raptor species during all seasons (0.14 in spring and 0.11 in fall). Raptors comprised less than 10% of the overall bird use in during any season. Raptors were observed during 31.9% of surveys in the summer compared to 22.7% of the surveys in the spring and 18.1% in the fall.

Upland Gamebirds

Upland gamebirds had the highest use in the summer (0.72 birds/plot/20-min survey) and relatively constant use in fall and spring (0.33 and 0.32 birds/plot/20-min survey, respectively). High use in the summer was primarily due to increase use of the WEWRA by ring-necked pheasants (*Phasianus colchicus*; 0.69 birds/plot/20-min survey). Upland gamebirds comprised approximately 14% of large bird use during summer and fall, and only 3.6% in spring. Upland gamebirds were observed during 54.2% of surveys in the summer compared to 22.7% in spring and 14.6% in fall.

Large Corvids

American crow (*Corvus brachyrynchos*) had relatively low use during fixed-point surveys (0.14 birds/plot/20-min survey in fall, 0.21 in spring, and 0.10 in summer). Use by large corvids comprised less than six percent in any given season. Large corvids were seldom observed, with frequencies ranging from 6.9% to 9.1%.

Passerines

Passerine use was highest in summer (2.15 birds/plot/20-min survey), compared to spring (1.78), and fall (0.66). Red-winged blackbird had the highest use by any one species in fall (0.42 birds/plot/20-min survey) and had the same use as western meadowlark (*Sturnella neglecta)* use in summer (0.36). Horned lark (*Eremophila alpestris*) had the highest use in spring (0.42). Passerines were observed during 91.7% of the summer surveys compared to 56.6% in spring and only 12.5% of fall surveys.

Bird Flight Height and Behavior

Flight height characteristics were determined for both bird types and species (Tables 5 and 6). During fixed-point bird use surveys, 1,774 large birds in 237 groups were observed flying within the 800-m radius plot. Just under half (48.9%) were flying within the zone of risk (ZOR) for collision with turbine blades (35 to 135 m [114 – 427 ft] AGL). Approximately 18% were flying below the ZOR, and 33% were flying above the ZOR. A total of 76 raptors (64.4% of observations) were observed flying, of which 43.4% were within the ZOR. The majority of flying buteos and other raptors were observed within the ZOR, while most accipiters, northern harriers, falcons, and owls were observed below the ZOR. No raptors were observed flying above the ZOR. Only one vulture was observed flying, and it was recorded below the ZOR. Over 1,030 waterbirds recorded (97.0% of waterbird observations) were flying, of which 39.6% were within the ZOR. Only 13.1% of waterfowl were recorded in flight, but nearly 83% of flying waterfowl were within the ZOR. Large corvids had the second highest percentage of flying birds within the ZOR (53.5%). Shorebirds, rails and coots, doves and pigeons, and upland gamebirds, were typically observed flying below the ZOR. The majority of passerines were observed below the estimate ZOR (99%), while one percent was recorded within the ZOR. Of 296 individuals observed, 49.1% of passerines were observed flying with a mean flight height of 5.4 ft.

Of all large bird species, two had at least 30 groups observed flying, and only red-tailed hawk was observed flying within the likely ZOR during at least 50% of the observations (75.8%; Table 6a). Three species were always seen flying within the likely ZOR; however, these were only based on one observation. Of all passerine and small bird species, two had at least 20 groups observed flying; neither was observed within the ZOR during the majority of observations.

Bird Exposure Index

A relative exposure index was calculated for each bird species (Tables 6a and 6b). This index is only based on initial flight height observations and relative abundance (defined as the use estimate) and does not account for other possible collision risk factors such as foraging, courtship behavior, or avoidance behaviors. Sandhill crane had an exposure index higher than any other species with 0.93. Canada goose also had a relatively high exposure index (0.65). The only raptor species with a relatively high exposure index was red-tailed hawk (0.06); all other raptor species had an exposure index of 0.01 or less.

Based on observations within 100 m, the small bird species with the highest exposure index was western meadowlark, with an index of 0.01 (Table 6b). All other small bird species had exposure indices of zero.

Spatial Use

Use by large birds was highest at Point 15 (25.5 birds/20-min survey; Figure 5). Large bird use at other points ranged from 1.13 to 18.2 birds/20-min survey. The high mean use estimate for Point 15 was largely due to high waterfowl and waterbird use at this point (16.1 and 7.74 birds/20-min survey, respectively). Waterbird use was highest at Points 14 and 16 with 10.8 and 10.9 birds/20-min survey, respectively, and other points had waterbird use ranging from zero to 7.74 birds/20-min survey. Waterfowl use was highest at Points eight and 15, with 15.7 and 16.1 birds/20-min survey, respectively. Waterfowl use at other points was low, ranging from zero to 0.91 birds/20-min survey at other points. Mean shorebird use was fairly uniform between points, ranging from 0.83 birds/20-min survey at Point two to zero at Points five and nine. Rails and coots were only observed at Points eight and 15 with use of 0.35 and 0.30 birds/20-min survey, respectively. Raptor use was highest at Point two (0.74 birds/20-min survey), and ranged from 0.04 to 0.65 birds/20-min survey at other points. Vultures were only seen at Point 17 (0.04 birds/20-min survey). Upland gamebird use was highest at Points nine and 14 (0.83 and 0.91 birds/20-min survey, respectively), and ranged from 0.04 to 0.61 bird/20-min survey at other points. Large corvids had relatively low use that ranged from zero to 0.52 birds/20-min survey. Passerine use, focused within 100 m, was highest at Point nine (3.04 birds/ 20-min survey), and ranged from 0.74 to 2.65 at other points.

No obvious flyways or concentration areas were observed for any species. The available data do not indicate that any portions of the study area warrant being excluded from development due to very high bird use.

Sensitive Species Observations
A total of 15 sensitive species were recorded during fixed-point surveys (Table 7). Eight of these species are considered level one species (S1), or species of greatest conservation need, by the North Dakota Game and Fish Department (NDGFD) including 39 Franklin's gulls (*Larus pipixcan*), nine grasshopper sparrows (*Ammodramus savannarum*), six upland sandpipers (*Bartramia longicauda*), six Swainson's hawks (*Buteo swainsoni*), five marbled godwits (*Limosa fedoa*), two Wilson's phalaropes (*Phalaropus tricolor*), one black tern (*Chlidonias niger*), and one horned grebe (*Podiceps auritus*). Seven species considered level two (S2) species by the NDGFD, or species in need of conservation but supported by other wildlife programs, were observed: 59 canvasbacks (*Aythya valisinaria*), 33 northern harriers, 31 redheads (*Aythya americana*), 28 northern pintails (*Anas acuta*), 24 bobolink (*Dolichonyx oryzivorus*), 12 sharp-tailed grouse (*Tympanuchus phasianellus*), and one loggerhead shrike (*Lanius ludovicianus*).

Raptor Nest Surveys

Five active nests (three red-tailed hawk and two unidentified hawk) and 11 inactive raptor nests were located in or within 0.25 mile (400 m) of the WEWRA. One active and one inactive nest were within the 0.25-mile buffer of the project boundary. The remaining 12 nests fell within the project boundary (Figure 6).

Incidental Wildlife Observations

Twenty-one bird species were observed incidentally within the WEWRA, totaling 1,289 birds within 99 separate groups (Table 8). Five mammal species were also observed incidentally within the WEWRA.

Bird Observations
The most abundant bird species recorded as an incidental wildlife observation was sandhill crane (620 individuals). Six species, great-horned owl (*Bubo virginianus*), tundra swan (*Cygnus columbianus*), bald eagle (*Haliaeetus leucocephalus*), barn own (*Tyto alba*), ferruginous hawk (*Buteo regalis*), and rough-legged hawk (*Buteo lagopus*) were only seen incidentally at the WEWRA.

Mammal Observations
The most abundant mammal species recorded was white-tailed deer (*Odocoileus virginianus*) with 164 -individuals observed within 15 groups. Six coyote (*Canis latrans*), two white-tailed jack rabbits (*Lepus townsendii*), one fox squirrel (*Sciurus niger*), and one thirteen-lined ground squirrel (*Spermophilus tridecemlineatus*) were also observed incidentally within the WEWRA.

Sensitive Species Observations
A total of five sensitive species were recorded incidentally within the WEWRA (Table 7). One ferruginous hawk, a North Dakota level one species, was observed outside of standardized surveys. Four North Dakota level two species were observed incidentally, including 10 northern harrier, eight sharp-tailed grouse, two bald eagles, and one loggerhead shrike.

DISCUSSION

Bird Impacts

Direct Effects
The most probable direct impact to birds from wind-energy facilities is direct mortality or injury due to collisions with turbines or guy wires of meteorological (met) towers. Collisions may occur with resident birds foraging and flying within the WEWRA or with migrant birds seasonally moving through the study area. Project construction could affect birds through loss of habitat, or potential fatalities from construction equipment. Impacts from the decommissioning of the facility are anticipated to be similar to construction in terms of noise, disturbance, and equipment. Potential mortality from construction equipment is expected to be very low, 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 tree/shrub-nesting species during initial site clearing. One red-tailed hawk nest was provided a 0.25-mile “no construction” buffer during initial clearing activities until the nest became inactive.

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 (more than 70% from the Altamont Pass facility in California), about 39% were diurnal raptors, about 19% were passerines (excluding house sparrows [*Passer domesticus*] and European starlings [*Sturnus vulgaris*]), and about 12% were owls. Non-protected birds including house sparrows, European starlings, and rock doves (*Columba livia*) comprised about 15% of the fatalities. Other bird types generally made up less than 10% of the fatalities (Erickson et al. 2002b). During 12 fatality monitoring studies conducted outside of California, diurnal raptor fatalities comprised about 2% of the wind-energy facility-related fatalities and raptor mortality averaged 0.03/turbine/year. Passerines (excluding house sparrows and European starlings) were the most common collision victims, comprising about 82% of the 225 fatalities documented. For all bird species combined, estimates of the number of bird fatalities per turbine per year from individual studies ranged from zero at the Searsburg wind-energy facility in Vermont (Kerlinger 1997) and the Algona facility in Iowa (Demastes and Trainer 2000), to 7.7 at the Buffalo Mountain facility in Tennessee (Nicholson 2003). Using mortality data from a 10-year period from wind-energy facilities throughout the entire United States, the average number of bird collision fatalities is 3.1 per megawatt (MW) per year, or 2.3 per turbine per year (NWCC 2004). Based bird use rates along with species composition at the WEWRA, it is expected that direct fatalities would be low and similar to other rates in the Midwest.

Raptor Use and Exposure Risk

The annual mean raptor use at the WEWRA (0.28 raptors/plot/20-min survey) was compared with other wind-energy facilities that implemented similar protocols and had data for three or four seasons. Similar studies were conducted at 36 other wind-energy facilities. The annual mean raptor use at these wind-energy facilities ranged from 0.09 to 2.34 raptors/plot/20-min survey (Figure 7). Based on the results from these wind-energy facilities, a ranking of seasonal raptor mean use was developed as: low (0 – 0.5 raptors/plot/20-min survey); low to moderate (0.5 – 1.0); moderate (1.0 – 2.0); high (2.0 – 3.0); and very high (> 3.0). Under this ranking, mean raptor use (number of raptors divided by the number of 800-m plots and the total number of surveys) at the WEWRA is considered to be low. Compared to 36 other wind-energy facilities, the WEWRA ranked twenty-ninth (Figure 7).

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

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 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, avoidance), 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 observed during the surveys and within the WEWRA. Actual risk for some species may be lower or higher than indicated by these data. At the WEWRA, the raptor species with the highest exposure indices was red-tailed hawk which was influenced by the relatively high use estimates by this species. All other raptor species had exposure indices of 0.01 or less due primarily to the lower use estimates or low proportion of flight heights observed in the ZOR.

A regression analysis of raptor use and mortality for 13 new-generation wind-energy facilities, where similar methods were used to estimate raptor use and mortality, found that there was a significant correlation between use and mortality ($R^2 = 69.9\%$; Figure 8). Using this regression to predict raptor collision mortality at the WEWRA, based on an adjusted mean raptor use of 0.28

raptors/20-min survey, yields an estimated fatality rate of 0.01 fatalities/MW/year, or one raptor fatality per year for each 100-MW of wind-energy development. A 90% prediction interval around this estimate is zero to 0.25 fatalities/MW/year.

Based on the relative abundance of red-tailed hawks throughout the year and a higher exposure index than other raptor species, there is higher potential for red-tailed hawk fatalities compared to other species.

Non-Raptor Use and Exposure Risk

Most bird species in the US are protected by the Migratory Bird Treaty Act (MBTA 1918). Passerines (primarily perching birds) have been the most abundant bird fatality at wind-energy facilities outside California (Erickson et al. 2001a, 2002b), often comprising more than 80% of the bird fatalities. Both migrant and resident passerine fatalities have been observed. Given that passerines made up a large proportion of the birds observed during the baseline study, passerines would be expected to make up a large proportion of fatalities at the WEWRA. Exposure indices based on observations within 100 m indicate that western meadowlark is the most likely passerine to be exposed to collision from wind turbines at the WEWRA. Other passerine species are not at high risk based on abundance and flight behavior (Table 6b), but again, this analysis does not take into consideration other behavioral characteristics that could increase or decrease an individual's chance of being impacted. Most non-raptors had relatively low exposure indices due to the majority of individuals flying below the likely zone of risk. Due to the high number of common individuals (e.g., western meadowlarks) that are most likely at risk and the overall low exposure risks at WEWRA, it is unlikely that non-raptor populations will be adversely affected by direct mortality from the operation of the wind-energy facility.

Wind-energy facilities with year-round use by water dependent species have shown higher mortalities of individuals within these groups, but the levels of waterfowl/waterbird/shorebird mortality appear insignificant compared to the use of the facilities by these groups. Of 1,033 bird carcasses collected at US wind-energy facilities, waterbirds comprised about 2%, waterfowl comprised about 3%, and shorebirds comprised less than 1% (Erickson et al. 2002b). At the Klondike, Oregon wind-energy facility, only two Canada goose fatalities were documented (Johnson et al. 2003) even though 43 groups totaling 4,845 individual Canada geese were observed during pre-construction surveys (Johnson et al. 2002). The recently constructed Top of Iowa wind-energy facility is located in cropland between three Wildlife Management Areas (WMAs) with historically high bird use, including migrant and resident waterfowl. During a recent study, approximately one million goose-use days and 120,000 duck-use days were recorded in the WMAs during the fall and early winter, and no waterfowl fatalities were documented during concurrent and standardized wind-energy facility fatality studies (Jain 2005). Similar findings were observed at the Buffalo Ridge wind-energy facility in southwestern Minnesota, which is located in an area with relatively high waterfowl/waterbird use and some shorebird use. Snow geese (*Chen caerulescens*), Canada geese, and mallards (*Anas platyrhynchos*) were the most common waterfowl observed. Three of the 55 fatalities observed during the fatality monitoring studies were waterfowl, including two mallards and one blue-winged teal (*Anas discors*). Two American coots, one grebe, and one shorebird fatality were also found (Johnson et al. 2002). Based on available evidence, waterfowl do not seem especially vulnerable to turbine collisions, but given their overall numbers in the WEWRA some minimal level of mortality would be expected.

A study conducted in England to assess displacement of wintering farmland birds by wind turbines located in an agricultural landscape found that only ring-necked (common) pheasants (*Phasianus colchicus*) apparently avoided turbines to a small degree. 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). It is possible that the WEWRA may have some minimal displacement of pheasant and sharp-tailed grouse use near turbines. Sharp-tailed grouse leks were not surveyed for nor observed incidentally in the project area and it is unknown if the WEWRA would impact any leks.

<u>Sensitive Species Use and Exposure Risk</u>
No federal- or state-listed threatened, endangered, proposed, or candidate species, potentially occurring in Burleigh County, North Dakota, was observed at the WEWRA during fixed-point bird use surveys or incidentally (Table7). However, there were 17 state sensitive species recorded during biological work at the WEWRA (Table 7). Sensitive raptor and waterfowl species probably are at a greater risk than the other sensitive species observed due to their flight characteristics and relative abundance (see discussion above).

The NDGFD and the US Fish and Wildlife Service (USFWS) have expressed concern over potential impacts to whooping cranes (*Grus americana*) for wind-energy facilities constructed in their migratory corridors. Because whooping and sandhill cranes show similar habitat use and behavior during migration, the presence of sandhill cranes may indicate suitability of an area for whooping cranes. No whooping cranes were observed during the study but sandhill cranes were observed flying over the project area in the fall and flying over and feeding within the project boundary during spring. Since surveys were only conducted once a week, crane use of the area may be underestimated. Limited or no mortality of common cranes (G*rus grus*) has been documented at large wind-energy facilities located in western Europe, where common cranes are abundant (Hartwig Prange, pers. comm., 2003 North American Crane Working Group Meeting). Erickson et al. (2001a) did not identify any studies that documented cranes being killed or injured at wind-energy facilities in the US in their review of bird collisions with wind turbines. The low rate of crane collisions with turbines makes it unlikely that whooping or sandhill cranes will be directly impacted by the proposed WEWRA. However, as cranes ascend and descend during landing, or migrate during inclement weather and as thermal lift decreases, they may fly at lower altitudes, and may be at risk for collision with turbine blades.

Indirect Effects
The presence of wind turbines may alter the landscape so that wildlife use patterns are affected, displacing wildlife away from the wind-energy 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 US has been where these facilities have been constructed in grassland or other native habitats (Leddy et al. 1999; Mabey and Paul 2007); however, Crockford

(1992) suggests that disturbance appears to impact feeding, resting, and migrating birds, rather than breeding birds. Results from studies at the Stateline wind-energy facility in Washington and Oregon (Erickson et al. 2004) and the Buffalo Ridge wind-energy facility in Minnesota (Johnson et al. 2000a) suggest that breeding birds are also affected by wind-facility operations.

Raptor Displacement

In addition to possible direct effects on raptors within the study area (discussed above), indirect effects caused by disturbance-type impacts, such as construction activity near an active nest or primary foraging area, also have a potential impact on raptor species. Although there were only five active raptor nests within or next to (0.25 mi) the WEWRA, one nest (nest eight, Figure 6) was in the construction path for this project. A 0.25-mi buffer was established around this nest. However this nest attempt was unsuccessful due to the nest being destroyed by an undetermined cause.

Birds displaced from wind-energy facilities might move to areas with fewer disturbances, but lower quality, with an overall effect of reducing breeding success. Most studies on raptor displacement at wind-energy facilities, however, indicate effects to be negligible (Howell and Noone 1992; Johnson et al. 2000a, Johnson et al. 2003; Madders and Whitfield 2006). Notable exceptions to this include a study in Scotland that described territorial golden eagles avoiding the entire wind-energy facility area, except when intercepting non-territorial birds (Walker et al. 2005). A study at the Buffalo Ridge wind-energy facility in Minnesota found evidence of northern harriers avoiding turbines on both a small scale (less than 100 m from turbines) and a larger scale in the year following construction (Johnson et al. 2000a). Two years following construction, however, no large-scale displacement of northern harriers was detected.

The only published report of avoidance of wind turbines by nesting raptors in the US occurred at Buffalo Ridge, Minnesota, where raptor nest density on 101 mi^2 (262 km^2) of land surrounding a wind-energy facility was 5.94 nests/39 mi^2 (5.94 nests/101 km^2), yet no nests were present in the 12-mi^2 (31 km^2) facility itself, even though habitat was similar (Usgaard et al. 1997). However, this analysis assumes that raptor nests are uniformly distributed across the landscape, an unlikely event, and even though no nests were found, only two nests would be expected for an area 12 mi^2 in size if the nests were distributed uniformly. At a wind-energy facility in eastern Washington, based on extensive monitoring using helicopter flights and ground observations, raptors still nested in the study area at approximately the same levels after construction, and several nests were located within 0.5 miles (0.8 km) of turbines (Erickson et al. 2004). At the Foote Creek Rim wind-energy facility in southern Wyoming, one pair of red-tailed hawks nested within 0.3 mi (0.5 km) of the turbine strings, and seven red-tailed hawk nests, one great horned owl nest, and one golden eagle nest located within one mi (1.6 km) of the wind-energy facility successfully fledged young (Johnson et al. 2000b). The golden eagle pair successfully nested 0.5 mi from the facility for three different years after it became operational. A Swainson's hawk also nested within 0.25 mi of a turbine string at the Klondike I wind-energy facility in Oregon after the facility was operational (Johnson et al. 2003). A red-tailed hawk nest (nest three, Figure 6) located approximately 0.5 mi from a turbine string on the WEWRA was active through the last fixed-point survey date. These observations suggest that there will be limited nesting displacement of raptors at the WEWRA, although the creation of a buffer surrounding known nests when siting turbines will further reduce any impact.

Displacement of Non-Raptor Bird Species

Studies concerning displacement of non-raptor species have concentrated on grassland passerines and waterfowl/waterbirds (Winkelman 1990; Larsen and Madsen 2000; Mabey and Paul 2007). Wind-energy facility construction appears to cause small scale local displacement of grassland passerines and is likely due to the birds avoiding turbine noise and maintenance activities. Construction also reduces habitat effectiveness because of the presence of access roads and large gravel pads surrounding turbines (Leddy 1996; Johnson et al. 2000a). Leddy et al. (1999) surveyed bird densities in Conservation Reserve Program (CRP) grasslands at the Buffalo Ridge wind-energy facility in Minnesota, and found mean densities of 10 grassland bird species were four times higher at areas located 180 m (591 ft) from turbines than they were at grasslands nearer turbines. Johnson et al. (2000a) found reduced use of habitat by seven of 22 grassland-breeding birds following construction of the Buffalo Ridge wind energy facility in Minnesota. Results from the Stateline wind-energy facility in Oregon and Washington (Erickson et al. 2004), and the Combine Hills wind-energy facility in Oregon (Young et al. 2005), suggest a relatively small impact of the wind-energy facilities on grassland nesting passerines. Transect surveys conducted prior to and after construction of the wind-energy facilities found that grassland passerine use was significantly reduced within approximately 50 m (164 ft) of turbine strings, but areas further away from turbine strings did not have reduced bird use. Shaffer and Johnson (2007) documented avoidance by grasshopper sparrows out to 150 m (492 ft) at a wind-energy facility in northern South Dakota. While research concerning displacement impacts to songbirds, waterfowl, and waterbirds is limited, the projects that have been completed have only shown small scale (150-200 m [492-656 ft]), while impacts to birds at larger scales has not been shown. As the WEWRA contains areas of native and planted grasslands it is likely that there will be some amount of grassland nesting bird use. Turbines placed in tilled landscapes will have further minimal displacement to grassland nesting birds.

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 wind-energy facility in England, found no effect of wind turbines on populations of cormorant (*Phalacrcorax xarbo*), purple sandpipers (*Calidris maritima*), eiders (*Somateria mollissima*), or gulls, although the cormorants were temporarily displaced during construction (Lawrence et al. 2007). At the Buffalo Ridge wind-energy facility in Minnesota, the abundance of several bird types, including shorebirds and waterfowl, were found to be significantly lower at survey plots with turbines than at reference plots without turbines (Johnson et al. 2000a). The report concluded that the area of reduced use was limited primarily to those areas within 100 m of the turbines. Disturbance tends to be greatest for migrating birds while feeding and resting (Crockford 1992; NRC 2007). The majority of waterfowl/waterbirds use at the WEWRA included 20 groups of sandhill crane, 56 groups of mallards, and 14 groups of Canada geese, comprising a total of 1,498 individuals (77.3% of waterfowl/waterbird observations). The presence of similar habitat surrounding the WEWRA means that any displacement of these species is unlikely to impact the population.

Much debate has occurred recently regarding the potential impacts of wind-energy facilities on prairie grouse. Under a set of voluntary guidelines, the USFWS has taken a precautionary approach regarding potential impacts to lek locations (USFWS 2003). The USFWS argues that because prairie grouse evolved in habitats with little vertical structure, placement of tall man-made structures, such as wind turbines, in occupied prairie grouse habitat may result in a decrease in habitat suitability (USFWS 2004). The WEWRA lies within the range of the sharp-tailed grouse. There were 10 groups totaling 20 individuals observed during surveys and incidentally. While no sharp-tailed grouse leks were observed on the WEWRA, no formal lek survey was conducted. With the presences of individual sharp-tailed grouse and suitable leking habitat, there is the potential for sharp-tailed leks within the WEWRA.

CONCLUSIONS AND RECOMMENDATIONS

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

Currently, few published studies are available from the Midwest that compare bird use to bird mortality rates. Based on research conducted at wind-energy facilities throughout the US, raptor use at the WEWRA is generally lower than use levels recorded at other wind-energy facilites. Raptor fatality rates are expected to be within the range of fatality rates observed at other facilities where raptor use levels are lower. To date, no relationships have been observed between overall use by other bird types, and fatality rates of those bird 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 WEWRA.

The proposed wind-energy facility contains a diversity of habitats; approximately 55% of the WEWRA contains cropland habitats, while another approximate 41% of the area is grassland (Table 1, Figure 3). Some species considered to be sensitive or of conservation concern were observed within the WEWRA. These species have a greater potential to occur in non-cropland areas, such as grassland. Some potential exists for wind turbines to displace birds within non-cropland habitats. Research concerning displacement impacts to songbirds, waterfowl and waterbirds and wind-energy facilities is limited, but some studies show the potential for small scale (180 m [591 ft] or less) displacement, while impacts to densities of birds at larger scales has not been shown.

Two bird species of concern and/or interest with regard to wind energy development have the potential to occur within the WERA. Since the WEWRA lies within the whooping crane migration corridor and a similar species, sandhill crane, was documented to occur within the WEWRA, the potential exist for whooping cranes to use this area, but to what extent cannot be determined. Although no sharp-tailed grouse leks were observed during this study, suitable lekking habitat and individual sharp-tailed grouse were observed within the WEWRA. It is possible that there are sharp-tailed grouse leks in the project area.

One factor the data for this report does not take into affect is the extreme climatic condition found at the WEWRA throughout this study. Coming into and during the fall of 2008, central North Dakota was experiencing moderate to severe drought conditions. Most wetlands were dry and upland and agricultural habitats were drought stressed. Near record snowfall (100+ inches; 254 centimeters [cm]) during the winter created ample spring flooding and re-charged most wetlands and severe snow storms persisted into mid April. Rainfall was also above normal through mid summer. This drastic change in habitat conditions within the WEWRA may have influenced bird use during this study. However, without seasonal replication of this study, the influence of these weather events on bird use of the WEWRA cannot be quantified.

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

Habitat	Acres	% Composition
Cropland	25,795.6	55.2
Planted Grassland	10,594.9	22.7
Native Grassland	8,472.4	18.1
Wetland/Water	847.2	1.8
Shrubland	533.4	1.1
Woodland	362.4	0.8
Developed	69.9	0.2
Barren	63.3	0.1
Total	**46,739.1**	**100**

Data from the North Dakota GAP Analysis (NDGAP 2004).

Table 2. Summary of species richness (species/plot[a]/20-min survey), and sample size by season and overall during fixed-point bird use surveys at the Wilton Wind Resource Area, September 17, 2008 – June 25, 2009.

Season	Number of Visits	# Surveys Conducted	# Unique Species	Species Richness	
				Large Birds	Small Birds
Fall	8	144	25	0.51	0.14
Spring	11	198	62	1.39	0.93
Summer	4	72	45	2.51	1.82
Overall	**23**	**414**	**76**	**1.21**	**0.75**

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

Table 3. Total number of individuals and groups for each bird type and species, by season and overall, during fixed-point bird use surveys at the Wilton Expansion Wind Resource Area , September 17, 2008 - June 25, 2009.

		Fall		Spring		Summer		Total	
Species/Type	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Waterbirds		**4**	**183**	**33**	**896**	**14**	**21**	**51**	**1,100**
black tern	*Chlidonias niger*	0	0	0	0	1	1	1	1
double-crested cormorant	*Phalacrocorax auritus*	1	1	0	0	2	2	3	3
Franklin's gull	*Larus pipixcan*	0	0	4	39	0	0	4	39
horned grebe	*Podiceps auritus*	0	0	1	1	0	0	1	1
pied-billed grebe	*Podilymbus podiceps*	0	0	2	2	0	0	2	2
ring-billed gull	*Larus delawarensis*	0	0	9	37	10	16	19	53
sandhill crane	*Grus canadensis*	3	182	17	817	0	0	20	999
unidentified gull		0	0	0	0	1	2	1	2
Waterfowl		**0**	**0**	**102**	**659**	**63**	**179**	**165**	**838**
American wigeon	*Anas americana*	0	0	0	0	4	6	4	6
blue-winged teal	*Anas discors*	0	0	9	30	9	22	18	52
bufflehead	*Bucephala albeola*	0	0	1	1	0	0	1	1
Canada goose	*Branta canadensis*	0	0	9	338	5	14	14	352
canvasback	*Aythya valisineria*	0	0	3	27	7	32	10	59
gadwall	*Anas strepera*	0	0	5	15	4	4	9	19
greater white-fronted goose	*Anser albifrons*	0	0	1	55	0	0	1	55
green-winged teal	*Anas crecca*	0	0	2	6	0	0	2	6
lesser scaup	*Aythya affinis*	0	0	5	24	2	8	7	32
mallard	*Anas platyrhynchos*	0	0	36	79	20	68	56	147
northern pintail	*Anas acuta*	0	0	11	20	4	8	15	28
northern shoveler	*Anas clypeata*	0	0	10	30	6	12	16	42
redhead	*Aythya americana*	0	0	5	26	2	5	7	31
ring-necked duck	*Aythya collaris*	0	0	3	6	0	0	3	6
snow goose	*Chen caerulescens*	0	0	1	1	0	0	1	1
unidentified duck		0	0	1	1	0	0	1	1

Table 3. Total number of individuals and groups for each bird type and species, by season and overall, during fixed-point bird use surveys at the Wilton Expansion Wind Resource Area , September 17, 2008 - June 25, 2009.

		Fall		Spring		Summer		Total	
Species/Type	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Shorebirds		**5**	**35**	**28**	**43**	**17**	**20**	**50**	**98**
common snipe	*Gallinago gallinago*	0	0	0	0	3	4	3	4
greater yellowlegs	*Tringa melanoleuca*	0	0	1	3	2	3	3	6
killdeer	*Charadrius vociferus*	3	10	20	24	6	6	29	40
marbled godwit	*Limosa fedoa*	0	0	1	2	2	3	3	5
solitary sandpiper	*Tringa solitaria*	1	13	0	0	0	0	1	13
unidentified dowitcher		0	0	1	3	0	0	1	3
unidentified sandpiper		1	12	1	2	0	0	2	14
unidentified shorebird		0	0	1	5	0	0	1	5
upland sandpiper	*Bartramia longicauda*	0	0	2	2	4	4	6	6
Wilson's phalarope	*Phalaropus tricolor*	0	0	1	2	0	0	1	2
Rails/Coots		**0**	**0**	**2**	**2**	**6**	**13**	**8**	**15**
American coot	*Fulica americana*	0	0	2	2	6	13	8	15
Raptors		**26**	**29**	**52**	**56**	**31**	**33**	**109**	**118**
Accipiters		*2*	*2*	*3*	*3*	*0*	*0*	*5*	*5*
Cooper's hawk	*Accipiter cooperii*	2	2	1	1	0	0	3	3
northern goshawk	*Accipiter gentilis*	0	0	1	1	0	0	1	1
sharp-shinned hawk	*Accipter striatus*	0	0	1	1	0	0	1	1
Buteos		*13*	*16*	*26*	*30*	*21*	*23*	*60*	*69*
red-tailed hawk	*Buteo jamaicensis*	13	16	24	28	19	19	56	63
Swainson's hawk	*Buteo swainsoni*	0	0	2	2	2	4	4	6
Northern Harrier		*8*	*8*	*16*	*16*	*9*	*9*	*33*	*33*
northern harrier	*Circus cyaneus*	8	8	16	16	9	9	33	33
Falcons		*0*	*0*	*2*	*2*	*0*	*0*	*2*	*2*
American kestrel	*Falco sparverius*	0	0	2	2	0	0	2	2
Owls		*1*	*1*	*0*	*0*	*0*	*0*	*1*	*1*
unidentified owl		1	1	0	0	0	0	1	1

Table 3. Total number of individuals and groups for each bird type and species, by season and overall, during fixed-point bird use surveys at the Wilton Expansion Wind Resource Area , September 17, 2008 - June 25, 2009.

		Fall		Spring		Summer		Total	
Species/Type	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Other Raptors		*2*	*2*	*5*	*5*	*1*	*1*	*8*	*8*
unidentified hawk		2	2	5	5	1	1	8	8
Vultures		**0**	**0**	**1**	**1**	**0**	**0**	**1**	**1**
turkey vulture	*Cathartes aura*	0	0	1	1	0	0	1	1
Upland Gamebirds		**21**	**48**	**56**	**64**	**44**	**52**	**121**	**164**
gray partridge	*Perdix perdix*	1	9	0	0	0	0	1	9
ring-necked pheasant	*Phasianus colchicus*	17	32	52	60	43	50	112	142
sharp-tailed grouse	*Tympanuchus phasianellus*	3	7	3	3	1	2	7	12
wild turkey	*Meleagris gallopavo*	0	0	1	1	0	0	1	1
Doves/Pigeons		**7**	**23**	**12**	**18**	**23**	**31**	**42**	**72**
mourning dove	*Zenaida macroura*	4	4	10	15	23	31	37	50
rock pigeon	*Columba livia*	3	19	2	3	0	0	5	22
Large Corvids		**10**	**20**	**19**	**42**	**5**	**7**	**34**	**69**
American crow	*Corvus brachyrhynchos*	10	20	19	42	5	7	34	69
Passerines		**18**	**95**	**196**	**353**	**135**	**155**	**349**	**603**
American goldfinch	*Carduelis tristis*	0	0	2	4	1	1	3	5
American robin	*Turdus migratorius*	1	1	2	2	1	1	4	4
American tree sparrow	*Spizella arborea*	1	1	0	0	0	0	1	1
barn swallow	*Hirundo rustica*	0	0	6	7	8	10	14	17
bobolink	*Dolichonyx oryzivorus*	0	0	6	6	15	18	21	24
Brewer's blackbird	*Euphagus cyanocephalus*	0	0	0	0	2	3	2	3
brown-headed cowbird	*Molothrus ater*	0	0	8	16	7	9	15	25
chipping sparrow	*Spizella passerina*	0	0	1	7	0	0	1	7
clay-colored sparrow	*Spizella pallida*	0	0	7	21	17	18	24	39
cliff swallow	*Petrochelidon pyrrhonota*	0	0	1	2	0	0	1	2
common grackle	*Quiscalus quiscula*	2	5	8	11	3	3	13	19
dark-eyed junco	*Junco hyemalis*	1	1	0	0	0	0	1	1
eastern kingbird	*Tyrannus tyrannus*	0	0	1	1	8	10	9	11

Table 3. Total number of individuals and groups for each bird type and species, by season and overall, during fixed-point bird use surveys at the Wilton Expansion Wind Resource Area , September 17, 2008 - June 25, 2009.

		Fall		Spring		Summer		Total	
Species/Type	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
European starling	*Sturnus vulgaris*	0	0	1	3	0	0	1	3
grasshopper sparrow	*Ammodramus savannarum*	0	0	3	3	6	6	9	9
horned lark	*Eremophila alpestris*	0	0	39	84	4	4	43	88
lark sparrow	*Chondestes grammacus*	0	0	0	0	1	2	1	2
loggerhead shrike	*Lanius ludovicianus*	1	1	0	0	0	0	1	1
northern rough-winged swallow	*Stelgidopteryx serripennis*	0	0	1	1	1	1	2	2
red-winged blackbird	*Agelaius phoeniceus*	2	60	23	73	22	26	47	159
savannah sparrow	*Passerculus sandwichensis*	0	0	5	7	0	0	5	7
song sparrow	*Melospiza melodia*	2	16	1	1	2	2	5	19
tree swallow	*Tachycineta bicolor*	0	0	2	2	0	0	2	2
unidentified meadowlark		5	6	0	0	0	0	5	6
unidentified sparrow		1	2	9	11	0	0	10	13
vesper sparrow	*Pooecetes gramineus*	2	2	5	5	2	2	9	9
western kingbird	*Tyrannus verticalis*	0	0	2	4	10	13	12	17
western meadowlark	*Sturnella neglecta*	0	0	63	82	25	26	88	108
Other Birds		**2**	**2**	**1**	**1**	**1**	**1**	**4**	**4**
hairy woodpecker	*Picoides villosus*	1	1	0	0	0	0	1	1
northern flicker	*Colaptes auratus*	0	0	1	1	1	1	2	2
yellow-shafted flicker	*Colaptes auratus*	1	1	0	0	0	0	1	1
Overall		**93**	**435**	**502**	**2,135**	**339**	**512**	**934**	**3,082**

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 fixed-point bird use surveys at the Wilton Expansion Wind Resource Area, September 17, 2008 - June 25, 2009.

	Use			% Composition			% Frequency		
Species/Type	**Fall**	**Spring**	**Summer**	**Fall**	**Spring**	**Summer**	**Fall**	**Spring**	**Summer**
Waterbirds	**1.27**	**4.53**	**0.29**	**54.1**	**50.3**	**5.9**	**2.8**	**11.1**	**16.7**
black tern	0	0	0.01	0	0	0.3	0	0	1.4
double-crested cormorant	0.01	0	0.03	0.3	0	0.6	0.7	0	2.8
Franklin's gull	0	0.20	0	0	2.2	0	0	2.0	0
horned grebe	0	0.01	0	0	0.1	0	0	0.5	0
pied-billed grebe	0	0.01	0	0	0.1	0	0	1.0	0
ring-billed gull	0	0.19	0.22	0	2.1	4.5	0	4.0	12.5
sandhill crane	1.26	4.13	0	53.8	45.9	0	2.1	5.6	0
unidentified gull	0	0	0.03	0	0	0.6	0	0	1.4
Waterfowl	**0**	**3.33**	**2.49**	**0**	**37.0**	**50.3**	**0**	**20.2**	**27.8**
American wigeon	0	0	0.08	0	0	1.7	0	0	4.2
blue-winged teal	0	0.15	0.31	0	1.7	6.2	0	4.5	11.1
bufflehead	0	0.01	0	0	0.1	0	0	0.5	0
Canada goose	0	1.71	0.19	0	19.0	3.9	0	3.5	5.6
canvasback	0	0.14	0.44	0	1.5	9.0	0	1.5	9.7
gadwall	0	0.08	0.06	0	0.8	1.1	0	2.0	5.6
greater white-fronted goose	0	0.28	0	0	3.1	0	0	0.5	0
green-winged teal	0	0.03	0	0	0.3	0	0	1.0	0
lesser scaup	0	0.12	0.11	0	1.3	2.2	0	2.5	2.8
mallard	0	0.40	0.94	0	4.4	19.1	0	15.2	22.2
northern pintail	0	0.10	0.11	0	1.1	2.2	0	5.6	5.6
northern shoveler	0	0.15	0.17	0	1.7	3.4	0	5.1	6.9
redhead	0	0.13	0.07	0	1.5	1.4	0	2.5	2.8
ring-necked duck	0	0.03	0	0	0.3	0	0	1.5	0
snow goose	0	0.01	0	0	0.1	0	0	0.5	0
unidentified duck	0	0.01	0	0	0.1	0	0	0.5	0

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 fixed-point bird use surveys at the Wilton Expansion Wind Resource Area, September 17, 2008 - June 25, 2009.

	Use			% Composition			% Frequency		
Species/Type	**Fall**	**Spring**	**Summer**	**Fall**	**Spring**	**Summer**	**Fall**	**Spring**	**Summer**
Shorebirds	**0.24**	**0.22**	**0.28**	**10.4**	**2.4**	**5.6**	**3.5**	**12.6**	**22.2**
common snipe	0	0	0.06	0	0	1.1	0	0	4.2
greater yellowlegs	0	0.02	0.04	0	0.2	0.8	0	0.5	2.8
killdeer	0.07	0.12	0.08	3.0	1.3	1.7	2.1	10.1	8.3
marbled godwit	0	0.01	0.04	0	0.1	0.8	0	0.5	2.8
solitary sandpiper	0.09	0	0	3.8	0	0	0.7	0	0
unidentified dowitcher	0	0.02	0	0	0.2	0	0	0.5	0
unidentified sandpiper	0.08	0.01	0	3.6	0.1	0	0.7	0.5	0
unidentified shorebird	0	0.03	0	0	0.3	0	0	0.5	0
upland sandpiper	0	0.01	0.06	0	0.1	1.1	0	1.0	5.6
Wilson's phalarope	0	0.01	0	0	0.1	0	0	0.5	0
Rails/Coots	**0**	**0.01**	**0.18**	**0**	**0.1**	**3.7**	**0**	**1.0**	**8.3**
American coot	0	0.01	0.18	0	0.1	3.7	0	1.0	8.3
Raptors	**0.20**	**0.28**	**0.46**	**8.6**	**3.1**	**9.3**	**18.1**	**22.7**	**31.9**
Accipiters	*0.01*	*0.02*	*0*	*0.6*	*0.2*	*0*	*1.4*	*1.5*	*0*
Cooper's hawk	0.01	0.01	0	0.6	0.1	0	1.4	0.5	0
northern goshawk	0	0.01	0	0	0.1	0	0	0.5	0
sharp-shinned hawk	0	0.01	0	0	0.1	0	0	0.5	0
Buteos	*0.11*	*0.15*	*0.32*	*4.7*	*1.7*	*6.5*	*9.0*	*12.6*	*23.6*
red-tailed hawk	0.11	0.14	0.26	4.7	1.6	5.3	9.0	11.6	20.8
Swainson's hawk	0	0.01	0.06	0	0.1	1.1	0	1.0	2.8
Northern Harrier	*0.06*	*0.08*	*0.13*	*2.4*	*0.9*	*2.5*	*5.6*	*7.1*	*11.1*
northern harrier	0.06	0.08	0.13	2.4	0.9	2.5	5.6	7.1	11.1
Falcons	*0*	*0.01*	*0*	*0*	*0.1*	*0*	*0*	*1.0*	*0.0*
American kestrel	0	0.01	0	0	0.1	0	0	1.0	0
Owls	*0.01*	*0*	*0*	*0.3*	*0*	*0*	*0.7*	*0*	*0*
unidentified owl	0.01	0	0	0.3	0	0	0.7	0	0

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 fixed-point bird use surveys at the Wilton Expansion Wind Resource Area, September 17, 2008 - June 25, 2009.

	Use			% Composition			% Frequency		
Species/Type	**Fall**	**Spring**	**Summer**	**Fall**	**Spring**	**Summer**	**Fall**	**Spring**	**Summer**
Other Raptors	*0.01*	*0.03*	*0.01*	*0.6*	*0.3*	*0.3*	*1.4*	*2.5*	*1.4*
unidentified hawk	0.01	0.03	0.01	0.6	0.3	0.3	1.4	2.5	1.4
Vultures	**0**	**0.01**	**0**	**0**	**0.1**	**0**	**0**	**0.5**	**0**
turkey vulture	0	0.01	0	0	0.1	0	0	0.5	0
Upland Gamebirds	**0.33**	**0.32**	**0.72**	**14.2**	**3.6**	**14.6**	**14.6**	**22.7**	**54.2**
gray partridge	0.06	0	0	2.7	0	0	0.7	0	0
ring-necked pheasant	0.22	0.30	0.69	9.5	3.4	14.0	11.8	21.2	52.8
sharp-tailed grouse	0.05	0.02	0.03	2.1	0.2	0.6	2.1	1.5	1.4
wild turkey	0	0.01	0	0	0.1	0	0	0.5	0
Doves/Pigeons	**0.16**	**0.09**	**0.43**	**6.8**	**1.0**	**8.7**	**4.9**	**6.1**	**27.8**
mourning dove	0.03	0.08	0.43	1.2	0.8	8.7	2.8	5.1	27.8
rock pigeon	0.13	0.02	0	5.6	0.2	0	2.1	1.0	0
Large Corvids	**0.14**	**0.21**	**0.10**	**5.9**	**2.4**	**2.0**	**6.9**	**9.1**	**6.9**
American crow	0.14	0.21	0.10	5.9	2.4	2.0	6.9	9.1	6.9
Overall	**2.35**	**8.99**	**4.94**	**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 fixed-point bird use surveys at the Wilton Expansion Wind Resource Area, September 17, 2008 - June 25, 2009.

	Use			% Composition			% Frequency		
Species/Type	**Fall**	**Spring**	**Summer**	**Fall**	**Spring**	**Summer**	**Fall**	**Spring**	**Summer**
Passerines	**0.66**	**1.78**	**2.15**	**97.9**	**99.7**	**99.4**	**12.5**	**56.6**	**91.7**
American goldfinch	0	0.02	0.01	0	1.1	0.6	0	1.0	1.4
American robin	0.01	0.01	0.01	1.0	0.6	0.6	0.7	1.0	1.4
American tree sparrow	0.01	0	0	1.0	0	0	0.7	0	0
barn swallow	0	0.04	0.14	0	2.0	6.4	0	3.0	11.1
bobolink	0	0.03	0.25	0	1.7	11.5	0	3.0	19.4
Brewer's blackbird	0	0	0.04	0	0	1.9	0	0	2.8
brown-headed cowbird	0	0.08	0.13	0	4.5	5.8	0	4.0	9.7
chipping sparrow	0	0.04	0	0	2.0	0	0	0.5	0
clay-colored sparrow	0	0.11	0.25	0	5.9	11.5	0	3.5	23.6
cliff swallow	0	0.01	0	0	0.6	0	0	0.5	0
common grackle	0.03	0.06	0.04	5.2	3.1	1.9	1.4	4.0	4.2
dark-eyed junco	0.01	0	0	1.0	0	0	0.7	0	0
eastern kingbird	0	0.01	0.14	0	0.3	6.4	0	0.5	11.1
European starling	0	0.02	0	0	0.8	0	0	0.5	0
grasshopper sparrow	0	0.02	0.08	0	0.8	3.8	0	1.5	8.3
horned lark	0	0.42	0.06	0	23.7	2.6	0	17.2	5.6
lark sparrow	0	0	0.03	0	0	1.3	0	0	1.4
loggerhead shrike	0.01	0	0	1.0	0	0	0.7	0	0
northern rough-winged swallow	0	0.01	0.01	0	0.3	0.6	0	0.5	1.4
red-winged blackbird	0.42	0.37	0.36	61.9	20.6	16.7	1.4	10.1	26.4
savannah sparrow	0	0.04	0	0	2.0	0	0	2.5	0
song sparrow	0.11	0.01	0.03	16.5	0.3	1.3	1.4	0.5	2.8
tree swallow	0	0.01	0	0	0.6	0	0	1.0	0
unidentified meadowlark	0.04	0	0	6.2	0	0	3.5	0	0
unidentified sparrow	0.01	0.06	0	2.1	3.1	0	0.7	4.5	0

Table 4b. Mean use (number of birds/100-m plot/20-min survey), percent of total composition (%), and frequency of occurrence (%) for each small bird type and species by season during fixed-point bird use surveys at the Wilton Expansion Wind Resource Area, September 17, 2008 - June 25, 2009.

	Use			% Composition			% Frequency		
Species/Type	**Fall**	**Spring**	**Summer**	**Fall**	**Spring**	**Summer**	**Fall**	**Spring**	**Summer**
vesper sparrow	0.01	0.03	0.03	2.1	1.4	1.3	1.4	2.5	2.8
western kingbird	0	0.02	0.18	0	1.1	8.3	0	1.0	13.9
western meadowlark	0	0.41	0.36	0	23.2	16.7	0	29.8	33.3
Other Birds	**0.01**	**0.01**	**0.01**	**2.1**	**0.3**	**0.6**	**1.4**	**0.5**	**1.4**
hairy woodpecker	0.01	0	0	1.0	0	0	0.7	0	0
northern flicker	0	0.01	0.01	0	0.3	0.6	0	0.5	1.4
yellow-shafted flicker	0.01	0	0	1.0	0	0	0.7	0	0
Overall	**0.67**	**1.79**	**2.17**	**100**	**100**	**100**			

Table 5. Flight height characteristics by bird type during fixed-point bird use surveys at the Wilton Expansion Wind Resource Area, September 17, 2008 - June 25, 2009. Large bird observations were limited to within 800-m and small birds were limited to within 100-m.

Bird Type	# Groups Flying	# Obs Flying	Mean Flight Height (m)	% Obs Flying	% within Flight Height Categories 0-35 m	35-130 m	>130 m
Large Birds							
Waterbirds	39	1,067	89.67	97.0	7.6	39.6	52.9
Waterfowl	51	450	30.35	53.7	13.1	82.9	4.0
Shorebirds	12	50	4.83	51.0	100	0	0
Rails/Coots	0	0	0	0	0	0	0
Raptors	73	76	34.93	64.4	56.6	43.4	0
Accipiters	*3*	*3*	*33.33*	*60.0*	*66.7*	*33.3*	*0*
Buteos	*32*	*35*	*57.03*	*50.7*	*25.7*	*74.3*	*0*
Northern Harrier	*30*	*30*	*11.80*	*90.9*	*93.3*	*6.7*	*0*
Falcons	*1*	*1*	*3.00*	*50.0*	*100*	*0*	*0*
Owls	*1*	*1*	*3.00*	*100*	*100*	*0*	*0*
Other Raptors	*6*	*6*	*44.17*	*75.0*	*33.3*	*66.7*	*0*
Vultures	1	1	30.00	100	100	0	0
Upland Gamebirds	16	36	6.00	22.0	94.4	5.6	0
Doves/Pigeons	26	51	12.62	70.8	70.6	29.4	0
Large Corvids	19	43	27.05	62.3	46.5	53.5	0
Overall	**237**	**1,774**	**36.38**	**71.7**	**18.3**	**48.9**	**32.8**
Small Birds							
Passerines	133	296	5.41	49.1	99.0	1.0	0
Other Birds	1	1	18.00	25.0	100	0	0
Overall	**134**	**297**	**5.50**	**48.9**	**99.0**	**1.0**	**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 6a. Relative exposure index and flight characteristics of large bird species during fixed-point bird use surveys at the Wilton Expansion Wind Resource Area, September 17, 2008 - June 25, 2009.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within ZOR based on initial obs	Exposure Index	% Within ZOR at anytime
sandhill crane	15	2.26	97.5	42.1	0.93	41.4
Canada goose	7	0.75	92.6	93.3	0.65	93.3
greater white-fronted goose	1	0.12	100	100	0.12	100
red-tailed hawk	30	0.15	52.4	75.8	0.06	54.5
American crow	19	0.16	62.3	53.5	0.05	39.5
rock pigeon	5	0.06	100	68.2	0.04	0
ring-billed gull	18	0.12	98.1	21.2	0.02	21.2
mallard	25	0.32	29.3	18.6	0.02	20.9
unidentified hawk	6	0.02	75.0	66.7	0.01	66.7
northern pintail	7	0.06	28.6	37.5	0.01	62.5
sharp-tailed grouse	4	0.03	66.7	25.0	0.01	0
northern harrier	30	0.08	90.9	6.7	<0.01	0
northern shoveler	5	0.09	21.4	22.2	<0.01	22.2
Cooper's hawk	3	0.01	100	33.3	<0.01	33.3
double-crested cormorant	1	0.01	33.3	100	<0.01	0
Swainson's hawk	2	0.01	33.3	50.0	<0.01	100
snow goose	1	<0.01	100	100	<0.01	100
ring-necked pheasant	11	0.33	13.4	0	0	0
canvasback	0	0.13	0	0	0	0
mourning dove	21	0.11	58.0	0	0	0
blue-winged teal	5	0.11	15.4	0	0	12.5
killdeer	7	0.09	40.0	0	0	0
Franklin's gull	4	0.08	100	0	0	0
lesser scaup	0	0.07	0	0	0	0
redhead	0	0.07	0	0	0	0
gadwall	0	0.04	0	0	0	0
unidentified sandpiper	1	0.04	85.7	0	0	0

Table 6a. Relative exposure index and flight characteristics of large bird species during fixed-point bird use surveys at the Wilton Expansion Wind Resource Area, September 17, 2008 - June 25, 2009.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within ZOR based on initial obs	Exposure Index	% Within ZOR at anytime
solitary sandpiper	1	0.04	100	0	0	0
American coot	0	0.03	0	0	0	0
gray partridge	1	0.03	100	0	0	0
American wigeon	0	0.01	0	0	0	0
upland sandpiper	0	0.01	0	0	0	0
greater yellowlegs	0	0.01	0	0	0	0
green-winged teal	0	0.01	0	0	0	0
ring-necked duck	0	0.01	0	0	0	0
marbled godwit	1	0.01	20.0	0	0	0
unidentified shorebird	1	0.01	100	0	0	0
common snipe	0	0.01	0	0	0	0
unidentified dowitcher	1	0.01	100	0	0	0
unidentified gull	0	<0.01	0	0	0	0
American kestrel	1	<0.01	50.0	0	0	0
pied-billed grebe	0	<0.01	0	0	0	0
Wilson's phalarope	0	<0.01	0	0	0	0
unidentified owl	1	<0.01	100	0	0	0
black tern	1	<0.01	100	0	0	0
bufflehead	0	<0.01	0	0	0	0
horned grebe	0	<0.01	0	0	0	0
northern goshawk	0	<0.01	0	0	0	0
sharp-shinned hawk	0	<0.01	0	0	0	0
turkey vulture	1	<0.01	100	0	0	0
unidentified duck	0	<0.01	0	0	0	0
wild turkey	0	<0.01	0	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 6b. Relative exposure index and flight characteristics for small birds during fixed-point bird use surveys at the Wilton Expansion Wind Resource Area, September 17, 2008 - June 25, 2009.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within ZOR based on initial obs	Exposure Index	% Within ZOR at anytime
western meadowlark	21	0.23	28.7	9.7	0.01	9.7
red-winged blackbird	24	0.39	66.0	0	0	0
horned lark	16	0.19	33.0	0	0	0
clay-colored sparrow	1	0.09	35.9	0	0	0
brown-headed cowbird	4	0.05	40.0	0	0	0
bobolink	12	0.05	58.3	0	0	0
song sparrow	1	0.05	78.9	0	0	0
common grackle	9	0.04	78.9	0	0	0
western kingbird	11	0.04	82.4	0	0	0
barn swallow	13	0.04	94.1	0	0	0
unidentified sparrow	8	0.03	76.9	0	0	0
eastern kingbird	2	0.02	18.2	0	0	0
vesper sparrow	0	0.02	0	0	0	0
grasshopper sparrow	0	0.02	0	0	0	0
unidentified meadowlark	1	0.02	16.7	0	0	0
chipping sparrow	1	0.01	100	0	0	0
savannah sparrow	0	0.01	0	0	0	0
American goldfinch	3	0.01	100	0	0	0
American robin	1	0.01	25.0	0	0	0
Brewer's blackbird	1	0.01	66.7	0	0	0
European starling	0	0.01	0	0	0	0
lark sparrow	0	<0.01	0	0	0	0
northern flicker	1	<0.01	50.0	0	0	0
northern rough-winged swallow	1	<0.01	50.0	0	0	0
cliff swallow	1	<0.01	100	0	0	0
tree swallow	2	<0.01	100	0	0	0
American tree sparrow	0	<0.01	0	0	0	0

Table 6b. Relative exposure index and flight characteristics for small birds during fixed-point bird use surveys at the Wilton Expansion Wind Resource Area, September 17, 2008 - June 25, 2009.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within ZOR based on initial obs	Exposure Index	% Within ZOR at anytime
dark-eyed junco	0	<0.01	0	0	0	0
hairy woodpecker	0	<0.01	0	0	0	0
loggerhead shrike	0	<0.01	0	0	0	0
yellow-shafted flicker	0	<0.01	0	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 Wilton Expansion Wind Resource Area during fixed-point bird use surveys (FP) and as incidental wildlife observations (Inc.), September 17, 2008 – June 25, 2009.

			FP		Inc.		Total	
Species	**Scientific Name**	**Status**	**# of grps**	**# of obs**	**# of grps**	**# of obs**	**# of grps**	**# of obs**
canvasback	*Aythya valisineria*	S2	10	59	0	0	10	59
northern harrier	*Circus cyaneus*	S2	33	33	10	10	43	43
Franklin's gull	*Larus pipixcan*	S1	4	39	0	0	4	39
redhead	*Aythya americana*	S2	7	31	0	0	7	31
northern pintail	*Anas acuta*	S2	15	28	0	0	15	28
bobolink	*Dolichonyx oryzivorus*	S2	21	24	0	0	21	24
sharp-tailed grouse	*Tympanuchus phasianellus*	S2	7	12	3	8	10	20
grasshopper sparrow	*Ammodramus savannarum*	S1	9	9	0	0	9	9
upland sandpiper	*Bartramia longicauda*	S1	6	6	0	0	6	6
Swainson's hawk	*Buteo swainsoni*	S1	4	6	0	0	4	6
marbled godwit	*Limosa fedoa*	S1	3	5	0	0	3	5
loggerhead shrike	*Lanius ludovicianus*	S2	1	1	1	1	2	2
bald eagle	*Haliaeetus leucocephalus*	S2	0	0	1	2	1	2
Wilson's phalarope	*Phalaropus tricolor*	S1	1	2	0	0	1	2
black tern	*Chlidonias niger*	S1	1	1	0	0	1	1
ferruginous hawk	*Buteo regalis*	S1	0	0	1	1	1	1
horned grebe	*Podiceps auritus*	S1	1	1	0	0	1	1
Total	**17 Species**		**123**	**257**	**16**	**22**	**139**	**279**

S1= level one species, or species of greatest conservation need, S2= level two species, or species in need of conservation but supported by other wildlife programs. (Data from ND Outdoors 2004).

Table 8. Incidental wildlife observed while conducting surveys at the Wilton Expansion Wind Resource Area, September 17, 2008 - June 25, 2009.

Species	Scientific Name	# grps	# obs
sandhill crane	*Grus canadensis*	6	620
mallard	*Anas platyrhynchos*	3	404
Canada goose	*Branta canadensis*	6	116
American crow	*Corvus brachyrhynchos*	17	59
unidentified hawk		19	19
red-tailed hawk	*Buteo jamaicensis*	15	17
ring-billed gull	*Larus delawarensis*	3	12
northern harrier	*Circus cyaneus*	10	10
sharp-tailed grouse	*Tympanuchus phasianellus*	3	8
turkey vulture	*Cathartes aura*	2	6
great horned owl	*Bubo virginianus*	3	3
tundra swan	*Cygnus columbianus*	1	3
American kestrel	*Falco sparverius*	2	2
unidentified gull		2	2
bald eagle	*Haliaeetus leucocephalus*	1	2
barn owl	*Tyto alba*	1	1
ferruginous hawk	*Buteo regalis*	1	1
loggerhead shrike	*Lanius ludovicianus*	1	1
rough-legged hawk	*Buteo lagopus*	1	1
unidentified owl		1	1
wild turkey	*Meleagris gallopavo*	1	1
Bird Subtotal	**21 Species**	**99**	**1,289**
white-tailed deer	*Odocoileus virginianus*	15	164
coyote	*Canis latrans*	5	6
white-tailed jack rabbit	*Lepus townsendii*	2	2
fox squirrel	*Sciurus niger*	1	1
thirteen-lined ground squirrel	*Spermophilus tridecemlineatus*	1	1
Mammal Subtotal	**5 Species**	**24**	**174**

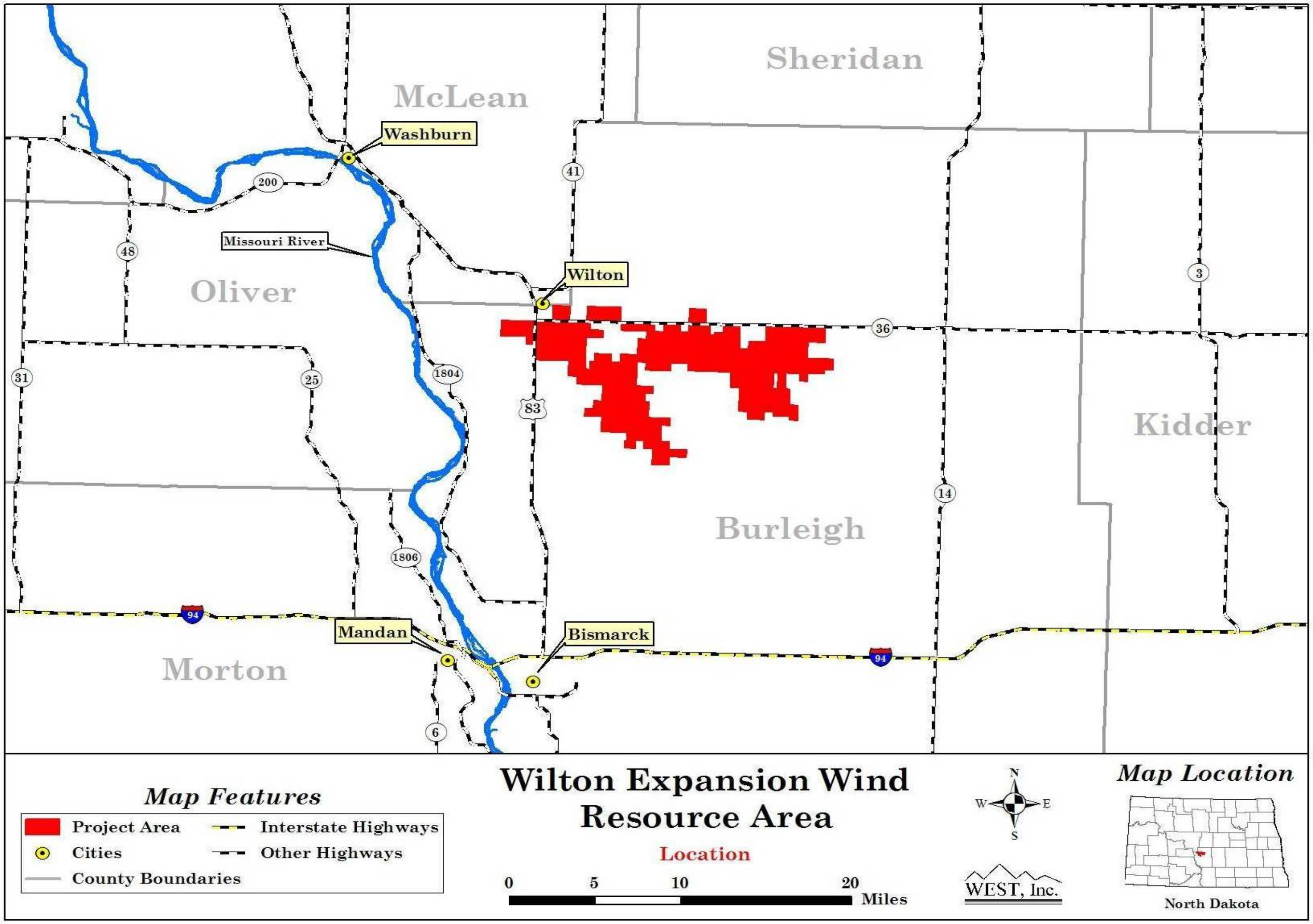


Figure 1. Location of the Wilton Expansion Wind Resource Area.

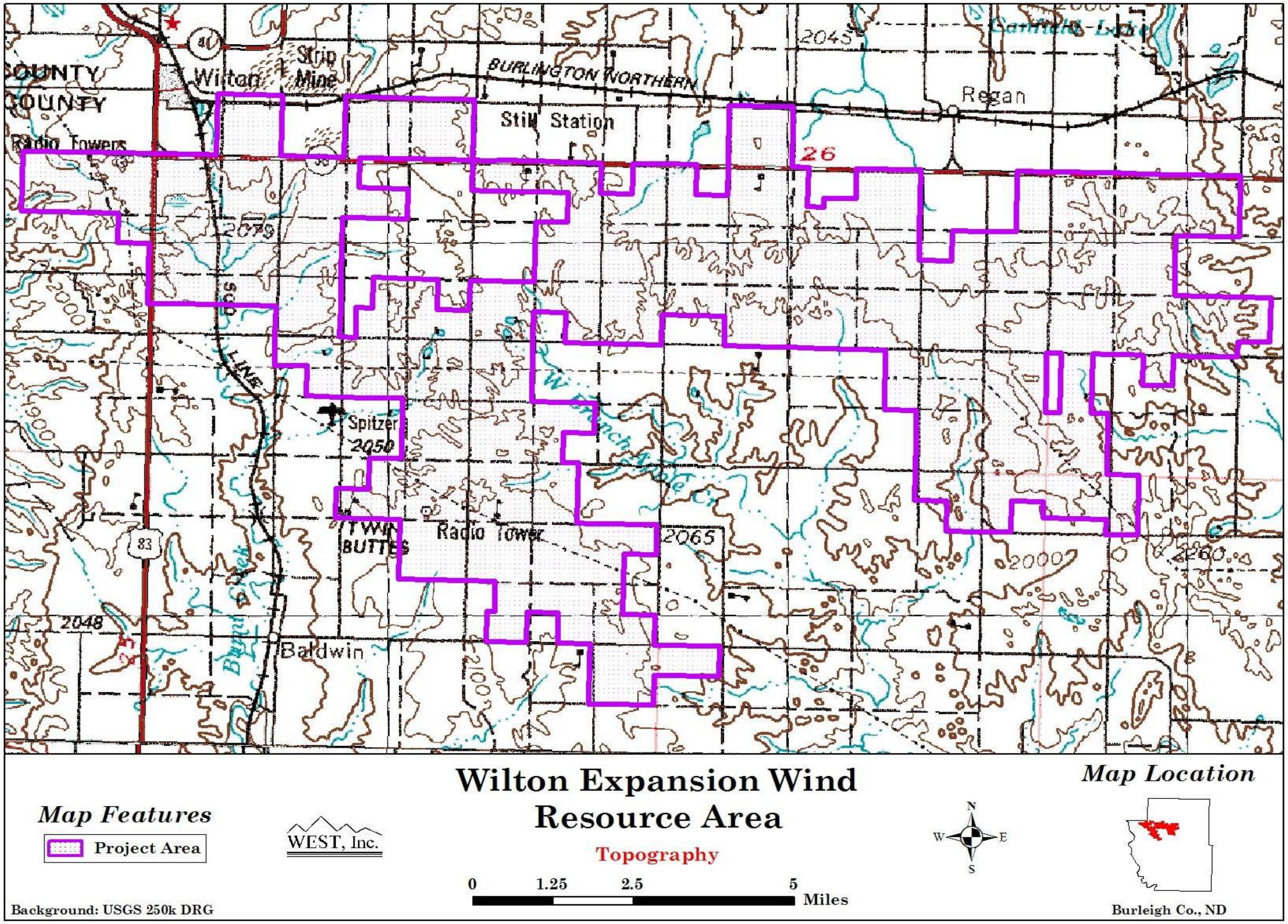


Figure 2. Overview of the Wilton Expansion Wind Resource Area.

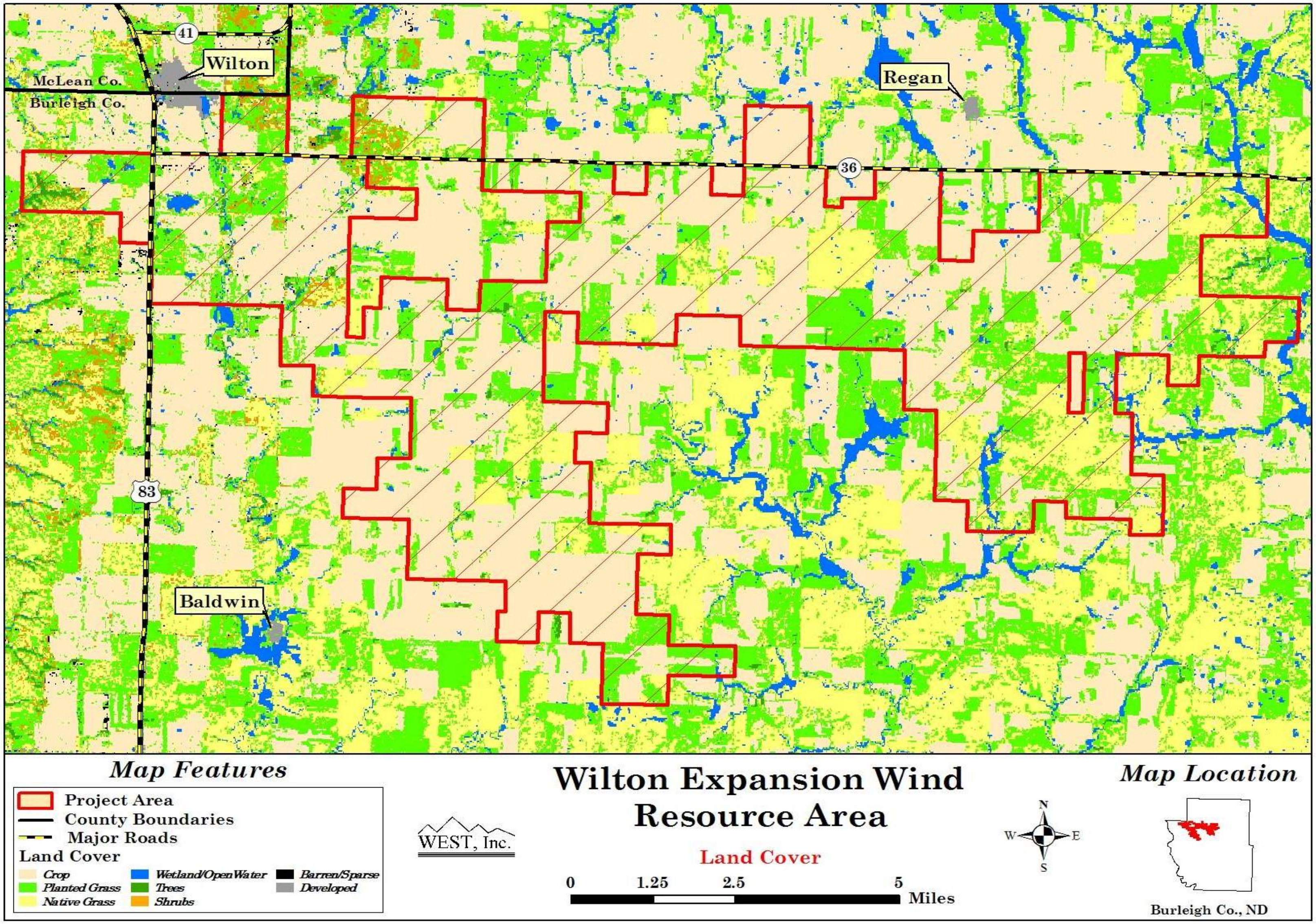


Figure 3. The land cover types and coverage within the Wilton Expansion Wind Resource Area (NDGAP 2004).

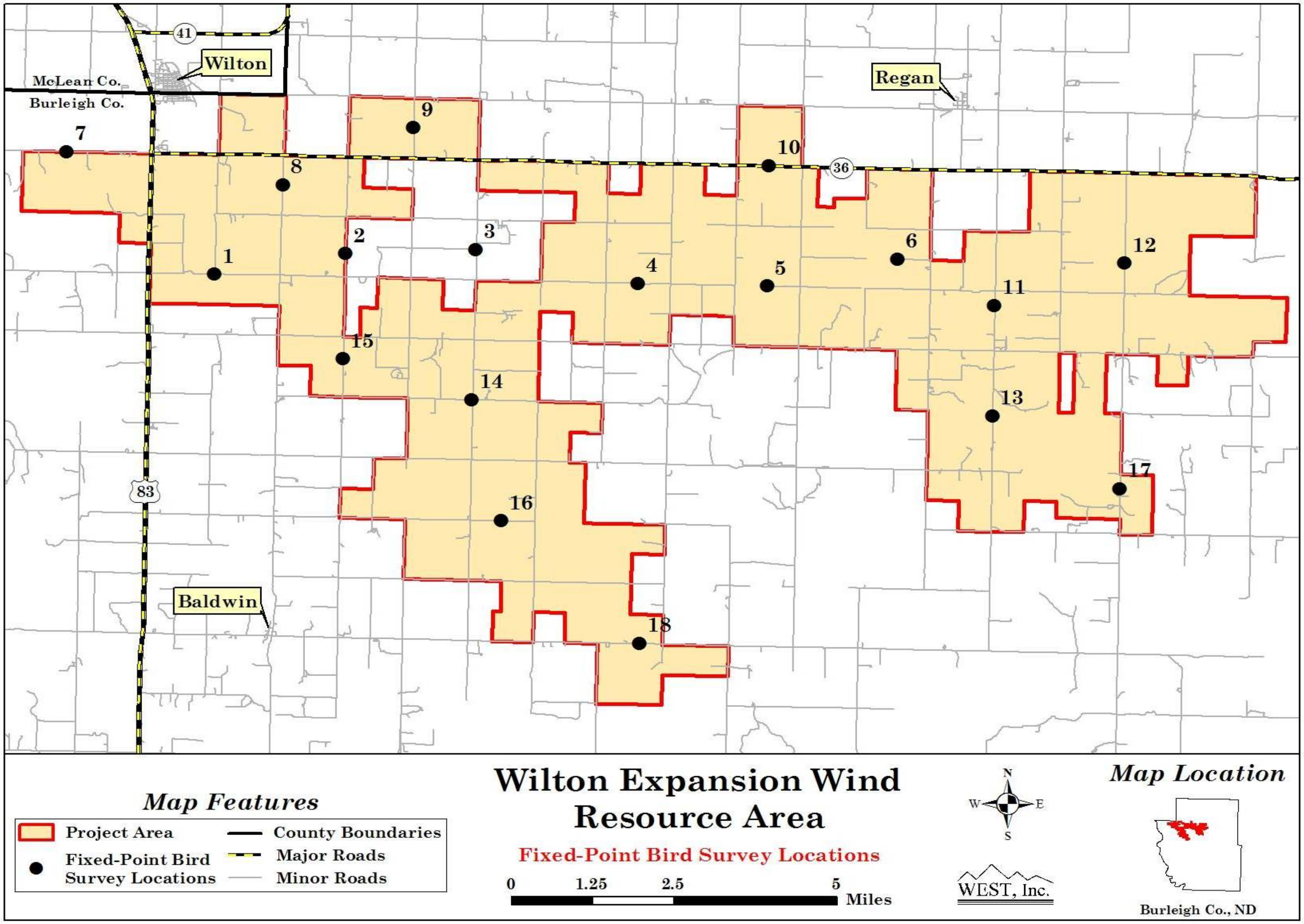


Figure 4. Fixed-point bird use survey points at the Wilton Expansion Wind Resource Area.

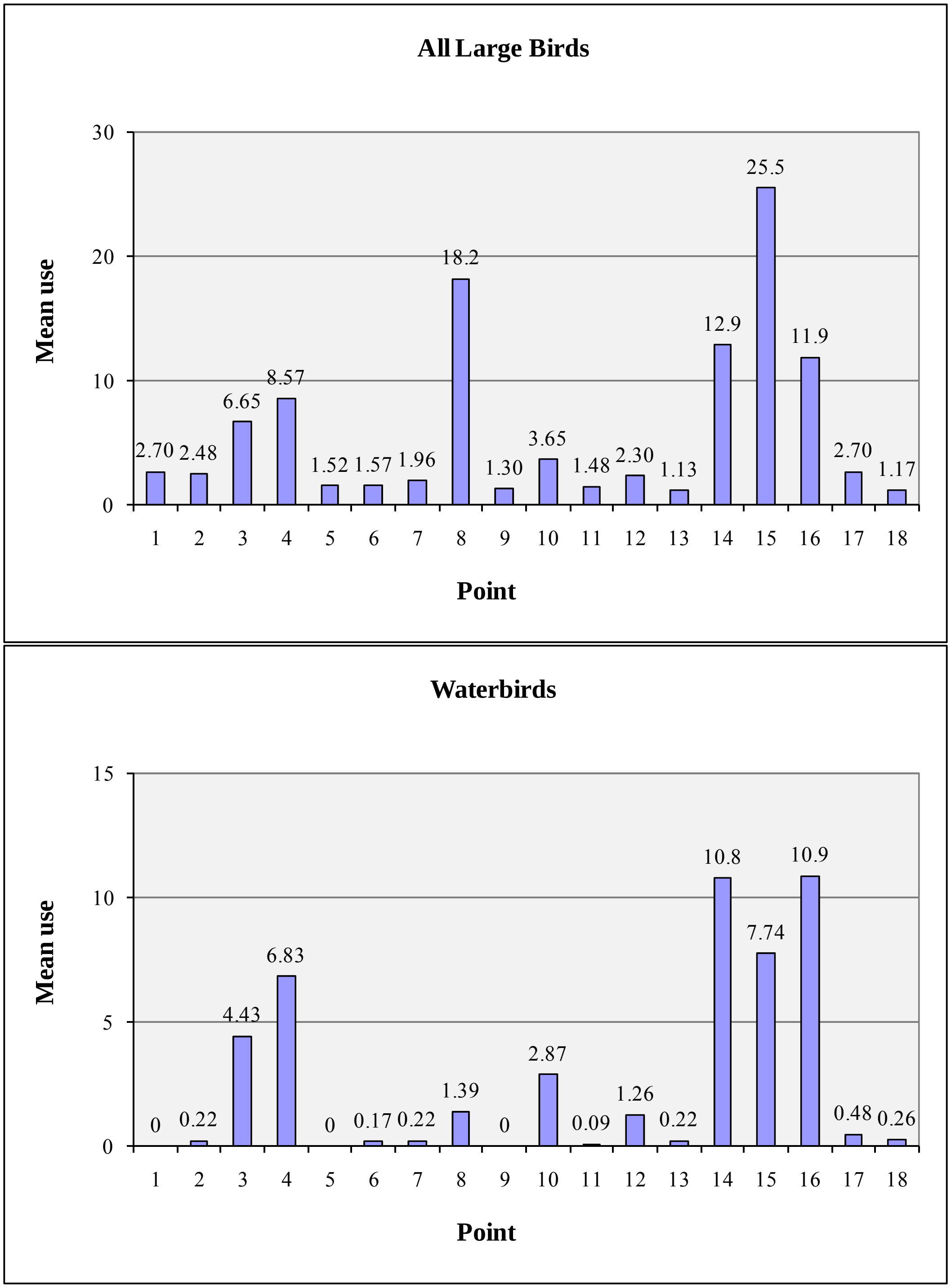
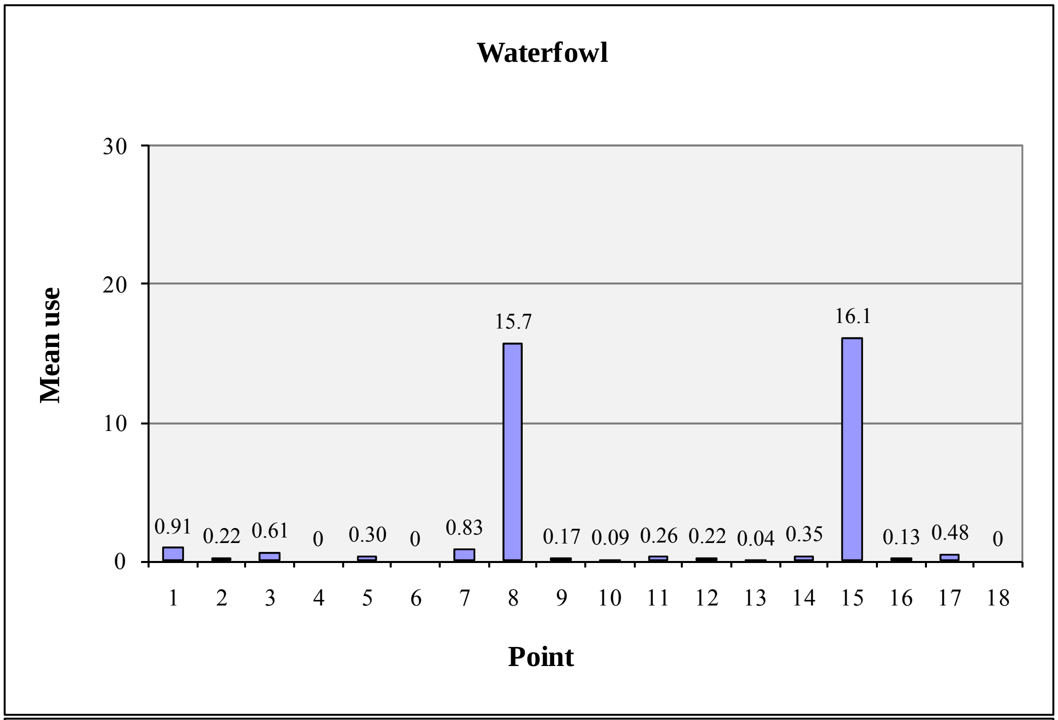


Figure 5. Mean use (number of birds/20-min survey) at each fixed-point bird use survey point for all birds, major bird types, and raptor sub-types at the Wilton Expansion Wind Resource Area.



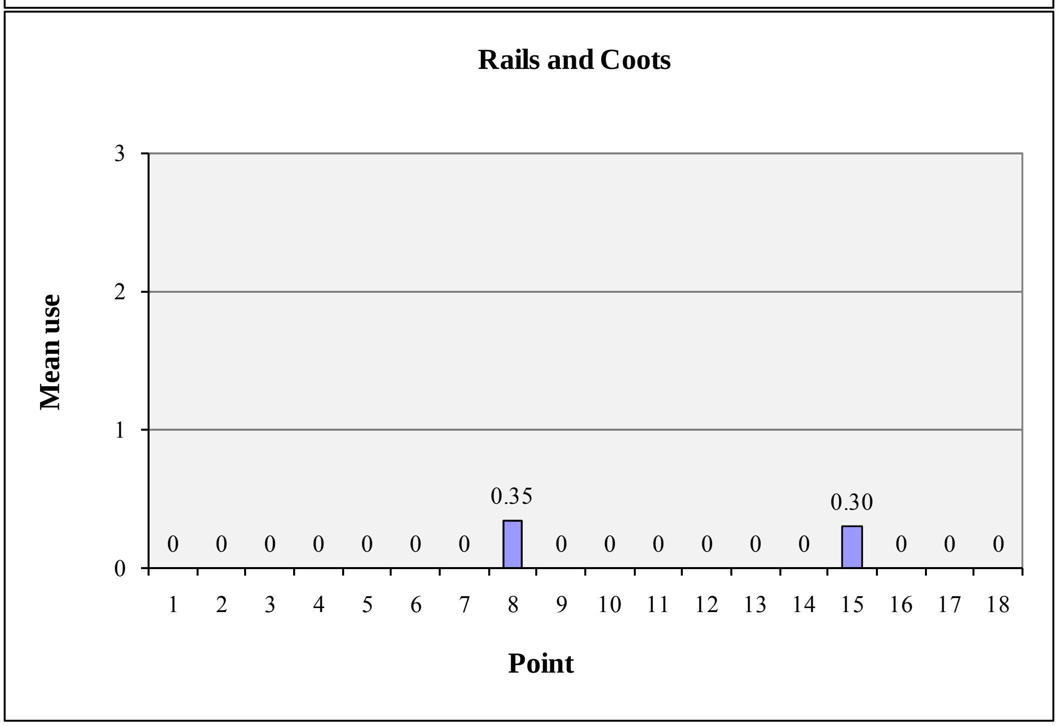
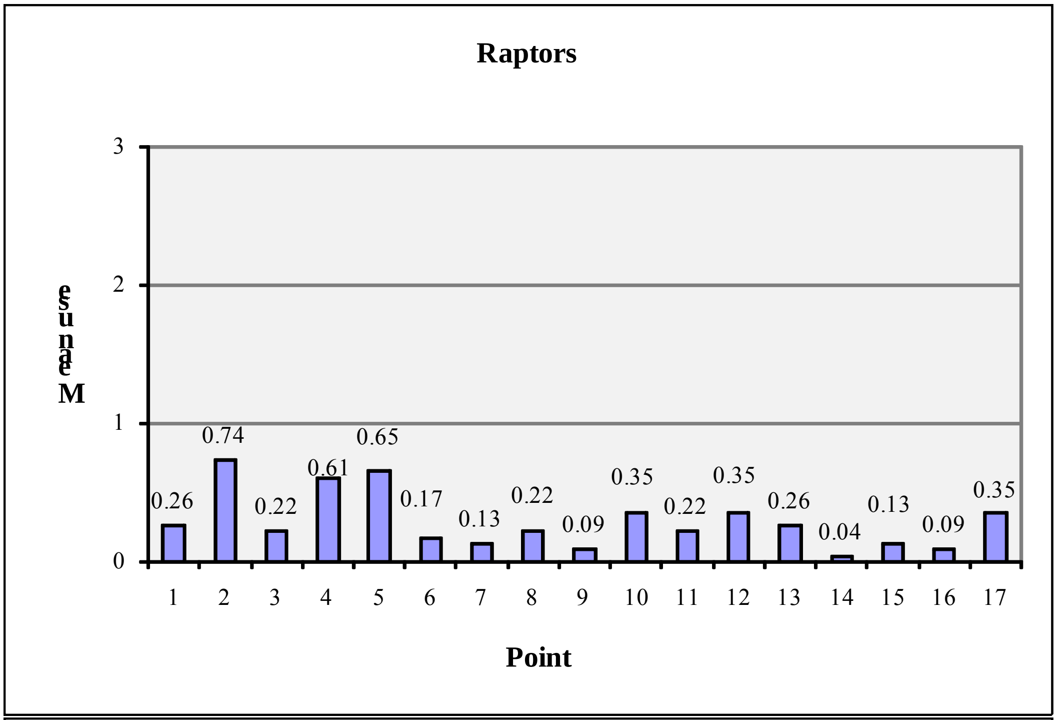


Figure 5 (*continued*). Mean use (number of birds/20-min survey) at each fixed-point bird use survey point for all birds, major bird types, and raptor sub-types at the Wilton Expansion Wind Resource Area.



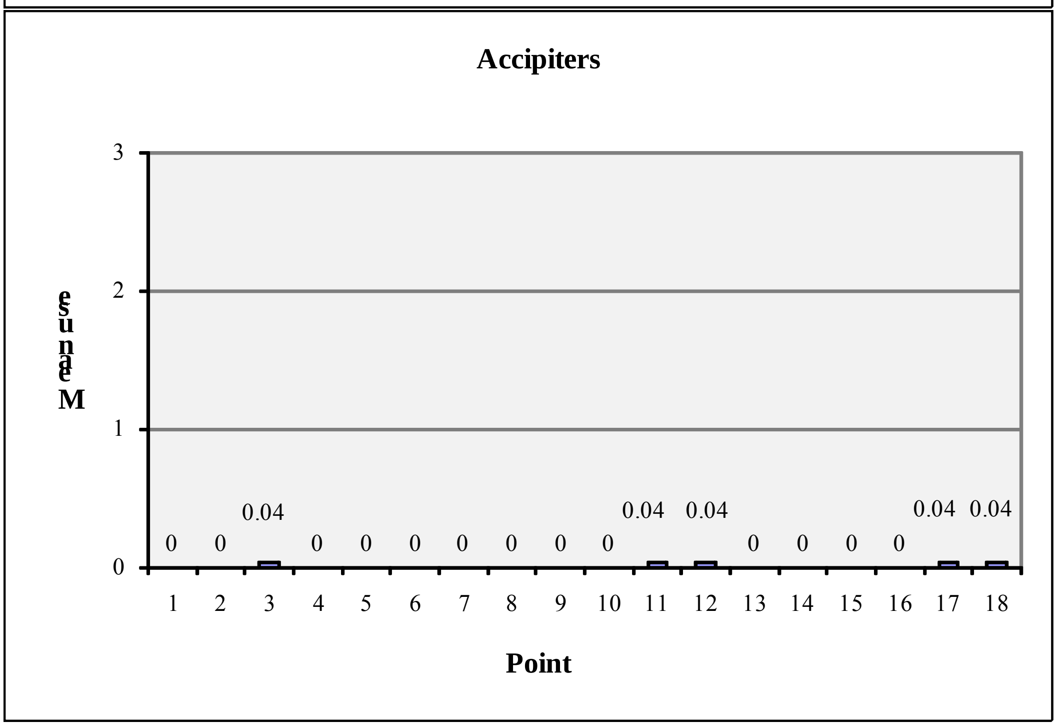
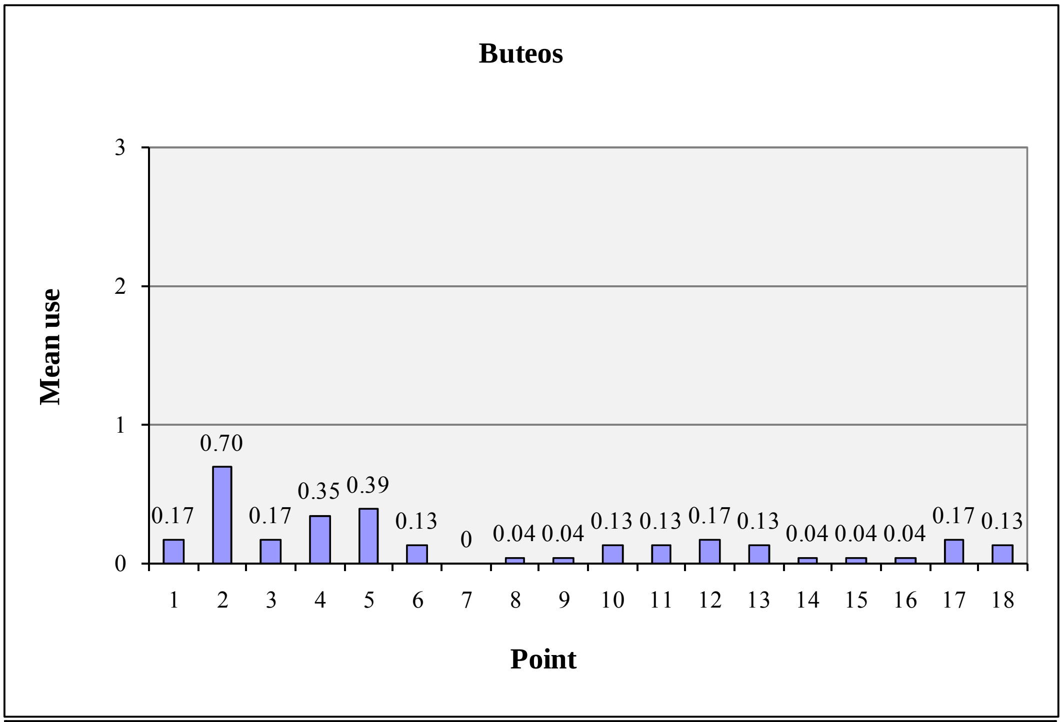


Figure 5 (*continued)*. Mean use (number of birds/20-min survey) at each fixed-point bird use survey point for all birds, major bird types, and raptor sub-types at the Wilton Expansion Wind Resource Area.



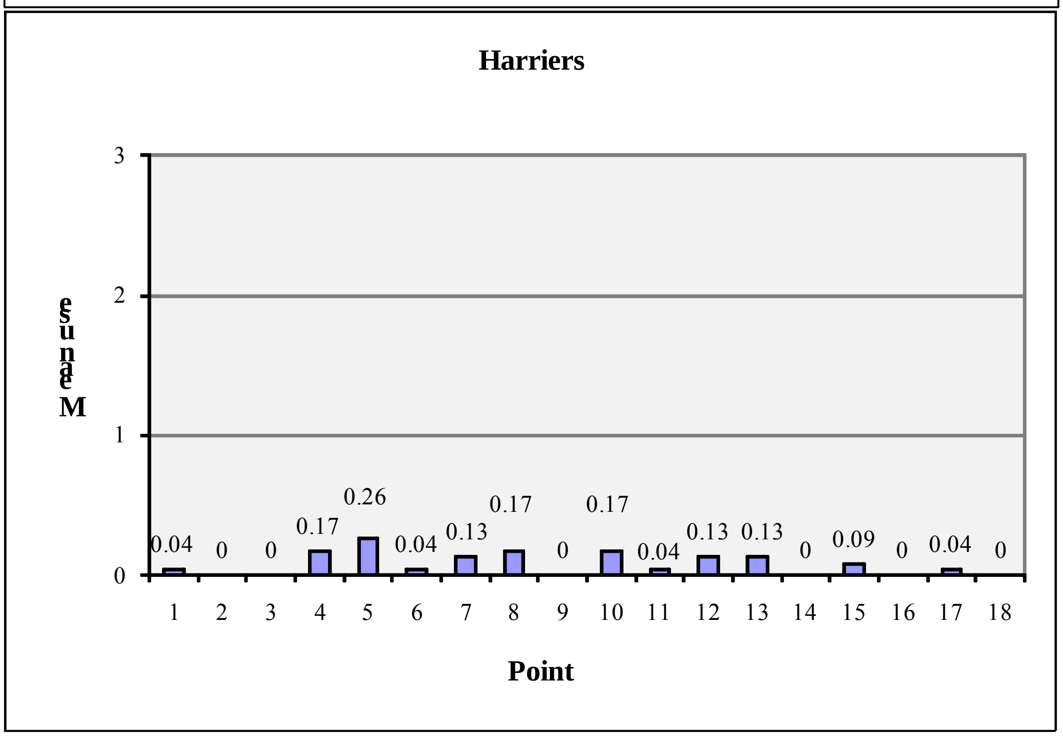
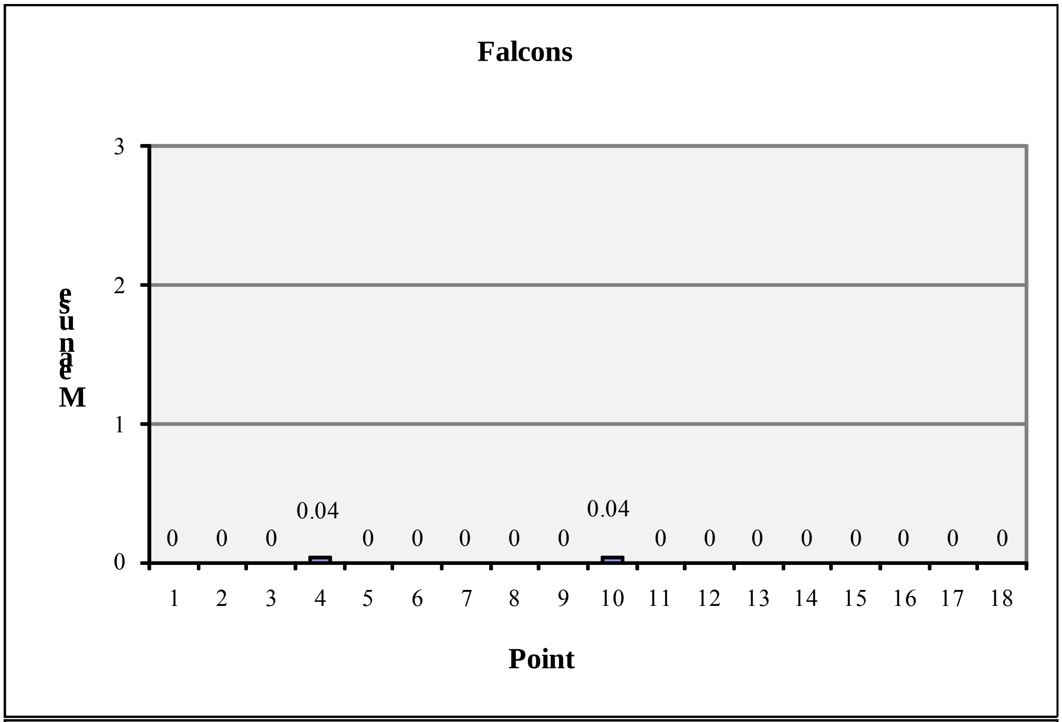


Figure 5 (*continued*). Mean use (number of birds/20-min survey) at each fixed-point bird use survey point for all birds, major bird types, and raptor sub-types at the Wilton Expansion Wind Resource Area.



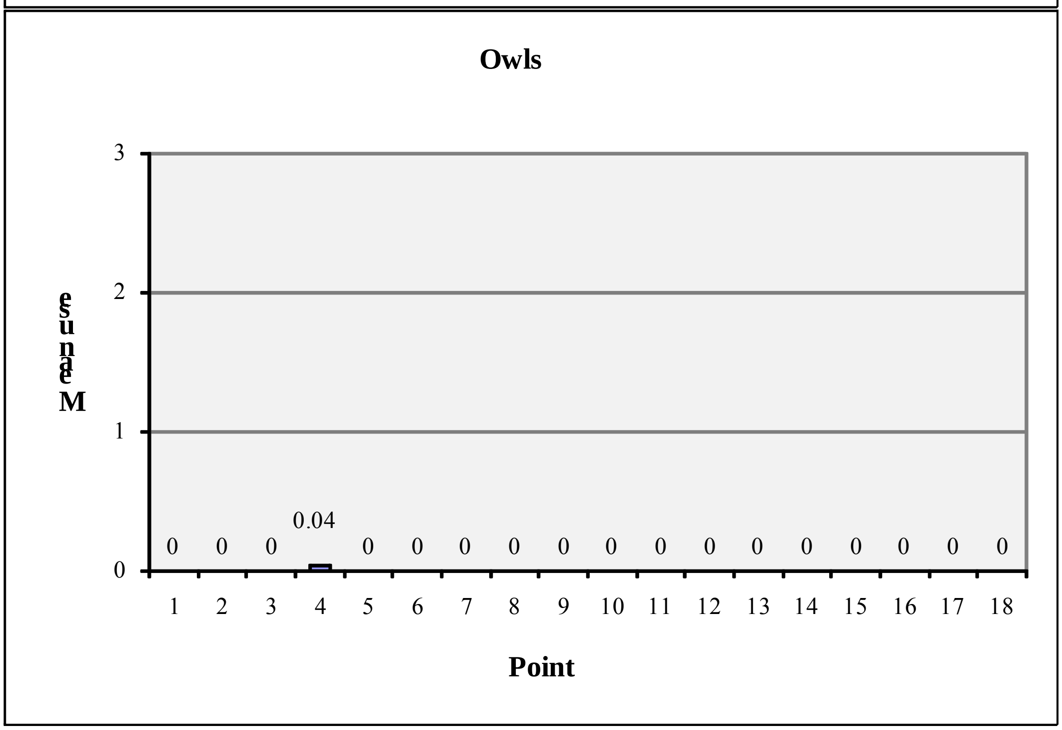
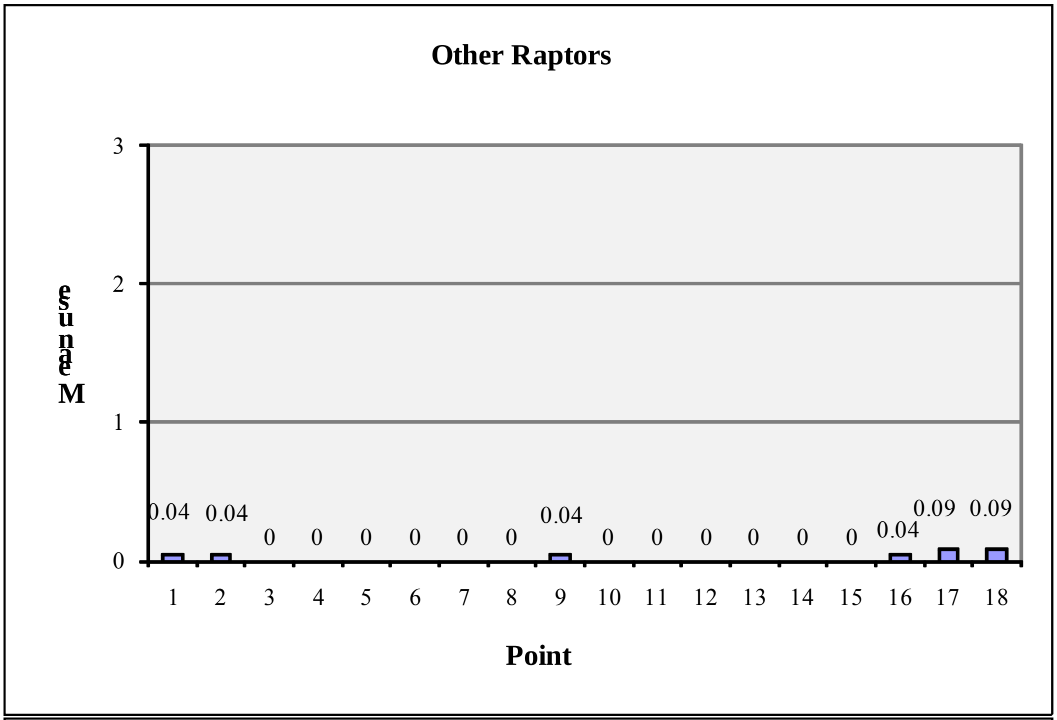


Figure 5 (*continued*). Mean use (number of birds/20-min survey) at each fixed-point bird use survey point for all birds, major bird types, and raptor sub-types at the Wilton Expansion Wind Resource Area.



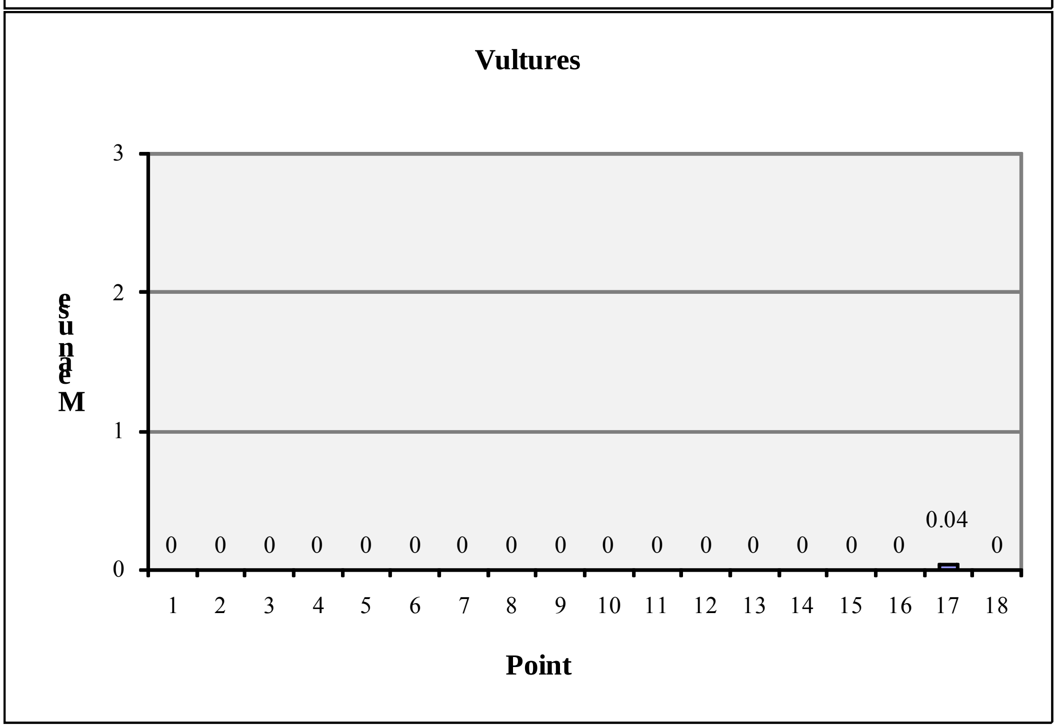
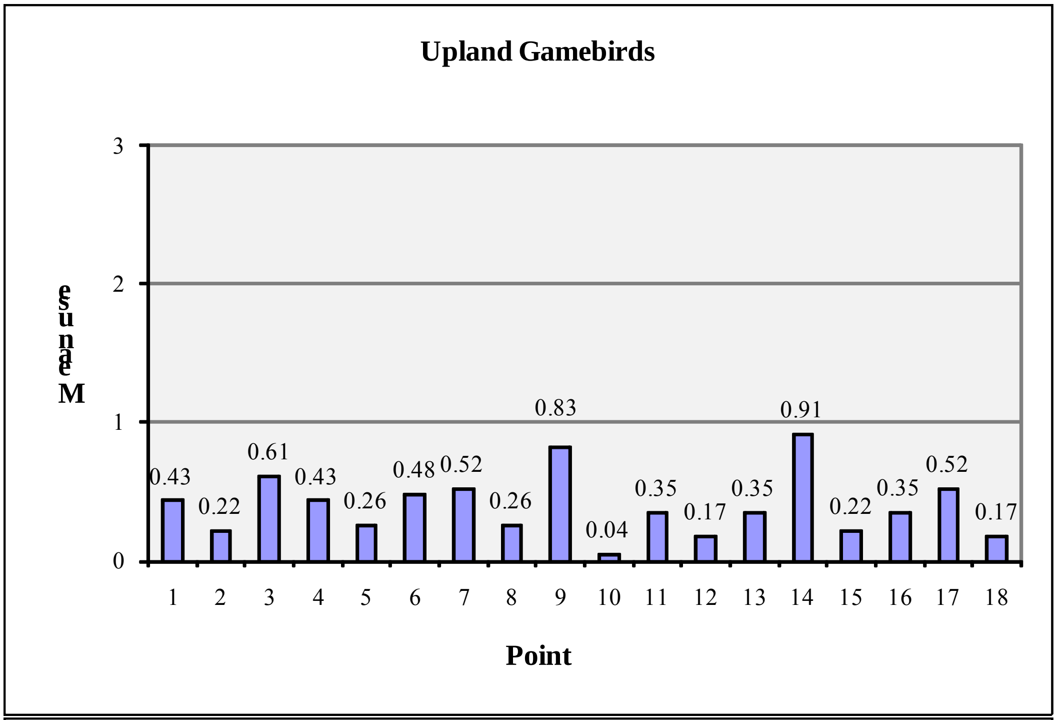


Figure 5 (*continued)*. Mean use (number of birds/20-min survey) at each fixed-point bird use survey point for all birds, major bird types, and raptor sub-types at the Wilton Expansion Wind Resource Area.



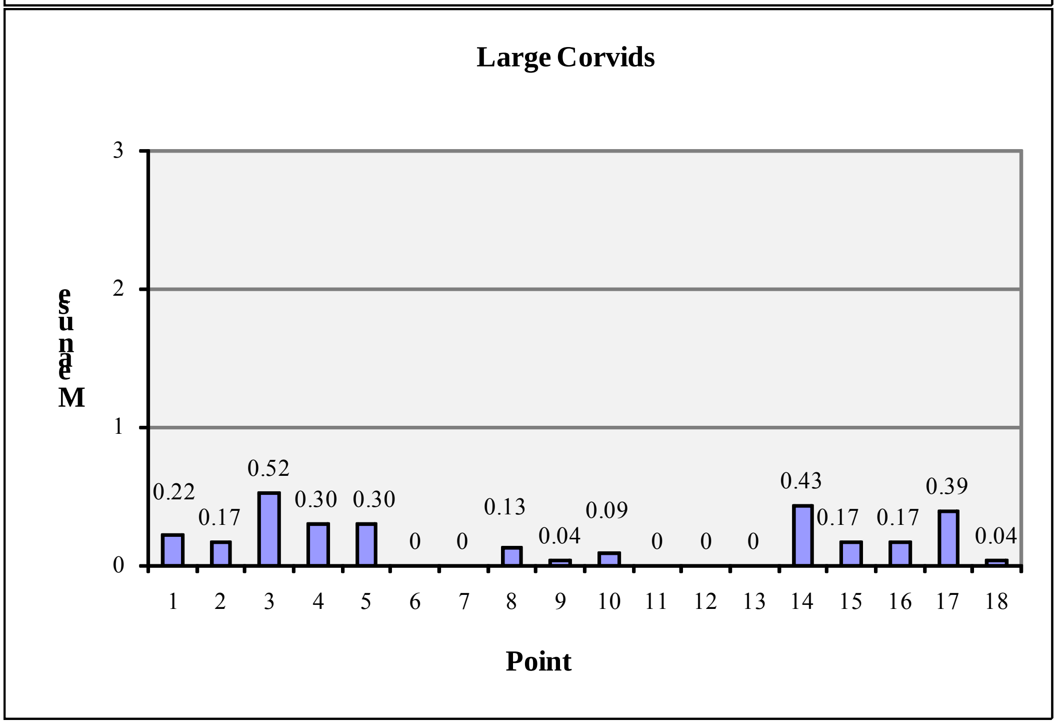


Figure 5 (*continued*). Mean use (number of birds/20-min survey) at each fixed-point bird use survey point for all birds, major bird types, and raptor sub-types at the Wilton Expansion Wind Resource Area.

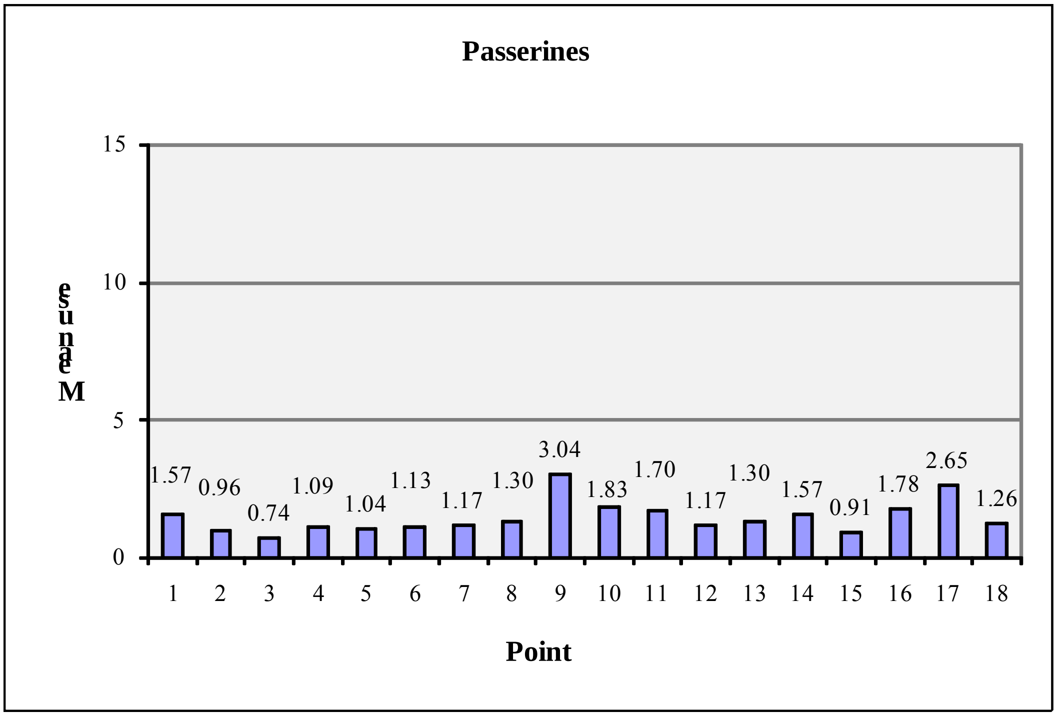


Figure 5 (*continued*). Mean use (number of birds/20-min survey) at each fixed-point bird use survey point for all birds, major bird types, and raptor sub-types at the Wilton Expansion Wind Resource Area. Passerine observations were focused within a 100-m viewshed.

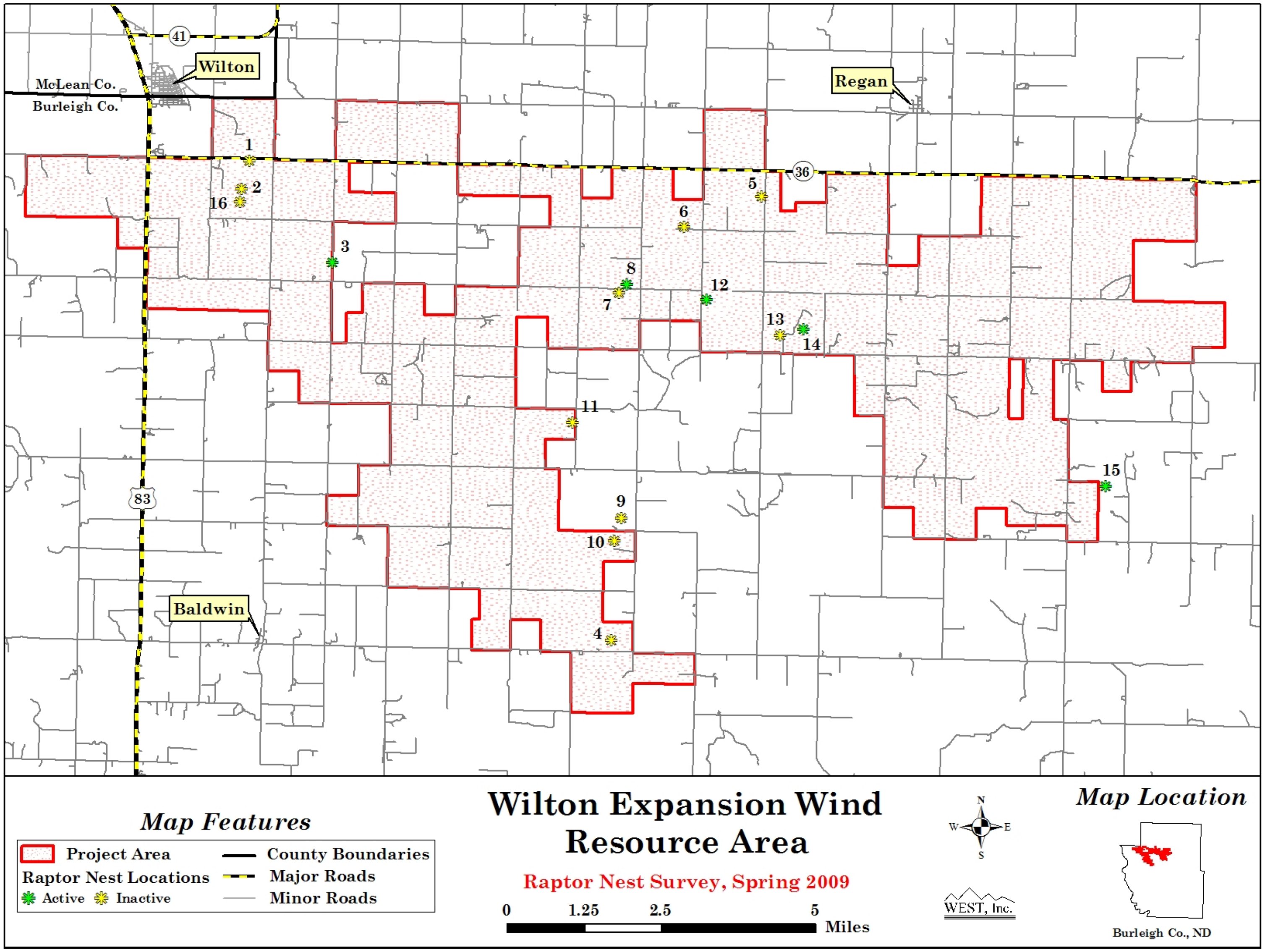


Figure 6. Location of raptor nests at the Wilton Expansion Wind Resource Area.

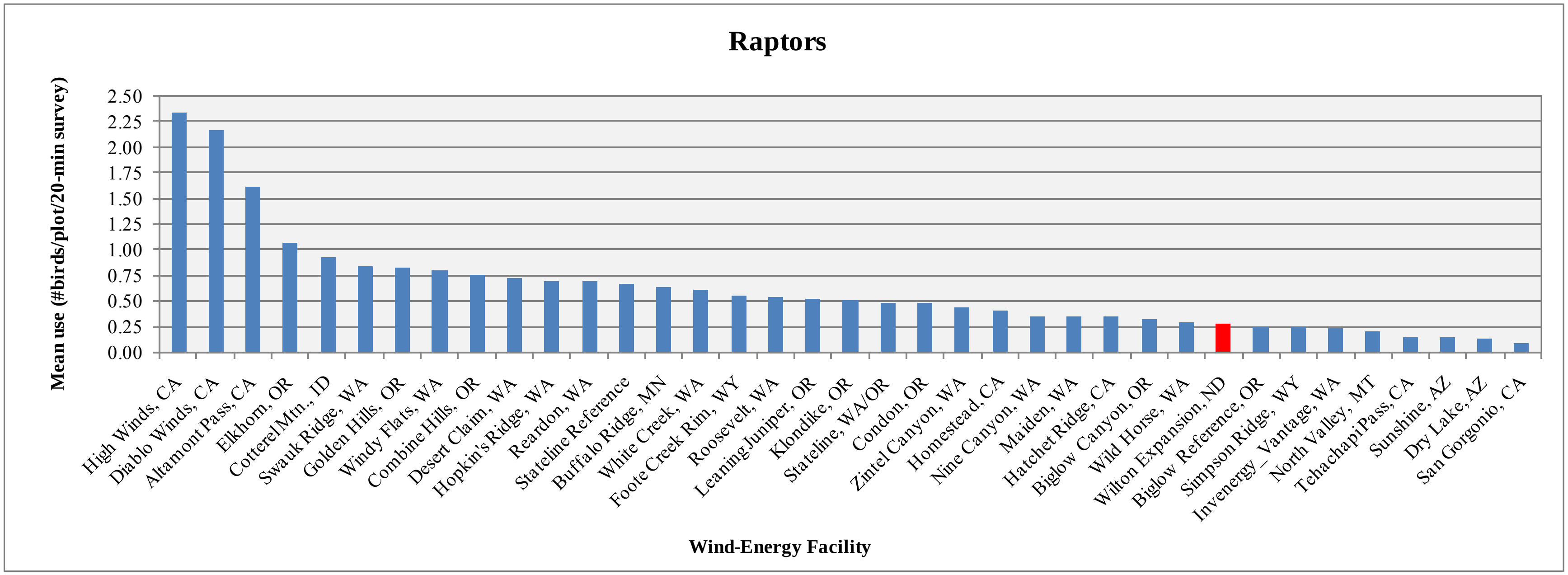
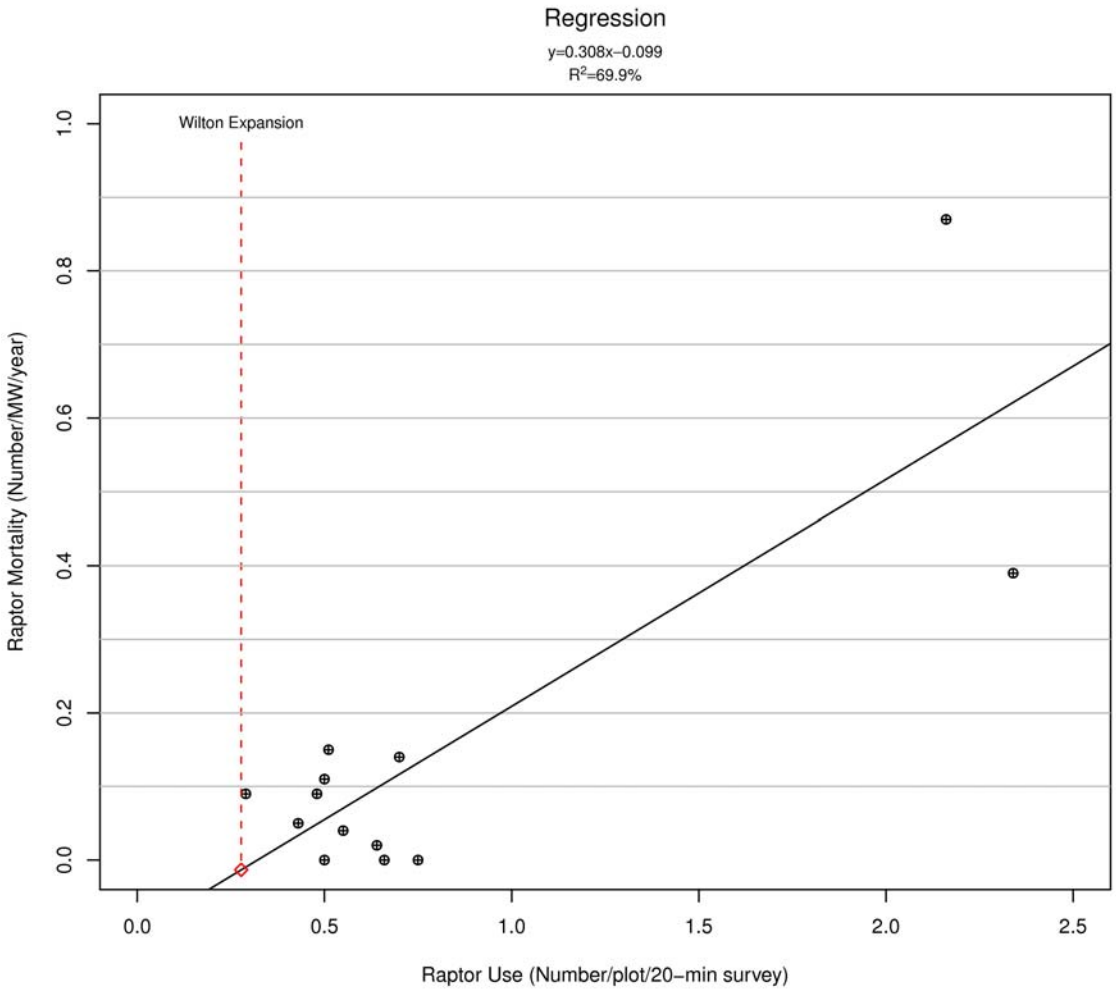


Figure 7. Comparison of annual raptor use between the Wilton Expansion Wind Resource Area and other US wind-energy facilities.

Data from the following sources:

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



Overall Raptor Use 0.28
Predicted Fatality Rate 0.01/MW/year
90.0% Prediction Interval (0, 0.25/MW/year)

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

Data from the following sources:

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