

**BASELINE AVIAN STUDIES FOR THE
PROPOSED MAIDEN WIND FARM,
YAKIMA & BENTON COUNTIES, WASHINGTON**

FINAL REPORT

November 20, 2002

Prepared For:

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Portland, Oregon, 97232

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EXECUTIVE SUMMARY

Bonneville Power Administration is evaluating whether to purchase power from a proposed wind power development in Benton and Yakima Counties, Washington. The proposed *Maiden Wind Farm* is located in the Rattlesnake Hills northeast of the town of Sunnyside, Washington. The proposed development could be up to 494 MW with as many as 549 turbines and four met towers depending on factors such as turbine model selected and power purchase agreements.

In support of the environmental impact evaluation for the project, a detailed 12-month baseline avian resources study plan was developed and implemented at the site to assist in project design and for use in evaluating potential avian impacts from the project. The study protocol was developed based on expertise and experience of WEST, Inc. and NWC, Inc. studying wind power effects on birds and wildlife and in cooperation with the Washington Department of Fish and Wildlife and the U.S. Fish and Wildlife Service. Information and results from the baseline avian study have been used in the overall environmental impact assessment for the project.

Studies conducted for the project include fixed-point surveys which targeted raptors and large birds, paired-plots surveys which targeted breeding passerines in the study area, raptor nest surveys, vegetation/habitat mapping, and general wildlife observations. The principal goals of the baseline studies were to: (1) quantitatively describe the temporal and spatial use by birds of the study area; and (2) provide baseline information on avian species and their habitat sufficient to use in evaluating the probable impact of the development. Detailed study methodology of the surveys for each component is provided below in the text of the report.

For the avian use surveys (fixed point surveys), use estimates of the study area by species and groups are calculated as the number of detections per survey (either 10 or 30 minutes depending on the survey type) standardize to a fixed plot (either 100 m or 800 m). Two measures of species diversity in the study area were also calculated. Frequency of occurrence was calculated as the percent of surveys where a particular species was observed. Species composition was represented by the mean use for a species divided by the total use for all species and multiplied by 100 to provide percent composition. An exposure index was calculated by species and group which was a relative measure of the risk of each species coming in contact with a turbine based on use of the study area, the proportion of observations of a species flying, and the proportion of observations of a species flying within the rotor swept area. Detailed analyses of the data and additional results are provided below in the text and tables of the report.

A total of 336 30-minute point count surveys were conducted between April 20, 2001 and April 11, 2002. Based on these fixed-point surveys, passerines comprised 81.0% of all birds observed; corvids (magpies, crows, and ravens) comprised 9.6% of all birds observed; raptors comprised 4.8% of all birds observed; and all other groups combined (e.g., upland game birds, doves, waterfowl, shorebirds) comprised 4.6% of all birds observed. Based on the use estimates from the fixed-point surveys, the three most abundant species in the study area were horned lark (7.2 detections/30-minute survey), common raven (1.2 detection/30-minute survey) and western meadowlark (0.67 detections/survey). Together these species comprised more than 76% of the total bird use during the fixed-point surveys. The most abundant raptors observed were northern harrier (51 detections), American kestrel (35), red-tailed hawk (30), Swainson's hawk (26). On

average approximately one northern harrier was observed every 7 surveys, one American kestrel every 10 surveys, one red-tailed hawk every 12 surveys, and one Swainson's hawk every 16 surveys. As a group, approximately 0.56 raptors were observed per 30-minute survey or approximately 1 raptor every two 30-minute surveys.

Two aerial surveys for raptor nests were completed (April 30–May 2 and June 18-19, 2001) within the raptor nest study area (the study area plus five-mile radius buffer). The total area surveyed was approximately 609 km² (235 square miles). A total of 107 raptor or large stick nests were located, 55 of which were classified as active nests during the first survey. Nest density for buteos (ferruginous hawk, red-tailed hawk, Swainson's hawk) was approximately 0.04 nest/km² (0.11 nest/mi²). Nest density for all raptors located (buteos, falcons, owls) was approximately 0.06 nest/km² (0.16 nest/mi²).

Fifteen paired-plots (30 total points) were established within the grassland and shrub-steppe habitat in the study area and surveyed once each month from May-July. Ten-minute surveys were conducted at each point on a survey day with the focus of recording breeding passerines in the study area. Based on use, the three most abundant species observed during the paired-plot surveys were horned lark (2.98 detections/10-minute survey), western meadowlark (1.41 detections/survey), and vesper sparrow (1.19 detections/survey). Together, these species comprised more than 74% of the total use during the paired-plot surveys. As expected, grassland/shrub-steppe species were the most abundant group observed with approximately 7 individuals seen during each 10-minute survey. The most abundant raptor observed during the paired-plot surveys was northern harrier (6 observations). As a group, less than 0.1 raptor was observed per 10-minute survey, or approximately 1 raptor every 11 surveys.

Four basic habitat types (agriculture, steppe, riparian, and wetland) occur in the study area. The agriculture habitat type is comprised of one vegetation type, cropland, and makes up approximately 35% of the study area (6419 acres). The steppe habitat is comprised of four types, grassland steppe, shrub steppe, lithosol, and rock outcrop shrub. The steppe habitats combined make up approximately 64% of the study area (8527 acres). Riparian habitat was found in draws below springs and along Sulphur Creek. Riparian habitat comprised 1% of the study area (135 acres). The wetland vegetation type was a minor component of the study area and comprised <0.1% (3 acres) and is confined to springs and a fringe along Sulphur Creek.

Several avian species of interest (bald eagle, ferruginous hawk, merlin, loggerhead shrike, sage thrasher, and sage sparrow) were observed on or near the site outside of scheduled surveys when observers were traveling to or between points. Six species of mammals (coyote, mule deer, elk, porcupine, Townsend's ground squirrel, and unidentified jackrabbit) and three species of reptiles (rattlesnake, short-horned lizard and yellow-bellied racer) were recorded in the study area during the studies. No federally listed threatened or endangered species were observed in the study area.

The estimates of avian use from the study area are similar to other sites studied for wind development. The species diversity was relatively low with few species comprising the majority of observations. Raptor use and raptor nest density were similar to those estimated for other wind sites that have been studied. Some state sensitive species were recorded during the surveys including ferruginous hawk, golden eagle, peregrine falcon, loggerhead shrike, and sage thrasher.

An active ferruginous hawk nest was located in the study area during the raptor nest survey; however, this nest failed to produce chicks in 2001. Estimated impacts from the project are not expected to exceed what has been reported from other newer generation wind plants that have been studied. Additional discussion topics and potential mitigation measures to off-set or minimize impacts are addressed in the text below.

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1.0 INTRODUCTION

Bonneville Power Administration (BPA) is evaluating whether to purchase power from a proposed wind power development in Yakima and Benton Counties, Washington. The proposed site for the *Maiden Wind Farm* is located primarily in the Rattlesnake Hills northeast of the town of Sunnyside, Washington. The proposed development could be up to 494 MW with as many as 549 turbines and four meteorological towers (met towers) depending on factors such as the turbine model selected and power purchase agreements.

BPA contracted with Western EcoSystems Technology, Inc. (WEST) and Northwest Wildlife Consultants, Inc. (NWC) to develop a study protocol and conduct a twelve-month baseline study of avian use of the project area. BPA has committed to characterizing the avian use and resources at the Maiden site to estimate the level of potential impacts the project could have on these resources. The following report contains the results of the avian baseline study for the one-year period from April 2001 to April 2002. This baseline study provides data for describing the temporal and spatial use by birds of the study area and for evaluating the probable impact of wind power development in the study area. Information and results from the baseline avian study have been used in the overall environmental impact assessment for the project.

Key questions addressed by the study include:

- What avian species and other wildlife use the study area?
- What vegetation/habitat types are present in the study area?
- Where in the study area (spatial use) do birds occur and what vegetation types/habitats do they use?
- What is the seasonal and daily (temporal) use of the study area for given species or groups of species?
- Are there key habitat features (biotic and/or abiotic) that increase the probability of avian use of an area?
- If determinable, do individual species or groups of species exhibit distinctive behavior patterns over specific habitats, landforms, time of day, or seasons?
- How do indices of use of the study area by raptors and other birds compare with other wind plants that have been studied in western North America (e.g., Minnesota, Oregon, Washington, Wyoming, California)?

The protocol follows similar avian studies at the Vansycle and Stateline Wind Plant in Oregon and Washington (Erickson *et al.* 2000), the Buffalo Ridge Wind Plant in southwest Minnesota (Johnson *et al.* 2000a), the Foote Creek Rim Wind Plant in Wyoming (Johnson *et al.* 2000b), and other proposed wind plants in Oregon and Washington (e.g., Nine Canyon, and Condon wind sites). The Washington Department

of Fish and Wildlife (WDFW) and the U.S. Fish and Wildlife Service (USFWS) were provided a copy of the study protocol for review and comment prior to implementation.

2.0 STUDY AREA

The Maiden project area is within the Columbia Basin Physiographic Province (Franklin and Dyrness 1988). The study area is approximately 12 miles northeast of Sunnyside and 24 miles northwest of Richland, Washington (Figure 1). The study area is east and south of the Department of Energy, Hanford Site. The initial development would be located in the Rattlesnake Hills along the primary ridgeline. The north edge of the site is approximately the top of the ridge with the site encompassing a portion of the south-facing slope (Figure 2). Expansion of the wind farm would occur to the south and east of the initial development in flat to rolling terrain that is primarily agriculture (Figure 2).

The vegetation of the study area is a mix of grassland/shrub-steppe and dryland agriculture (wheat fields). The grassland/shrub-steppe community is predominantly big sagebrush (*Artemisia tridentata*), bluebunch wheatgrass (*Pseudoroegneria spicata*), and Sandberg's bluegrass (*Poa secunda*), with the introduced species cheatgrass (*Bromus tectorum*) common in disturbed areas (see also Eagle Cap Consulting 2001 for additional vegetation species common in the study area). Agriculture and livestock grazing have converted the overall area to a mosaic of grazed shrub and grassland-steppe, Conservation Reserve Program (CRP) pastures, and cultivated wheat fields. The area where wind turbines would be located is primarily grassland and shrub-steppe ridge tops and south facing slopes, and areas of dryland wheat. Prevailing winds are from the southwest.

The primary study area includes the proposed development area or the location of the wind turbines and associated facilities such as met towers, substations, new roads, operations and maintenance facility, underground and overhead powerlines, and construction permit areas for gravel/borrow material, plant sites, equipment storage or lay-down areas, parking areas, and the area within a buffer of approximately 1 mile (1.6 km) from all project facilities. All avian use surveys, general wildlife observations, and vegetation surveys occurred within the study area.

The raptor nest study area included the primary study area and the surrounding area within five miles. The helicopter surveys for raptor and other large bird nests occurred within this area.

3.0 METHODS

The avian baseline study consisted of five components:

1. Fixed-point surveys: point count surveys which target raptors and other large birds;
2. Raptor nest survey: aerial surveys to locate raptor nests on and within five miles of the site;
3. Paired-plot surveys: point count surveys which target breeding passerines and small birds;
4. General wildlife observations: observations of other wildlife and species of interest made while traveling (in-transit) between survey points or incidentally while on site;
5. Vegetation/habitat mapping.

3.1 Fixed-point Survey

The primary objective of the fixed-point surveys was to estimate the spatial and temporal use of the Maiden site by raptors and other large birds. Point counts (variable circular plots) were conducted on site using methods described by Reynolds *et al.* (1980). The fixed points were selected to survey as much of the study area as possible (Figure 3). All birds observed during the point counts were recorded, however, the emphasis of the surveys was in locating and counting raptors and other large birds (waterfowl, shorebirds, waterbirds, corvids, and grouse), which are commonly thought to be most at risk from collisions with turbines. Binoculars were used diligently throughout the observation periods to view likely perch sites, areas where birds might not be detectable due to background color and/or texture, and sites where birds have been previously observed.

3.1.1 Survey Plots

Eight survey plots were established over the entire study area: four points in the area designated for the initial development which were primarily in grassland/shrub-steppe habitats (labeled points A, B, C, D) and four points in the expansion area (labeled F, I, J, K)¹, which were primarily in agriculture habitats. Each survey plot is a variable circular plot centered on an observation point permanently marked in the field. Observation points were established so that 800 m radius circles surrounding each point did not overlap (Figure 3). All birds observed were recorded, however, the survey concentrated in the area within an approximate 800 m (0.5 mi) radius circle centered on the

¹ Originally 8 points were labeled A-H, however, the boundaries of the proposed development area changed due to landowner leases and therefore the survey point layout changed. The original points E, G, and H were dropped and three new points added and labeled I, J, K to avoid confusion with data collected from a few initial surveys at the earlier points.

observation point. Landmarks were located to identify the 800 m distance from each observation point. Observations of birds beyond the 800 m radius were recorded and logged in the database, however, only observations within 800 m of the fixed point were included in the analyses so that results were standardized among points as well as with other similar studies at other wind plants.

Survey periods lasted for 30 minutes at each point. All points were visited once per week between April 20, 2001 and April 11, 2002, weather permitting. All native wildlife observed during each survey period were assigned a unique observation number. Raptors and other large birds were plotted on a map of the survey plot. Weather information such as temperature, wind speed, wind direction and cloud cover was recorded for each survey. The date, start and end time of the observation period, species or best possible identification, number of individuals, sex and age class (if possible), distance from plot center when first observed, closest distance, altitude above ground, activity (behavior), and habitat(s) were recorded. Flight or movement paths were mapped and given the corresponding unique observation number.

Four instantaneous counts were conducted during each 30-minute observation period. The first instantaneous count was made at the beginning of the observation period and the remaining counts occurred at 10-minute intervals. An instantaneous count consists of a summary of all birds present in and near the plot at a particular time. During the instantaneous count, the observer made a 360-degree visual scan of the survey plot. For each raptor or large bird seen during an instantaneous count, the approximate height above ground and approximate distance from the observer was recorded.

The behavior of each raptor/large bird observed and the habitat in which or over which the bird occurred was recorded. Habitats were recorded as fallow, CRP, stubble, wheat, plowed, tree, riparian, grassland/shrub-steppe, and other. Behavior categories recognized include perched, soaring, flapping, flushed, circle/soaring, hunting, gliding, and other. The initial flight patterns and habitats (first observation) were uniquely identified on the data sheet and subsequent patterns and habitats (if any) also recorded. The general flight direction of observed birds was recorded on the data sheet map. Approximate flight height at first observation was recorded to the nearest meter and the approximate lowest flight height and highest flight height observed were also recorded. Any comments or unusual observations were also recorded.

3.1.2 Observation Schedule

Sampling intensity for the study area was designed to document avian use and behavior by habitat within the study area. Depending on the weather, at least one observer was at the site one day per week. Surveys were conducted weekly and survey periods were scheduled to approximately cover all daylight hours. During a set of surveys, each selected plot was visited once. Observation days were divided into two periods, morning (6-12) and afternoon (12-6), with each station being surveyed for 30 minutes during one of these periods. To the extent practical, a pre-established schedule was developed by the field personnel to ensure that each station was surveyed about the same number of times each period of the day during each season. The schedule was flexible in response to

adverse weather conditions (e.g., fog), which caused delays and/or rescheduling of surveys.

3.2 Raptor Nest Survey

The objective of the raptor nest survey was to gather information on species nesting in the area including nest locations visible from the air, nesting season (timing), and nest success. The nest survey area included the full study area and the area within an approximate 5-mile buffer (Figure 4). The focal species for the nesting surveys was ferruginous hawk (*Buteo regalis*), a state threatened species known to occur in Benton and Yakima counties. Richardson (1996) reports the average home range for ferruginous hawks in Washington at 79 km² (30 mi²). The 5-mile buffer was deemed sufficient to identify nesting raptors and, in particular, ferruginous hawks potentially affected by the wind plant.

The initial nest survey was conducted via helicopter from April 30 - May 2, 2001 when ferruginous hawks in the study area would be actively incubating or brooding/attending young (Richardson 1996). GPS coordinates were recorded for all raptor or other large bird species nests located and mapped on topographic maps (1:24,000 scale). A follow-up survey was conducted on June 18 and 19 to visit located nests and look for evidence of nest success (e.g., fledged young nearby, full-grown chicks in the nest) and new nests of late nesting species [e.g., Swainson's hawk (*Buteo swainsoni*)].

Locations of all nests, including inactive nests, were recorded as they may be occupied during other years. All nests, whether active or inactive, were given a unique identification number and their locations recorded in Universal Transverse Mercator (UTM) coordinates. The surveys were conducted by a wildlife biologist experienced in raptor nest surveys. All trees and other structures, such as power poles with platforms and old windmills, were checked. Permission to fly over the Hanford Site, Arid Lands Ecology Reserve (ALE) was also obtained to cover the portion of the ALE within five miles of the proposed project. Data about raptor nest sites and nest success were opportunistically gathered during other surveys in the study area that were visible from the routes the observers regularly traveled.

3.3 Paired-plot Surveys

The primary objective of the paired-plot surveys was to characterize the breeding passerine community of the shrub- and grassland-steppe habitat on the site. A secondary objective was to gather information that may be used to estimate potential displacement effects due to development of the site. A paired-plot point-count study design was utilized to count birds at proposed turbine locations and at points in areas where no turbines would be constructed. Paired-points were approximately 300 m apart and oriented perpendicular to proposed turbine strings (Figure 5), and were established using a systematic sample to get good coverage of the study area. Survey methods were similar to point count methods used for the fixed-points except that survey duration was 10 minutes at each survey point. All birds seen during the point counts were recorded;

however, the emphasis of the surveys was passerines within a 100 m radius of the point. All paired-plots were visited once each month in May, June, and July.

3.4 General Wildlife Observations

The objective of the general wildlife observations was to document other wildlife occupying the study area. All mammals, reptiles, amphibians, and avian species of interest (e.g., state species of concern², raptors, waterfowl, upland game birds) sighted while field observers were on-site or traveling between plots were recorded on data sheets for incidental observations. The data recorded are similar to those recorded during other surveys. The observation number, date, time, species, number, sex/age class, height above ground (for birds), and habitat were recorded and the point of first observation was mapped on a project map with a corresponding observation number.

3.5 Vegetation Mapping

The objective of the vegetation mapping was to characterize habitats in the area and potential avian community that may be impacted. The vegetation of the study area was mapped on 1:24000 scale USGS topographic maps based on aerial photos (Benton County) and ground observations. Information from the vegetation mapping was used to help locate avian survey points, describe habitat used by avian species observed, and determine the need for more detailed vegetation impact analyses. For each vegetation type identified in the study area, a list of dominant species was compiled based on field surveys and from previous work when available.

3.6 Data Compilation and Report Preparation

3.6.1 Data Compilation and Storage

A database was created to store, retrieve and organize field observations. Data from field forms were keyed into electronic data files using a pre-defined format that made subsequent data analysis straightforward. All field data forms, field notebooks, and electronic data files have been retained for future reference.

3.6.2 Quality Assurance/Quality Control (QA/QC)

QA/QC measures were implemented at all stages of the study, including in the field, during data entry, during data analysis, and report writing. At the end of each survey day, each observer was responsible for inspecting his or her data forms for completeness, accuracy, and legibility. The study team leader periodically reviewed data forms to ensure completeness and legibility; any problems detected were corrected. Any changes made to the data forms were initialed and dated by the person making the change.

The electronic database was compared to the original data sheets by randomly choosing electronic records and verifying these with the field data sheet. Any errors detected were corrected by referencing the raw data forms and/or consulting with the observer(s) who collected the data. Any irregular codes detected, or any data suspected as questionable,

² State Species of Concern are collectively state endangered, threatened, sensitive, and candidate species.

were discussed with the observer and study team leader. All changes made to the raw data were documented for future reference. Any errors or suspect data identified in later stages of analysis were traced back to the raw data forms, and appropriate changes in all steps were made.

3.7 Statistical Analysis and Products

Statistics/data generated for the study area include the following:

- Species list and number detected by season;
- Vegetation/habitat mapping;
- Raptor nest locations by species;
- Raptor nest occupancy and success;
- Relative use by species, species group, and season;
- Mean frequency of occurrence and species composition;
- Spring/Summer passerine use by survey plots;
- Exposure indices by species and species group;
- Mean flight characteristics by species and species group;
- Wildlife observed in the study area.

The number of raptors and other species seen during each point count survey was standardized to a unit area and unit time searched. For example, if 4 raptors were seen during a survey at a point with a viewing area of 2.01 km², these data may be standardized to $4/2.01 = 1.98$ raptors/km² in a 30-minute survey. Mean use is reported as the number of individuals observed per 30-minute (or 10-minute) survey.

The frequency of occurrence by species is calculated as the percent of surveys in which a particular species is observed. Species composition is represented by the mean use for a species divided by the total use for all species and multiplied by 100 to provide percent composition. Frequency of occurrence and percent composition provide relative estimates of the avian diversity of the study area. A particular species may have high use estimates of the site based on just a few observations of large flocks, however, the frequency of occurrence will indicate that it occurs during very few of the surveys and therefore, may be less likely affected by the project.

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

$$R = A * P_f * P_t$$

Where A = mean relative use for species i (observations within 800 m of observer) averaged across all surveys, P_f = 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 = proportion of all flight height observations of species i within the rotor-swept area (RSA). This index does not account for differences

in behavior other than flight characteristics (i.e., flight heights and percent of birds observed flying).

Data were plotted (means and standard deviation) to illustrate differences in raptor and other bird use between survey period (season) and stations (habitat). Maps of raptor and large bird spatial use by observation point as well as the whole study area were developed. For analysis, seasons were defined as follows: spring, April 20-May 15, 2001 and March 16 - April 11, 2002; summer, May 16 - August 15, 2001; fall, August 16 - October 31, 2001; and winter, November 1, 2001 - March 15, 2002.

4.0 RESULTS

4.1 Fixed-point Raptor and Large Bird Surveys

Surveys were conducted at 8 fixed-point count stations located within the study area (Figure 3) approximately once each week between April 20, 2001 and April 11, 2002. A total of 336 30-minute point count surveys were conducted.

A total of 62 avian species and an additional 11 unidentified bird types (best possible identifications, e.g. unidentified accipiter) were observed during the fixed-point surveys (Table 1). 4,736 total observations in 1,437 different groups³ were recorded during the fixed-point surveys (Table 1). These are simply raw counts of observations, that are not standardized by the number of hours of observation, but do provide an overall list of what was observed. These counts likely contain duplicate sightings of the same birds.

Passerines were by far the most numerous group; horned lark and western meadowlark were the most numerous species observed. Passerines comprised 68.0% of all groups observed and 81.0% of the total number of birds observed. Raptors comprised 13.6% of all groups and 4.8% of all birds observed. Corvids (magpies, crows, and ravens) comprised 16.4% of all groups and 9.6% of all birds observed. Other birds (waterfowl, shorebirds, doves, upland game birds, and other non-passerine species) comprised 1.9% of all groups and 4.6% of all birds observed due mainly to a few large flocks of Canada geese observed flying over the study area during the fixed-point surveys. Upland game birds observed on the site included three introduced species, ring-necked pheasant, chukar, and Hungarian (gray) partridge.

Observations varied by season (Table 1), with summer having the most groups observed and fall the most individuals. Winter had the second highest number of individuals observed but the fewest number of groups.

4.1.1 Avian Use

To standardize the data for comparison between points and with other studies, avian use, frequency of occurrence, and species composition were calculated only from observations within 800 m of the observation point. Because individual birds were not marked, counts do not distinguish between individuals; rather, they provide an estimate of avian use of the study area. For example, if one red-tailed hawk was observed during five surveys, it is unknown if this was the same bird seen five times or five different birds seen once. But this does provide an index of how often or frequent red-tailed hawks occur in the study area, and therefore are at risk of being impacted by the proposed project. Any reference to abundance refers to the use estimates and not absolute density or numbers of individuals. Avian use by species was calculated as the mean number of observations per 30-minute survey (Table 3).

³ Group is defined as an observation of a species of bird regardless of number seen together. For example, a flock of 8 horned larks flying together is a group as well as an individual horned lark observed by itself.

Based on use, the three most abundant species in the study area were horned lark (7.24 detections/30-minute survey), common raven (1.16 detections/survey) and western meadowlark (0.67 detections/survey). Together these species comprised more than 73% of the total bird use during the fixed-point surveys (Table 2). Passerines were the most abundant group observed with approximately 10 individuals seen during each 30-minute survey (Table 2). The most abundant raptors observed were northern harrier (0.14 detections/30-minute survey), American kestrel (0.10), red-tailed hawk (0.08), and Swainson's hawk (0.06) (Table 2). On average approximately one northern harrier was observed every 7 30-minute surveys, one American kestrel every 11 surveys, one red-tailed hawk every 12 surveys, and one Swainson's hawk was observed every 16 surveys. As a group, approximately 0.56 raptors were observed per 30-minute survey (Table 2) or approximately 1 raptor every 2 surveys.

Mean use for passerines, corvids, and raptors, the three most abundant groups based on use (Table 2), was plotted by survey period. Passerine use generally increased throughout the study period, with the highest use occurring during the fall migration period (Figure 6). Larger flocks of horned larks and other passerines were observed in the fall and winter. Corvid use was similar in the fall and winter periods, and lowest during the spring and summer (Figure 7). Raptor use tended to increase throughout the spring, summer, fall period, but dropped off in the winter (Figure 8). Mean use for these three groups was also plotted by survey station. Passerine use was generally higher in the survey plots located primarily in agriculture fields, points F, I, J, K (Figure 9); corvid use varied across all plots (Figure 10); and raptor use was also highest in the agricultural areas (Figure 11).

4.1.2 Frequency of Occurrence and Species Composition

The frequency of occurrence was calculated as the percent of surveys where a particular species was observed (Table 3). Species composition is represented by the mean use for a species divided by the total use for all species and multiplied by 100 to provide percent composition (Table 4). Frequency of occurrence and percent composition provide relative estimates of the avian diversity of the study area. For example, only three species were observed in more than one-third (33%) of the surveys, horned lark (74%), common raven (45%), western meadowlark (33%), and these three species made up nearly three-quarters of all bird use (74%). The vast majority of species were observed in less than 5% of the surveys (Table 3). The most frequently observed raptor was northern harrier seen in approximately 12% of all surveys but comprising only 1.2% of the total use. American kestrel was seen in approximately 8% of all surveys but comprised only 0.9% of the total use. In contrast, horned larks were observed during more than 74% of all surveys and comprised approximately 61% of the total use (Table 4).

As a group, and due primarily to the abundance of horned larks, passerines comprised more than 83% of the avian use and were observed in nearly 85% of all the surveys (Table 3). Raptor use of the site as a group was relatively low with less than one raptor observed during each 30-minute survey (Table 2) and during approximately 45% of the surveys (Table 3). Overall, based on the use estimates, raptors, as a group, comprised 4.7% of all avian use (Table 4).

Frequency of occurrence for passerines, corvids, and raptors, the three most abundant groups based on use (Table 4), was plotted by survey period. Passerine occurrence was generally steady across the study period but dropped during the winter (Figure 6). Corvid occurrence was similar in the fall and winter periods, and lowest during the spring and summer (Figure 7). Raptor occurrence increased throughout the spring, summer, and fall but was very low in the winter (Figure 8). Frequency of occurrence for these three groups was also plotted by survey station. Passerine occurrence was variable but slightly higher in the survey plots dominated by agriculture fields (Figure 9); corvid occurrence was highest in the grassland/shrub-steppe plots (Figure 10); and raptor occurrence was highest in the agricultural areas (Figure 11).

An additional index of species diversity is the mean number of species observed per survey. In general, the mean number of species per survey was relatively stable through the spring, summer, and fall but dropped during the winter (Figure 12).

4.1.3 Flight Height Characteristics

The proportion of observations of a bird species flying within the rotor swept area provides a rough estimate of the propensity of that species to fly within the area occupied by the turbine rotors (Table 5). Since the turbine sizes have yet to be determined, the “zone of risk” used included the area from 25 m above ground level (AGL) to 125 m AGL, which is the union of rotor swept areas for smaller (e.g., 900 kw) and larger (e.g., 2 MW) turbines being considered. Most of the passerines observed, with the exception of the swallows, were regularly observed flying less than 10 meters above the ground. The larger birds tend to fly higher, and frequently flew greater than 25 meters high, which is within the primary zone of influence for turbine blades for most newer generation turbines. As a group, 51% of corvids were observed in the zone of risk, followed by raptors (48%), whereas passerines were not likely to be observed within the zone of risk (6%) (Table 7). Waterfowl had the greatest percent of individuals observed within the zone of risk, however, only 3 groups of waterfowl were observed.

4.1.4 Exposure index

The exposure index is a relative measure of the risk of each species observed on-site during the fixed-point surveys coming in contact with a turbine, based on the use (measure of abundance) of the site by the species and the flight characteristics observed for that species. Common raven, gray-crowned rosy finch, and horned lark had the highest exposure indices (Table 6). Horned lark was by far the most abundant species observed, but was nearly always observed below the zone of risk, whereas the one large flock of rosy finches observed flying was within the zone of risk. Mortality studies at other wind plants have indicated that although ravens are often observed at wind plants within the zone of risk, they appear to be less susceptible to collision with wind turbines than other similar size birds (e.g., raptors, waterfowl). Raptor species with the highest exposure index for the study area include Swainson’s hawk, red-tailed hawk and northern harrier. Although northern harrier and American kestrel were the most abundant raptor species observed, both species were observed less often in the zone of risk than the *buteo* species.

4.1.5 Spatial Use

Point of first observation, approximate flight paths, and perch locations were mapped for raptors and other large birds observed in the project area (Figures 13-16). The objective of mapping observed bird locations was to look for areas of concentrated use by raptors and other large birds. Northern harriers were the most common raptor observed. Most northern harrier observations were made in the agricultural portion of the study area (points F, I, J, K), which was generally flat to gently sloping (Figure 13). No patterns in spatial use by northern harriers were noted. Buteo observations occurred throughout the project area (Figure 14). No obvious patterns in spatial use were noted by buteos, however, there was a concentration of observations associated with the powerlines running across the western portion of the area (Figure 14). Falcon observations also occurred throughout the project area (Figure 15). Prairie falcons were mostly observed in the steppe habitats while American kestrels appear to be more abundant in the agriculture areas (Figure 15). While there were very few golden eagle observations, they appeared to be somewhat concentrated around the powerlines in the western part of the project area (Figure 16). Waterfowl observations were of flocks making long distance movements across the study area (Figure 16).

4.2 Raptor Nest Survey

Two aerial surveys for raptor nests were completed within the raptor nest study area (RNA) (the study area plus five-mile radius buffer). The total RNA was approximately 235 square miles (609 km²) (Figure 4). A total of 107 raptor or large stick nests were located, 55 of which were classified as active nests during the first survey (Table 7). Nest density for buteos (ferruginous hawk, red-tailed hawk, Swainson's hawk) was 0.04 nest/km² (0.11 nest/mi²). Nest density for all raptors located (buteos, falcons, owls) was approximately 0.06 nest/km² (0.16 nest/mi²).

During the second raptor nest survey of the study area, two new active Swainson's hawk nests were located and two nests initially recorded as a common raven and great-horned owl were occupied by Swainson's hawks. The second survey was intended to gain as much information as possible about nest success from the active nests located during the first survey. Based on the second survey, five raptors, ferruginous hawk, red-tailed hawk, Swainson's hawk, prairie falcon, and barn owl, as well as common ravens, were confirmed producing or fledging chicks in the study area (Table 7). Swainson's hawks generally nest later than other buteos and some of the Swainson's hawk nests in the study area had not produced young by the second visit. While these nest success rates are based on relatively small sample sizes, they provide an estimate of approximate nest success (i.e., percent of nests that are successful by species), and a record of successful breeding by several raptor species in the study area.

In general, the RNA contained relatively poor habitat in terms of nest site availability. No large riparian corridors are encompassed by the five-mile radius buffer of the site and there are no large cliffs or highwalls. Suitable raptor nesting structures consisted primarily of isolated trees, power poles, rocky outcrops, and low rocky cliffs. The aerial

survey method enables/facilitates locating nests which are easily seen from the air and generally focuses on locating suitable raptor nest structures. Ground nesting species are generally missed with this type of survey. It is likely that some ground nesting species such as northern harriers, short-eared owls, and burrowing owls nest within the survey area. The number of these species is unknown. The WDFW Priority Habitats and Species database was queried for the study area. This database indicates that burrowing and short-eared owls nest in the study area. This database also documents Swainson's hawk, red-tailed hawk, ferruginous hawk, and prairie falcon nesting in the study area. With the exception of burrowing and short-eared owls, all of these species were recorded during the raptor nest surveys.

4.3 Paired-plot Surveys

Fifteen paired-plots (30 total points) were established in native habitats within the study area (Figure 5). These points were surveyed three times, once each in May, June, and July. While all birds observed were recorded, the focus of the surveys was to record breeding passerines and other small birds, primarily grassland/shrub-steppe species. The survey effort concentrated on identifying birds within 100 m of the survey point.

A total of 28 avian species and an additional 6 unidentified bird types (best possible identifications, e.g. unidentified hummingbird) were observed during the paired-plot (passerine) surveys (Table 8). Horned lark and western meadowlark were the most numerous species observed, comprising 34.3% and 27.3% of all groups and 34.9% and 25.1% of all birds observed respectively. Grassland/shrub-steppe species were the most common groups observed comprising nearly 91% of all groups and 88% of all birds observed. No waterfowl and only one shorebird (killdeer) were observed during the surveys. Raptors comprised only 1.9% of all groups and 1.7% of all birds observed.

4.3.1 Avian Use

Avian use by species was calculated as the mean number of observations per 10-minute survey within 100 m of the point (Table 10). 841 total observations in 726 different groups⁴ were observed during the paired-plot surveys (Table 8). As with the fixed-point surveys, these are simply raw counts of observations, that were not standardized by the number of hours of observation or distance from observer, but do provide an overall list of what was observed. Because individual birds were not marked, these counts also do not distinguish between individuals; rather, they provide an estimate of use. Reference to abundance refers to the use estimates and not absolute density or numbers of individuals.

Based on use, the three most abundant species observed during the paired-plot surveys were horned lark (2.98 detections/10-minute survey), western meadowlark (1.41 detections/survey), and vesper sparrow (1.19 detections/survey). Together, these species comprised more than 74% of the total use during the paired-plot surveys (Table 10). As expected, grassland/shrub-steppe species were the most abundant group observed with approximately 7 individuals seen during each 10-minute survey (Table 11). The most

⁴ Group is defined as an observation of a species of bird regardless of number seen together. For example, a flock of 8 horned larks flying together is a group as well as an individual horned lark observed by itself.

abundant raptor observed during the paired-plot surveys was northern harrier (6 observations) (Table 9). As a group, less than 0.1 raptor was observed/10-minute survey (Table 11), or approximately 1 raptor every 11 surveys.

The paired-plot survey was set up so that one point of each pair was located at a proposed turbine location (ridge top) and one point off-set perpendicular to the turbine string by 300 m (ridge slope or valley). This design will enable post-construction displacement effect monitoring if desired. Use was calculated separately for the turbine points and the off-set points (Table 12) for possible future use in understanding displacement effects. The offset points indicated slightly higher overall use, as well as use by grassland/shrub-steppe and raptor species compared to the turbine plots, but the differences were not statistically significant (Table 13).

4.3.2 Frequency of Occurrence and Species Composition

The frequency of occurrence was calculated as the percent of surveys where a particular species was observed (Table 10). Species composition is represented by the mean use for a species divided by the total use for all species and multiplied by 100 to provide percent composition (Table 10). Four species were observed in more than 30% of the surveys, horned lark (86%), western meadowlark (82%), vesper sparrow (74%), and grasshopper sparrow (32%) (Table 10), and these four species made up nearly 84% of the avian use during the paired-plot surveys. The vast majority of species were observed in less than 5% of the surveys. The most frequently observed raptor was northern harrier which was seen in approximately 3% of all surveys but comprising only 0.5% of all avian use. Horned larks were observed during more than 85% of all surveys and comprised nearly 42% of the avian use during the paired-plot surveys (Table 10).

As a group, due primarily to the abundance of horned larks on the site, the grassland/shrub-steppe species comprised nearly 93% of all bird observations and were observed during all the surveys (Table 11). Raptor use of the site as a group was relatively low. Raptors were seen in approximately 9% of the surveys and averaged less than one raptor observed during each 10-minute survey. Overall, based on the use estimates, raptors, as a group, only comprised 1.2% of all avian use during the paired-plot surveys (Table 11).

4.4 General Wildlife and In-Transit Observations

4.4.1 Avian species

Avian species of interest were recorded when observed on-site during periods when observers were traveling to survey points, in-transit between survey points, or on-site for other purposes (Table 14). Several avian species of interest were observed on-site outside of the scheduled surveys (fixed-point or paired-plot), including merlin, sage thrasher, sage sparrow, and loggerhead shrike.

4.4.2 Threatened, Endangered, State Species of Concern, and Species of Interest

One bald eagle was observed in the study area on March 20, 2002. This observation was made incidentally while the observer was traveling to the survey points, so did not factor

into the use estimates for the site. The bald eagle was observed perched on the ground foraging on an unknown carcass and was accompanied by 15 common ravens.

One state endangered species, peregrine falcon, was observed on-site. Two peregrine falcons were observed during a fixed-point count on September 30, 2001. One state threatened species, ferruginous hawk, was also observed on-site. Several observations of ferruginous hawk were made incidentally on-site and during fixed-point and paired-plot surveys, and an active ferruginous nest was located on-site during the April 30, 2001 raptor nest survey. Several state candidate species were recorded on the site including merlin, golden eagle, sage thrasher, loggerhead shrike, and sage sparrow.

4.4.3 Non avian species

Five species of mammals, elk (*Cervis elaphus*), mule deer (*Odocoileus hemionus*), Townsend's ground squirrel (*Spermophilus townsendii*), porcupine (*Erethizon dorsatum*), and coyote (*Canis latrans*); and two species of reptiles, short-horned lizard (*Phrynosoma douglassi*), and yellow-bellied racer (*Coluber constrictor*) were observed in the study area during the studies. Sign (scat) from one additional mammal, unidentified jackrabbit (*Lepus* sp.) was also found on site. Elk and mule deer were fairly common on-site. A total of 176 elk and 67 mule deer were observed in 5 and 17 groups respectively (Table 14). Both elk and mule deer were observed primarily along the ridgeline of Rattlesnake Ridge and the adjoining slopes. However, mule deer were also observed in the eastern sections of the study area which consist primarily of agricultural (wheat) fields.

4.5 Vegetation Mapping

The vegetation in the study area was classified into seven types (Table 14). Vegetation type refers to the generally recognizable assemblage of plant species that currently exists in a pattern across the landscape. Vegetation types were determined based on a visual assessment of dominant and co-dominant plant species. Vegetation types varied in quality from site to site depending on the aspect, soil depth, percentage of non-native plants, and land use, all of which can influence the extent of wildlife use within the habitat type.

Agricultural. This vegetation type consists of all lands within the study area used for the production of crops, primarily non-irrigated wheat. These areas provide foraging and cover areas for some common wildlife species such as horned larks and western meadowlarks. Agriculture also provides foraging areas for raptors due, presumably, to a concentration or abundance of small mammals. Agricultural habitat is found in the eastern portion of the study area (Figure 6).

Riparian. Riparian habitat includes those areas adjacent to streams, springs, and seeps within the study area. Riparian habitat is typically narrow and often confined within the steep walls of drainages. Tree and shrub species are common in most riparian habitat. Common tree and shrub species include chokecherry (*Prunus virginiana*), golden current (*Ribes aureum*), and red-osier dogwood (*Cornus sericea* ssp. *sericea*) in the higher elevation riparian habitat, and black cottonwood (*Populus balsamifera* ssp. *trichocarpa*) and various willows (*Salix* spp.) in the lower elevations. Common understory plants

include various rush species (*Juncus* spp.), speedwell species (*Veronica* spp.), and mesic grasses such as spike bentgrass (*Agrostis exarata*) and slender hairgrass (*Deschampsia elongata*). Riparian areas are of high value to wildlife for water, food, and shelter throughout the year. Where trees are present, riparian areas provide habitat for nesting birds, particularly raptors. They also serve as travel corridors for wildlife.

Shrub-Steppe. Big sagebrush and/or threetip sage (*Artemisia tripartita*) are the dominant shrub species in the shrub-steppe habitat type. Big sagebrush is more common at the lower elevations in deeper soils, where in some areas it reaches 4 to 5 feet tall. Threetip sage is more common on the upper slopes in drier, shallower soils. Bluebunch wheatgrass and cheatgrass are the most common grasses associated with this habitat type; Idaho fescue (*Festuca idahoensis*), Sandberg's bluegrass, and Cusick's bluegrass (*Poa cusickii*) also occur. Common forbs include longleaf phlox (*Phlox longifolia*), yarrow (*Achillea millifolium*), sulphur lupine (*Lupinus sulphureus*), and largeflower triteleia (*Triteleia grandiflora* var. *grandiflora*). Some areas of shrub-steppe habitat show evidence of recent burns. The condition of this habitat type in the study area ranges from poor quality (heavily grazed and weedy) to good quality (lightly grazed, vigorous shrubs) habitat. The shrub-steppe provides important habitat for many species; for example, deer and small game find escape cover, breeding habitat, and forage in the shrub-steppe. Several State candidate species, loggerhead shrike, sage thrasher, and sage sparrow also utilize the shrub-steppe type for cover and nesting.

Grassland-Steppe. The grassland-steppe encompasses those areas where grass species are dominant; however, scattered shrubs (low density) also occur. Much of the grassland-steppe is dominated by cheatgrass; other common grass species found include bulbous bluegrass (*Poa bulbosa*) and varying amounts of native grasses, such as bluebunch wheatgrass, Sandberg's bluegrass, and Idaho fescue. In some isolated moist areas, giant wildrye is dominant. Common forbs include longleaf phlox and sulphur lupine. The grassland-steppe tends to occur at higher elevations and on steeper slopes than the shrub-steppe, and those areas where the soils appear to be shallower. Like the shrub-steppe, the grassland-steppe is subject to grazing with habitat quality varying from poor to good. The grassland-steppe provides cover, breeding habitat, and forage for a variety of bird and wildlife species.

Lithosol Habitat. The lithosol habitat is a subset of the grassland-steppe. Lithosol refers to areas of exposed shallow, rocky soils, as found along some areas of the ridgetop. In this habitat, various buckwheats (*Eriogonum* spp.) and Sandberg's bluegrass are dominant. Vegetative cover is sparse. This habitat appears to provide limited value for birds and other wildlife; however, it likely receives occasional use by various birds, small mammals, and reptiles (e.g., short-horned lizard) and creates a mosaic of steppe habitats where it is present, increasing species diversity and habitat variability.

Rocky Outcrop/Shrub. This habitat type is found on the upper steep, north-facing slope of Rattlesnake Hill. This habitat is limited in size, making up only a small portion of the total habitat in the study area. Dominant shrub species include chokecherry and squaw current. Although small in size, this habitat type provides habitat for nesting birds,

including raptors, as well as food and shelter throughout the year for passerines and upland game species.

Wetlands. The wetland habitat type includes those areas that may meet the Army Corps of Engineers' (ACOE) definition of a wetland and may be regulated by that agency. In the study area, six locations qualify as wetlands; five are associated with springs and the sixth is located along Sulphur Creek where the access road crosses the creek. The wetland habitats are very small in size (0.04 acres or less), and are heavily used by cattle. Common plant species associated with the wetlands include celery-leaved buttercup (*Ranunculus sceleratus*), yellow monkeyflower (*Mimulus guttatus*), speedwell (*Veronica anagallis-aquatica*), and water-cress (*Rorippa nasturtium-aquaticum*). Although the wetlands receive heavy cattle use, they also provide important habitat and water sources for other species such as big game, reptiles, songbirds, bats, and game birds, which will concentrate their activities near these watering sites at various times of the year.

5.0 SUMMARY AND DISCUSSION

5.1 Avian Use

Based on the fixed-point surveys, three species made up the vast majority of observations: horned lark, common raven, and western meadowlark. Together these three species comprised nearly three-quarters of all birds observed during the fixed-point surveys. This trend held across all seasons. On average, slightly more than 7 horned larks, slightly more than 1 raven, and approximately 1 western meadowlark were observed during every 30-minute survey. The fourth most common bird recorded was unidentified passerine followed by vesper sparrow. It is likely that many of the unidentified passerines recorded were actually horned larks, based on the abundance of this species on the site, but were at distances from observers that made identification difficult. Highest passerine use occurred during the fall and winter due primarily to large flocks of horned larks observed during these seasons (Figure 6).

The paired-plot surveys were designed to target breeding grassland/shrub-steppe species that occupy the site. Use estimates from these surveys reflect the fixed-point survey results, with the exception that common raven drops out of the three most abundant species (based on use) and is replaced by vesper sparrow, the fifth most abundant species during fixed-point surveys.

Over all three seasons, the most abundant raptors observed in order were northern harrier, American kestrel, red-tailed hawk, and Swainson's hawk. On average approximately one northern harrier was observed every 7 surveys, one American kestrel every 11 surveys, one red-tailed hawk every 12 surveys, and one Swainson's hawk was observed every 16 surveys. The most abundant raptor varied by season, however, and raptor use and raptor species observed were highest in the fall (Table 2, Figure 8). As expected, and similar to most other wind sites studied, raptor use dropped substantially during the winter.

5.2 Species Diversity

Frequency of occurrence and percent composition were calculated to provide a relative estimate of the avian diversity of the study area. These statistics reflect the results of the use calculations in that there is relatively low species diversity on the site with three species (horned lark, common raven, western meadowlark) making up the vast majority of the observations. For example, these three species were the only species observed in more than 30% of the surveys with the vast majority of species observed in less than 5% of the surveys (336 total surveys), and comprised more than three-quarters of all bird use at the site (76.5%). Horned larks had the greatest influence on these statistics. They were observed during more than 74% of all surveys and comprised greater than 61% of all bird use.

The most frequently observed raptor was northern harrier, seen in approximately 12% of all surveys but comprising only 1.2% of all bird use. American kestrel was seen in

approximately 8% of all surveys and comprised 0.9% of all birds use. Overall, raptors as a group comprised 4.7% of all bird use with less than one raptor observed during each 30-minute survey (0.56). In contrast, due primarily to the abundance of horned larks on the site, passerines comprised nearly 85% of all bird observations and approximately 10 passerines were observed during each 30-minute survey.

5.3 Risk of Turbine Collision

5.3.1 Exposure Index

The species with the highest exposure indices for the site were common raven, gray-crowned rosy finch, and horned lark (Table 7). Horned lark is by far the most abundant species observed, but was nearly always observed below the zone of risk, whereas the one observation of a flock of 52 rosy finches was observed flying within the zone of risk. Mortality studies at other wind plants have indicated that although ravens are often observed at wind plants within the zone of risk, they appear to be less susceptible to collision with wind turbines than other similar size birds (e.g., raptors, waterfowl). Raptor species with the highest exposure index include Swainson's hawk, red-tailed hawk and northern harrier. Although northern harrier and American kestrel were the most abundant raptor species observed, both species were observed less often in the zone of risk than the buteo species.

5.3.2 Raptors

Based on the relative low use of the study area by raptors, potential raptor mortality for this project is expected to be low. One potentially confounding factor is the presence of three active raptor nests (one ferruginous hawk, one red-tailed hawk, one prairie falcon) in the study area during the 2001 raptor nest survey that were within 0.25 to 0.5 mile of proposed project features. The presence of these nests may put adult birds of the nesting pair at greater risk while they actively attend young in the nest and may put fledgling juveniles at risk due simply to their proximity to turbines. The raptors expected to be most at risk of collision are the species most abundant in the study area, American kestrel, northern harrier, and red-tailed hawk. All three of these species have also been casualties at other studied wind plants (see Erickson *et al.* 2001).

Raptor use of the Maiden site was similar to other wind plants studied. As a group, overall raptor use of the study area was approximately 0.56 raptors observed per 30-minute survey or roughly one raptor observed every 1.8 surveys. For comparison, raptor use at three wind plants studied with the same methods⁵ varied from slightly lower to much higher. Raptor use at the Vansycle Wind Plant was approximately 0.55 raptors per 30-minute survey; at the Buffalo Ridge Wind Plant raptor use was approximately 0.74 raptors per 30-minute survey; and at the Foote Creek Rim Wind Plant raptor use was approximately 1.10 raptors per 30-minute survey.

Raptor mortality at other newer generation wind plants is very low. The estimate of raptor mortality at the Foote Creek Rim Wind Plant in Wyoming is the highest observed

⁵ Fixed-point surveys were conducted following the same methods at all three wind plants but had variable survey duration. The calculated use at these wind plants was standardized to 30-minute duration surveys under the assumption that raptor observations were uniform across time for each survey period.

and is 0.036 raptors per turbine per year based on a two-year study of 69 turbines (Erickson *et al.* 2001). No raptor mortality was observed at the Vansycle Wind Plant in Oregon during a one-year study; and 0.001 raptors per turbine per year were found at the Buffalo Ridge Wind Plant in Minnesota during a four-year study (Erickson *et al.* 2001).

Considering these mortality results as well as raptor use estimates at these wind plants, it is estimated that potential mortality of raptors at the proposed project would be less than one-half that of the Foote Creek Rim Wind Plant (or less than 0.016 raptors per turbine per year); approximately equal to that of the Buffalo Ridge Wind Plant (or approximately 0.001 raptor per turbine per year); or slightly greater than that of the Vansycle Wind Plant (or greater than 0 raptors per turbine per year). Using these raptor mortality rates, a range of 0 to 9 raptor fatalities per year at the Maiden Wind Farm could occur if all 549 turbines were constructed. This estimate would be lower if only a portion of the wind plant is constructed.

5.3.3 *Passerines*

Passerines have been the most abundant avian fatality at other wind plants studied (see Johnson *et al.* 2000, Young *et al.* 2001, Erickson *et al.* 2000), often comprising more than 80% of the avian fatalities. Both migrant and resident passerine fatalities have been observed. Given that passerines make up the vast majority of the avian observations on-site, it is expected passerines would make up the largest proportion of fatalities. Common species such as horned larks, western meadowlarks and vesper sparrows (all confirmed casualties at other wind plants) would be most at risk. Nocturnal migrating species may also be affected, but would not be expected to be found in large numbers based on data collected at other wind plants [i.e., no large mortality events documented at wind plants (Erickson *et al.* 2001)].

Carcass search studies at the Foote Creek Rim Wind Plant, Wyoming, have found avian casualties associated with guyed met towers. Based on searches of five permanent met towers at Foote Creek Rim over a two-year period, it was estimated that these towers resulted in 7.5 avian casualties per tower per year, the majority of which were passerines (Young *et al.* 2001). The four permanent met towers proposed for the project, if guyed, would be expected to result in collision deaths for passerines at the site.

5.3.4 *Waterfowl*

Some waterfowl mortality has been documented at other wind plants (Johnson *et al.* 2000), although studies at Foote Creek Rim, Vansycle, and Buffalo Ridge have not documented mortality of Canada geese, one of two waterfowl species observed flying over the Maiden study area. Because of the low use of the site by waterfowl, no waterfowl mortality would be expected from the project.

5.3.5 *Other Groups/Species*

Other avian groups (e.g., upland game birds, doves, shorebirds) occur in relatively low numbers within the study area and mortality would be expected to be low. Other species only observed during migration may be at risk; however, mortality would be expected to be low given the low use estimates by other species.

5.4 Raptor Nesting

Two aerial surveys for raptor nests were completed within the raptor nest study area (RNA) (the study area plus five-mile radius buffer). The total RNA was approximately 235 square miles (609 km²) (Figure 4). Nest density for buteos (ferruginous hawk, red-tailed hawk, Swainson's hawk) was 0.04 nest/km² (0.11 nest/mi²) and for all raptors (buteos, falcons, owls) was approximately 0.06 nest/km² (0.16 nest/mi²). This index of raptor nest density falls within the range of other wind plants that have been studied. For example, the nest density in a 10-mile buffer surrounding the Foote Creek Rim Wind Plant in Wyoming is 0.07 nest/km² (0.19 nest/mi²) (Johnson *et al.*, 2000b). Nest density within a 2-mile buffer around the Stateline Wind Plant in Oregon and Washington is 0.08 nest/km² (0.20 nest/mi²) (URS and WEST 2001).

5.5 Mitigation and Monitoring

5.5.1 Technical Advisory Committee

It is recommended that a Technical Advisory Committee (TAC) be formed to evaluate the mitigation and monitoring program and determine the need for further studies or further mitigation measures should the project go forward. The TAC should be composed of representatives from Bonneville Power Administration, Washington Department of Fish and Wildlife, U.S. Fish and Wildlife Service, Yakima and Benton Counties, landowners, and the project proponent. The role of the TAC will be to coordinate appropriate habitat and avian fatality mitigation measures, monitor impacts to wildlife and habitat, and address issues that arise regarding wildlife impacts during construction and operation of the wind plant. The post-construction monitoring plan should be developed in coordination with the TAC.

5.5.2 Mitigation Measures

The following are potential mitigation measures for impacts to wildlife from construction and operation of the Maiden Wind Farm:

- An environmental inspector should be designated by the Technical Advisory Committee (TAC) (see above) and/or BPA to monitor construction activity and ensure compliance with the mitigation measures.
- Sensitive habitat areas such as the springs, riparian corridors, and raptor nest sites should be mapped, flagged, and identified to all contractors working on-site and should be designated as no disturbance zones during the construction phase. If any new nesting, denning, or otherwise sensitive wildlife sites are located during construction, these areas should also be mapped and flagged and included in the off-limit areas.
- During project construction, best management practices should be employed to reduce peripheral impacts to adjacent vegetation and habitats and to minimize the construction footprint.

- A site management plan should be developed in coordination with the TAC to address the following items at a minimum:
 - minimizing road construction and vehicle use where possible to reduce impacts to shrub-steppe habitats
 - educating construction personnel to the sensitive nature of the habitat and wildlife resources
 - maintaining and enforcing reasonable driving speeds so as not to harass or accidentally strike wildlife
 - providing adequate on-site waste disposal
 - identifying off-limit zones
 - identifying fire management and erosion control procedures.
- The raptor nests on-site should be monitored for activity prior to construction of the wind plant to determine the need for construction timing restrictions around the nests or adjustment to the project design to avoid impacts.
- Consideration should be made for moving or eliminating all turbines within 0.25 mile of raptor nests on-site.
- All power and communication lines on-site should be buried underground where feasible.
- Consideration should be made for using free standing non-guyed met towers on-site.

5.5.3 Monitoring

A post construction monitoring study is recommended for the project to quantify impacts to avian species and assess the adequacy of mitigation measures implemented. A monitoring plan for the project should consider the following components: 1) fatality monitoring involving standardized carcass searches, scavenger removal trials, searcher efficiency trials, and reporting of incidental fatalities by maintenance personnel and others; 2) a minimum of one breeding season of post construction paired-plot surveys; 3) a minimum of one post construction breeding season raptor nest survey of the study area and a 2-mile buffer to locate active raptor nests potentially affected by the construction and operation of the wind plant.

The protocol for the fatality monitoring study should be similar to protocols used at the Vansycle Wind Plant in northeastern Oregon (Erickson *et al.* 2000) and the Stateline Wind Plant in Washington and Oregon (FPL *et al.* 2001).

6.0 REFERENCES & LITERATURE CITED

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Table 1. Avian species/groups observed while conducting fixed-point surveys (April 20, 2001 - April 11, 2002) on the Maiden Project Site. ^a

Species/Group	Summer		Fall		Winter		Spring		Grand Total	
	#	#	#	#	#	#	#	#	#	#
	obs. ^b	groups ^c	obs.	groups	obs.	groups	obs.	groups	obs.	groups
Waterfowl										
Canada Goose	15	1	0	0	140	1	0	0	155	2
Mallard	0	0	0	0	8	1	0	0	8	1
Subtotal	15	1	0	0	148	2	0	0	163	3
Shorebirds										
Killdeer	0	0	1	1	0	0	0	0	1	1
Corvids										
Black-billed Magpie	2	2	7	5	2	2	0	0	11	9
Common Raven	79	45	172	68	138	75	55	39	444	227
Subtotal	81	47	179	73	140	77	55	39	455	236
Upland Gamebirds										
California Quail	0	0	0	0	0	0	2	1	2	1
Chukar	7	3	6	2	0	0	4	3	17	8
Gray (Hungarian) Partridge	0	0	4	1	0	0	0	0	4	1
Ring-necked Pheasant	1	1	0	0	0	0	2	2	3	3
Subtotal	8	4	10	3	0	0	8	6	26	13
Doves										
mourning dove	5	3	14	1	0	0	2	1	21	5
Raptors										
<i>Accipiter</i>										
Cooper's Hawk	0	0	4	4	0	0	0	0	4	4
Sharp-shinned Hawk	0	0	1	1	0	0	0	0	1	1
Unidentified Accipiter	1	1	2	2	0	0	0	0	3	3
Subtotal	1	1	7	7	0	0	0	0	8	8
<i>Buteos</i>										
Ferruginous Hawk	1	1	1	1	0	0	4	4	6	6
Rough-legged Hawk	0	0	4	4	6	6	3	3	13	13
Red-tailed Hawk	16	14	10	7	0	0	4	4	30	25
Swainson's Hawk	20	14	3	2	0	0	3	3	26	19
Unidentified Buteo	9	7	13	9	8	5	10	7	40	28
Subtotal	46	36	31	23	14	11	24	21	115	91
<i>Eagles</i>										
Golden Eagle	0	0	1	1	4	3	1	1	6	5
<i>Harriers</i>										
Northern Harrier	16	16	21	19	6	6	8	8	51	49
<i>Falcons</i>										
American Kestrel	3	3	25	20	2	2	5	5	35	30
Peregrine Falcon	0	0	2	1	0	0	0	0	2	1
Prairie Falcon	2	2	6	6	2	2	2	2	12	12
Subtotal	5	5	33	27	4	4	7	7	49	43
Raptor Subtotal	68	58	93	77	28	24	40	37	229	196

Table 1. Avian species/groups observed while conducting fixed-point surveys (April 20, 2001 - April 11, 2002) on the Maiden Project Site.^a

Species/Group	Summer		Fall		Winter		Spring		Grand Total	
	#	#	#	#	#	#	#	#	#	#
	obs. ^b	groups ^c	obs.	groups	obs.	groups	obs.	groups	obs.	groups
Passerines										
American Goldfinch	1	1	0	0	522	3	0	0	523	4
American Pipit	0	0	22	2	0	0	0	0	22	2
American Robin	4	2	0	0	2	1	4	1	10	4
Barn Swallow	4	2	0	0	0	0	0	0	4	2
Brown-headed cowbird	0	0	2	1	0	0	0	0	2	1
Brewer's Sparrow	20	17	0	0	0	0	5	4	25	21
Cassin's Finch	11	3	0	0	0	0	0	0	11	3
Cliff Swallow	6	3	0	0	0	0	0	0	6	3
Dark-eyed Junco	0	0	54	13	1	1	1	1	56	15
European Starling	2	1	0	0	0	0	0	0	2	1
Golden-crowned Kinglet	0	0	3	3	0	0	1	1	4	4
Gray-crowned Rosy Finch	0	0	0	0	52	1	0	0	52	1
Grasshopper Sparrow	6	6	0	0	0	0	1	1	7	7
House Finch	3	2	0	0	20	1	0	0	23	3
Horned Lark	377	213	1148	137	650	108	262	134	2437	592
Lapland Longspur	0	0	0	0	1	1	0	0	1	1
Loggerhead Shrike	2	2	0	0	0	0	1	1	3	3
Mountain Bluebird	0	0	5	2	0	0	0	0	5	2
N. Rough-winged Swallow	0	0	20	2	0	0	0	0	20	2
Red-breasted Nuthatch	0	0	0	0	0	0	1	1	1	1
Rock Wren	6	6	2	2	0	0	3	2	11	10
Say's Phoebe	0	0	2	2	0	0	0	0	2	2
Sage Thrasher	1	1	1	1	0	0	0	0	2	2
Savannah Sparrow	1	1	0	0	0	0	2	2	3	3
Snow Bunting	0	0	0	0	8	1	0	0	8	1
Spotted Towhee	3	3	1	1	0	0	0	0	4	4
Swainson's Thrush	0	0	1	1	0	0	0	0	1	1
Tree Swallow	12	1	0	0	0	0	0	0	12	1
Varied Thrush	0	0	1	1	0	0	1	1	2	2
Vesper Sparrow	38	30	6	5	0	0	25	20	69	55
Violet-green Swallow	0	0	0	0	0	0	1	1	1	1
White-crowned Sparrow	0	0	14	3	0	0	0	0	14	3
Western Bluebird	0	0	0	0	0	0	1	1	1	1
Western Kingbird	1	1	4	3	0	0	2	1	7	5
Western Meadowlark	112	91	29	23	11	10	80	61	232	185
Western Tanager	4	1	0	0	0	0	0	0	4	1
Wilson's Warbler	0	0	1	1	0	0	0	0	1	1
Yellow-rumped Warbler	0	0	1	1	0	0	0	0	1	1
Yellow Warbler	0	0	1	1	0	0	0	0	1	1
Unidentified Blackbird	0	0	0	0	0	0	2	1	2	1
Unidentified Bluebird	0	0	0	0	0	0	1	1	1	1
Unidentified Finch	0	0	35	1	0	0	0	0	35	1
Unidentified Flycatcher	5	2	3	2	0	0	0	0	8	4
Unidentified Passerine	0	0	145	2	34	3	6	4	185	9
Unidentified Sparrow	0	0	1	1	0	0	0	0	1	1
Unidentified Swallow	4	3	7	3	0	0	1	1	12	7
Unidentified Warbler	0	0	1	1	0	0	0	0	1	1
Subtotal	623	392	1510	215	1301	130	401	240	3835	977

Table 1. Avian species/groups observed while conducting fixed-point surveys (April 20, 2001 - April 11, 2002) on the Maiden Project Site.^a

Species/Group	Summer		Fall		Winter		Spring		Grand Total	
	# obs. ^b	# groups ^c	# obs.	# groups	# obs.	# groups	# obs.	# groups	# obs.	# groups
Other Birds										
Common Nighthawk	1	1	0	0	0	0	0	0	1	1
Northern Flicker	0	0	2	2	0	0	1	1	3	3
Unidentified Hummingbird	2	2	0	0	0	0	0	0	2	2
Subtotal	3	3	2	2	0	0	1	1	6	6
Grand Total	803	508	1809	372	1617	233	507	324	4736	1437

^a Includes observations recorded at distances greater than 800 m from the observer.

^b Number of observed (individuals detected).

^c Number of groups observed. Group is defined as an observation of a species regardless of number seen together.

Table 2. Avian species/groups observed within 800 m of point and estimated mean use for fixed-point surveys (April 20, 2001 - April 11, 2002).

Species/Group	Summer Use		Fall Use		Winter Use		Spring Use		Overall Use	
	mean	st dev	mean	st dev	mean	st dev	mean	st dev	mean	st dev
Waterfowl	0.14	0.52	0.00	0.00	0.11	0.33	0.00	0.00	0.07	0.44
Canada goose	0.14	0.52	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.29
mallard	0.00	0.00	0.00	0.00	0.11	0.33	0.00	0.00	0.02	0.15
Shorebirds										
killdeer	0.00	0.00	0.01	0.04	0.00	0.00	0.00	0.00	0.00	0.02
Corvids	0.74	0.59	1.79	1.79	1.49	0.45	0.70	0.53	1.19	1.13
common raven	0.72	0.61	1.72	1.72	1.46	0.43	0.70	0.53	1.16	1.10
black-billed magpie	0.02	0.05	0.07	0.15	0.03	0.06	0.00	0.00	0.03	0.09
Upland Gamebirds	0.08	0.14	0.10	0.20	0.00	0.00	0.10	0.15	0.07	0.15
California quail	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.09	0.01	0.04
chukar	0.07	0.14	0.06	0.16	0.00	0.00	0.06	0.11	0.05	0.12
gray partridge	0.00	0.00	0.04	0.14	0.00	0.00	0.00	0.00	0.01	0.08
ring-necked pheasant	0.01	0.03	0.00	0.00	0.00	0.00	0.02	0.04	0.01	
Doves										0.03
mourning dove	0.05	0.10	0.15	0.51	0.00	0.00	0.03	0.09	0.06	0.28
Raptors	0.52	0.54	0.93	0.75	0.23	0.43	0.44	0.57	0.56	0.73
<i>Accipiters</i>	<i>0.01</i>	<i>0.03</i>	<i>0.07</i>	<i>0.10</i>	<i>0.00</i>	<i>0.00</i>	<i>0.00</i>	<i>0.00</i>	<i>0.02</i>	<i>0.06</i>
Cooper's hawk	0.00	0.00	0.04	0.08	0.00	0.00	0.00	0.00	0.01	0.05
sharp-shinned hawk	0.00	0.00	0.01	0.04	0.00	0.00	0.00	0.00	0.00	0.02
unidentified accipiter	0.01	0.03	0.02	0.05	0.00	0.00	0.00	0.00	0.01	0.03
<i>Buteos</i>	<i>0.33</i>	<i>0.32</i>	<i>0.28</i>	<i>0.16</i>	<i>0.04</i>	<i>0.07</i>	<i>0.21</i>	<i>0.31</i>	<i>0.23</i>	<i>0.26</i>
ferruginous hawk	0.01	0.03	0.01	0.04	0.00	0.00	0.06	0.18	0.02	0.08
Swainson's hawk	0.15	0.23	0.03	0.08	0.00	0.00	0.04	0.08	0.06	0.15
red-tailed hawk	0.13	0.13	0.10	0.14	0.00	0.00	0.04	0.09	0.08	0.12
rough-legged hawk	0.00	0.00	0.04	0.11	0.04	0.07	0.03	0.06	0.03	0.07
unidentified buteo	0.04	0.06	0.09	0.12	0.00	0.00	0.03	0.08	0.04	0.09
<i>Eagles</i>										
golden eagle	0.00	0.00	0.01	0.04	0.06	0.13	0.02	0.04	0.02	0.07
<i>Harriers</i>										
northern harrier	0.13	0.11	0.22	0.21	0.07	0.13	0.12	0.09	0.14	0.15
<i>Falcons</i>	<i>0.05</i>	<i>0.08</i>	<i>0.34</i>	<i>0.24</i>	<i>0.06</i>	<i>0.10</i>	<i>0.10</i>	<i>0.12</i>	<i>0.15</i>	<i>0.19</i>
American kestrel	0.03	0.07	0.26	0.25	0.03	0.08	0.07	0.08	0.10	0.18
prairie falcon	0.02	0.05	0.06	0.08	0.04	0.07	0.03	0.06	0.04	0.07
peregrine falcon	0.00	0.00	0.02	0.07	0.00	0.00	0.00	0.00	0.01	0.04
Passerines	5.99	2.36	15.73	13.59	11.21	10.36	5.97	1.46	9.89	9.52
American goldfinch	0.01	0.03	0.00	0.00	0.31	0.66	0.00	0.00	0.07	0.32
American pipit	0.00	0.00	0.23	0.79	0.00	0.00	0.00	0.00	0.07	0.42
American robin	0.04	0.11	0.00	0.00	0.03	0.08	0.06	0.18	0.03	0.10
barn swallow	0.04	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.06
Brewer's sparrow	0.19	0.27	0.00	0.00	0.00	0.00	0.07	0.11	0.07	0.18

Table 2. Avian species/groups observed within 800 m of point and estimated mean use for fixed-point surveys (April 20, 2001 - April 11, 2002).

Species/Group	Summer Use		Fall Use		Winter Use		Spring Use		Overall Use	
	mean	st dev	mean	st dev	mean	st dev	mean	st dev	mean	st dev
brown-headed cowbird	0.00	0.00	0.02	0.07	0.00	0.00	0.00	0.00	0.01	0.04
Cassin's finch	0.11	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.14
cliff swallow	0.06	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.09
dark-eyed junco	0.00	0.00	0.56	1.12	0.01	0.04	0.02	0.04	0.17	0.63
European starling	0.02	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.04
golden-crowned kinglet	0.00	0.00	0.03	0.08	0.00	0.00	0.02	0.04	0.01	0.05
grasshopper sparrow	0.06	0.06	0.00	0.00	0.00	0.00	0.02	0.04	0.02	0.05
gray-crowned rosy finch	0.00	0.00	0.00	0.00	0.72	2.17	0.00	0.00	0.15	1.00
horned lark	3.63	1.29	11.96	13.78	9.11	10.80	3.94	1.88	7.24	9.40
house finch	0.03	0.07	0.00	0.00	0.28	0.83	0.00	0.00	0.07	0.39
lapland longspur	0.00	0.00	0.00	0.00	0.01	0.04	0.00	0.00	0.00	0.02
loggerhead shrike	0.02	0.07	0.00	0.00	0.00	0.00	0.02	0.04	0.01	0.04
mountain bluebird	0.00	0.00	0.05	0.18	0.00	0.00	0.00	0.00	0.01	0.10
n. rough-winged swall.	0.00	0.00	0.21	0.68	0.00	0.00	0.00	0.00	0.06	0.37
red-breasted nuthatch	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.04	0.00	0.02
rock wren	0.06	0.10	0.02	0.05	0.00	0.00	0.05	0.09	0.03	0.07
sage thrasher	0.01	0.03	0.01	0.04	0.00	0.00	0.00	0.00	0.01	0.03
savannah sparrow	0.01	0.03	0.00	0.00	0.00	0.00	0.03	0.08	0.01	0.04
Say's phoebe	0.00	0.00	0.02	0.05	0.00	0.00	0.00	0.00	0.01	0.03
snow bunting	0.00	0.00	0.00	0.00	0.11	0.33	0.00	0.00	0.02	0.15
spotted towhee	0.03	0.07	0.01	0.04	0.00	0.00	0.00	0.00	0.01	0.05
Swainson's thrush	0.00	0.00	0.01	0.04	0.00	0.00	0.00	0.00	0.00	0.02
tree swallow	0.12	0.42	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.23
unidentified blackbird	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.09	0.01	0.04
unidentified bluebird	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.04	0.00	0.02
unidentified finch	0.00	0.00	0.36	1.26	0.00	0.00	0.00	0.00	0.10	0.68
unidentified flycatcher	0.05	0.14	0.03	0.08	0.00	0.00	0.00	0.00	0.02	0.09
unidentified passerine	0.00	0.00	1.51	5.23	0.47	1.32	0.08	0.16	0.55	2.85
unidentified sparrow	0.00	0.00	0.01	0.04	0.00	0.00	0.00	0.00	0.00	0.02
unidentified swallow	0.04	0.08	0.07	0.22	0.00	0.00	0.01	0.04	0.04	0.12
unidentified warbler	0.00	0.00	0.01	0.04	0.00	0.00	0.00	0.00	0.00	0.02
varied thrush	0.00	0.00	0.01	0.04	0.00	0.00	0.02	0.04	0.01	0.03
vesper sparrow	0.37	0.36	0.06	0.08	0.00	0.00	0.36	0.26	0.20	0.28
violet-green swallow	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.04	0.00	0.02
western bluebird	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.04	0.00	0.02
western kingbird	0.01	0.03	0.04	0.08	0.00	0.00	0.03	0.09	0.02	0.06
western meadowlark	1.08	0.71	0.30	0.25	0.15	0.29	1.16	0.80	0.67	0.70
western tanager	0.04	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.08
white-crowned sparrow	0.00	0.00	0.15	0.38	0.00	0.00	0.00	0.00	0.04	0.21
Wilson's warbler	0.00	0.00	0.01	0.04	0.00	0.00	0.00	0.00	0.00	0.02
yellow warbler	0.00	0.00	0.01	0.04	0.00	0.00	0.00	0.00	0.00	0.02
yellow-rumped warbler	0.00	0.00	0.01	0.04	0.00	0.00	0.00	0.00	0.00	0.02
Other Birds	0.03	0.05	0.02	0.05	0.00	0.00	0.02	0.04	0.02	0.04
common nighthawk	0.01	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
northern flicker	0.00	0.00	0.02	0.05	0.00	0.00	0.02	0.04	0.01	0.03
unid'd hummingbird	0.02	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03
All Birds	7.55	13.92	18.73	1.73	13.03	2.53	7.27	10.47	11.86	18.16

Table 3. Avian species/groups observed within 800 m of point and estimated frequency of occurrence for fixed-point surveys (April 20, 2001-April 11, 2002).

Species/Group	Summer % Freq	Fall % Freq	Winter % Freq	Spring % Freq	Overall % Freq
Waterfowl	0.96	0.00	1.39	0.00	0.60
Canada goose	0.96	0.00	0.00	0.00	0.30
mallard	0.00	0.00	1.39	0.00	0.30
Shorebirds					
killdeer	0.00	1.04	0.00	0.00	0.30
Corvids	32.69	52.08	60.83	40.21	45.69
common raven	30.77	50.00	60.83	40.21	44.50
black-billed magpie	1.92	5.21	2.78	0.00	2.68
Upland Gamebirds	3.85	3.13	0.00	4.38	2.92
California quail	0.00	0.00	0.00	1.56	0.30
Chukar	2.88	2.08	0.00	2.81	2.02
gray partridge	0.00	1.04	0.00	0.00	0.30
ring-necked pheasant	0.96	0.00	0.00	1.56	0.60
Doves					
mourning Dove	2.88	1.04	0.00	1.56	1.49
Raptors	43.27	70.83	18.33	37.12	44.63
<i>Accipiters</i>	<i>0.96</i>	<i>7.29</i>	<i>0.00</i>	<i>0.00</i>	<i>2.38</i>
Cooper's hawk	0.00	4.17	0.00	0.00	1.19
sharp-shinned hawk	0.00	1.04	0.00	0.00	0.30
unidentified accipiter	0.96	2.08	0.00	0.00	0.89
<i>Buteos</i>	<i>24.04</i>	<i>20.83</i>	<i>3.61</i>	<i>14.48</i>	<i>16.92</i>
ferruginous hawk	0.96	1.04	0.00	4.69	1.49
Swainson's hawk	9.62	2.08	0.00	4.03	4.34
red-tailed hawk	10.58	6.25	0.00	4.38	5.89
rough-legged hawk	0.00	4.17	3.61	3.13	2.56
unidentified buteo	3.85	7.29	0.00	1.39	3.54
<i>Eagles</i>					
golden eagle	0.00	1.04	2.78	1.56	1.19
<i>Harriers</i>					
northern harrier	13.46	15.63	5.56	12.01	12.11
<i>Falcons</i>	<i>4.81</i>	<i>26.04</i>	<i>6.39</i>	<i>9.06</i>	<i>12.02</i>
American kestrel	2.88	18.75	2.78	5.94	7.98
prairie falcon	1.92	6.25	3.61	3.13	3.75
peregrine falcon	0.00	1.04	0.00	0.00	0.30
Passerines	94.23	83.33	69.72	89.06	84.88
American goldfinch	0.96	0.00	2.78	0.00	0.89
American pipit	0.00	2.08	0.00	0.00	0.60
American robin	1.92	0.00	1.39	1.56	1.19
barn swallow	1.92	0.00	0.00	0.00	0.60

Table 3. Avian species/groups observed within 800 m of point and estimated frequency of occurrence for fixed-point surveys (April 20, 2001-April 11, 2002).

Species/Group	Summer % Freq	Fall % Freq	Winter % Freq	Spring % Freq	Overall % Freq
Brewer's sparrow	14.42	0.00	0.00	6.08	5.62
brown-headed cowbird	0.00	1.04	0.00	0.00	0.30
Cassin's finch	2.88	0.00	0.00	0.00	0.89
cliff swallow	2.88	0.00	0.00	0.00	0.89
dark-eyed junco	0.00	8.33	1.39	1.56	2.98
European starling	0.96	0.00	0.00	0.00	0.30
golden-crowned kinglet	0.00	2.08	0.00	1.56	0.89
grasshopper sparrow	5.77	0.00	0.00	1.56	2.08
gray-crowned rosy finch	0.00	0.00	1.39	0.00	0.30
horned lark	85.58	66.67	62.78	79.86	74.20
house finch	1.92	0.00	1.39	0.00	0.89
lapland longspur	0.00	0.00	1.39	0.00	0.30
loggerhead shrike	0.96	0.00	0.00	1.56	0.60
mountain bluebird	0.00	2.08	0.00	0.00	0.60
n. rough-winged swallow	0.00	2.08	0.00	0.00	0.60
red-breasted nuthatch	0.00	0.00	0.00	1.25	0.24
rock wren	5.77	2.08	0.00	3.13	2.98
sage thrasher	0.96	1.04	0.00	0.00	0.60
savannah sparrow	0.96	0.00	0.00	1.39	0.56
Say's phoebe	0.00	2.08	0.00	0.00	0.60
snow bunting	0.00	0.00	1.39	0.00	0.30
spotted towhee	1.92	1.04	0.00	0.00	0.89
Swainson's thrush	0.00	1.04	0.00	0.00	0.30
tree swallow	0.96	0.00	0.00	0.00	0.30
unidentified blackbird	0.00	0.00	0.00	1.56	0.30
unidentified bluebird	0.00	0.00	0.00	1.56	0.30
unidentified finch	0.00	1.04	0.00	0.00	0.30
unidentified flycatcher	1.92	2.08	0.00	0.00	1.19
unidentified passerine	0.00	1.04	4.17	5.31	2.20
unidentified sparrow	0.00	1.04	0.00	0.00	0.30
unidentified swallow	2.88	3.13	0.00	1.39	2.05
unidentified warbler	0.00	1.04	0.00	0.00	0.30
varied thrush	0.00	1.04	0.00	1.56	0.60
vesper sparrow	23.08	5.21	0.00	23.37	13.08
violet-green swallow	0.00	0.00	0.00	1.25	0.24
western bluebird	0.00	0.00	0.00	1.56	0.30
western kingbird	0.96	3.13	0.00	1.56	1.49
western meadowlark	49.04	18.75	9.72	54.10	32.92
western tanager	0.96	0.00	0.00	0.00	0.30
white-crowned sparrow	0.00	2.08	0.00	0.00	0.60
Wilson's warbler	0.00	1.04	0.00	0.00	0.30
yellow warbler	0.00	1.04	0.00	0.00	0.30
yellow-rumped warbler	0.00	1.04	0.00	0.00	0.30
Other Birds	2.88	2.08	0.00	1.56	1.79
common nighthawk	0.96	0.00	0.00	0.00	0.30
northern flicker	0.00	2.08	0.00	1.56	0.89
unidentified hummingbird	1.92	0.00	0.00	0.00	0.60

Table 4. Avian species/groups observed within 800 m of point and estimated group composition for fixed-point surveys (April 20, 2001- April 11, 2002).

Species/Group	Summer % Comp	Fall % Comp	Winter % Comp	Spring % Comp	Overall % Comp
Waterfowl	1.91	0.00	0.85	0.00	0.58
Canada goose	1.91	0.00	0.00	0.00	0.38
mallard	0.00	0.00	0.85	0.00	0.20
Shorebirds					
killdeer	0.00	0.06	0.00	0.00	0.03
Corvids	9.81	9.57	11.40	9.70	10.06
common raven	9.55	9.18	11.19	9.70	9.79
black-billed magpie	0.25	0.39	0.21	0.00	0.28
Gamebirds	1.02	0.56	0.00	1.42	0.62
California quail	0.00	0.00	0.00	0.43	0.05
chukar	0.89	0.33	0.00	0.77	0.42
gray partridge	0.00	0.22	0.00	0.00	0.10
ring-necked pheasant	0.13	0.00	0.00	0.22	0.05
Doves					
mourning dove	0.64	0.78	0.00	0.43	0.53
Raptors	6.88	4.95	1.73	6.12	4.71
<i>Accipiters</i>	<i>0.13</i>	<i>0.39</i>	<i>0.00</i>	<i>0.00</i>	<i>0.20</i>
Cooper's hawk	0.00	0.22	0.00	0.00	0.10
sharp-shinned hawk	0.00	0.06	0.00	0.00	0.03
unidentified accipiter	0.13	0.11	0.00	0.00	0.08
<i>Buteos</i>	<i>4.33</i>	<i>1.50</i>	<i>0.28</i>	<i>2.83</i>	<i>1.93</i>
ferruginous hawk	0.13	0.06	0.00	0.86	0.15
Swainson's hawk	2.04	0.17	0.00	0.55	0.54
red-tailed hawk	1.66	0.56	0.00	0.60	0.65
rough-legged hawk	0.00	0.22	0.28	0.43	0.22
unidentified buteo	0.51	0.50	0.00	0.38	0.37
<i>Eagles</i>					
golden eagle	0.00	0.06	0.43	0.22	0.15
<i>Harriers</i>					
northern harrier	1.78	1.17	0.53	1.65	1.20
<i>Falcons</i>	<i>0.64</i>	<i>1.84</i>	<i>0.49</i>	<i>1.42</i>	<i>1.23</i>
American kestrel	0.38	1.39	0.21	0.99	0.87
prairie falcon	0.25	0.33	0.28	0.43	0.32
peregrine falcon	0.00	0.11	0.00	0.00	0.05
Passerines	79.36	83.98	86.02	82.12	83.33
American goldfinch	0.13	0.00	2.34	0.00	0.58
American pipit	0.00	1.22	0.00	0.00	0.55
American robin	0.51	0.00	0.21	0.86	0.25
barn swallow	0.51	0.00	0.00	0.00	0.10

Table 4. Avian species/groups observed within 800 m of point and estimated group composition for fixed-point surveys (April 20, 2001- April 11, 2002).

Species/Group	Summer % Comp	Fall % Comp	Winter % Comp	Spring % Comp	Overall % Comp
Brewer's sparrow	2.55	0.00	0.00	1.03	0.62
brown-headed cowbird	0.00	0.11	0.00	0.00	0.05
Cassin's finch	1.40	0.00	0.00	0.00	0.28
cliff swallow	0.76	0.00	0.00	0.00	0.15
dark-eyed junco	0.00	3.00	0.11	0.22	1.40
European starling	0.25	0.00	0.00	0.00	0.05
golden-crowned kinglet	0.00	0.17	0.00	0.22	0.10
grasshopper sparrow	0.76	0.00	0.00	0.22	0.18
gray-crowned rosy finch	0.00	0.00	5.54	0.00	1.30
horned lark	48.03	63.85	69.92	54.25	61.04
house finch	0.38	0.00	2.13	0.00	0.58
lapland longspur	0.00	0.00	0.11	0.00	0.03
loggerhead shrike	0.25	0.00	0.00	0.22	0.08
mountain bluebird	0.00	0.28	0.00	0.00	0.13
n. rough-winged swallow	0.00	1.11	0.00	0.00	0.50
red-breasted nuthatch	0.00	0.00	0.00	0.17	0.02
rock wren	0.76	0.11	0.00	0.65	0.28
sage thrasher	0.13	0.06	0.00	0.00	0.05
savannah sparrow	0.13	0.00	0.00	0.38	0.07
Say's phoebe	0.00	0.11	0.00	0.00	0.05
snow bunting	0.00	0.00	0.85	0.00	0.20
spotted towhee	0.38	0.06	0.00	0.00	0.10
Swainson's thrush	0.00	0.06	0.00	0.00	0.03
tree swallow	1.53	0.00	0.00	0.00	0.30
unidentified blackbird	0.00	0.00	0.00	0.43	0.05
unidentified bluebird	0.00	0.00	0.00	0.22	0.03
unidentified finch	0.00	1.95	0.00	0.00	0.88
unidentified flycatcher	0.64	0.17	0.00	0.00	0.20
unidentified passerine	0.00	8.06	3.62	1.12	4.62
unidentified sparrow	0.00	0.06	0.00	0.00	0.03
unidentified swallow	0.51	0.39	0.00	0.19	0.30
unidentified warbler	0.00	0.06	0.00	0.00	0.03
varied thrush	0.00	0.06	0.00	0.22	0.05
vesper sparrow	4.84	0.33	0.00	5.00	1.69
violet-green swallow	0.00	0.00	0.00	0.17	0.02
western bluebird	0.00	0.00	0.00	0.22	0.03
western kingbird	0.13	0.22	0.00	0.43	0.18
western meadowlark	14.27	1.61	1.17	15.94	5.67
western tanager	0.51	0.00	0.00	0.00	0.10
white-crowned sparrow	0.00	0.78	0.00	0.00	0.35
Wilson's warbler	0.00	0.06	0.00	0.00	0.03
yellow warbler	0.00	0.06	0.00	0.00	0.03
yellow-rumped warbler	0.00	0.06	0.00	0.00	0.03
Other Birds	0.38	0.11	0.00	0.22	0.15
common nighthawk	0.13	0.00	0.00	0.00	0.03
northern flicker	0.00	0.11	0.00	0.22	0.08
unid'd hummingbird	0.25	0.00	0.00	0.00	0.05

Table 5. Flight height characteristics by species observed during fixed-point surveys.

Species/Group	# groups flying	# birds flying	% birds flying	25-125 m above ground level		
				below	within	above
Waterfowl	3	163	100.00	0.00	85.89	14.11
Canada goose	2	155	100.00	0.00	90.32	9.68
mallard	1	8	100.00	0.00	0.00	100.00
Shorebirds						
killdeer	0	0	0.00	N/A	N/A	N/A
Corvids	182	345	75.82	47.83	50.72	1.45
common raven	179	342	77.03	47.37	51.17	1.46
black-billed magpie	3	3	27.27	100.00	0.00	0.00
Upland Gamebirds	0	0	0.00	N/A	N/A	N/A
California quail	0	0	0.00	N/A	N/A	N/A
chukar	0	0	0.00	N/A	N/A	N/A
gray partridge	0	0	0.00	N/A	N/A	N/A
ring-necked pheasant	0	0	0.00	N/A	N/A	N/A
Doves						
mourning dove	3	17	80.95	100.00	0.00	0.00
Raptors	180	207	90.39	33.33	48.31	18.36
<i>Accipiters</i>						
Cooper's hawk	4	4	100.00	25.00	50.00	25.00
sharp-shinned hawk	1	1	100.00	0.00	100.00	0.00
unidentified accipiter	2	2	66.67	50.00	0.00	50.00
<i>Buteos</i>						
ferruginous hawk	6	6	100.00	50.00	50.00	0.00
Swainson's hawk	19	26	100.00	3.85	73.08	23.08
red-tailed hawk	24	29	96.67	10.34	58.62	31.03
rough-legged hawk	13	13	100.00	0.00	84.62	15.38
unidentified buteo	24	34	85.00	2.94	61.76	35.29
<i>Eagles</i>						
golden eagle	5	6	100.00	0.00	33.33	66.67
<i>Harriers</i>						
northern harrier	48	50	98.04	78.00	20.00	2.00
<i>Falcons</i>						
American kestrel	24	25	71.43	80.00	16.00	4.00
prairie falcon	9	9	75.00	0.00	88.89	11.11
peregrine falcon	1	2	100.00	0.00	100.00	0.00
Passerines	3	17	80.95	100.00	0.00	0.00
American goldfinch	3	522	99.81	100.00	0.00	0.00
American pipit	1	18	81.82	100.00	0.00	0.00
American robin	1	2	20.00	0.00	100.00	0.00
barn swallow	2	4	100.00	100.00	0.00	0.00
Brewer's sparrow	4	5	20.00	60.00	40.00	0.00

Table 5. Flight height characteristics by species observed during fixed-point surveys.

Species/Group	# groups flying	# birds flying	% birds flying	25-125 m above ground level		
				below	within	above
brown-headed cowbird	0	0	0.00	N/A	N/A	N/A
Cassin's finch	0	0	0.00	N/A	N/A	N/A
cliff swallow	3	6	100.00	100.00	0.00	0.00
dark-eyed junco	6	15	26.79	100.00	0.00	0.00
European starling	0	0	0.00	N/A	N/A	N/A
golden-crowned kinglet	4	4	100.00	100.00	0.00	0.00
grasshopper sparrow	2	2	28.57	100.00	0.00	0.00
gray-crowned rosy finch	1	52	100.00	0.00	100.00	0.00
horned lark	376	1976	81.08	98.38	1.62	0.00
house finch	2	21	91.30	4.76	95.24	0.00
lapland longspur	0	0	0.00	N/A	N/A	N/A
loggerhead shrike	1	1	33.33	100.00	0.00	0.00
mountain bluebird	2	5	100.00	100.00	0.00	0.00
n. rough-winged swallow	2	20	100.00	0.00	100.00	0.00
red-breasted nuthatch	1	1	100.00	100.00	0.00	0.00
rock wren	1	1	9.09	100.00	0.00	0.00
sage thrasher	0	0	0.00	N/A	N/A	N/A
savannah sparrow	1	1	33.33	100.00	0.00	0.00
say's phoebe	1	1	50.00	100.00	0.00	0.00
snow bunting	1	8	100.00	0.00	100.00	0.00
spotted towhee	0	0	0.00	N/A	N/A	N/A
Swainson's thrush	0	0	0.00	N/A	N/A	N/A
tree swallow	1	12	100.00	100.00	0.00	0.00
unidentified blackbird	1	2	100.00	100.00	0.00	0.00
unidentified bluebird	0	0	0.00	N/A	N/A	N/A
unidentified finch	1	35	100.00	100.00	0.00	0.00
unidentified flycatcher	1	1	12.50	100.00	0.00	0.00
unidentified passerine	9	185	100.00	81.08	18.92	0.00
unidentified sparrow	1	1	100.00	100.00	0.00	0.00
unidentified swallow	6	10	83.33	80.00	20.00	0.00
unidentified warbler	1	1	100.00	100.00	0.00	0.00
varied thrush	0	0	0.00	N/A	N/A	N/A
vesper sparrow	10	13	18.84	100.00	0.00	0.00
violet-green swallow	0	0	0.00	N/A	N/A	N/A
western bluebird	0	0	0.00	N/A	N/A	N/A
western kingbird	2	3	42.86	100.00	0.00	0.00
western meadowlark	27	38	16.38	97.37	2.63	0.00
western tanager	1	4	100.00	100.00	0.00	0.00
white-crowned sparrow	1	10	71.43	100.00	0.00	0.00
Wilson's warbler	0	0	0.00	N/A	N/A	N/A
yellow warbler	0	0	0.00	N/A	N/A	N/A
yellow-rumped warbler	0	0	0.00	N/A	N/A	N/A
Other Birds	5	5	83.33	80.00	20.00	0.00
common nighthawk	1	1	100.00	0.00	100.00	0.00
northern flicker	3	3	100.00	100.00	0.00	0.00
unidentified hummingbird	1	1	50.00	100.00	0.00	0.00
All Birds	850	3717	78.48	82.35	15.87	1.78

Table 6. Mean exposure indices calculated by species observed during fixed-point surveys (April 20, 2001-April 11, 2002).

Species/Group	Mean use	% Flying	% Flying within RSA	Exposure Index
Waterfowl				
Canada goose	0.04	100.00	90.32	0.04
mallard	0.02	100.00	0.00	0.00
Shorebirds				
killdeer	0.00	0.00	n/a	0.00
Corvids				
common raven	1.16	77.03	51.17	0.46
black-billed magpie	0.03	27.27	0.00	0.00
Upland Gamebirds				
California quail	0.01	0.00	n/a	0.00
chukar	0.05	0.00	n/a	0.00
gray partridge	0.01	0.00	n/a	0.00
ring-necked pheasant	0.01	0.00	n/a	0.00
Doves				
mourning dove	0.06	80.95	0.00	0.00
Raptors				
<i>Accipiters</i>				
Cooper's hawk	0.01	100.00	50.00	0.01
sharp-shinned hawk	0.00	100.00	100.00	0.00
unidentified accipiter	0.01	66.67	0.00	0.00
<i>Buteos</i>				
ferruginous hawk	0.02	100.00	50.00	0.01
Swainson's hawk	0.06	100.00	73.08	0.05
red-tailed hawk	0.08	96.67	58.62	0.04
rough-legged hawk	0.03	100.00	84.62	0.02
unidentified buteo	0.04	85.00	61.76	0.02
<i>Eagles</i>				
golden eagle	0.02	100.00	33.33	0.01
<i>Harriers</i>				
northern harrier	0.14	98.04	20.00	0.03
<i>Falcons</i>				
American kestrel	0.10	71.43	16.00	0.01
prairie falcon	0.04	75.00	88.89	0.03
peregrine falcon	0.01	100.00	100.00	0.01
Passerines				
American goldfinch	0.07	99.81	0.00	0.00
American pipit	0.07	81.82	0.00	0.00
American robin	0.03	20.00	100.00	0.01
barn swallow	0.01	100.00	0.00	0.00
Brewer's sparrow	0.07	20.00	40.00	0.01

Table 6. Mean exposure indices calculated by species observed during fixed-point surveys (April 20, 2001-April 11, 2002).

Species/Group	Mean use	% Flying	% Flying within RSA	Exposure Index
brown-headed cowbird	0.01	0.00	n/a	0.00
Cassin's finch	0.03	0.00	n/a	0.00
cliff swallow	0.02	100.00	0.00	0.00
dark-eyed junco	0.17	26.79	0.00	0.00
European starling	0.01	0.00	n/a	0.00
golden-crowned kinglet	0.01	100.00	0.00	0.00
grasshopper sparrow	0.02	28.57	0.00	0.00
gray-crowned rosy finch	0.15	100.00	100.00	0.15
horned lark	7.24	81.08	1.62	0.10
house finch	0.07	91.30	95.24	0.06
lapland longspur	0.00	0.00	n/a	0.00
loggerhead shrike	0.01	33.33	0.00	0.00
mountain bluebird	0.01	100.00	0.00	0.00
n. rough-winged swallow	0.06	100.00	100.00	0.06
Red-breasted Nuthatch	0.00	100.00	0.00	0.00
rock wren	0.03	9.09	0.00	0.00
sage thrasher	0.01	0.00	n/a	0.00
savannah sparrow	0.01	33.33	0.00	0.00
say's phoebe	0.01	50.00	0.00	0.00
snow bunting	0.02	100.00	100.00	0.02
spotted towhee	0.01	0.00	n/a	0.00
Swainson's thrush	0.00	0.00	n/a	0.00
tree swallow	0.04	100.00	0.00	0.00
unidentified blackbird	0.01	100.00	0.00	0.00
unidentified bluebird	0.00	0.00	n/a	0.00
unidentified finch	0.10	100.00	0.00	0.00
unidentified flycatcher	0.02	12.50	0.00	0.00
unidentified passerine	0.55	100.00	18.92	0.10
unidentified sparrow	0.00	100.00	0.00	0.00
unidentified swallow	0.04	83.33	20.00	0.01
unidentified warbler	0.00	100.00	0.00	0.00
varied thrush	0.01	0.00	n/a	0.00
vesper sparrow	0.20	18.84	0.00	0.00
violet-green Swallow	0.00	0.00	N/A	0.00
western bluebird	0.00	0.00	n/a	0.00
western kingbird	0.02	42.86	0.00	0.00
western meadowlark	0.67	16.38	2.63	0.00
western tanager	0.01	100.00	0.00	0.00
white-crowned sparrow	0.04	71.43	0.00	0.00
Wilson's warbler	0.00	0.00	n/a	0.00
yellow warbler	0.00	0.00	n/a	0.00
yellow-rumped warbler	0.00	0.00	n/a	0.00
Other Birds				
common nighthawk	0.00	100.00	100.00	0.00
northern flicker	0.01	100.00	0.00	0.00
unidentified hummingbird	0.01	50.00	0.00	0.00

Table 7. Raptor and large bird nests located in the raptor nest survey area (study area plus area within a five-mile radius buffer).

Species	Number Active Nests ^a	Number of Nests Which Produced Young ^b	Total Young Observed (young per successful nest)
Ferruginous hawk	4	2	3 (1.5)
Red-tailed hawk	14	9	16 (1.78)
Swainson's hawk	9	2	Unknown
Prairie falcon	8	3	8 (2.2)
Great-horned owl	2	Unknown	Unknown
Barn owl	1	1	1 (1.0)
Common raven	17	6	11
Inactive nests	52	N/A	N/A

^a based on April 30- May 2 survey

^b based on June 18-19 survey

Table 8. Avian species observed during the three paired-point surveys

Species / Group	Number of groups	Total number observed
Blackbirds		
Brown-headed Cowbird	5	9
European Starling	1	2
Unidentified Blackbird	3	4
Subtotal	9	15
Corvids		
Black-billed Magpie	3	4
Common Raven	13	13
Subtotal	16	17
Doves		
Mourning Dove	1	3
Finches		
American Goldfinch	1	2
Unidentified Finch	1	5
Subtotal	2	7
Flycatchers		
Western Flycatcher	1	1
Western Kingbird	1	1
Subtotal	2	2
Grassland / Shrub Steppe		
Brewer's Sparrow	37	42
Grasshopper Sparrow	40	40
Horned Lark	249	294
Savannah Sparrow	8	8
Sage Thrasher	3	3
Vesper Sparrow	111	119
White-crowned Sparrow	12	24
Western Meadowlark	198	211
Subtotal	658	741
Raptors		
Ferruginous Hawk	1	1
Northern Harrier	6	6
Red-tailed Hawk	1	1
Sharp-shinned Hawk	1	1
Swainson's Hawk	4	5
Unidentified Buteo	1	1
Subtotal	14	15
Shorebirds		
Killdeer	1	1

Table 8. Avian species observed during the three paired-point surveys

Species / Group	Number of groups	Total number observed
Upland Game birds		
Chukar	5	11
Gray Partridge	3	4
Subtotal	8	15
Wrens		
House Wren	1	1
Rock Wren	3	3
Subtotal	4	4
Others		
American Robin	3	3
Golden-crown Kinglet	1	2
Unidentified Hummingbird	2	2
Unidentified Passerine	2	2
Unidentified Warbler	1	1
Subtotal	9	10
Total	726	841

Table 9. Average use, frequency of occurrence, and percent composition by species for paired plot surveys for all three survey dates.

Species	Use		Frequency of Occurrence	Percent Composition
	mean	std dev		
Brown-headed Cowbird	0.0778	0.1876	4.4	1.1
European Starling	0.0222	0.0861	1.1	0.3
Unidentified Blackbird	0.0000	0.0000	3.3	N/A
Black-billed Magpie	0.0000	0.0000	3.3	N/A
Common Raven	0.0222	0.0586	14.4	0.3
Mourning Dove	0.0333	0.1291	1.1	0.5
American Goldfinch	0.0222	0.0861	1.1	0.3
Unidentified Finch	0.0556	0.2152	1.1	0.8
Western Flycatcher	0.0000	0.0000	1.1	N/A
Western Kingbird	0.0111	0.0430	1.1	0.2
Brewer's Sparrow	0.3889	0.4115	20.0	5.4
Grasshopper Sparrow	0.4111	0.3556	32.2	5.7
Horned Lark	2.9778	0.8883	85.6	41.6
Savannah Sparrow	0.0556	0.1361	5.6	0.8
Sage Thrasher	0.0222	0.0861	2.2	0.3
Vesper Sparrow	1.1889	0.5487	74.4	16.6
White-crowned Sparrow	0.2222	0.3191	8.9	3.1
Western Meadowlark	1.4111	0.4792	82.2	19.7
Ferruginous Hawk	0.0000	0.0000	1.1	N/A
Northern Harrier	0.0333	0.0690	5.6	0.5
Red-tailed Hawk	0.0111	0.0430	1.1	0.2
Sharp-shinned Hawk	0.0111	0.0430	1.1	0.2
Swainson's Hawk	0.0222	0.0861	4.4	0.3
Unidentified Buteo	0.0111	0.0430	1.1	0.2
Killdeer	0.0000	0.0000	1.1	N/A
Chukar	0.0000	0.0000	5.6	N/A
Gray Partridge	0.0222	0.0861	3.3	0.3
House Wren	0.0111	0.0430	1.1	0.2
Rock Wren	0.0111	0.0430	3.3	0.2
American Robin	0.0333	0.0934	2.2	0.5
Golden-crown Kinglet	0.0222	0.0861	1.1	0.3
Unidentified Hummingbird	0.0222	0.0586	2.2	0.3
Unidentified Passerine	0.0222	0.0586	2.2	0.3
Unidentified Warbler	0.0111	0.0430	1.1	0.2

Table 10. Average use, frequency of occurrence, and percent composition by group for paired plot surveys for all three survey dates.

Groups	Use		Frequency of Occurrence	Percent Composition
	mean	std dev		
Blackbirds	0.1000	0.1972	6.7	1.4
Corvids	0.0222	0.0586	16.7	0.3
Doves	0.0333	0.1291	1.1	0.5
Finches	0.0778	0.2260	2.2	1.1
Flycatchers	0.0111	0.0430	2.2	0.2
Grassland / Shrub-Steppe	6.6778	1.3325	100.0	93.2
Raptors	0.0889	0.1067	13.3	1.2
Shorebirds	0.0000	0.0000	1.1	N/A
Upland Game birds	0.0222	0.0861	8.9	0.3
Wrens	0.0222	0.0586	4.4	0.3
Others	0.1111	0.2152	8.9	1.6

Table 11. Average use separated by plot for each species for all three survey dates.

Species	<u>Turbine Plots</u>		<u>Offset Plots</u>	
	mean	std dev	mean	std dev
Brown-headed Cowbird	0.0889	0.3443	0.0667	0.1869
European Starling	0.0000	0.0000	0.0444	0.1721
Unidentified Blackbird	0.0000	0.0000	0.0000	0.0000
Black-billed Magpie	0.0000	0.0000	0.0000	0.0000
Common Raven	0.0000	0.0000	0.0444	0.1173
Mourning Dove	0.0000	0.0000	0.0667	0.2582
American Goldfinch	0.0000	0.0000	0.0444	0.1721
Unidentified Finch	0.0000	0.0000	0.1111	0.4303
Western Flycatcher	0.0000	0.0000	0.0000	0.0000
Western Kingbird	0.0000	0.0000	0.0222	0.0861
Brewer's Sparrow	0.0889	0.1979	0.6889	0.7814
Grasshopper Sparrow	0.4444	0.5443	0.3778	0.3752
Horned Lark	3.3111	1.1372	2.6444	1.8015
Savannah Sparrow	0.0444	0.1173	0.0667	0.1869
Sage Thrasher	0.0000	0.0000	0.0444	0.1721
Vesper Sparrow	1.1111	0.9230	1.2667	0.5521
White-crowned Sparrow	0.1556	0.4340	0.2889	0.5616
Western Meadowlark	1.1556	0.5018	1.6667	0.8452
Ferruginous Hawk	0.0000	0.0000	0.0000	0.0000
Northern Harrier	0.0222	0.0861	0.0444	0.1173
Red-tailed Hawk	0.0000	0.0000	0.0222	0.0861
Sharp-shinned Hawk	0.0222	0.0861	0.0000	0.0000
Swainson's Hawk	0.0222	0.0861	0.0222	0.0861
Unidentified Buteo	0.0000	0.0000	0.0222	0.0861
Killdeer	0.0000	0.0000	0.0000	0.0000
Chukar	0.0000	0.0000	0.0000	0.0000
Gray Partridge	0.0444	0.1721	0.0000	0.0000
House Wren	0.0000	0.0000	0.0222	0.0861
Rock Wren	0.0222	0.0861	0.0000	0.0000
American Robin	0.0222	0.0861	0.0444	0.1721
Golden-crown Kinglet	0.0000	0.0000	0.0444	0.1721
Unidentified Hummingbird	0.0222	0.0861	0.0222	0.0861
Unidentified Passerine	0.0222	0.0861	0.0222	0.0861
Unidentified Warbler	0.0000	0.0000	0.0222	0.0861

Table 12. Average use separated by plot for each group for all three survey dates.

Groups	<u>Turbine Plots</u>		<u>Offset Plots</u>	
	mean	std dev	mean	std dev
Blackbirds	0.0889	0.3443	0.1111	0.2412
Corvids	0.0000	0.0000	0.0444	0.1173
Doves	0.0000	0.0000	0.0667	0.2582
Finches	0.0000	0.0000	0.1556	0.4519
Flycatchers	0.0000	0.0000	0.0222	0.0861
Grassland / Shrub-Steppe	6.3111	2.1693	7.0444	1.5679
Raptors	0.0667	0.1380	0.1111	0.1627
Shorebirds	0.0000	0.0000	0.0000	0.0000
Upland Game birds	0.0444	0.1721	0.0000	0.0000
Wrens	0.0222	0.0861	0.0222	0.0861
Others	0.0667	0.1380	0.1556	0.3534

Table 13. Number of groups and the total number of individuals of avian species of interest, mammals, and reptiles observed incidentally on-site.

Species	Groups	Observations
Birds		
American kestrel	31	36
merlin	1	1
bald eagle	1	1
golden eagle	2	2
osprey	1	1
ferruginous hawk	1	1
rough-legged hawk	6	6
red-tailed hawk	12	15
Swainson's hawk	3	3
northern harrier	9	9
prairie falcon	5	5
short-eared owl	1	2
chukar	2	14
killdeer	1	1
northern oriole	2	2
common raven	19	27
common yellowthroat	1	1
gray-crowned rosy finch	3	4
loggerhead shrike	4	6
rufous hummingbird	1	1
sage thrasher	1	2
lark sparrow	1	2
sage sparrow	1	2
red-naped sapsucker	1	1
Mammals		
Elk	5	175
Mule deer	17	67
Townsend's ground squirrel	1	1
porcupine	1	1
coyote	1	1
jackrabbit (droppings)	1	1
Reptiles		
rattlesnake	1	1
Short-horned lizard	2	2
Yellow-bellied racer	1	1

Table 14. Vegetation types in the study area.

Basic Type	Vegetation Type	Approx. Acres	Percent of Study Area	General Habitat Description
Agricultural	Cropland	6419	35	Current croplands or recently abandoned cropland; potential to support wildlife variable depending on stage of crop or age since last tilled.
Riparian	Riparian	135	1	Vegetation located along drainages; most drainages are narrow and steep. Riparian vegetation includes an overstory of scattered chokecherry, golden current, and/or red-osier dogwood, which provide potential habitat for nesting raptors when the trees are sufficiently large to provide nest platforms. Riparian areas with dense shrub/trees also provide cover for big game and other wildlife.
Steppe	Shrub-steppe	4217	32	Big sagebrush or threetip sage is dominant with a grass/forb understory. The potential to support wildlife varies depending on habitat quality (degree of grazing/ weeds)
	Grassland steppe	4114	31	Predominantly grassland (native and non-native grass species), and may have scattered sagebrush patches. Potential to support wildlife varies depending on habitat quality (degree of grazing/weeds).
	Lithosol habitat	184	1	Shallow-soiled habitat on ridgetops where native buckwheats and Sandberg's bluegrass dominate. Potential to support wildlife varies depending on habitat quality (degree of grazing/weeds).
	Rock outcrop/shrub	12	<0.1	Rocky outcrops and associated shrubs, including chokecherry and squaw current; giant wildrye often present. Potential feeding, perching, and nesting habitat for birds, and cover for game species and other wildlife.
Wetlands	Emergent wetlands	3	<0.1	Wetland habitat characterized by rooted, hydrophytic vegetation for most of the growing season; potential to support sensitive wildlife species varies depending on habitat quality (degree of grazing/weeds).

Figure 1. Proposed Maiden Wind Farm location.

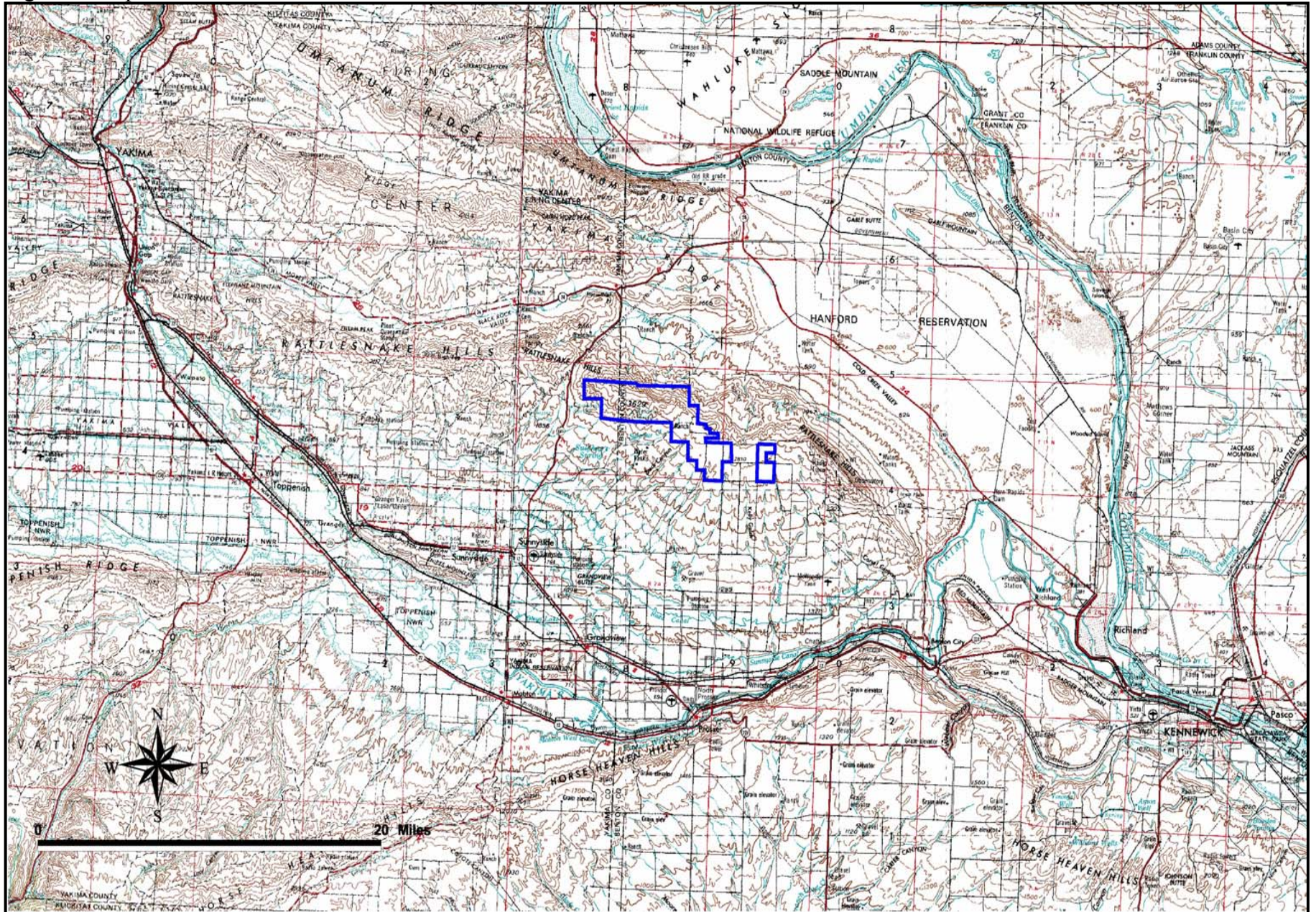


Figure 2. Maiden Wind Farm study area map.

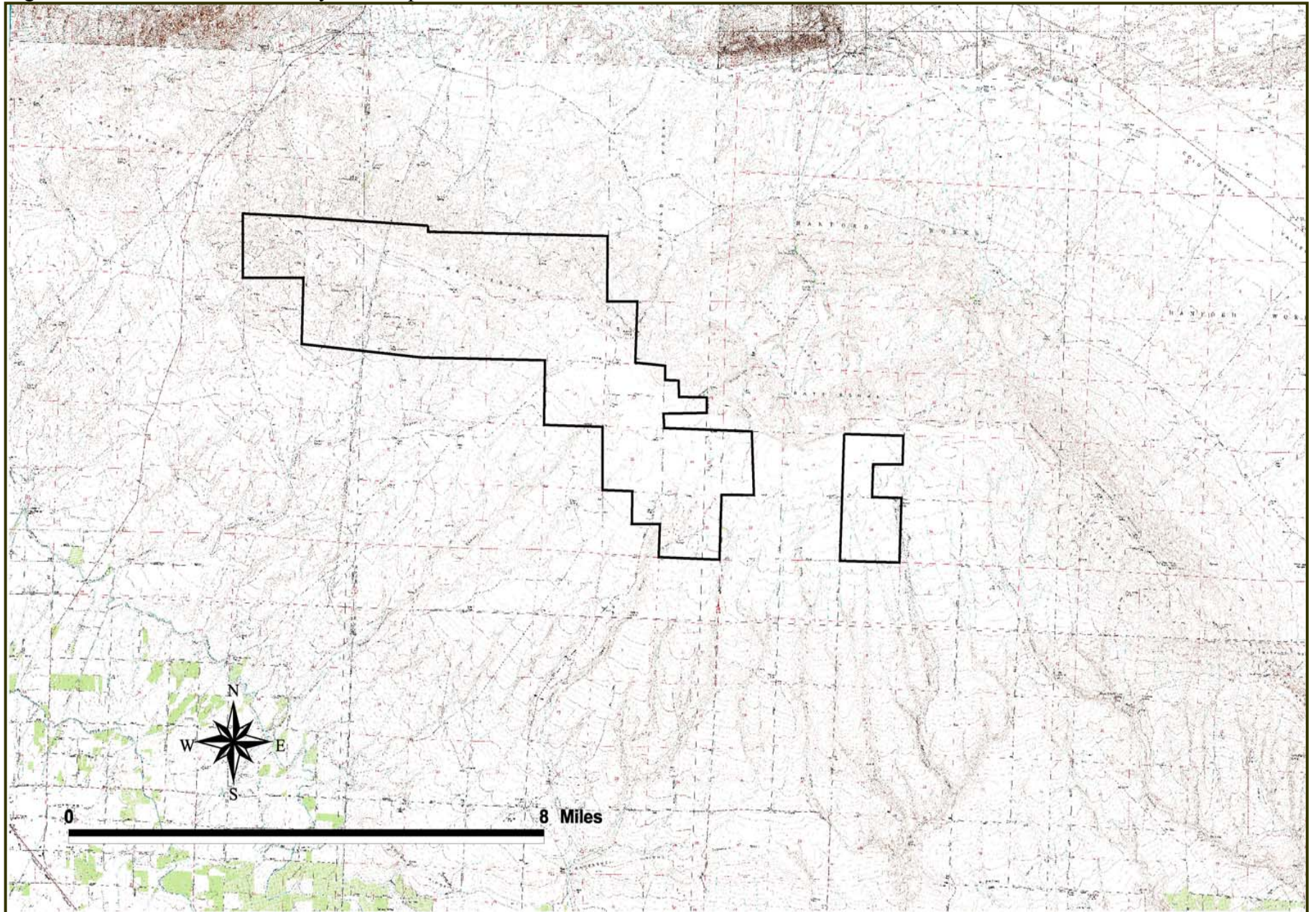


Figure 3. Fixed point survey plots and 800 m buffer.

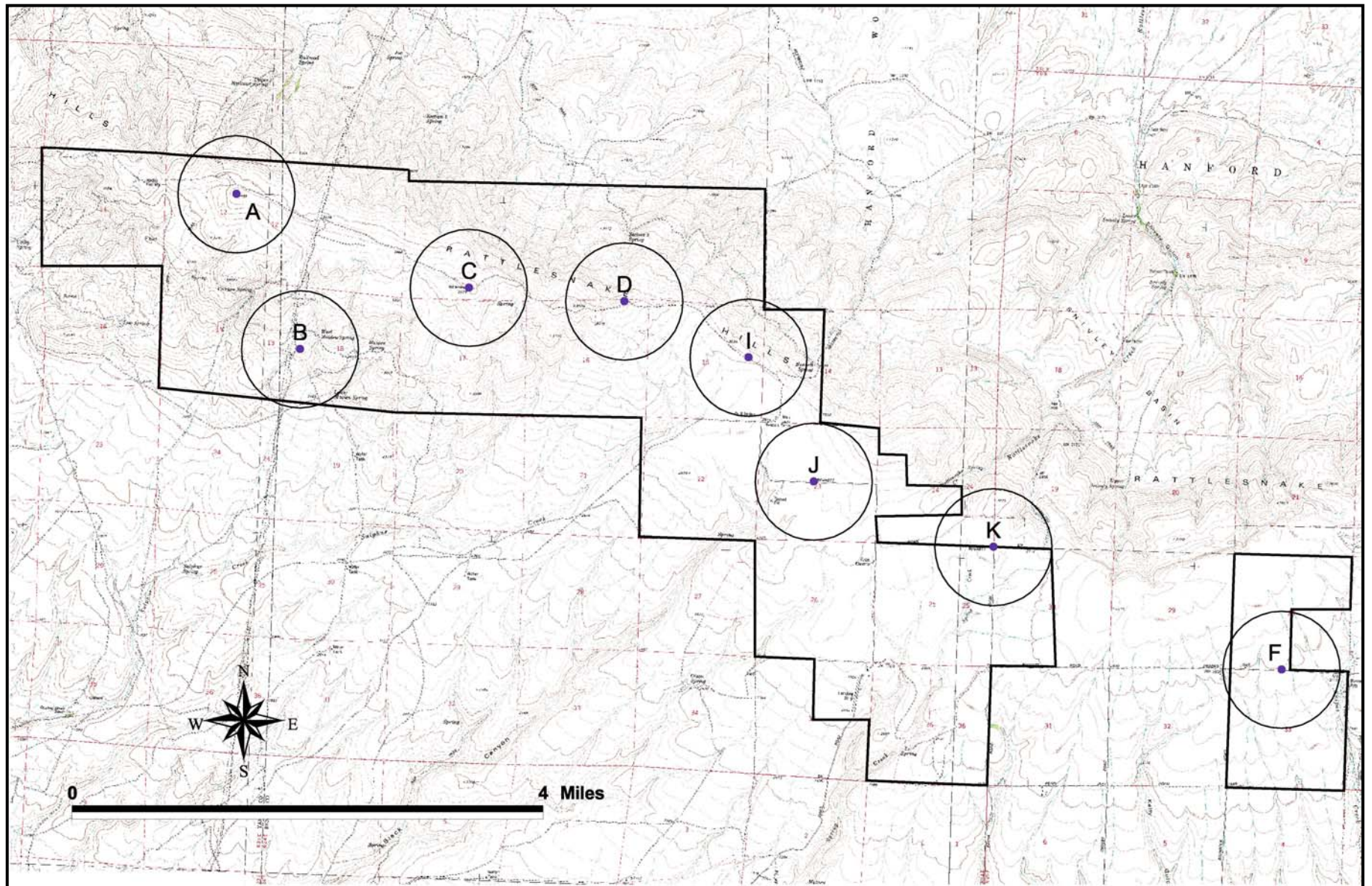


Figure 4. Raptor nest survey area.

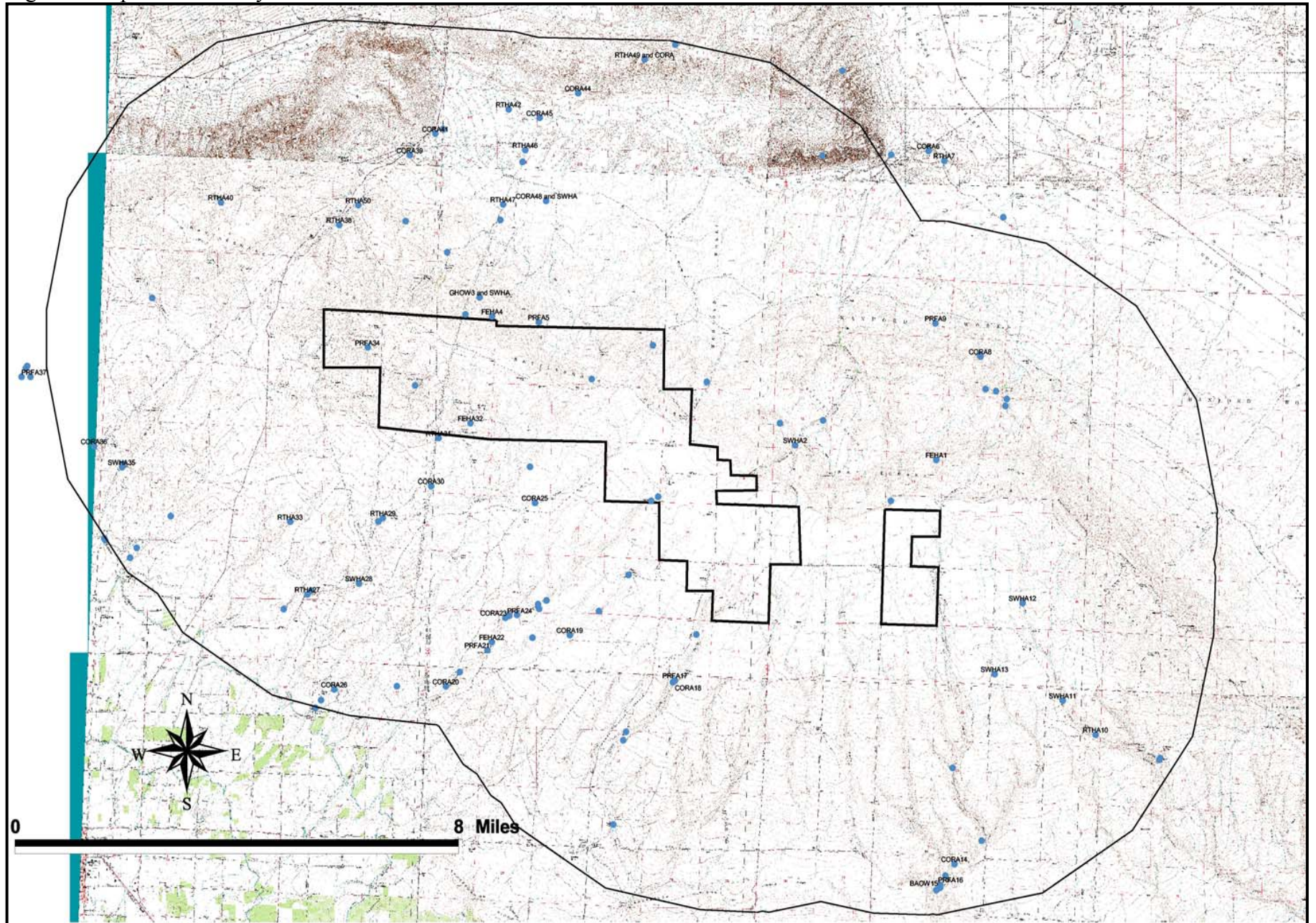


Figure 5. Paired-point survey plots and 100 m buffer.

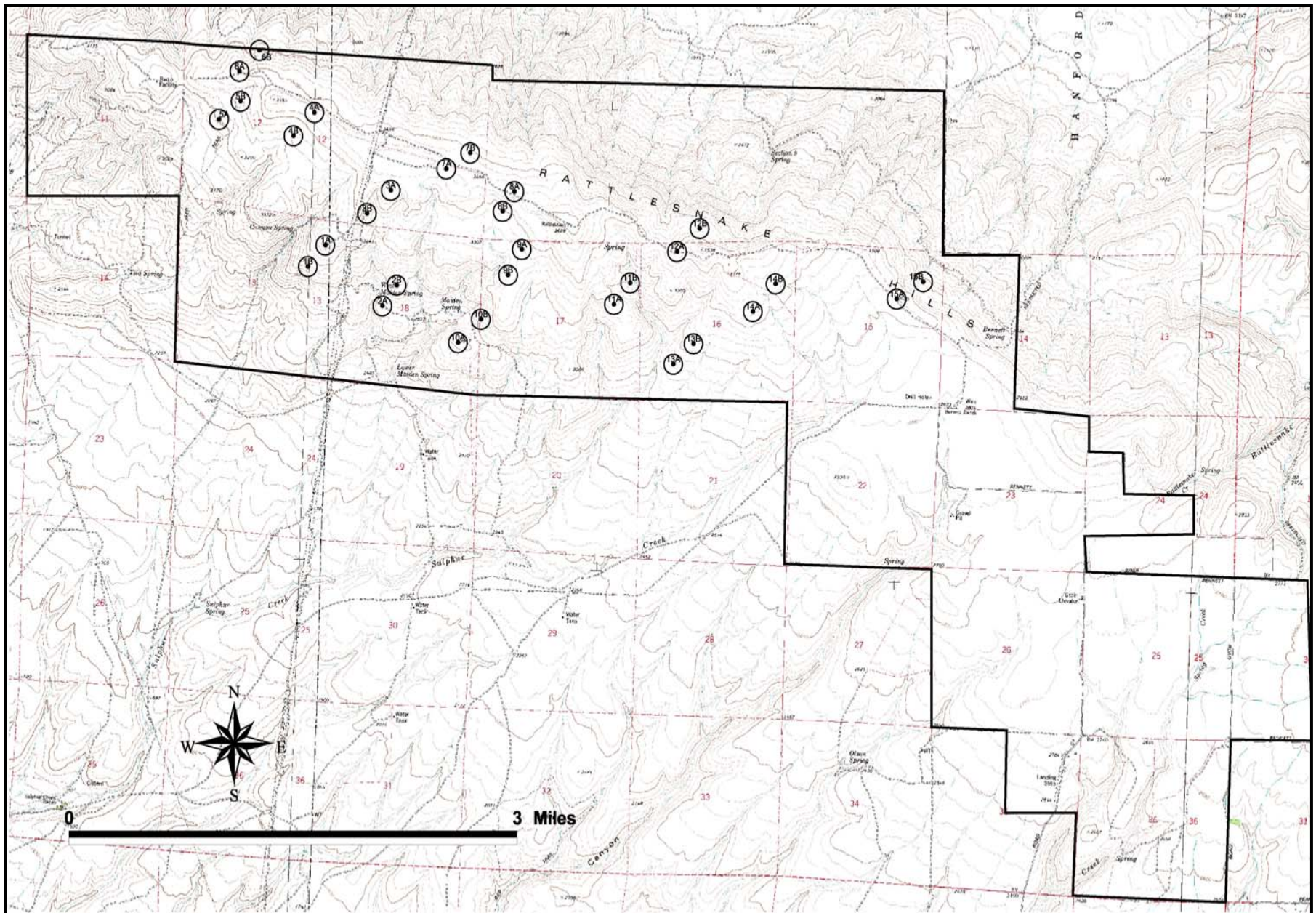


Figure 6. Mean use and frequency of occurrence for passerines by survey period (dashed line represents a smoothed estimate).

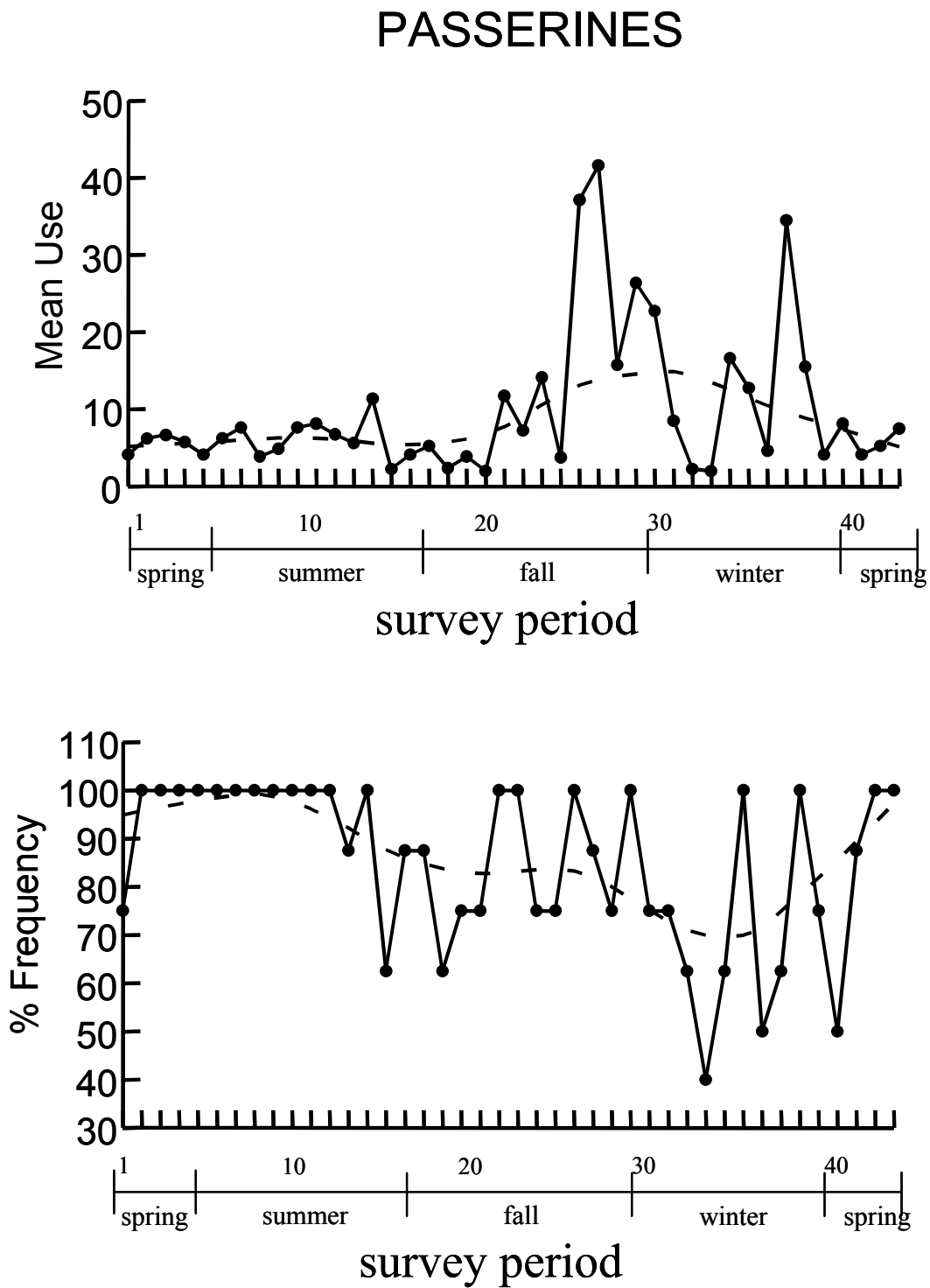


Figure 7. Mean use and frequency of occurrence for corvids by survey period (dashed line represents a smoothed estimate).

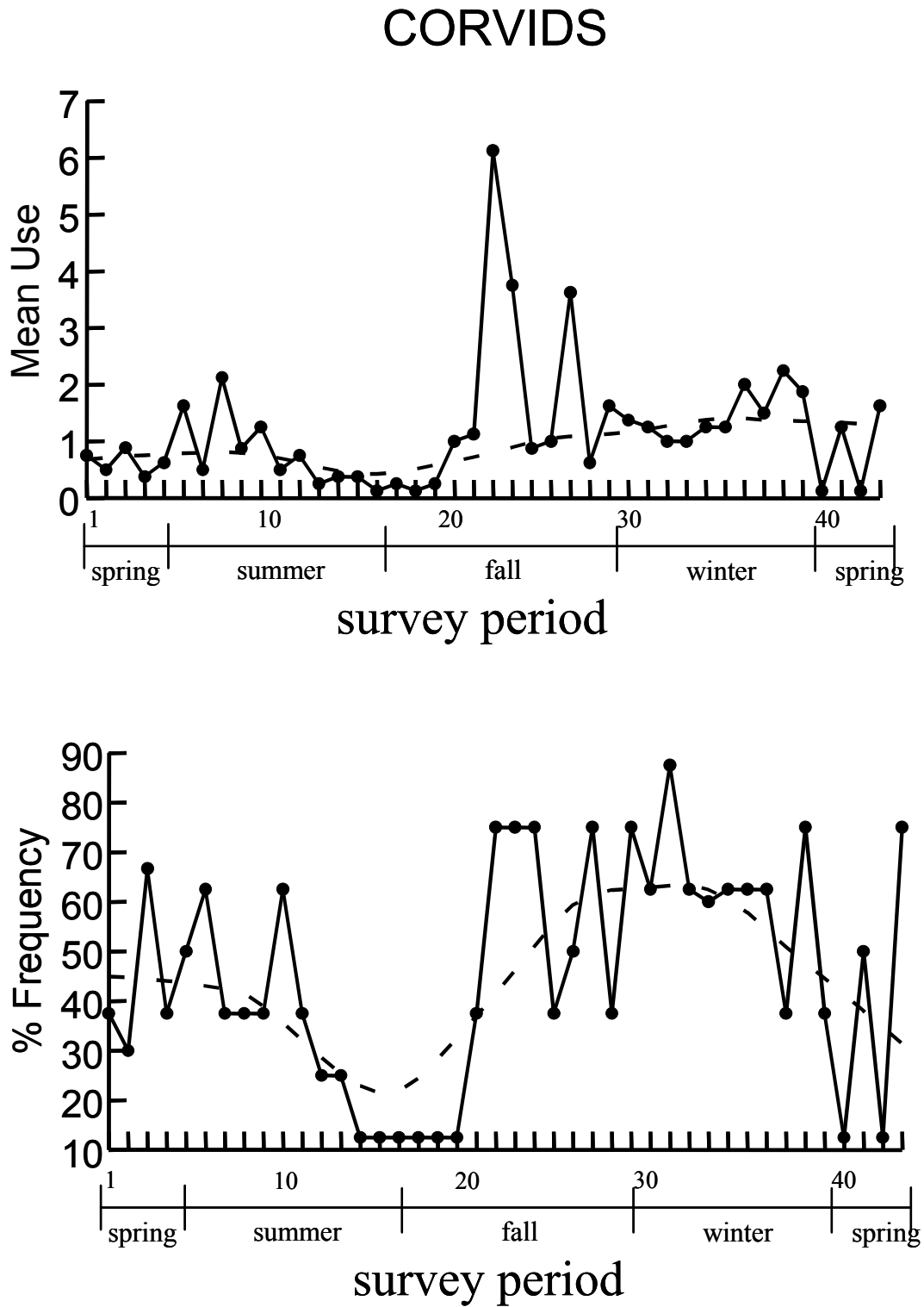


Figure 8. Mean use and frequency of occurrence for raptors by survey period (dashed line represents a smoothed estimate).

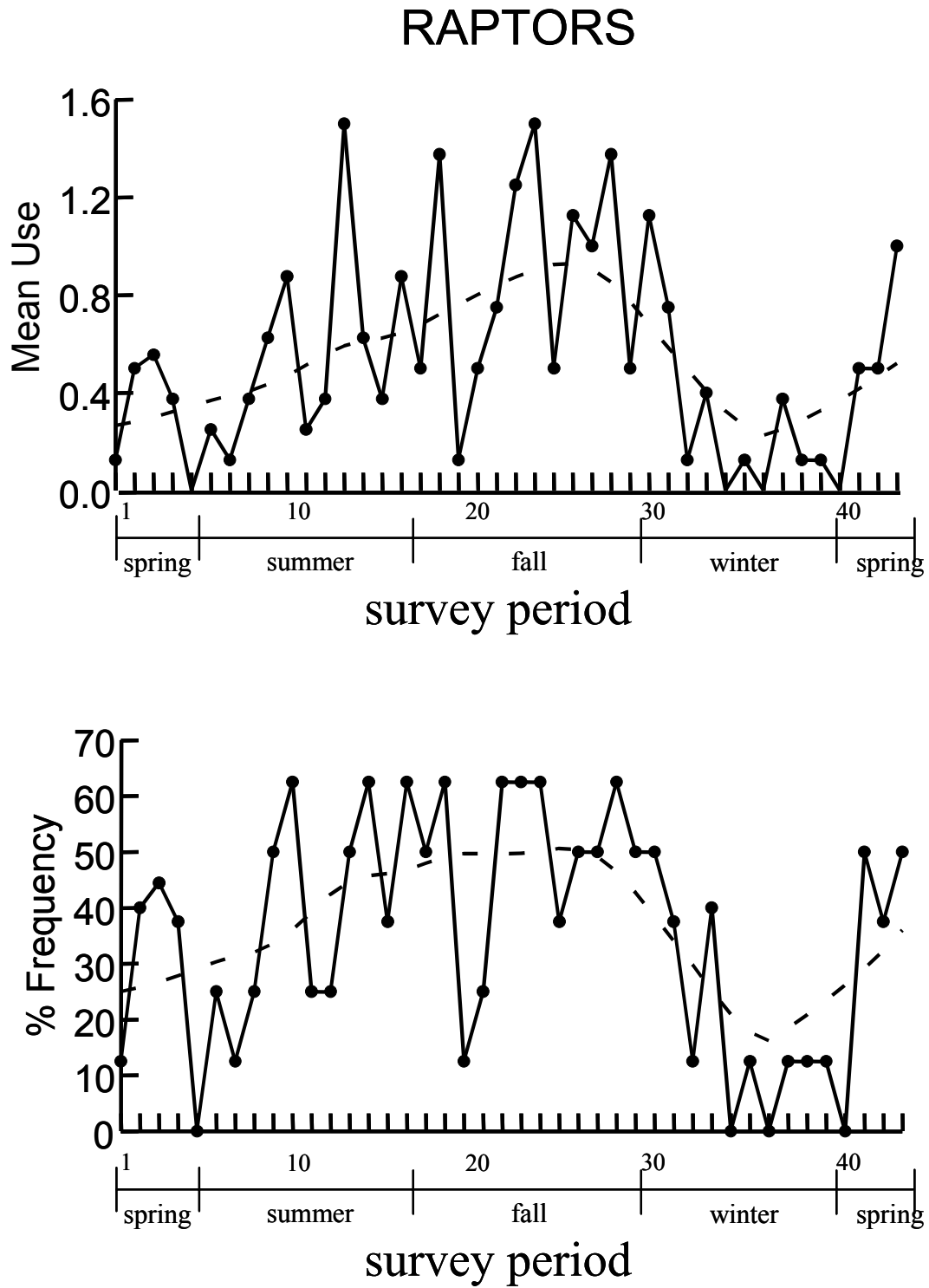


Figure 9. Mean use and frequency of occurrence for passerines by station (bar represents ± 1 standard error).

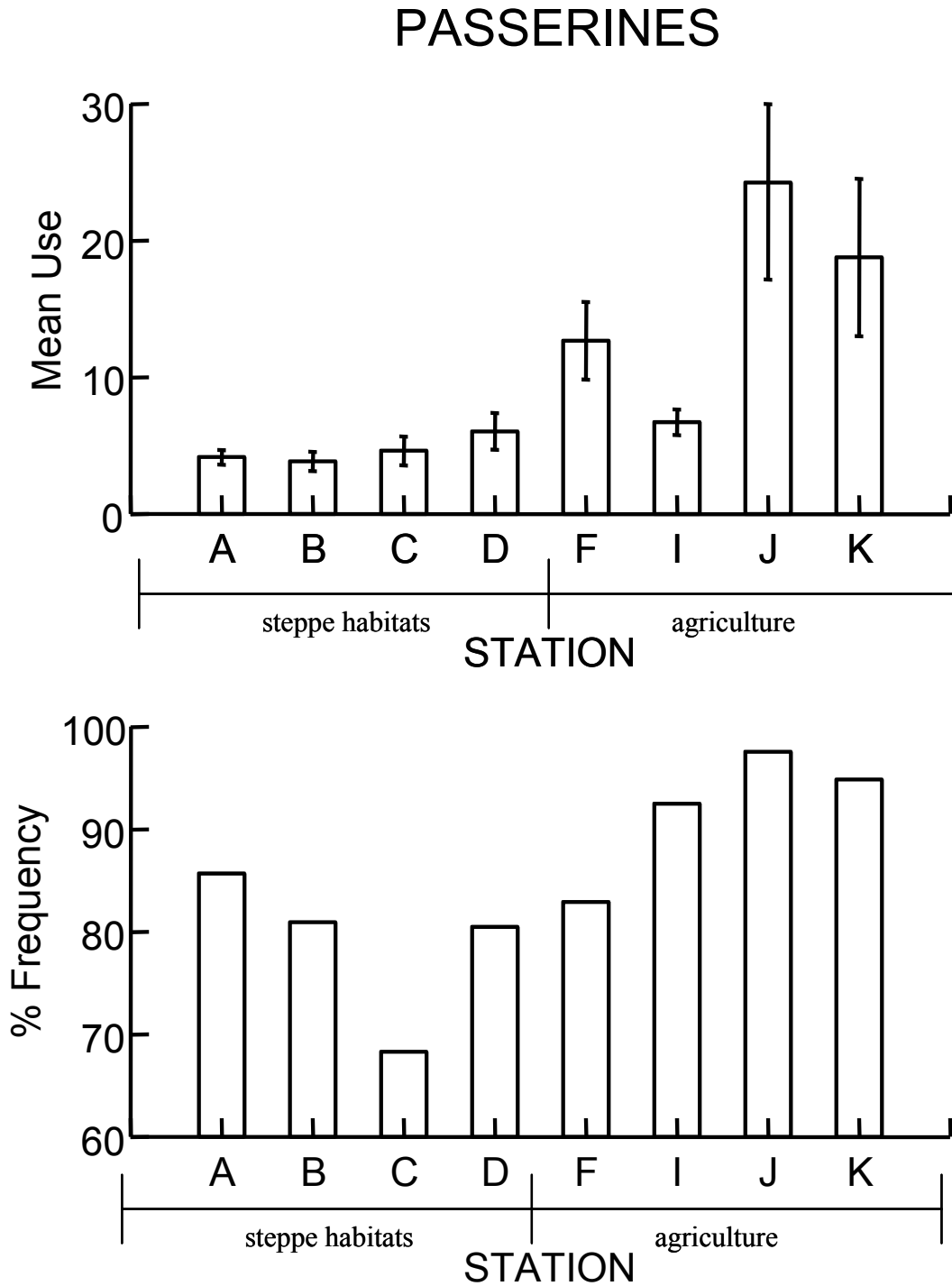


Figure 10. Mean use and frequency of occurrence for corvids by station (bar represents ± 1 standard error).

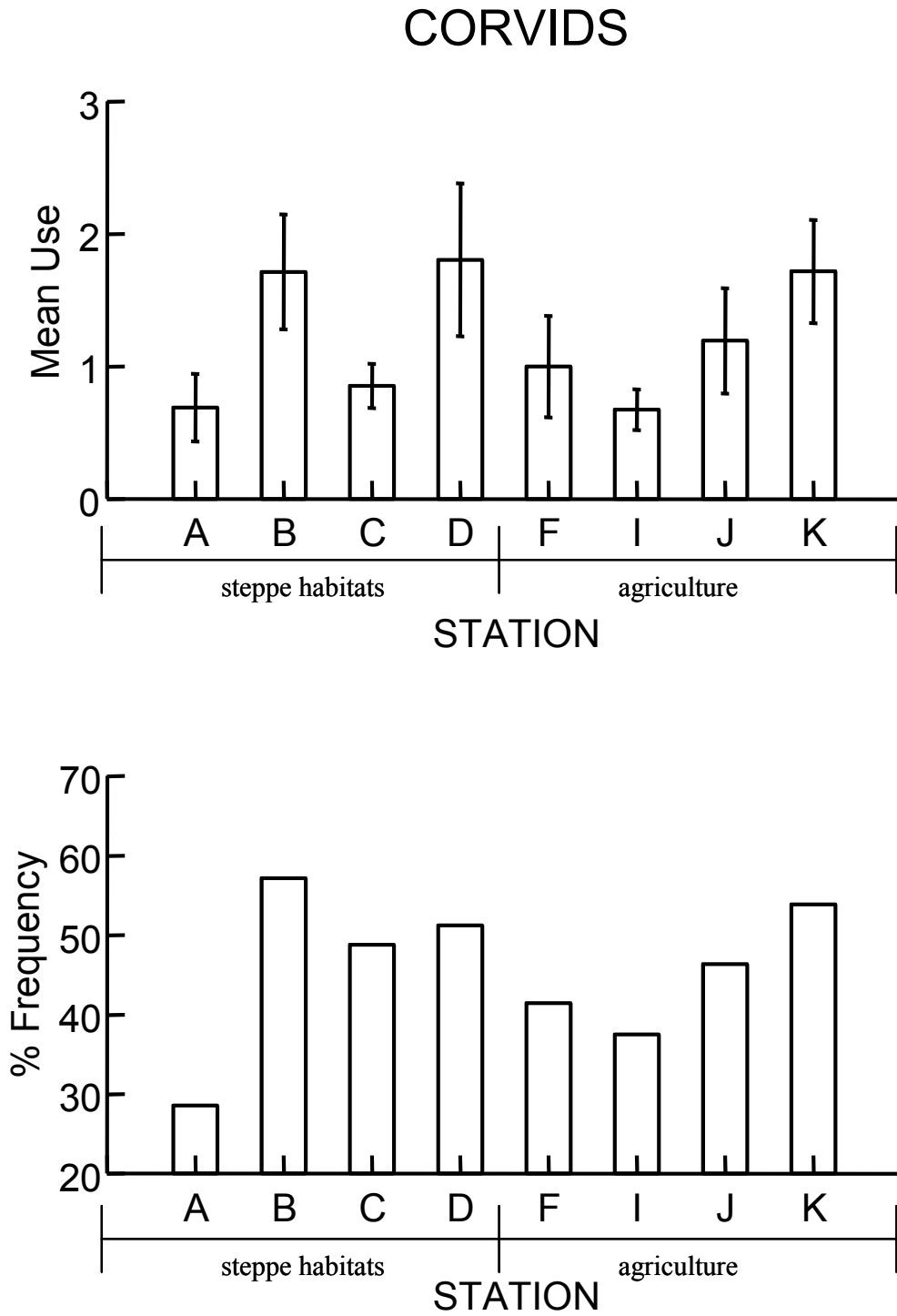


Figure 11. Mean use and frequency of occurrence for raptors by station (bar represents ± 1 standard error).

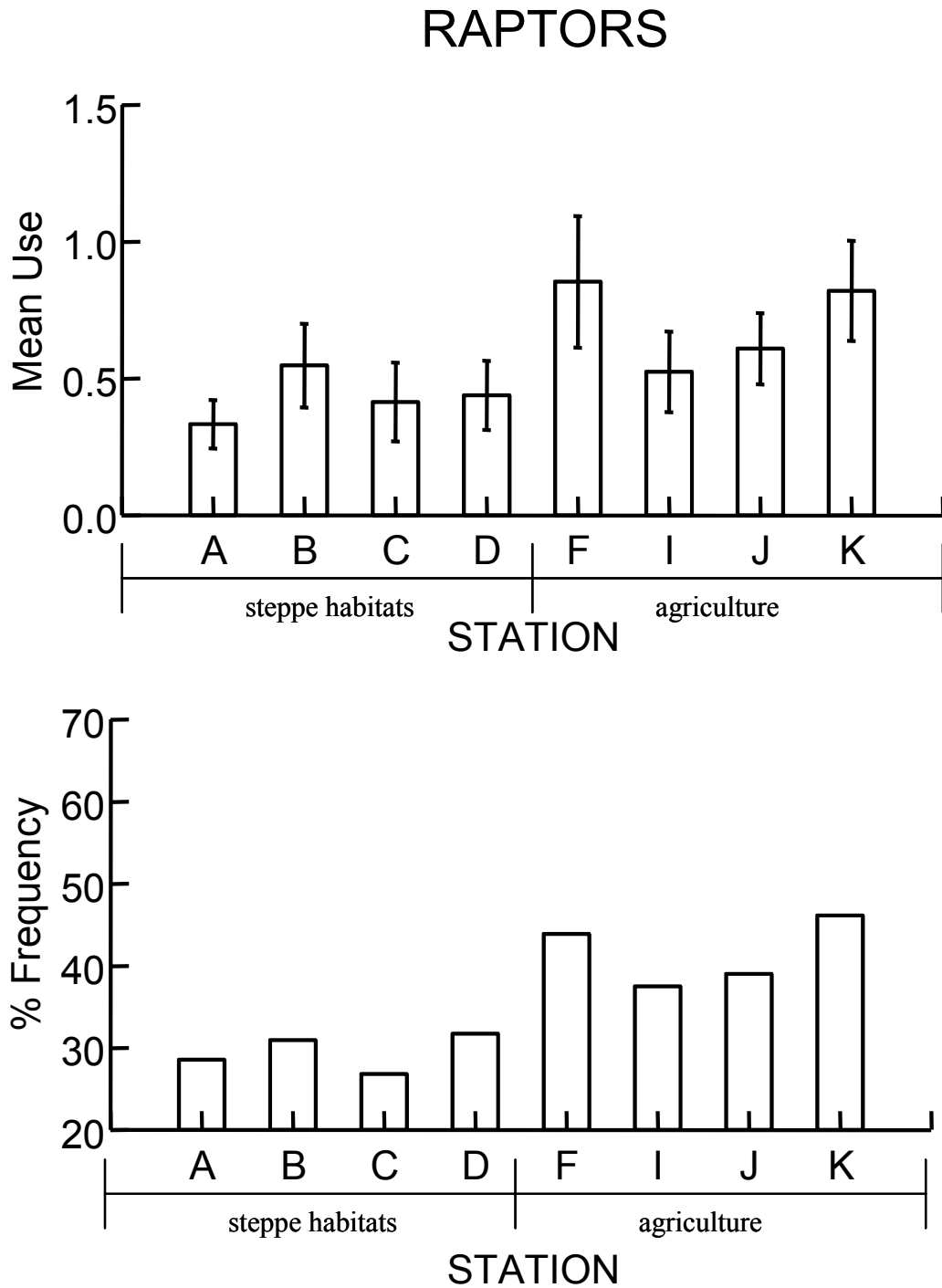


Figure 12. Mean number of species per survey by survey period (dashed line represents a smoothed estimate).

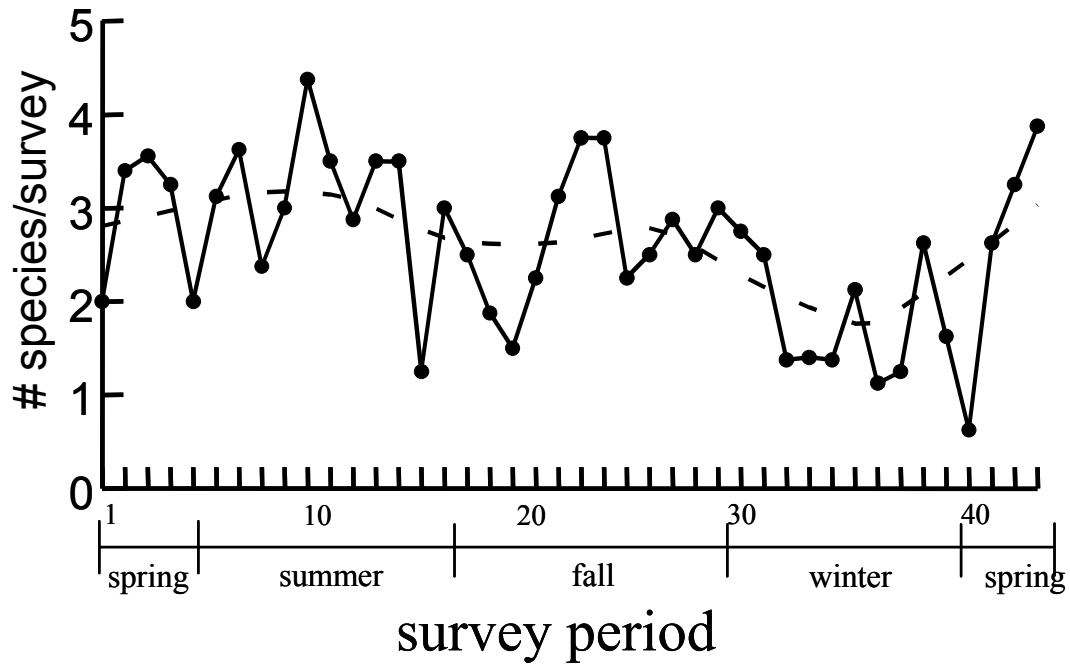


Figure 13. Northern harrier flight paths and perch locations recorded during fixed-point surveys and incidentally on the Maiden Wind Site.

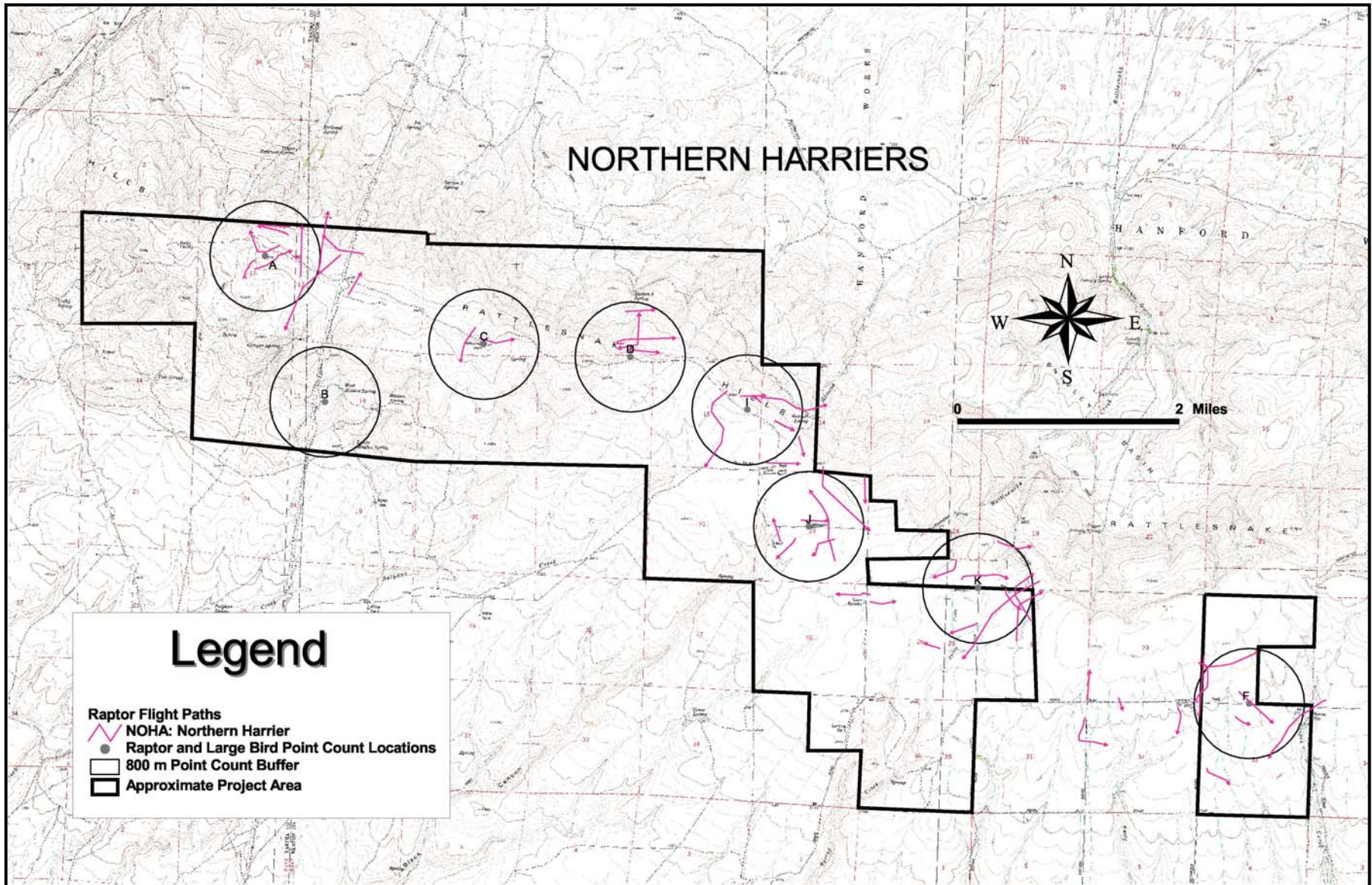


Figure 14. Buteo flight paths and perch locations recorded during fixed-point surveys and incidentally on the Maiden Wind Site.

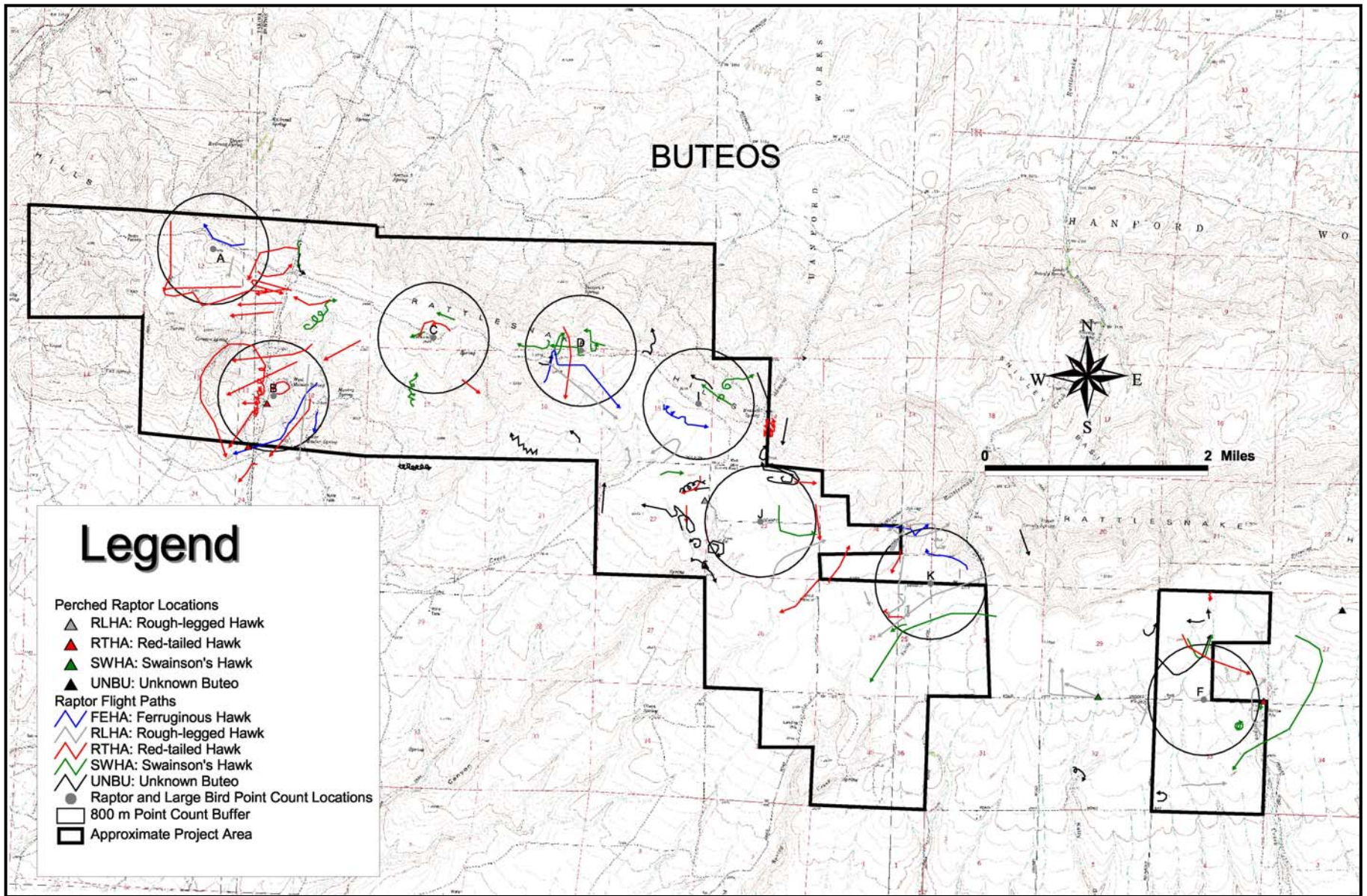


Figure 15. Falcon flight paths and perch locations recorded during fixed-point surveys and incidentally on the Maiden Wind Site.

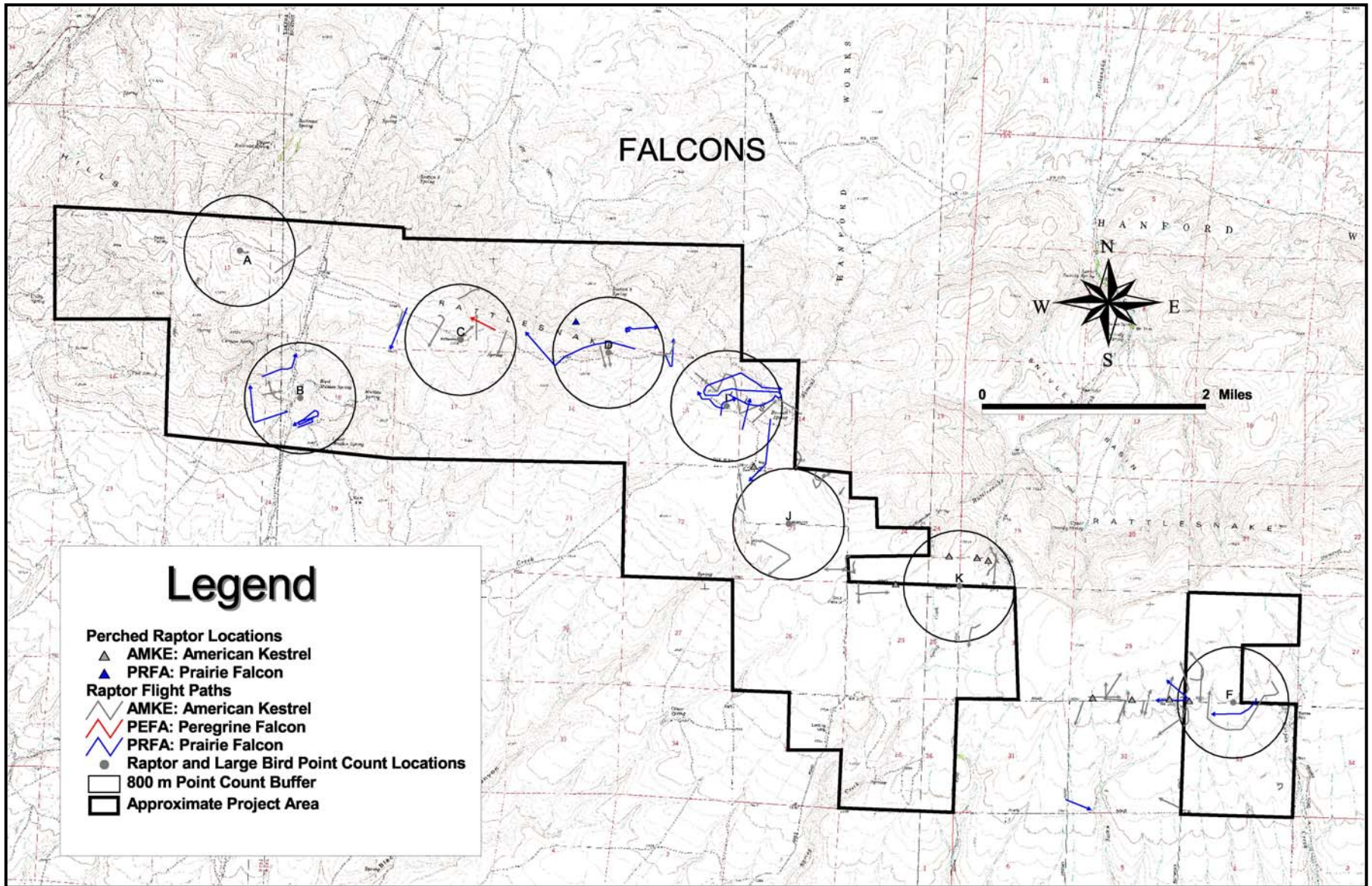


Figure 16. Other raptor and large bird flight paths and perch locations recorded during fixed-point surveys and incidentally on the Maiden Wind Site.

