ECOLOGICAL BASELINE STUDIES REPORT PROPOSED DRY LAKE WIND PROJECT, NAVAJO COUNTY, ARIZONA

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EXECUTIVE SUMMARY

PPM Energy, Inc. (PPM) is proposing to construct, operate, and maintain a wind generation facility in Navajo County, Arizona. PPM's project, the Dry Lake Wind Power Project , is located about 6 to 18 miles north-northwest of the City of Snowflake, just east of Arizona State Highway 377 and southwest of the I-40 corridor. The Project would provide up to 378 megawatts (MW) of wind-generated energy and consist of multiple phases:

- Phase I would include 64 MW of wind energy with up to 43 wind turbines, access roads, an interconnection substation, an Operations & Maintenance (O&M) facility, and collector lines to transmit the generated energy to the substation. The turbines would range in size from 1.5 to 3.0 MW each.
- Subsequent phases would include comparable facilities with capacity to provide a total of up to 314 MW of additional wind energy.

The turbines, access roads, collector lines, substation and O&M facilities would be constructed on private leased land, Arizona state lands, and federal lands managed by the Bureau of Land Management.

As part of the environmental impact evaluation for the project, a detailed 12-month baseline ecological resources study plan was developed and implemented at the site. The study protocol was developed in cooperation with the Arizona Game and Fish Department and the U.S. Fish and Wildlife Service and based largely on previous studies of wind power effects on wildlife. Objectives of the study were to provide data that are useful in evaluating potential impacts from the proposed project and to assist in siting of project facilities within the project area. The field surveys were designed to: (1) describe and quantify seasonal avian use of the proposed project area; (2) describe and quantify raptor use and nesting in the proposed project area; (3) investigate the presence and relative abundance of bats on the proposed project area; and (4) describe vegetation types and rare plant occurrence in the proposed project area. This report includes results of studies on all phases of the project. The Phase I area was studied in greater detail to cover the areas that would be developed first. It is the intent to expand these studies once the layout and scope of subsequent phases are finalized.

Fixed-point avian use surveys were conducted to estimate the seasonal, spatial, and temporal use of the site by birds and in particular raptors. Surveys were conducted at half (5-6) of the 11 fixed-point count stations located within the study area approximately once each week between September 12, 2005 and September 15, 2006, resulting in 279 30-minute point count surveys during the study. Sixty-five avian species were observed during the surveys. Passerines were the most numerous group and comprised over 95% of all birds observed. Horned lark, common raven, mountain bluebird, and dark-eyed junco were the most abundant passerines. Raptors comprised only 1% of all birds observed. The most common raptor was red-tailed hawk. Other birds (shorebirds, doves, non-passerines) comprised approximately 3% of all birds observed.

To standardize the data for comparison between points, seasons, and with other studies, avian use, frequency of occurrence, and species composition were calculated from observations within

800 m of the survey point. Avian use by species was calculated as the mean number of observations per 30-minute survey. Over all seasons based on use, passerines were the most abundant group (19.44/survey), followed by doves (0.44/survey) and raptors (0.22/survey). Horned lark was the most common bird observed with 12.76 detections per survey, followed by common raven (1.90), mountain bluebird (0.62), and dark-eyed junco (0.57). These four species comprised 78% of all bird use of the site for the year.

During the point count surveys 782 groups totaling 4273 individual birds were observed flying. For all species combined, 90.2% of all birds observed flying were below, 8.1% were within, and 1.8% of birds were above the turbine rotor-swept height. For species with at least five observations of flying birds, those most often observed at rotor-swept heights were Townsend's solitaire (71.4%), golden eagle (60.0%), turkey vulture (50.0%), common raven (44.4%), and red-tailed hawk (42.9%). Based on the use (measure of abundance) of the site by each species and the flight characteristics observed for that species, common raven, pinyon jay, horned lark, and Townsend's solitaire had the highest probability of turbine exposure. The only raptor with a relatively high exposure index was red-tailed hawk, which ranked 8^{th} of all species. Mean use and raptor flight paths were plotted by survey point. Based on that analysis, raptor use was concentrated along the slopes of Pink Cliffs in the southern portion of the study area.

An aerial survey for raptor nests was conducted via helicopter on May 23, 2006 and via ground surveys on May 4, 2007. The aerial nest survey area included the area within an approximate 2-mile buffer of the Phase 1 site. The total area searched was approximately 45,787 acres (71.5 mi^2). Four active raptor nests were located during the survey: one golden eagle nest, a red-tailed hawk nest, a great horned owl nest, and a barn owl nest. The only nest within the Phase 1 project area boundary was a barn owl located in a cave within the Pink Cliffs area. The golden eagle nest was located approximately 0.75 mile southeast of the project area. A pair of adult golden eagles was observed on a power line tower but no nest was observed at that location. The red-tailed hawk nest was located approximately 0.3 miles south of the project area, and the great horned owl nest was located approximately 1.0 mile west of the project area. Based on the total survey area, active raptor nest density was $0.05/mi^2$, which is low compared to most other wind resource areas in the western U.S. Two common raven nests and no raptor nests were located in the subsequent phases area, however, the study area contained some habitat features such as large bluffs (mesas) and canyons which could not thoroughly be covered by ground based surveys.

The objective of the bat use surveys was to estimate the relative abundance and spatial use of the site by bats and determine species of bats using the project area, to the extent possible. AnaBat detectors were deployed at two sampling stations using passive sampling methods. One location was at the project met tower in the southeast portion of the project. The other location was based on habitat and was near a complex of ground fissures or caves that could support roosting bats. A third area near a stockpond was sampled for three nights in July when the AnaBats were first deployed. AnaBat detectors were operated from July to November, however due to technical difficulties sampling did not occur over this whole period.

The number of bats detected per detector night varied from 3.0 in July to 0 in November. Over all sampling nights, 1.78 bats per detector night were recoded with greatest use at the sampling station adjacent to the ground caves. While bat call characteristics overlap among species, several species of bats were recorded on site or presumed present based on the characteristics of call and other regional research in similar habitat including pallid bat, Brazilian free-tailed bat, fringed myotis, yuma myotis, California myotis, and western pipistrelle.

Background information indicated that three sensitive plant taxa may potentially occur in the proposed project area: roundleaf errazurizia, paper-spined cactus, and Peebles Navajo cactus. The survey for sensitive plant species was conducted from April 24-27, 2006 and involved meandering pedestrian transects across the project site at proposed turbine locations and along proposed project roads. A 150-meter buffer was surveyed around turbine locations and an approximately 10-meter buffer was surveyed along either side of existing access roads. No individuals of roundleaf errazurizia or Peebles Navajo cactus were found within the project site. A total of nine subpopulations of paper-spined cactus were detected within the project site. The number of individuals within each of the subpopulations ranged from 6 to 35 individuals.

The Phase 1 project area was also surveyed for wetlands and other waters of the U.S. during the rare plant survey. The survey area included a 150-meter buffer on all turbine locations and an approximately 10-meter buffer along either side of existing access roads. No wetlands were identified within the Phase 1 project boundary. Three waterbodies meeting the criteria for waters of the U.S. were mapped on site, including Washboard Wash, a tributary to Washboard Wash, and an unnamed tributary.

Based on the use data collected for the Dry Lake site, mean annual raptor use (adjusted as number of raptors observed per 20-min survey within an 800-m radius for comparison with other wind project studies) was 0.15/survey. Raptor use at Dry Lake is lower than most wind resource areas evaluated in the U.S. using similar protocols. A regression analysis of raptor use and raptor mortality for several newer wind projects where similar methods were used to obtain raptor use estimates showed a significant ($r^2 = 90.3\%$) correlation between raptor use and collision mortality. Using this regression to predict raptor mortality at the Dry Lake project yielded an estimated fatality rate of 0.0/MW/year, or no raptors per year for a 100-MW project. A 90% confidence interval around this estimate is 0 to 0.10 raptor fatalities/MW/year, or 0 to 10 raptor fatalities per year for a 100-MW project. Based on species composition of the most common raptor fatalities at other western wind farms and species composition of raptors observed at Dry Lake during the fixed-point surveys, the majority of the fatalities of diurnal raptors would likely consist of red-tailed hawks and American kestrels. Small numbers of other raptors may occur as fatalities over the life of the project.

Mean use data expressed as the number of birds observed per 20-minutes with an 800-m viewshed are available for 25 other wind resource areas (WRAs) in the U.S. Use of the Dry Lake site by all bird species combined is moderately high compared to these WRAs, and is higher than 18 of the other sites. However, the vast majority of the Dry Lake use is due to horned larks, a species common in flat desert scrub and grazed rangeland. The data collected during this study suggest that the Dry Lake project is not within a major migratory pathway or does not provide important stopover habitat for migrants as there was generally low variation in avian diversity across seasons. Based on all survey data, passerine mortality at Dry Lake would likely be similar to the national average of 3.1 birds/MW/year. Because habitat at the Dry Lake site is not unique for the area, and similar habitats are common in the region, it is unlikely that displacement of birds would result in any substantial impacts or population changes.

The number of bats recorded per AnaBat detector night was most similar to other western wind projects studied. The number of bats recorded does not suggest that bat mortality would be high; however, Brazilian free-tailed bats, documented fatalities at other wind projects, were likely present on the site based on the bat calls recorded. Other species that are expected fatalities would include long distance migrant species such as hoary bat and silver-haired bat although habitat for these species does not occur on the site. These species are common fatalities at all wind projects studied in the U.S. Typical resident bats or species that make short distant dispersals from suitable hibernacula are not expected to be greatly affected by the project. Bat use of the subsequent phases area is expected to be similar to the Phase 1 study area but may be more consistent if perennial water sources are expected.

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INTRODUCTION

PPM Energy, Inc. (PPM) is proposing to construct, operate, and maintain a wind generation facility in Navajo County, Arizona. PPM's project, the *Dry Lake Wind Power Project* (Project), is located about 6 to 18 miles north-northwest of the City of Snowflake, just east of Arizona State Highway 377 and southwest of the I-40 corridor (Figure 1). The proposed Project would provide up to 378 megawatts (MW) of wind-generated energy and consist of multiple phases:

- Phase I would include 64 MW of wind energy with up to 43 wind turbines, access roads, an interconnection substation, an Operations & Maintenance (O&M) facility, and collector lines to transmit the generated energy to the substation. The proposed turbines would range in size from 1.5 to 3.0 MW each.
- Subsequent phases of the project would include comparable facilities with capacity to provide a total of up to 314 MW of additional wind energy. The number, size, and capacity of each subsequent phase of the project is yet to be determined

The turbines, access roads, collector lines, substation and O&M facilities would be constructed on private leased land, state land administered by the Arizona State Land Department (ASLD), and federal lands managed by the U.S. Department of the Interior, Bureau of Land Management (BLM).

The primary natural resource issues for wind development typically include concern over direct impacts to avian and bat resources and the potential for impacts to listed or sensitive species. Secondary concerns often center around a general lack of knowledge about a proposed development area, habitat loss, or indirect impacts to wildlife such as displacement or disturbance. Total annual mortality estimates for birds at wind projects in the U.S. range from less than 1 to approximately 10 birds/turbine (see Erickson *et al.* 2001), with raptors and passerines appearing most susceptible to collision (AWEA 1995, Erickson *et al.* 2001). Collision fatality of bats has been recognized as a concern for some eastern wind projects (see Nicholson 2003, Kerns and Kerlinger 2004, Kerns *et al.* 2005); however, bat mortality at western wind plants is not as high (see Erickson *et al.* 2003; Young *et al.* 2003a, 2003b; Smallwood and Thelander 2004; Johnson 2005).

There are few operating large-scale wind projects in the southwestern U.S. and the potential for and extent of impacts from wind projects in Arizona is largely unknown. Pre-project or baseline studies are typically conducted at proposed wind power sites to collect data that may be used to describe avian and bat resources in the context of the proposed development; assist in addressing potential impacts from the development; assess the relative risk of the development to birds and bats; and to the extent possible, assist in wind plant design and siting that minimizes risk to avian and bat resources.

PPM Energy requested that Western EcoSystems Technology, Inc. (WEST) conduct a one-year study to address the typical concerns and provide site specific data for resources of concern within the Phase 1 development area. The principal goals of the study were to:

1) provide information on avian and bat resources and use of the study area that is useful in evaluating the potential impacts and the relative risk from the proposed wind project;
2) provide information on avian and bat use of the study area that will help in designing a wind project that is less likely to expose species to potential collisions with turbines, and;
3) provide recommendations for further monitoring studies and potential mitigation measures, if appropriate.

Specific study components were designed to: (1) describe and quantify seasonal avian use of the proposed project area; (2) describe and quantify raptor use of and migration through the proposed project; (3) describe and quantify seasonal bat use of the proposed project; and (4) identify the presence of any special status species (e.g., state sensitive species) that may occur in the study area. Habitats in the study area were also described and any wetlands or other jurisdictional waters of the U.S. were identified. In addition, a reconnaissance level field survey was made to the area proposed for subsequent phases to assess the similarity of the habitat and avian resources between the two areas, the pertinence of the current studies to describing wildlife resources for subsequent phases, and the need for additional studies. This report includes results of studies on all phases of the project. The Phase I area was studied in greater detail to cover the areas that would be developed first. The analyses and results reported here are primarily for the studies of the Phase I area of the project. It is the intent to expand these studies to include subsequent phases as they are proposed for development.

STUDY AREA

The Dry Lake project area is located within the Colorado Plateau Semi-Desert Province Ecoregion in the northeastern quarter of Arizona. Phase I of the project falls within pinyon-juniper and desert scrub vegetation types just north of the Pink Cliffs which separates the Colorado Plateau Semi-Desert province from the Arizona-New Mexico Mountains Semi-Desert province to the south. Elevation in the Phase I area varies from approximately 5500 to 6000 feet. The primary vegetation within the area proposed for subsequent phases is similar desert scrub interspersed with pinyon-juniper primarily along the southern portion of the project area and on higher elevation bluffs. There are a few canyons cutting through the expansion area that provide variation in topographic relief but do not substantially influence the primary vegetation types. The proposed project areas lie just east of Arizona State Highway 377 and “Dry Lake”, southwest of Holbrook and the I-40 corridor (Figure 1).

The land within the project is a mix of private, state, and BLM lands (Figure 1). Most of the project area is undeveloped and grazing is the primary land use. Several water tanks have been developed throughout the project area for livestock watering. In addition to cattle, there are a few pig farms on the site confined to buildings and a small area of the western portion near State Highway 377 (within Phase 1) and in a larger area within the eastern half of the subsequent phases area. Both areas are bisected by several unimproved roads (two-tracks) and several transmission lines and the expansion areas is bisected north-south by a railroad. A 69 kV transmission line borders the Phase 1 project area on the west side.

Phase I of the project site drains to the north and east, toward the Little Colorado River Valley. One, large intermittent drainage (Washboard Wash) conveys runoff from the central portion of the site to the northeast and continues through the northwest quarter of area planned for subsequent phases. Several smaller intermittent drainages, in the western and southern portions of the site, serve as tributaries to Washboard Wash. No perennial drainages occur within the site. Many of the intermittent drainages on site feature impoundments that are used for livestock grazing, the dominant land use in the area.

METHODS

Study Plan Development

A study plan was prepared based primarily on similar studies for wind energy development throughout the U.S. and to address wildlife resources typically of concern for wind power projects. The overall proposed approach to the studies was consistent with past and current pre-project studies of wind projects throughout the Midwest and West and the methods described in the document "Studying Wind Energy/Bird Interactions: A Guidance Document" (Anderson *et al.* 1999). Initially the study plan focused solely on the Phase 1 area, however, it is the intent to expand studies as needed to address concerns within the area proposed of subsequent phases as future phases of development are proposed.

The draft of the study plan was circulated to agency representatives whose jurisdiction covered the project area or wind power proposals in general. Comments were solicited during the initial study phase to insure that concerns were addressed. An agency meeting was held on January 17, 2006 at the Arizona Game and Fish Department (AGFD) office in Pinetop to discuss the proposed project, the study plan, and agency questions, comments and/or concerns about the project. Representatives of the AGFD, U.S. Fish and Wildlife Service (USFWS) and BLM were in attendance. An optional site visit was held on January 18, 2006 so that the agency representatives could view the Phase 1 site and ask further questions. No major concerns or comments were raised over the proposed study plan by the agencies.

Avian Use Surveys

The objective of the avian use surveys was to estimate the seasonal, spatial, and temporal use of the study area by birds and in particular raptors. Point counts (variable circular plots) were conducted on the proposed Phase 1 study area using methods similar to those described by Reynolds *et al.* (1980) and Bibby *et al*. (1992). The points were selected to provide good coverage of the study area while sampling the major vegetation types and topographic features. All birds detected during the point counts were recorded; however, an emphasis of the surveys was locating and counting raptors and large birds within approximately 800 m (0.5 mi) of each point.

<u>Survey Plots</u>

Eleven fixed-point survey locations were established over the study area to provide thorough coverage of the vegetation types, topographic features, and area proposed for turbines. Survey points were established to maximize visibility over long distances in 360^o around the point and so that the areas encompassed by an 800 m radius circle around the points did not overlap (Figure 2).

Each survey plot was a variable circular plot centered on the observation point. All birds observed were recorded, although the survey effort concentrated within an approximate 800 m radius circle centered on the observation point. Observations of birds beyond the 800 m radius were recorded, but were not included in the calculation of the standard metrics.

Survey periods at each point were 30 minutes long. All raptors and other large birds observed during the survey were assigned a unique observation number and plotted on a map of the survey plot. Approximate flight paths were mapped for raptor and large bird observations and labeled with the corresponding observation number. The date, start and end time of the survey period, and weather information such as temperature, wind speed, wind direction, and cloud cover were recorded for each survey. Species or best possible identification, number of individuals, sex and age class (if possible), distance from plot center when first observed, closest distance, altitude above ground, activity (behavior), and habitat(s) were recorded for each raptor observed.

The behavior of each bird observed and the vegetation type in which or over which the bird occurred were recorded. Behavior categories included perched, circling/soaring, flying, foraging, singing, and other (noted in comments). Vegetation types (habitats) included desert scrub, pinyon-juniper, rock outcrop/cliff, wetland/water/stock pond, and other (noted in comments). The initial behavior and habitat (when first observed) were uniquely identified on the data sheet and subsequent behaviors and habitats used (if any) were also recorded. Approximate flight height at first observation and the approximate lowest and highest flight heights were recorded to the nearest meter or 5-meter interval. Comments or unusual observations were described on the data sheet.

Observation Schedule

Sampling intensity was designed to document avian use and behavior by habitat and season within the project area. Weekly surveys were conducted throughout one calendar year, and observers were on the site at least one day per week throughout the year. During each site visit five or six of the survey points were surveyed. The points surveyed each week were alternated so that all points were surveyed an equal number of times.

Seasons were based roughly on the calendar seasons and were defined as fall: September 1 - November 31; winter: December 1 - February 28; spring: March 1 - May 30; summer: June 1 - August 31. Surveys were conducted during daylight hours and survey periods were scheduled to approximately cover all daylight hours during a season. To the extent practicable, the order in which survey points were visited was rotated to vary the time of day in which plots were surveyed and distribute observations over the daylight hours throughout the year.

Observations of raptors, other large birds, bird species of concern, large flocks, and bird species not previously recorded on site were recorded when traveling between points. These data were coded as in-transit or incidental observations. For each incidental raptor observation, additional details on behavior and habitat were recorded.

Raptor Nest Survey

The objective of the raptor nest survey was to locate nests that may be subjected to disturbance and/or displacement effects from wind plant construction and/or operation. The nest survey gathered information on species nesting in the area including nest locations, nesting season (timing), and nest status.

The nest survey was conducted via helicopter on May 23, 2006 when *Buteos* (e.g., red-tailed hawk) and golden eagles should be actively incubating eggs or brooding/attending young. The aerial survey area included the Phase 1 study area and the area within an approximate 2-mile buffer of the site. The total area searched was approximately 45,787 acres (~ 71.5 square miles). A ground based survey for raptor nests was conducted in the subsequent phases area on May 4, 2007.

GPS coordinates were recorded for all nests located of all raptor or other large bird species and mapped on a GIS ArcView project utilizing USGS topographic maps (1:24000 scale) as the base. Opportunistic ground observations supplemented the raptor nest survey by recording additional nests not found during the aerial survey. Locations of inactive nests were recorded as they may be occupied during future years. All nests, whether active or inactive, were given a unique identification number.

Bat Use Surveys

The objective of the bat use surveys was to estimate the relative abundance and spatial use of the study area by bats and determine, to the extent possible, the species of bats using the project area. AnaBat detectors were deployed at two sampling stations using passive sampling methods within the Phase 1 area. One location was at a project met tower located in the southeast portion of the project. The second location was based on habitat and was near a complex of ground fissures or caves that could support roosting bats. A third area near a stockpond was sampled for three nights in July when the AnaBats were first deployed. The two sampling locations were fixed for the duration of the AnaBat surveys to provide an estimate of the relative abundance of bats over the study period. AnaBat detectors were operated from July to October; however, due to technical difficulties sampling did not occur over this whole period. AnaBat sampling occurred continuously from approximately sunset to sunrise on each survey night.

In addition to the passive AnaBat sampling, walking surveys were conducted along the Pink Cliffs area to search for caves and ground fissures that may be suitable for roosting bats, maternal areas, or hibernacula. GPS coordinates were recorded for each area deemed suitable and they were mapped to show distribution in relation to proposed turbines.

The AnaBat recordings were analyzed to determine relative abundance or use estimates (e.g., number of bat calls per detector-night) and species present, to the extent possible. While AnaBat detector recordings are often unique to species, there is substantial overlap in call characteristics between many species and individual bats may vary calls based on numerous factors such as habitat, spatial location, season, behavior, activity, and presence of other bats. These variances make species identification from recordings difficult. Recorded bat vocalizations were categorized based on call frequency to help in species identification among known possible bat species occurrence.

General Wildlife Observations

In addition to the routine surveys described above, observers recorded general wildlife observations while they were in the project area or traveling between survey stations. The objective of recording general wildlife observations was to document wildlife other than avian species that may be affected by the proposed development as well as document avian use in areas outside of the survey plots. Raptors, unusual or unique avian sightings, sensitive species, mammals, reptiles/amphibians sighted while field observers were on site or traveling between survey stations were recorded on data sheets for incidental observations.

Vegetation Mapping

The objectives of the vegetation mapping were to identify the vegetation types (communities) that may be directly impacted by the project and characterize the habitat suitability of the study area for sensitive species (e.g., rare plants). The vegetation of the project area was mapped at 1:24,000 scale (USGS topographic maps) based on aerial photos. Ground reconnaissance observations were used to identify the vegetation type signature on the aerial photos and confirm polygon boundaries or transitions to other types. Information from the vegetation mapping was used to describe habitat used by wildlife species observed and determine the need for additional surveys for species of concern (e.g., rare plants, federal and state listed wildlife). The vegetation mapping study area included both the primary Phase 1 study area and subsequent phases area (see Figure 2).

Rare Plant Surveys

The screening process for identifying rare plant species with potential for occurrence within the project area consisted of gathering available information about each species with an emphasis on the habitats in which they occur, elevational ranges, and known occurrences. Information was obtained from literature (e.g., the Arizona Rare Plant Field Guide), database searches (AGFD Heritage Data Management System), and contact with resource specialists. Habitats present within the project area were identified based on review of existing data, such as land use/land cover maps, aerial photographs, information available from agencies such as the natural resource database, and field reconnaissance.

The screening process resulted in the identification of three sensitive plant species as potentially occurring in the proposed project area (Table 1): roundleaf errazurizia (*Errazurizia rotundata*), paper-spined cactus (*Pediocactus papyracanthus*), and Peebles Navajo cactus (*Pediocactus peeblesianus* var. *peeblesianus*). Pedestrian surveys were conducted within the Phase 1 study area for these species by performing meandering transects, zigzagging back and forth across proposed turbine locations and other project facilities and along proposed and existing access roads. A 150-meter buffer was surveyed around proposed turbine locations and an approximately 10-meter buffer was surveyed along either side of existing access roads. Surveys were conducted in appropriate habitats and during flowering/fruiting periods for the target species (Table 1). The intensity of the pattern and the speed at which the surveyor(s) walk varied, depending on the structural complexity of the habitat, the visibility of the target species, and the probability of species occurrence in a given area.

Wetland Delineations

Wetlands were delineated in accordance with the 1987 *Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory 1987). This manual emphasizes a three-parameter approach to identify wetlands that may be federally regulated, including the presence of hydrophytic vegetation, hydric soils, and wetland hydrology. These criteria were applied to establish the presence and extent of wetlands. Delineated wetlands, if any, were to be classified according to methodologies set forth in *Wetlands and Deepwater Habitats of the United States* (Cowardin *et al*., 1979).

Prior to conducting field surveys, U.S. Geological Survey (USGS) topographic maps, soil survey information from the Natural Resource Conservation Service (NRCS), and USFWS National Wetlands Inventory (NWI) maps were reviewed for the survey area. Field surveys for wetlands were conducted during field surveys for rare plants. The survey area included a 150-meter buffer along proposed Phase 1 turbine corridors and an approximately 10-meter buffer along either side of existing access roads. Wetlands and waters of the U.S. that were located within these areas were delineated with a GPS and photographed with a digital camera. A standard Army Corps of Engineers datasheet was also completed for each feature mapped. In situations were waterbodies had very marginal channel definition, the drainages were observed further downstream (beyond the identified survey area) to assess channel definition/incision and/or connectivity to a tributary water. Waterbodies determined to be waters of the U.S. were digitized onto an aerial photo of the site using ArcView 9.0. During the digitization effort, waterbodies were extended downstream to the project boundaries.

Subsequent Phases Area

While it is the intent to study each phase of development for the Dry Lake project, the area proposed for subsequent phases was investigated during this first year of study through a reconnaissance level field survey. Driving and on-foot surveys were conducted during a one-day field visit in the Spring season to survey for raptor nests, assess habitat/vegetation types, unique land features, current land use and management, and similarities of the two areas and the applicability of study results.

Data Compilation and Storage

Electronic databases were established to store, retrieve and organize all 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 were retained for future reference. QA/QC measures were implemented at all stages of the study, including in the field, during data entry and analysis, and report writing. At the end of each survey, each field observer was responsible for inspecting his/her data forms for completeness, accuracy, and legibility. The study team leader reviewed data forms to insure completeness and legibility; any problems detected were addressed and any changes made to the data forms were initialed and dated by the person making the change. A sample of records from the electronic database files was compared to the raw data forms and any errors detected were corrected. Any irregular codes detected, or any data suspected as questionable, were discussed with the observer and study team leader. 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.

Statistical Analysis and Products

Statistics/data generated for the study included the following:

- Species lists and observations by season;
- Relative use by species, species group, and season;
- Mean frequency of occurrence and species composition;
- Mapped relative abundance (use) by observation points;
- Mapped summary of raptor observations and flight paths by species;
- Raptor nest location mapping;
- Flight characteristics and exposure indices by species and species group;
- Mean relative abundance of echo-locating bats per survey period and location;
- Wildlife observed in the study area and sensitive species locations mapping, if any;
- Comparisons of avian use, raptor nest density, and bat detections between the proposed project and other new or existing wind plants with similar data.

The number of species seen during each point count survey was standardized to a unit area and unit time. Avian use by species was calculated as the mean number of observations per 30-minute survey within 800 m of the survey point. Because of the relative close proximity of points to each other, the variability of estimates of avian use was based on survey to survey variability (i.e., temporal variability). Standardizing the data to a unit area and unit time allows comparison of avian use between sample locations (habitats), time (time of day, seasons), proposed developments, and to other wind farms where use data exist.

The frequency of occurrence by species was 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. Frequency of occurrence and percent composition provide relative estimates of the avian diversity of the study area. For example, a particular species may have high use estimates for 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 (*E*) was calculated for bird species observed flying during the fixed-point surveys using the formula:

$$E = A*Pf*Pt$$

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. This index does not account for differences in behavior other than flight characteristics (i.e., flight heights and percent of birds observed flying).

The relative abundance of echo-locating bats was standardized to the number of echolocation detections per night. Data were plotted to illustrate variation over time (date) and sampling station. Risk to bats was estimated by the relative abundance of bat detections compared to studies of existing wind farms where mortality estimates and AnaBat detection surveys were conducted.

RESULTS

Avian Use Surveys

Surveys were conducted at half (5-6) of the 11 fixed-point count stations located within the study area (Figure 2) approximately once each week between September 12, 2005 - September 15, 2006, resulting in 279 30-minute point count surveys during the study.

Sixty-five avian species were observed during the fixed-point surveys (Table 2). A total of 5793 observations in 1568 different groups[1] were recorded during the fixed-point surveys (Table 2). 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 the most numerous group; horned lark comprised over 65% of the passerines observations. Passerines comprised 90% of all groups observed and 95% of the total number of birds observed. Raptors comprised approximately 4% of all groups and 1% of all birds observed. The most common raptor was red-tailed hawk. Other birds (shorebirds, doves, and other non-passerine species) comprised approximately 6% of all groups and 3% of all birds observed (Table 2).

Avian Use

To standardize the data for comparison between points, seasons, and with other studies, avian use, frequency of occurrence, and species composition were calculated from observations within 800 m of the survey point. Avian use by species was calculated as the mean number of observations per 30-minute survey (Table 3). 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 frequently red-tailed hawks occur in the study area, and therefore are at

[1] 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.

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.

Use varied across seasons (Table 3). In the fall, the four most abundant species were horned lark (15.04 detections/30-minute survey), common raven (2.42), mountain bluebird (1.50) and chipping sparrow (0.73), which comprised 81% of the total bird use (Table 3). In the winter, the four most abundant species were horned lark (22.39), common raven (1.39), dark-eyed junco (1.29), and mountain bluebird (0.59). These species comprised 95% of the total bird use for the winter (Table 3). In spring, the four most abundant species in the study area were horned lark (6.55), common raven (1.50), pinyon jay (0.83), and northern mockingbird (0.44). Together these species comprised 76% of the total bird use during the spring (Table 3). During the summer, the four most abundant species were horned lark (6.30), common raven (2.09), mourning dove (1.49), and northern mockingbird (0.74). These species comprised 64% of the total bird use during the summer (Table 3). Over all seasons, horned lark was the most common bird observed with 12.76 detections per survey, followed by common raven (1.90), mountain bluebird (0.62) and dark-eyed junco (0.57). These four species comprised 78% of all bird use of the site for the year (Table 3).

Over all seasons based on use, passerines were the most abundant group observed followed by doves, raptors and other birds (Table 3). Passerine use was higher in winter (26.85) and fall (23.83) compared to summer (13.96) and spring (11.64) (Figure 3). Raptor use was similar across all seasons, ranging from 0.12–0.32/survey (Figure 3). Use for all birds was higher in winter (27.08) and fall (24.35) compared to summer (16.67) and spring (12.21) (Figure 3).

Species Percent Composition and Frequency of Occurrence

Percent composition is represented by the mean use for a species divided by the total use for all species and multiplied by 100 (Table 4). Frequency of occurrence was calculated as the percent of surveys where a particular species was observed (Table 5). Percent composition provides a relative estimate of the proportion of overall bird use attributable to each species and frequency of occurrence provides information on how often a species occurs in the study area. Avian diversity on the site was low because one species (horned lark) comprised nearly 63% of all birds observed. Only one other species comprised more than 5% of all birds observed, common raven (9.30%). All other species comprised ≤3% of all avian use of the site (Table 4).

Passerines were the most frequently observed group, as they were seen during most surveys (97.2%). Raptors had the second highest frequency of occurrence but were only observed during 18% of the surveys. The species of birds most frequently observed included horned lark (77.5% of surveys), and common raven (62.7%). The most frequently observed raptor was red-tailed hawk, which was observed during 7.0% of the surveys (Table 5).

An additional index of species diversity is the mean number of species observed per survey. Species diversity was highest in the summer (5.5 species/survey), followed by fall (3.7), spring (3.1) and winter (2.1).

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 6). A range of potential tower heights and rotor diameters was use to determine the "zone of risk"; the estimate used was 18 m above ground level (AGL) to 152 m AGL. This range is a conservative estimate that includes a small buffer of approximately 2-5 m on the upper and lower limits.

During the study 782 single birds or flocks totaling 4273 individuals were observed flying during point count surveys (Table 7). For all species combined, 90.2% of all flying birds observed were below the rotor-swept height, 8.1% were within the rotor-swept height, and 1.8% of birds were observed flying above the rotor-swept height (Table 7). For groups with at least 5 separate observations of flying birds, those most often observed flying within the turbine rotor-swept height were raptors (42.9%). Groups with the lowest percent of observations within the rotor-swept height were doves (0.0%), other birds (4.3%), and passerines (7.8%). For species with at least five separate observations of flying birds, those most often observed at rotor-swept heights were Townsend's solitaire (71.4%), golden eagle (60.0%), turkey vulture (50.0%), common raven (44.4%), and red-tailed hawk (42.9%) (Table 6).

Exposure Index

The exposure index is a relative measure of the risk of each species observed on-site during the 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, pinyon jay, horned lark, and Townsend's solitaire had the highest exposure indices (Table 8). All five of these species either had relatively high use in the study area or were frequently seen in the zone of risk (44.4%–100.0% of the time). The higher exposure index for horned lark was due to its high use of the study area. The only raptor with a relatively high exposure index was red-tailed hawk, which ranked 8^{th} of all species.

Spatial Use

Mean use was plotted by avian survey point for the most abundant avian groups in the study area and for all birds combined. Passerine use was relatively consistent across 10 of the 11 survey points (2-11), ranging from 12.92-24.80/survey (Figure 4), but was significantly higher at survey point 1 (38.69). Raptor use was also very consistent among 9 of the 11 survey points (1-7, 9, and 11), ranging from 0.04–0.27/survey. The raptor use was higher at survey points 8 (0.72) and 10 (0.48) (Figure 4). For all bird species combined, use across the surveys points was very similar to passerines, consistent across survey points 2 - 11 and highest at survey point 1.

Point of first observation, approximate flight paths, and perch locations were mapped for raptors and other large birds observed in the project area (Figure 5). The objective of mapping observed bird locations was to look for areas of concentrated use by raptors and other large birds. Red-tailed hawks were the most common raptor observed. Most red-tailed hawk observations occurred near point 8 located on the west end of Pink Cliffs (Figure 5). The birds appeared to show concentrated use along the south slopes of Pink Cliff in this location. Turkey vultures also showed fairly concentrated use of this area (Figure 5). Few other raptors were observed during surveys, and those that were observed were fairly evenly distributed across the survey area (Figure 5). The remainder of the study area is relatively flat and no strong association of use with topographic features was noted.

Raptor Nest Surveys

Four active raptor nests were located during the aerial survey one nest each of golden eagle, red-tailed hawk, great horned owl, and barn owl (Figure 6). During the survey, two adult golden eagles were observed at one location on a power line tower but no nest was observed at this location. Four inactive nests were also located, two of which were suspected to be common raven nests and two of which were suspected to be old golden eagle nests. The red-tailed hawk nest was located on a power line tower, the golden eagle nest was located on a rocky cliff of a small mesa southeast of the project area, the great horned owl nest was in a juniper tree, and the barn owl nest was in a rock crevice. The only nest within the project area boundary was the barn owl nest. The golden eagle nest and pair of eagles were located in the southeastern portion of the survey area but outside the proposed development area. The red-tailed hawk nest was located approximately 0.3 mile south of the project area, and the great horned owl nest was located approximately 1.0 mile west of the project area. Based on a survey area of approximately 45,787 acres, active raptor nest density was $0.05/mi^2$.

No raptor nests were located in the subsequent phases area; however, two common raven nests were located on transmission line poles. The expansion area has some habitat features such as rocky bluffs and canyons that are not easily covered by ground based raptor nest surveys and there could be some nests that were missed during the field survey. However, based on similarity of habitat and low density of raptor nests in the Phase I area, it is not expected that a substantial number of nesting raptors occur in the subsequent phases area.

Bat Use Surveys

AnaBat sampling occurred on three nights from July 6-8 at the fixed met tower station and at a stockpond with water in the southeastern portion of the project (Figure 2). A total of 15 bats were recorded at the stock pond and 3 at the met tower site over the three-night period for approximately 3.0 bats per AnaBat-night during the sampling period. Due to equipment technical difficulties, AnaBat sampling on the site did not resume until September 21 but occurred continuously through October 15. During this period, sampling occurred at the project met tower station and at a station adjacent to a complex of ground fissures and caves in the southeast portion of the project (Figure 2). A total of 6 bats were recorded at the met tower station and 76 bats at the ground cave station over the 25-night period (Table 9). Over both sampling stations approximately 1.64 bats were recorded per AnaBat-night during the September-October sampling period. Sampling also occur from November 1-7 at the met tower and ground fissure site, however no bats were recorded during this period at either location. Excluding the November sampling that did not record any bats, overall approximately 1.78 bats were recorded per detector night (56 sampling nights).

Based on available information, 17 species of bat potentially occur in northeastern Arizona (Table 10). No calls were recoded of the low frequency (<20kHz) bats. Thirteen (13) calls were recorded of bats in the 20-35kHz range. Based on the habitat of the site, characteristics of the recorded calls, and other regional research (Chambers 2007), these were thought to be primarily from pallid bats and Brazilian free-tailed bats. Sparse pinyon-juniper vegetation occurs along the

Pink Cliffs area, however, no calls were recorded of typical forest dwelling species such as hoary bat, silver-haired bat, or big-brown bat. Most of the calls recorded fell within the two high frequency categories (Table 9). Within the 40-50 kHz range the possible species are *Myotis* species which have very similar call characteristics and most of the calls could not be identified to species. A few calls had characteristics of fringed myotis and it is likely this species occurred on site based on other research in the region (Chambers 2007). Of the >50khz calls recorded, some calls displayed characteristics of all three possible species and it is likely that all three occurred on site based on the calls and other regional research (Chambers 2007).

During ground surveys of the Pink Cliffs area for rare plants and bird surveys, ground fissures and caves that appeared as if they could contain roost areas for bats were mapped (Figure 7). At least five caves were thought to be suitable for roosting bats or had bat guano present confirming use by bats. The AnaBat detector station located in the southeast portion of the project also confirmed use by bats of the ground caves.

The subsequent phases area of the Dry Lake wind project area is expected to have similar bat use that may concentrated in space around suitable habitat features but may have more consistent temporal use due to expected perennial water sources associated the pig farm operation on the site. Bat use surveys prior to development of subsequent phases may be warranted if additional studies of Phase I (see below) confirm any sensitive species on site. Estimates of relative abundance, species present, and potential concentration areas for subsequent phase would provide additional information for meeting study objectives.

General Wildlife Observations

Three avian species were observed incidentally on site while surveyors were traveling between stations that were not recorded during the standardized point-count surveys: tree swallow (2), greater roadrunner (1), and western wood-peewee (1) (Table 11). Ten raptors of four species were also observed while surveyors were on site traveling between survey stations, American kestrel (4), northern harrier (3), red-tailed hawk (2), and turkey vulture (1) (Table 11), but these species were all recorded during standardized surveys. One species of interest for Arizona, pronghorn antelope, was observed regularly on site. A total of 97 individuals in 14 groups of pronghorn were recorded on site during the study (Table 11).

Vegetation Mapping

Two habitat types were identified within the project area (Figure 7): desert scrub/grassland and pinyon-juniper. The project area has a prevalence of bare ground and vegetal cover varies from 50% to as little as 10%

Desert Scrub

The majority of the project site is dominated by desert scrub and short/mixed grass grassland (Figure 7). This habitat consists of very open stands of short bunchgrasses with scattered low shrubs and tall grasses. Dominant graminoid species include blue grama (*Bouteloua gracilis*), galleta (*Hilaria* sp.), muhly (*Muhlenbergia* sp.), threeawn (*Aristida* sp.), needleandthread (*Stipa comata*), and alkali sacaton (*Sporobolus airoides*). Low shrub species include broom snakeweed

(*Gutierrezia sarothrae*), rabbitbrush (*Chrysothamnus* sp.), saltbush (*Atriplex* spp.), and Mormon tea (*Ephedra* sp.).

Pinyon Juniper
Portions of the project area along Washboard Wash and the Pink Cliffs are areas of pinyon-juniper woodland (Figure 7). The pinyon-juniper woodland habitat is composed of an open canopy of oneseed juniper (*Juniperus osteosperma*) and pinyon pine (*Pinus edulis*), with an open understory of grasses, forbs, and low shrub species such as dropseed (*Sporobolus* sp.), needle grass (*Stipa* sp.), buckwheat (*Eriogonum* sp.), prickly pear (*Opuntia* sp.), cymopterus (*Cymopterus* sp.) and species found in the desert scrub type.

Rare Plant Surveys

Field surveys were conducted between April 24-27, 2006. No individuals of roundleaf errazurizia or Peebles Navajo cactus were found within the project site. A total of nine subpopulations of paper-spined cactus were detected within the project area (Figure 7). The number of individuals within each of the subpopulations ranged from 6 to 35 individuals. Seven of the nine subpopulations were observed within the desert scrub-short/mixed grass grassland vegetation type. The seven subpopulations occurred within relatively homogenous areas, exhibiting no apparent microsite characteristics including little topographic relief. Dominant vegetation in these areas was composed of blue grama, galleta, and needleandthread. Soils were typically loamy sands and fine sandy loams. The two subpopulations found in the southwestern portion of the site (Figure 7) occurred in slight depressions (2-3 inches lower than the surrounding terrain) that appeared to convey periodic surface runoff, although no true drainage channels were present. Topography within and adjacent to these areas was relatively flat, and sloped slightly to the northeast. The reddish soils observed in this area were silty clay loams with scattered pea gravel and a baked appearance on the surface. Overall vegetation cover was approximately 10 percent, and was composed of dropseed, needle grass, buckwheat, prickly pear, and cymopterus. Numbers of individuals observed at these two locations were 6 and 15.

With the exception of the two, somewhat-unique subpopulations described above, all of the paper-spined cactus found within the project site occurred on relatively homogenous desert scrub -short/mixed grass grassland. As the project area is mostly composed of this habitat and since surveys for the cactus were limited to a relatively narrow corridors within the project boundary, it is likely that more individuals/subpopulations of the species occur in the area. Similarly, based on the similar vegetation type composition in the subsequent phases area, it is expected that subpopulations of paper-spined cactus would be found scattered through that area as well. The extent to which a subpopulation would be affected by any phase of development would be dependant on the location of the proposed facilities.

The likelihood of occurrence of roundleaf errazurizia and Peebles Navajo cactus on site is very low. Neither species is known to occur within the immediate project area, and appropriate soils/substrates for the species are absent from the site. Nonetheless, per recommendation from the BLM, surveys were conducted for both species within the most appropriate habitats. These surveys were primarily conducted within the Pink Cliffs area, a linear rocky ridge along the southern boundary of the site, and on other rock outcrops within the project area. Neither of these species are expected in the subsequent phases area either.

Wetlands and Waters of the U.S.

No wetlands were identified within the project boundary. Three waterbodies meeting the criteria for waters of the U.S. were surveyed within development corridors on site (Figure 7). In addition, seven impoundments were identified along drainages, one of which occurs along a tributary water. No hydrophytic vegetation (and thus no wetland) was observed within any of these impoundments.

Washboard Wash
Washboard Wash is a large, intermittent drainage that conveys runoff in a northeasterly direction across the project area. It is a named blue-line stream on the two USGS 7.5 minute quadrangle maps on which the project site occurs (Dry Lake NE and Flattop Hill Quads). The broad drainage featured a sandy channel bottom with overall marginal definition. Drainage banks were steep and highly eroded and the channel ranged in width from 10-20 feet. Some portions featured considerable downcutting likely due to livestock grazing. The majority of Washboard Wash within the project site occurs within a long, broad stringer of pinyon-juniper woodland. In addition to pinyon and juniper, sagebrush, rabbitbrush and upland grasses were observed along the banks. No hydrophytic vegetation was observed along the drainage.

Tributary to Washboard Wash
One tributary to Washboard Wash was surveyed within the project site. The tributary flows from west to east meeting Washboard Wash in the central portion of the project area. It is similar in dimensions to Washboard Wash and features considerable erosion and downcutting as well as similar vegetation composition.

Unnamed Tributary
An unnamed tributary was identified in the northwestern portion of the project site along a proposed development corridor. This tributary generally flowed in a southerly direction towards a larger unnamed tributary of Washboard Wash. This sandy wash featured a narrow, marginally-defined channel (1-2 feet wide). Although channel width was relatively constant, the top of bank width was variable, ranging from 5 to 10 feet. The sandy banks supported about 50% cover of upland grasses and shrubs and were approximately 2 feet high.

Subsequent Phases Area

A reconnaissance level field survey was made within the area proposed for subsequent phases on May 4, 2007. The area consists mainly of desert scrub and pinyon-juniper vegetation bisected by a few canyons of variable depth (Figure 8). Vegetation characteristics within the desert scrub community were similar to the Phase 1 area with a prevalence of bare ground and low plant species diversity. Within the landscape several livestock water impoundments were located with some scattered *Salix spp.* shrubs growing along the edges. Many of the higher elevation ridges are influenced by juniper shrubs and there are bluffs within the southern portion of the project that consist of pinyon-juniper habitat. These bluffs were not easily accessible by vehicle and appear to have areas suitable for nesting raptors similar to the southeastern portion of the Phase 1 survey area where the golden eagle nest was located (see Figure 6).

Within the eastern half of the subsequent phases area there is a larger pig farm that contains approximately 30 large watering ponds (Figure 8). These ponds provide variation in the primary vegetation types and landscape in the area and could potentially provide an attractant to avian species such as waterfowl that are not typically found in arid desert scrub environs. Two common raven nests were located on power lines that crossed the subsequent phases project area; however, no raptor nests were located during the field survey. Bird species detected during the survey were similar to species seen during the Phase 1 studies and included common raven, mourning dove, American kestrel, northern harrier, Brewer's blackbird, horned lark, Say's phoebe, and northern mockingbird.

DISCUSSION AND IMPACT ASSESSMENT

The most probable impact to birds resulting from wind projects is direct mortality or injury due to collisions with turbines, meteorological towers (met towers), or guy wires of towers. Collisions may occur with resident birds flying within the project area or with migrant birds moving through the project area. Other impacts from wind development, may arise from project construction and could affect birds through loss of habitat, potential fatalities from construction equipment, and disturbance/displacement effects from construction activities. Potential mortality from construction equipment is expected to be low. Equipment used in wind facility construction generally moves at slow rates or is stationary for long periods (e.g., cranes). The risk of direct mortality from construction to birds is most likely limited to potential destruction of a nest for ground- and shrub-nesting species during initial site clearing. Disturbance-type impacts can be expected if construction activity occurs near an active nest or a primary foraging area. Birds displaced from these areas might move to areas with fewer disturbances, depending on the stage of nesting; however, breeding effort and fledging success could be affected, or foraging opportunities and locations might be altered during the construction period. In general, despite potential impacts, construction activity has not been considered a major impact from wind development on birds, in part because of the temporary nature of construction and because measures such as constructing outside the breeding season or limiting construction within predefined buffers around areas of concern (e.g., raptor nests) during the breeding season may be effective in minimizing the direct and indirect impacts.

The assessment of operational impacts on birds from wind projects can be based on the site-specific measures of bird use and species composition compared to the same metrics at projects with direct measures of impact (e.g., mortality and displacement). Measured bird use of the Dry Lake area in addition to measured use and mortality estimates from other existing wind farms were used to predict mortality of birds for the project.

Data on avian mortality at wind projects are available from studies in California and throughout the west and Midwest but there is little information available for projects in the desert southwest, including Arizona. Of 841 avian fatalities reported from California studies (>70% from Altamont Pass, CA), 39% were diurnal raptors, 19% were passerines (excluding house sparrows and European starlings), and 12% were owls. Non-protected birds including house sparrows, European starlings, and rock doves comprised 15% of the fatalities. Other avian groups generally made up <15% of the fatalities (Erickson et al. 2002). Of 225 avian fatalities documented during 12 fatality monitoring studies conducted outside of California, diurnal raptor fatalities comprised only 2% of the wind project-related fatalities and raptor mortality averaged 0.03/turbine/year. Passerines (excluding house sparrows and European starlings) were the most common collision victims, comprising 82% of the 225 fatalities documented. No other group (e.g., waterfowl, non-passerines) comprised more than 5% of the fatalities. The projects that were studied outside of California were generally smaller in scale (<100 MW) and have more modern and much larger turbines than the older California projects.

For all avian species combined, estimates of the number of bird fatalities per turbine per year from individual studies have ranged from 0 at the Searsburg, Vermont (Kerlinger 1997) and Algona, Iowa sites (Demastes and Trainer 2000) to 7.7 at the Buffalo Mountain, Tennessee site (Nicholson 2003). Using mortality data from the last 10 years from wind projects throughout the entire U.S., the average number of avian collision fatalities is 3.1 per megawatt per year or 2.3 per turbine per year (NWCC 2004).

Raptors

Based on site specific avian use data collected for the Dry Lake site, mean annual raptor/vulture use (adjusted as number of raptors observed per 20-minute period at a station with an 800-m radius) was 0.15/survey. Based on studies of 29 other WRAs using similar protocols, mean annual raptor/vulture use (also defined as number of raptors/vultures observed per 20-minute period at a station with an 800–m radius) ranged from 0.10/survey to 1.3/survey (Figure 9). The only areas studied with higher than typical raptor use were Altamont Pass, California, where annual use averaged 2.4/survey, and the High Winds site in Solano County, California, where annual raptor use averaged 3.5/survey. Raptor/vulture use at the Dry Lake site is only 4% of that observed at High Winds and 6% of that observed at Altamont. Raptor/vulture use at Dry Lake is lower than almost all of the other WRA with reporting studies; it was only higher than one other WRA evaluated in the U.S. using similar protocols (Figure 9).

The exposure index analysis may provide insight into what species might be the most likely turbine casualties. However, this index only considers relative probability of exposure based on abundance, proportion of daily activity spent flying, and flight height of each species. This analysis is based on observations of birds during the daylight period and does not take into consideration flight behavior or abundance of nocturnal migrants. It also does not take into consideration varying ability among species to detect and avoid turbines, habitat selection and other factors that may influence exposure to turbine collision; therefore, the actual risk may be lower or higher than indicated by these data. For example, in the Altamont Pass WRA in California, mortality among the five most common species was not related to their abundance. American kestrels, red-tailed hawks, and golden eagles were killed more often, and turkey vultures and common ravens were killed less often than predicted based on abundance (Orloff and Flannery 1992). Similarly, at the Tehachapi Pass WRA in California, common ravens were found to be the most common large bird in the WRA, yet no fatalities for this species were documented during monitoring studies (Anderson et al. 1996).

The Altamont Pass WRA contains 5,400 turbines, most of which are small, obsolete, lattice tower, Kenetech turbines. The latest raptor fatality estimates at Altamont based on searches using 30-90 day search intervals indicate that annual mortality averages 1.5 to 2.2 raptor fatalities per megawatt (MW) per year when adjusted for searcher efficiency and removal bias. The High Winds Project is a modern wind farm with 1.8 MW turbines, and estimated mortality was 0.30 raptors per MW per year (unadjusted for scavenger removal or searcher efficiency) with searches conducted every 14 days. Most of the raptor mortality at the High Winds Project involved American kestrels, and the relative use of the High Winds site by kestrels was approximately 6 times higher than at the Altamont Pass. With the exception of American kestrels at the High Winds Project in California, raptor mortality at new-generation wind projects both within and outside California has been relatively low.

A regression analysis of raptor use and raptor collision mortality for several new-generation wind projects where similar methods were used to obtain raptor use estimates found that the correlation between raptor use and raptor collision mortality is significant (r^2 = 90.3%; Figure 10). Using this regression to predict raptor collision mortality at the Dry Lake project based on an adjusted mean raptor use of 0.15/20-minute plot survey yields an estimated fatality rate of 0.0/MW/year, or no raptors per year for a 100-MW project. A 90% confidence interval around this estimate is 0 to 0.10 raptor fatalities/MW/year, or 0 to 10 raptor fatalities per year for the 100-MW project. Based on species composition of the most common raptor fatalities at other western wind farms and species composition of raptors observed at Dry Lake during baseline studies, the majority of the fatalities of diurnal raptors will likely consist of red-tailed hawk and American kestrels. Small numbers of other raptors, including harriers, owls, or golden eagles, may also occur as fatalities over the life of the project.

Other Birds

Due perhaps to their abundance, passerines have been the most common fatality of all avian groups at other wind projects studied. Both migrant and resident passerine fatalities have been observed. Therefore, it is expected that passerines will make up the largest proportion of fatalities at the Dry Lake project. When all species of birds are considered, mean use data expressed as the number of birds observed per 20-minutes per plot with an 800-m viewshed are available for 25 other WRAs in the U.S. (Figure 11). Use of the Dry Lake site by all bird species combined is moderately high compared to these other WRAs, as 7 of the 25 sites had higher bird use than that observed at Dry Lake while 18 sites had lower use (Figure 11).

Some fatalities of nocturnal migrating birds have been observed at wind energy projects within the U.S. (Erickson et al. 2001), although the rates of fatalities at individual wind farms appear to be relatively low compared to estimates of the numbers of migrants flying over the sites (Young and Erickson 2006). Most nocturnal songbird migration is believed to occur above 150 meters (500 feet) above ground level (Longcore *et al*. 2005, Young and Erickson 2006). There are several records of large mortality events at tall guyed communications towers (Kerlinger 2000, Kemper 1996) and these events are typically associated with bad weather conditions (low ceilings, fog). There has been no reported large episodic mortality event (e.g., >50 birds during a single night) recorded at a U.S. wind farm. The largest mortality events reported at U.S. wind energy projects to date have been 14 migrant songbirds found at two turbines during spring migration at the Buffalo Ridge, Minnesota Wind Project (Johnson et al. 2002b) and 33 spring migrants at the Mountaineer Wind Project in West Virginia (Kerns and Kerlinger 2004). The West Virginia mortalities apparently occurred during inclement weather and the fatalities occurred at a heavily lit substation and the adjacent turbine. Most migrant songbird casualties recorded during carcass searches at turbines have been single fatalities and most searches at individual turbines result in no documented fatalities (Erickson et al. 2001).

The data collected during this study suggest that the Dry Lake project is not within a major migratory pathway, either for diurnal or nocturnal migrants. Mean raptor use at Dry Lake is one of the lowest recorded for a WRA in the U.S. The project area also does not appear to provide important stopover habitat for migrant songbirds based on the point count surveys. There were no seasonal increases in use by passerines and other typical nocturnal migrants that might be detected if the project area was within a major migratory corridor. Based on all survey data, song bird mortality at Dry Lake would likely be similar to the national average of 2.3 birds/turbine/year (NWCC 2004). Also based on the species use and composition from the Dry Lake site it is likely that horned larks would make up the majority of the passerine fatalities. Horned larks are one of the most common avian fatalities at wind project most likely due to their abundance in habitats that are receptive to wind development (see Erickson et al. 2001).

Indirect Effects

The presence of wind turbines may alter the landscape so that wildlife use patterns are altered, thereby displacing wildlife away from the project facilities and suitable habitat. In Europe, displacement effects related to some wind energy projects are considered to have a greater impact on birds than collision mortality, and several European studies have addressed this issue. Avian displacement associated with wind power development has not received as much research attention in North America. Development of wind turbines near raptor nests may result in indirect impacts to the nesting birds; however, the only published report of avoidance of wind turbines by raptors occurred at Buffalo Ridge, Minnesota, where raptor nest density on 101 mi^2 of land surrounding a wind project was 0.15 / mi^2 , yet no nests were present in the 12 mi^2 wind project facility itself, even though habitat was similar (Usgaard *et al.* 1997). No red-tailed hawks or golden eagles are known to nest within the Altamont Pass Wind Resource Area, suggesting that the large numbers of turbines present within that area may discourage nesting by raptors or that collision mortality prevents nesting in the APWRA. At the Foote Creek Rim wind farm in southern Wyoming, one pair of red-tailed hawks nested within 0.3 miles of the turbine strings, and seven red-tailed hawk, one great horned owl, and one golden eagle nests located within 1 mile of the wind farm successfully fledged young (Johnson *et al*. 2000a). The golden eagle pair successfully nested ½ mile from the wind farm for three different years after it became operational. A Swainson's hawk nested within 0.5 miles of the Klondike, Oregon Wind Project (Johnson *et al.* 2003). Studies at the Stateline Wind Project in Oregon and Washington have not shown any measurable short-term effects to nesting raptors (Erickson *et al.* 2004).

Based on a survey area of 45,787 acres, active raptor nest density was 0.05/mi^2. This is low compared to most other wind resource areas in the western U.S. where raptor nest density has ranged from 0.03–0.30/mi^2, and averaged 0.15/mi^2 (Erickson et al. 2002). Of 10 other WRA in the western U.S. with raptor nest density data, only 2 had $\leq$0.05 nests/mi^2. Because of the low nest density and distance to the nearest nests, no impacts are expected to nesting raptors from the proposed Dry Lake wind project.

At the Buffalo Ridge Wind Project, Minnesota, the abundance of shorebirds, waterfowl, upland game birds, woodpeckers, and several groups of passerines was found to be statistically significantly lower at survey plots with turbines than at plots without turbines. There were fewer differences in avian use as a function of distance from turbines, however, suggesting that the area of reduced use was limited primarily to those areas within 100 meters of the turbines (Johnson *et al*. 2000b). These results are similar to those of Osborn *et al.* (1998), who reported that birds at Buffalo Ridge avoided flying in areas with turbines. Some birds apparently did become accustomed to turbines, as Osborn *et al*. (1998) also reported a mallard nest within 31 m of a turbine. Also at Buffalo Ridge, Leddy *et al*. (1999) found that densities of male songbirds were significantly lower in Conservation Reserve Program (CRP) grasslands containing turbines than in CRP grasslands without turbines. Grasslands without turbines and portions of grasslands located at least 180 meters from turbines had bird densities four times greater than grasslands located near turbines. Reduced avian use near turbines was attributed to avoidance of turbine noise and maintenance activities and reduced habitat effectiveness because of the presence of access roads and large gravel pads surrounding turbines (Leddy 1996; Johnson *et al*. 2000b).

Preliminary results from the Stateline Wind Project in Oregon and Washington (Erickson *et al.* 2004) and the Combine Hills project in Oregon (Young *et al*. 2006) suggest a relatively small-scale impact of the wind facility on grassland nesting passerines. Transect surveys conducted prior to and after construction of the wind farm indicated that grassland songbird use was significantly reduced within 50 m of turbine strings; areas further away from turbine strings did not have reduced avian use. The reduced use was attributed to temporary and permanent habitat disturbance near the turbines. Horned larks appeared least impacted. Because the Dry Lake Wind Farm will be sited in a region with extensive similar habitats, it is unlikely that small scale displacement of grassland birds would result in any population impacts.

Bats

AnaBat surveys at the Dry Lake site were not as successful as originally planned. Technical difficulties with equipment malfunctioning, unexplained power losses, and monsoon rains affecting equipment and recordings contributed to fewer survey nights in particular during August, a peak month for bat activity and migration. However, based on the data that was acquired there appears to be some temporal variation and spatial differences in bat movement through the area. The sampling location at the met tower in the southeast corner of the project had relatively low bat numbers compared to locations near a stockpond and some ground fissures and caves. While all sampling sites were within the Pink Cliffs area, the habitat features of the stockpond and caves appeared to influenced bat use and occurrence.

The AnaBat sampling did confirm a low level of use by bats in general which is to be expected from a site primarily of desert scrub habitat and that the Pink Cliffs area has suitable roost habitat in the form of the fissures and caves, and to some degree the pinyon-juniper habitat. Foot surveys of the caves confirmed use by bats from the presence of guano. Overall bat use of the site is expected to be concentrated around the Pink Cliffs area based on these habitat characteristics and the presence of stock ponds for water.

The mean number of bat passes per detector per night was compared to existing data at wind projects where both bat activity and mortality levels have been measured (Table 12). The data from these studies was collected with AnaBat units placed on the ground which is comparable to this study. The level of bat activity documented at the Dry Lake site is much lower than the Eastern and one Midwestern wind project, all of which had fairly high levels of bat mortality (Table 12). However, it is similar to the Foote Creek Rim, Wyoming, and Buffalo Ridge, Minnesota wind farms, both of which had relatively low levels of bat mortality. The data collected on site do not indicate that substantial numbers of bats occur or migrate through the Dry Lake project area, although sampling during one key month for bat migration, August, was missed. Some bat mortality will likely occur at this site. However, the available data indicate it would probably be lower than that experienced in the East and similar to more western wind projects. Based on previous mortality studies at wind projects, it is expected that bats that are foliage or forest dwelling long distance migrants such as hoary bat and silver-haired bat would make up a large portion of the bat fatalities (see Johnson 2005), although there is little habitat for these species present on the site. A hoary bat was recorded during other regional surveys for bats, indicating that they likely move through during migration (Chambers 2007). Brazilian free-tailed bat, also a migratory species, would likely be at risk based on a short-term study in Oklahoma (Piorkowski 2006). *Myotis* species and big brown bat would make up a smaller proportion of the bat mortality.

Subsequent Phases Area

The avian, bat, and raptor nest surveys reported here focused on the Phase 1 area or area proposed for initial development. A larger area east of the study area has been proposed for future expansions of the Dry Lake wind power project. This area was visited during a reconnaissance level field survey in May 2007 made by vehicle and on-foot walking surveys to investigate the similarities of the two areas, survey for habitat and raptor nests, and evaluate the need for additional studies prior to subsequent developments.

In general, the vegetation and habitat characteristics of the subsequent phases area are similar to Phase 1. The predominant vegetation is desert scrub interspersed with areas of pinyon-juniper, primarily on higher elevation ridges within the southern quarter of the area. Washboard wash which bisects the Phase 1 area continues through the northwest portion of subsequent phases area and there are several other tributaries to Washboard Wash, ephemeral drainages, and small narrow canyons within larger area draining toward the east. There are a few scattered mesas and rock spires in the area primarily in the southwest corner. The subsequent phases area currently has a sizable pig farm operation that contains numerous waterponds, and there is a railroad line bisecting the site from north to south. These features create habitat diversity that is atypical of the desert scrub environment and may be an attractant to some species of birds and wildlife and in particular the water ponds.

No raptor nests were found within the subsequent phases area during the field survey, however, two common raven nests were located on transmission line towers within the area. There is other suitable nesting habitat on the mesas and rock spires and potentially within the small canyons that was not easily surveyed during the site visit.

In general, bird use of the subsequent phases area is expected to be very similar to Phase 1 in that a few common species would make up the majority of bird use on the site. The diversity of avian species may be higher in the expansion area and/or more concentrated due to the artificial habitat features (e.g., ponds); however, overall use is not likely to be substantially greater. Raptor use and nest density is expected to be low similar to Phase 1. Bat use may be higher and more constant due to the presence of the water ponds that might sustain use in the area through dry periods when other stock ponds or water sources dry up. Bat use is also expected in and around the drainages and canyons similar to the Pink Cliffs area of Phase 1.

While it is premature to estimate impacts without knowing a project size and configuration, impacts from subsequent developments are expected to be similar to Phase 1 based on the overall expectations regarding wildlife use of the area. While bird and bat use of the site may be distributed differently than the Phase 1 area, it is not expected that is would be substantially greater and expose greater numbers of species or individuals to collision hazards.

Further Study Recommendations

In general, results of the studies do not suggest that the proposed Dry Lake wind power project would result in substantial impacts to avian species. Impacts are expected to be similar to other wind power projects monitored throughout the western and Midwestern U.S. No avian resources that might warrant adjustment to the project design were found in the project area. The raptor nests located were far enough outside the proposed development area that no additional setback is recommended. Also in general, raptor use of the site was low and while the Pink Cliffs area appears to have greater raptor use, use was lower than most other wind resource areas studied and no set backs for raptors are recommended.

There are currently no operational commercial scale wind projects in Arizona. Dry Lake may be the first large scale Arizona wind energy project to become operational. As such, valuable information could be gained from a minimum one-year monitoring study that is designed to estimate avian and bat mortality.

Results of the bat survey work were inconclusive but suggest that there may be some resident bat populations that occupy caves within the Pink Cliffs area. Further bat survey work is recommended for the site to quantify bat use and species occupying the caves and ground fissures. Mist netting surveys at the caves and stockponds could be used to document species present and exit count surveys (crepuscular surveys) could provide an estimate of use and seasonal occupation of the ground caves. The additional work would be designed to address issues regarding need for or amount of set back from the caves that could help minimize impacts to bat habitat and risk of collision mortality.

It is the intent to conduct studies as needed for each additional Phase of the Dry Lake project, however, it is recommended that the studies for the subsequent phases area focus on resources of concern or those with less information available from the Phase 1 studies and in particular raptor nests and bat use. Extensive weekly avian use surveys are not recommended, however, point count surveys during the spring could identify whether the water ponds associated with the pig farm operation provide an attractant to avian species. An aerial survey during the nesting season prior to development would identify raptor nests that may be subject to disturbance from construction and/or operation of the wind project and provide information for appropriate timing restrictions or buffer zones. Ground surveys for caves and ground fissures could identify areas for further bat use surveys for determining buffer needs for potential roost areas.

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Table 1. Rare plant species for which surveys were conducted at the Phase I project area.

Scientific Name/ Common Name	Flowering/ Fruiting Period	Agency Status	Habitat	Species Encountered on site?
Errazurizia rotundata / Roundleaf errazurizia	April-mid May/ May-June	BLM-sensitive; State- SR (Salvage Restricted)	Exposed sites in outcrops ranging from sandy soils in sandstone, gravelly soils in calcareous outcrops, to deep, alluvial cinders in sandstone breaks	No
Pediocactus papyracanthus / Paper-spined cactus	April-June	ESA-SC (Species of Concern); State-SR	Open flats in desert grasslands and pinyon-juniper woodlands	Yes
Pediocactus peeblesianus var. *peeblesianus* / Peebles Navajo cactus	April-early May/ May-June	ESA-FE (Federally Endangered)	Gravelly alluvium derived from the Shinarump Member of the Chinle Formation, on gently sloping hills to flat hilltops in desert scrub and grassland	No

Table 2. Avian species observed while conducting fixed-point surveys at the Phase Iproject area.

Species/Group	Fall		Winter		Spring		Summer		Total	
	Number of Individuals	Number Groups	Number of Individuals	Number Groups	Number of Individuals	Number Groups	Number of Individuals	Number Groups	Number of Individuals	Number Groups
Shorebirds										
unidentified shorebird	0	0	0	0	0	0	9	1	9	1
Raptors	**28**	**25**	**14**	**11**	**10**	**9**	**16**	**15**	**68**	**60**
Buteos										
red-tailed hawk	12	9	3	3	3	3	11	10	29	25
Northern Harriers	*0*	*0*	*3*	*3*	*0*	*0*	*0*	*0*	*3*	*3*
Eagles	*2*	*2*	*3*	*3*	*2*	*2*	*3*	*3*	*10*	*10*
bald eagle	0	0	3	3	0	0	0	0	3	3
golden eagle	2	2	0	0	2	2	3	3	7	7
Falcons										
American kestrel	8	8	5	2	0	0	0	0	13	10
Other Raptors										
unidentified raptor	0	0	0	0	0	0	1	1	1	1
Vultures										
turkey vulture	6	6	0	0	5	4	1	1	12	11
Passerines	**2077**	**482**	**1779**	**274**	**730**	**274**	**927**	**380**	**5513**	**1410**
American robin	18	3	9	3	0	0	0	0	27	6
ash-throated flycatcher	1	1	0	0	7	7	32	30	40	38
Bewick's wren	8	6	1	1	0	0	1	1	10	8
black-headed grosbeak	0	0	0	0	1	1	0	0	1	1
black-throated gray warbler	2	1	0	0	0	0	0	0	2	1
black-throated sparrow	11	4	0	0	6	6	40	19	57	29
blue-gray gnatcatcher	8	5	0	0	11	9	10	9	29	23
Brewer's blackbird	6	1	0	0	0	0	0	0	6	1
Brewer's sparrow	15	3	1	1	5	2	1	1	22	7
brown-headed cowbird	0	0	0	0	0	0	5	4	5	4
Bullock's oriole	0	0	0	0	0	0	2	1	2	1
bushtit	18	1	0	0	0	0	20	4	38	5
cactus wren	0	0	0	0	0	0	1	1	1	1
Cassin's finch	4	2	0	0	0	0	0	0	4	2
chipping sparrow	64	17	0	0	0	0	12	6	76	23
common raven	209	108	92	64	102	69	144	53	547	294
curve-billed thrasher	1	1	0	0	0	0	1	1	2	2
dark-eyed junco	52	22	85	20	22	7	1	1	160	50
gray flycatcher	1	1	0	0	1	1	7	4	9	6
green-tailed towhee	0	0	0	0	1	1	2	2	3	3
horned lark	1313	196	1485	159	413	103	416	99	3627	557
house finch	24	9	2	2	23	5	26	11	75	27
lark sparrow	9	2	0	0	5	3	21	13	35	18
lesser goldfinch	0	0	0	0	0	0	11	3	11	3
loggerhead shrike	8	8	5	5	9	7	11	11	33	31
mountain bluebird	128	23	39	4	2	2	3	3	172	32
Nashville warbler	2	1	0	0	0	0	0	0	2	1
northern mockingbird	2	2	0	0	29	22	49	41	80	65
pinyon jay	0	0	0	0	55	2	9	3	64	5

Species/Group	Fall		Winter		Spring		Summer		Total	
	Number of Individuals	Number Groups	Number of Individuals	Number Groups	Number of Individuals	Number Groups	Number of Individuals	Number Groups	Number of Individuals	Number Groups
rock wren	14	9	10	6	6	6	32	24	62	45
ruby-crowned kinglet	7	3	0	0	1	1	3	1	11	5
sage sparrow	1	1	0	0	0	0	0	0	1	1
sage thrasher	13	5	0	0	5	4	5	5	23	14
Say's phoebe	13	12	0	0	4	4	5	5	22	21
Scott's oriole	0	0	0	0	1	1	0	0	1	1
spotted towhee	0	0	0	0	1	1	0	0	1	1
Swainson's thrush	8	1	0	0	0	0	0	0	8	1
Townsend's solitaire	14	6	35	3	0	0	0	0	49	9
unidentified blackbird	0	0	0	0	0	0	9	1	9	1
unidentified flycatcher	0	0	0	0	1	1	1	1	2	2
unidentified sparrow	2	2	0	0	0	0	2	2	4	4
unidentified swallow	0	0	0	0	6	2	10	1	16	3
vesper sparrow	11	5	0	0	1	1	0	0	12	6
violet-green swallow	36	11	0	0	0	0	19	5	55	16
western bluebird	4	2	13	5	2	1	3	2	22	10
western kingbird	0	0	0	0	2	2	11	10	13	12
western meadowlark	3	1	2	1	1	1	1	1	7	4
western scrub-jay	2	2	0	0	6	1	0	0	8	3
western tanager	1	1	0	0	0	0	1	1	2	2
white-crowned sparrow	43	3	0	0	0	0	0	0	43	3
yellow warbler	0	0	0	0	1	1	0	0	1	1
yellow-rumped warbler	1	1	0	0	0	0	0	0	1	1
Doves/Pigeons										
mourning dove	9	5	0	0	17	9	98	35	124	49
Other Birds	**8**	**8**	**1**	**1**	**9**	**8**	**47**	**22**	**65**	**39**
common nighthawk	0	0	0	0	0	0	39	14	39	14
greater roadrunner	0	0	1	1	1	1	0	0	2	2
rufous hummingbird	2	2	0	0	0	0	0	0	2	2
black-chinned hummingbird	0	0	0	0	2	1	0	0	2	1
blue-throated hummingbird	0	0	0	0	0	0	1	1	1	1
broad-tailed hummingbird	0	0	0	0	4	4	4	4	8	8
unidentified hummingbird	1	1	0	0	1	1	0	0	2	2
downy woodpecker	1	1	0	0	0	0	0	0	1	1
hairy woodpecker	1	1	0	0	0	0	3	3	4	4
northern flicker	3	3	0	0	1	1	0	0	4	4
Unidentified Birds	1	1	0	0	1	1	12	7	14	9
Total	**2123**	**521**	**1794**	**286**	**767**	**301**	**1109**	**460**	**5793**	**1568**

Table 3. Estimated mean use for avian species observed during fixed-point surveys at the Phase I project area.

Species/Group	**Fall Use**	**Winter Use**	**Spring Use**	**Summer Use**	**Overall Use**
Shorebirds					
unidentified shorebird	0.000	0.000	0.000	0.136	0.031
Raptors	**0.319**	**0.212**	**0.121**	**0.212**	**0.224**
Buteos					
red-tailed hawk	0.138	0.045	0.030	0.136	0.091
Northern Harrier	*0.000*	*0.045*	*0.000*	*0.000*	*0.010*
Eagles	*0.023*	*0.045*	*0.030*	*0.045*	*0.035*
bald eagle	0.000	0.045	0.000	0.000	0.010
golden eagle	0.023	0.000	0.030	0.045	0.024
Falcons					
American kestrel	0.091	0.076	0.000	0.000	0.045
Other Raptors					
unidentified raptor	0.000	0.000	0.000	0.015	0.003
Vultures					
turkey vulture	0.068	0.000	0.061	0.015	0.038
Passerines	**23.828**	**26.848**	**11.664**	**13.955**	**19.440**
American robin	0.205	0.136	0.000	0.000	0.094
ash-throated flycatcher	0.011	0.000	0.106	0.485	0.140
Bewick's wren	0.093	0.015	0.000	0.015	0.036
black-headed grosbeak	0.000	0.000	0.015	0.000	0.003
black-throated gray warbler	0.023	0.000	0.000	0.000	0.007
black-throated sparrow	0.125	0.000	0.091	0.606	0.199
blue gray gnatcatcher	0.091	0.000	0.258	0.152	0.122
Brewer's blackbird	0.068	0.000	0.000	0.000	0.021
Brewer's sparrow	0.170	0.015	0.148	0.015	0.094
brown-headed cowbird	0.000	0.000	0.000	0.076	0.017
Bullock's oriole	0.000	0.000	0.000	0.030	0.007
bushtit	0.205	0.000	0.000	0.303	0.133
Carolina wren	0.000	0.000	0.000	0.015	0.003
Cassin's finch	0.045	0.000	0.000	0.000	0.014
chipping sparrow	0.727	0.000	0.000	0.182	0.266
common raven	2.416	1.394	1.512	2.091	1.897
curve-billed thrasher	0.011	0.000	0.000	0.015	0.007
dark-eyed junco	0.599	1.288	0.352	0.015	0.566
gray flycatcher	0.011	0.000	0.015	0.106	0.031
green-tailed towhee	0.000	0.000	0.015	0.030	0.010
horned lark	15.036	22.394	6.548	6.303	12.760
house finch	0.278	0.030	0.348	0.394	0.264
lark sparrow	0.102	0.000	0.076	0.318	0.122
lesser goldfinch	0.000	0.000	0.000	0.167	0.038
loggerhead shrike	0.091	0.076	0.155	0.167	0.120
mountain bluebird	1.503	0.591	0.030	0.045	0.616
Nashville warbler	0.023	0.000	0.000	0.000	0.007

Species/Group	Fall Use	Winter Use	Spring Use	Summer Use	Overall Use
northern mockingbird	0.023	0.000	0.439	0.742	0.280
pinyon jay	0.000	0.000	0.833	0.136	0.224
rock wren	0.159	0.152	0.091	0.485	0.217
ruby-crowned kinglet	0.080	0.000	0.015	0.045	0.038
sage sparrow	0.011	0.000	0.000	0.000	0.003
sage thrasher	0.148	0.000	0.112	0.076	0.089
Say's phoebe	0.148	0.000	0.061	0.076	0.077
Scott's oriole	0.000	0.000	0.015	0.000	0.003
spotted towhee	0.000	0.000	0.015	0.000	0.003
Swainson's thrush	0.091	0.000	0.000	0.000	0.028
Townsend's solitaire	0.160	0.530	0.000	0.000	0.172
unidentified blackbird	0.000	0.000	0.000	0.136	0.031
unidentified *Empidonax*	0.000	0.000	0.015	0.015	0.007
unidentified sparrow	0.023	0.000	0.000	0.030	0.014
unidentified swallow	0.000	0.000	0.200	0.152	0.081
vesper sparrow	0.125	0.000	0.015	0.000	0.042
violet-green swallow	0.409	0.000	0.000	0.288	0.192
western bluebird	0.049	0.197	0.030	0.045	0.078
western kingbird	0.000	0.000	0.030	0.167	0.045
western meadowlark	0.034	0.030	0.015	0.015	0.024
western scrub-jay	0.023	0.000	0.091	0.000	0.028
western tanager	0.011	0.000	0.000	0.015	0.007
white-crowned sparrow	0.489	0.000	0.000	0.000	0.150
yellow warbler	0.000	0.000	0.015	0.000	0.003
yellow-rumped warbler	0.011	0.000	0.000	0.000	0.003
Doves/Pigeons					
mourning dove	0.102	0.000	0.276	1.485	0.438
Other Birds	**0.092**	**0.015**	**0.136**	**0.712**	**0.228**
black-chinned hummingbird	0.000	0.000	0.030	0.000	0.007
blue-throated hummingbird	0.000	0.000	0.000	0.015	0.003
broad-tailed hummingbird	0.000	0.000	0.061	0.061	0.028
common nighthawk	0.000	0.000	0.000	0.591	0.136
downy woodpecker	0.011	0.000	0.000	0.000	0.003
greater roadrunner	0.000	0.015	0.015	0.000	0.007
hairy woodpecker	0.011	0.000	0.000	0.045	0.014
northern flicker	0.035	0.000	0.015	0.000	0.014
Rufous hummingbird	0.023	0.000	0.000	0.000	0.007
unidentified hummingbird	0.011	0.000	0.015	0.000	0.007
Unidentified Birds	**0.011**	**0.000**	**0.015**	**0.167**	**0.045**
Overall	**24.353**	**27.076**	**12.212**	**16.667**	**20.406**

Table 4. Estimated percent composition for avian species observed during fixed-point surveys at the Phase I project area.

Species/Group	Fall % Comp	Winter % Comp	Spring % Comp	Summer % Comp	Overall % Comp
Shorebirds					
unidentified shorebird	0.00	0.00	0.00	0.82	0.15
Raptors	**1.31**	**0.78**	**0.99**	**1.27**	**1.10**
Buteos					
red-tailed hawk	0.56	0.17	0.25	0.82	0.45
Northern Harriers	*0.00*	*0.17*	*0.00*	*0.00*	*0.05*
Eagles	*0.09*	*0.17*	*0.25*	*0.27*	*0.17*
bald eagle	0.00	0.17	0.00	0.00	0.05
golden eagle	0.09	0.00	0.25	0.27	0.12
Falcons					
American kestrel	0.37	0.28	0.00	0.00	0.22
Other Raptors					
unidentified raptor	0.00	0.00	0.00	0.09	0.02
Vultures					
turkey vulture	0.28	0.00	0.50	0.09	0.19
Passerines	**97.84**	**99.16**	**95.51**	**83.73**	**95.26**
American robin	0.84	0.50	0.00	0.00	0.46
ash-throated flycatcher	0.05	0.00	0.87	2.91	0.69
Bewick's wren	0.38	0.06	0.00	0.09	0.17
black-headed grosbeak	0.00	0.00	0.12	0.00	0.02
black-throated gray warbler	0.09	0.00	0.00	0.00	0.03
black-throated sparrow	0.51	0.00	0.74	3.64	0.98
blue gray gnatcatcher	0.37	0.00	2.11	0.91	0.60
Brewer's blackbird	0.28	0.00	0.00	0.00	0.10
Brewer's sparrow	0.70	0.06	1.22	0.09	0.46
brown-headed cowbird	0.00	0.00	0.00	0.45	0.09
Bullock's oriole	0.00	0.00	0.00	0.18	0.03
bushtit	0.84	0.00	0.00	1.82	0.65
Carolina wren	0.00	0.00	0.00	0.09	0.02
Cassin's finch	0.19	0.00	0.00	0.00	0.07
chipping sparrow	2.99	0.00	0.00	1.09	1.30
common raven	9.92	5.15	12.38	12.55	9.29
curve-billed thrasher	0.05	0.00	0.00	0.09	0.03
dark-eyed junco	2.46	4.76	2.88	0.09	2.77
gray flycatcher	0.05	0.00	0.12	0.64	0.15
green-tailed towhee	0.00	0.00	0.12	0.18	0.05
horned lark	61.74	82.71	53.62	37.82	62.53
house finch	1.14	0.11	2.85	2.36	1.29
lark sparrow	0.42	0.00	0.62	1.91	0.60
lesser goldfinch	0.00	0.00	0.00	1.00	0.19
loggerhead shrike	0.37	0.28	1.27	1.00	0.59
mountain bluebird	6.17	2.18	0.25	0.27	3.02

Species/Group	Fall % Comp	Winter % Comp	Spring % Comp	Summer % Comp	Overall % Comp
Nashville warbler	0.09	0.00	0.00	0.00	0.03
northern mockingbird	0.09	0.00	3.60	4.45	1.37
pinyon jay	0.00	0.00	6.82	0.82	1.10
rock wren	0.65	0.56	0.74	2.91	1.06
ruby-crowned kinglet	0.33	0.00	0.12	0.27	0.19
sage sparrow	0.05	0.00	0.00	0.00	0.02
sage thrasher	0.61	0.00	0.92	0.45	0.44
Say's phoebe	0.61	0.00	0.50	0.45	0.38
Scott's oriole	0.00	0.00	0.12	0.00	0.02
spotted towhee	0.00	0.00	0.12	0.00	0.02
Swainson's thrush	0.37	0.00	0.00	0.00	0.14
Townsend's solitaire	0.66	1.96	0.00	0.00	0.84
unidentified blackbird	0.00	0.00	0.00	0.82	0.15
unidentified *Empidonax*	0.00	0.00	0.12	0.09	0.03
unidentified sparrow	0.09	0.00	0.00	0.18	0.07
unidentified swallow	0.00	0.00	1.64	0.91	0.40
vesper sparrow	0.51	0.00	0.12	0.00	0.21
violet-green swallow	1.68	0.00	0.00	1.73	0.94
western bluebird	0.20	0.73	0.25	0.27	0.38
western kingbird	0.00	0.00	0.25	1.00	0.22
western meadowlark	0.14	0.11	0.12	0.09	0.12
western scrub-jay	0.09	0.00	0.74	0.00	0.14
western tanager	0.05	0.00	0.00	0.09	0.03
white-crowned sparrow	2.01	0.00	0.00	0.00	0.74
yellow warbler	0.00	0.00	0.12	0.00	0.02
yellow-rumped warbler	0.05	0.00	0.00	0.00	0.02
Doves/Pigeons					
mourning dove	0.42	0.00	2.26	8.91	2.15
Other Birds	**0.38**	**0.06**	**1.12**	**4.27**	**1.12**
black-chinned hummingbird	0.00	0.00	0.25	0.00	0.03
blue-throated hummingbird	0.00	0.00	0.00	0.09	0.02
broad-tailed hummingbird	0.00	0.00	0.50	0.36	0.14
common nighthawk	0.00	0.00	0.00	3.55	0.67
downy woodpecker	0.05	0.00	0.00	0.00	0.02
greater roadrunner	0.00	0.06	0.12	0.00	0.03
hairy woodpecker	0.05	0.00	0.00	0.27	0.07
northern flicker	0.14	0.00	0.12	0.00	0.07
Rufous hummingbird	0.09	0.00	0.00	0.00	0.03
unidentified hummingbird	0.05	0.00	0.12	0.00	0.03
Unidentified Birds	**0.05**	**0.00**	**0.12**	**1.00**	**0.22**
Overall	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

Table 5. Estimated frequency of occurrence for avian species observed during fixed-point surveys at the Phase I project area.

Species/Group	Fall % Freq	Winter % Freq	Spring % Freq	Summer % Freq	Overall % Freq
Shorebirds					
unidentified shorebird	0.00	0.00	0.00	1.52	0.35
Raptors	**23.98**	**16.67**	**10.61**	**18.18**	**17.87**
Buteos					
red-tailed hawk	9.20	4.55	3.03	10.61	7.03
Northern Harrier	*0.00*	*4.55*	*0.00*	*0.00*	*1.05*
Eagles	*2.27*	*4.55*	*3.03*	*4.55*	*3.50*
bald eagle	0.00	4.55	0.00	0.00	1.05
golden eagle	2.27	0.00	3.03	4.55	2.45
Falcons					
American kestrel	7.95	3.03	0.00	0.00	3.15
Other Raptors					
unidentified raptor	0.00	0.00	0.00	1.52	0.35
Vultures					
turkey vulture	6.82	0.00	4.55	1.52	3.50
Passerines	**100.00**	**93.94**	**93.94**	**100.00**	**97.20**
American robin	3.41	4.55	0.00	0.00	2.10
ash-throated flycatcher	1.14	0.00	7.58	40.91	11.54
Bewick's wren	6.93	1.52	0.00	1.52	2.83
black-headed grosbeak	0.00	0.00	1.52	0.00	0.35
black-throated gray warbler	1.14	0.00	0.00	0.00	0.35
black-throated sparrow	4.55	0.00	6.06	27.27	9.09
blue gray gnatcatcher	5.68	0.00	14.24	12.12	7.83
Brewer's blackbird	1.14	0.00	0.00	0.00	0.35
Brewer's sparrow	3.41	1.52	4.85	1.52	2.87
brown-headed cowbird	0.00	0.00	0.00	6.06	1.40
Bullock's oriole	0.00	0.00	0.00	1.52	0.35
bushtit	1.14	0.00	0.00	6.06	1.75
Carolina wren	0.00	0.00	0.00	1.52	0.35
Cassin's finch	2.27	0.00	0.00	0.00	0.70
chipping sparrow	18.18	0.00	0.00	9.09	7.69
common raven	70.23	54.55	66.06	57.58	62.73
curve-billed thrasher	1.14	0.00	0.00	1.52	0.70
dark-eyed junco	20.80	22.73	9.39	1.52	14.16
gray flycatcher	1.14	0.00	1.52	6.06	2.10
green-tailed towhee	0.00	0.00	1.52	3.03	1.05
horned lark	80.45	66.67	69.39	92.42	77.48
house finch	9.55	3.03	6.06	15.15	8.53
lark sparrow	2.27	0.00	4.55	18.18	5.94
lesser goldfinch	0.00	0.00	0.00	4.55	1.05
loggerhead shrike	9.09	7.58	10.91	13.64	10.21
mountain bluebird	13.98	6.06	1.52	4.55	7.10
Nashville warbler	1.14	0.00	0.00	0.00	0.35

Species/Group	Fall % Freq	Winter % Freq	Spring % Freq	Summer % Freq	Overall % Freq
northern mockingbird	2.27	0.00	19.70	39.39	14.34
pinyon jay	0.00	0.00	3.03	4.55	1.75
rock wren	10.23	9.09	9.09	28.79	13.99
ruby-crowned kinglet	3.41	0.00	1.52	1.52	1.75
sage sparrow	1.14	0.00	0.00	0.00	0.35
sage thrasher	4.55	0.00	6.36	4.55	3.92
Say's phoebe	13.64	0.00	4.55	7.58	6.99
Scott's oriole	0.00	0.00	1.52	0.00	0.35
spotted towhee	0.00	0.00	1.52	0.00	0.35
Swainson's thrush	1.14	0.00	0.00	0.00	0.35
Townsend's solitaire	6.93	3.03	0.00	0.00	2.83
unidentified blackbird	0.00	0.00	0.00	1.52	0.35
unidentified *Empidonax*	0.00	0.00	1.52	1.52	0.70
unidentified sparrow	2.27	0.00	0.00	3.03	1.40
unidentified swallow	0.00	0.00	6.67	1.52	1.89
vesper sparrow	3.41	0.00	1.52	0.00	1.40
violet-green swallow	11.36	0.00	0.00	6.06	4.90
western bluebird	2.39	6.06	1.52	3.03	3.18
western kingbird	0.00	0.00	3.03	15.15	4.20
western meadowlark	1.14	1.52	1.52	1.52	1.40
western scrub-jay	2.27	0.00	1.52	0.00	1.05
western tanager	1.14	0.00	0.00	1.52	0.70
white-crowned sparrow	3.41	0.00	0.00	0.00	1.05
yellow warbler	0.00	0.00	1.52	0.00	0.35
yellow-rumped warbler	1.14	0.00	0.00	0.00	0.35
Doves/Pigeons					
mourning dove	4.55	0.00	13.94	42.42	14.41
Other Birds	**6.93**	**1.52**	**10.61**	**25.76**	**10.87**
black-chinned hummingbird	0.00	0.00	1.52	0.00	0.35
blue-throated hummingbird	0.00	0.00	0.00	1.52	0.35
broad-tailed hummingbird	0.00	0.00	4.55	6.06	2.45
common nighthawk	0.00	0.00	0.00	16.67	3.85
downy woodpecker	1.14	0.00	0.00	0.00	0.35
greater roadrunner	0.00	1.52	1.52	0.00	0.70
hairy woodpecker	1.14	0.00	0.00	4.55	1.40
northern flicker	3.52	0.00	1.52	0.00	1.43
Rufous hummingbird	1.14	0.00	0.00	0.00	0.35
unidentified hummingbird	1.14	0.00	1.52	0.00	0.70
Unidentified Birds	**1.14**	**0.00**	**1.52**	**9.09**	**2.80**

Table 6. Flight height characteristics of avian species observed during fixed-point surveys at the Phase I project area.

Species/Group	Number groups flying	Number birds flying	Percent of birds flying	<18 m	18-152 m	> 152 m
pinyon jay	1	50	78.13	0.00	100.00	0.00
unidentified blackbird	1	9	100.00	0.00	100.00	0.00
western bluebird	3	12	54.55	16.67	83.33	0.00
Townsend's solitaire	7	42	85.71	28.57	71.43	0.00
bald eagle	3	3	100.00	33.33	66.67	0.00
golden eagle	5	5	71.43	40.00	60.00	0.00
turkey vulture	11	12	100.00	33.33	50.00	16.67
common raven	197	369	67.46	35.50	44.44	20.05
red-tailed hawk	17	21	72.41	57.14	42.86	0.00
violet-green swallow	15	52	94.55	69.23	30.77	0.00
American kestrel	8	11	84.62	72.73	27.27	0.00
common nighthawk	9	32	82.05	93.75	6.25	0.00
horned lark	323	3113	85.83	98.68	1.32	0.00
mountain bluebird	18	141	81.98	100.00	0.00	0.00
dark-eyed junco	21	79	49.38	100.00	0.00	0.00
mourning dove	23	46	37.10	100.00	0.00	0.00
white-crowned sparrow	2	39	90.70	100.00	0.00	0.00
house finch	14	38	50.67	100.00	0.00	0.00
American robin	5	26	96.30	100.00	0.00	0.00
bushtit	1	18	47.37	100.00	0.00	0.00
loggerhead shrike	14	16	48.48	100.00	0.00	0.00
lark sparrow	4	13	37.14	100.00	0.00	0.00
unidentified swallow	2	11	68.75	100.00	0.00	0.00
northern mockingbird	9	10	12.50	100.00	0.00	0.00
Say's phoebe	9	10	45.45	100.00	0.00	0.00
unidentified bird	6	10	71.43	100.00	0.00	0.00
western scrub-jay	3	8	100.00	100.00	0.00	0.00
Brewer's blackbird	1	6	100.00	100.00	0.00	0.00
broad-tailed hummingbird	6	6	75.00	100.00	0.00	0.00
chipping sparrow	2	6	7.89	100.00	0.00	0.00
ruby-crowned kinglet	2	6	54.55	100.00	0.00	0.00
rock wren	3	5	8.06	100.00	0.00	0.00
vesper sparrow	2	5	41.67	100.00	0.00	0.00
western meadowlark	2	5	71.43	100.00	0.00	0.00
ash-throated flycatcher	3	4	10.00	100.00	0.00	0.00
blue-gray gnatcatcher	3	3	10.34	100.00	0.00	0.00
Brewer's sparrow	2	3	13.64	100.00	0.00	0.00
Cassin's finch	1	3	75.00	100.00	0.00	0.00
northern harrier	3	3	100.00	100.00	0.00	0.00
unidentified sparrow	3	3	75.00	100.00	0.00	0.00
western kingbird	3	3	23.08	100.00	0.00	0.00
black-chinned hummingbird	1	2	100.00	100.00	0.00	0.00
hairy woodpecker	2	2	50.00	100.00	0.00	0.00
rufous hummingbird	2	2	100.00	100.00	0.00	0.00

Species/Group	Number groups flying	Number birds flying	Percent of birds flying	<18 m	18-152 m	> 152 m
black-throated sparrow	1	1	1.75	100.00	0.00	0.00
blue-throated hummingbird	1	1	100.00	100.00	0.00	0.00
brown-headed cowbird	1	1	20.00	100.00	0.00	0.00
curve-billed thrasher	1	1	50.00	100.00	0.00	0.00
downy woodpecker	1	1	100.00	100.00	0.00	0.00
lesser goldfinch	1	1	9.09	100.00	0.00	0.00
Scott's oriole	1	1	100.00	100.00	0.00	0.00
unidentified flycatcher	1	1	50.00	100.00	0.00	0.00
unidentified hummingbird	1	1	50.00	100.00	0.00	0.00
western tanager	1	1	50.00	100.00	0.00	0.00
Bewick's wren	0	0	0.00	N/A	N/A	N/A
black-headed grosbeak	0	0	0.00	N/A	N/A	N/A
black-throated gray warbler	0	0	0.00	N/A	N/A	N/A
Bullock's oriole	0	0	0.00	N/A	N/A	N/A
cactus wren	0	0	0.00	N/A	N/A	N/A
gray flycatcher	0	0	0.00	N/A	N/A	N/A
greater roadrunner	0	0	0.00	N/A	N/A	N/A
green-tailed towhee	0	0	0.00	N/A	N/A	N/A
Nashville warbler	0	0	0.00	N/A	N/A	N/A
northern flicker	0	0	0.00	N/A	N/A	N/A
sage sparrow	0	0	0.00	N/A	N/A	N/A
sage thrasher	0	0	0.00	N/A	N/A	N/A
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
unidentified raptor	0	0	0.00	N/A	N/A	N/A
unidentified shorebird	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
Overall	782	4273	73.76	90.15	8.07	1.78

Table 7. Flight height characteristics of avian groups observed during fixed-point surveys at the Phase I project area.

Species/Group	Number groups flying	Number birds flying	Percent of birds flying	<18 m	18-152 m	> 152 m
Raptors	47	55	80.88	54.55	41.82	3.64
Buteos	*17*	*21*	*72.41*	*57.14*	*42.86*	*0.00*
Northern Harriers	*3*	*3*	*100.00*	*100.00*	*0.00*	*0.00*
Eagles	*8*	*8*	*80.00*	*37.50*	*62.50*	*0.00*
Falcons	*8*	*11*	*84.62*	*72.73*	*27.27*	*0.00*
Vultures	*11*	*12*	*100.00*	*33.33*	*50.00*	*16.67*
Passerines	683	4115	74.64	90.43	7.78	1.80
Doves/Pigeons	23	46	37.10	100.00	0.00	0.00
Other Birds	23	47	72.31	95.74	4.26	0.00
Unidentified Birds	6	10	71.43	100.00	0.00	0.00
Overall	782	4273	73.76	90.15	8.07	1.78

Table 8. Exposure indices calculated for avian species observed during fixed-point surveys at the Phase I project area.

Species/Group	Mean use	Percent flying	Percent flying within RSA	Exposure Index
common raven	1.897	67.46	44.44	0.569
pinyon jay	0.224	78.13	100.00	0.175
horned lark	12.760	85.83	1.32	0.144
Townsend's solitaire	0.172	85.71	71.43	0.105
violet-green swallow	0.192	94.55	30.77	0.056
western bluebird	0.078	54.55	83.33	0.035
unidentified blackbird	0.031	100.00	100.00	0.031
red-tailed hawk	0.091	72.41	42.86	0.028
turkey vulture	0.038	100.00	50.00	0.019
American kestrel	0.045	84.62	27.27	0.010
golden eagle	0.024	71.43	60.00	0.010
common nighthawk	0.136	82.05	6.25	0.007
bald eagle	0.010	100.00	66.67	0.007
mountain bluebird	0.616	81.98	0.00	0.000
dark-eyed junco	0.566	49.38	0.00	0.000
mourning dove	0.438	37.10	0.00	0.000
northern mockingbird	0.280	12.50	0.00	0.000
chipping sparrow	0.266	7.89	0.00	0.000
house finch	0.264	50.67	0.00	0.000
rock wren	0.217	8.06	0.00	0.000
black-throated sparrow	0.199	1.75	0.00	0.000
white-crowned sparrow	0.150	90.70	0.00	0.000
ash-throated flycatcher	0.140	10.00	0.00	0.000
bushtit	0.133	47.37	0.00	0.000
blue gray gnatcatcher	0.122	10.34	0.00	0.000
lark sparrow	0.122	37.14	0.00	0.000
loggerhead shrike	0.120	48.48	0.00	0.000
American robin	0.094	96.30	0.00	0.000
Brewer's sparrow	0.094	13.64	0.00	0.000
unidentified swallow	0.081	68.75	0.00	0.000
Say's phoebe	0.077	45.45	0.00	0.000
unidentified bird	0.045	71.43	0.00	0.000
western kingbird	0.045	23.08	0.00	0.000
vesper sparrow	0.042	41.67	0.00	0.000
lesser goldfinch	0.038	9.09	0.00	0.000
ruby-crowned kinglet	0.038	54.55	0.00	0.000
broad-tailed hummingbird	0.028	75.00	0.00	0.000
western scrub-jay	0.028	100.00	0.00	0.000
western meadowlark	0.024	71.43	0.00	0.000
Brewer's blackbird	0.021	100.00	0.00	0.000
brown-headed cowbird	0.017	20.00	0.00	0.000

Species/Group	Mean use	Percent flying	Percent flying within RSA	Exposure Index
Cassin's finch	0.014	75.00	0.00	0.000
hairy woodpecker	0.014	50.00	0.00	0.000
unidentified sparrow	0.014	75.00	0.00	0.000
northern harrier	0.010	100.00	0.00	0.000
black-chinned hummingbird	0.007	100.00	0.00	0.000
curve-billed thrasher	0.007	50.00	0.00	0.000
Rufous hummingbird	0.007	100.00	0.00	0.000
unidentified *Empidonax*	0.007	50.00	0.00	0.000
unidentified hummingbird	0.007	50.00	0.00	0.000
western tanager	0.007	50.00	0.00	0.000
blue-throated hummingbird	0.003	100.00	0.00	0.000
downy woodpecker	0.003	100.00	0.00	0.000
Scott's oriole	0.003	100.00	0.00	0.000
sage thrasher	0.089	0.00	N/A	N/A
Bewick's wren	0.036	0.00	N/A	N/A
gray flycatcher	0.031	0.00	N/A	N/A
unidentified shorebird	0.031	0.00	N/A	N/A
Swainson's thrush	0.028	0.00	N/A	N/A
northern flicker	0.014	0.00	N/A	N/A
green-tailed towhee	0.010	0.00	N/A	N/A
black-throated gray warbler	0.007	0.00	N/A	N/A
Bullock's oriole	0.007	0.00	N/A	N/A
greater roadrunner	0.007	0.00	N/A	N/A
Nashville warbler	0.007	0.00	N/A	N/A
black-headed grosbeak	0.003	0.00	N/A	N/A
Carolina wren	0.003	0.00	N/A	N/A
sage sparrow	0.003	0.00	N/A	N/A
spotted towhee	0.003	0.00	N/A	N/A
unidentified raptor	0.003	0.00	N/A	N/A
yellow warbler	0.003	0.00	N/A	N/A
yellow-rumped warbler	0.003	0.00	N/A	N/A

Table 9. Number of bat passes per AnaBat detector at the Phase I project area.

Date	Ground Site				Met Tower Site			
	25 kHz	40 kHz	50 kHz	Total	25 kHz	40 kHz	50 kHz	Total
July	1	0	14	15	1	1	1	3
August	ns	ns	ns	ns	ns	ns	ns	ns
September	4	5	8	17	1	3	0	4
October	5	41	13	59	1	1	0	2
November	0	0	0	0	0	0	0	0
Overall	10	46	35	91	3	5	1	9

ns = no sampling

Table 10. Bat species of northeastern Arizona

Species	Distribution and Habitat	Call Frequency	Migratory status
Spotted bat *Euderma maculatum*	Aural records for eastern AZ; desert scrub to Ponderosa forest habitat, large canyons; may be an elevational migrant	<20kHz	Capable of nightly long distance flights
Allen's big-eared bat *Idionycteris phyllotis*	Most of AZ excluding SW deserts; woodland and riparian areas, desert scrub with cliffs or rocky outcrops nearby	<20kHz	Long distance flier
Big free-tailed bat *Nyctinomops macrotus*	Throughout AZ; desert and arid grassland with rocky outcrops, cliffs and canyons, winters in southern AZ and Mexico	<20kHz	Migratory
Pallid bat *Antrozous pallidus*	Throughout AZ, but winters in southern AZ; arid forests, brushy terrain, rocky canyons, deserts with suitable roosts.	20-35 kHz	Unknown
Townsend's big-eared bat *Corynorhinus townsendii*	Widespread in AZ, arid desert scrub, dry woodlands, forests; winter in vicinity of Grand Canyon to SE AZ;	20-35 kHz	Short distance migrant to suitable hibernacula
Big brown bat *Eptesicus fuscus*	Throughout AZ in summer, winters in southern AZ; habitat generalist; conifer forests, woodlands, urban areas	20-35 kHz	Short distance migrant to hibernacula
Silver-haired bat *Lasionycteris noctivagans*	Throughout AZ, in forested areas; roosts in trees and snags; riparian woodlands, forests near water; hibernates in hollow trees and under bark of snags	20-35 kHz	Migratory from northern range
Hoary bat *Lasiurus cinereus*	Found statewide in forests and woodlands, roosts in foliage	20-35 kHz	Long distance migrant
Brazilian free-tailed bat *Tadarida brasiliensis*	Found throughout AZ, desert scrub to forests; forms large maternal colonies juniper stands and oak brush woodlands	20-35 kHz	Migrant from southern regions to summer colonies
Western small-footed myotis *Myotis ciliolabrum*	Throughout northern AZ in deserts, chaparral, riparian, oak-juniper forests with rocky areas and outcrops	40-50 kHz	Likely short distant migrant to hibernacula
Long-eared myotis *Myotis evotis*	Northern AZ in coniferous forests; prefer large-diameter trees for roosts	40-50 kHz	Unknown
Arizona myotis *Myotis occultus*	Most records from north central AZ; summers in ponderosa and oak-pine woodlands near water, desert areas near permanent water, winter roosts not known	40-50 kHz	Unknown
Fringed myotis *Myotis thysanodes*	Throughout most of AZ; found in deserts, grasslands, woodlands, riparian, roosts in caves, mines, buildings	40-50 kHz	Likely short distant migrant to hibernacula
Long-legged myotis *Myotis volans*	Northern AZ; wooded and riparian habitats, primarily coniferous forest	40-50 kHz	Unknown
California myotis *Myotis californicus*	Throughout AZ, desert scrub to oak, ponderosa woodlands but less common in high mountain ranges, woodlands	>50 kHz	Likely short distant migrant to hibernacula
Yuma myotis *Myotis yumanensis*	Throughout AZ, typically found in woodland habitats near water	>50 kHz	Unknown
Western pipistrelle *Pipistrellus hesperus*	Throughout AZ, inhabits desert dry woodlands with water and rocky areas	>50 kHz	Non-migratory, hibernates in caves

Table 11. Summary of observations avian and non-avian species observed incidentally on the Phase I site.

Species	Number of Individuals	Number Groups
horned lark	1194	48
common raven	99	32
mountain bluebird	81	6
mourning dove	34	3
house finch	22	2
dark-eyed junco	14	4
western meadowlark	8	2
unidentified sparrow	7	1
western bluebird	6	2
northern mockingbird	5	2
American kestrel	4	3
sage thrasher	4	2
western kingbird	4	2
Brewer's sparrow	4	1
loggerhead shrike	3	3
northern harrier	3	3
blue gray gnatcatcher	3	2
Townsend's solitaire	3	2
ruby-crowned kinglet	3	1
white-crowned sparrow	3	1
red-tailed hawk	2	2
ash-throated flycatcher	2	1
black-throated sparrow	2	1
Say's phoebe	2	1
tree swallow	2	1
greater roadrunner	1	1
turkey vulture	1	1
unidentified thrush	1	1
violet-green swallow	1	1
western wood-pewee	1	1
Avian Subtotal	**1519**	**133**
pronghorn antelope	97	14
desert cottontail	6	2
elk	4	2
black-tailed jack rabbit	3	3
Gunnison's Prairie Dog	3	1
coyote	2	2
unidentified deer	2	1
mule deer	1	1
unidentified ground squirrel	1	1
Mammal Subtotal	**119**	**27**

Table 12. Comparison of bat echolocation activity and collision mortality wind projects across the U.S.

Study Area	Bat Mortality (#/turbine/year)	Bat activity (#/detector/night)	Total detector nights
Mountaineer, WV(1 fall season)	38.0	38.2	33
Buffalo Mountain, TN (2 years)	20.8	23.7	149
Top of Iowa (2 years)	10.2	34.9	42
Buffalo Ridge, MN (2 years)	2.2	2.1	216
Foote Creek Rim, WY (2 years)	1.3	2.2	39
Dry Lake, AZ (1 fall season)	NA	1.8	56

Figure 1. Proposed Dry Lake Wind Project location.

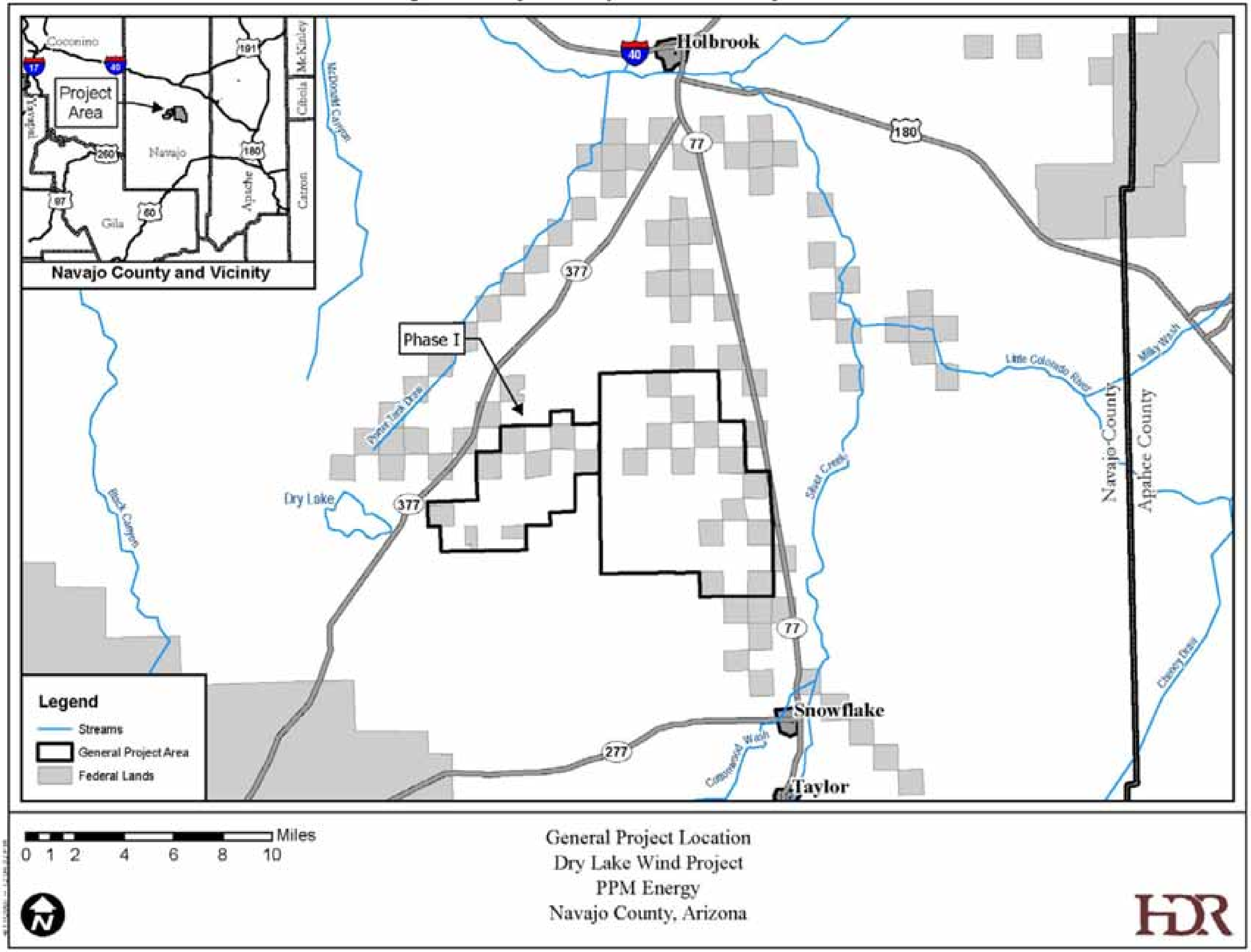


Figure 2. Fixed-point bird survey stations and AnaBat sampling locations in the Phase I project area.

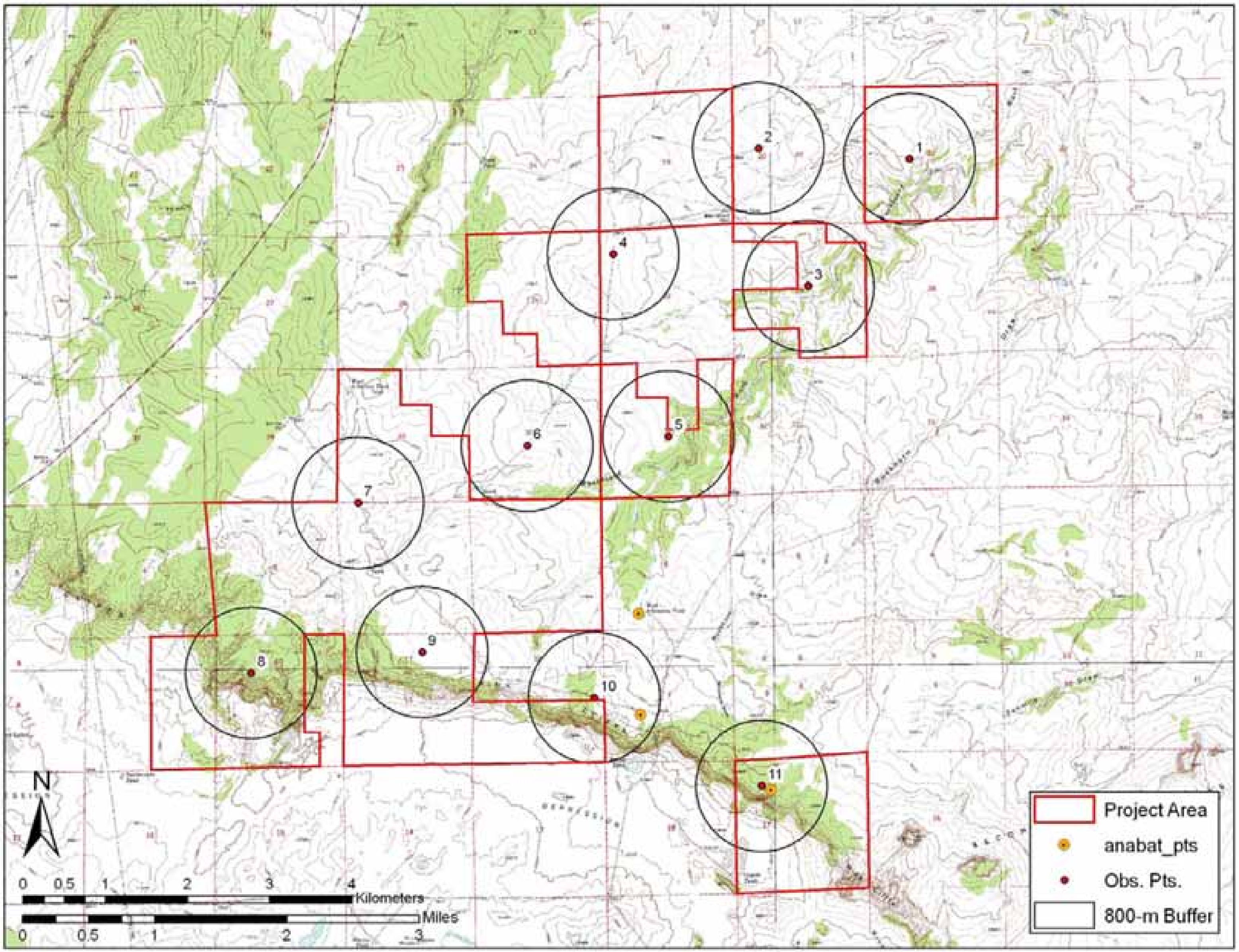
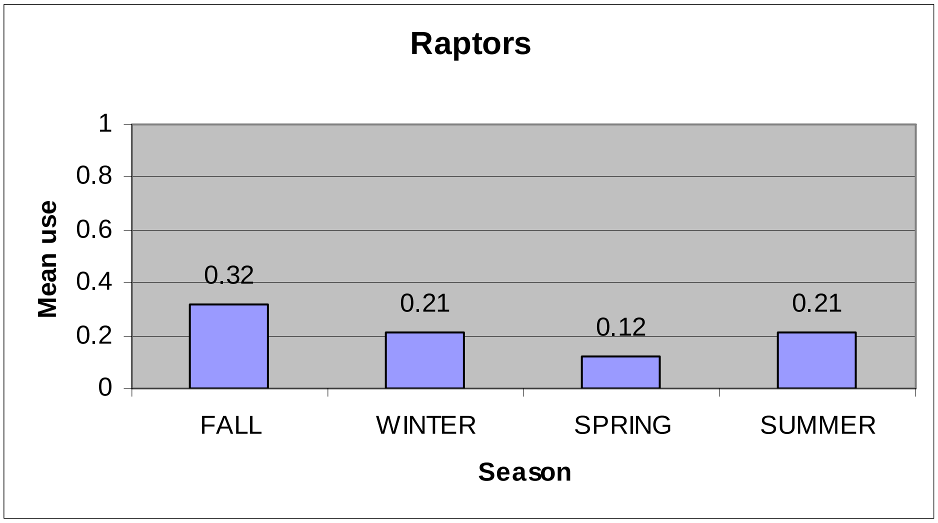
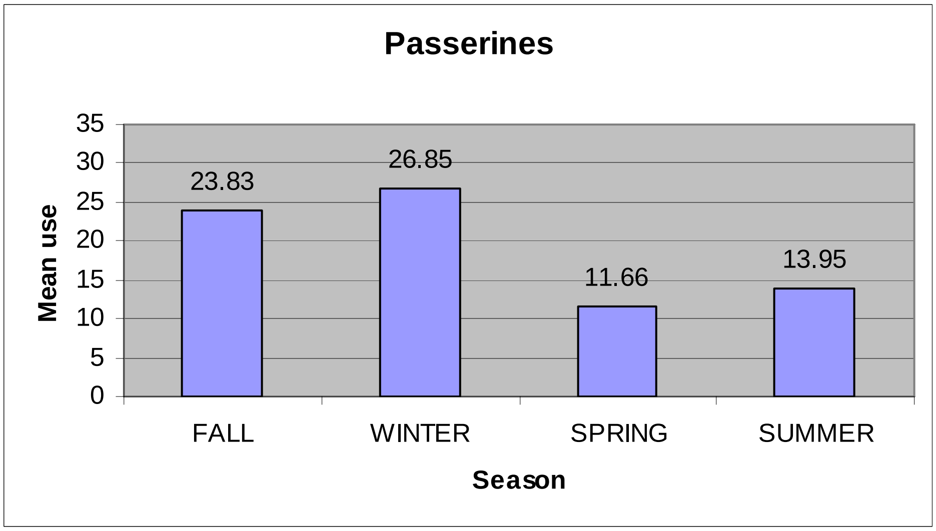


Figure 3. Avian use of the Phase I project area by season.





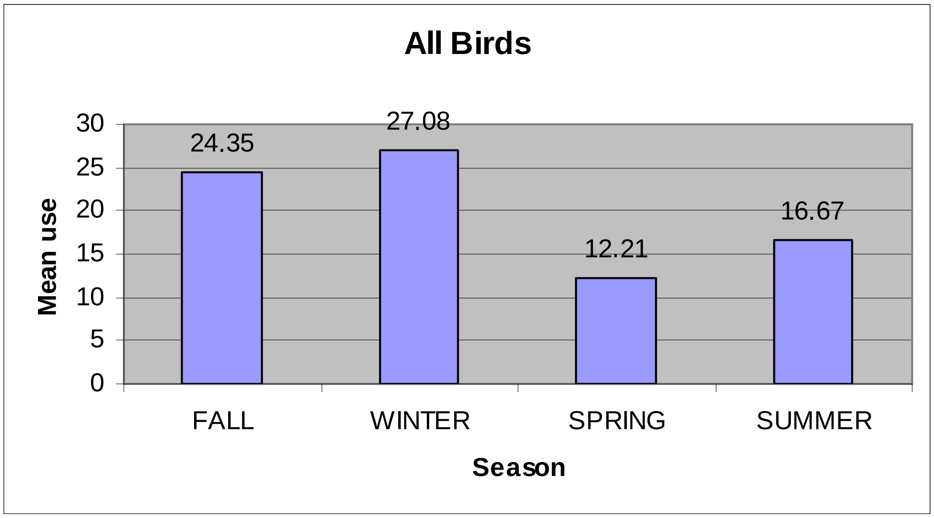


Figure 4. Avian use of the Phase I project area by survey point.

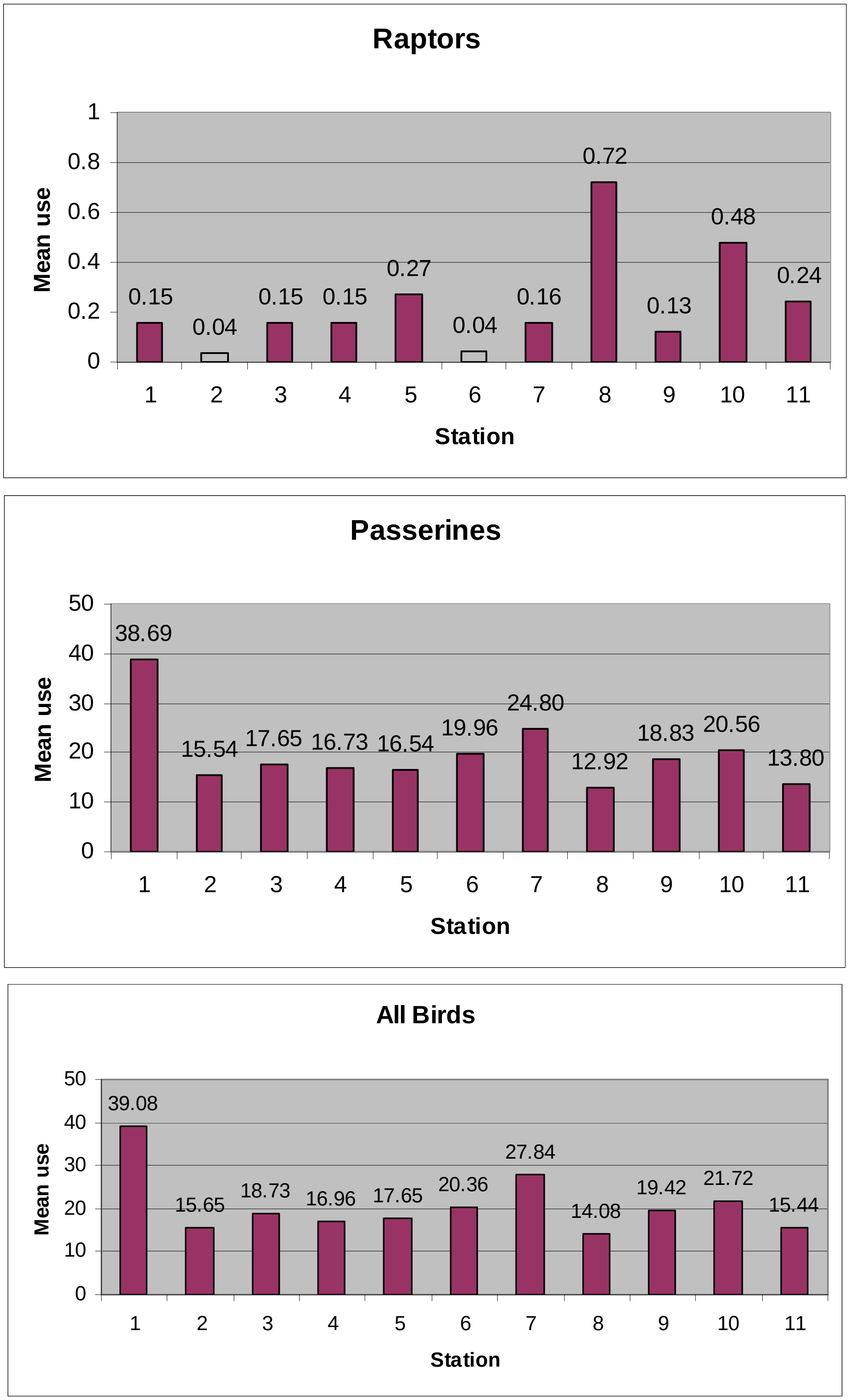


Figure 5. Flight paths of raptors at the Phase I project area.

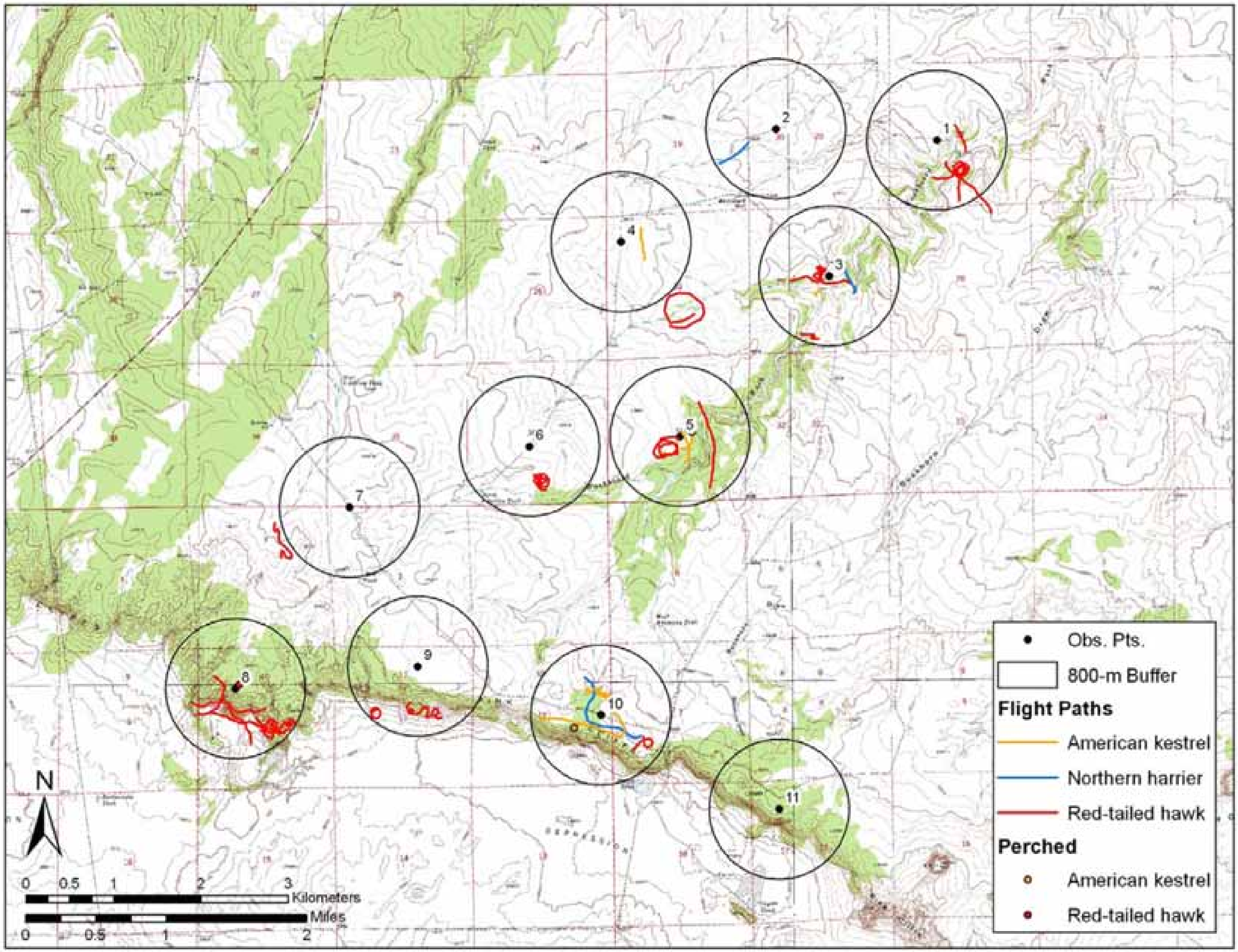


Figure 5 (continued). Flight paths of raptors at the Phase I project area.

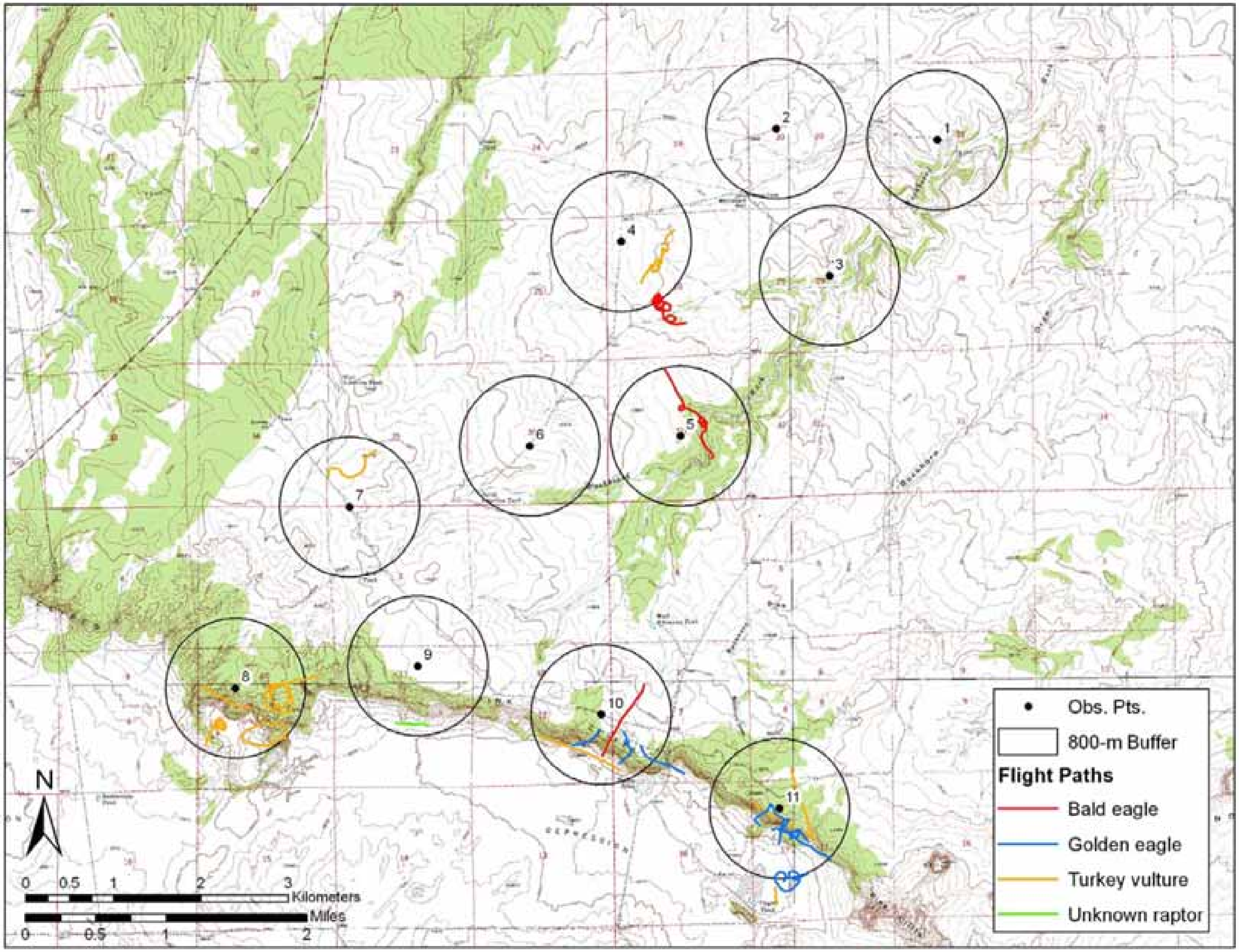


Figure 6. Raptor nest survey area and raptor nests located during the survey of the Phase I project area.

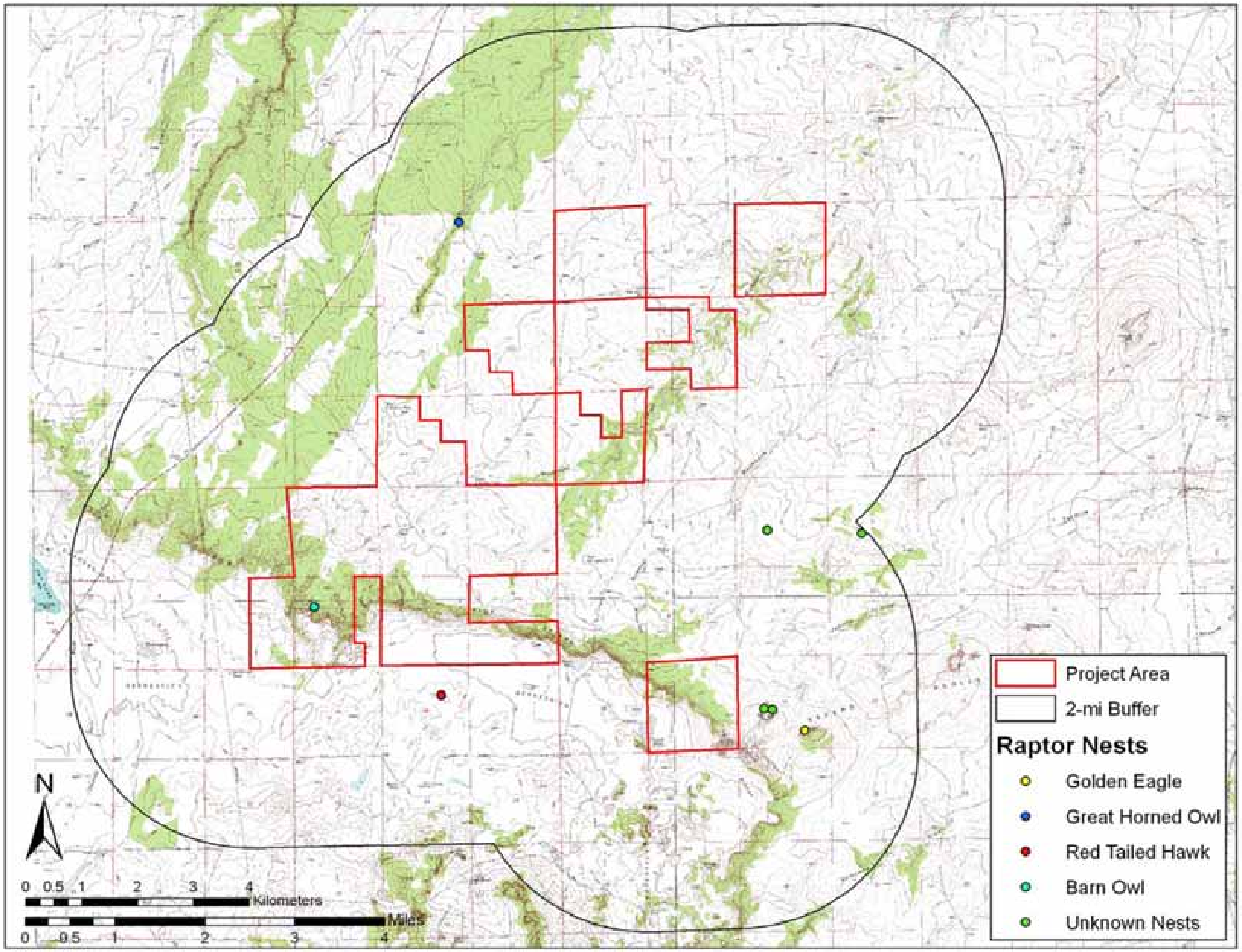


Figure 7. Vegetation types, paper-spined cactus locations, and Waters of the U.S. in the Phase I project area.

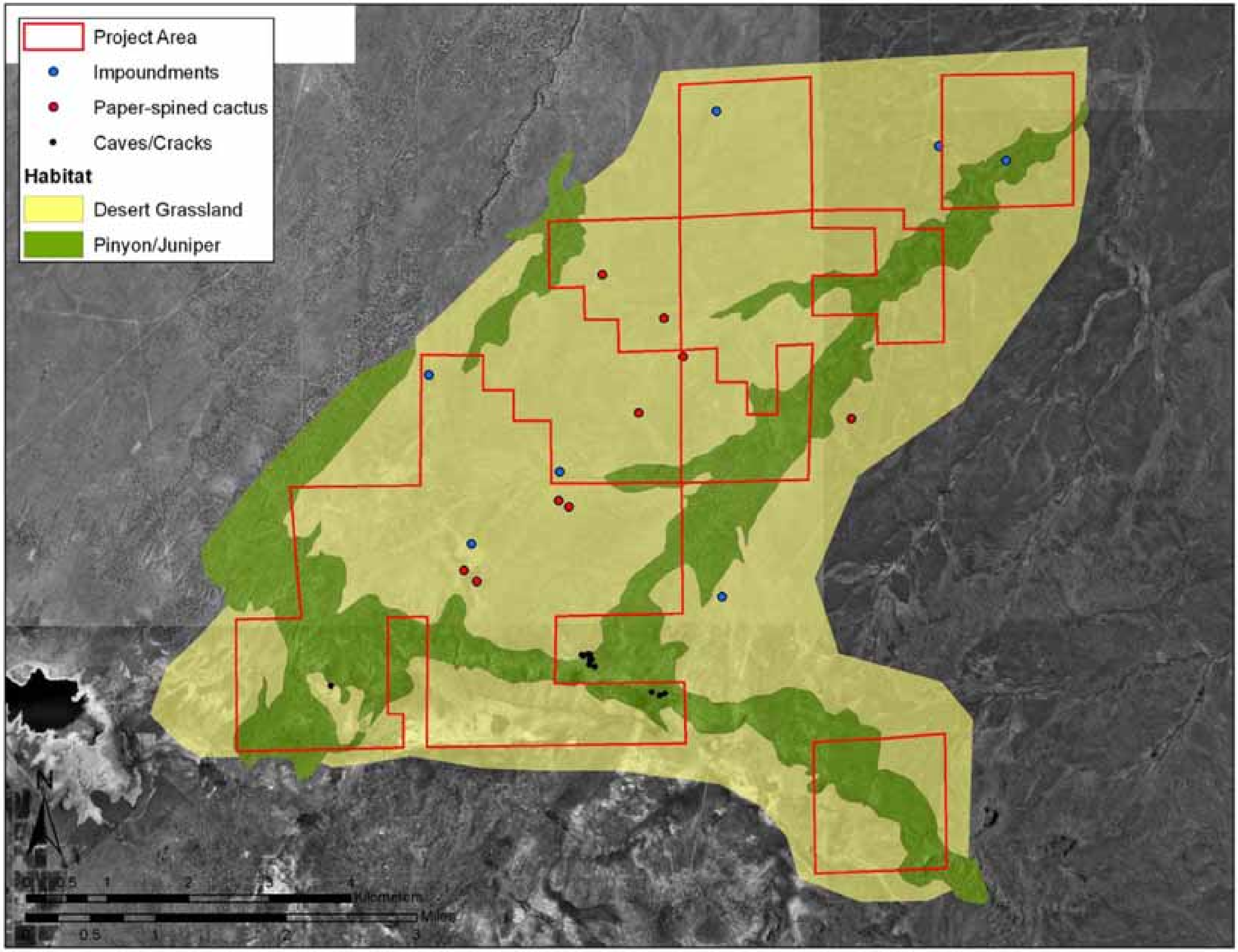


Figure 8. Aerial photo of Phase1 and subsequent phases area of the proposed Dry Lake wind power project.

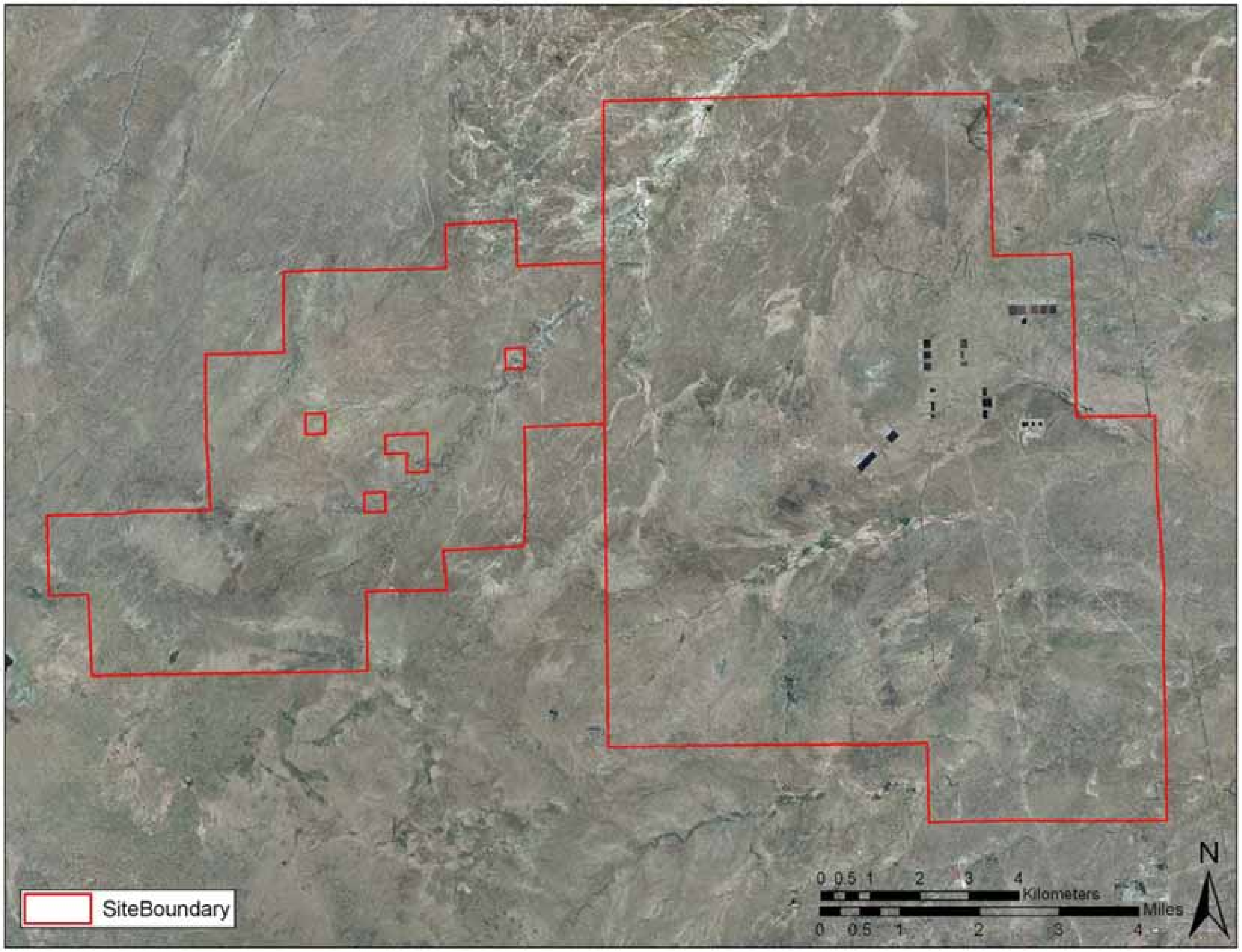


Figure 9. Annual raptor use estimates at western and midwestern wind projects and wind resource areas.

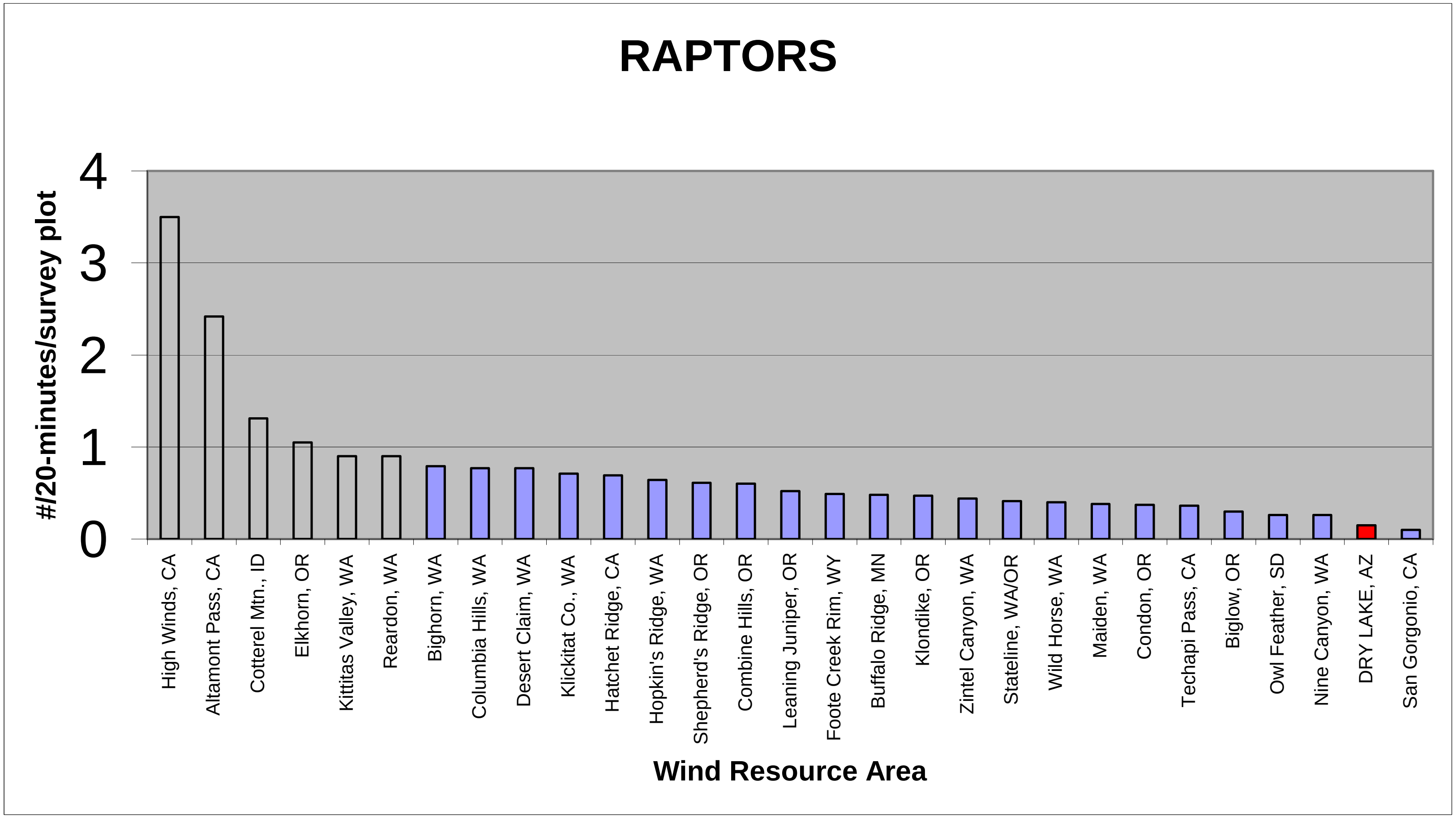
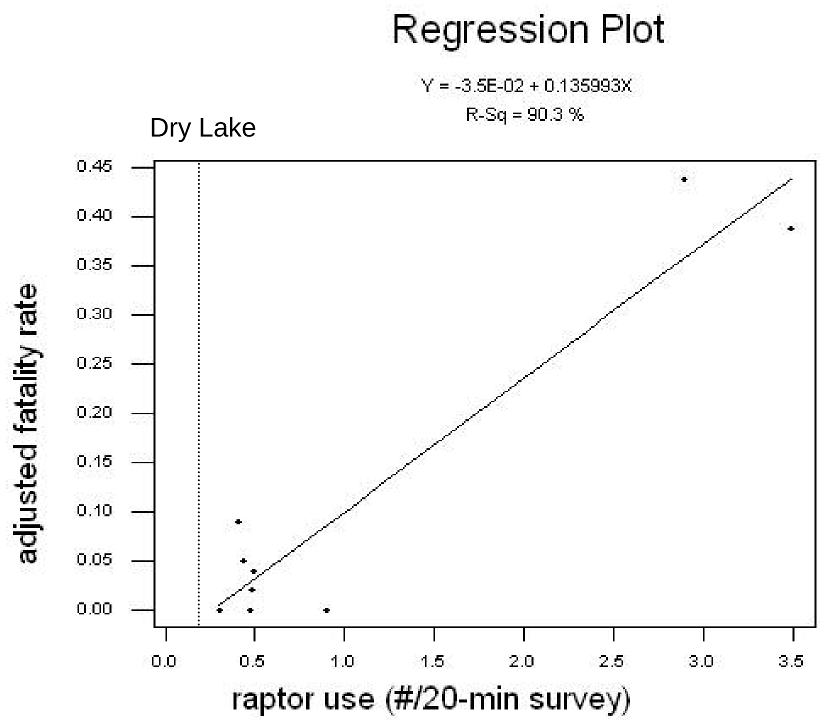


Figure 10. Regression analysis between raptor use and adjusted[2] raptor fatality rates for nine newer wind projects[3]



[2] Corrected for searcher and carcass removal biases
[3] The data are from the High Winds project, Solano County, California; Diablo Winds repowering project, Altamont Pass, California; Buffalo Ridge, Minnesota, Foote Creek Rim project, Wyoming; Stateline Wind Project, Washington/Oregon border; Combine Hills, Oregon; Vansycle, Oregon; Klondike Wind Project, Oregon; and Nine Canyon Wind Project, Washington.

Figure 11. Annual avian use estimates for all species at western and midwestern wind project and wind resource areas.