ANALYSIS OF POTENTIAL WILDLIFE/WIND PLANT INTERACTIONS

BIGHORN SITE, KLICKITAT COUNTY, WASHINGTON

Prepared for

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INTRODUCTION

PPM Energy is currently considering a site for potential wind power development in eastern Klickitat County, Washington (Figure 1). This report presents the results of screening to identify any ecological (wildlife and vegetation) issues that might affect site selection and development of wind power projects in the area. This report also summarizes data collected near the site as part of the Klickitat County Energy Overlay Programmatic Environmental Impact Statement (PEIS) (Johnson et al. 2002).

The biological characteristics of a site most likely to affect suitability of an area for windplant development as well as siting of turbine strings include (1) raptor use, (2) presence of federal or state listed species, (3) presence of crucial habitat for big game or other game species, (4) presence of bird migration corridors, (5) presence of bat habitats, and (6) presence of unique habitats. One of the most important issues related to raptors is the species composition in the area. Areas where ubiquitous species such as the red-tailed hawk are most common would be of less concern than areas where more rare species such as Ferruginous hawks occur. Raptor nesting densities in the proposed area are also of concern. Areas with relatively high nest densities compared to other areas are less favorable for development because of potential impact to breeding raptors. Presence of raptor nests within the site itself is not the only factor associated with raptor use of an area. Raptors may forage as far as 15 miles away from nest sites throughout the reproductive cycle. Therefore, even if a site is chosen to minimize conflicts with nesting raptors, raptor use of an area could still be substantial if the area contains high prey density, usually in the form of ground squirrels, pocket gophers and rabbits. Finally, because of their physical and biological characteristics, certain sites are known to have high numbers of migrating raptors in the spring and/or fall. Most of the major migration corridors are known, but some of the smaller ones likely go undetected. Such migration corridors should be avoided when possible. In addition to concerns with migrant raptors, collision deaths of migrant songbirds have also been reported at several windplants. Most song birds migrate at night, and the number of migrant songbird collision fatalities will likely increase as turbines become taller and require lighting, which has been shown to attract nocturnal migrants.

For obvious reasons, windplants should be carefully sited to avoid federally or state listed candidate, proposed, threatened, endangered or state protected species and their habitat. Potential impacts include collision mortality for some species of listed or sensitive birds or bats as well as loss or degradation of habitat for other species. Displacement may occur to nesting songbirds which, for some less abundant species, may ultimately result in a reduction in the local breeding population. The potential for presence of listed or sensitive species should be carefully evaluated prior to locating wind plant facilities.

Other wildlife habitats that should be considered when siting wind plants include big game winter ranges, migration routes and transitory range, or parturition (fawning) areas; waterfowl flight corridors, feeding areas and staging areas; and other areas considered highly valuable for protected game and nongame species. Turbines placed in frequently-used waterfowl flight corridors between roosting and feeding areas may result in unacceptable levels of collision mortality or displacement, especially during inclement weather such as fog or snow. Turbines placed within big game winter ranges result in elimination of habitat where physical structures and roads are placed, and may also reduce habitat effectiveness over a much larger area if big game are disturbed by operational turbines and/or routine maintenance activities.

Finally, bat collision mortality has recently been documented at several windplants, including some in Washington and Oregon (Johnson 2003, Johnson et al. 2003). In many cases the number of bat fatalities has far exceeded the number of bird fatalities. Presence of bat habitats such as mines, caves, abandoned buildings, and woodlands should be considered when siting new windplants. Areas in proximity to known bat maternal colonies or hibernacula should be avoided. Presence of areas that attract foraging bats such as small ponds and stock reservoirs should be considered when micro siting turbines or turbine strings. Most bat fatalities at windplants in the U.S. appear to be migrants and little is known about bat migratory pathways, numbers of migrating individuals, and their destinations.

STUDY AREA

The proposed project area is in Klickitat County. The project area begins 2.5 miles south of Bickleton and extends southward for approximately nine miles (Figure 2). Primary habitats in the general region include dryland agriculture, Conservation Reserve Program (CRP) grasslands and native grassland. Minor habitat types on leased areas and within two miles of the proposed windplant include sagebrush shrublands, lithosol habitats within grasslands, and scattered stands of oak, juniper, cottonwood and coniferous trees. Elevation of the project area ranges from approximately 2100' – 3000'.

METHODS

The Washington Natural Heritage Program and Washington Department of Fish and Wildlife Priority Habitats and Species databases were searched for existing data on species and habitats of concern. As part of the Energy Overlay Programmatic Environmental Impact Statement (PEIS) completed for Klickitat County, nine avian survey points were established within approximately three miles of the proposed project (Figure 2). These points were surveyed weekly from April 15 through July 15, 2002, a time period that covered late migration and the breeding season for most raptors and other birds in the project area. A total of 75 surveys were conducted at the points, including 42 in the spring (April 15 to May 31) and 33 in the summer (June 1 through July 15).

Avian use surveys were conducted to estimate the temporal and spatial use of the project area by birds. The data collected consisted of counts of bird use of circular plots around observation points during a specific survey period. All birds seen during each survey were recorded. Estimated distance to each bird observed was recorded to the nearest meter. The radius of the circular plots was up to 2,625 feet (800 m) depending on the limitations of the terrain. Each plot was surveyed for 20 minutes each survey day. The behavior of each bird observed and the habitat in which or over which the bird occurred were recorded. Approximate flight height at first observation was recorded to the nearest meter and the approximate lowest and highest flight heights were also recorded. Any comments or unusual observations were also noted. Locations of raptors, other large birds, and any species of concern seen were recorded on the field maps by observation number. Plot surveys were scheduled to cover all daylight hours. During a set of surveys, each plot was visited once. A pre-established schedule was developed prior to the field surveys to ensure that each station was surveyed approximately the same number of times each

period of the day and to efficiently utilize personnel time by minimizing travel time between plots.

Species lists were generated by season including all observations of birds detected regardless of their distance from the observer. The number of birds seen during each point count survey was standardized to a unit area and unit time surveyed. The standardized unit time was 20 minutes and the standardized unit area was 2.01 km^2 (800-m radius view shed for each station). For example, if four raptors were seen during the 20 minutes at a point with a viewing area of 2.01 km^2, these data would be standardized to 4/2.01 = 1.98 raptors/km^2 in a 20-minute survey. For the standardized avian use estimates, only observations of birds detected within 800 m of the observer were used.

Estimates of avian use (expressed in terms of number of birds/plot/20-minute survey) were tabulated to compare differences in avian use between avian groups and seasons. The total number of unique species was calculated by season. The mean number of species observed per survey (i.e., per station per 20-minute survey) was used as an index to avian richness in the study area. Mean number of species per survey was tabulated to illustrate and compare differences between seasons.

The rotor-swept height of many of the newer generation turbines ranges from approximately 30 to 100 m above ground. We used this range to approximate the percentage of birds flying below, within and above typical rotor swept area heights and in comparing differential risk of collision between bird groups. The first flight height recorded was used to estimate percentages of birds flying below, within and above the rotor swept area (RSA) of turbines. A relative index to collision risk (*R*) was calculated for bird species observed in the project area using the following formula:

$$R = A * P_f * P_t$$

Where A = mean relative use for species *i* 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 height (RSH). This index does not account for differences in behavior other than flight characteristics (i.e., flight heights and proportion of time spent flying).

An aerial survey was conducted to search for raptor nests within the proposed project area and a two mile buffer, an area totaling approximately 80 mi^2 (Figure 3). Surveys were conducted from a helicopter with one observer on April 16-17, 2003. Search paths were recorded with a handheld Global Positioning System (GPS) at five second intervals. Flight paths totaled 356 miles in length. Surveys were scheduled after most species of raptor finished courtship and were incubating eggs or brooding young. Surveys were also scheduled just prior to the onset of leaf out to increase the visibility of raptor nests within deciduous tree habitats. Nest searches were conducted by searching habitat suitable for most above ground nesting species, such as cottonwood, juniper, ponderosa pine, oak patches, cliffs or rocky outcrops. Data recorded for each nest location included species occupying the nest, nest status (inactive, bird incubating, young present, eggs present, adult present, unknown or other), nest substrate (pine, oak, cottonwood, juniper, shrub, rocky outcrop, cliff or powerline), number of young present, time and date of observation and the nest location (recorded with a handheld GPS).

RESULTS

Avian Point Counts

Species Abundance and Composition

Forty-three species of birds were observed during point count surveys (Table 1). Over the course of the study, 382 flocks comprised of 766 individual birds were recorded. The number of birds observed by species used to obtain use and composition estimates are presented in Appendix A. Twenty-eight species were observed in spring and 28 were observed in summer. Avian richness (defined as number of species per survey) was 3.86/survey in the spring and 4.15/survey in the summer (Table 1). The mean number of birds observed per survey plot was similar in the spring (10.13) and summer (10.48), and averaged 10.28 over both seasons.

Small passerines were the most abundant group in spring (7.93/survey), followed by corvids (1.67) and raptors (0.40); these groups comprised 78.3%, 16.5%, and 4.0% of all birds observed, respectively. The groups of birds most frequently observed during surveys, regardless of the number observed, were small passerines (97.2%), corvids (37.5%), and raptors (36.1%) (Table 2). Species with the highest use in spring were western meadowlark (2.06/survey), common raven (1.67), white-crowned sparrow (1.50), mountain bluebird (1.10), European starling (0.90) and horned lark (0.76) (Table 3). The only raptor with any significant use of the area in spring was American kestrel (0.25/survey). Mean use of the other raptor species observed in spring was very low (i.e., 0.03/survey for Cooper's and sharp-shinned hawk, 0.10/survey for red-tailed hawk). The species of birds most frequently observed during surveys were western meadowlark (81.9% of surveys), horned lark (48.6%), mountain bluebird (45.8%), and common raven (37.5%)(Table 4).

In the summer, small passerines remained the most abundant group (6.57/survey), followed by corvids (2.83), waterbirds (0.56) and raptors (0.44). Small passerines comprised 62.7% of all birds observed, corvids comprised 27.0% and waterbirds comprised 5.3%. Raptors comprised 4.2% of all birds observed in the area. The most frequently occurring groups were passerines (100% of surveys), raptors (35.2%) and corvids (27.8%). Species with the highest use in summer were common raven (2.80/survey), horned lark (2.00), western meadowlark (1.72), and mountain bluebird (0.89). American kestrel again had the highest use of any raptor (0.19/survey), followed by northern harrier and red-tailed hawk, each with mean use of 0.09/survey, and Swainson's hawk and unidentified eagle, each with mean use of 0.04/survey. The species of birds most frequently observed during summer surveys were western meadowlark (75.9% of surveys), horned lark (57.4%), mountain bluebird (46.3%), and common raven (24.1%).

Flight Height and Risk of Turbine Collision

A total of 167 avian groups of 488 individuals was observed flying during the study (Table 5). For all species combined, 79.1% of all flying birds observed were below the rotor-swept height (RSH) and 20.9% were within the RSH; no birds were observed flying above the RSH (Table 5). Only four species/groups were observed flying within the turbine RSH. For avian groups with at least 10 observations of flying birds, corvids had the highest percentage of flight heights within the RSH (56.4%), followed by buteos (41.2%) (Table 5). For species with at least 5 observations

of flying birds, common raven (56.8%) and red-tailed hawk (50.0%) had the highest percentage of flight heights within the RSH (Table 6).

Turbine exposure indices could be calculated only for those species/groups observed flying at least once at the RSH. Common raven had the highest index (1.20), followed by unidentified gull (0.24), red-tailed hawk (0.04) and long-billed curlew (0.02) (Table 7). All other species had a "0" in the equation for "percent of observations within the rotor-swept height", which results in an exposure index of 0.

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 intensive studies (Anderson *et al.* 1996).

Raptor Nest Surveys

A total of 46 nests were found during surveys, of which 32 showed no signs of raptor activity (Table 8). Five active red-tailed hawk, three active great-horned owl, and one possibly active prairie falcon nest were found (Figure 3). The resulting active raptor nest density is approximately 0.11/mi^2. One nest was observed with egg fragments within the nest cup, but no adults were observed. The nest may have been occupied by raptors earlier in the year but was predated or abandoned and the eggs scavenged. One adult prairie falcon was observed perched on a cliff face and may have had an unobserved nest within a pothole or cavity. Prairie falcons have been documented as nesting on the cliff face in the past by the Washington Department of Fish and Wildlife (WDFW). Four structures apparently built by squirrels were also observed. The structures were roughly the size of a red-tailed hawk nest, but were made of several small twigs and other vegetation, differing from a typical raptor nest made of relatively large branches. The structures are of suitable size and may be used by raptors as nest sites in the future.

Federal and State Protected or Sensitive Species

The Washington Priority Habitat and Washington Natural Heritage Program databases did not contain any records of federal or state endangered, threatened, candidate or sensitive species or habitats within the sections being considered for development (Figure 4). Within a two-mile buffer of the project area, there is one prairie falcon nest, one western bluebird record, and one Woodhouse's toad record. There are several records of western gray squirrel in the riparian zone along Wood Gulch that runs approximately one to two miles west of the project area.

No federal or state endangered or threatened species were documented during the field study. The only candidate species documented was loggerhead shrike (state candidate), with one observation of a single individual (Table 9). Six state sensitive species were observed during point count surveys of the study area, including long-billed curlew, Swainson's hawk, turkey

vulture, ash-throated flycatcher, grasshopper sparrow, and western bluebird. All six species are classified as State Monitor species, which is the lowest level of concern. Use of the project area by state sensitive species was very low. Only one individual long-billed curlew, one Swainson's hawk, two ash-throated flycatchers, two grasshopper sparrows, and five western bluebirds were observed.

The WDFW is especially concerned over declining long-billed curlew populations in eastern Washington. Long-billed curlews typically breed in shortgrass or mixed grass native prairies and prefer to nest in areas with large, open expanses of low vegetation. Although long-billed curlews typically occur in grasslands and prairies, they may occasionally occur in agricultural settings and rangelands used for cattle grazing (Bent 1962, Johnsgard 1986). Habitat types in the Bighorn project area include Conservation Reserve Program (CRP) grasslands, lithosol, shrub-steppe, wheat fields and riparian areas. There are no short or midgrass prairied in the area that provide optimal habitat for this species. Only one individual was observed during the Klickitat County Energy Overlay study, and CH2M HILL biologists working at the site from early spring though late summer over the last two years have not observed this species (Peggy O'Neill, CH2M HILL, pers. commun.). Low use of the area by long-billed curlew indicates that the Bighorn project area does not provide important habitat for this species. In addition, no long-billed curlew collision fatalities have been found at existing wind plants (Erickson et al. 2001). Shorebirds as a group are rarely killed at wind farms; of 1036 avian fatalities collected at U.S. wind farms, only 1 was a shorebird (a killdeer found at Buffalo Ridge, Minnesota) (Erickson et al. 2001). Based on the above, the Bighorn project is not likely to adversely impact long-billed curlew populations.

State Wildlife Issues and Unique Habitat

Within the lease boundaries, the Washington Department of Fish and Wildlife (WDFW) has identified shrub-steppe and riparian zones associated with Wood Gulch and Pine Creek (Figure 4) as priority habitats. *Priority habitats* are defined by the WDFW as "those habitat types or elements with unique or significant value to a diverse assemblage of species" (http://www.wa.gov/wdfw/hab/phslist.htm). The WDFW typically places a high value on protecting habitats designated as "priority habitats." These two habitat types comprise only a small portion of the southern end of the lease area and can likely be avoided during wind plant siting.

Within a 2-mile buffer of the project area, identified priority habitats include wild turkey range approximately 1.2 miles northwest of the project, mule and black-tailed deer winter range beginning 0.5 miles west of the project, and a small area of cliff habitat 1.75 miles south of the site. Areas of shrub-steppe and riparian habitats also occur outside the lease boundary but within 2 miles of the project (Figure 4).

According to the WNHP (1999) a total of 39 rare plant species potentially occur within Klickitat County. Many of these species occur within shrub-steppe habitats. No species have been documented within the lease area or within a 2-mile buffer of the project. The nearest known sensitive plant populations include two records of Pauper milk-vetch, both of which are over 5 miles from the project. Woven-spored lichen, another sensitive species, has been found approximately 3 miles west of the project (Figure 4).

Bats

Based on range maps, 13 of the16 species of bats in Washington may occur in Klickitat County (WDFW 1999). Of these 13 species, 11 are considered resident, non-migratory species, one is considered to be strongly migratory (hoary bat) and the other is suspected to be at least partially migratory (silver-haired bat). The 11 resident species are colonial species that form communal roosts during the summer. Except for the Townsend's big-eared bat, a state candidate species, bats within Washington do not receive federal or state protection. Very little is known about the current distribution of Townsend's Big-eared bat in Washington. According to Marshall et al. (1996) the subspecies *Coryhorhinus townsendii pallescens* occurs east of the Cascade Range. The development area falls within the predicted distribution of the species (WDFW 1999).

Bat roost sites are varied and may include cliffs, rock crevices, caves, buildings, bridges, and trees. Typical roost sites in the Bighorn area may include cottonwood riparian zones, oak woodlots, ponderosa pine stands, rock outcrops, and farm buildings. The hoary and silver-haired bats are generally considered solitary bats that roost in both deciduous and coniferous trees. Bat foraging areas are fairly common in the study area and would include riparian zones, oak and ponderosa pine stands, shrublands, stock ponds and streams.

The colonial species either remain in the general area or make short-distance migrations to hibernate in caves and underground mines during the winter. The two migratory species likely travel through the area in late July through September (see Johnson et al. 2003). Hoary bats occur throughout Washington, but do not appear to be abundant in any area of the region. The silver-haired bat also occurs throughout most of Washington (Hayes and Waldien 2000). No studies have been conducted to characterize bat abundance and composition in Klickitat County. There are no known cave locations used by hibernating bats within Wind Class Areas 3 through 6 in Klickitat County. The only known caves used by hibernating bats in the area are near Trout Lake (B. Weiler, Washington Department of Fish and Wildlife, pers. commun.).

Areas used by bats for roosting and foraging are typically not the same areas conducive to development of wind farms, which are usually constructed in open areas to take advantage of the wind. Therefore, construction of wind farms would not result in the loss or degradation of bat habitat in the project area. The primary impact to bats would be collision mortality. Available evidence indicates that this would be confined primarily to the migratory species. Although there are 45 species of bats in the U.S., only 11 species comprise all known bat fatalities at U.S. wind plants, despite the fact that wind plants with bat mortality occur in a variety of regions and habitats. The three most common species of migratory bats in the U.S. (hoary, eastern red, and silver-haired bats) comprised 84% of the bat fatalities documented at U.S. windplants (Johnson 2004). At several wind plants evaluated in the U.S., bat collision mortality during the breeding season was virtually non-existent, despite the fact that relatively large populations of resident bats of several species were documented breeding in close proximity to the wind plant (see Johnson 2003). Based on these studies, it appears that windplants would pose little risk to non-migratory bat populations in the study area, including the Townsend's big-eared bat.

Bat mortality patterns at windplants in Washington and Oregon have followed patterns similar to the rest of the country. Of 193 bat fatalities collected at existing windplants in eastern Oregon and Washington, 183 (95%) have been the two migratory species, including 91 hoary bats and 92 silver-haired bats. The other mortalities have consisted of small numbers of big brown bats,

little brown bats, and unidentified Myotis bats. Virtually all of the mortality has occurred in late summer and early fall, during the fall migration period for hoary and silver-haired bats.

Nocturnal Migratory Songbirds and Waterfowl

Many species of songbirds and waterfowl migrate at night and may collide with tall man-made structures. Large numbers of songbirds may collide with structures at lighted communication towers and buildings when foggy conditions and spring or fall migration coincide. Birds appear to become confused by the lights during foggy or low ceiling conditions, flying circles around lighted structures until they become exhausted or collide with the structure. To date, no large mortality events have been documented at wind plants in North America (Erickson et al. 2001). However, turbines used by many wind developers are getting taller and are required to be lighted by the Federal Aviation Administration, increasing the risk of collision by nocturnal migrants with wind turbines. Avian use data collected for the Klickitat County PEIS are representative of daytime use of the area and do not reflect abundance of nocturnal migrants.

The proposed wind plant does not appear to be located within an obvious migratory funnel for songbirds. However, songbirds likely migrate through the project area. The Migratory Bird Treaty Act, administered by the U.S. Fish and Wildlife Service, protects many of these species. In the Pacific Northwest, nocturnal migration at a wind plant site has been studied only at the Stateline Windplant on the Oregon/Washington border. The study was designed to monitor waterfowl, shorebird and passerine movements during fall and spring migrations. Marine radar was used to study nocturnal bird migration at two stations: one near the existing Vansycle Wind Project near the southeastern end of the Stateline project area, and one to the north of the project area in Washington. Targets flying below 100 m were considered within the zone of collision risk with the turbines. For targets observed from 0-1500 m above ground level, 87% were flying above 100 m during the spring of 2001, and 94% were flying above 100 m in the fall of 2001. The northern and southern stations had very similar passage rates, suggesting no distinct differences in migration patterns throughout the project site. The overall migration rates were considered moderate compared to rates observed in other parts of the U.S. Subsequent carcass searching has shown very low avian collision mortality during migration periods.

Bluebirds

As evidenced by the large number of bluebird boxes that have been erected on fences alongside roads in the project area, there is some local concern over potential effects of the project on bluebirds. Bluebirds were fairly common in the area, as 75 mountain bluebirds and 5 western bluebirds were observed during the avian point count surveys. A review of flight height data collected at nine other wind resource areas in the Pacific Northwest indicates that bluebirds very rarely fly at turbine rotor-swept heights. Of 235 observations of bluebirds, only 14 (6%) were observed flying at turbine rotor-swept heights, indicating very low risk of collision mortality to bluebirds. Data on bluebird flight heights collected for the Bighorn Project follow the same pattern, as all of the 15 flying bluebirds observed during the study were flying below the rotor-swept height of turbines.

Erickson et al. (2001) summarized all available wind farm mortality data for the entire U.S. Of 1036 avian fatalities collected at U.S. wind farms, 6 bluebirds have been found, including 4 of 613 birds found at Altamont Pass, California and 2 of 96 birds found at Foote Creek Rim, Wyoming. These data indicate that although bluebird fatalities do occur at wind farms,

collisions are very rare and it is unlikely the Bighorn Project would have any negative impacts on bluebird populations in the area.

IMPACT PREDICTIONS

For the Klickitat County PEIS, the county was divided into six strata. Based on total raptor abundance for the spring and summer seasons combined, the six strata were ranked from highest raptor use to lowest raptor use as follows:

1 West of U.S. 97, ≤1.5 miles from Columbia River (raptor use=1.23/survey).

2 West of U.S. 97, >1.5 miles from Columbia River (raptor use=1.17/survey); and

3 Between U.S. 97 and Rock Creek, ≤1.5 miles from Columbia River (raptor use=1.09/survey)

4 East of Rock Creek, ≤1.5 miles from the Columbia River (raptor use=1.08/survey);

5 Between U.S 97 and Rock Creek, >1.5 miles from the Columbia River (raptor use=0.81/survey);

6 East of Rock Creek, >1.5 miles from Columbia River (raptor use=0.48/survey);

The Bighorn Project area is within Strata 6, which has the lowest raptor use of any area in Klickitat County. In addition, raptor use data at the Bighorn site itself (mean = 0.42/survey) was slightly lower than the mean determined for the entire strata (0.48/survey). The estimated raptor nest density at the Bighorn site (0.11/mi^2) was similar to other areas east of Rock Creek and >1.5 miles from the Columbia River sampled during the energy overlay project (0.09/mi^2), and was much lower than the highest raptor nest density (0.31/mi^2) occurring between Rock Creek and U.S. Highway 97. Songbird and waterfowl use of this area was also relatively low (rank = 5 of 6 for both groups) in comparison to other portions of the county. Based on results of the avian study conducted as part of the PEIS, it was concluded that the most suitable area for wind plant development in Klickitat County is that area east of Rock Creek and greater than 1.5 miles from the Columbia River (Johnson et al. 2002), which the Bighorn Project is in.

Raptor mortality for this Project is expected to be low given the number of proposed turbines (180), relatively low raptor use of the site, and the low raptor mortality observed at other new wind plants (Erickson *et al.* 2001a, Erickson *et al.* 2002). Based on the raptor use estimates for Klickitat County, Johnson *et al*. (2003b) predicted that annual raptor collision mortality would range from 0.02/turbine east of Rock Creek and >1.5 miles from the Columbia River to 0.06/turbine west of U.S. 97 and ≤1.5 miles from the Columbia River. Based on the estimate for the Klickitat County strata encompassing the Bighorn site, expected raptor mortality for the Bighorn site would be 3 to 4 per year. Because of their relatively high use of Klickitat County and susceptibility to collisions at other windplants, it was predicted that American kestrels would comprise nearly 2/3 (66.2%) of all raptor mortality at Klickitat County wind plants. Large falcons (i.e., prairie falcons) would comprise approximately 9.8% of the raptor fatalities, buteos would comprise approximately 5.5%, eagles would comprise 3.8%, northern harriers would comprise 2.6%, and other raptor species would comprise 12.8% of the mortality (Johnson et al. 2002).

Passerine (songbird) use data are collected at most wind plants during the day, yet available evidence indicates that a large proportion of the passerine mortality at wind plants involves nocturnal migrants (e.g., Johnson *et al.* 2002). As a result, there is little correlation between passerine use estimates obtained from diurnal observations and passerine collision mortality at wind plants. Also, there has been relatively low variability in passerine mortality estimates at wind plants in the Midwest and West (0 to 2 passerine fatalities per turbine per year). Therefore, rather than attempting to use passerine data collected during the field study to estimate collision mortality, the mean passerine mortality estimate presented in Erickson *et al.* (2001) derived from passerine collision mortality studies at several existing new-generation wind plants was used. Based on this estimate of 1.6 passerines per turbine per year, total songbird mortality at the Bighorn Project would average approximately 288 per year. No waterfowl and very few waterbirds or shorebirds were observed at the Bighorn site, indicating little to no risk to these groups of birds. With the possible exception of golden eagle populations at Altamont Pass, California, no studies conducted to date have indicated wind farms have caused population declines of any avian species (Kerlinger and Curry 2002).

Bat mortality estimates have been made for several existing wind farms in the Pacific Northwest, including the Stateline Project on the Oregon/Washington border, the Vansycle and Klondike Projects in Oregon, and the Nine Canyon Project in Washington. At these existing facilities, bat mortality has averaged 1.2 per turbine per year. Assuming similar fatality rates would be associated with the proposed 180-turbine Bighorn Project, then expected annual bat mortality would be approximately 216 per year.

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Table 1.Mean use, mean # species/survey, total number of species, and total number of fixed-point surveys conducted by season and overall for the Bighorn Project Site.

Season	# visits	Mean use	# species per survey	# Species	# Surveys
Spring	4	10.13	3.86	28	42
Summer	3	10.48	4.15	28	33
Overall	7	10.28	3.98	43	75

Table 2. Mean use, percent composition and percent frequency of occurrence for avian groups by season for the Bighorn Project Site.

Avian group	spring	summer
Mean Use		
Waterbirds	0.000	0.556
Shorebirds	0.056	0.000
Accipiters	0.056	0.000
Buteos	0.097	0.130
Northern Harrier	0.000	0.093
Eagles	0.000	0.037
Small Falcons	0.250	0.185
Raptors/Vultures	0.403	0.444
Corvids	1.667	2.833
Passerines	7.931	6.574
Other Birds	0.028	0.000
Gamebirds	0.042	0.000
Doves/Pigeons	0.000	0.074
Overall	10.125	10.481
Percent composition		
Group	spring	summer
Waterbirds	0.0	5.3
Shorebirds	0.5	0.0
Accipiters	0.5	0.0
Buteos	1.0	1.2
Northern Harrier	0.0	0.9
Eagles	0.0	0.4
Small Falcons	2.5	1.8
Raptors/Vultures	4.0	4.2
Corvids	16.5	27.0
Passerines	78.3	62.7
Other Birds	0.3	0.0
Gamebirds	0.4	0.0
Doves/Pigeons	0.0	0.7
Frequency of occurrence (%)		
Waterbirds	0.0	3.7
Shorebirds	5.6	0.0
Accipiters	5.6	0.0
Buteos	9.7	9.3
Northern Harrier	0.0	9.3
Eagles	0.0	3.7

Small Falcons	20.8	14.8
Raptors/Vultures	36.1	35.2
Corvids	37.5	27.8
Passerines	97.2	100.0
Other Birds	2.8	0.0
Gamebirds	4.2	0.0
Doves/Pigeons	0.000	5.556

Table 3. Avian species observed within 800 m of observer and estimated mean use for large and small birds on the Bighorn Project Site (April 15, 2002 – July 12, 2002).

Small Birds			
Species	spring	Species	summer
western meadowlark	2.06	Horned lark	2.00
white-crowned sparrow	1.50	Western meadowlark	1.72
mountain bluebird	1.10	Mountain bluebird	0.89
European starling	0.90	Unidentified finch	0.81
horned lark	0.76	Western bluebird	0.19
Brewer's blackbird	0.47	Brewer's blackbird	0.15
barn swallow	0.42	Lark sparrow	0.11
chipping sparrow	0.14	Vesper sparrow	0.09
vesper sparrow	0.11	American goldfinch	0.07
western kingbird	0.07	Pine siskin	0.07
American robin	0.06	Rock wren	0.07
dark-eyed junco	0.06	Unidentified swallow	0.07
grasshopper sparrow	0.06	Mourning dove	0.07
rock wren	0.04	Ash-throated flycatcher	0.04
loggerhead shrike	0.03	Brown-headed cowbird	0.04
red-winged blackbird	0.03	House finch	0.04
savannah sparrow	0.03	Lazuli bunting	0.04
song sparrow	0.03	Savannah sparrow	0.04
unidentified passerine	0.03	Unidentified bluebird	0.04
unidentified sparrow	0.03	unidentified sparrow	0.04
unidentified swallow	0.03	western kingbird	0.04
northern flicker	0.03	barn swallow	0.02
Large Birds			
common raven	1.67	common raven	2.80
American kestrel	0.25	unidentified gull	0.56
red-tailed hawk	0.10	American kestrel	0.19
California quail	0.04	northern harrier	0.09
killdeer	0.03	red-tailed hawk	0.09
long-billed curlew	0.03	Swainson's hawk	0.04
Cooper's hawk	0.03	unidentified eagle	0.04
sharp-shinned hawk	0.03	Stellar's jay	0.04

Table 4. Avian species observed within 800 m of observer and estimated frequency of occurrence for large and small birds on the Bighorn Project Site (April 15, 2002 – July 12, 2002).

Small Birds			
Species	Spring	Species	Summer
western meadowlark	81.9	western meadowlark	75.9
horned lark	48.6	horned lark	57.4
mountain bluebird	45.8	mountain bluebird	46.3
vesper sparrow	9.7	western bluebird	14.8
white-crowned sparrow	8.3	vesper sparrow	9.3
American robin	5.6	lark sparrow	7.4
western kingbird	5.6	mourning dove	5.6
Brewer's blackbird	4.2	American goldfinch	3.7
European starling	4.2	brown-headed cowbird	3.7
rock wren	4.2	Brewer's blackbird	3.7
barn swallow	2.8	house finch	3.7
chipping sparrow	2.8	lazuli bunting	3.7
dark-eyed junco	2.8	pine siskin	3.7
grasshopper sparrow	2.8	rock wren	3.7
loggerhead shrike	2.8	savannah sparrow	3.7
red-winged blackbird	2.8	unidentified bluebird	3.7
savannah sparrow	2.8	unidentified finch	3.7
song sparrow	2.8	unidentified swallow	3.7
unidentified passerine	2.8	western kingbird	3.7
unidentified sparrow	2.8	ash-throated flycatcher	1.9
unidentified swallow	2.8	barn swallow	1.9
northern flicker	2.8	unidentified sparrow	1.9
Large Birds			
common raven	37.5	common raven	24.1
American kestrel	20.8	American kestrel	14.8
red-tailed hawk	9.7	northern harrier	9.3
California quail	4.2	red-tailed hawk	9.3
killdeer	2.8	unidentified gull	3.7
long-billed curlew	2.8	Swainson's hawk	3.7
Cooper's hawk	2.8	unidentified eagle	3.7
sharp-shinned hawk	2.8	Stellar's jay	3.7

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

Group	Number of Groups	Number of Individuals	Percent Flight	below	within	above
Waterbirds	1	15	100.0	0.0	100.0	N/A
Shorebirds	2	2	100.0	50.0	50.0	N/A
Accipiters	2	2	100.0	100.0	0.0	N/A
Buteos	16	17	70.8	58.8	41.2	N/A
Northern Harrier	3	3	100.0	100.0	0.0	N/A
Eagles	1	1	100.0	100.0	0.0	N/A
Small Falcons	14	15	71.4	100.0	0.0	N/A
Other Raptors	1	2	100.0	100.0	0.0	N/A
Raptors/Vultures	37	40	75.5	82.5	17.5	N/A
Passerines	96	289	52.8	100.0	0.0	N/A
Corvids	29	140	97.9	43.6	56.4	N/A
Doves	1	1	33.3	100.0	0.0	N/A
Upland gamebirds	0	0	0.0	N/A	N/A	N/A
Other birds	1	1	100.0	100.0	0.0	N/A
Overall	167	488	63.7	79.1	20.9	N/A

Table 6. Flight height characteristics by species observed during fixed-point surveys.

Species	Number of Groups	Number of Individuals	Percent Flight	below	within	above
long-billed curlew	1	1	100.0	0.0	100.0	N/A
unidentified gull	1	15	100.0	0.0	100.0	N/A
common raven	28	139	97.9	43.2	56.8	N/A
red-tailed hawk	8	8	72.7	50.0	50.0	N/A
unidentified buteo	7	8	66.7	62.5	37.5	N/A
Brewer's blackbird	5	26	100.0	100.0	0.0	N/A
Cooper's hawk	1	1	100.0	100.0	0.0	N/A
European starling	2	33	100.0	100.0	0.0	N/A
Stellar's jay	1	1	100.0	100.0	0.0	N/A
Swainson's hawk	1	1	100.0	100.0	0.0	N/A
ash-throated flycatcher	2	2	100.0	100.0	0.0	N/A
barn swallow	6	16	100.0	100.0	0.0	N/A
killdeer	1	1	100.0	100.0	0.0	N/A
northern flicker	1	1	100.0	100.0	0.0	N/A
northern harrier	3	3	100.0	100.0	0.0	N/A
red-winged blackbird	1	1	100.0	100.0	0.0	N/A
sharp-shinned hawk	1	1	100.0	100.0	0.0	N/A
turkey vulture	1	2	100.0	100.0	0.0	N/A
unidentified eagle	1	1	100.0	100.0	0.0	N/A
unidentified finch	1	22	100.0	100.0	0.0	N/A
unidentified passerine	1	1	100.0	100.0	0.0	N/A
unidentified sparrow	3	3	100.0	100.0	0.0	N/A
unidentified swallow	2	3	100.0	100.0	0.0	N/A
white-crowned sparrow	2	50	92.6	100.0	0.0	N/A
western kingbird	3	4	80.0	100.0	0.0	N/A
American kestrel	14	15	71.4	100.0	0.0	N/A
horned lark	31	62	59.0	100.0	0.0	N/A
savannah sparrow	1	1	50.0	100.0	0.0	N/A
vesper sparrow	3	4	50.0	100.0	0.0	N/A
mountain bluebird	17	34	45.3	100.0	0.0	N/A
mourning dove	1	1	33.3	100.0	0.0	N/A
western meadowlark	16	27	17.5	100.0	0.0	N/A
American goldfinch	0	0	0.0	N/A	N/A	N/A
American robin	0	0	0.0	N/A	N/A	N/A
California quail	0	0	0.0	N/A	N/A	N/A
brown-headed cowbird	0	0	0.0	N/A	N/A	N/A
chipping sparrow	0	0	0.0	N/A	N/A	N/A
dark-eyed junco	0	0	0.0	N/A	N/A	N/A
grasshopper sparrow	0	0	0.0	N/A	N/A	N/A

house finch	0	0	0.0	N/A	N/A	N/A
lark sparrow	0	0	0.0	N/A	N/A	N/A
lazuli bunting	0	0	0.0	N/A	N/A	N/A
loggerhead shrike	0	0	0.0	N/A	N/A	N/A
pine siskin	0	0	0.0	N/A	N/A	N/A
rock wren	0	0	0.0	N/A	N/A	N/A
song sparrow	0	0	0.0	N/A	N/A	N/A
unidentified bluebird	0	0	0.0	N/A	N/A	N/A
western bluebird	0	0	0.0	N/A	N/A	N/A
Overall	167	488	63.7	79.1	20.9	N/A

Table 7. Mean exposure indices calculated by species observed during fixed-point surveys at the Bighorn Project Site.

Species	Mean Use	% Flying	% within RSH	Exposure Index
common raven	2.151	97.9	56.8	1.197
unidentified gull	0.238	100.0	100.0	0.238
red-tailed hawk	0.095	72.7	50.0	0.035
long-billed curlew	0.016	100.0	100.0	0.016
western meadowlark	1.913	17.5	0.0	0.000
horned lark	1.294	59.0	0.0	0.000
mountain bluebird	1.008	45.3	0.0	0.000
white-crowned sparrow	0.857	92.6	0.0	0.000
European starling	0.516	100.0	0.0	0.000
unidentified finch	0.349	100.0	0.0	0.000
Brewer's blackbird	0.333	100.0	0.0	0.000
barn swallow	0.246	100.0	0.0	0.000
American kestrel	0.222	71.4	0.0	0.000
vesper sparrow	0.103	50.0	0.0	0.000
chipping sparrow	0.079	0.0	N/A	N/A
western bluebird	0.079	0.0	N/A	N/A
rock wren	0.056	0.0	N/A	N/A
western kingbird	0.056	80.0	0.0	0.000
lark sparrow	0.048	0.0	N/A	N/A
unidentified swallow	0.048	100.0	0.0	0.000
northern harrier	0.040	100.0	0.0	0.000
American goldfinch	0.032	0.0	N/A	N/A
American robin	0.032	0.0	N/A	N/A
dark-eyed junco	0.032	0.0	N/A	N/A
grasshopper sparrow	0.032	0.0	N/A	N/A
mourning dove	0.032	33.3	0.0	0.0
pine siskin	0.032	0.0	N/A	N/A
savannah sparrow	0.032	50.0	0.0	0.0
unidentified sparrow	0.032	100.0	0.0	0.0
California quail	0.024	0.0	N/A	N/A
brown-headed cowbird	0.016	0.0	N/A	N/A
Cooper's hawk	0.016	100.0	0.0	0.0
house finch	0.016	0.0	N/A	N/A
lazuli bunting	0.016	0.0	N/A	N/A
loggerhead shrike	0.016	0.0	N/A	N/A
song sparrow	0.016	0.0	N/A	N/A
Stellar's jay	0.016	100.0	0.0	0.0

Swainson's hawk	0.016	100.0	0.0	0.0
ash-throated flycatcher	0.016	100.0	0.0	0.0
killdeer	0.016	100.0	0.0	0.0
northern flicker	0.016	100.0	0.0	0.0
red-winged blackbird	0.016	100.0	0.0	0.0
sharp-shinned hawk	0.016	100.0	0.0	0.0
unidentified eagle	0.016	100.0	0.0	0.0
unidentified bluebird	0.016	0.0	N/A	N/A
unidentified passerine	0.016	100.0	0.0	0.0
unidentified buteo	0.000	66.7	37.5	0.000
turkey vulture	0.000	100.0	0.0	0.000

Table 8. Raptor and other nests observed within the two mile search buffer.

Species	**Number of Nests**	**Nest Substrate**						**Notes**
		Cottonwood	*Pine*	*Juniper*	*Rock or Cliff*	*Oak*	*Shrub*	
Red-tailed Hawk	5	0	2	2	1	0	0	Four birds were incubating and one nest had 2 adults but no eggs or young
Great-horned Owl	3	0	2	1	0	0	0	Two nests had incubating adults and one nest contained young
Prairie Falcon	1	0	0	0	1	0	0	1 Adult observed on cliff face, nest hole was not located.
Squirrel Nest	4	0	0	0	0	4	0	Nests appeared to be built by squirrels, but could be used by raptors in the future. No birds or squirrels observed.
Inactive	32	16	6	4	0	4	2	No adults, young or signs of activity were observed.
Unknown	1	1	0	0	0	0	0	Nest contained egg fragments, but no adults were observed. Apparent predation.
Total	**46**	**17**	**10**	**7**	**2**	**8**	**2**	

Table 9. State and federally protected or sensitive wildlife species documented on or within two miles of the Bighorn Project (no sensitive plant species have been documented within 2 miles of the area).

Species	**Status**[1]	**Notes**
Turkey Vulture	State Monitor	Two birds observed during surveys for Klickitat Co. PEIS in project area
Swainson's Hawk	State Monitor	One bird observed during surveys for Klickitat Co. PEIS in project area
Prairie Falcon	State Monitor	One nest site on WPHS database within 2 miles of project area
Long-billed Curlew	State Monitor	One bird observed during surveys for Klickitat Co. PEIS in project area
Ash-throated Flycatcher	State Monitor	Two birds observed during surveys for Klickitat Co. PEIS in project area
Loggerhead Shrike	State Candidate	One bird observed during surveys for Klickitat Co. PEIS in project area
Western Bluebird	State Monitor	Five birds observed during surveys for Klickitat Co. PEIS in project area; one record on WPHS database within 2 miles of project area
Grasshopper Sparrow	State Monitor	Two birds observed during surveys for Klickitat Co. PEIS in project area
Western Gray Squirrel	State Threatened	Several WPHS database records along Wood Gulch west of project area
Woodhouse's Toad	State Sensitive	One record on WPHS database within 2-mile buffer of project area

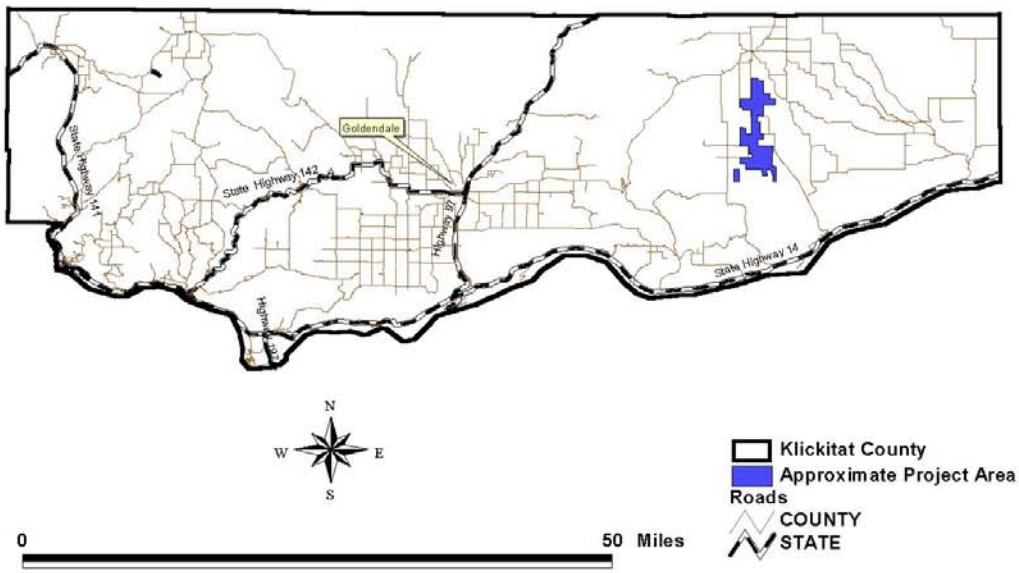
[1] State Monitor: Animal taxon of potential concern in some areas of state, but for which no official status has yet been assigned. This taxon is in need of additional field work before a status can be assigned. Populations in some areas of Washington do not have 'monitor' status.

State Threatened: Likely to become Endangered in Washington within the foreseeable future if factors contributing to its population decline or habitat degradation or loss continue;

State Candidate: Candidate animal that will be reviewed for possible listing as Endangered, Threatened, or Sensitive. There is sufficient evidence to suggest that its status may meet the listing criteria.

State Sensitive: Vulnerable or declining and could become Endangered or Threatened in the state without active management or removal of threats;

Figure 1. Approximate Location of the Project Area in Klickitat County.



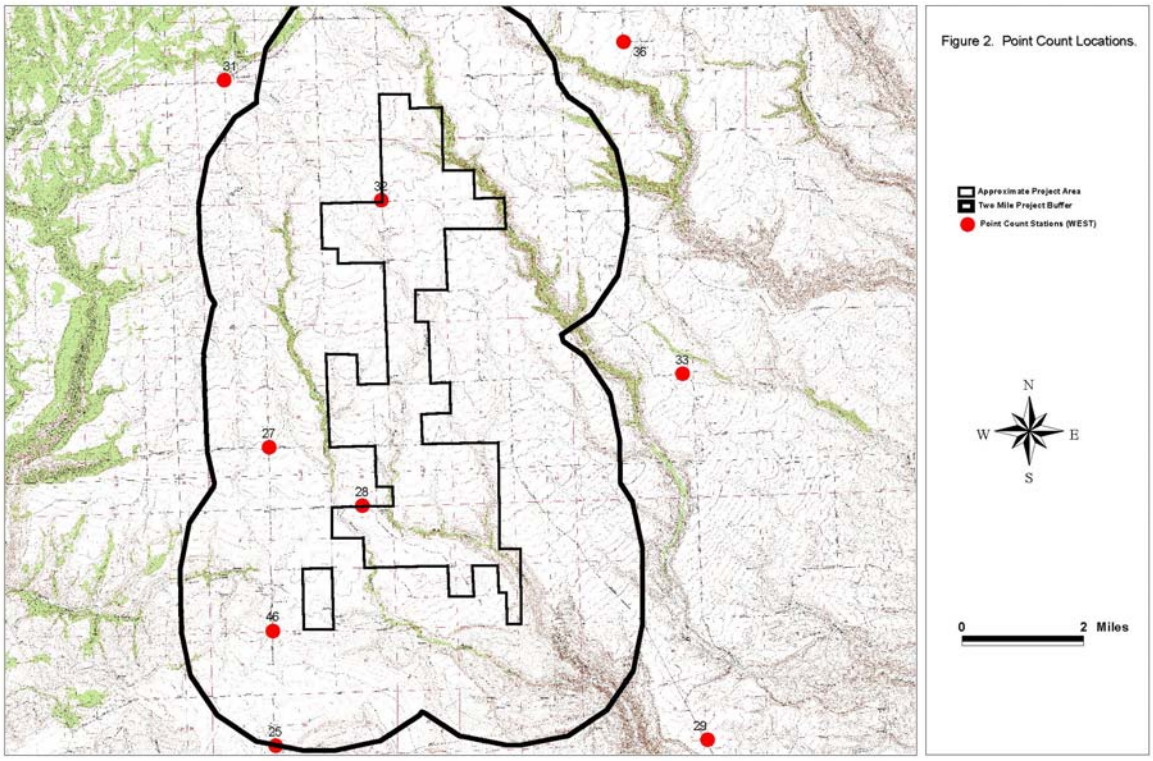


Figure 2. Point Count Locations.

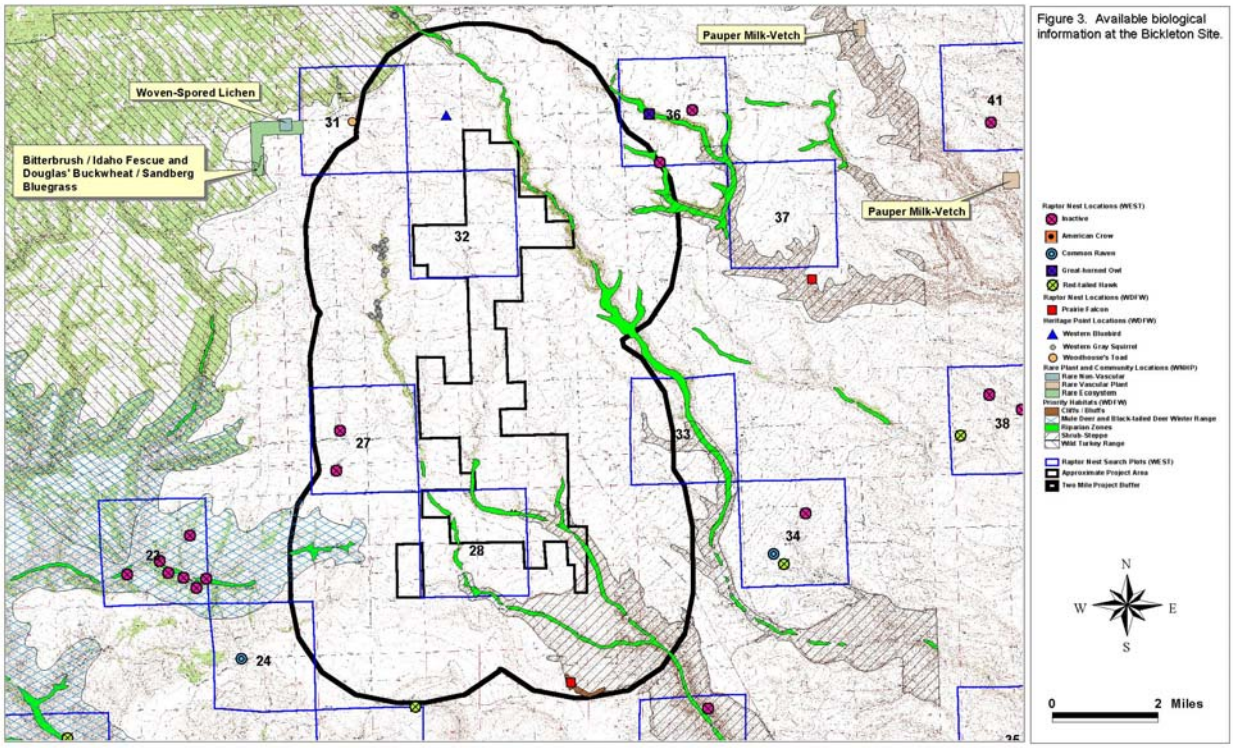


Figure 3. Available biological information at the Bickleton Site.

Appendix A. Number of avian groups and individuals by species used in the use and composition estimates

Species	Spring		Summer		Total	
	# groups	# individs	# groups	# individs	# groups	# individs
unidentified gull	0	0	1	15	1	15
Waterbirds	0	0	1	15	1	15
killdeer	1	1	0	0	1	1
long-billed curlew	1	1	0	0	1	1
Shorebirds	2	2	0	0	2	2
Cooper's hawk	1	1	0	0	1	1
sharp-shinned hawk	1	1	0	0	1	1
Accipiters	2	2	0	0	2	2
red-tailed hawk	6	6	5	5	11	11
Swainson's hawk	0	0	1	1	1	1
unidentified buteo	3	4	8	8	11	12
Buteos	9	10	14	14	23	24
unidentified eagle	0	0	1	1	1	1
Eagles	0	0	1	1	1	1
American kestrel	12	13	8	8	20	21
Falcons	12	13	8	8	20	21
northern harrier	0	0	3	3	3	3
turkey vulture	0	0	1	2	1	2
Other Raptors	0	0	4	5	4	5
Raptor Subtotal	23	25	27	28	50	53
common raven	20	65	11	77	31	142
Stellar's jay	0	0	1	1	1	1
Corvids	20	65	12	78	32	143
American goldfinch	0	0	1	2	1	2
American robin	2	2	0	0	2	2
ash-throated flycatcher	0	0	2	2	2	2
barn swallow	5	15	1	1	6	16
Brewer's blackbird	4	22	1	4	5	26
brown-headed cowbird	0	0	1	1	1	1
chipping sparrow	2	5	0	0	2	5
dark-eyed junco	1	2	0	0	1	2
European starling	2	33	0	0	2	33
grasshopper sparrow	1	2	0	0	1	2
horned lark	28	37	35	68	63	105
house finch	0	0	1	1	1	1
lark sparrow	0	0	5	5	5	5
lazuli bunting	0	0	1	1	1	1
loggerhead shrike	1	1	0	0	1	1

mountain bluebird	23	45	23	30	46	75
pine siskin	0	0	1	2	1	2
red-winged blackbird	1	1	0	0	1	1
rock wren	2	2	4	4	6	6
savannah sparrow	1	1	1	1	2	2
song sparrow	1	1	0	0	1	1
unidentified bluebird	0	0	1	1	1	1
unidentified finch	0	0	1	22	1	22
unidentified passerine	1	1	0	0	1	1
unidentified sparrow	1	1	2	2	3	3
unidentified swallow	1	1	1	2	2	3
vesper sparrow	4	5	3	3	7	8
western bluebird	0	0	5	5	5	5
western kingbird	3	4	1	1	4	5
western meadowlark	58	86	54	68	112	154
white-crowned sparrow	4	54	0	0	4	54
Passerines	146	321	145	226	291	547
California quail	2	2	0	0	2	2
Upland Gamebirds	2	2	0	0	2	2
mourning dove	0	0	3	3	3	3
Doves	0	0	3	3	3	3
northern flicker	1	1	0	0	1	1
Other Birds	1	1	0	0	1	1
Subtotal	194	416	188	350	382	766