YEAR 1 POST-CONSTRUCTION AVIAN AND BAT MONITORING REPORT

Biglow Canyon Wind Farm Phase II
Sherman County, Oregon

September 10, 2009 – September 12, 2010

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EXECUTIVE SUMMARY

The Biglow Canyon Wind Farm is located in the Columbia Plateau Ecoregion approximately 140 miles east of Portland, Oregon. The project area is generally bordered by the John Day River corridor to the east and the Columbia River gorge to the north. Biglow Canyon consists of three individual phases (I, II, and III). Phase II contains 65 2.3-megawatt (MW) Siemens wind turbines with a nameplate capacity of 150 MW. The Site Certificate issued by the State of Oregon Energy Facility Siting Council for the Biglow Canyon Wind Farm requires the certificate holder, Portland General Electric, to conduct a two-year Fatality Monitoring Program to determine whether operation of the facility causes significant fatalities of birds and bats and to determine whether the facility results in a loss of habitat quality.

This report summarizes the results for the first year (Year 1) of post-construction monitoring at Phase II of the Biglow Canyon Wind Farm. The study period for Year 1 post-construction monitoring was September 10, 2009 through September 12, 2010. In accordance with the protocols outlined in the Biglow Canyon Wind Farm: Wildlife Monitoring and Mitigation Plan, Year 1 monitoring included searches for bird and bat carcasses at turbines (Fatality Monitoring Program) and fixed-point avian use surveys (Avian Use and Behavior Study). Monitoring was conducted in accordance with protocols developed in collaboration with the Oregon Department of Fish and Wildlife (ODFW). This report presents the results of bird and bat fatality searches and fixed-point avian use surveys, as well as a summary of incidental wildlife observations.

Fatality Monitoring

The primary objective of the Fatality Monitoring Program is to estimate the number of avian and bat casualties attributable to collisions with wind turbines on an annual basis. Fatality monitoring consisted of four primary components: 1) standardized carcass surveys at select turbines; 2) searcher efficiency trials to estimate the proportion of carcasses found by searchers; 3) carcass removal trials to estimate the length of time that a carcass remains in the field for potential detection by searchers; and 4) statistical analyses including estimates of annual avian and bat fatality rates at Biglow Canyon Phase II adjusted for searcher efficiency and carcass removal.

Carcass searches were conducted at 50 turbines selected in consultation with ODFW. Square search plots (125 meters) were established around each search turbine. Surveyors walked parallel transects within the search plot spaced approximately six meters apart while scanning the ground for fatalities or injured birds or bats. In accordance with the Wildlife Monitoring and Mitigation Plan, standardized searches were conducted at each of the 50 search turbines once every two weeks during the spring and fall migration periods and once every four weeks during summer and winter. Each turbine was searched on 17 occasions throughout the study period resulting in a total of 850 individual turbine searches during Year 1.

Forty-three bird fatalities and 17 bat fatalities were found during carcass searches. Fatalities included fifteen bird species and 2 bat species. Species composition for bird and bat fatalities was similar to species composition documented during fatality monitoring at Biglow Canyon

Phase I and other wind projects in the Pacific Northwest. The most common bird species found during standardized searches was the horned lark (eight individuals; 18.2% of bird fatalities), the golden-crowned kinglet (5; 11.4%), and the ring-necked pheasant (4; 9.1%). Documented raptor fatalities included two red-tailed hawks, one northern harrier, one American kestrel, and one prairie falcon. Additionally, one large bird collected during standardized searches was unidentifiable to species but was classified by searchers as a possible hawk. Therefore, a total of six birds were included in the raptor fatality estimates. One great-horned owl fatality was found incidentally by Facility personnel. Although the owl carcass was found in a search plot, cause of death was attributed to collision with a power line based upon location and injuries. The great-horned owl was not included in raptor fatality estimates.

Bird fatalities were found throughout the year, with the highest number of fatalities in the fall. There was no strong concentration of avian fatalities at any individual turbine, and at least one fatality was found at 30 of the 50 turbines searched. No special status avian species were found as fatalities in Year 1.

Bat fatalities included nine hoary bats (52.9% of bat fatalities) and five silver-haired bats (29.4%). One bat fatality was an unidentified Myotis (5.9%) and two (11.8%) were not identifiable to species. The majority of bat fatalities occurred during the fall migration period. The greatest number of bat fatalities found at an individual turbine was two. The hoary bat and silver-haired bat are both classified as sensitive-vulnerable in the State of Oregon.

Searcher efficiency trials were conducted to estimate the proportion of casualties found by searchers. A total of 226 bird carcasses were placed in the field during searcher efficiency trials, with small brown birds used as surrogates for bats. Observer detection rates across all seasons were 78.3% for large birds and 27.5% for small birds. These rates were relatively lower than efficiency rates documented during two years of fatality monitoring at Biglow Canyon Phase I.

Carcass removal trials were conducted to estimate the length of time that a carcass remained in the field for possible detection by searchers. The mean removal rates were 9.71 days for large birds and 3.48 days for small birds. These rates were significantly lower (carcasses were removed faster) than rates documented during fatality monitoring at Biglow Canyon Phase I.

Annual fatality estimates were calculated by adjusting search results for carcass removal, observer detection bias, and the proportion of project turbines searched. The estimated number of bird fatalities per turbine per year was 12.73 (7.72/MW/year). When non-native and introduced species are removed from the analysis, the estimate is 12.19 fatalities per turbine per year (7.39/MW/year). The estimated number of raptor fatalities per turbine per year was 0.33 (0.20/MW/year). The estimated number of bat fatalities for Year 1 was 6.24 (3.78/MW/year). There was no significant statistical difference in fatality rates between lit turbines, unlit turbines, and unlit turbines adjacent to lit turbines.

Since all fatalities found were assumed to be associated with the facility, these figures likely overestimate actual project-related mortality. The estimated Phase II-Year 1 avian and bat fatality rates are higher than those documented at Biglow Canyon Phase I and other wind projects in the Columbia Plateau Ecoregion. The higher estimates were largely due to adjustments based upon results of searcher efficiency and carcass removal trials. This is evidenced by the fact that a total of 44 avian fatalities were found at Biglow Canyon Phase II and the resulting annual estimate was 7.72 birds/MW/year. In comparison, a total of 80 avian fatalities were found at Biglow Canyon Phase I (Year 2) and the resulting annual estimate was 2.47 birds/MW/year. The fatality estimates are likely positively biased due to the searcher efficiency and carcass removal trial results and may not be reflective of actual fatality rates occurring in the Phase II area.

Avian Use and Behavior

The principle objective of the post-construction avian use and behavior study (PWT surveys) was to document bird use and abundance near the Biglow Canyon Phase II wind turbines. The PWT surveys involved 400-m fixed-point surveys conducted for five minutes immediately prior to standardized fatality searches at each of the 50 turbines. A total of 842 PWT surveys were conducted between September 10, 2009 and September 12, 2010.

A total of 2,476 individual birds within 878 separate groups were recorded during the PWT surveys. Thirty unique species were identified, with horned lark (1,009 individuals) being the most common species. Overall bird use was highest during the winter (3.87 birds per plot per survey), followed by fall (1.72), spring (1.37), and summer (1.09). Passerines were the most common birds in all seasons, and were highest in winter (3.52 birds per plot per survey). Raptor use was highest during fall surveys (0.07 birds per point per survey), followed by winter (0.04), summer (0.03) and spring (0.02). Species composition was similar to those documented during similar surveys previously conducted at Biglow Canyon Phase I. For all bird species combined, use was higher in the southeast portion of the Phase II project area. There are no habitat or landscape features that would explain the observed use pattern.

Overall species richness for the PWT surveys was 0.71 species per point per survey, and overall mean use for the surveys was 2.29 birds per point per survey. Species richness and mean use at Phase II was lower than observed during Phase I–Year 2 fatality monitoring, which documented 1.03 species per point per survey and 3.20 birds per point per survey. This is likely due to habitat characteristics in the Phase II project area, which consists almost entirely of cultivated agricultural lands. Raptor use at Phase II was similar to that observed in Phase I.

Four special status bird species were recorded during PWT surveys at Biglow Canyon Phase II, including 20 grasshopper sparrows and one Swainson’s hawk (sensitive-vulnerable), one ferruginous hawk (sensitive-critical), and one golden eagle (Bald and Golden Eagle Protection Act). One white-tailed jackrabbit (sensitive-vulnerable) was observed incidentally.

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1.0 INTRODUCTION

The Biglow Canyon Wind Farm is located in Sherman County, Oregon, approximately 140 miles east of Portland and near the town of Wasco (Figure 1). The Biglow Canyon project is comprised of three phases. Phase I was completed in December 2007 and consists of 76 V82 1.65-megawatt (MW) Vestas wind turbines. Phase II was completed in August 2009 and consists of 65 2.3-MW Siemens wind turbines with an installed capacity of 150 MW. Each Siemens turbine is 415 feet tall (ft; 126 meters [m]) from base to the tip of the fully extended blade. Rotor diameter is 305 ft (93 m) with maximum blade tip speed of 164 miles per hour (mph). Turbines begin producing electricity at wind speeds of nine mph, and shut down at constant wind speeds of 56 mph.

The Site Certificate issued by the State of Oregon Energy Facility Siting Council for the Biglow Canyon Wind Farm requires the certificate holder (Portland General Electric) to implement a Wildlife Monitoring and Mitigation Plan (Plan). The Plan includes a two-year Fatality Monitoring Program and Avian Use and Behavior Surveys which must be implemented to determine whether operation of the facility causes significant fatalities of birds and bats and to determine whether the facility results in a loss of habitat quality.

This report presents the results of the Year 1 (September 10, 2009 through September 12, 2010) post-construction monitoring at Biglow Canyon Phase II, including standardized fatality searches, 5-minute fixed-point avian use surveys, and incidental wildlife observations. The ability to estimate potential for avian fatalities at proposed wind energy facilities has been greatly enhanced by the collection of standardized avian use and fatality data from operational facilities. Relative comparisons of the results of Phase II Year 1 surveys with data from Biglow Canyon Phase I and other regional and local facilities are presented.

2.0 STUDY AREA

The Biglow Canyon Wind Farm, which consists of three phases and encompasses approximately 25,000 acres (39 mi^2; 101 km^2), is located approximately four miles northeast of the town of Wasco, Oregon (Figure 1). The project area is generally bordered by the John Day River canyon to the east and the Columbia River gorge to the north. Elevations in the general project area range from approximately 250 feet above sea level near the mouth of the John Day River to 1,600 feet on the higher ridges (Figures 1 and 2). Biglow Canyon is located in the Columbia Plateau Level III Ecoregion (CPE; Thorson et al. 2003). While native habitats in the CPE historically included arid shrub-steppe and grassland-steppe, much of the ecoregion has been converted to dry land agriculture and rangeland. The Biglow Canyon Phase I Year 1 report (Jeffrey et al. 2009) contains a detailed description of habitat types in the project area.

The Phase II area is located in the southwest portion of the general Biglow Canyon project area. Habitat in the Phase II area consists almost entirely of cultivated agriculture with a few very small patches of CRP, shrub steppe, and developed lands.

3.0 FATALITY MONITORING PROGRAM

3.1 Methods

The primary objective of fatality monitoring was to estimate the number of bird and bat fatalities attributable to collisions with the Phase II wind turbines on an annual basis. Fatality monitoring consisted of four primary components: 1) standardized carcass surveys at select turbines; 2) searcher efficiency trials to estimate the proportion of carcasses found by searchers; 3) carcass removal trials to estimate the length of time that a carcass remains in the field for potential detection by searchers; and 4) statistical analyses including adjusted estimates of annual avian and bat fatality rates at Biglow Canyon Phase II incorporating results of searcher efficiency and carcass removal trials.

There are three scenarios under which avian and bat fatalities were found at Biglow Canyon Phase II: 1) by study personnel during standardized carcass searches; 2) while study personnel were in the project area but not conducting a standardized search (incidental find); and 3) by facility operations and maintenance personnel. All fatalities found by study personnel (regardless of whether found during a standardized search or incidentally) were recorded as described below. Fatalities found in a designated search plot, even if not found during a standardized search, were included in the analyses under the broad assumption that they would have been found during a scheduled search. All bird and bat fatalities found within search plots were recorded and assumed to be turbine casualties for purposes of this study. While this approach likely resulted in an overestimate of the actual number of facility-related fatalities, this is standard protocol for wind energy facilities because of the relatively high costs associated with obtaining accurate estimates of natural or reference mortality (Johnson et al. 2000*a*).

3.1.1 Search Plots

In accordance with the Wildlife Monitoring and Mitigation Plan, Year 1 fatality monitoring was conducted at 50 turbines selected in consultation with ODFW (Figure 3). Square or rectangular plots were established around each of the 50 selected turbines and searched for carcasses. The size of search plots was determined based on maximum tip height of the rotor blade, and measured 125 m from the turbine to the nearest edge of the plot for Phase II turbines (Figure 4). Previous fatality studies conducted at wind energy facilities in the CPE, including Klondike in Sherman County, Oregon (Johnson et al. 2003*b*) and Combine Hills in Umatilla County, Oregon (Young et al. 2005) indicate nearly all turbine-related bird and bat fatalities are found within an area that is roughly equivalent to the maximum turbine height.

3.1.2 Standardized Carcass Searches

Standardized carcass searches were conducted by biologists trained in proper search techniques at each of the 50 turbines selected for Year 1 fatality monitoring. Searchers systematically walked parallel transects while scanning both sides of each transect for bird and bat carcasses. Transects were spaced approximately six meters apart and were established to allow 100% coverage of each search plot. In accordance with the Wildlife Monitoring and Mitigation Plan, standardized searches were conducted at each of the 50 turbines once every two weeks (14 days) during the spring and fall migration periods (March 15 – May 15 and August 15 – October 31, respectively) and once every four weeks (28 days) during the remainder of the year.

All bird and bat carcasses were assigned a unique number and searchers completed a data sheet on which species, sex and age, date and time collected, GPS location, condition, and cause of death were recorded. The location of the carcass was plotted on a detailed map identifying the study plot and nearest wind turbine and photographs were taken of the carcass as found in the field. Once the data was recorded, each carcass was bagged with a copy of the data sheet and stored in a freezer on-site for future reference and possible necropsy. Casualties found outside search plots, or observed within search areas but outside of a formal search, were coded as incidental discoveries and documented in the same manner.

Carcass condition was recorded using the following categories:

- ***Intact*** - a carcass that is completely intact, is not badly decomposed, and shows no sign of being fed upon by a predator or scavenger.
- ***Scavenged*** - an entire carcass, that shows signs of being fed upon by a predator or scavenger, or a portion(s) of a carcass in one location (e.g., wings, skeletal remains, portion of a carcass, etc.), or a carcass that has been heavily infested by insects.
- ***Feather Spot*** - 10 or more feathers (or two or more primaries) at one location indicating predation or scavenging.

3.1.3 Searcher Efficiency Trials

The objective of the searcher efficiency trials was to determine the proportion of carcasses found by searchers, and the results of these trials were used to adjust estimates of annual fatality rates for detection bias. Searcher efficiency trials were conducted simultaneous to fatality searches, and trial results were analyzed to distinguish effects of carcass size and season.

Trial carcasses were randomly placed within fatality search plots by a field supervisor prior to that day's scheduled carcass search. Searchers did not know when trials were being conducted or the location of the searcher efficiency carcasses. Each carcass was discreetly marked so that it could be identified as a trial carcass. The number and location of the searcher efficiency carcasses found by carcass searchers were recorded. Immediately following completion of the search, the field supervisor attempted to find all carcasses not found by searchers to determine whether they were available for detection.

Two carcass size classes (large and small) were utilized and trials were conducted throughout the year to incorporate seasonal effects. Carcasses used for searcher efficiency trials included common species such as house sparrow (*Passer domesticus*), rock pigeon (*Columba livia*), mallard (*Anas platyrhynchos*), and ring necked pheasant (*Phasianus colchicus*). Due to limited availability of bat carcasses, small brown birds were used as surrogates for bats in the trials. Carcasses were placed in a variety of postures to simulate a range of conditions. For example, birds were: 1) placed in an exposed posture (tossed randomly to one side), 2) partially hidden, or 3) mostly hidden to simulate a crippled bird (e.g., placed beneath a shrub or bunch of grass).

3.1.4 Carcass Removal Trials

The objective of carcass removal trails was to estimate the average length of time a carcass remained in the study area and was available for detection, and the results of these trials were used to adjust estimates of annual fatality rates for removal bias. Carcass removal includes removal by predators, scavengers, or other factors (i.e., agricultural activities). Carcass removal trials were conducted throughout the year to incorporate seasonal effects associated with varying weather conditions, farming practices, and scavenger densities. Trials were not conducted in search plots to minimize the chance of confusing a trial bird with a true casualty.

Two size classes of removal trial carcasses (small and large) were randomly placed throughout a plot that was adjacent to a turbine and similar in size to the carcass search plots. Carcasses were discreetly marked for recognition by searchers and other personnel and, similar to searcher efficiency trials, were placed in a variety of postures to simulate a turbine fatality. Personnel conducting carcass searches monitored the trial birds over a 40-day period. In general, carcasses were checked every day for the first four days, and then on days 7, 10, 14, 20, 30, and 40. All carcasses and/or evidence remaining at day 40 were removed.

3.1.5 Statistical Methods

Statistical analyses were conducted on data collected through the fatality monitoring program in order to develop an estimate of total annual bird and bat fatality rates at Biglow Canyon Phase II. Specifically, estimates of facility-related fatalities were developed based upon the following:

(1) the number of fatalities found during standardized carcass searches;

(2) the results of searcher efficiency trials expressed as the proportion of trial carcasses found by searchers;

(3) results of carcass removal trials expressed as the probability that a carcass is expected to remain in the study area and be available for detection by the searchers; and

(4) the proportion of project turbines searched.

Annual fatality estimates were calculated for several categories including all birds, small birds only, large birds only, all raptors, and all bats. In accordance with the Wildlife Monitoring and Mitigation Plan, fatality estimates were also developed for nocturnal avian migrants, raptor species of special concern, target grassland bird species, and state sensitive avian species.

Definition of Variables

The following variables are used in the equations below:

c_i the number of carcasses detected at plot *i* for the study period of interest (e.g., one monitoring year) for which the cause of death is either unknown or is attributed to the facility

n	the number of search plots
k	the number of turbines searched (including the turbines centered within each search plot)
$\bar{c}$	the average number of carcasses observed per turbine per monitoring year
s	the number of carcasses used in removal trials
s_c	the number of carcasses in removal trials that remain in the study area after 30 days
se	standard error (square of the sample variance of the mean)
t_i	the time (in days) a carcass remains in the study area before it is removed, as determined by the removal trials
$\bar{t}$	the average time (in days) a carcass remains in the study area before it is removed, as determined by the removal trials
d	the total number of carcasses placed in searcher efficiency trials
p	the estimated proportion of detectable carcasses found by searchers, as determined by the searcher efficiency trials
I	the average interval between standardized carcass searches, in days
$\hat{\pi}$	the estimated probability that a carcass is both available to be found during a search and is found, as determined by the removal trials and the searcher efficiency trials
m	the estimated annual average number of fatalities per turbine per year, adjusted for removal and searcher efficiency bias

Observed Number of Carcasses

The estimated average number of carcasses ($\bar{c}$) observed per turbine per monitoring year is:

$$\bar{c} = \frac{\sum_{i=1}^{n} c_i}{k} \tag{1}$$

Estimation of Carcass Non-Removal Rates

Estimates of carcass non-removal rates are used to adjust carcass counts for removal bias. Mean carcass removal time ($\bar{t}$) is the average length of time a carcass remains in the study area before it is removed:

$$\bar{t} = \frac{\sum_{i=1}^{s} t_i}{s - s_c} \tag{2}$$

Estimation of Searcher Efficiency Trials

Searcher efficiency rates are expressed as *p,* the proportion of trial carcasses that are detected by searchers in the searcher efficiency trials. These rates are estimated by carcass size and season.

Estimation of Facility-Related Fatality Rates

The estimated per turbine annual fatality rate (*m*) is calculated by:

$$m = \frac{\bar{c}}{\hat{\pi}} \tag{3}$$

where $\hat{\pi}$ includes adjustments for both carcass removal (from scavenging and other means) and searcher efficiency bias. Data for carcass removal and searcher efficiency bias were pooled across the study to estimate $\hat{\pi}$. $\hat{\pi}$ is calculated as follows:

$$\hat{\pi} = \frac{\bar{t} \cdot p}{I} \cdot \left[\frac{\exp\left({}^{I}\!/_{\bar{t}} \right) - 1}{\exp\left({}^{I}\!/_{\bar{t}} \right) - 1 + p} \right] \tag{4}$$

This formula (4) has been independently verified by Shoenfeld (2004). Separate estimates were obtained for migration seasons and other seasons. Then, final estimates were calculated by a weighted average of these estimates by length of season.

The final reported estimates of *m* and associated standard errors and 90% confidence intervals were calculated using bootstrapping (Manly 1997). Bootstrapping is a computer simulation technique that is useful for calculating point estimates, variances, and confidence intervals for complicated test statistics.

For each bootstrap sample, $\bar{c}$, $\bar{t}$, p, $\hat{\pi}$, and m are calculated. A total of 1,000 bootstrap samples were used. The reported estimates are the mathematical means of the 1,000 bootstrap estimates. The standard deviation of the bootstrap estimates is the estimated standard error. The lower 5^{th} and upper 95^{th} percentiles of the 1,000 bootstrap estimates are estimates of the lower limit and upper limit of 90% confidence intervals.

This formula was used because search effort was concentrated (more frequent) during the migration seasons when the search interval was approximately 14 days compared to 28 days during non-migration periods. Therefore, separate estimates were calculated for each search effort pattern and a weighted average was used based on the number of days for the seasons. This estimate more accurately reflects the true value since it accounts for the differences between search efforts and better accounts for the variability due to carcass removal.

3.2 Results

Fifty wind turbines were searched 17 times each for a total of 850 turbine searches during Year 1 fatality monitoring at Biglow Canyon Phase II. A total of 43 bird carcasses and 17 bat carcasses were found during standardized searches (Table 1). Additionally, one bird was found incidentally during this period (Tables 1 and 2). This section describes fatality monitoring results including characteristics of the bird and bat fatalities, and provides fatality estimates adjusted for searcher efficiency and carcass removal biases.

3.2.1 Bird Fatalities

A total of 44 bird carcasses representing 16 species were found during Year 1 fatality monitoring at Biglow Canyon Phase II (Table 2). Of the 44 fatalities, 43 were found during standardized searches and one was found by facility personnel and documented as an incidental fatality. The most common species found as fatalities at Phase II were the horned lark (*Eremophila alpestris*; n=8), golden-crowned kinglet (*Regulus satrap*a; n=5) and ring-necked pheasant (*Phasianus colchicus;* n=4). These species accounted for 46.5% of all fatalities found during searches (Table 2). Eight birds (18.6% of all fatalities) could not be identified to species.

Five raptors were found during standardized searches including two red-tailed hawks (*Buteo jamaicensis*), one American kestrel (*Falco sparverius*), one northern harrier (*Circus cyaneus*), and one prairie falcon (*Falco mexicanus;* Table 2). Additionally, one large bird collected during standardized searches was unidentifiable to species but was classified by searchers as a possible hawk and was included in raptor fatality estimates. One great-horned owl was found incidentally in a search plot by Facility personnel. Cause of death was attributed to collision with a power line based upon location and injuries, and the great-horned owl was not included in raptor fatality estimates in accordance with post-construction monitoring protocol. No fatalities of avian species classified as federal threatened or endangered, state threatened or endangered, or state sensitive (ODFW 2008; USFWS 2010) were documented during Year 1 fatality monitoring at Biglow Canyon Phase II.

Bird fatalities were found at 30 of the 50 turbines searched (60%) in Year 1 (Figure 5). The most fatalities found at any individual turbine were three, which occurred at turbines 307, 314, and 332 (Figure 6). The majority of fatalities (90.8%) were found within 100 m of the turbine (Table 3 and Figure 7). There was no statistically-significant spatial pattern of bird fatalities in the Phase II area.

Fatalities were documented in all seasons, with more than half (52.3%) found during the fall migration period (Table 1; Figure 8). Fatality rates were the same during spring migration and summer periods (18.2%) and lower during winter (11.4%). Cumulatively, the majority of bird fatalities (70%) were found during spring and fall migration periods.

3.2.2 Bat Fatalities

A total of 17 bat fatalities representing three species were found during Year 1 fatality monitoring (Table 2). The hoary bat (*Lasiurus cinereus*; n=9) and silver-haired bat (*Lasionycteris* *noctivagans*; n=5) accounted for 82.3% of all fatalities. The remaining bat fatalities included one unidentified Myotis and two individuals that were not identifiable to species. Both the hoary bat and the silver-haired bat are listed as sensitive-vulnerable by the State of Oregon.

Bat fatalities were found at 14 of the 50 searched turbines (28.0%), and the maximum number of bat fatalities at any turbine was two at turbines 302, 329, and 330 (Figures 9 and 10). Six of the 14 turbines (42.9%) with the most fatalities were located in the northwest portion of the project area. Seven of the 17 fatalities (41.2%) were found in the vicinity turbines 301-303 and 308-310 (Figures 9 and 10).

The majority of bat fatalities (94.1%) were found within 80 m of the search turbine (Table 3 and Figure 11). Most fatalities (88.2%) were found in August and September during the fall migration period (Table 1; Figure 12).

3.2.3 Searcher Efficiency Trials

A total of 226 carcasses (111 large birds and 115 small birds) were placed in the field during searcher efficiency trials (Table 4). Due to the limited availability of bat carcasses, small brown birds were used as a surrogate for bats for most searcher efficiency trials. Across all seasons, observer detection rates were 78.3% for large birds and 27.5% for small birds/bats (Table 4).

3.2.4 Carcass Removal Trials

A total of 160 carcasses (80 large birds and 80 small birds) were placed in the field during carcass removal trials. Estimated mean removal time was 9.71 days for large birds and 3.48 days for small birds (Table 5). By day ten, approximately 90% of the small birds and 60% of large birds had been removed by scavengers (Figure 13).

3.2.5 Adjusted Fatality Estimates

Fatality estimates with standard errors and confidence intervals were calculated for birds and bats (Table 5). The fatality estimates are adjusted based on the corrections for carcass removal rates, observer detection bias, and the proportion of project turbines searched. Based on searcher efficiency and the carcass removal rate at the site, the estimated average probability that a bird casualty would remain in the plot until a scheduled search and would be found during the migration season was 41% for large birds and 6% for small birds. The probability that a carcass would remain and be found during non-migration season was 23% for large birds and 3% for small birds (Table 5).

<u>All Birds</u>

The estimated total number of bird fatalities per turbine per year and associated 90% confidence limits for Phase II–Year 1 monitoring are 12.73 (7.84, 21.50), or 7.72 fatalities/MW/year and 0.035 fatalities/day (Table 5). When non-native and introduced species are excluded from analyses, fatality estimates are 12.19 fatalities/turbine/year, or 7.39 fatalities/MW/year (Table 5).

Large Birds

Large birds included any upland gamebirds, raptors, corvids, waterfowl, and waterbird species. Twelve (12) large bird fatalities were found during the standardized searches (Table 2). The estimated number of large bird fatalities per turbine per year and associated 90% confidence limits for Phase II–Year 1 monitoring are 0.87 (0.49, 1.38), or 0.53 fatalities/MW/year (Table 5). These estimates do not include the great-horned owl found incidentally by Facility personnel.

Small Birds

Thirty-one (31) small bird fatalities were found during the standardized searches (Table 2). The estimated number of small bird fatalities per turbine per year and associated 90% confidence interval limits for Phase II–Year 1 monitoring are 11.86 (7.05, 20.65), or 7.19 fatalities/MW/year (Table 5).

Nocturnal Avian Migrants

The estimated number of nocturnal migrant fatalities per turbine per year and associated 90% confidence limits for Phase II–Year 1 monitoring are 11.86 (7.19, 19.72), or 7.19 fatalities/MW/year (Table 5).

Target Grassland Bird Species

No target grassland bird species were documented as fatalities at Biglow Canyon Phase II during Year 1 monitoring.

State Sensitive Avian Species

No state sensitive avian species were documented as fatalities at Biglow Canyon Phase II during Year 1 monitoring.

Raptors

Six (6) raptor fatalities were recorded during the standardized searches (Table 2). The estimated number of raptors per turbine per year and associated 90% confidence limits for Phase II–Year 1 monitoring are 0.33 (0.09, 0.66), or 0.20 fatalities/MW/year and 0.001 fatalities/day (Table 5).

Raptor Species of Special Concern

No raptor species of special concern were documented as fatalities at Biglow Canyon Phase II during Year 1 monitoring.

Bats

Adjustments for carcass removal and observer detection bias for bats were made using the estimates for small birds. The estimated number of bat fatalities per turbine per year and associated 90% confidence limits for Phase II–Year 1 monitoring are 6.24 (3.45, 11.10), or 3.78 fatalities/MW/year (Table 5).

3.2.6 Turbine Lighting

There has been concern that lights on wind turbines may attract nocturnal avian migrants and bats, and thereby increase the risk of collision for these species (Kerlinger 2005). In accordance with the Wildlife Monitoring and Mitigation Plan, analyses were conducted to evaluate differences in fatality rates of nocturnal avian migrants and bats between lit turbines and unlit turbines, as well as turbines adjacent to unlit turbines. Twenty-five of the 65 turbines at Biglow Canyon Phase II have FAA warning lights. Each warning light is an ORGA/TWT Medium Intensity Red Obstacle Light (Model L350-864-G) and is only activated during evening hours at a flash rate of 20 flashes per minute.

One-way ANOVA analysis was utilized to compare fatality rates at lit turbines, unlit turbines, and unlit turbines adjacent to lit turbines. No statistically-significant differences were found in fatality rates of nocturnal avian migrants (F=1.33; p-value=0.27) or bats (F=2.32; p-value=0.11; Table 6).

4.0 AVIAN USE AND BEHAVIOR STUDIES

4.1 Methods

The primary objective of the avian use and behavior study was to determine post-construction bird use and abundance near project wind turbines, and was designed to document changes in general post-construction bird utilization at Biglow Canyon Phase II. PWT fixed-point bird use surveys were conducted to provide information on the species composition and seasonal use of the project wind turbines.

4.1.1 Bird Use Survey Plots

Fixed-point surveys (circular plots) were conducted following the methods described by Reynolds et al. (1980). These surveys are referred to as project wind turbines (PWT) surveys. PWT fixed-point bird use survey stations were established at each of the 50 standardized carcass search plots (Figure 3). Each PWT plot was a 400-m (1,312 ft) radius circle centered on a fixed location that provided the best viewshed near the wind turbine. Each plot was surveyed by a qualified biologist for a 5-minute period prior to conducting carcass searches.

4.1.2 Bird Survey Methods

Surveys were conducted at various times during daylight hours prior to each standardized carcass search. Observers recorded all bird species detected in a 5-minute period. Observations of birds beyond the 400 m plot radius were recorded but excluded from analyses.

All species of birds observed during fixed-point surveys were recorded, and a unique observation number was assigned to each observation. The date, start, and end time of the survey period, and weather information were recorded for each survey. Species or best possible identification, number of individuals, sex and age class (if possible), distance from plot center when first observed, closest distance, altitude above ground, activity (behavior), and habitat(s) were recorded for each observation. The behavior of each bird observed and the vegetation type in which or over which the bird occurred were recorded based on the point of first observation. Approximate flight height and flight direction at first observation were recorded to the nearest 5 m (16 ft) interval. Other information recorded about the observation included whether or not the observation was auditory only.

4.1.3 Observation Schedule

Survey intensity was designed to document bird use and behavior by habitat and season within the study areas. PWT fixed-point bird use surveys were conducted from September 10, 2009, through September 12, 2010. PWT surveys were not conducted during periods of excessive or abnormal heat, cold, wind (greater than 2 on Beaufort scale), or rain that may reduce the surveyor’s ability to detect bird species. Surveys were conducted simultaneously with carcass searches, and were completed twice a month during spring (March 15 to May 15) and fall (August 15 – October 31) and once a month in the summer (May 16 – August 14) and winter (November 1 – March 14).

4.1.4 Statistical Analysis

Quality Assurance and Quality Control

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

4.1.5 Data Compilation and Storage

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

Bird Diversity and Species Richness

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

Bird Use, Composition, and Frequency of Occurrence

For the standardized fixed-point bird use estimates, only observations of birds detected within the plot were used. Estimates of bird use (i.e., number of birds/plot/survey) were used to compare differences between bird types, seasons, and other wind-energy facilities.

The frequency of occurrence was calculated as the percent of surveys in which a species/bird type was observed. Percent composition was calculated as the proportion of the overall mean use for a particular species/bird type. Frequency of occurrence and percent composition provide relative estimates of species exposure to the wind project. For example, a species may have high use estimates for the site based on just a few observations of large groups; 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. Data were analyzed by comparing use among plots.

4.2 Results

A total of 842 PWT 5-min surveys were conducted between September 10, 2009, and September 12, 2010 (Figure 3; Table 7).

4.2.1 Diversity and Species Richness

A total of 2,476 individual birds within 878 separate groups were recorded during the PWT surveys (Table 8). Thirty unique species were identified, with a mean of 0.71 species per survey (Table 7). The horned lark was the most common species observed (1,009 individuals) and represented 40.8% of all birds observed (Table 8). Canada goose (*Branta canadensis;* 590 individuals; 23.8% of all observations) and European starlings (*Sturnus vulgaris*; 345 individuals; 13.9% of all observations) were other common species. No other individual species accounted for more than approximately four percent of observations during the PWT surveys (Table 8).

4.2.2 Bird Use, Composition, and Frequency of Occurrence by Season

Mean bird use, percent composition, and frequency of occurrence for all bird types recorded during PWT surveys were calculated by season (Table 9). The highest level of overall bird use occurred in the winter (3.87 birds/plot/5-min survey), followed by fall (1.72) spring (1.37), and summer (1.09; Table 9).

<u>Waterfowl</u>

Waterfowl comprised 4.2% of overall bird use and were only recorded during the winter (0.16 birds/plot/5-min survey; Table 9). Waterfowl were recorded during less than 1% of all surveys (Table 9). Canada goose comprised 100% of all waterfowl observations (Table 8).

<u>Diurnal Raptors</u>

Diurnal raptor use was highest during the fall (0.07 birds/plot/5-min survey), followed by winter (0.04), summer (0.03), and spring (0.02; Table 9). Diurnal raptors comprised almost four percent of overall bird use in the fall, about three percent in the spring, and less than two percent in the summer and winter. Diurnal raptors were recorded during 6.5% of fall surveys, 4.4% of winter surveys, 3.3% of summer surveys, and 2.5% of spring surveys (Table 9). Red-tailed hawk (30 individuals) and northern harrier (15 individuals) comprised 69.2% of all raptors observed during PWT surveys. One golden eagle (*Aquila chrysaetos*) was observed.

<u>Passerines</u>

Passerines accounted for 71.6% of all observations and comprised over 90% of all observations in surveys during the four seasons (Table 9). Passerine use was highest in the winter (3.52 birds/plot/5-min survey), followed by fall (1.65), spring (1.35), and summer (1.05). Passerines were recorded during 64.1% of spring surveys, 56.9 % of winter surveys, 50.7% of summer surveys, and 45.8% of fall surveys (Table 9).

4.2.3 Spatial Use

Mean use (number of birds/5-min survey) was plotted by point (turbine number) for all bird species combined as well as primary avian groups (waterfowl, raptors, and passerines) and passerine subtypes (blackbirds/orioles, grassland/sparrows, and corvids; Figures 14a-g). Mean use across all points was largely associated with passerines, particularly with the passerine subtype grassland/sparrows. For all bird species combined, use ranged from 0.47–6.35 birds/survey. Mean use was somewhat higher in the southeast portion of the Phase II project area, where the only three points (turbines 359, 344, and 340) with mean use greater than 4.0 were located (Figure 14a).

4.2.4 Special Status Species

Four special status bird species were recorded during PWT surveys at Biglow Canyon Phase II (Table 10). These included one ferruginous hawk (*Buteo regalis*), a state sensitive-critical species, and one golden eagle, which is protected under the Bald and Golden Eagle Protection Act. Two species listed as state sensitive-vulnerable, grasshopper sparrow (*Ammodramus savannarum*; 20 individuals in one group) and Swainson's hawk (*Buteo swainsoni*; one individual), were also observed (Table 10).

5.0 INCIDENTAL WILDLIFE OBSERVATIONS

5.1 Methods

The objective of incidental wildlife observations was to provide a record of wildlife seen outside of the standardized surveys. All birds, mammals, reptiles, and amphibians were recorded in a similar fashion to standardized surveys. The observation number, date, time, species, number of individuals, sex/age class, distance from observer, activity, height above ground (for bird species), habitat type, and (for sensitive species) the location was recorded by UTM or GPS coordinates.

5.2 Results

A total of 202 birds in three groups were recorded incidentally within the project area (Table 11). These included Canada goose (200 individuals) and two northern harriers. Two mammal species were recorded incidentally, including mule deer (*Odocoileus hemionus;* seven individuals) and one white-tailed jackrabbit (*Lepus townsendii;* Table 11). The white-tailed jackrabbit is classified as state sensitive-vulnerable in Oregon.

6.0 DISCUSSION

6.1 Bird and Bat Mortality

The fatality monitoring program at Biglow Canyon Phase II was designed to provide estimates of annual avian and bat fatality rates that are comparable with other wind energy facilities. Post-construction raptor fatality monitoring data are available from 14 wind energy facilities in the CPE that range from 24 to 300 MW in capacity (Tables 12 and 13). Five of these projects (Condon, Bighorn I, Klondike I and II, and Leaning Juniper I) are located within approximately 40 miles of Biglow Canyon. With the exception of the Condon wind energy facility in Gilliam County, Oregon, where no rigorous monitoring was conducted, all data sets were collected under the same protocols and fatality rates were calculated from standardized carcass searches adjusted for searcher efficiency and carcass removal biases. While the methods and statistical analysis for the other regional studies may have varied, the results are considered comparable because the overall objectives and study components were similar. It is generally believed that the statistical analysis methods have improved over time, resulting in more accurate (less variable) estimates that are more reflective of true conditions.

6.1.1 Potential Biases in Fatality Rate Estimation

The study design incorporates several assumptions or factors that potentially contribute to both positive and negative biases in estimating fatality rates (Erickson 2006). First, all bird casualties found within the standardized search plots during the study were included in the analysis. If carcasses were found incidentally within a search plot during other activities, it was assumed that these carcasses would have been found during scheduled carcass searches. Second, it was assumed that all carcasses found during the study were due to collision with wind turbines. True cause of death is unknown for most of the fatalities, and it is likely that some of the fatalities included in the data pool were caused by predators (e.g., raptors, coyotes), farming or ranching activity, vehicles, or natural causes. The effect of these assumptions is a potential positive bias – the analysis likely provides a conservative estimate (overestimate) of bird fatalities associated with the wind facility. It is unlikely that any of the bat fatalities were due to factors other than interactions with wind turbines.

There are also potential negative biases. For example, no adjustments were made for fatalities possibly occurring outside of the established search plots. The search plot size for this study was based upon the maximum turbine height. This is standard protocol for current fatality monitoring, and is based upon results of studies conducted at wind energy facilities where a distance equal to the approximate height of the turbine captured a very large percentage of fatalities (Erickson et al. 2004; Higgins et al. 1996; Johnson et al. 2002*b*, 2003*a*, 2004; Kerlinger et al. 2007; Young et al. 2003*c*, 2007*a*). Based on the distribution of fatalities as a function of distance from turbines (Figures 7 and 11), a small percentage of fatalities may have fallen outside the search plots and been missed. This factor could lead to an underestimate of bird fatality rates in particular because bat casualties are typically found closer to turbines than birds (e.g., Erickson et al. 2004; Kerlinger and Kerns 2004; Kerlinger et al. 2007; Young et al. 2003*c*). In this study, almost all bat fatalities (94.1%) were found within 80 m of turbines while only

74.9% of bird fatalities were found within 80 m and nearly 10% were found more than 110 m from turbines (Table 3).

Other potential biases are associated with carcasses used in searcher efficiency and carcass removal trials, and specifically whether they are representative of actual bird carcasses. Bias may occur if trial birds are larger or smaller than the carcasses of fatalities, more or less cryptic in color than the actual fatalities, etc. Rock pigeons, European starlings, and house sparrows, and mallards were used to represent the range of bird sizes and characteristics.

Concern has also been raised regarding how the number of carcasses placed in the field for carcass removal trials on a given day could lead to biased estimates of scavenging rates. Hypothetically, this would lead to underestimating true scavenging rates if the scavenger densities are low enough such that scavenging rates for these placed carcasses are lower than for actual fatalities. The logic is that if the trials are based on too many carcasses on a given day, scavengers are unable to access all trial carcasses, whereas they could access all wind turbine collisions. If this is the case, and the trial carcass density is much greater than actual turbine fatality density, the trials would potentially underestimate scavenging rates.

In this study, results of both the searcher efficiency trials and the carcass removal trials had a significant influence on the adjusted estimates of bird and bat fatalities. As previously noted, observer detection rates across all seasons at Biglow Canyon Phase II were 78.3% for large birds and 27.5% for small birds/bats (Table 4). This is somewhat lower than the results of searcher efficiency trials conducted at Biglow Canyon Phase I during Year 1 (90.0% for large birds and 36.8% for small birds/bats; Jeffrey et al. 2009) and Year 2 (93.9% for large birds and 46.2% for small birds/bats; Enk et al. 2010). The lower proportion of trial birds found during searcher efficiency trials during Year 1 fatality monitoring at Biglow Canyon Phase II resulted in a greater adjustment (positive bias) to the fatality estimates compared to previous studies at Biglow Canyon Phase I and other projects in the CPE.

Results of carcass removal trials also likely represented a positive bias for the annual fatality estimates. Estimated mean removal time was 9.71 days for large birds and 3.48 days for small birds/bats. These removal rates were somewhat faster than removal rates at Biglow Canyon Phase I during Year 1 (17.8 days for large birds and 10.1 days for small birds/bats; Jeffrey et al. 2009) and Year 2 (27.7 days for large birds and 16.6 days for small birds/bats; Enk et al. 2010). During this study, approximately 10% of the small bird carcasses and 40% of large bird carcasses remained at day ten of the scavenger removal trials. In comparison, approximately 40% of the small birds and 55% of large birds remained during Year 2 monitoring at Biglow Canyon Phase I (Enk et al. 2010). The faster removal rates documented in this study resulted in a greater adjustment (positive bias) to the annual fatality estimates compared to previous studies at Biglow Canyon Phase I and other projects in the CPE.

Based on searcher efficiency and carcass removal rates, the estimated average probability that a bird casualty would remain in the plot until a scheduled search and would be found was 41% for large birds and 6% for small birds during the migration seasons and 23% for large birds and

3% for small birds during non-migration periods. These results are significantly lower than results for Biglow Canyon Phase I. For example, the percentages for Biglow Canyon Phase I-Year 2 studies were 73% for large birds and 40% for small birds during migration and 61% for large birds and 28% for small birds during non-migration (Enk et al. 2010).

Year 1 fatality estimates developed at Biglow Canyon Phase II included significant adjustments based upon results of the searcher efficiency and carcass removal trials. In this study, a total of 43 fatalities (8 large birds, 31 small birds, and 17 bats) were found during standardized searches. Annual adjusted fatality estimates were 0.53/MW/year for large birds, 7.19 for small birds, and 3.8 for bats. In comparison, a total of 76 fatalities (12 large birds, 68 small birds, and 20 bats) were found during Year 2 searches at Biglow Canyon Phase I with associated adjusted fatality estimates of 0.14 for large birds, 2.33 for small birds, and 0.58 for bats (Enk et al. 2010).

As previously described, searcher efficiency and carcass removal trial results likely represent a significant positive bias to adjusted fatality estimates, which are substantially higher than similar adjusted estimates for calculated for Biglow Canyon Phase I and other wind facilities in the CPE (see discussion below). The observed searcher efficiency and carcass removal rates are likely due to several factors associated with the Biglow Canyon Phase II project area. First, land cover in the Phase II area is primarily cultivated croplands (wheat) and the visibility of carcasses likely changes with crop growth. This may explain why the lowest searcher efficiency rates for small birds occurred in summer, which corresponds with the peak of wheat growth. Second, field personnel have evidence that scavengers, including ravens and coyotes, may be keying into human activity. Given that fatality monitoring was conducted during the previous two years at the adjacent Phase I, scavengers may have correlated human activity with the presence of carcasses which may inflate scavenging rates. Third, the cultivated fields and lack of grass or shrub vegetation likely improves the ability of scavengers to detect carcasses, and may have resulted in inflated scavenging rates compared to Biglow Canyon Phase I.

In summary, while the fatality monitoring program and associated analyses were conducted in accordance with well-defined, standard protocols, the Biglow Canyon Phase II–Year 1 fatality estimates are likely positively biased due to the searcher efficiency and carcass removal trial results and may not be reflective of actual fatality rates occurring in the Phase II area.

6.1.2 Bird Fatalities

The adjusted overall bird fatality rate for the first year fatality monitoring at Biglow Canyon Phase II (including non-native species such as ring-necked pheasant, gray partridge, and rock pigeon) was 12.73 birds per turbine per year (Table 5). This is higher than estimates for Biglow Canyon Phase I–Year 1 (2.90) and Year 2 (4.07) and other wind energy projects in the CPE, including Vansycle (0.63), Kondike I (1.4), Stateline (1.9), Combine Hills (2.56), Bighorn I (3.8), Klondike II (4.7), and Hopkins Ridge (5.4) (Enk et al. 2010; Erickson et al. 2000; Jeffery et al. 2009; Johnson et al. 2003; Erickson et al. 2004; Young et al. 2005; Kronner et al. 2008; NWC and WEST 2007; Young et al. 2007*a*).

However, fatality estimates calculated on a per turbine basis may be misleading when comparing wind energy projects since turbine sizes vary among projects. For example, the Vestas V80 turbines at Hopkins Ridge are 1.8 MW turbines with a rotor swept area of approximately 5,026 m^2 (Young et al. 2003*a*). This is significantly larger than the Mitsubishi MWT-1000A 1.0 MW turbines at Combine Hills, which have a rotor swept area of approximately 2,961 m^2 (Young et al. 2005), and Vestas V-47 0.66kW turbines at Stateline, which have with a rotor swept area of approximately 1,735 m^2 (Erickson et al. 2004). In order to reduce turbine bias and facilitate comparison of fatalities across projects, fatality estimates are typically standardized on a "per MW" basis.

The overall fatality rate for the first year fatality monitoring at Biglow Canyon Phase II (including non-native species) on a per MW basis was 7.72 birds/MW/year (Table 13). This is much higher than Year 1 and Year 2 fatality monitoring at Biglow Canyon Phase I (1.76 and 2.47, respectively) and other wind energy projects in the CPE including Klondike II (3.1), Bighorn I (2.6), Leaning Juniper I (3.2), Nine Canyon I (2.8), and Bighorn I (2.6; Table 13). Based on these comparisons, estimated rates of bird fatality at Biglow Canyon Phase II are higher than other wind projects in the CPE and United States in general. As previously discussed, the adjusted Phase II fatality estimates are likely positively biased based upon the results of searcher efficiency and carcass removal trials, and may overestimate actual fatality rates. There was no apparent spatial pattern to avian fatalities.

Six raptor fatalities documented at Biglow Canyon Phase II during Year 1 monitoring included two red-tailed hawks, one American kestrel, one northern harrier, one prairie falcon, and one great-horned owl (Table 2). None of these species have a special status, and red-tailed hawks are abundant in the CPE and have been a common fatality at CPE wind energy facilities (WEST 2005*a*, 2007; Jeffrey et al. 2009; Enk et al. 2010). The raptor fatality rate was 0.20 birds/MW/year, which is higher than Year 1 and Year 2 monitoring at Biglow Canyon Phase I (0.03; Jeffrey et al. 2009; 0.04; Enk et al. 2010) and other regional wind energy projects, including Bighorn I wind project (0.15) and Klondike II (0.11) and similar to fatality rates at Leaning Juniper I (0.21; Table 13) and other wind farms in the western United States (Table 12).

Species composition of fatalities at Biglow Canyon Phase II during Year 1 monitoring was similar to Biglow Canyon Phase I and other wind energy facilities in the CPE (Johnson and Erickson 2008). Passerines represented 70.4% of all fatalities, with the horned lark being the most common fatality comprising 18.2% of all avian fatalities. As noted below, the horned lark was the most common bird during the PWT surveys. Based upon regional population estimates (Blancher et al. 2007) and anticipated fatality rates, the Biglow Canyon Phase II facility is not likely to have populations-level effects on any avian species.

6.1.3 Bat Fatalities

Two bat species, the silver-haired bat and hoary bat, were documented as fatalities during Year 1 fatality monitoring at Biglow Canyon Phase II (Table 2). The species composition was similar to Biglow Canyon Phase I and other projects in the CPE, where these two species have comprised 93.5% of all documented bat fatalities (Johnson and Erickson 2008). One unidentified Myotis species was also found. As there are seven Myotis species that could occur in the project area, it is difficult to narrow down the identity of this individual. It should be noted that three Myotis species are listed as state sensitive-vulnerable. The majority of bat fatalities were found during the fall during migration period, which is consistent with the other monitoring studies in the CPE and throughout the United States (Cryan et al. 2004). There was no apparent spatial pattern to documented bat fatalities.

The adjusted annual bat fatality rate for Year 1 at Biglow Canyon Phase II (6.24 bats per turbine) is higher than fatality rates documented at Biglow Canyon Phase I Year 1 (3.29) and Year 2 (0.96) and several other wind energy facilities in the CPE including Bighorn I (2.85), Leaning Juniper I (1.28), and Klondike I (1.16) (Enk et al. 2010, Jeffrey et al. 2009, Kronner et al. 2007; Kronner et al. 2008; Johnson et al 2003*a*). On a per MW basis, the Year 1 estimate of 3.78 fatalities is significantly higher than the Year 1 (1.99) and Year 2 (0.58) fatality estimates for Biglow Canyon Phase I and other regional projects such as Bighorn I (1.90), Leaning Juniper I (1.98), and Klondike I (0.77). It is also higher than the average rate for new generation wind projects in the west and Midwest of 2.10 per MW per year (Table 14).

There are potential biases in the estimates because small birds were used as surrogates for the experimental trials; however, the results are consistent with the patterns observed at other wind energy facilities in the Pacific Northwest. As previously discussed, the adjusted fatality estimates are likely positively biased based upon the results of searcher efficiency and carcass removal trials, and may overestimate actual bat fatality rates at Biglow Canyon Phase II.

6.1.4 Turbine Lighting

There has been concern that lights on wind turbines may attract nocturnal avian migrants and bats, and thereby increase the risk of collision for these species (Kerlinger 2000). Previous studies have generally shown no increased risk at lit turbines (Arnett 2005; Erickson et al. 2004; Young et al. 2005). Typically, wind turbines have one light on top of the nacelle and not every turbine in a wind farm is lighted. Lighting on other structures such as communication towers is typically different than lighting at wind turbines because they often have more than one light and therefore, may have a stronger attraction (Kerlinger 2003).

No statistically significant differences were found in fatality rates of nocturnal avian migrants ($F=1.33$; p-value=0.27) or bats ($F=2.32$; p-value=0.11) at lit turbines, unlit turbines, and unlit turbines adjacent to lit turbines (Table 6). Similar results have been found at Biglow Canyon Phase I (Enk et al. 2010, Jeffrey et al. 2009) and other projects in the CPE such as Stateline (Erickson et al. 2004), Nine Canyon (Erickson et al 2002*a*), Wild Horse (Erickson et al. 2008), and Bighorn I (Kronner et al. 2008). No statistical significance has been shown at the meta-analysis level for wind projects in the United States suggesting no differences in fatality rates at lit and unlit turbines (Erickson 2009; Kerlinger et al. 2010).

6.2 Avian Use and Behavior

6.2.1 PWT Avian Use

The results of the PWT avian use surveys were generally similar to PWT surveys previously conducted at Biglow Canyon Phase I. Passerines, and specifically the horned lark, comprised the majority of all PWT observations and the general numbers of birds observed were similar across studies. Species diversity and richness documented in this study were somewhat lower than Phase I, which likely reflects the presence of native grassland habitat in the Phase I project area and the proximity of that area to the John Day River canyon. Seasonal use estimates for all avian groups were generally similar to those recorded previously at Phase I.

6.2.2 PWT Avian Spatial Behavior

Relatively high bird use was observed at a number of turbines during the 5-minute point count (Figure 14a). Mean use was somewhat higher in the southeast portion of the Phase II project area, where the only three points (turbines 359, 344, and 340) with mean use greater than 4.0 were located. There were no physical landscape features that this pattern was attributable to, as most of these turbines are located in flat or undulating terrain although turbine 344 is located closer to a ridge.

Fatalities were generally correlated with observed use at the Phase II turbines based on limited data as only two of four turbines mentioned above (4.0 % of all turbines searched) were used in fatality searches and accounted for four fatalities (9% of all fatalities). The turbine string (341-346; 12% of all turbines searched) were responsible for eight fatalities (18% of all fatalities). Turbine 359 showed the highest bird use but was not included in fatality surveys. Turbine string 360-364 (10% of all turbines searched) were responsible for 6 fatalities (13.6% of all fatalities). Given the predominance of nocturnal migrant species as fatalities, the spatial pattern of fatalities may indicate that migrants first contact turbines in the southeast portion of the Phase II project area.

6.3 Sensitive Species Use

Twenty-one individuals representing two avian species listed as state sensitive-vulnerable and one avian species listed as state sensitive-critical by the State of Oregon were observed during Year 1 studies at Biglow Canyon Phase II (Table 10). The grasshopper sparrow, a state sensitive-vulnerable species, comprised the highest number of individuals observed (20). The other state sensitive-vulnerable species was the Swainson’s hawk (one). The state sensitive-critical species was a ferruginous hawk (one). There were no documented fatalities of any sensitive bird species during Year 1 monitoring.

Fatalities were documented for two state sensitive-vulnerable bat species, the hoary bat (9) and the silver-haired bat (5). These bat fatalities appear to be associated with migrants passing through the project area during fall migration rather than with local breeding populations.

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Table 1. Summary of bird and bat fatalities found during Year 1 at Biglow Canyon Phase II.

Season	Dates	# of visits	# of surveys	# of Turbines Searched	# Bird Species	# Bird Fatalities	# Bat Species	# Bat Fatalities
Fall migration	8/15 to 10/31	6	300	50	11	23	3	15
Winter	11/1 to 3/14	4	200	50	3	5	0	0
Spring migration	3/15 to 5/15	4	200	50	5	8	0	0
Summer	5/16 to 8/14	3	150	50	5	8[1]	1	2
Overall		**17**	**850**	**50**	**16**	**44**	**3**	**17**

[1]= Includes one bird found incidentally by Facility personnel.

Table 2. Species composition of fatalities found during Year 1 monitoring at Biglow Canyon Phase II

Species	Fatalities found at scheduled search plots Total	% Composition	All Fatalities Total	% Composition
horned lark	8	18.6	8	18.2
unidentified bird	7	16.3	7	15.9
golden-crowned kinglet	5	11.6	5	11.4
ring-necked pheasant	4	9.3	4	9.1
gray partridge	2	4.7	2	4.5
northern flicker	2	4.7	2	4.5
red-tailed hawk	2	4.7	2	4.5
rock pigeon	2	4.7	2	4.5
ruby-crowned kinglet	2	4.7	2	4.5
yellow-rumped warbler	2	4.7	2	4.5
American kestrel	1	2.3	1	2.3
black-throated gray warbler	1	2.3	1	2.3
northern harrier	1	2.3	1	2.3
prairie falcon	1	2.3	1	2.3
Townsend's warbler	1	2.3	1	2.3
unidentified large bird	1	2.3	1	2.3
western tanager	1	2.3	1	2.3
great horned owl	0	0	1	2.3
Overall	**43**	**100**	**44**	**100**
hoary bat	9	52.9	9	52.9
silver-haired bat	5	29.4	5	29.4
unidentified Myotis	1	5.9	1	5.9
unidentified bat	2	11.8	2	11.8
Overall	**17**	**100**	**17**	**100**

Table 3. Distances of fatalities from turbines during Year 1 monitoring at Biglow Canyon Phase II.

Distance to Turbine (m)	% Bat Fatalities	% Bird Fatalities
0 – 10	5.9	9.1
11 – 20	5.9	4.5
21 – 30	11.8	15.9
31 – 40	23.5	13.6
41 – 50	17.6	6.8
50 – 60	11.8	9.1
60 – 70	11.8	11.4
70 – 80	5.9	4.5
80 – 90	0	2.3
90 – 100	0	13.6
100 – 110	5.9	0
110 – 120	0	2.3
120 – 130	0	2.3
130 – 140	0	2.3
140 – 150	0	0
150 – 160	0	2.3
>160	0	0

Table 4. Results of Searcher Efficiency trials during Year 1 monitoring at Biglow Canyon Phase II.

Season	# Placed	#Available	#Found	%Found
		Large Birds[1]		
Fall	28	28	19	67.9
Winter	30	29	21	72.4
Spring	22	21	19	90.5
Summer	31	28	24	85.7
Total	**111**	**106**	**83**	78.3
		Small Birds[1]		
Season	**# Placed**	**#Available**	**#Found**	**%Found**
Fall	37	24	7	29.2
Winter	27	13	4	30.8
Spring	18	7	3	42.9
Summer	33	25	5	20.0
Total	**115**	**69**	**19**	27.5

[1] No statistically significant differences between seasons.

Table 5. Adjusted annual bird and bat fatality estimates for Biglow Canyon Phase II–Year 1

		Standard	90% Confidence Interval	
	Estimate	Error	Lower Limit	Upper Limit
Searcher Efficiency Rates				
Large Birds	0.78	0.04	0.72	0.85
Small Birds	0.28	0.05	0.19	0.36
Mean Carcass Removal Time (days)				
Large Birds	9.71	1.26	7.85	11.88
Small Birds	3.48	0.58	2.61	4.49
Available and Detection Probabilities				
Large Birds migration season	0.41	0.04	0.34	0.47
Large Birds other seasons	0.23	0.03	0.18	0.28
Small Birds migration season	0.06	0.02	0.04	0.09
Small Birds other seasons	0.03	0.008	0.02	0.04
Fatality Estimates (#/turbine/yr)				
Large Birds	0.87	0.27	0.49	1.38
Small Birds	11.86	4.31	7.05	20.65
All Birds	12.73	4.31	7.84	21.50
All Birds (without introduced species)	12.19	4.31	7.32	20.88
Nocturnal Migrant Birds	11.86	4.20	7.19	19.72
Target Grassland Birds	0.00	0.00	0.00	0.00
Raptors	0.33	0.17	0.09	0.66
Raptor Species of Special Concern	0.00	0.00	0.00	0.00
State Sensitive Avian Species	0.00	0.00	0.00	0.00
Bats	6.24	2.57	3.45	11.10
Fatality Estimates (#/MW/yr)				
Large Birds	0.53	0.16	0.30	0.84
Small Birds	7.19	2.61	4.27	12.52
All Birds	7.72	2.61	4.75	13.03
All Birds (without introduced species)	7.39	2.61	4.44	12.65
Nocturnal Migrants	7.19	2.55	4.36	11.95
Target Grassland Birds	0.00	0.00	0.00	0.00
Raptors	0.20	0.10	0.05	0.40
Raptor Species of Special Concern	0.00	0.00	0.00	0.00
State Sensitive Avian Species	0.00	0.00	0.00	0.00
Bats	3.78	1.56	2.09	6.73
Daily Estimates (#/day)				
Large Birds	0.002	0.001	0.001	0.004
Small Birds	0.032	0.012	0.019	0.056
All Birds	0.035	0.012	0.021	0.059
All Birds (without introduced species)	0.033	0.012	0.020	0.057
Nocturnal Migrants	0.032	0.011	0.020	0.054
Target Grassland Birds	0.00	0.00	0.00	0.00
Raptors	0.001	<0.001	<0.001	0.002
Raptor Species of Special Concern	0.00	0.00	0.00	0.00
State Sensitive Avian Species	0.00	0.00	0.00	0.00
Bats	0.017	0.007	0.009	0.030

Table 6. Comparison of fatalities at lit turbines, unlit turbines, and unlit turbines adjacent to lit turbines during Year 1 surveys at Biglow Canyon Phase II.

	Lit Turbines	Non-adjacent Unlit Turbines	Adjacent Unlit Turbines	Overall
No. of Turbines	18	15	17	50
Total Number of Bird Casualties	10	18	15	43
Mean Number of Bird Casualties/Turbine	0.56	1.2	0.88	0.86
One-way ANOVA for Bird Fatalities[1]	**F = 2.32** **p-value = 0.11**			
Total number of Bat Casualties	8	2	7	17
Mean Number of Bat Casualties/Turbine	0.44	0.13	0.41	0.34
One-way ANOVA for Bat Fatalities[1]	**F = 1.33** **p-value = 0.27**			

[1] **One-way ANOVA indicate insufficient evidence to conclude that means are statistically significantly different between lit turbines, turbines adjacent to lit turbines, and turbine not adjacent to lit turbines**

Table 7. Species richness (species/plot/5-min survey) and mean use based on Year 1 PWT surveys at Biglow Canyon Phase II

Season	Number of Visits	# Surveys Conducted	# Unique Species	Mean Use	Species Richness
Fall	7	260	21	1.72	0.66
Winter	4	184	17	3.87	0.75
Spring	5	248	8	1.37	0.83
Summer	3	150	8	1.09	0.61
Overall	**19**	**842**	**30**	**2.29**	**0.71**

Table 8. Summary of avian observations during Year 1 PWT surveys at Biglow Canyon Phase II.

		Fall		Winter		Spring		Summer		Total	
Species/Type	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Waterfowl		**0**	**0**	**6**	**590**	**0**	**0**	**0**	**0**	**6**	**590**
Canada goose	*Branta canadensis*	0	0	6	590	0	0	0	0	6	590
Diurnal Raptors		**30**	**30**	**19**	**20**	**9**	**9**	**6**	**6**	**64**	**65**
American kestrel	*Falco sparverius*	0	0	1	1	0	0	0	0	1	1
Cooper's hawk	*Accipiter cooperii*	1	1	0	0	0	0	0	0	1	1
ferruginous hawk	*Buteo regalis*	0	0	1	1	0	0	0	0	1	1
golden eagle	*Aquila chrysaetos*	1	1	0	0	0	0	0	0	1	1
northern harrier	*Circus cyaneus*	4	4	2	2	7	7	2	2	15	15
osprey	*Pandion haliaetus*	1	1	0	0	0	0	0	0	1	1
red-tailed hawk	*Buteo jamaicensis*	17	17	8	9	1	1	3	3	29	30
rough-legged hawk	*Buteo lagopus*	1	1	6	6	0	0	0	0	7	7
sharp-shinned hawk	*Accipiter striatus*	2	2	0	0	0	0	0	0	2	2
Swainson's hawk	*Buteo swainsoni*	0	0	0	0	0	0	1	1	1	1
unidentified buteo		1	1	0	0	0	0	0	0	1	1
unidentified hawk		0	0	1	1	1	1	0	0	2	2
unidentified raptor		2	2	0	0	0	0	0	0	2	2
Owls		**0**	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**1**	**1**
great horned owl	*Bubo virginianus*	0	0	1	1	0	0	0	0	1	1
Doves/Pigeons		**2**	**2**	**1**	**7**	**0**	**0**	**0**	**0**	**3**	**9**
mourning dove	*Zenaida macroura*	1	1	0	0	0	0	0	0	1	1
rock pigeon	*Columba livia*	1	1	1	7	0	0	0	0	2	8
Passerines		**203**	**574**	**183**	**701**	**288**	**341**	**126**	**157**	**800**	**1,773**
Passerines		*4*	*15*	*0*	*0*	*0*	*0*	*0*	*0*	*4*	*15*
unidentified passerine		4	15	0	0	0	0	0	0	4	15
Blackbirds/Orioles		*15*	*142*	*32*	*254*	*48*	*67*	*24*	*25*	*119*	*488*
Brewer's blackbird	*Euphagus cyanocephalus*	0	0	1	30	1	11	2	2	4	43
European starling	*Sturnus vulgaris*	6	128	16	208	1	9	0	0	23	345
western meadowlark	*Sturnella neglecta*	9	14	15	16	46	47	22	23	92	100
Finches		*2*	*21*	*0*	*0*	*0*	*0*	*0*	*0*	*2*	*21*
American goldfinch	*Carduelis tristis*	1	20	0	0	0	0	0	0	1	20
house finch	*Carpodacus mexicanus*	1	1	0	0	0	0	0	0	1	1
Flycatchers		*1*	*1*	*0*	*0*	*0*	*0*	*0*	*0*	*1*	*1*
western kingbird	*Tyrannus verticalis*	1	1	0	0	0	0	0	0	1	1
Grassland/Sparrows		*148*	*350*	*124*	*409*	*219*	*252*	*99*	*126*	*590*	*1,137*
chipping sparrow	*Spizella passerina*	0	0	0	0	1	1	0	0	1	1

Table 8. Summary of avian observations during Year 1 PWT surveys at Biglow Canyon Phase II.

		Fall		Winter		Spring		Summer		Total	
Species/Type	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
dark-eyed junco	*Junco hyemalis*	1	2	0	0	0	0	0	0	1	2
grasshopper sparrow	*Ammodramus savannarum*	0	0	1	20	0	0	0	0	1	20
horned lark	*Eremophila alpestris*	146	347	118	286	218	251	98	125	580	1,009
house sparrow	*Passer domesticus*	0	0	4	99	0	0	1	1	5	100
white-crowned sparrow	*Zonotrichia leucophrys*	1	1	1	4	0	0	0	0	2	5
Thrushes		*3*	*3*	*1*	*1*	*0*	*0*	*0*	*0*	*4*	*4*
American robin	*Turdus migratorius*	1	1	0	0	0	0	0	0	1	1
mountain bluebird	*Sialia currucoides*	1	1	0	0	0	0	0	0	1	1
varied thrush	*Ixoreus naevius*	1	1	1	1	0	0	0	0	2	2
Corvids		*30*	*42*	*26*	*37*	*21*	*22*	*3*	*6*	*80*	*107*
common raven	*Corvus corax*	30	42	26	37	21	22	3	6	80	107
Unidentified Birds		**2**	**12**	**1**	**25**	**0**	**0**	**1**	**1**	**4**	**38**
unidentified bird		2	12	1	25	0	0	1	1	4	38
Overall		**237**	**618**	**211**	**1,344**	**297**	**350**	**133**	**164**	**878**	**2,476**

Table 9. Mean avian use (number of birds/plot/5-min survey), composition, and frequency of occurrence by season during Year 1 PWT surveys at Biglow Canyon Phase II.

	Mean Avian Use				% Composition				% Frequency			
Species/Type	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer
Waterfowl	**0**	**0.16**	**0**	**0**	**0**	**4.2**	**0**	**0**	**0**	**0.5**	**0**	**0**
Diurnal Raptors	**0.07**	**0.04**	**0.02**	**0.03**	**3.8**	**1.1**	**1.8**	**3.1**	**6.5**	**4.4**	**2.5**	**3.3**
Owls	**0**	**<0.01**	**0**	**0**	**0**	**0.1**	**0**	**0**	**0**	**0.5**	**0**	**0**
Doves/Pigeons	**<0.01**	**0**	**0**	**0**	**0.3**	**0**	**0**	**0**	**0.6**	**0**	**0**	**0**
Passerines	**1.65**	**3.52**	**1.35**	**1.05**	**95.9**	**90.8**	**98.2**	**96.3**	**45.8**	**56.9**	**64.1**	**50.7**
Passerines	*<0.01*	*0*	*0*	*0*	*0.3*	*0*	*0*	*0*	*0.6*	*0*	*0*	*0*
Blackbirds/Orioles	*0.13*	*1.23*	*0.27*	*0.17*	*7.3*	*31.7*	*19.5*	*15.3*	*4.0*	*11.1*	*14.1*	*11.3*
Finches	*0.06*	*0*	*0*	*0*	*3.5*	*0*	*0*	*0*	*0.6*	*0*	*0*	*0*
Grassland/Sparrows	*1.32*	*2.16*	*1.02*	*0.84*	*76.7*	*55.7*	*73.9*	*77.3*	*40.8*	*46.6*	*58.6*	*43.3*
Thrushes	*<0.01*	*<0.01*	*0*	*0*	*0.3*	*0.1*	*0*	*0*	*0.6*	*0.5*	*0*	*0*
Corvids	*0.13*	*0.13*	*0.07*	*0.04*	*7.7*	*3.3*	*4.8*	*3.7*	*9.7*	*6.6*	*6.2*	*2.0*
Unidentified Birds	**0**	**0.14**	**0**	**<0.01**	**0**	**3.7**	**0**	**0.6**	**0**	**0.6**	**0**	**0.7**
Overall	**1.72**	**3.87**	**1.37**	**1.09**	**100**	**100**	**100**	**100**				

Table 10. Special status species observed during PWT surveys and incidentally during Year 1 monitoring at Biglow Canyon Phase II.

			PWT		Incidental		Total	
Species	**Scientific Name**	**Status[1]**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
grasshopper sparrow	*Ammodramus savannarum*	SV	1	20	0	0	1	20
ferruginous hawk	*Buteo regalis*	SC	1	1	0	0	1	1
golden eagle	*Aquila chrysaetos*	EA	1	1	0	0	1	1
Swainson's hawk	*Buteo swainsoni*	SV	1	1	0	0	1	1
Bird Subtotal	**4 species**		**4**	**23**	**0**	**0**	**0**	**0**
white-tailed jackrabbit	*Lepus townsendii*	SV	0	0	1	1	1	1
Total	**5 species**		**4**	**23**	**1**	**1**	**5**	**24**

[1] **SC = State sensitive-critical; SV = State sensitive-vulnerable; EA = Bald and Golden Eagle Protection Act**

Table 11. Wildlife species observed incidentally while conducting Year 1 surveys at Biglow Canyon Phase II.

Species	Scientific Name	# grps	# obs
Canada goose	*Branta canadensis*	1	200
northern harrier	*Circus cyaneus*	2	2
Bird Subtotal	**2 species**	**3**	**202**
mule deer	*Odocoileus hemionus*	1	7
white-tailed jackrabbit	*Lepus townsendii*	1	1
Mammal Subtotal	**2 species**	**2**	**8**

Table 12. Comparison of raptor use estimates and raptor mortality at wind energy facilities in North America.

Wind Energy Facility	Use Estimate[A]	Raptor Fatality[B]	No. of Turbines	Total MW
Biglow Canyon Phase II, OR		0.20	65	149.5
Western				
Zintel, WA	0.43	0.05	38	50
Leaning Juniper, OR	0.52	0.21	67	100.5
High Winds, CA	2.34	0.39	90	162
Diablo Winds, CA	2.16	0.87	31	20
SMUD, CA		0.53	22	15
Big Horn, WA	0.51	0.15	133	199.5
Hopkins Ridge, WA	0.70	0.14	83	150
Klondike II, OR	0.50	0.11	50	75
Stateline, OR/WA (2002)	0.23	0.09	454	300
Stateline, OR/WA (2003)	0.21	0.09	454	300
Wild Horse, WA	0.29	0.09	127	229
Klondike III, OR		0.06	122	375
Nine Canyon, WA		0.05	37	48
Marengo II, WA		0.05	39	70.2
Biglow Canyon I, OR (Year 2)		0.04	76	125.4
Biglow Canyon I, OR (Year 1)		0.03	76	125.4
Marengo I, WA		0	78	140.4
Combine Hills, OR	0.75	0	41	41
Dillon, CA		0	45	45
Klondike, OR	0.50	0	16	24
Vansycle, OR	0.66	0	38	24.9
Rocky Mountains				
Judith Gap, MT		0.09	90	135
Summerview, Alb. (2005/2006)		0.11	39	70.2
Foote Creek Rim, WY (Phase I; 1999)		0.08	69	41.4
Foote Creek Rim, WY (Phase I; 2000)		0.05	69	41.4
Foote Creek Rim, WY (Phase I; 2001/2002)		0	69	41.4
Midwest				
NPPD Ainsworth, NE		0.06	36	59.4
Wolfe Island, Ont.		0.04	86	197.8
Buffalo Ridge, MN	0.64	0.02	281	210.75
Blue Sky Green Field, WI		0	88	145
Southern Plains				
Buffalo Gap, TX		0.10	67	134

Table 12. Comparison of raptor use estimates and raptor mortality at wind energy facilities in North America.

Northeastern			
Noble Ellenburg, NY (2009)	0.49	54	80
Noble Ellenburg, NY (2008)	0.32	54	80
Noble Clinton, NY (2008)	0.29	67	100
Maple Ridge, NY (2007)	0.25	195	321.75
Noble Clinton, NY (2009)	0.24	67	100
Noble Bliss, NY (2008)	0.19	67	100
Noble Bliss, NY (2009)	0.18	67	100
Maple Ridge, NY (2006)	0.04	120	198
Buffalo Mountain, TN (2006)	0	18	29
Buffalo Mountain, TN (2000-2003)	0	3	1.98
Mount Storm, WV (2008)	0	82	164

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

Facility	Use Estimate	Mortality Estimate	Facility	Use Estimate	Mortality Estimate
Zintel, WA	Erickson et al. 2002	Kronner et al. 2008	Buffalo Ridge, MN	Erickson et al. 2002b	Erickson et al. 2002b
Leaning Juniper, OR		NWC 2008	Buffalo Gap, TX		Tierney 2007
High Winds, CA	Kerlinger et al. 2005	Kerlinger et al. 2006	Noble Ellenburg, NY (2009)		Jain et. al 2010
Diablo Winds, CA	WEST 2006	WEST 2008	Noble Ellenburg, NY (2008)		Jain et. al 2009
SMUD, CA		URS, Erickson et al. 2005	Noble Clinton, NY (2008)		Jain et. al 2009
Big Horn, WA	Johnson and Erickson 2004	Kronner et al. 2008	Maple Ridge, NY (2007)		Jain et al. 2008
Hopkins Ridge, WA	Young et al. 2003	Young et al. 2007	Noble Clinton, NY (2009)		Jain et. al 2010
Klondike II, OR	Johnson 2004	NWC and WEST 2007	Noble Bliss, NY (2008)		Jain et. al 2009
Stateline, OR/WA (2002)	Erickson et al. 2002	Erickson et al. 2004	Noble Bliss, NY (2009)		Jain et. al 2010
Stateline, OR/WA (2003)	Erickson et al. 2002	Erickson et al. 2004	Maple Ridge, NY (2006)		Jain et al. 2007
Wild Horse, WA	Erickson et al. 2003	Erickson et al. 2008	Buffalo Mountain, TN (2006)		Fiedler et al. 2007
Klondike III, OR		Gritski et al. 2009	Buffalo Mountain, TN (2000-2003)		Nicholson 2003, Nicholson 2005
Nine Canyon, WA		Erickson et al. 2003	Mount Storm, WV (2008)		Young et. al 2009
Combine Hills, OR	Young et al. 2003	Young et al. 2006	Marengo I, WA (2009)	URS 2010	Marengo I, WA (2009)
Dillon, CA		Chatfield et al. 2009	Marengo II, WA (2009)	URS 2010	Marengo II, WA (2009)
Klondike, OR	Johnson et al. 2002	Johnson et al. 2003	Biglow Canyon I, OR (2008)	Jeffrey et al. 2009	Biglow Canyon I, OR (2008)
Vansycle, OR	WCIA and WEST 1997	Erickson et al. 2000	Biglow Canyon I, OR (2009)	Enk et al. 2010	Biglow Canyon I, OR (2009)
Judith Gap, MT		TRC 2008			
Summerview, Alb. (2005/2006)		Brown and Hamilton 2006			
Foote Creek Rim, WY (Phase I; 1999)		Young et al. 2003			
Foote Creek Rim, WY (Phase I; 2000)		Young et al. 2003			
Foote Creek Rim, WY (Phase I; 2001/2002)		Young et al. 2003			
NPPD Ainsworth, NE		Derby et al. 2007			
Wolfe Island, Ont.		Stantec 2010			

Table 13. Fatality estimates for wind energy projects in the Columbia River Plateau.

Project	Fatality Rate (#/MW/study period)			Source
	Raptors	All Birds	Bats	
Biglow Canyon Phase II, OR	**0.20**	**7.72**	**3.78**	**This report**
Biglow Canyon I, OR (Yr. 2)	0.04	2.47	0.58	Enk et al. 2010
Biglow Canyon I, OR (Yr. 1)	0.03	1.76	1.99	Jeffrey et al. 2009
Wild Horse, WA	0.09	1.60	0.40	Erickson et al. 2008
Bighorn I, WA	0.15	2.60	1.90	Kronner et al. 2008
Combine Hills, OR	0.00	2.60	1.90	Young et al. 2005
Hopkins Ridge I, WA (2006)	0.14	1.20	0.60	Young et al. 2007
Klondike I, OR	0.00	0.90	0.80	Johnson et al. 2003
Klondike II, OR	0.11	3.10	0.40	NWC and WEST 2007
Klondike III, OR	0.06	3.55	1.33	Gritski et al. 2009
Leaning Juniper, OR	0.06	3.20	0.90	Kronner et al. 2007
Nine Canyon, WA	0.05	2.80	2.50	Erickson et al. 2003
Stateline, OR/WA	0.10	2.40	1.70	Erickson et al. 2004, 2007
Condon, OR	0.02[a]	0.05[a]	n/a	Fishman 2003
Vansycle, OR	0.00	1.00	1.10	Erickson et al. 2000

[a]= not adjusted for searcher efficiency or carcass removal; study methods differed from other projects and were not as rigorous; therefore this estimate should be regarded as a minimum fatality estimate.

Table 14. Bat fatalities at wind energy facilities in North America by geographic region.[1]

Wind Energy Facility	Bat Use Estimate[A]	Fatality Estimate[B]	No. of Turbines	Total MW
Biglow Canyon Phase II		**3.78**	**65**	**149.5**
	Western			
Stateline, OR/WA (2003)		2.52	454	300
High Winds, CA (2004)		2.51	90	162
Nine Canyon, WA		2.47	37	48
Dillon, CA		2.17	45	45
Biglow Canyon I, OR (Year 1)		1.99	76	125.4
Leaning Juniper, OR		1.98	67	100.5
Big Horn, WA		1.90	133	199.5
Combine Hills, OR		1.88	41	41
High Winds, CA (2005)		1.52	90	162
Stateline, OR/WA (2002)		1.20	454	300
Vansycle, OR		1.12	38	24.9
Klondike, OR		0.77	16	24
Hopkins Ridge, WA		0.63	83	150
Biglow Canyon I, OR (Year 1)		0.58	76	125.4
Klondike II, OR		0.41	50	75
Wild Horse, WA		0.39	127	229
Marengo II, WA		0.27	39	70.2
Marengo I, WA		0.17	78	140.4
SMUD, CA		0.07		15
	Rocky Mountains			
Summerview, Alb. (2006)	7.6	14.62	39	70.2
Summerview, Alb. (2005/6)		10.27	39	70.2
Judith Gap, MT		8.93	90	135
Summerview, Alb. (2007)		8.23	39	70.2
Foote Creek Rim, WY (Phase I; 1999)		3.97	69	41.4
Foote Creek Rim, WY (Phase I; 2001/2)		1.57	69	41.4
Foote Creek Rim, WY (Phase I; 2000)	2.2	1.05	69	41.4
	Midwest			
Blue Sky Green Field, WI	7.7[D]	24.57	88	145
Top of Iowa, IA (2004)	34.9[C]	10.27	89	80
Top of Iowa, IA (2003)	34.9[C]	7.16	89	80
Kewaunee County, WI		6.55	31	20
Buffalo Ridge, MN (Phases II&III; 2001)	2.2	4.03	281	210.75
Crescent Ridge, IL		3.27	33	49.5
Buffalo Ridge, MN (Phase III; 1999)		2.72	138	103.5
Buffalo Ridge, MN (Phase II; 1999)		2.59	143	107.25
Buffalo Ridge, MN (Phase II; 1998)		2.16	143	107.25
Buffalo Ridge, MN (Phases II&III; 2002)	1.9	1.73	281	210.75
NPPD Ainsworth, NE		1.16	36	59.4
Buffalo Ridge, MN (Phase I; 1999)		0.76	73	25
	Southern Plains			
Oklahoma Wind Energy Center, OK		0.53	68	102
Buffalo Gap, TX		0.10	67	134

Table 14. Bat fatalities at wind energy facilities in North America by geographic region.[1]

	Northeastern			
Buffalo Mountain, TN (2006)		39.70	18	29
Mountaineer, WV	38.3	31.69	44	66
Buffalo Mountain, TN (2000-2003)	23.7	31.54	3	2
Meyersdale, PA		18.00	20	30
Cohocton/Dutch Hill, NY		16.02	50	125
Casselman, PA		15.66	23	34.5
Maple Ridge, NY (2006)		15.00	120	198
Noble Bliss, NY (2008)		14.66	67	100
Mount Storm, WV (2008)	35.2	12.11	82	164
Maple Ridge, NY (2007)		9.42	195	321.75
Noble Clinton, NY (2009)		6.48	67	100
Wolfe Island, Ont.		6.42	86	197.8
Noble Bliss, NY (2009)		5.50	67	100
Noble Ellenburg, NY (2008)		5.45	54	80
Noble Ellenburg, NY (2009)		5.34	54	80
Ripley, Ont.		4.67	38	76
Noble Clinton, NY (2008)		3.63	67	100
Mars Hill, ME (2007)		2.91	28	42
Stetson Mountain, ME	0.30	1.40	38	57
Munnsville, NY		0.46	23	34.5
Mars Hill, ME (2008)		0.45	28	42

A=bat passes per detector night
B=number of bat fatalities/MW/study period
C=averaged across phases and/or study years, and may not be directly related to mortality estimates
D=bat activity not measured concurrently with bat mortality studies
Data from the following sources:

Facility	Use Estimate	Mortality Estimate	Facility	Use Estimate	Mortality Estimate
High Winds, CA (2004)		Kerlinger 2006	Crescent Ridge, IL		Kerlinger et al. 2007
Stateline, OR/WA (2003)		Erickson et al. 2004	Buffalo Ridge, MN (Phase III)		Johnson et al. 2004
Nine Canyon, WA		Erickson et al. 2003b	Buffalo Ridge, MN (Phase II; 1999)	Johnson et al. 2000	Johnson et al. 2004
Big Horn, WA		Kronner et al. 2008	Buffalo Ridge, MN (Phase II; 1998)	Johnson et al. 2000	Johnson et al. 2004
Combine Hills, OR		Young et al. 2006	NPPD Ainsworth, NE		Derby et al. 2007
High Winds, CA (2005)		Kerlinger 2006	Buffalo Ridge, MN (Phase I)		Johnson et al. 2000
Stateline, OR/WA (2002)		Erickson et al. 2004	Oklahoma Wind Energy Center, OK		Piorkowski 2006
Vansycle, OR		Erickson et al. 2000	Buffalo Gap, TX		Tierney 2007
Klondike, OR		Johnson et al. 2003b	Buffalo Mountain, TN (2006)		Fiedler et al. 2007
Hopkins Ridge, WA		Young et al. 2007	Mountaineer, WV	Arnett (pers comm. 2005)	Kerns and Kerlinger 2004
Klondike II, OR		NWC and WEST 2007	Buffalo Mountain, TN (2000-2003)	Fiedler 2004	Nicholson 2005
Wild Horse, WA		Erickson et al. 2008	Meyersdale, PA		Arnett et al. 2005
SMUD, CA		URS, Erickson et al. 2005	Casselman, PA		Arnett et al. 2009
Summerview, Alb. (2006)	Baerwald 2008	Baerwald 2008	Maple Ridge, NY (2006)		Jain et al. 2007
Summerview, Alb. (2005/6)		Brown and Hamilton 2006	Noble Bliss, NY (2008)		Jain et. al 2009
Judith Gap, MT		TRC 2008	Mount Storm, WV (2008)	Young et. al 2009	Young et. al 2009
Summerview, Alb. (2007)		Baerwald 2008	Maple Ridge, NY (2007)		Jain et al. 2008
Foote Creek Rim, WY (Phase I; 1999)		Young et al. 2003b	Noble Ellenburg, NY (2008)		Jain et. al 2009
Foote Creek Rim, WY (Phase I; 2001/2)	Gruver 2002	Young et al. 2003b	Noble Clinton, NY (2008)		Jain et. al 2009
Foote Creek Rim, WY (Phase I; 2000)	Gruver 2002	Young et al. 2003b	Mars Hill, ME (2007)		Stantec 2008b
Top of Iowa, IA (2004)	Jain 2005	Jain 2005	Kewaunee County, WI		Howe et al. 2002
Top of Iowa, IA (2003)	Jain 2005	Jain 2005	Stetson Mountain, ME	Stantec 2009	Stantec 2009
Blue Sky Green Field, WI	Gruver 2008	Gruver et al. 2010	Noble Bliss, NY (2009)		Jain et. al 2010
Dillon, CA		Chatfield et al. 2009	Noble Clinton, NY (2009)		Jain et. al 2010
Cohocton/Dutch Hill, NY		Stantec 2010	Noble Ellenburg, NY (2009)		Jain et. al 2010
Munnsville, NY		Stantec 2009	Ripley, Ont.		Stantec 2009
Buffalo Ridge, MN (Phases II&III; 2001)	Johnson et al. 2004	Johnson et al. 2004	Wolfe Island, Ont.		Stantec 2010
Buffalo Ridge, MN (Phases II&III; 2002)	Johnson et al. 2004	Johnson et al. 2004	Marengo I, WA (2009)		URS 2010
Biglow Canyon I, OR (2008)		Jeffrey et al. 2009	Marengo II, WA (2009)		URS 2010
Biglow Canyon I, OR (2009)		Enk et al. 2010	Mars Hill (2008)		Stantec 2009

[1] Bat use rates are included where available. To date, not bat fatality estimates from southwestern or southeastern wind facilities have been made public.

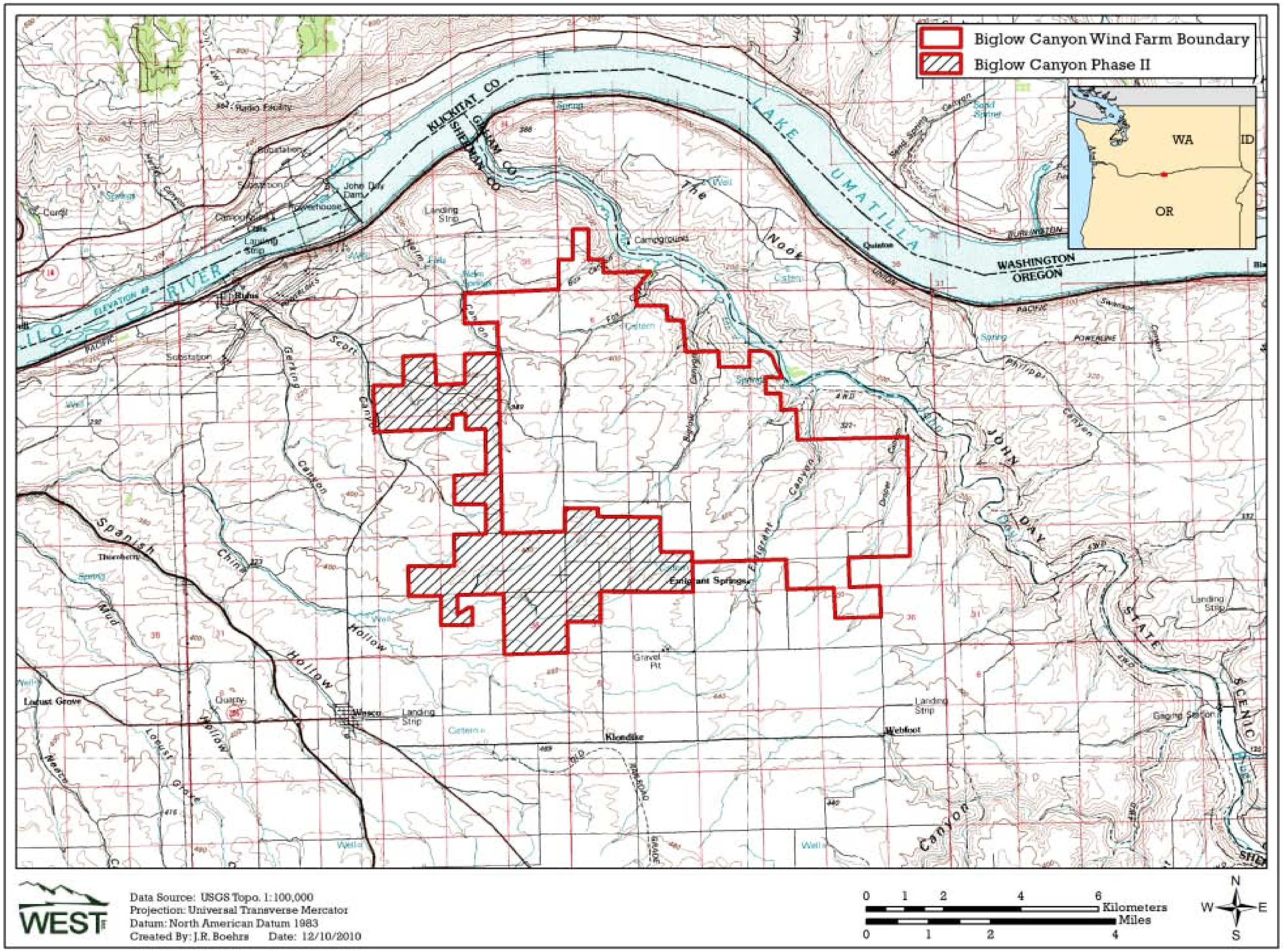

Figure 1. Location of Biglow Canyon Wind Farm –Phase II Project Area.

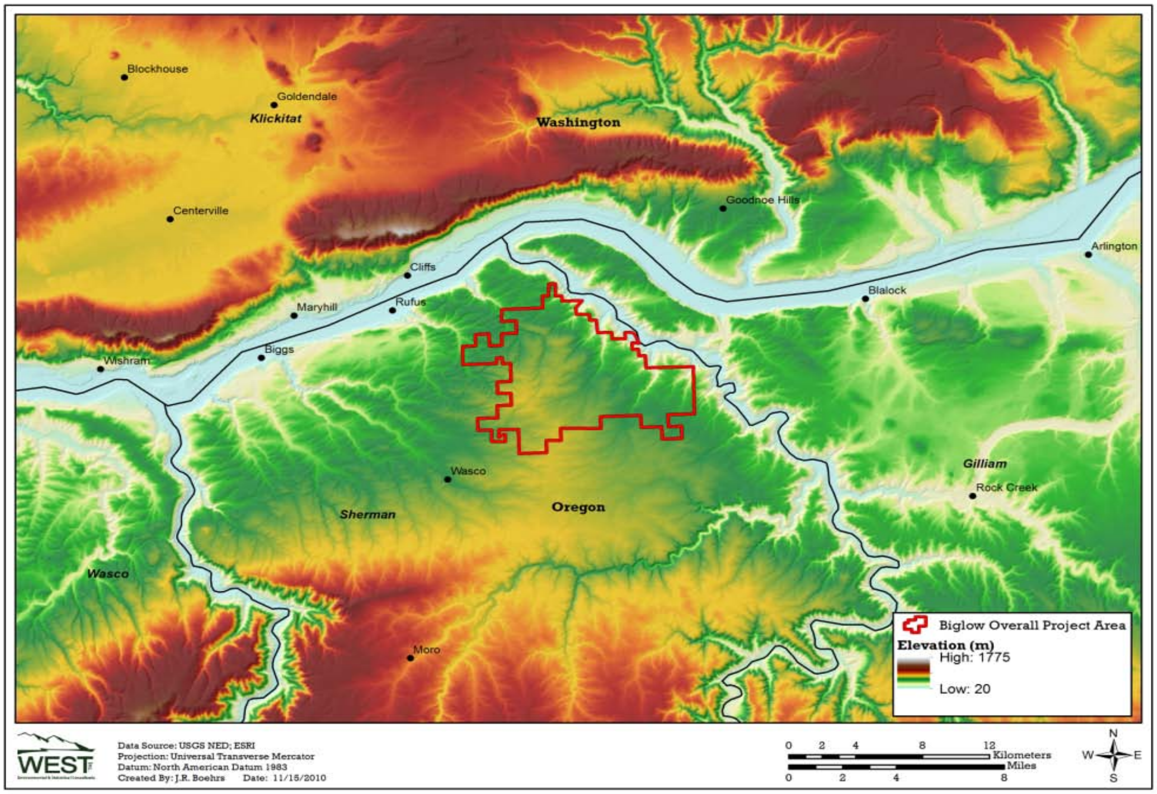

Figure 2. Topography of Biglow Canyon Wind Farm.

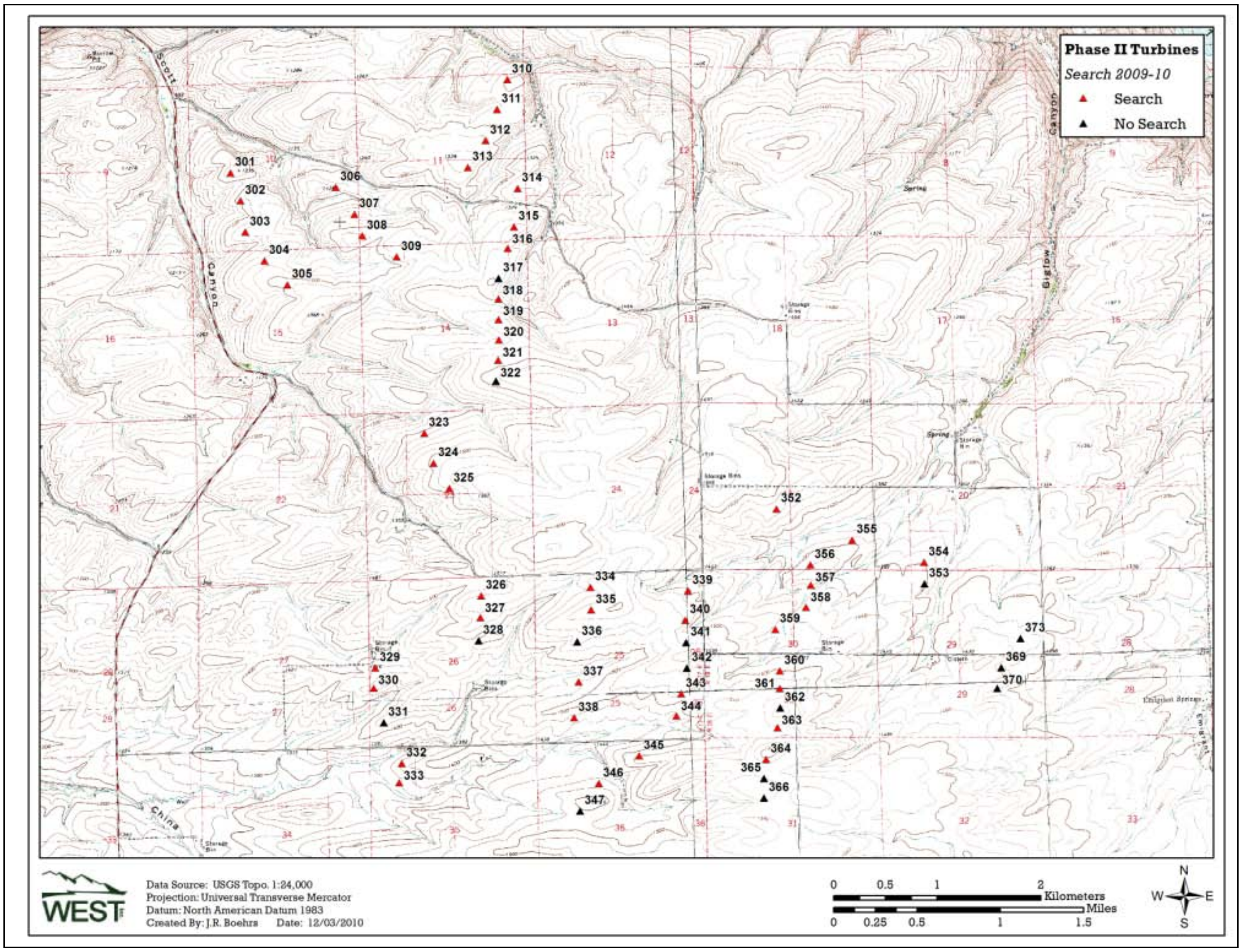

Figure 3. Turbines searched during Year 1 fatality monitoring at Biglow Canyon Wind Farm Phase II.

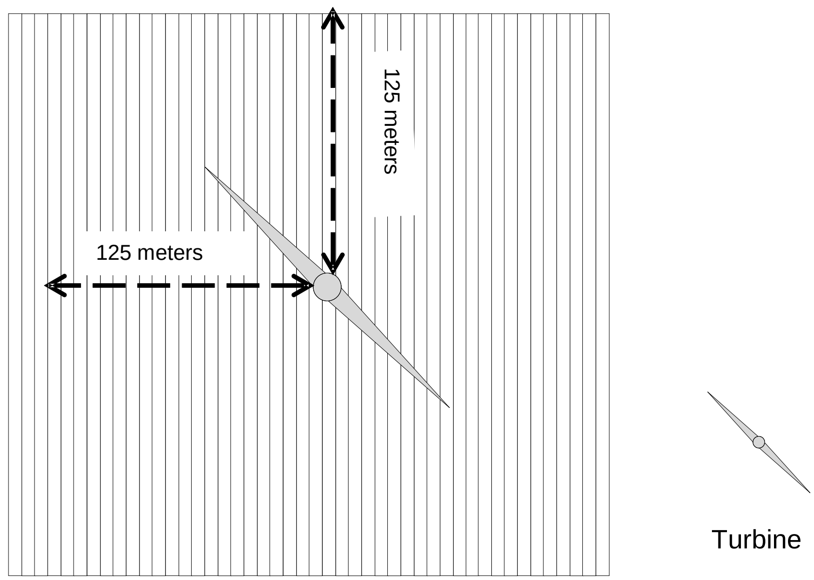

Figure 4. Illustration of search plots and search transects used at the Biglow Canyon Wind Farm Phase II.

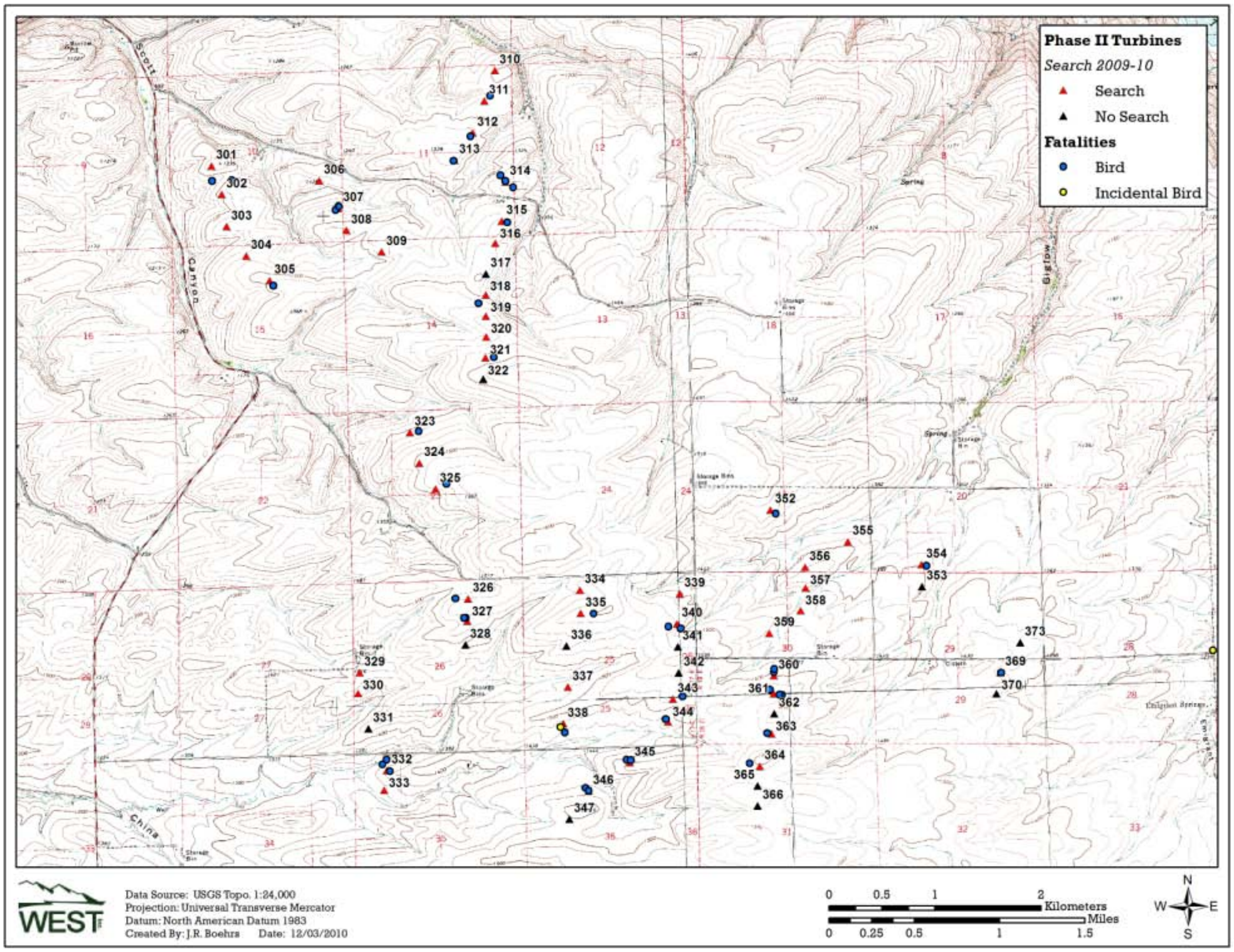

Figure 5. Locations of bird fatalities found during Year 1 monitoring at Biglow Canyon Phase II.

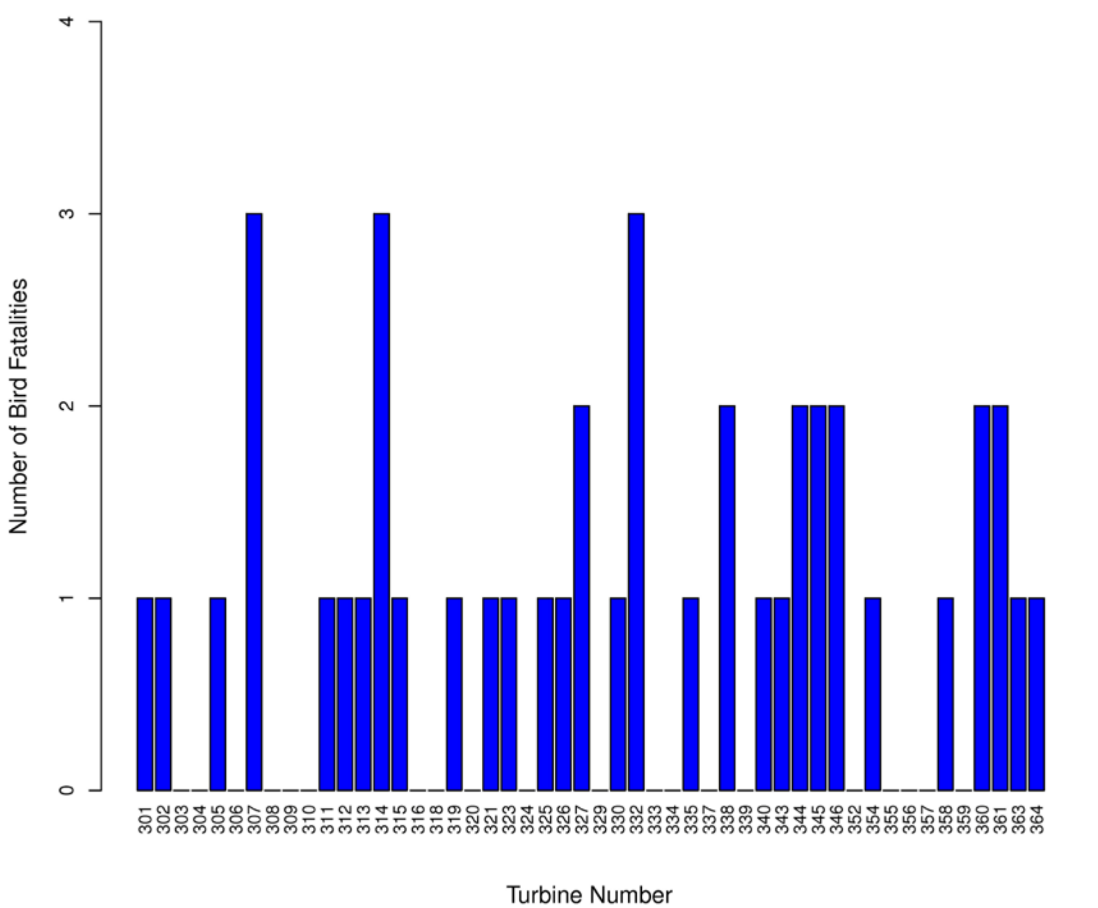

Figure 6. Number of bird fatalities by turbine found during Year 1 monitoring at Biglow Canyon Phase II.

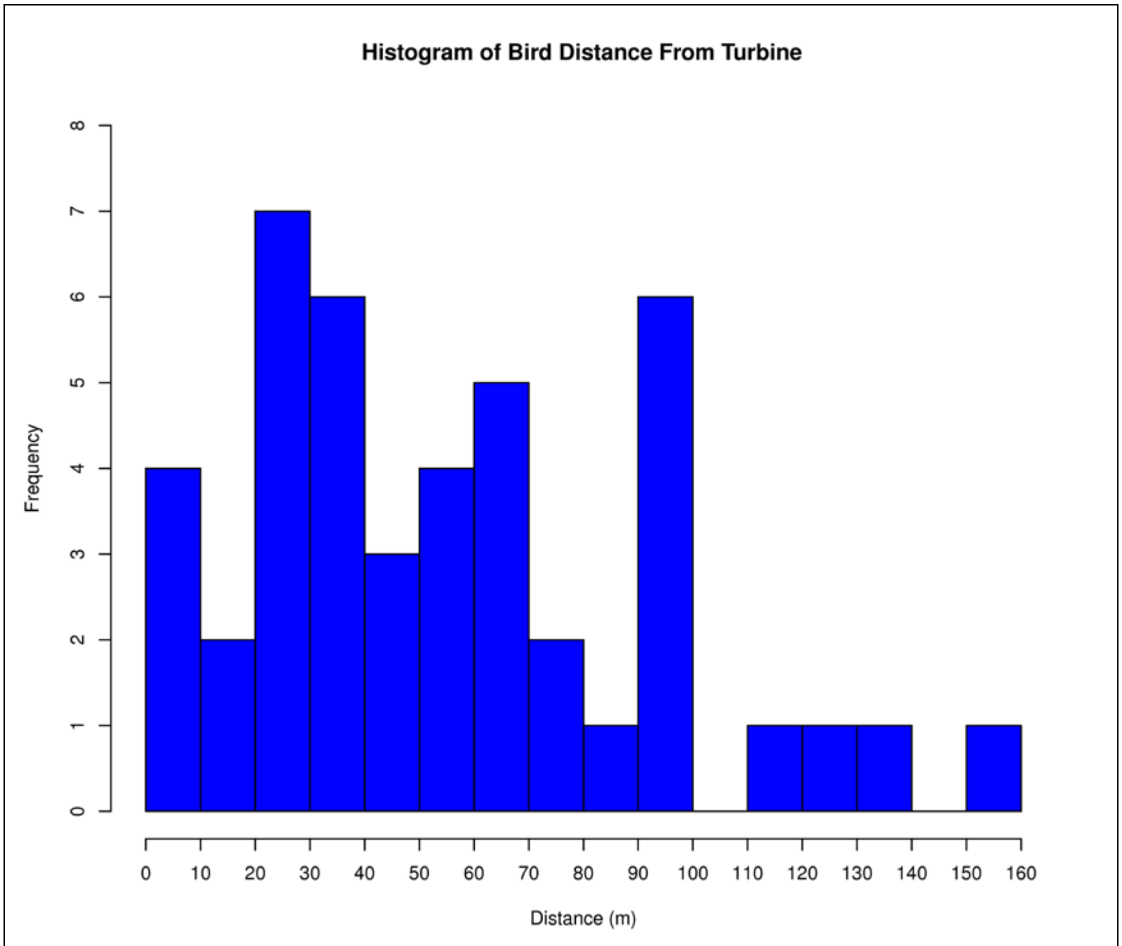

Figure 7. Distance of bird fatalities from turbines during Year 1 monitoring Biglow Canyon Phase II.

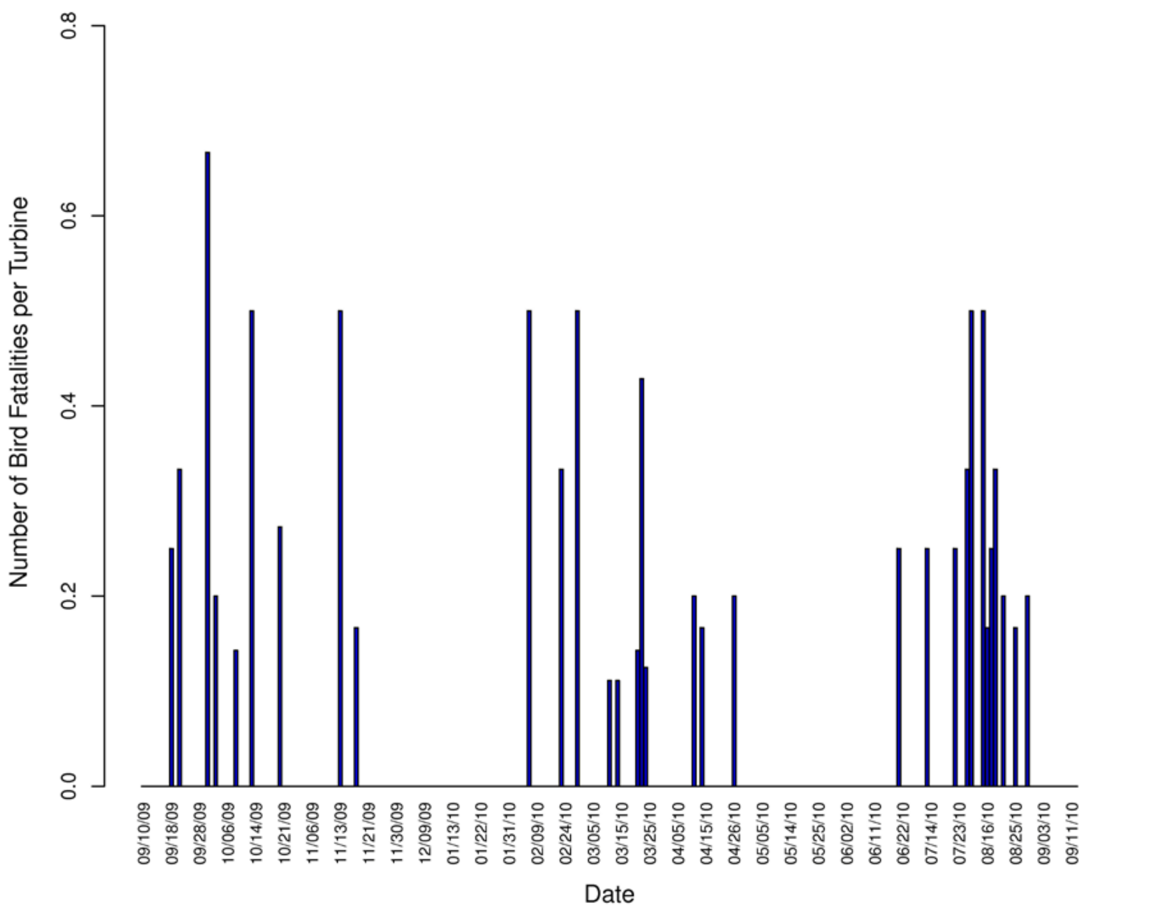

Figure 8. Timing of bird fatalities during Year 1 monitoring at Biglow Canyon Phase II

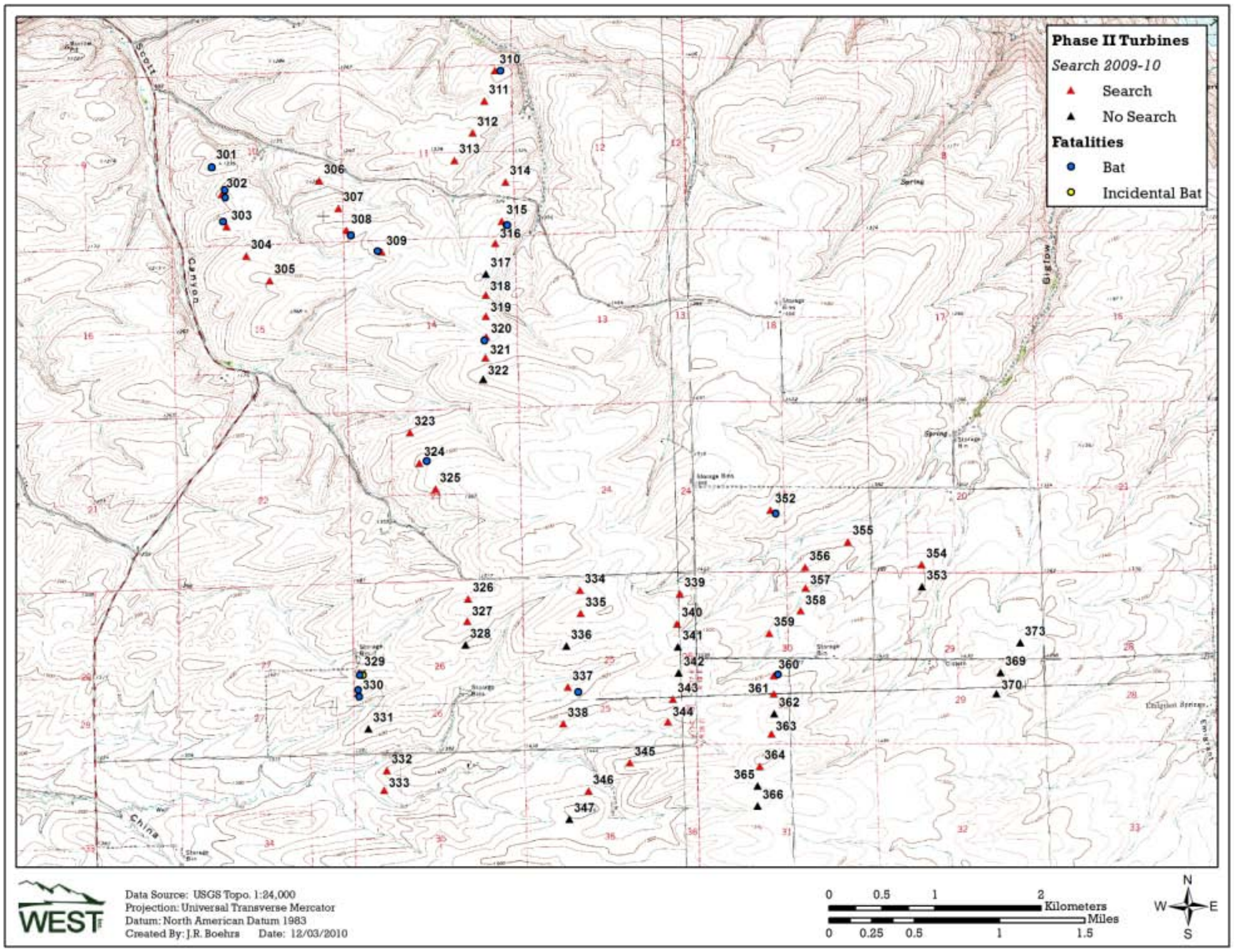

Figure 9. Locations of bat fatalities found during Year 1 monitoring at Biglow Canyon Phase II.

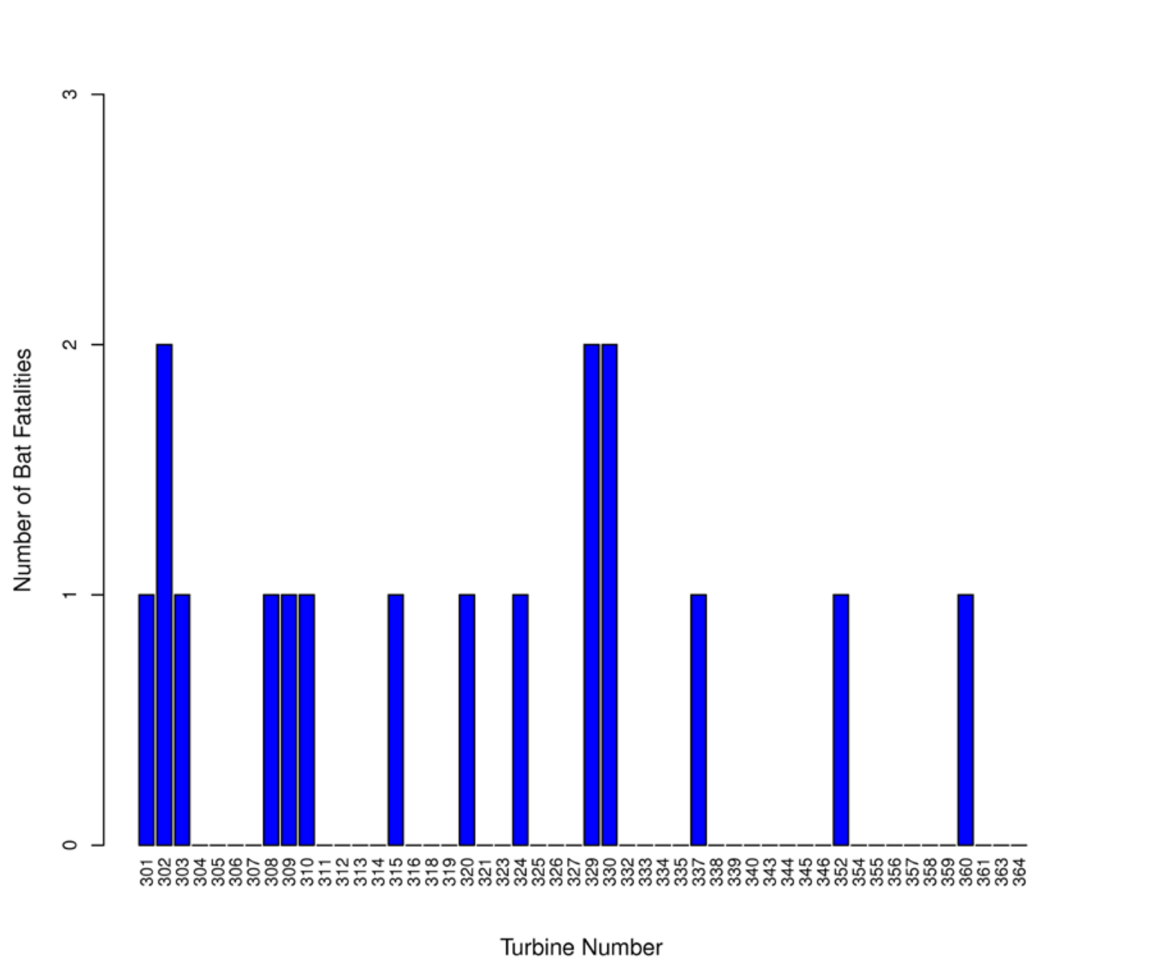

Figure 10. Number of bat fatalities by turbine during Year 1 monitoring at Biglow Canyon Phase II.

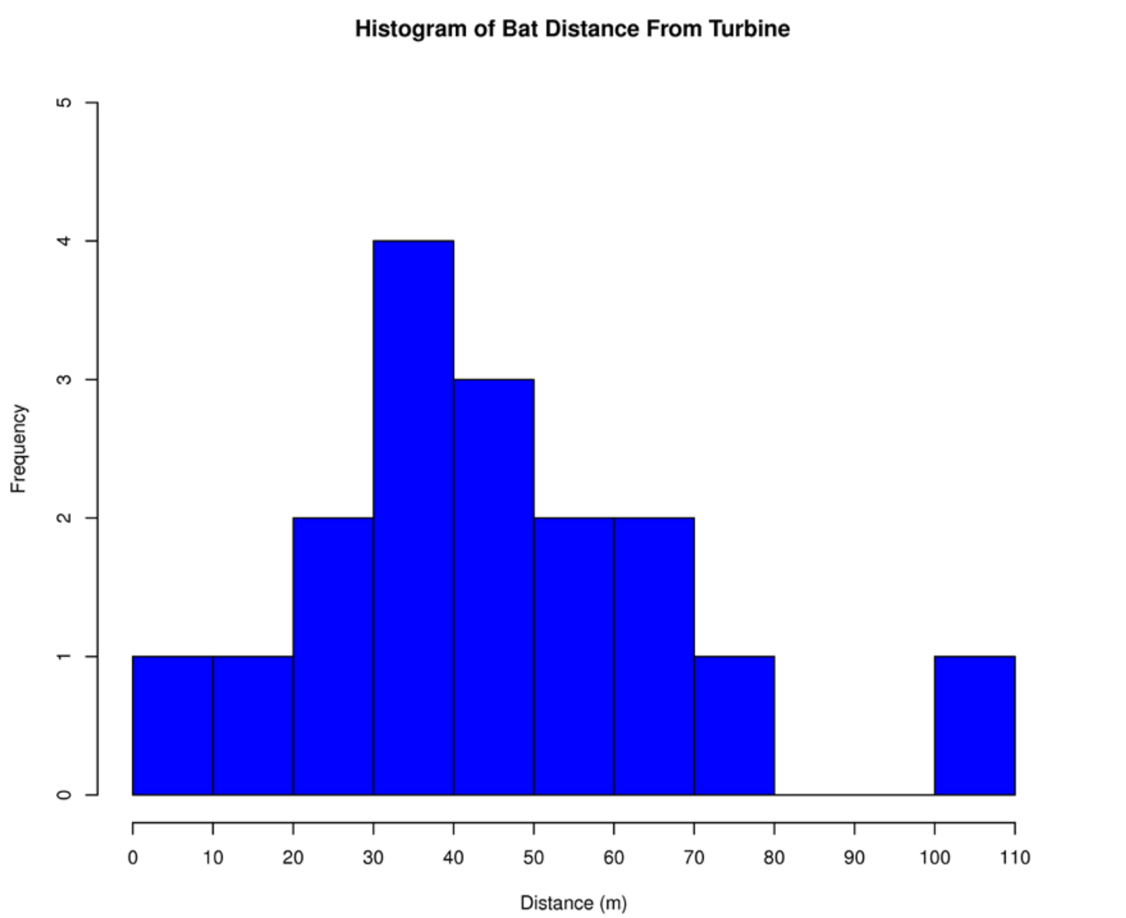

Figure 11. Distance of bat fatalities from turbines during Year 1 monitoring at Biglow Canyon Phase II.

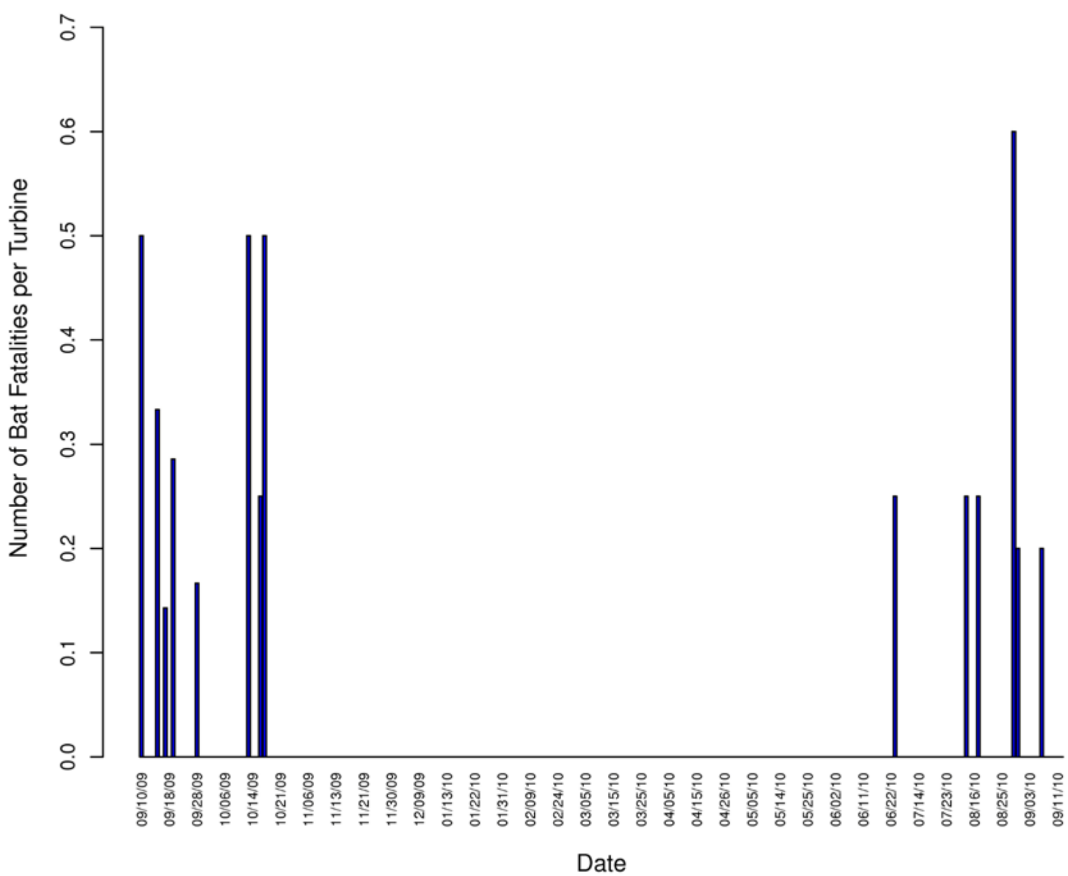

Figure 12. Timing of bat fatalities during Year 1 monitoring at Biglow Canyon Phase II.

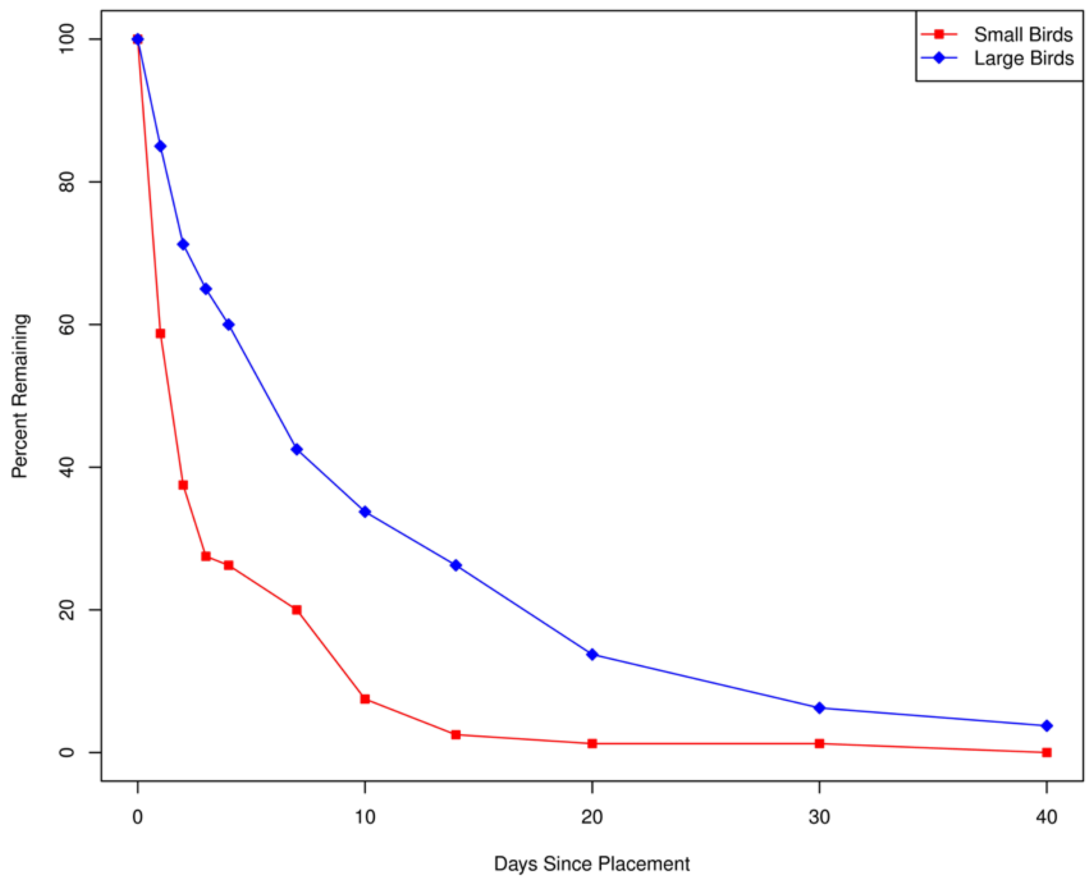

Figure 13. Carcass removal rates for Year 1 removal trials at Biglow Canyon Phase II.

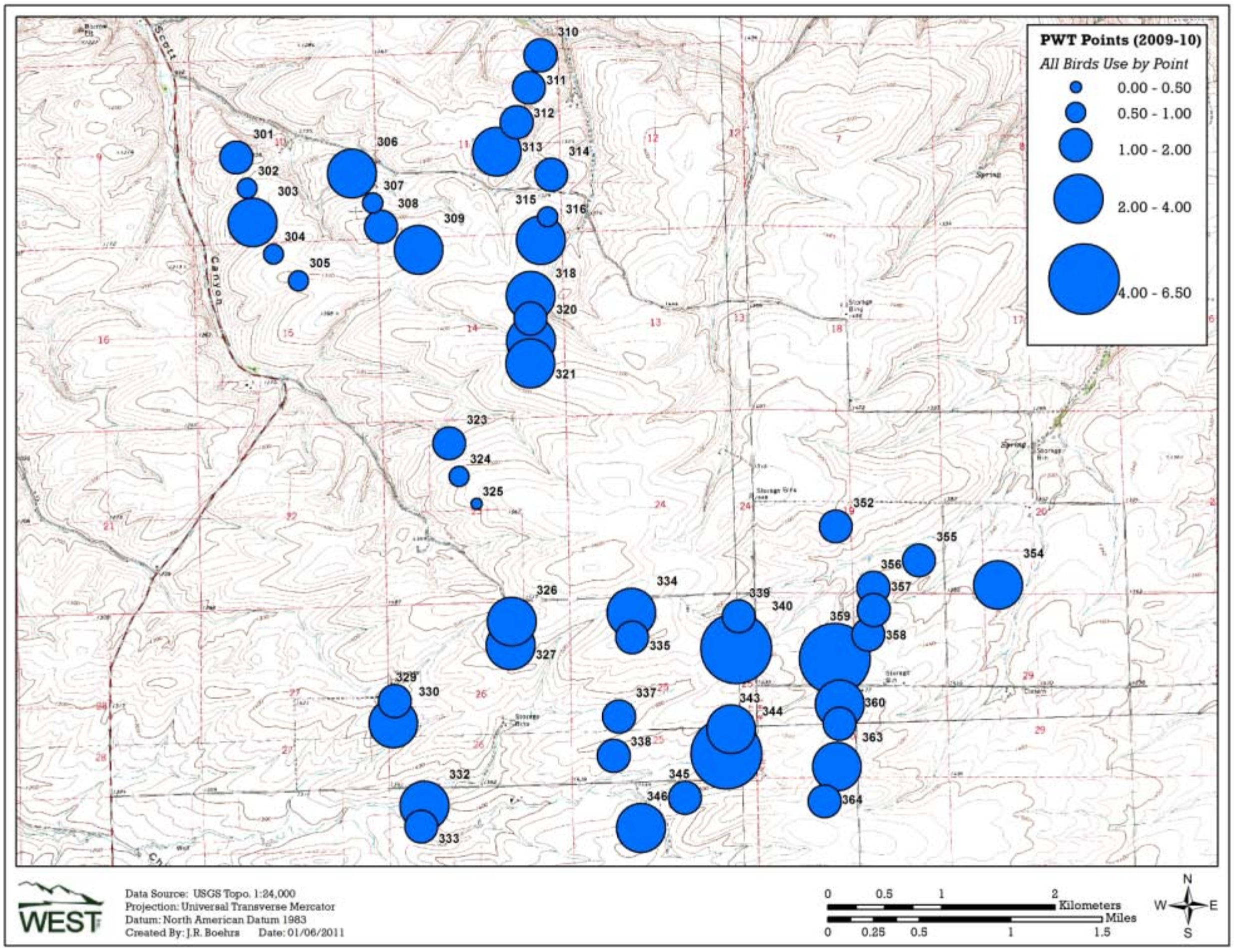

Figure 14a. Mean total bird use (number of birds/5-min survey) by PWT point (turbine number) for Year 1 at Biglow Canyon Phase II.

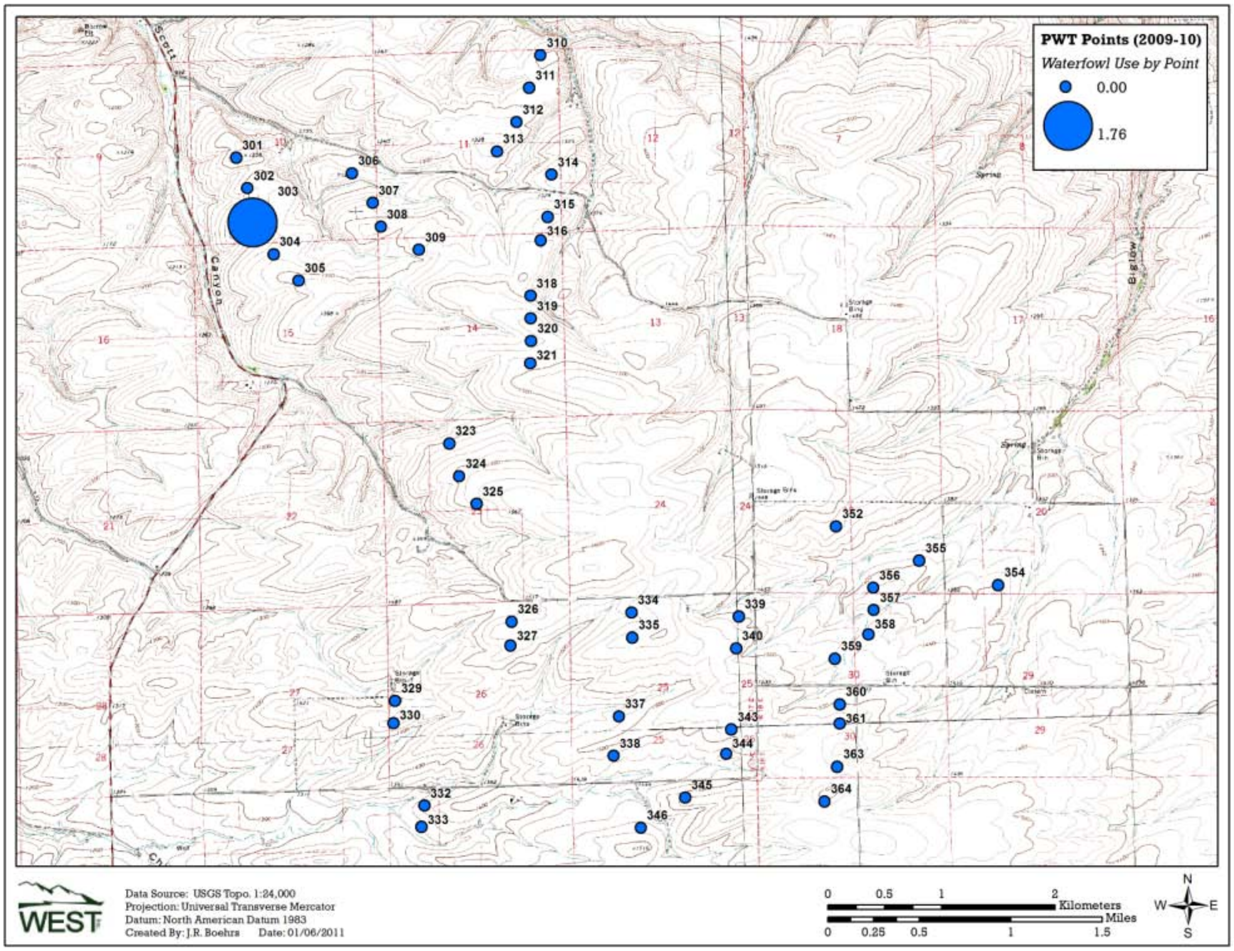

Figure 14b. Mean waterfowl use (number of birds/5-min survey) by PWT point (turbine number) for Year 1 at Biglow Canyon Phase II.

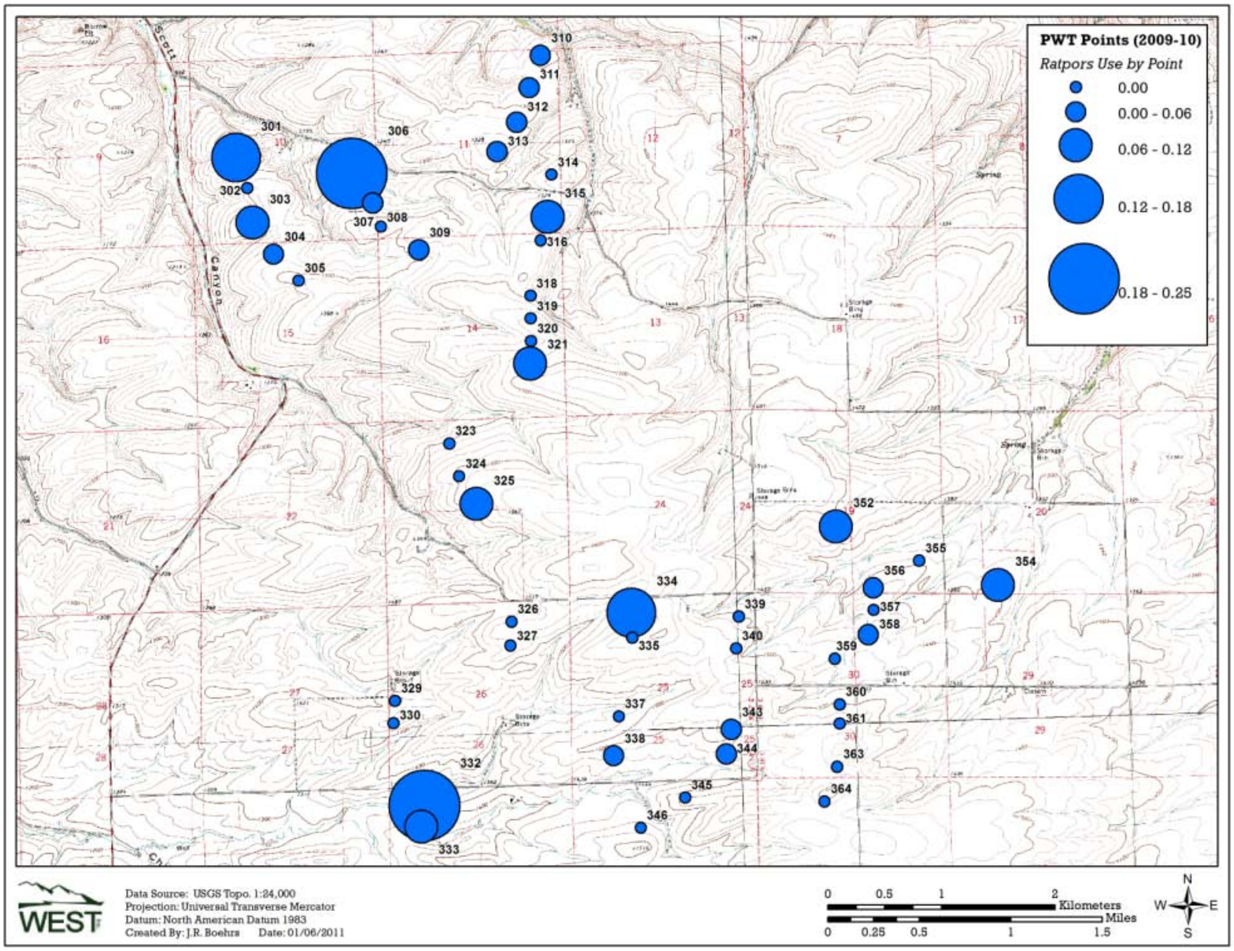

Figure 14c. Mean raptor use (number of birds/5-min survey) by PWT point (turbine number) for Year 1 at Biglow Canyon Phase II.

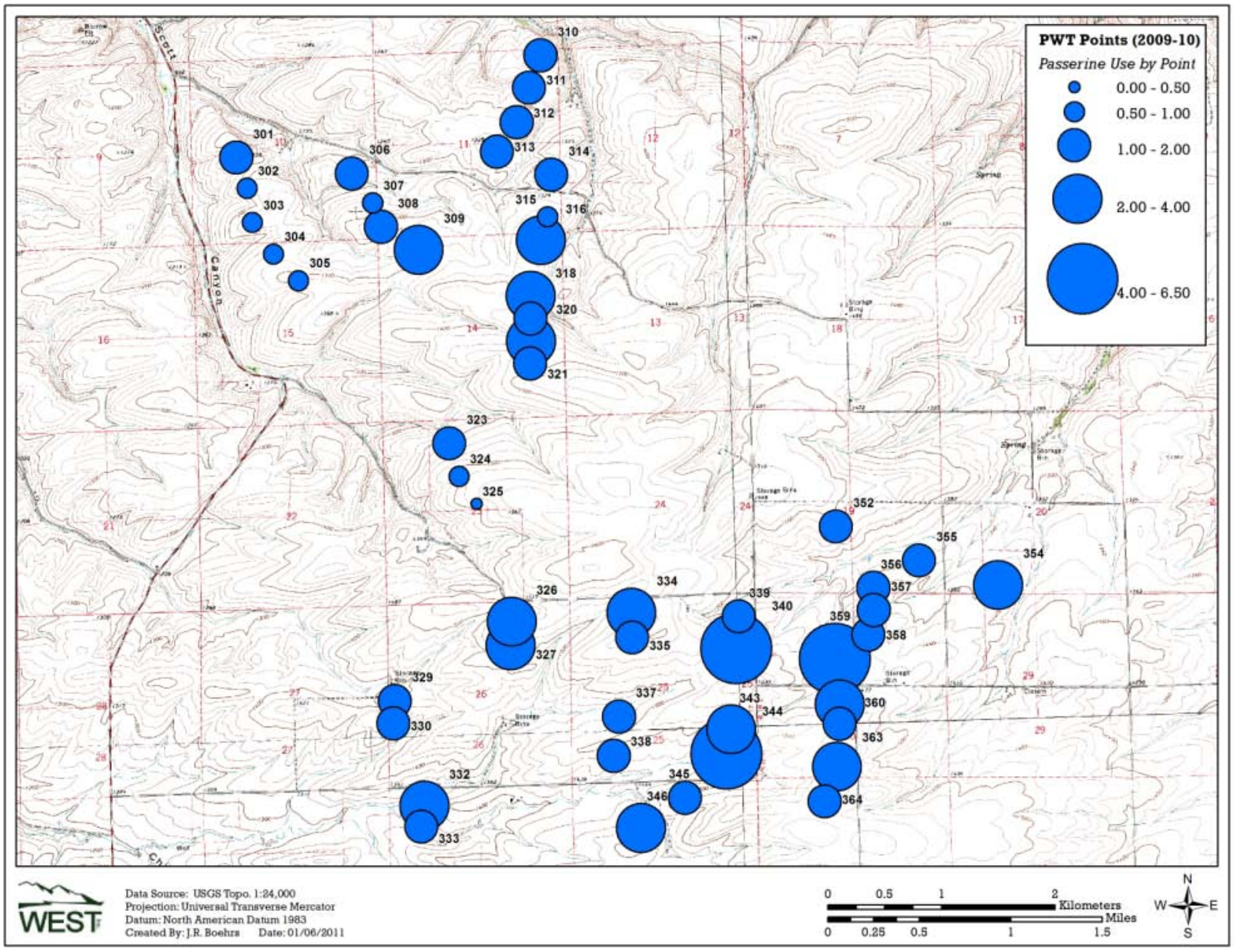

Figure 14d. Mean passerine use (number of birds/5-min survey) by PWT point (turbine number) for Year 1 at Biglow Canyon Phase II.

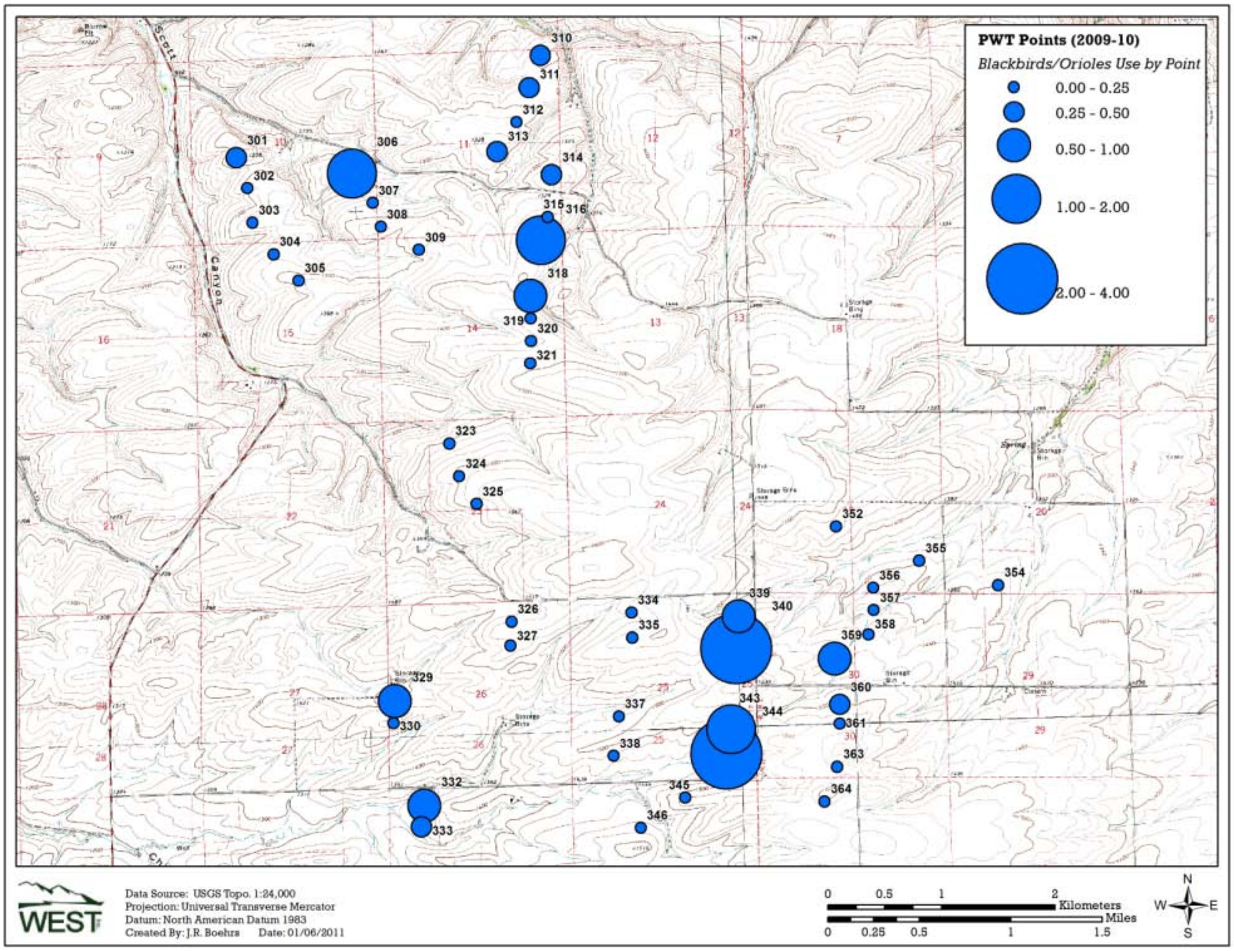

Figure 14e. Mean blackbird/oriole use (number of birds/5-min survey) by PWT point (turbine number) for Year 1 at Biglow Canyon Phase II.

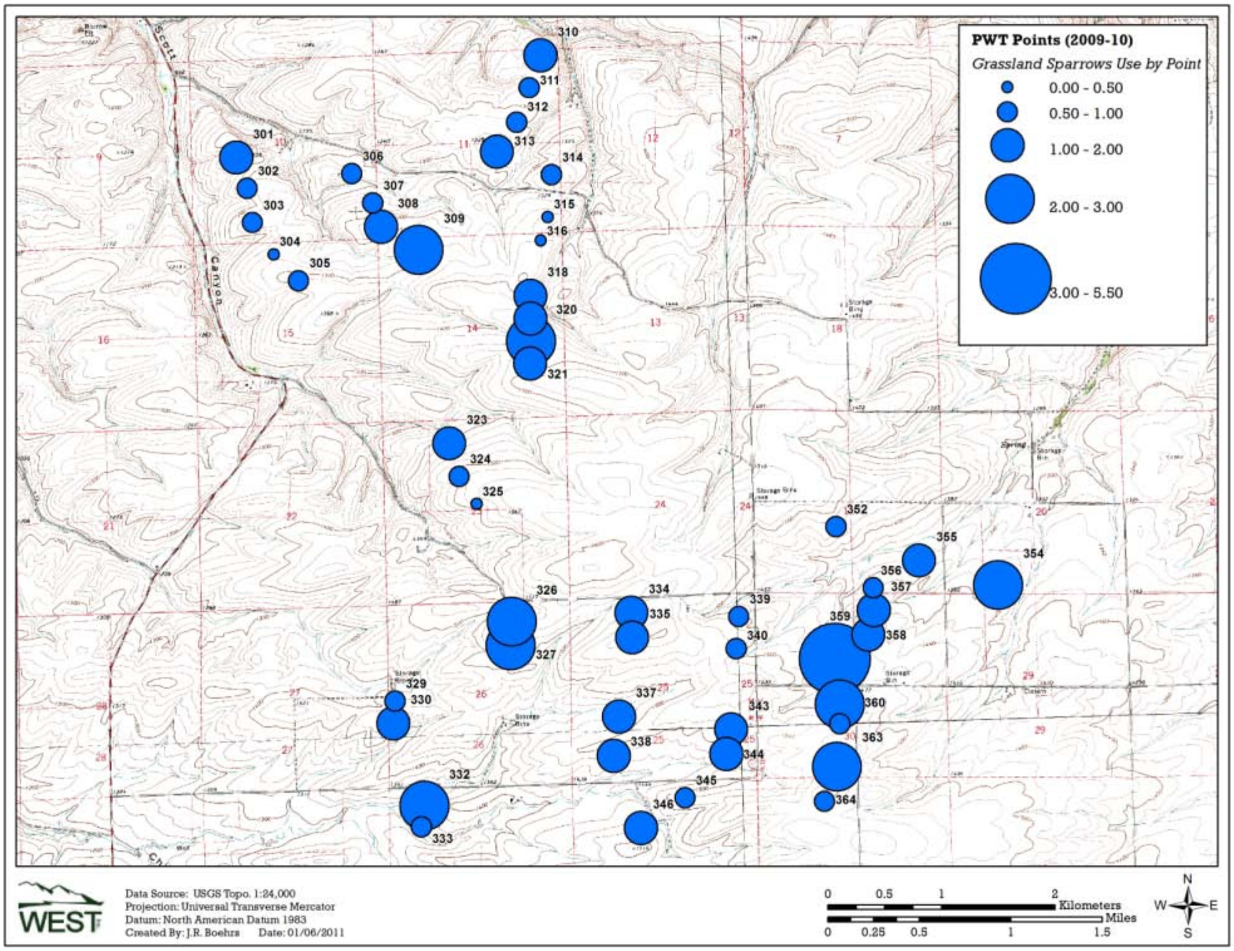

Figure 14f. Mean grassland bird/sparrow use (number of birds/5-min survey) by PWT point (turbine number) for Year 1 at Biglow Canyon Phase II.

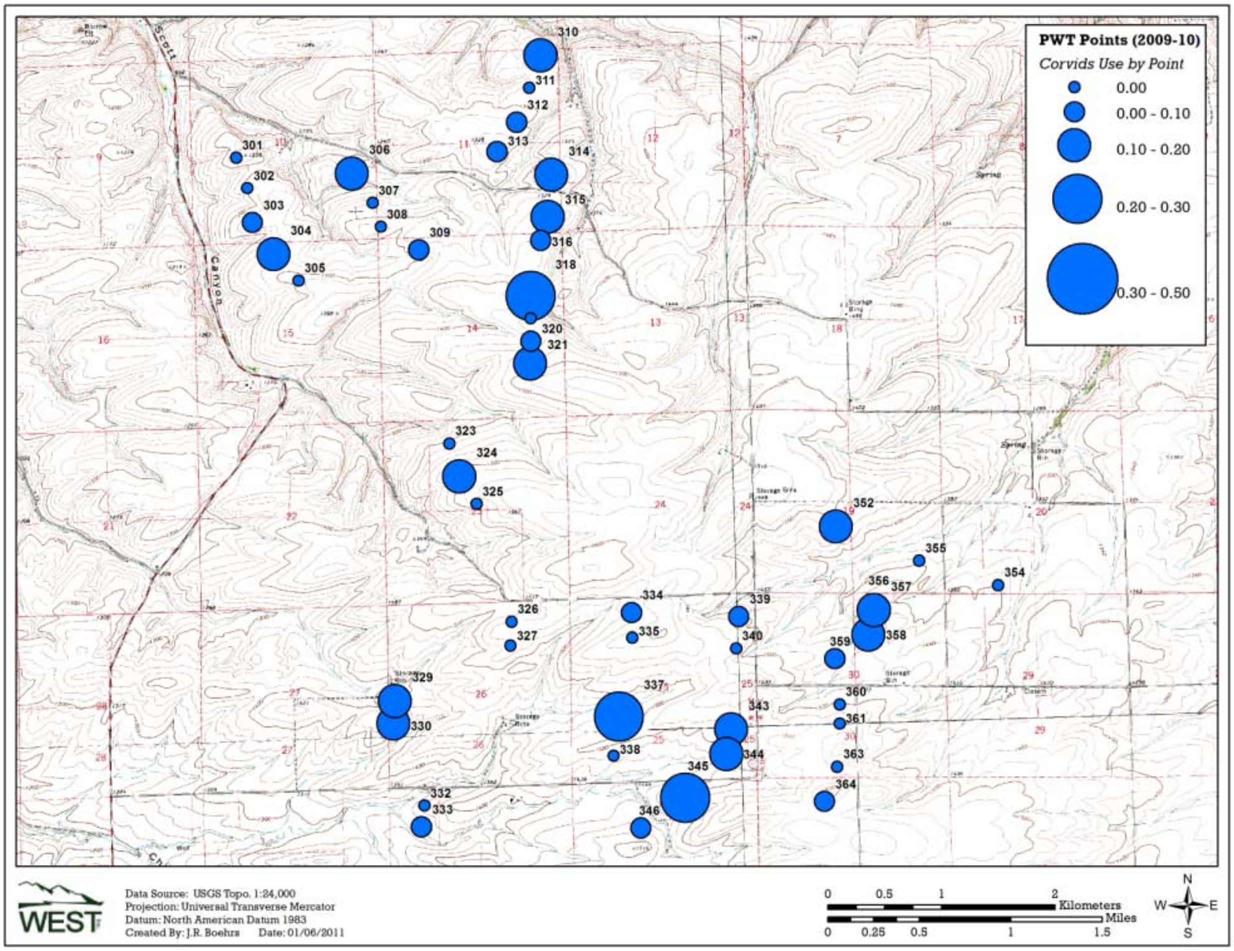

Figure 14g. Mean corvid use (number of birds/5-min survey) by PWT point (turbine number) for Year 1 at Biglow Canyon Phase II.