Eurus Combine Hills Turbine Ranch
Phase 1
Post Construction Wildlife Monitoring First Annual Report

February 2004 – February 2005

Prepared for:

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and

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EXECUTIVE SUMMARY

Eurus Energy America Corporation completed construction the *Eurus Combine Hills Turbine Ranch, Phase 1* near the end of 2003. Due to concern over potential impacts from the wind project development, Eurus developed a post-construction study plan to monitor impacts to birds and bats over a minimum of two years. The first year of monitoring surveys were conducted on the site between February 2004 and February 2005.

The project is located approximately 6 miles west of Milton Freewater, Oregon, and is north and east of Vansycle Ridge and the existing Vansycle wind plant and east and southeast of the existing Stateline wind project. Agriculture and livestock grazing have converted the overall area to a mosaic of cultivated wheat fields, CRP pastures, and grazed native grassland/shrub-steppe rangeland.

The wind project consists of 41 Mitsubishi MWT-1000A wind turbines, rated at 1.0 MW each. Turbines are mounted on 53 m tubular steel towers. The rotor diameter of the three-bladed turbines is 61.4 m, resulting in a rotor swept area of approximately 2961 m^2. The maximum height above ground to the tip of an upward vertical blade is approximately 84 m; the minimum height above ground to the tip of a downward vertical blade is 22 m. The wind turbines operate at wind speeds from approximately 10-90 kph at a relatively constant speed of 19.8 rpm. Fourteen of the wind turbines are lit with FAA recommended medium intensity red/white dual strobe light with white strobe during the day and red flashing at night.

The overall objectives of the monitoring studies were to determine whether the project causes significant mortality of birds and bats and to determine whether the project results in a loss of habitat quality or displacement related impacts. The monitoring study consists of four components designed to address different potential impacts: (1) fatality monitoring involving standardized carcass searches and searcher efficiency trials to address direct mortality impacts; (2) paired plot avian point count surveys during the nesting season to assess potential displacement effects; (3) a raptor nest survey within two miles of the development area boundary to assess potential disturbance or displacement impacts; and (4) sensitive species monitoring surveys to address potential disturbance or displacement impacts.

The primary study area for the monitoring studies included all the turbine strings constructed for Phase 1 of the project, associated meteorological and communications towers and new roads constructed adjacent to the turbine strings. Carcass searching surveys took place within 90 meters of all turbines, met towers, and the communications tower. Paired point avian surveys were conducted near turbines constructed for Phase 1 and out to approximately 300 meters and used the same plots established in the baseline study. The raptor nest survey occurred within 2 miles of the Phase 1 development and focused on existing and known ferruginous hawk nests found during the baseline surveys. No sensitive species are known to occur within 300 m of Phase 1 facilities and no surveys for sensitive species were conduced during the first year study. Detailed survey methods for each study component are included in the following report.

A total of 14 searches of all plots were conducted during the first year of study (February 9, 2004 – February 8, 2005). Thirty-four bird fatalities comprised of 12 identified species and at least one unidentified passerine species were located and 21 bat fatalities comprised of two species were located. Bird fatalities were found near 21 different turbines; bat fatalities were found near 17 different turbines. The average distance of bird casualties to the nearest turbine was 70.0 meters; the average distance of bat casualties to the nearest turbine was 44.4 meters. No bird or bat carcasses were found that were attributed to the met towers or the communications tower.

Passerines comprised 65% and upland gamebirds comprised 26% of the avian fatalities. Horned lark comprised 41% of all fatalities; the most common fatality found. Including the unknown passerines as possible migrants, approximately 86% of the passerines were considered resident and 14% were considered migrants. No raptors or Federal or State Threatened or Endangered species were found during the study. Three avian fatalities were of unprotected species, rock dove and starling. Fatalities rate was lowest in the summer (18%) and highest in the winter (35%). No increase in fatalities was observed during the spring and fall migration seasons. There was no strong concentration of avian fatalities within the wind project.

Bat fatalities were found between June 22 and November 16, 2004. Hoary bat comprised 62% and silver-haired bat 38% of the bat fatalities. There did not appear to be any strong concentrations of bat fatalities within the facility. For hoary bats, 77% were adults and 23% were unidentified to age. For silver-haired bats, 75% were adults, 12.5% were juveniles, and 12.5% were unidentified to age.

Overall fatality estimates were calculated by adjusting for carcass removal and observer detection bias. The estimated number of all bird fatalities per turbine per year and associated 90% confidence limits for the first year of study was 2.56 (1.70, 3.60). The estimated number of small bird fatalities per turbine per year was 1.89 (1.10, 2.89) and large bird fatalities per turbine per year was 0.67 (0.31, 1.15). Horned larks were the most commonly observed fatality with an estimated fatality rate of 1.20 per turbine per year. Excluding non-protected species (rock dove, starling), the overall estimate is approximately 2.36 bird fatalities per turbine per year. Only three casualties were found which were considered nocturnal migrants; the estimated number of nocturnal migrant fatalities per turbine per year was 0.27 (0.07, 0.57).

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 first year of study was 1.88 (1.15, 2.80).

Thirty-three avian point count surveys were conducted between April 22 and June 13, 2004. During the baseline studies conducted in 2001 and 2002, 84 total avian point count surveys were conducted at the same point count stations. A total of 43 species were identified during the point counts for all years; twenty-two species were identified in both the pre-construction and post-construction surveys. A total of 620 individual bird detections in 299 separate groups of birds were recorded during pre-construction surveys; a total of 614 individual birds in 136 separate groups were recorded during post-construction surveys. Approximately 59% of the observations were of horned larks and western meadowlarks over all years of study. The majority of species comprised less than 3% of the observations.

The difference in bird use at turbine points and the offset points was compared for both pre- and post construction surveys. For the pre-construction surveys there was significantly greater use by horned larks at the turbine points than the offset points and significantly less use by western meadowlarks at the turbines points than the offset points. For post-construction surveys there was significantly less use again by western meadowlark at the turbine points than the offset points.

The difference in bird use between pre- and post-construction surveys was also compared for both the turbine and offset points. For all passerines combined there was a significant increase in use post-construction for the offset survey point locations. There was also a significant increase in horned lark use at offset survey points post construction. For western meadowlark there was a significant decrease in use at the turbine points post construction; and for rock wren there was a significant increase in use at both turbine and offset points post-construction.

Ferruginous hawk nest monitoring occurred between April 22 and May 21, 2004. No active ferruginous hawk nests were located within the project area; however, two active ferruginous nests were located within the two mile buffer zone. The two ferruginous hawk nests located during the baseline studies (2001-2002) were not active in 2004.

Overall, the first year of monitoring studies at the Combine Hills Turbine Ranch Phase 1 wind project did not raise significant concerns. Fatality estimates for birds and bats from the study are similar to other wind projects in the region. All fatalities found were assumed to be wind project related so the estimate of avian mortality is an over-estimate of actual wind project mortality. In order to compare Combine Hills to other wind projects with different trubines, the fatality rates were standardized on a per rotor-swept area equivalent to one MW. For Combine Hills the estimated 2.56 bird fatalities per MW capacity is slightly lower than Stateline, 2.90 fatalities per MW, and the overall average for new generation wind projects in the U.S of 3.05 fatalities per MW. The Combine Hills bat fatality rate of 1.88 per MW capacity is similar to Stateline, 1.70 per MW, and below the average rate for new generation wind projects in the west and mid-west of 2.10 per MW.

Species composition for bird and bat fatalities was similar to composition at other wind projects in the Pacific Northwest with horned lark making up the majority of the avian fatalities and hoary and silver-haired bats the bat fatalities. When grouped together, upland gamebirds were also common fatalities. Notable differences to other wind projects were the lack of any raptor fatalities and a lower rate of nocturnal migrant fatalities. Only three avian fatalities found during the study were potential nocturnal migrants. No difference in fatality rate was found between lit and un-lit turbines.

Results of the pair-plot avian use surveys suggest that there may be a relatively small-scale impact of the wind facility on grassland nesting passerines. One species, western meadowlark showed a significant negative decline in use at turbine locations between pre- and post-construction surveys. Over all passerines, there was a significant increase in bird use post-construction at the off-set survey points and no change at the turbine points suggesting that other factors which influence bird use may have greater influence than the turbines.

The original monitoring plan for Combine Hills Phase 1 called for two years of monitoring studies which did not necessarily have to be consecutive years. It is recommended that based on the results of the first year of monitoring and the monitoring program of the nearby Stateline wind project, that the second year of monitoring for Combine Hills Phase 1 be postponed until habitat in the project has fully recovered and/or until Phase 2 of the project has been constructed. Delaying the study by two or more years, would allow comparison of mortality over a longer time frame to investigate changes over time (e.g., possible reduced mortality due to habituation or behavior responses to turbines); recovery of vegetation in construction zones to investigate displacement effects; monitoring long term changes in populations (e.g., increased number of nesting ferruginous hawks); avoiding a year with on-going construction which may generate other displacement effects; or comparing multiple turbine types within a development or with nearby developments. Prior to the initiation of the second year of monitoring, new developments and results from wind project monitoring as a whole should be considered to determine if changes to the sampling protocol should be made.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

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REPORT REFERENCE

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A number of individuals from different and varied organizations were instrumental in the completion of the first year of monitoring Combine Hills Turbine Ranch Phase 1. Mark Kirsch, Kevin Blakley, and Gail McEwen, Oregon Department of Fish and Wildlife provided the overall framework for surveys to include in all the biological resource studies of the Combine Hills project as well as valuable comments, suggestions, guidance, and methods for improving the studies. They also actively commented on drafts of the written protocol and reports. Mike Denny, Blue Mountain Audubon, provided early comments in the overall development of biological resource studies for the Combine Hills project and has been an active participant in renewable energy project review throughout the region.

Members of the Technical Advisory Committee include Mike Kirsch, ODFW; Clinton Reeder Umatilla County Planning Commissioner; Don Bain, Eurus Energy America Corp; and Jim Schubert, landowner. Their participation is greatly appreciated. Eurus Energy America Corporation provided funding for the field study project and access to the Combine Hills facility, with special thanks to Mitsuoka Hidenori for contract management and administration. On-site personnel, Richard Ledwidge and Scott Stiles, were helpful in safety instruction, access, storage, and other logistical considerations for the study. Don Bain, Aeropower Services Inc., provided on-going coordination and guidance throughout the life of studies in the Combine Hills Turbine Ranch. Bill Alexander, BAF Enterprises, provided maps, GIS expertise, and technical support for mapping.

All the landowners in the Combine Hills project, Jim and Gayl Schubert, Bob and Betty Schubert, Pat Kelly, Bud Schubert, and Arlene Kessler deserve special recognition for their support and cooperation in allowing safe, secure, and trouble-free property access.

1.0 INTRODUCTION

Eurus Energy America Corporation (Eurus) completed construction of the first phase of the *Eurus Combine Hills Turbine Ranch* (the project) near the end of 2003. The project is located in the rolling hills north and east of Vansycle Ridge west of the town of Milton-Freewater, Umatilla County, Oregon. The Phase 1 development consists of 41 1.0 MW turbines with a total nameplate capacity of 41 MW.

Due to concern over potential impacts from wind project developments, Eurus developed a post-construction study plan to monitor impacts to birds and bats over a minimum of two years. This report presents results from the first year of the avian and bat monitoring program conducted at the project. The first year of monitoring surveys were conducted on the site between February 2004 and February 2005. Data was collected according to a detailed monitoring protocol developed in cooperation with the Oregon Department of Fish and Wildlife (Young *et al*. 2003a).

The overall objective of the monitoring studies and those expressed by the ODFW are to determine whether the project causes significant mortality of birds and bats and to determine whether the project results in a loss of habitat quality or displacement related impacts. The study consists of four components designed to address different potential impacts: (1) fatality monitoring involving standardized carcass searches and searcher efficiency trials to address direct mortality impacts; (2) paired plot avian point count surveys during the nesting season to assess potential displacement effects; (3) a raptor nest survey within two miles of the development area boundary to assess potential disturbance or displacement impacts; and (4) sensitive species monitoring surveys (if needed based on the presence of state listed species) to address potential disturbance or displacement impacts.

The protocol for the monitoring study is similar to protocols used at the nearby Vansycle project, Umatilla County, Oregon (Erickson *et al*. 2000), the Stateline project in Oregon and Washington (FPL *et al*. 2001), and the Nine Canyon project, Benton County, Washington (Energy Northwest *et al*. 2002). The protocol for the paired plot avian point count surveys is identical to the protocol for the same surveys conducted on the site during baseline (pre-construction) studies (Young *et al*. 2003b).

The Umatilla County permitting agency for the project required that a Technical Advisory Committee (TAC) be convened to review the monitoring studies. The TAC consists of four members, one each from the Umatilla County Planning Commission; the project owner and operator, Eurus Energy; the Oregon Department of Fish and Wildlife; and a participating landowner. The role of the TAC is to oversee the project and make decisions about the need for continued study and/or mitigation measures.

2.0 STUDY AREA AND PROJECT DESCRIPTION

The project area is within the Columbia Basin Physiographic Province. The project is approximately 6 miles west of Milton Freewater, Oregon and is north and east of Vansycle Ridge and the existing Vansycle wind plant and primarily east and southeast of the existing Stateline wind project. The project falls within Sections 30-34, Township 6 N, Range 34 E; Sections 1-6 and 8-14, Township 5 N, Range 34 E; and Section 23-26, 35-36, Township 6 N, Range 33 E.

The vegetation of the project area is a mix of grassland/shrub-steppe, Conservation Reserve Program (CRP) pastures, and dryland agriculture. The grassland/shrub steppe community is predominantly rabbitbrush (*Chrysothamnus* spp.) and cheatgrass (*Bromus tectorum*), with stands of native bunch grass on some sites and deciduous shrubs and trees in the bottom of some drainages. Agriculture and livestock grazing have converted the overall area to a mosaic of cultivated wheat fields, CRP pastures, and grazed native rangeland.

The primary study area for the monitoring studies includes all the turbine strings constructed for Phase 1 of the project, associated meteorological (met) and communications towers and new roads constructed adjacent to the turbine strings (Figure 1). Carcass searching surveys took place within 90 meters of all turbines, met towers, and the communications tower. Paired point avian surveys were conducted near turbines constructed for Phase 1 out to approximately 300 meters. The paired plots used in the baseline studies that fell within the Phase 1 development were used in this study (see Young *et al*. 2003b). The raptor nest survey occurred within 2 miles of the Phase 1 development and focused on existing and known ferruginous hawk (a state threatened species) nests found during the baseline surveys.

The wind project consists of 41 Mitsubishi MWT-1000A wind turbines, rated at 1.0 MW each. Turbines are mounted on 53 m (174 ft) tubular steel towers. The rotor diameter of the three-bladed turbines is 61.4 m (201 ft), resulting in a rotor swept area (RSA) of approximately 2961 m^2. The maximum height above ground to the top of the RSA is approximately 84 m (275 ft). The minimum height above ground to the lower portion of the RSA is 22 m (73 ft). The wind turbines operate at wind speeds from approximately 10-90 kilometers per hour (kph) (~8-56 mph), at a relatively constant speed of approximately 19.8 revolutions per minute (rpm).

Fourteen of the wind turbines are lit with FAA recommended red-strobe lighting. Turbines located at the end of turbine strings are lit, and roughly every fourth turbine within turbine strings that have more than seven turbines in the string are also lit (see Appendix A). Each lit turbine is equipped with a Honeywell L-865 medium intensity red/white dual strobe light. The light is a white strobe during the day (~40 flashes per minute), and red flashing at night (~20 flashes per minute).

3.0 METHODS

A detailed study plan with sampling protocols was developed for the monitoring studies (Young *et al.* 2003a) and was based largely on recommendations of the ODFW and, in order to provide comparable data and results, other previously studied wind projects in Washington and Oregon.

Survey methods for each study component are summarized below but also see Young *et al.* 2003a for more details.

3.1 Avian and Bat Fatality Study

The avian and bat fatality study consisted of standardized carcass searches to measure observed fatality rates and searcher efficiency trials to measure searcher bias. Based on agreement with ODFW it was determined that carcass removal trial results from the nearby Stateline wind project could be used as a measure of carcass removal for this study; no carcass removal trials were conducted in the project. In addition, a Wildlife Response and Reporting System (WRRS) was developed for the project so that wind project personnel encountering an avian or bat fatality could accurately record and report the find (see Young *et al*. 2003a). During the first year of this study the WRRS system was temporarily suspended so that fatalities from the wind project would be available for finding during standardized carcass searches.

3.1.1 Standardized Search Plots

Rectangular survey plots were established around all turbines constructed for Phase 1 of the project (n=41), the two permanent project met towers (n=2), and a tubular communications tower (n=1) constructed for the project and which fell primarily within the boundary of one of the turbine plots (Figure 2). Each plot was approximately 180 meter in diameter (90 meter radius from the tower) and rectangular in shape to facilitate the search effort. In most cases search plots from adjacent turbines overlapped because the turbines in a string were less than 180 meter apart. Parallel transects that were roughly perpendicular to the turbine string were walked in each plot to insure complete coverage of the plot during a search.

3.1.2 Standardized Searches

Personnel trained in proper search techniques (searchers) conducted standardized carcass searches by walking parallel transects. Transects were set at approximately 6-10 meters apart in the area to be searched. Searchers walked at a rate of approximately 45 to 60 meters per minute along each transect searching both sides out to 3-6 meters for casualties. All search plots were searched once every 28 day (4 week) period.

All carcasses that meet one of the following criteria were included in the data set and subsequent fatality estimates, unless cause of death was determined not to be wind project related:

- Intact – a carcass that is completely intact, is not badly decomposed and shows no visible 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 portions of a carcass in one location (e.g., wings, skeletal remains, legs, pieces of skin, etc.)
- Feather Spot – 10 or more total feathers at one location or 3 or more primary feathers at one location indicating scavenging or predation.

For data reporting and analysis, the turbine or tower nearest the fatality was assumed to be the turbine responsible for the fatality. The level of background mortality in the project, or mortality due to natural causes such as predation, was not measured for this study. Some casualties that were discovered and used in the mortality estimation may not have been wind project related because true cause of death could not be determined. Including non-project related fatalities in the overall mortality estimates contributes to overestimation of project related mortality.

3.1.3 Searcher Efficiency Trials

The objective of searcher efficiency (or observer detection bias) experimental trials is to estimate the percentage of actual bird and bat fatalities that searchers are able to find. These trials were conducted throughout the year in the same area in which standardized carcass searches occurred in grassland/shrub-steppe and cultivated agriculture habitat types. Estimates of observer detection rates were used to adjust the number of carcasses found, correcting for detection bias. Bird carcasses of two size classes (74 total carcasses) were distributed at plots classified into four habitat types: agriculture – high (medium to tall growth wheat); agriculture – low (plowed fields, low growth wheat), grassland/shrub-steppe, and reclaimed areas from wind project construction (e.g., roads, reseeded dirt areas around turbines).

Before the beginning of a standardized search, detection trial carcasses were placed at randomly determined locations in plots to be searched that day. Personnel conducting searches did not know when trials were scheduled or how many trial carcasses were placed within search areas. Each trial carcass was discreetly marked so that it could be identified as a searcher efficiency trial carcass after it was found. The number and location of trial carcasses found during the standardized search were recorded. The number of efficiency trial carcasses available for detection during each trial was determined immediately after the trial by the person responsible for distributing the carcasses, since scavengers may have removed trial birds before searches were conducted.

3.1.4 Carcass Removal Trials

The objective of carcass removal trials[1] is to estimate the length of time avian and bat carcasses remain in the search area before being removed by scavengers or other means. No carcass removal field trials were conducted for this study. It was determined through consultation with ODFW that published carcass removal rates from the monitoring studies at the nearby Stateline wind project could be used in this study. Details about the methods used in the Stateline mortality study can be found in the final report (Erickson *et al*. 2004a).

3.1.5 Statistical Methods for Fatality Estimates

The estimate of the total number of wind facility-related fatalities is based on:

(1) Observed number of carcasses found during standardized searches between February 2004 and February 2005 and for which the cause of death is either unknown or is project related;
(2) Searcher efficiency expressed as the proportion of trial carcasses found by searchers during the entire survey period;

[1] Carcass removal trials are often referred to as scavenging trials, since most carcass removal is done by scavengers. However, removal can also be due to means other than scavengers (e.g., farming activities, wind, decomposition) and often times evidence of a scavenged carcass (e.g., feather spots) remains in the field for possible detection long after scavenging has occurred. Scavenging rates can vary dramatically from removal rates. The intent of the trials is to measure how long a carcass is detectable in the field in any condition.

(3) Non-removal rates expressed as the estimated average probability a carcass [or evidence of (e.g., feather spot)] is expected to remain in the study area and be available for detection by the searchers during the entire survey period.

The following variables are used in the estimation:

- c_i — the number of carcasses detected at plot *i* for the study period of interest (e.g., one 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
- $\bar{c}$ — the average number of carcasses observed per turbine per 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 40 days
- se — standard error (square of the sample variance of the mean)
- t_i — the time (days) a carcass remains in the study area before it is removed
- $\bar{t}$ — the average time (days) a carcass remains in the study area before it is removed
- d — the total number of carcasses placed in searcher efficiency trials
- p — the estimated proportion of detectable carcasses found by searchers
- I — the average interval between searches in days
- $\hat{\pi}$ — the estimated probability that a carcass is both available to be found during a search and is found
- m — the estimated annual average number of fatalities per turbine per year, adjusted for removal and observer detection bias

3.2.5.2 Observed Number of Carcasses

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

$$\bar{c} = \frac{\sum_{i=1}^{n} c_i}{k}. \qquad (1)$$

3.2.5.3 Estimation of Carcass Removal

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

$$\bar{t} = \frac{\sum_{i=1}^{s} t_i}{s - s_c}. \qquad (2)$$

This estimator is the maximum likelihood estimator assuming the removal times follow an exponential distribution and there is right-censoring of data. In the Stateline study, any trial carcasses still remaining at 40 days was collected, yielding censored observations at 40 days. If all trial carcasses are removed before the end of the trial, then s_c is 0, and $\bar{t}$ is just the arithmetic average of the removal times.

3.2.5.4 Estimation of Observer Detection Rates

Observer detection rates (i.e., searcher efficiency rates) are expressed as *p,* the proportion of trial carcasses that are detected by searchers. Observer detection rates were estimated by carcass size (small and large) and for the whole year since seasonal numbers from only one year of study were small.

3.2.5.5 Estimation of Facility-Related Fatality Rates

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

$$m = \frac{\bar{c}}{\hat{\pi}}, \qquad (3)$$

where $\hat{\pi}$ includes adjustments for both carcass removal and observer detection bias assuming that the carcass removal times t_i follow an exponential distribution. Data for carcass removal and observer detection bias were pooled across the study to estimate $\hat{\pi}$. Under these assumptions, this detection probability is estimated by

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

Fatality estimates were calculated for: all birds, small birds, large birds, grassland birds – small and large, nocturnal migrants, and bats. 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 uses iterative sampling of the data to calculate point estimates, variances, and confidence intervals for complicated test statistics. For each iteration (or bootstrap), the plots were sampled with replacement, trial carcasses were sampled with replacement, and $\bar{c}$, $\bar{t}$, p, $\hat{\pi}$, and m were calculated. A total of 5,000 bootstrap iterations were used. The reported estimates are the means of the 5,000 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 5,000 bootstrap estimates are estimates of the lower limit and upper limit of 90% confidence intervals.

3.2 Paired Plot Avian Use Surveys

The objective of the paired plot avian use surveys was to investigate the presence of displacement impacts due to the project on common grassland nesting birds. Variable circular plots (Reynolds *et al.* 1980) were established during the baseline studies for the project (see Young *et al*. 2003b), which were paired by having one point at or near a proposed turbine location and one offset by 300 m in a perpendicular direction from the turbine string. Standard breeding bird survey point counts were conducted at each point in the pair three times during the breeding season (approximately late April to late June). Only those points that occurred within or near the Phase 1 project features were surveyed in 2004 (Figure 3).

3.3 Raptor Nest Surveys

The objective of the raptor nest survey was to monitor activity at historic ferruginous hawk nest sites and to check suitable nesting structures or areas for new nests, focusing on suitability for ferruginous hawks. The area monitored was concentrated within two miles of Combine Hills Phase I turbines (Figure 4). All known ferruginous hawks nests that were located during the baseline studies were monitored for activity in the spring of 2004. In addition, potential nesting areas for ferruginous hawks (e.g., rocky outcrops, isolated trees) were investigated from the ground to search for new nests or look for re-occupation of previously inactive nests.

Survey methods included the following: (1) monitoring two historic nests [Nest numbers 9 and 10 from the baseline study (see Young *et al.* 2003b)], (2) searching for new nests detectable from project roads and if discovered, walking to potential vantage points to view the nest structure to confirm activity status. Outside of the wind project, public roads were driven and the surveyor scanned potential nest structures with binoculars or a spotting scope from frequent vantage points. Historic nest sites recorded by others (Stateline wind project records, etc.) that fell within approximately two miles of the Combine Hills project were also monitored.

3.4 Sensitive Species Surveys

Surveys for Washington ground squirrels and burrowing owl were conducted during the baseline studies (see Young *et al.* 2003b). Currently, there are no known active colonies or nests within the Phase 1 project area or a 300 meter buffer of project facilities. The area in and around the project will continue to be monitored for the presence of these species through the 2-year monitoring study. If any burrowing owls or Washington ground squirrels are found during that time they will be monitored for disturbance or displacement type impacts.

4.0 RESULTS

The standardized fatality estimates are based on one full year of the study from February 9, 2004 to February 8, 2005. The paired plot avian surveys were conducted between April 22 and June 13, 2004. Raptor nest monitoring occurred between April 22 and May 21, 2004.

4.1 Avian and Bat Fatality Study

A total of 14 searches of all plots were conducted during the first year of study. Thirty-four (34) bird fatalities comprised of 12 identified species and at least one unidentified passerine species were located and 21 bat fatalities comprised of two species were located (Appendix A). Thirty-three (33) of the bird carcasses were found during standardized carcass searches and one was found incidentally while observers were on-site for other reasons. Bird fatalities were found near 21 different turbines (Table 1); bat fatalities were found near 17 different turbines (Table 2). The maximum number of bird fatalities found at any one turbine was four fatalities found closest to turbine number 1 (Table 1, Figure 2); the maximum number of bat fatalities found at any one turbine was 2 found closest to turbines 7, 11, 18, 37 (Table 2, Figure 2). The average distance of bird casualties (n=34) to the nearest turbine was 70.0 meters; the average distance of bat casualties (n=21) to the nearest turbine was 44.4 meters. No bird or bat carcasses were found that were attributed to the met towers or the communications tower.

4.1.1 Bird Fatalities

Horned larks comprised approximately 41% of the fatalities found (14 fatalities, Table 3). Chukar (6), ring-necked pheasant (2), and rock dove (2) were the only other species with more than one carcass found (Table 3). Passerines comprised approximately 65% of the fatalities (22). Including the unknown passerines as possible migrants, approximately 86% (19) of the passerines were considered resident and 14% (3) were considered migrants. No raptors were found during the study and none of the birds found were listed as Federal or State Threatened or Endangered. Upland gamebirds comprised approximately 26% (9) of the fatalities. Three avian fatalities were of unprotected species, rock dove and starling. It is unknown but some of the fatalities such as the upland gamebirds were not likely due to collision with turbines and may have been due to natural predation (e.g., raptors, fox).

Very few potential migrant fatalities were found. One red-breasted nuthatch was found in September. There is little breeding and resting habitat for red-breasted nuthatches in the immediate vicinity wind project which is dominated by agriculture fields and grassland/shrubland steppe. Two unidentified passerine feather spots were found in February and October and if it is assumed that these were not horned larks they could have been migrants. The remainder of the passerines were either horned larks, which are year-round residents of the project area, or were found during the breeding season and common summer or year-round residents of the area (e.g., American robin, black-billed magpie, northern flicker, western meadowlark).

Fatalities were found throughout the year, but rates appeared lowest in the summer (18%) and highest in the winter (35%). No increase in fatalities was observed during the spring and fall migration seasons (Figure 5). When considering all bird fatalities, there did not appear to be any strong localization in casualties (see Figure 2). Four upland gamebirds were found around turbine number 1 but it is possible that some, if not all, of these fatalities were due to natural predation and not from collision with the turbine.

4.1.2 Bat Fatalities

Two species of bats fatalities were found. Hoary bat comprised 61.9% (13) and silver-haired bat 38.1% (8) of the fatalities (Table 4). Neither hoary nor silver-haired bat are Federal or State Threatened or Endangered. Silver-haired bat is listed as an Oregon Sensitive status species.

Bat fatalities were observed between June 22 and November 16, 2004, although due to the carcass condition of bats found in October and November it was likely that they had died earlier in the fall season (Figure 5, Appendix C). There did not appear to be any strong concentrations of bat fatalities within the facility (see Figure 2, Table 2).

The bat carcasses were examined to determine age and gender, if possible. Aging and sexing of fatalities followed criteria in Anthony (1988) and Racey (1988). For hoary bats, 77% (10) were adults and 23% (3) were unidentified to age. For silver-haired bats, 75% (6) were adults, 12.5% (1) were juveniles, and 12.5% (1) were unidentified to age. Only one bat was in good enough condition to determine gender – a female silver-haired bat. The rest were scavenged or desiccated enough that gender could not be determined accurately.

The large majority the bat fatalities were found during the fall migration period for hoary and silver-haired bats with the greatest number of bat fatalities found in September (Figure 5, Appendix C). The three bat carcasses found in October and the two bat carcasses found in November were highly desiccated indicating that they likely occurred earlier in the fall.

4.1.3 Search Efficiency Trials

A total of 45 large bird[2] trial carcasses and 29 small bird[2] trial carcasses were used in detection trials (Table 5). The trial carcasses were placed throughout the year to account for varying weather and habitat conditions. Overall, observers detected 53% of the large bird carcasses and 52% of the small bird carcasses (Table 5). In the agriculture fields the height of the vegetation appeared to affect carcass detectability. Detection rates for large and small birds were distinctly higher in short agriculture (79%, e.g. plowed fields, low growth winter wheat) than in grassland (55%), reclaimed areas (50%), and tall agriculture (27%). The number of trial carcasses used in any one season was too few to provide meaningful summary results by season for just one year of study.

4.1.4 Carcass Removal Trials

Removal rates from studies at the nearby Stateline wind project were used for this study. The Stateline project has been studied for nearly a three year period from 2001-2003. During this study carcass removal data for 430 carcasses representing over 40 different bird species were recorded (Erickson *et al*. 2004a). Mean removal time was estimated at 35.7 days (31.0, 41.4)[3] for large birds and 16.7 days (14.7, 19.0)[3] for small birds. For large birds, 62.4% remained until day 14 of the trial, 45.5% remained until day 30, and 34.2% were still present on day 40 of the trial (Erickson *et al*. 2004a). For small birds, 43.3% remained on day 14, 17.1% lasted until day 30, and 11.5% of small birds remained until day 40 of the trial (Erickson *et al.* 2004a).

4.1.5 Fatality Estimates

Fatality estimates, standard errors, and confidence intervals were calculated for: (1) all birds, (2) small birds, (3) large birds, (4) small grassland birds (passerines), (5) large grassland birds (upland gamebirds), (6) nocturnal migrant birds, and (7) bats (Table 6). Estimates, standard errors and confidence intervals were calculated from bootstrap distributions. The fatality estimates are adjusted for carcass removal and observer detection bias. Based on the average number of days between searches, the estimated average probability a small bird casualty will remain until a scheduled search and will be found is 0.28 (0.21, 0.35)[3]. The estimated average probability a large bird casualty will remain until a scheduled search and will be found is 0.48 (0.39, 0.58)[3]. Fatality estimates apply to the entire Combine Hills Phase 1 since all turbines and towers were included in the study.

[2] Large bird carcasses used included pen raised hen pheasants and rock doves; small bird carcasses used included house sparrows, starlings, and coturnix quail.
[3] upper and lower limits of 90% confidence intervals (from bootstrap analysis)

4.1.5.1 Small Birds

Twenty-two (22) small bird fatalities were found during the study. The estimated number of small bird fatalities per turbine per year and associated 90% confidence limits for the Combine Hills Phase 1 wind project from the first year of study is 1.89 (1.10, 2.89) (Table 6). Horned larks were the most commonly observed fatality with an estimated fatality rate of 1.20 per turbine per year.

4.1.5.2 Large Birds

Twelve large bird fatalities[4] were found during the study. The estimated number of large bird fatalities per turbine per year and associated 90% confidence limits for the first year of study is 0.67 (0.31, 1.15) (Table 6).

4.1.5.3 All Birds

The fatality estimate for all birds was obtained by summing the estimates for small and large birds. The estimated number of all bird fatalities per turbine per year and associated 90% confidence limits for the first year of study is 2.56 (1.70, 3.60) (Table 6). One European starling and two rock doves, which are not protected under the Migratory Bird Treaty Act, were included in the estimate. By excluding these birds, the estimate is approximately 2.36 bird fatalities per turbine per year.

4.1.5.4 Grassland Birds

Grassland birds found during the study included horned larks, western meadowlark, chukar, gray partridge, and ring-necked pheasant. The estimated number of small grassland bird fatalities (horned lark and western meadowlark) per turbine per year and associated 90% confidence limits for the first year of study is 1.53 (0.80, 2.45), or approximately 63 per year for the entire facility (Table 6). The highest fatality rate for individual grassland bird species is horned lark at 1.20 fatalities per turbine per year or approximately 49 total per year for the 41 turbines. The estimated number of large grassland bird fatalities (i.e., upland gamebirds) per turbine per year and associated 90% confidence limits for the first year of study is 0.47 (0.15, 0.89), or approximately 19 per year for the entire facility (Table 6).

4.1.5.5 Nocturnal Migrants

Based on date of find and species, only three casualties were found which were considered nocturnal migrants – one red-breasted nuthatch and two unidentified passerines. The estimated number of nocturnal migrant fatalities per turbine per year and associated 90% confidence limits for first year of study is 0.27 (0.07, 0.57), or approximately 11 per year for the entire facility (Table 6).

4.1.5.6 Bats

Adjustments for carcass removal and observer detection bias for bats were made using the estimates for small birds[5]. The estimated number of bat fatalities per turbine per year and

[4] Large birds were considered all upland gamebirds, rock doves, and waterfowl.

[5] During the Stateline study seven bat carcasses that were intact and fresh when found were left in the field to monitor removal rates. Results suggested that scavenging rates were similar to or lower than small birds, however, because the sample size was so small this data was not used and estimates for small bird removal were used in the bat mortality estimates.

associated 90% confidence limits for first year of study is 1.88 (1.15, 2.80) (Table 6), resulting in an estimated 77 bat fatalities per year for the entire facility or approximately 48 total hoary bats fatalities per year and 29 total silver-haired bat fatalities per year.

4.1.6 Lighting Effects and Turbine Location Effects

Because of the very low number of observed avian nocturnal migrant fatalities the effect of turbine lights on avian mortality could not be calculated with good levels of confidence. For bats the observed fatality rates for lit turbines was 0.60 per turbine per year and 0.36 for unlit turbines. This difference was not statistically significant ($t = -1.0602$, $df = 39$, $p\text{-value} = 0.2956$, not statistically different) suggesting that turbine lighting did not attract bats.

4.2 Paired Plot Avian Use Surveys

Thirty-three point count surveys were conducted between April 22 and June 13, 2004. During the baseline studies conducted in 2001 and 2002, seven point count surveys were conducted at each of the same point count stations associated with Phase 1 (total of 84 point count surveys). A total of 43 species were identified during the point counts for all years. Twenty-two (22) species were identified in both the pre-construction and post-construction surveys.

4.2.1 Avian Use by Species

A total of 620 individual bird detections in 299 separate groups of birds were recorded during pre-construction surveys (Table 7). A total of 614 individual birds in 136 separate groups were recorded during post-construction surveys (Table 7). Approximately 59% of the observations were of horned larks and western meadowlarks over all years of study. The majority of species comprised less than 3% of the observations.

Mean use estimates (number of birds/10-minute survey) were calculated (using observations within 150m of each point) by species. For pre-construction surveys horned lark (2.892/survey), western meadowlark (0.652/survey), European starling (0.117/survey), and vesper sparrow (0.104/survey) were the species with the highest use at proposed turbine plots; and horned lark (1.890), western meadowlark (1.006), American goldfinch (0.1.82) and rock wren (0.156) were the species with the highest use at off-set point (Table 8). For post construction surveys horned lark (4.182), rock dove (0.576), rock wren (0.485), and Brewer's blackbird (0.424) were the species with the highest use at turbine plots; and horned lark (4.152), western meadowlark (0.879), rock wren (0.879) and western kingbird (0.576) were the species with the highest use at off-set points (Table 9).

4.2.2 Turbine and Off-Set Effects

The difference in bird use at turbine points and the offset points was compared for both pre- and post construction surveys. For the pre-construction surveys there was significantly greater use by horned larks at the turbine points (on ridges) than the offset points and significantly less use by western meadowlarks at the turbines points than the offset points (Table 8). For post-construction surveys there was significantly less use again by western meadowlark at the turbine points than the offset points (Table 9).

4.2.3 Pre- and Post-Construction Effects

The difference in bird use between pre- and post-construction surveys was also compared for both the turbine and offset points (Table 10). For all passerines combined there was a significant increase in use post-construction for the offset survey point locations. There was also a significant increase in horned lark use at offset survey points post construction (Table 10). For western meadowlark there was a significant decrease in use at the turbine points post construction; and for rock wren there was a significant increase in use at both turbine and offset points post-construction.

4.3 Raptor Nest Surveys

Ferruginous hawk nest monitoring occurred between April 22 and May 21, 2004. Two ferruginous hawk nests were located in the study area (wind project plus area within a 2-mile buffer). Neither of the two ferruginous hawk nests located during the baseline studies (2001-2002) were active in 2004.

No active ferruginous hawk nests were located within the project area; however, the two active ferruginous nests were located within the two mile buffer zone. The first nest was approximately 0.25 mile southeast of Turbine 13 (Figure 4). It is located in a dead black locust in the bottom of a draw to the south of the turbines. One adult bird was present, and it was circling above the nest on May 21, 004. Three small juveniles were observed in the nest.

The second nest was located in a poplar tree approximately 0.5 miles south of Turbine 26 and south of a gravel quarry. There was an adult sentinel that flew first from an adjacent tree. Another adult flew from the nest and perched nearby. Observations were made from the road, where it was not possible to see if there were eggs or young in the nest.

The historic nests located during the baseline studies were checked, and all were found to be inactive. Ferruginous nest 10 (FEHA10) which is located in the project area east of turbines 10 and 11 was checked on April 22 and May 8, 2005. This nest appears to be falling apart and was not being used. This nest is approximately 0.75 mile northeast of the new nest located southeast of Turbine 13. Ferruginous nest 9 (FEHA9), which is just south of the 2-mile buffer (Figure 4) was occupied by common ravens on May 13, 2004. Ferruginous nest 47 (FEHA47) is a historic nest on North Fork Juniper Canyon Road and outside the study area. It was occupied by a great-horned owl in April, and was inactive on May 13, 2004.

4.4 Sensitive Species Surveys

No burrowing owl nests or Washington ground squirrel colonies are know to occur within 1,000 feet (300 m) of the Combine Hills Phase 1 project facilities, nor were any discovered during the first year of monitoring activities. No sensitive species monitoring occurred during the first year of monitoring of the project.

5.0 SUMMARY/DISCUSSION

The Combine Hills Turbine Ranch Phase 1 is located in an area with extensive wind power development. Umatilla County, Oregon and Walla Walla County, Washington are home to three utility scale wind projects: the Vansycle wind plant (24 MW), the Stateline wind project (300 MW), and the Combine Hills Turbine Ranch (41 MW). Monitoring studies have occurred at these wind projects since the late 1990's providing a pool of data for comparison. Studies at the Combine Hills project were designed to provide comparable results and utilized information gained from the Stateline wind project studies.

5.1 Bird and Bat Fatality Estimates

The overall study design incorporates several assumptions or factors that affect the results of the fatality estimates. First, all bird casualties found during the study were included in the analysis. One carcass was found incidentally during other activities on-site and it was assumed that this carcass would have been found during a scheduled carcass search. 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 many of the fatalities. Several of the upland gamebird fatalities are suspected to be caused by predators and some of the casualties may have been due to vehicles on project roads. It is likely that some of the casualties included in the estimates were due to natural causes (background mortality) such as predation[6]. The effect of these assumption is that the analysis provides a conservative estimate (an over estimate) of mortality due to the wind plant.

No adjustments were made for fatalities possibly occurring outside of the rectangular plot boundaries. Plot boundaries were established a minimum distance of 90 m from the turbines (Figure 2). Because the search plots were rectangular in shape, the maximum distance to a turbine within a search plot was 127 m at the corners. Also, because observers search both sides out to roughly 6 m, the effective transect length is nearly 100 m (90 m plus 5 m on either end). The search plot distance for this study was selected based on results of other studies (Higgins *et al.* 1996) where a 63 m distance appeared to capture a very large percentage of fatalities at smaller turbines and adjusted upwards based on the size and height of the Combine Hills turbines. Based on the distribution of fatalities as a function of distance from turbines (Figure 6), a small percentage of bird fatalities likely fell outside the search plots and were probably missed. This factor would lead to an underestimate of bird fatality rates.

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[6] A few wind project studies have provided information on background mortality. During a four-year study at Buffalo Ridge, Minnesota, 2,482 fatality searches were conducted on study plots without turbines to estimate reference mortality in the study area. Thirty-one (31) avian fatalities comprising 15 species were found (Johnson *et al.* 2000). Reference mortality for this study was estimated to average 1.1 fatalities per plot per year.

Some pre-project carcass searches were conducted at a proposed wind project in Montana (Harmata *et al.* 1998). Three bird fatalities were found during 8 searches of 5 transects, totaling 17.61 km per search. On average, approximately 1.8 km of transect is searched within every turbine search plot at Combine Hills. Therefore, the amount of transect searched at the Montana site per search was equivalent to searching approximately 9 turbines at Combine Hills. The background estimate for observed mortality would be approximately 0.33 per turbine plot per year, unadjusted for scavenging and searcher efficiency.

The background mortality information from Minnesota and Montana suggest that the estimates of bird mortality include some avian fatalities not related to turbine collision, and this factor alone would lead to an over-estimate of true avian collision mortality at wind plants.

The distribution of bat fatalities at Combine Hills (see Figures 2 and 6) and at other sites (e.g., Erickson *et al.* 2004a, Young *et al.* 2003c, Kerlinger and Kerns 2004) suggest bat casualties fall closer to turbines than bird casualties. No bat carcasses were found beyond 79 m from a turbine and it is unlikely that many bats fell outside the effective search area.

The trial carcasses used in the observer detection trials are believed to be reasonably representative of actual fatalities. It would be preferable to use "fresh" trial carcasses of species found in the project area, however, this is not practical and there is a risk of mistaking trial carcasses with actual fatalities. Therefore, unprotected species or commercially available species that were less common in the study area were used for the observer detection trials.

For the scavenging removal trials, it was agreed during the protocol development process that results from the nearby Stateline wind project studies could be used for this study. This may have some bias associated with locality but in general it is reasonable to assume that similar removal rates would be found at the Combine Hills site for a number of reasons. Much of the habitat between the two wind projects is similar. Dryland wheat fields and native grassland/shrub-steppe are the dominate habitats for both projects. The Stateline monitoring has been on-going for greater than two years. The scavenging removal data set is large and the estimates of length of stay for carcasses in the field are considered accurate. To obtain comparable results at the Combine Hills project would require a large number of carcasses be placed in the field which could affect the density of scavengers. Common scavengers recorded at Stateline (common raven, coyote) are free ranging species that can easily travel between the two projects. Results from the Stateline removal trials are similar to the Vansycle wind project monitoring study (Erickson *et al.* 2000), which is also very close to the Combine Hills project.

The overall bird fatality rate calculated for Combine Hills (2.56 per turbine per year) is higher than the estimates reported for Stateline (1.93) and Vansycle (0.63) (Erickson *et al*. 2004a and Erickson *et al.* 2000) and is slightly higher than the average bird fatality rates reported for new generation wind projects in the U.S. (2.11 per turbine per year, Erickson *et al.* 2004b). However, fatality estimates on a per turbine basis may be misleading when comparing different wind energy projects since turbine sizes vary among projects. For example, the Mitsubishi MWT-1000A turbines at Combine Hills are 1.0 MW turbines with a rotor swept area of approximately 2961 m^2. The nearby Stateline project used Vestas V-47 0.66 kW turbines with a rotor swept area of approximately 1735 m^2. Fatality estimates for smaller turbines may be less per turbine than for larger turbines, however, it would take more small turbines to generate the same amount of electricity. In an effort to account for differences in turbine size, the fatality rates standardized to a per rotor swept area can be compared. For this study, the rotor swept area equivalent to 1 MW was used. For Combine Hills where 1.0 MW turbines were used, the estimate is the same as the per turbine estimate (2.56 bird fatalities per MW), which is slightly lower than Stateline, 2.90 fatalities per MW capacity, and the overall average for new generation wind projects in the U.S of 3.05 fatalities per MW (Erickson *et al.* 2004b).

The overall bat fatality rate for Combine Hills (1.88 per turbine per year) is above the Stateline estimate for bat fatalities (1.12 per turbine per year) and the average bat fatality rate reported for western and mid-western wind projects in the U.S. (1.40 per turbine per year, Johnson *et al*. 2004). On a per rotor swept area equivalent to one MW basis, the Combine Hills estimate is similar to the Stateline bat fatality estimate (1.70 per MW capacity per year) and below the average rate for new generation wind projects in the west and mid-west of 2.10 per MW. Bat fatality estimates at new projects are more variable than bird estimates, with the highest estimates occurring at sites in the east (Nicholson 2003, Kerlinger and Kerns 2004). Based on these comparisons, bird and bat mortality at Combine Hills is similar to other newer generation wind projects studies in the Pacific Northwest and U.S. in general.

5.2.1 Species Composition

Species composition for bird casualties was similar to composition at other sites in the Pacific Northwest with horned lark making up the majority of the casualties. When grouped together, upland gamebirds were the next most common fatalities. Some notable differences to the nearby Stateline project are the lack of any raptor fatalities and golden-crowned kinglet fatalities at Combine Hills. Golden-crowned kinglets were the second most common passerine fatality at Stateline, yet none were found at Combine Hills.

Species composition for bats was almost identical to other Pacific Northwest projects with only two species found – silver-haired and hoary bat. Three silver-haired bat fatalities were found in early summer (June) at Combine Hills as compared to only one found during this same period at Stateline. The majority of bat fatalities were found in the late summer and early fall during the time period when both silver-haired and hoary bats are migrating (Hayes and Waldien 2000). Fatality rates at the Combine Hills project and other projects in the Pacific Northwest and Midwest are much lower than estimates from two of the most recently studied wind projects in the East (Kerlinger and Kerns 2004, Nicholson 2003). Bat Conservation International (BCI), the American Wind Energy Association (AWEA), the U.S. Fish and Wildlife Service, and the U.S. Department of Energy's National Renewable Energy Laboratory (NREL) have joined in a collaborative effort to study bats and wind turbine interactions in an effort to identify some mitigation strategies for minimizing or preventing bat fatalities at wind projects. Results and study recommendations from this collaborative study should be reviewed when available and considered for possible inclusion in the second year of study at Combine Hills.

5.2.2 Nocturnal Migrants and Lighting

Tall lighted structures are suspected of attracting nocturnal migrating birds, especially during inclement weather (Kerlinger 2000). There has been concern expressed that lighting wind turbines may increase the risk of collision fatalities for birds and bats if they are attracted to the lights. Typically not every turbine in a wind plant is lit, however, and to date, results have been inconclusive. Lighting at other structures like communication towers is typically different than lighting at wind turbines. Communication towers may have more than one light on a tower and therefore, cumulatively may have a stronger attraction (Kerlinger 2003). Wind turbines have only one location for the light on top of the nacelle.

The number of potential nocturnal avian migrants observed during the study (3) was too few for a meaningful analysis on the potential effects of lit versus unlit turbines. Bat fatality rates for lit turbines and unlit turbines were compared. Observed bat fatality rates were higher at unlit turbines (0.60/turbine/year) compared to lit turbines (0.36), but this difference was not statistically significant suggesting that, during the study, lighting did not appear to influence bat mortality. Similar results have been found at the Stateline wind project (Erickson *et al*. 2004a) and the Nine Canyon wind project (Erickson *et al.* 2003), which have the same lighting characteristics (red-flashing at night). The Buffalo Ridge wind project (Johnson *et al.* 2002) showed a similar result for smaller turbines than Combine Hills, although lighting types differ (solid red incandescent). It appears as if FAA required lighting on turbines does not influence the risk of bat mortality associated with wind turbines.

5.2 Grassland Bird Displacement

Results of the pair-plot avian use surveys suggest that there may be a relatively small-scale impact of the wind facility on grassland nesting passerines. One species, western meadowlark showed a significant negative decline in use at turbine locations between pre- and post-construction surveys. However, there was also significantly less use by this species at turbine plots versus off-set plots pre-construction. Over all passerines, there was a significant increase in bird use post-construction at the off-set survey points and no change at the turbine points suggesting that other factors which influence bird use may have greater influence than the turbines. For example, while the vegetation type of each survey point (agriculture versus grassland) remained the same pre- and post-construction, the wheat fields (agriculture) are typically rotated on an annual basis, so the presence of growing wheat versus a fallow field or wheat stubble at some points may have influenced bird use at the offset points.

The number of horned larks observed, which was by far the most common bird in the study area, increased post-construction and also likely influenced the analysis. Some studies in Europe have suggested that habitat quality may outweigh negative effects from wind turbines (e.g., Ketzenberg *et al*. 2002; Gill 2000a, 2000b). Horned larks are a prairie and steppe species that inhabit agriculture lands and native areas with low growing vegetation and a prevalence of bare ground (Beason 1995). The construction zone around the turbines in the early stages of recovery, while potentially void of vegetation, is certainly habitable by horned larks. The level of displacement of grassland birds by turbines may be more significant for some species which rely on the presence of vegetation (e.g., grasshopper sparrows). Unfortunately when some species such as horned lark are much more prevalent, effects on other less abundant species may go undetected or be masked. Small-scale displacement impacts to grassland nesting birds have been documented in several other studies of wind plants in the U.S. including the Stateline and the Buffalo Ridge projects (Erickson *et al*. 2004a, Leddy *et al.* 1999, Johnson *et al.* 2000). Continued monitoring of bird use near turbines may help determine if habitat impacts or avoidance of turbines are the more important factors.

5.3 Raptor Nesting

The overall objective of the ODFW is to monitor ferruginous hawk nests near wind developments and utilize the cumulative data from monitoring studies of wind projects in Oregon and the region to assess potential impacts from wind development. Ferruginous hawk is listed as a species of concern in Oregon and is a state threatened species in nearby Washington. While the sample size is very small, there are now two pairs of ferruginous hawks nesting within 2-miles of Combine Hills Phase 1 as opposed to one in 2002. During the baseline studies one ferruginous hawk nest was found within the boundary of the Combine Hills project and two others were found within approximately 3-4 miles of the site. During 2004 two ferruginous hawk pairs nested within 2 miles of the project area. It is suspected that the pair which nested within the project boundary moved to the location found in 2004 south of turbine 13. Up to four ferruginous hawk pairs have nested within 2-miles of the nearby Stateline project, however, results from those monitoring studies have been confounded by illegal shooting of two breeding adults by vandals during the study (Erickson *et al.* 2004a).

5.4 Additional Monitoring

The original monitoring plan for Combine Hills Phase 1 (Young *et al.* 2003a) calls for two years of monitoring studies which did not necessarily have to be consecutive years. Components of the study will be continued for a second year including: (1) the fatality monitoring and searcher efficiency trials; (2) the paired plot breeding bird surveys; and (3) the ferruginous hawk nest monitoring. Once the structured monitoring studies are complete, the Wildlife Response and Reporting System (WRRS) for documentation and reporting of incidentally discovered fatalities will be implemented for the duration of the project. It is recommended that based on the results of the first year of monitoring and the monitoring program of the nearby Stateline wind project, that the second year of monitoring for Combine Hills Phase 1 be postponed until habitat in the project area has fully recovered and/or construction of Phase 2 is complete. The timing of construction of Phase 2 of the Combine Hills development should be considered in planning the continued monitoring of Phase 1 to minimize confounding effects such as construction disturbance. Delaying the study by two or more years, allows (1) comparison of mortality over a longer time frame to investigate changes over time (e.g., possible reduced mortality due to habituation or behavior responses to turbines); (2) recovery of vegetation in construction zones to investigate displacement effects; (3) long term changes in populations (e.g., increased number of nesting ferruginous hawks); and (4) comparison between different turbine types within a development or to a nearby development. Prior to the initiation of the second year of monitoring, new developments and results from wind project monitoring as a whole should be considered to determine if changes to the sampling protocol should be made.

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Table 1. List of turbines and number of avian fatalities observed in standardized search plots from February 9, 2004 through February 8, 2005.

Turbine	# Fatalities
1	4
18	3
12	2
17	2
21	2
22	2
24	2
25	2
34	2
38	2
3	1
8	1
9	1
11	1
13	1
14	1
20	1
28	1
30	1
32	1
40	1

Table 2. List of turbines and number of bat fatalities observed on standardized search plots from February 9, 2004 through February 8, 2005.

Turbine	# Fatalities
7	2
11	2
18	2
37	2
6	1
9	1
10	1
12	1
17	1
19	1
27	1
30	1
33	1
34	1
35	1
38	1
41	1

Table 3. Summary of avian fatality composition based on fatalities observed in standardized search plots from February 9, 2004 through February 8, 2005.

	Fatalities found during Standardized Search Plots	
Species	**Total**	**% Comp.**
horned lark	14	41.18
chukar	6	17.65
ring-necked pheasant	2	5.88
rock dove	2	5.88
unidentified passerine	2	5.88
American robin	1	2.94
black-billed magpie	1	2.94
Canada goose	1	2.94
European starling	1	2.94
gray partridge	1	2.94
northern flicker	1	2.94
red-breasted nuthatch	1	2.94
western meadowlark	1	2.94
Total (13 identified species)	34	100

Table 4. Summary of bat fatality composition based on fatalities observed on standardized search plots from February 9, 2004 through February 8, 2005.

	Fatalities found on Standardized Search Plots	
Species	**Total**	**% Comp.**
hoary bat	13	61.90
silver-haired bat	8	38.10
Total (2 identified species)	21	100.00

Table 5. Results of observer detection trials conducted from February 9, 2004 through February 8, 2005.

	Overall	
Habitat	**# Placed**	**% Found**
Agriculture – High	15	27%
Agriculture – Short	14	79%
Grassland	33	55%
Reclaimed	12	50%
Overall	74	53%
	Large Birds	
Habitat	**# Placed**	**% Found**
Agriculture – High	9	33%
Agriculture – Short	8	75%
Grassland	21	52%
Reclaimed	7	57%
Overall	45	53%
	Small Birds	
Habitat	**# Placed**	**% Found**
Agriculture – High	6	17%
Agriculture – Short	6	83%
Grassland	12	58%
Reclaimed	5	40%
Overall	29	52%

Table 6. Mortality estimates for birds and bats associated with the first year of monitoring of the Combine Hills Turbine Ranch.

			90% Confidence Limits	
	Estimate	se	ll	ul
Searcher Efficiency Rates				
Large Birds	0.56	0.08	0.44	0.69
Small Birds	0.53	0.09	0.38	0.69
Mean Carcass Removal Times (days)				
Large Birds	35.82	3.20	30.85	41.40
Small Birds	16.79	1.33	14.65	19.03
Available and Detection Probabilities				
Large Birds	0.48	0.05	0.39	0.56
Small Birds	0.28	0.04	0.21	0.35
Fatality Estimates (#/turbine/yr)				
Small Birds	1.89	0.56	1.10	2.89
Large Birds	0.67	0.26	0.31	1.15
All Birds	2.56	0.59	1.70	3.60
Small Grassland Birds	1.53	0.51	0.80	2.45
Large Grassland Birds	0.47	0.23	0.15	0.89
All Grassland Birds	2.00	0.54	1.20	2.96
Nocturnal Migrants	0.27	0.16	0.07	0.57
Bats	1.88	0.51	1.15	2.80

Table 7. The number of observations and groups for species observed within 150m of the paired-ploy survey points.

Species/Group	Pre-construction # obs	Pre-construction # grp	Post-construction # obs	Post-construction # grp
Raptors	**19**	**16**	**24**	**8**
American kestrel	6	5	2	1
golden eagle	0	0	4	1
northern harrier	3	3	6	1
red-tailed hawk	9	7	9	4
Swainson's hawk	0	0	3	1
unidentified buteo	1	1	0	0
Gamebirds	**11**	**9**	**17**	**2**
chukar	2	1	3	1
ring-necked pheasant	9	8	14	1
Doves/Pigeons	**4**	**2**	**28**	**7**
mourning dove	4	2	3	1
rock dove	0	0	25	6
Other Birds	**3**	**2**	**0**	**0**
common nighthawk	3	2	0	0
Passerines	**583**	**270**	**545**	**119**
Grassland	*462*	*202*	*328*	*73*
grasshopper sparrow	10	9	7	1
horned lark	318	112	275	55
lark sparrow	0	0	13	2
savannah sparrow	11	5	0	0
unidentified sparrow	1	1	0	0
vesper sparrow	17	10	1	1
western meadowlark	100	63	32	14
white-crowned sparrow	5	2	0	0
American goldfinch	14	2	10	2
American pipit	9	2	0	0
American robin	12	5	4	1
Baltimore oriole	1	1	0	0
bank swallow	3	2	0	0
barn swallow	1	1	2	1
black-billed magpie	6	5	6	2
black-headed grosbeak	1	1	1	1
Brewer's blackbird	0	0	30	5
brown-headed cowbird	0	0	4	1
Bullock's oriole	4	3	14	4
cliff swallow	2	2	0	0
common raven	10	4	5	2
eastern kingbird	4	3	0	0
European starling	9	4	21	5
house wren	0	0	10	2
northern rough-winged swallow	6	4	16	2
red-winged blackbird	6	4	15	4
rock wren	18	12	45	9
Say's phoebe	2	1	0	0
song sparrow	1	1	12	1
unidentified empidomax	1	1	0	0
violet-green swallow	2	2	0	0

Species/Group	Pre-construction # obs	Pre-construction # grp	Post-construction # obs	Post-construction # grp
western flycatcher	2	1	0	0
western kingbird	4	4	22	4
western wood-pewee	1	1	0	0
Wilson's warbler	1	1	0	0
yellow-rumped warbler	1	1	0	0
Total	**620**	**299**	**614**	**136**

Table 8. Mean index of bird density (number observed per 10-minute survey) for turbine and offset survey points and the differences pre-construction.

Species/Group	Turbine	Offset	Diff-mean	Std. Err	90% LCL	90% UCL
Raptors	***0.110***	***0.173***	***-0.063***	***0.068***	***-0.187***	***0.061***
American kestrel	0.028	0.052	-0.024	0.047	-0.110	0.062
northern harrier	0.043	0.013	0.030	0.036	-0.035	0.095
red-tailed hawk	0.039	0.095	-0.056	0.054	-0.154	0.042
unidentified buteo	0.000	0.013	-0.013	0.013	-0.037	0.011
Gamebirds	***0.052***	***0.091***	***-0.039***	***0.039***	***-0.110***	***0.032***
Chukar	0.000	0.026	-0.026	0.026	-0.073	0.021
ring-necked pheasant	0.052	0.065	-0.013	0.049	-0.102	0.076
Doves/Pigeons	***0.000***	***0.052***	***-0.052***	***0.052***	***-0.146***	***0.042***
mourning dove	0.000	0.052	-0.052	0.052	-0.146	0.042
Other Birds	***0.013***	***0.026***	***-0.013***	***0.030***	***-0.068***	***0.042***
common nighthawk	0.013	0.026	-0.013	0.030	-0.068	0.042
Passerines	***4.413***	***4.301***	***0.113***	***0.675***	***-1.111***	***1.336***
Grassland Species	*3.807*	*3.225*	*0.582*	*0.459*	*-0.249*	*1.414*
grasshopper sparrow	0.071	0.067	0.004	0.060	-0.105	0.114
Horned lark[b]	2.892	1.890	1.002	0.306	0.448	1.557
savannah sparrow	0.058	0.091	-0.032	0.088	-0.192	0.127
unidentified sparrow	0.000	0.015	-0.015	0.015	-0.043	0.012
vesper sparrow	0.104	0.117	-0.013	0.013	-0.037	0.011
western meadowlark[a]	0.652	1.006	-0.355	0.111	-0.557	-0.153
American goldfinch	0.000	0.182	-0.182	0.135	-0.426	0.063
American pipit	0.000	0.121	-0.121	0.093	-0.290	0.047
American robin	0.039	0.117	-0.078	0.124	-0.302	0.147
Baltimore oriole	0.000	0.013	-0.013	0.013	-0.037	0.011
bank swallow	0.061	0.013	0.048	0.063	-0.067	0.162
barn swallow	0.013	0.000	0.013	0.013	-0.011	0.037
black-billed magpie	0.026	0.052	-0.026	0.017	-0.058	0.006
black-headed grosbeak	0.000	0.013	-0.013	0.013	-0.037	0.011
Bullock's oriole	0.000	0.052	-0.052	0.052	-0.146	0.042
cliff swallow	0.043	0.000	0.043	0.032	-0.014	0.101
common raven	0.074	0.093	-0.019	0.105	-0.211	0.172
Eastern kingbird	0.026	0.026	0.000	0.019	-0.035	0.035
European starling	0.117	0.000	0.117	0.117	-0.095	0.329
northern rough-winged swallow	0.039	0.039	0.000	0.058	-0.105	0.105
red-winged blackbird	0.000	0.078	-0.078	0.056	-0.179	0.023
rock wren	0.078	0.156	-0.078	0.121	-0.297	0.141
Say's phoebe	0.026	0.000	0.026	0.026	-0.021	0.073
song sparrow	0.000	0.013	-0.013	0.013	-0.037	0.011
unidentified empidomax	0.000	0.013	-0.013	0.013	-0.037	0.011
violet-green swallow	0.013	0.030	-0.017	0.034	-0.079	0.045
western flycatcher	0.026	0.000	0.026	0.026	-0.021	0.073
western kingbird	0.026	0.026	0.000	0.027	-0.049	0.049
western wood-pewee	0.000	0.013	-0.013	0.013	-0.037	0.011
white-crowned sparrow	0.030	0.039	-0.009	0.052	-0.102	0.085
Wilson's warbler	0.000	0.013	-0.013	0.013	-0.037	0.011
Yellow-rumped warbler	0.000	0.013	-0.013	0.013	-0.037	0.011

[a] significantly different than 0 and negative, suggesting a negative impact due to location
[b] significantly different than 0 and positive, suggesting a positive impact due to location

Table 9. Mean index of bird density (number observed per 10-minute survey) for turbine and offset survey points and the differences post-construction.

Species/Group	Turbine	Offset	Diff-mean	Std. Err	90% LCL	90% UCL
Raptors	***0.333***	***0.394***	***-0.061***	***0.320***	***-0.641***	***0.520***
American kestrel	0.061	0.000	0.061	0.061	-0.049	0.170
Golden eagle	0.121	0.000	0.121	0.121	-0.098	0.341
northern harrier	0.000	0.182	-0.182	0.182	-0.511	0.148
red-tailed hawk	0.061	0.212	-0.152	0.138	-0.401	0.098
Swainson's hawk	0.091	0.000	0.091	0.091	-0.074	0.256
Gamebirds	***0.091***	***0.424***	***-0.333***	***0.443***	***-1.136***	***0.469***
Chukar	0.091	0.000	0.091	0.091	-0.074	0.256
ring-necked pheasant	0.000	0.424	-0.424	0.424	-1.193	0.345
Doves/Pigeons	***0.576***	***0.273***	***0.303***	***0.332***	***-0.298***	***0.904***
mourning dove	0.000	0.091	-0.091	0.091	-0.256	0.074
rock dove	0.576	0.182	0.394	0.308	-0.163	0.951
Passerines	***5.848***	***10.667***	***-4.818***	***3.570***	***-11.290***	***1.653***
Grassland	*4.273*	*5.667*	*-1.394*	*1.491*	*-4.096*	*1.308*
grasshopper sparrow	0.000	0.212	-0.212	0.212	-0.597	0.172
Horned lark	4.182	4.152	0.030	1.156	-2.065	2.125
lark sparrow	0.000	0.394	-0.394	0.287	-0.914	0.127
vesper sparrow	0.000	0.030	-0.030	0.030	-0.085	0.025
western meadowlark[a]	0.091	0.879	-0.788	0.296	-1.324	-0.252
American goldfinch	0.000	0.303	-0.303	0.244	-0.745	0.139
American robin	0.000	0.121	-0.121	0.121	-0.341	0.098
barn swallow	0.061	0.000	0.061	0.061	-0.049	0.170
black-billed magpie	0.000	0.182	-0.182	0.182	-0.511	0.148
black-headed grosbeak	0.000	0.030	-0.030	0.030	-0.085	0.025
Brewer's blackbird	0.424	0.485	-0.061	0.389	-0.765	0.644
brown-headed cowbird	0.121	0.000	0.121	0.121	-0.098	0.341
Bullock's oriole	0.000	0.424	-0.424	0.277	-0.927	0.079
common raven	0.000	0.152	-0.152	0.104	-0.340	0.037
European starling	0.273	0.364	-0.091	0.169	-0.397	0.215
house wren	0.000	0.303	-0.303	0.303	-0.852	0.246
northern rough-winged swallow	0.000	0.485	-0.485	0.352	-1.123	0.153
red-winged blackbird	0.121	0.333	-0.212	0.235	-0.638	0.213
rock wren	0.485	0.879	-0.394	0.386	-1.094	0.306
song sparrow	0.000	0.364	-0.364	0.364	-1.023	0.295
western kingbird	0.091	0.576	-0.485	0.352	-1.123	0.153

[a] significantly different than 0 and negative, suggesting a negative impact due to the turbine

Table 10. Mean index of density for species observed during both pre- and post-construction surveys and the differences for turbine and offset survey points.

Species/Group	Position	Pre	Post	Diff-mean	Std. Err	90% LCL	90% UCL
Raptors	***turbine***	***0.110***	***0.333***	***0.223***	***0.196***	***-0.132***	***0.578***
	off-set	***0.173***	***0.394***	***0.221***	***0.211***	***-0.161***	***0.603***
American kestrel	turbine	0.028	0.061	0.032	0.066	-0.087	0.152
	off-set	0.052	0.000	-0.052	0.040	-0.124	0.020
northern harrier	turbine	0.043	0.000	-0.043	0.032	-0.101	0.014
	off-set	0.013	0.182	0.169	0.184	-0.164	0.502
red-tailed hawk	turbine	0.039	0.061	0.022	0.070	-0.106	0.149
	off-set	0.095	0.212	0.117	0.105	-0.074	0.308
Gamebirds	***turbine***	***0.052***	***0.091***	***0.039***	***0.070***	***-0.087***	***0.165***
	off-set	***0.091***	***0.424***	***0.333***	***0.377***	***-0.350***	***1.017***
chukar	turbine	0.000	0.091	0.091	0.091	-0.074	0.256
	off-set	0.026	0.000	-0.026	0.026	-0.073	0.021
ring-necked pheasant	turbine	0.052	0.000	-0.052	0.029	-0.105	0.001
	off-set	0.065	0.424	0.359	0.374	-0.318	1.037
Doves/Pigeons	***turbine***	***0.000***	***0.576***	***0.576***	***0.337***	***-0.034***	***1.186***
	off-set	***0.052***	***0.273***	***0.221***	***0.182***	***-0.109***	***0.551***
mourning dove	turbine	0.000	0.000	0.000	0.000		
	off-set	0.052	0.091	0.039	0.039	-0.032	0.110
Passerines	***turbine***	***4.413***	***5.848***	***1.435***	***0.940***	***-0.269***	***3.139***
	off-set [b]	***4.301***	***10.667***	***6.366***	***3.306***	***0.373***	***12.358***
Grassland Species	turbine	*3.807*	*4.273*	*0.465*	*0.964*	*-1.282*	*2.213*
	off-set	*3.225*	*5.667*	*2.442*	*1.508*	*-0.291*	*5.174*
grasshopper sparrow	turbine	0.071	0.000	-0.071	0.046	-0.155	0.012
	off-set	0.067	0.212	0.145	0.222	-0.258	0.548
horned lark	turbine	2.892	4.182	1.290	0.819	-0.195	2.775
	off-set [b]	1.890	4.152	2.262	0.964	0.514	4.010
vesper sparrow	turbine	0.104	0.000	-0.104	0.104	-0.292	0.084
	off-set	0.117	0.030	-0.087	0.073	-0.220	0.047
western meadowlark	turbine [a]	0.652	0.091	-0.561	0.156	-0.844	-0.277
	off-set	1.006	0.879	-0.128	0.324	-0.714	0.459
American goldfinch	off-set	0.000	0.000	0.000	0.000		
	off-set	0.182	0.303	0.121	0.140	-0.132	0.374
American robin	turbine	0.039	0.000	-0.039	0.028	-0.089	0.012
	off-set	0.117	0.121	0.004	0.004	-0.004	0.012
barn swallow	turbine	0.013	0.061	0.048	0.063	-0.067	0.162
	off-set	0.000	0.000	0.000	0.000		
black-billed magpie	turbine	0.026	0.000	-0.026	0.026	-0.073	0.021
	off-set	0.052	0.182	0.130	0.159	-0.159	0.419
black-headed grosbeak	turbine	0.000	0.000	0.000	0.000		
	off-set	0.013	0.030	0.017	0.017	-0.014	0.049
common raven	turbine	0.074	0.000	-0.074	0.061	-0.184	0.036
	off-set	0.093	0.152	0.058	0.140	-0.196	0.313
European starling	turbine	0.117	0.273	0.156	0.156	-0.127	0.438
	off-set	0.000	0.364	0.364	0.248	-0.086	0.813
northern rough-winged swallow	turbine	0.039	0.000	-0.039	0.039	-0.110	0.032
	off-set	0.039	0.485	0.446	0.360	-0.206	1.098
red-winged blackbird	turbine	0.000	0.121	0.121	0.121	-0.098	0.341
	off-set	0.078	0.333	0.255	0.153	-0.021	0.532

Species/Group	Position	Pre	Post	Diff-mean	Std. Err	90% LCL	90% UCL
rock wren	turbine [b]	0.078	0.485	0.407	0.210	0.026	0.788
	off-set [b]	0.156	0.879	0.723	0.303	0.173	1.273
song sparrow	turbine	0.000	0.000	0.000	0.000		
	off-set	0.013	0.364	0.351	0.351	-0.285	0.986
western kingbird	turbine	0.026	0.091	0.065	0.095	-0.107	0.237
	off-set	0.026	0.576	0.550	0.421	-0.213	1.312

[a] significantly different than 0 and negative, suggesting a negative impact due to the wind fatality
[b] significantly different than 0 and positive, suggesting no impact due to the wind fatality

Figure 1. Combine Hills Turbine Ranch Phase 1 development.

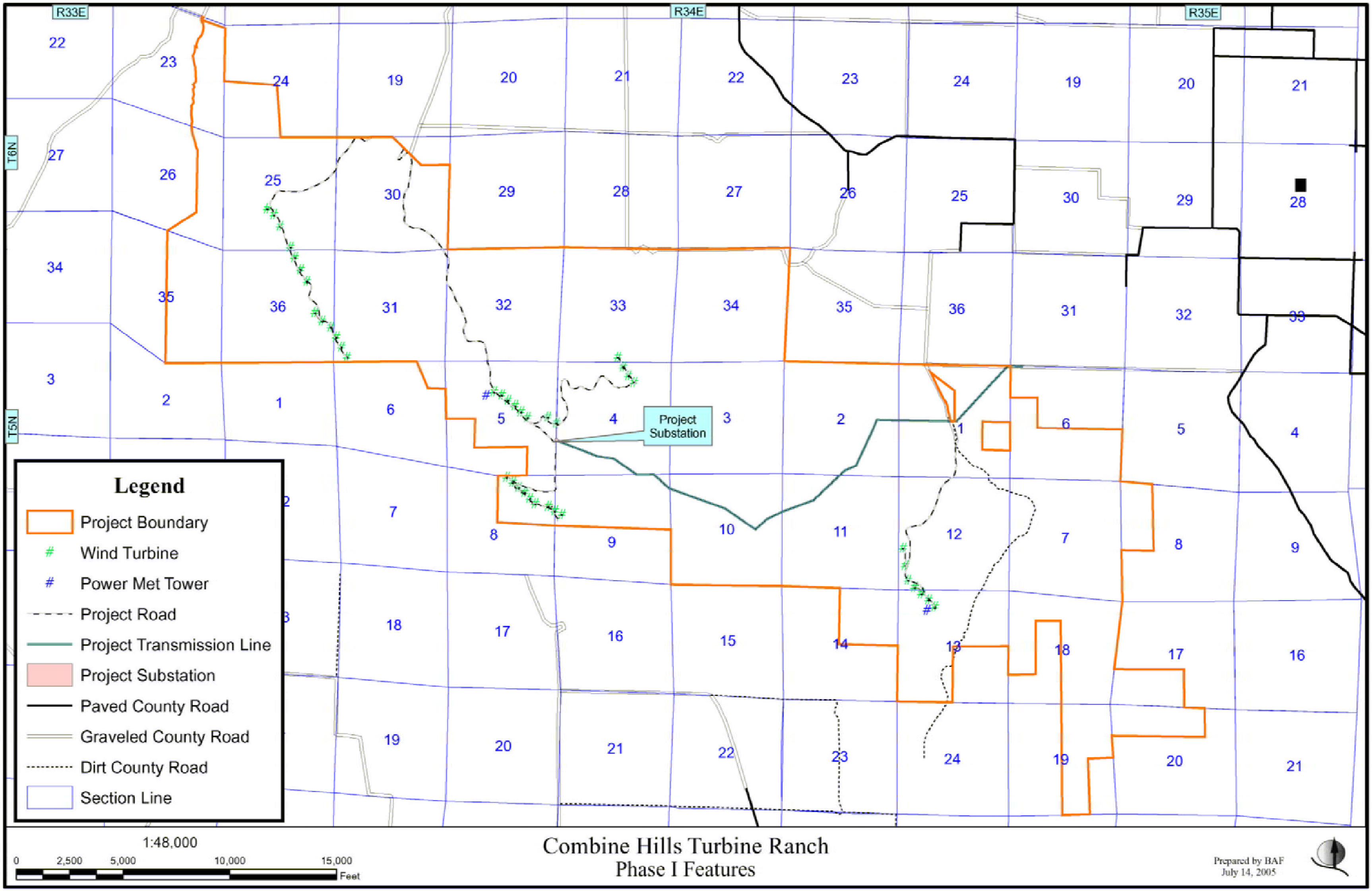


Figure 2a. Carcass search plots and distribution of carcasses found during the study. Northwest turbine strings.

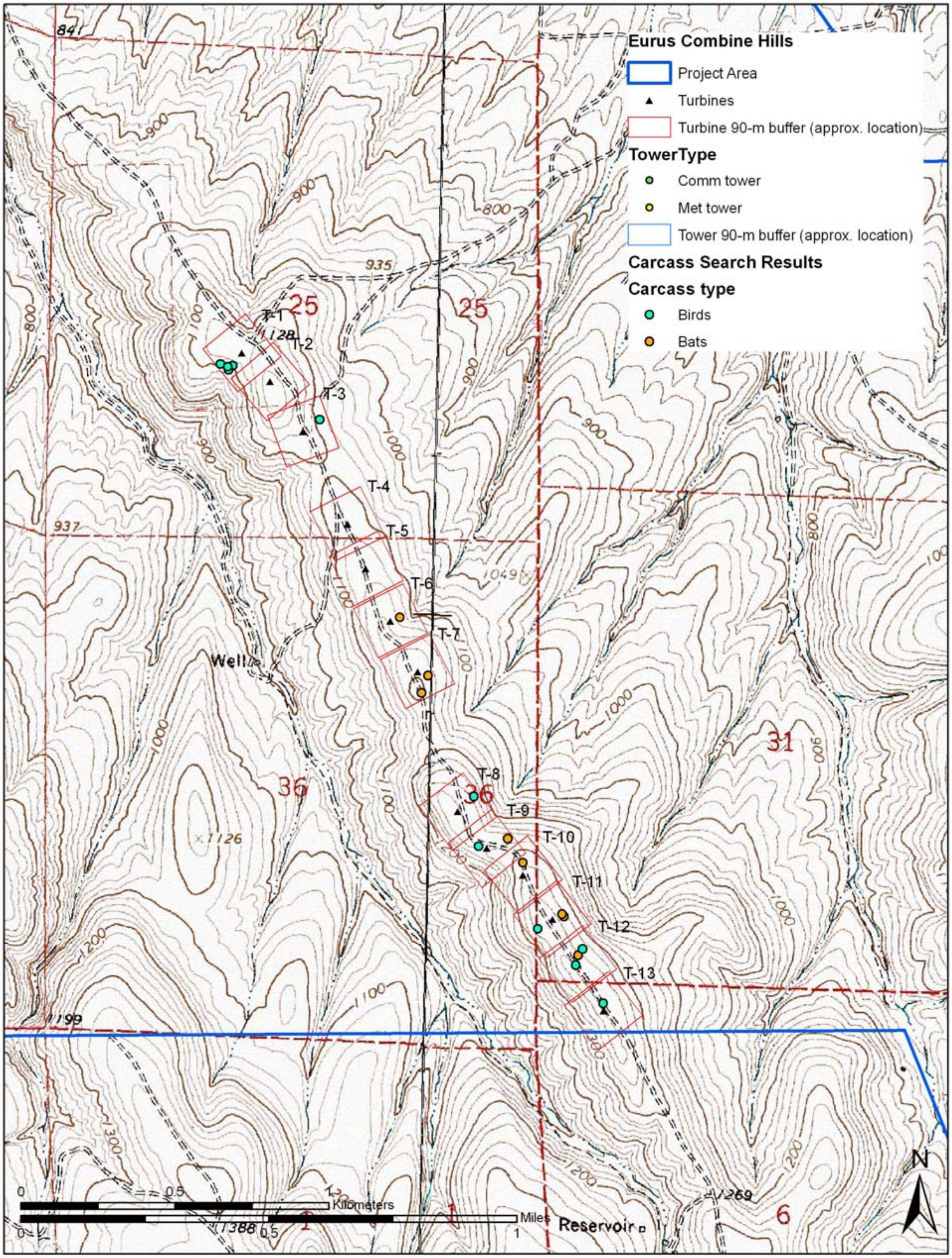


Figure 2b. Carcass search plots and distribution of carcasses found during the study. Central turbine strings.

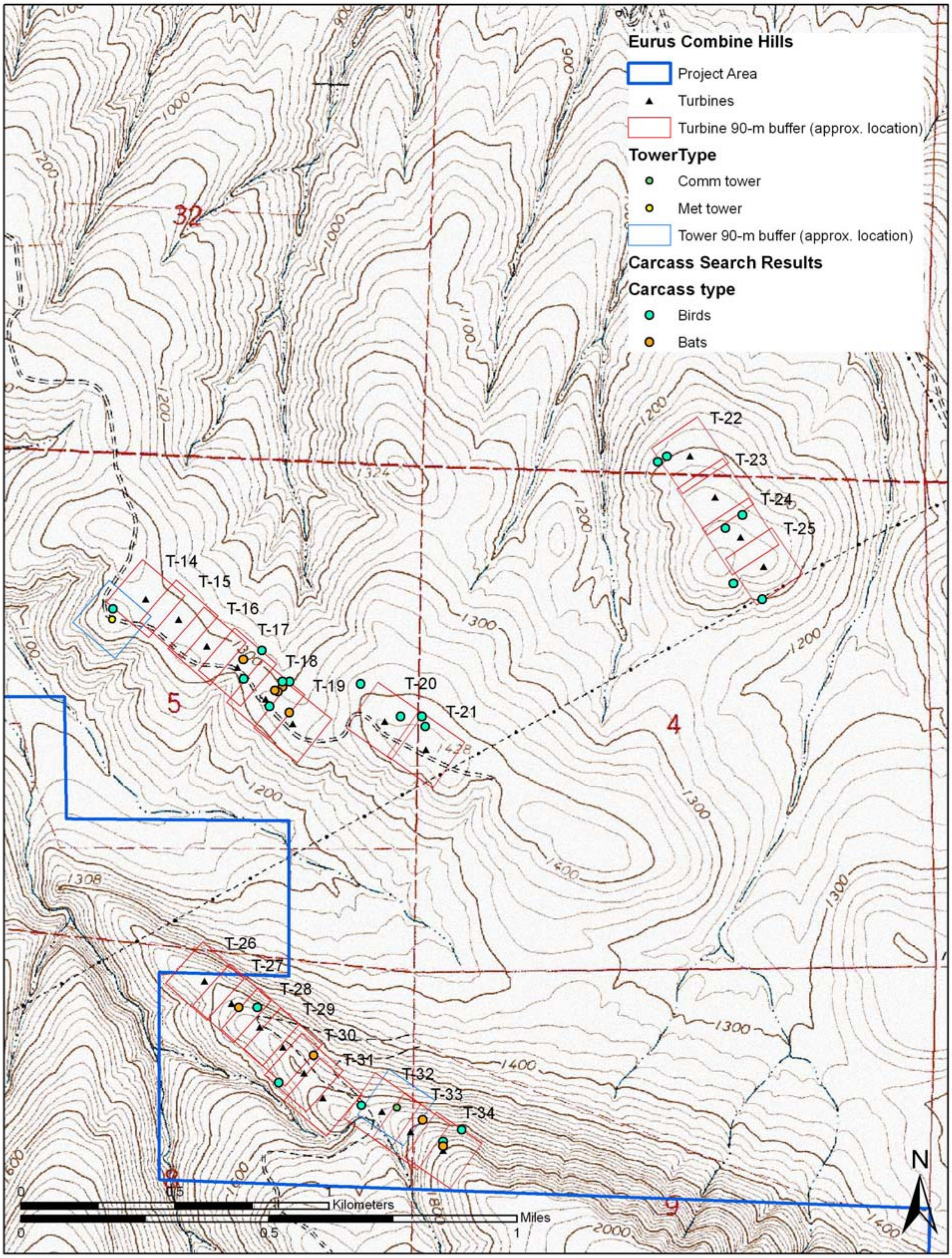


Figure 2c. Carcass search plots and distribution of carcasses found during the study. Southeastern turbine string.

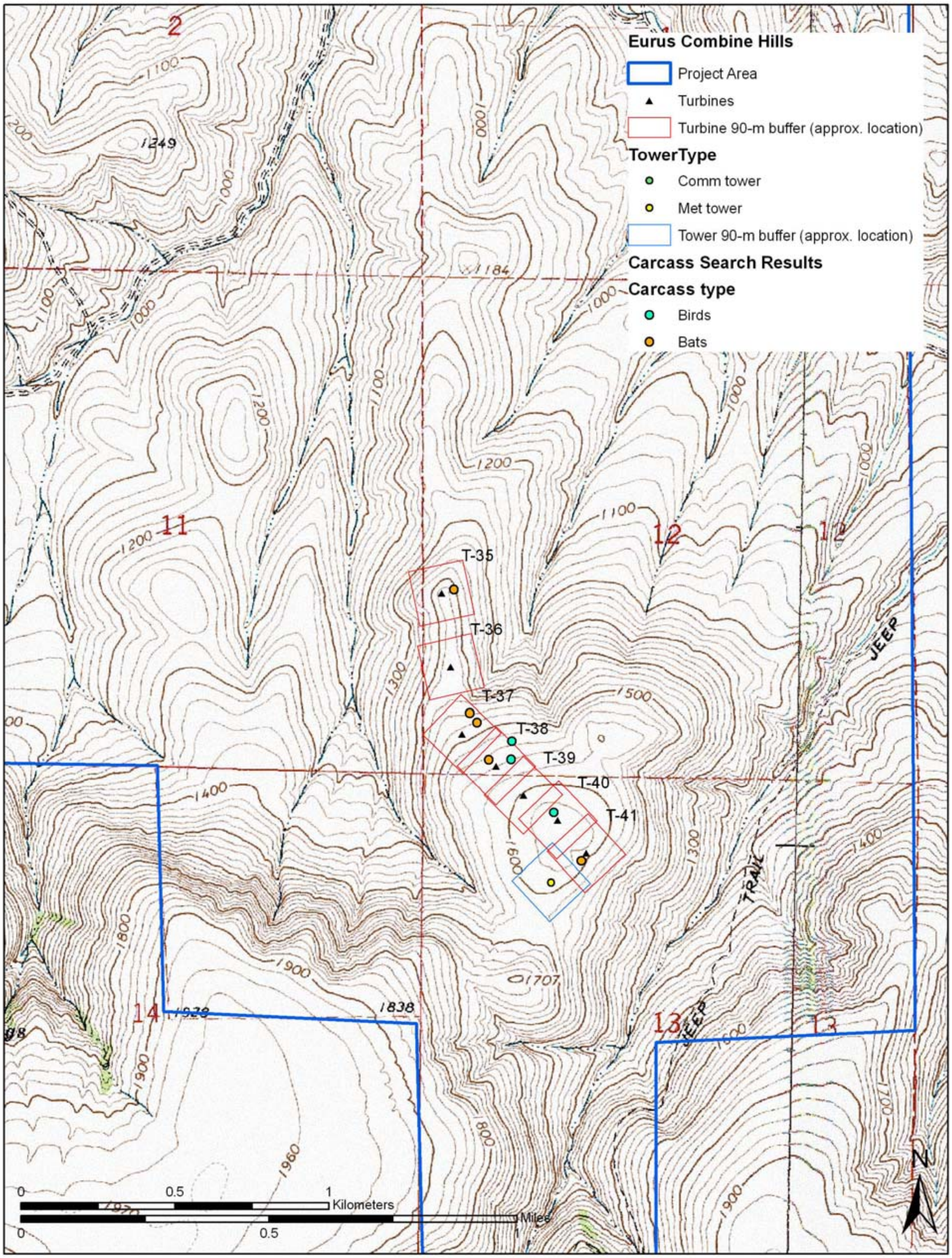


Figure 3. Paired plot survey locations.

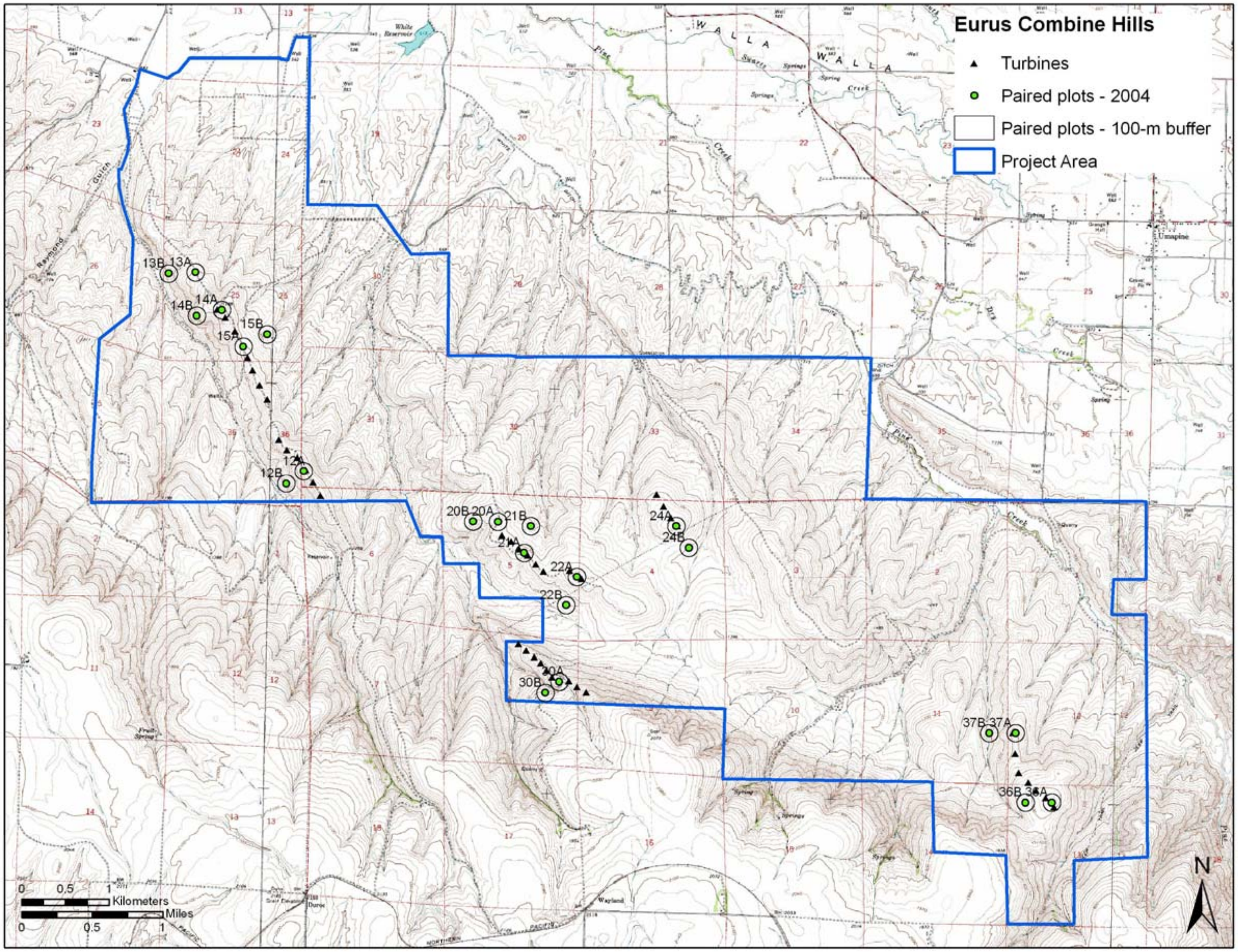


Figure 4. Ferruginous hawk nest locations in the project area.

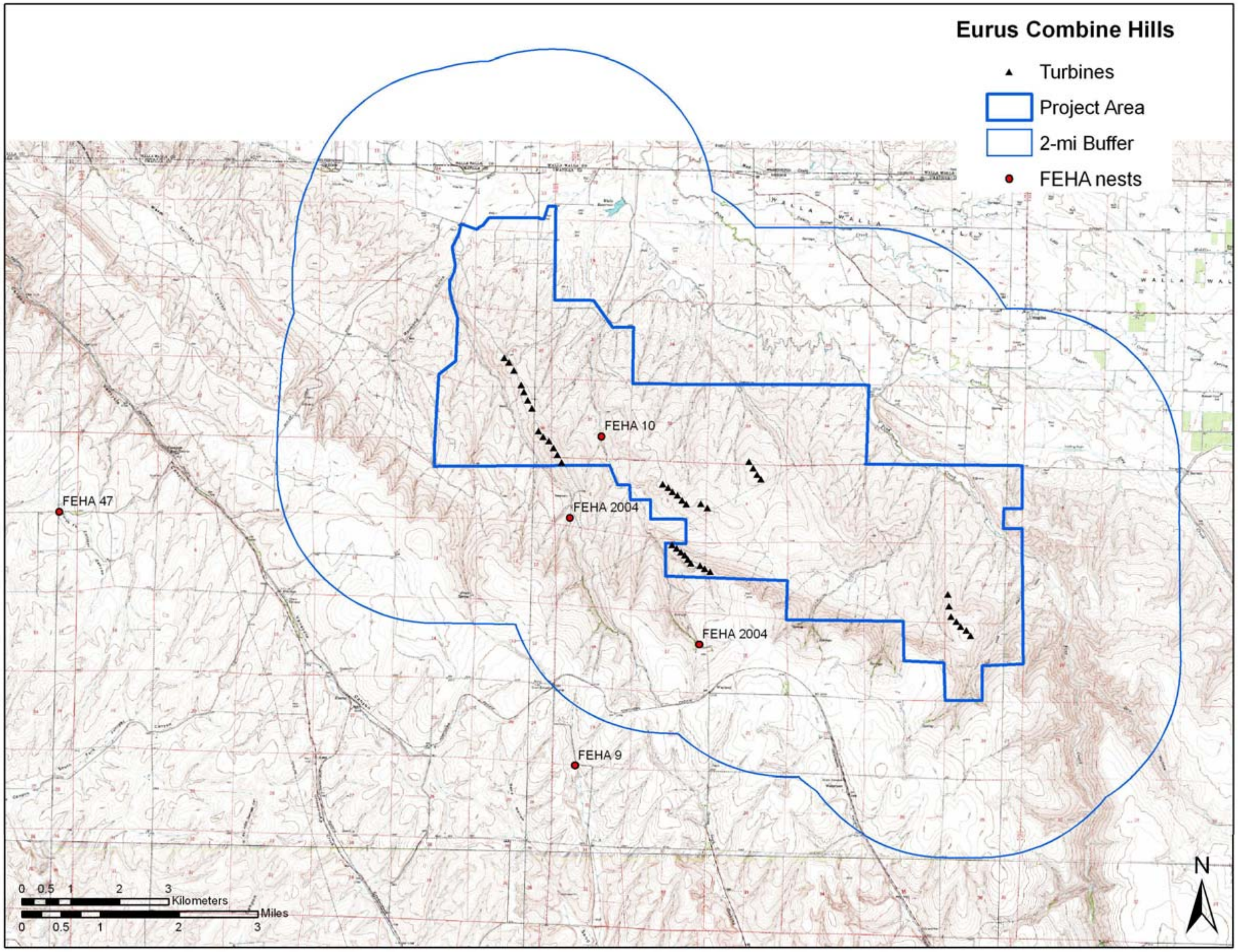
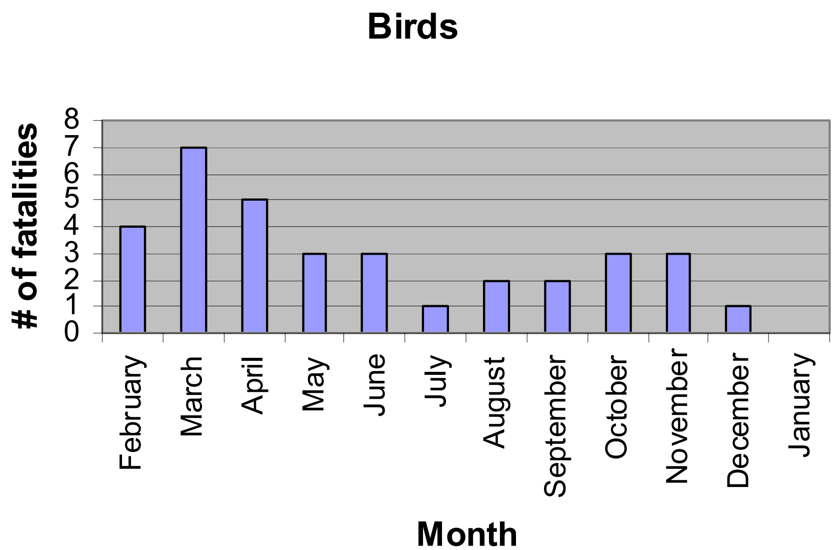


Figure 5. Seasonal distribution of carcass discovery over the one year study period.



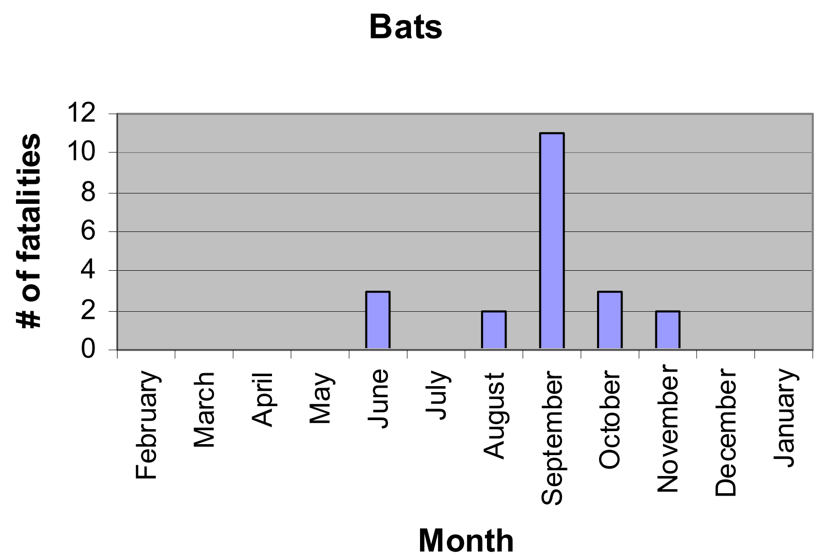
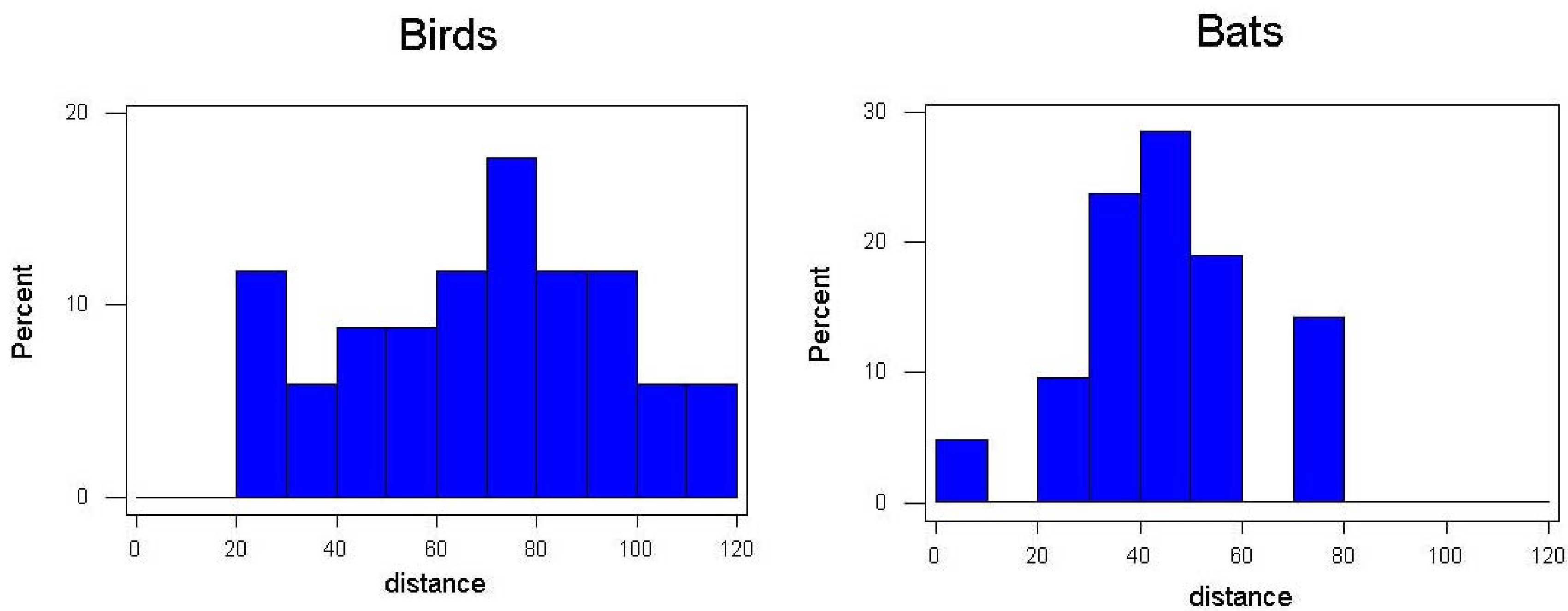


Figure 6. Distribution of carcasses as a function of distance (m) from turbine.



APPENDIX A
TURBINES AND TOWERS SAMPLED DURING STANDARDIZED SEARCHES

Turbine ID	Dominant Habitat[7]	Turbine Position[8]	FAA Light
1	GS	E	Y
2	GS	M	N
3	GS/AG	D	N
4	GS	D	Y
5	GS	M	Y
6	GS	M	N
7	GS	E	N
8	GS	E	Y
9	GS	M	N
10	GS/AG	M	N
11	GS	M	N
12	GS	M	N
13	GS	E	Y
14	AG	E	Y
15	AG	M	N
16	AG	M	N
17	AG	M	N
18	AG	M	Y
19	AG	M	N
20	GS/AG	M	N
21	GS/AG	E	Y
22	AG	E	Y
23	AG	M	N
24	AG	M	N
25	AG	E	N
26	GS	E	Y
27	GS	M	N
28	GS	M	N
29	GS	M	N
30	GS	M	N
31	GS	M	Y
32	GS	M	N
33	GS	E	N
34	GS	E	Y
35	GS	E	Y
36	GS	M	N
37	GS	M	N
38	GS	M	N
39	GS	M	N
40	GS	M	N
41	GS	E	Y
MET-14	GS		
MET-41	GS		
RAD-1	GS		

7 AG=agriculture (winter wheat, stubble, plowed), GS=grassland,

8 E=end-row, D=discontinuous/saddle, M=mid-row. A row was considered discontinuous if the space between two turbines was great enough so that one additional turbine could be spaced between them under normal spacing constraints for the turbines. If the area was large enough for two or more turbines, they were considered two turbine rows or strings.

APPENDIX B
LIST OF AVIAN FATALITIES OBSERVED DURING STANDARDIZED SEARCH FROM FEBRUARY 9, 2004 THROUGH FEBRUARY 8, 2005.

	Date	Species	Nearest Turbine	Distance to Nearest Turbine(m)
1	02/09/2004	horned lark[a]	11	49
2	02/10/2004	chukar	22	77
3	02/11/2004	horned lark	18	37
4	02/11/2004	unidentified passerine	25	110
5	03/01/2004	gray partridge	12	42
6	03/01/2004	horned lark	24	68
7	03/03/2004	chukar	1	64
8	03/05/2004	Canada goose	20	95.5[b]
9	03/29/2004	chukar	1	58
10	03/29/2004	European starling	3	66
11	03/31/2004	black-billed magpie	14	75[b]
12	04/01/2004	horned lark	18	90
13	04/01/2004	rock dove	21	86
14	04/01/2004	horned lark	25	115
15	04/28/2004	horned lark	24	66
16	04/29/2004	horned lark	40	23
17	05/02/2004	chukar	1	78
18	05/25/2004	horned lark	12	55
19	05/26/2004	horned lark	17	44
20	06/21/2004	ring-necked pheasant	1	76
21	06/22/2004	chukar	34	21
22	06/25/2004	American robin	38	58
23	07/21/2004	horned lark	13	29
24	08/16/2004	ring-necked pheasant	30	97
25	08/17/2004	chukar	28	75
26	09/14/2004	red-breasted nuthatch	8	85
27	09/15/2004	horned lark	9	28
28	10/14/2004	northern flicker	34	84
29	10/15/2004	unidentified passerine	38	104
30	10/16/2004	rock dove	21	38
31	11/10/2004	horned lark	17	103
32	11/11/2004	horned lark	22	95
33	11/15/2004	western meadowlark	32	82
34	12/08/2004	horned lark	18	77

[a] Found on a scheduled search plot but was found during plot set-up.
[b] Two parts were found the average distance of the parts is reported.

APPENDIX C
LIST OF BAT FATALITIES FOUND DURING STANDARDIZED SEARCHES FROM FEBRUARY 9, 2004 THROUGH FEBRUARY 8, 2005

	Date	Species	Nearest Turbine	Distance to Nearest Turbine(m)
1	06/22/2004	silver-haired bat	34	1
2	06/22/2004	silver-haired bat	37	74
3	06/24/2004	silver-haired bat	35	43
4	08/17/2004	hoary bat	7	42
5	08/17/2004	hoary bat	9	70
6	09/14/2004	silver-haired bat	6	33
7	09/14/2004	hoary bat	7	34
8	09/15/2004	silver-haired bat	10	41
9	09/16/2004	hoary bat	11	55
10	09/16/2004	hoary bat	11	54
11	09/16/2004	hoary bat	12	37
12	09/17/2004	silver-haired bat	17	36
13	09/17/2004	hoary bat	18	70
14	09/17/2004	hoary bat	18	39.5[a]
15	09/17/2004	silver-haired bat	19	26
16	09/18/2004	hoary bat	41	33
17	10/12/2004	silver-haired bat	27	42
18	10/14/2004	hoary bat	33	49
19	10/15/2004	hoary bat	38	26
20	11/15/2004	hoary bat	30	79
21	11/16/2004	hoary bat	37	53

[a] Two parts were found the average distance of the parts is reported.