Diablo Winds Wildlife Monitoring Progress Report

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INTRODUCTION

The Diablo Winds Energy Project is located in Alameda County California. The project was completed in February 2005 and consists of 31 Vestas V47 turbines located on the Elworthy property in the central portion of the Altamont Pass Wind Resource Area. These turbines replaced 169 FloWind model F-17 and F-19 vertical axis turbines. The vertical axis Flowind turbines were removed in 2004, as were approximately 8 miles of overhead electrical line, one guyed 30-m (98-ft) met tower, and 36 18-m (60-ft) free-standing lattice met towers.

The 660-kW-rated Vestas V47 turbine is an up-wind, 3-bladed, horizontal axis machine mounted on a steel tubular tower with neutral gray or white non-reflective coloring (Figure 1). The Vestas turbine has a rotor diameter of 47m (154ft). The hub height for 24 of the turbines is 50m (164ft, Turbines 1-24) and the remaining 7 turbines have a hub height of 55m (181ft, Turbines 25-31). The maximum height to the rotor tip when in the 12 o'clock position is 73.5m (241ft) for the shorter 24 turbines with 50m towers, and 78.5 m (258ft) for the remaining 7 turbines on the 55m towers. The blades rotate at 28.5 rpm at wind speeds between 6 and 56 mph. Electrical and communication cables are placed underground. The project included two 50-m (164-ft) self-supporting anemometer towers.

This progress report summarizes results of the avian and bat monitoring program for the Diablo Winds Repowering Project in Alameda County, California for March 2005 through February 2006. A final report that includes the first two complete years of monitoring will be completed in April 2007. The final report will include more detailed statistical analyses and discussion.

METHODS

The methods used in the monitoring studies are found in The Avian and Bat Monitoring Plan for the Diablo Winds Energy Center (WEST 2004). The monitoring program for the Project is consistent with the monitoring requirements included in the 1998 Repowering Program EIR (Alameda County 1998) and includes these tasks:

1. Determine whether or not the new turbines are contributing to mortality,
2. Compare bird deaths and injuries associated with the new project with the pre-existing project,
3. Document bird behavior around the new turbines to determine the influence of topography and turbine location, and to validate assumptions regarding perching, flight behavior, and siting of turbines based on topographic characteristics, and
4. Identify the need for remedial action, if any.

Components of the monitoring program include (1) avian use and behavior surveys, (2) avian and bat fatality monitoring, (3) searcher efficiency and scavenging trials, and (4) burrowing owl activity monitoring.

This study uses the following dates for defining seasons[1]:

Season	Dates
Spring/Migration	March 16 to May 31
Summer/Breeding	June 1 to August 31
Fall/Migration	September 1 to October 31
Winter	November 1 to March 15

Avian Use and Behavior Surveys

Eight survey stations (T1-T8) were established within the repowering area. Station locations and 800-m viewsheds are identified in Figure 2. Each survey station was visited approximately twice each month during the monitoring period. Each visit consisted of a 30 minute visual scan. Bird use, time within the station, and activity sampling efforts were stratified by time of day. Environmental conditions recorded at the beginning of each session included temperature, wind speed, vegetation characteristics (e.g., height) and cloud cover. Surveys were not conducted when the wind speed reached more than 55 km/hr (33 mph).

Data recorded for each observation followed methods in Smallwood and Thelander (2004a, b). The observer plotted sequential numbers onto a topographic map corresponding with the locations of raptors observed at 30 second intervals. Attributes were associated with each plotted number including species, number of individuals seen, whether it was the same individual or group as previously recorded, specific behavior (e.g., soaring, contour hunting, "fly-through"), height above ground, and type of perch being used. If perching was observed, the time and specific perching structure was recorded. Perching structures were grouped into four different categories according to their characteristics: (1) turbine devices, (2) electrical distribution poles, (3) metal/electrical towers, and (4) landscape features (e.g., rock piles, fences, etc.). After the observation session, these attributes were entered into a computer spreadsheet. All plotted numbers linked to the attribute data were then digitized and managed as a GIS database, and analyzed to test specific hypotheses that matter to this and other wind power projects. Analysis of behavior data will be conducted for the final report.

Burrowing Owl Monitoring

Burrowing owls were one of the most common raptor fatalities found during recent studies (Smallwood and Thelander 2004b). Burrowing owl fatalities were relatively common at the vertical axis turbines that were replaced as well as at other low elevation locations within and near the repowering area. Several burrowing owl colonies (breeding and wintering) have been observed recently in the repowering areas. A burrowing owl colony has been observed approximately 2000 feet northwest of turbines 27-31 in fall 2004. Another colony was identified near turbines 7 and 8. These colonies were monitored in conjunction with the avian fatality searches.

Avian and Bat Fatality Monitoring

[1] Carcass removal studies often overlapped seasons

Fatality monitoring methods include four primary components: 1) standardized carcass searches, 2) an incidental casualty and injured bird reporting system, 3) searcher efficiency trials, and 4) carcass removal trials.

Standardized Carcass Searches

All 31 turbines were searched. Rectangular plots a minimum distance of 75 m from the turbines and centered on the turbine, or long axis of the turbine string when more than one turbine existed in the search plot, were searched by walking parallel transects (Figure 3). During a two-week period each month carcass searches were conducted at each turbine. Approximately half of the sampled turbines were searched during one week, and the other half were searched the next week, so that carcass search technicians were present in the wind project on approximately 1/3 of the days during the study period.

Personnel trained in proper search techniques conducted the carcass searches according to a specific and detailed protocol. The search protocol contained directions for the conduct of the searches and for handling carcasses of various species. Personnel potentially involved in searches received training prior to working on the Project. A searcher walked transects approximately 7 meters apart at a rate of approximately 45-60 meters a minute, searching both sides out to three meters for casualties. Approximately 1.25 hours were required to survey the search area around each turbine.

The condition of each carcass found was recorded using the following condition 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, which 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, legs, pieces of skin, etc.).
- Feather Spot - 10 or more feathers or 2 or more primaries at one location indicating predation or scavenging.

Carcasses were collected, labeled with a unique number, bagged and frozen for future reference and possible necropsy. A copy of the data sheet for each carcass is maintained, bagged, and frozen with the carcass at all times. For all casualties found, data recorded included species, sex and age when possible, date and time collected, GPS location, condition (e.g., intact, scavenged, feather spot), and any comments that may indicate cause of death. All casualties were photographed as found.

Casualties or fatalities found throughout the study area by maintenance personnel and others not conducting the formal searches were documented using a wildlife incident reporting system (see WRRS section below). Collection of state or federal endangered, threatened, or protected species was coordinated with the USFWS and CDFG. Casualties or fatalities found in non-search areas were treated as incidental discoveries. Any injured native birds found were carefully captured by a trained technician and transported to the designated wildlife rehabilitation center or veterinary clinic in a timely fashion.

Wildlife Response and Reporting System (WRRS)

The Wildlife Response and Reporting System (WRRS) is a monitoring program set up to report and handle avian casualties found incidentally by maintenance personnel during construction and maintenance operations. Construction and maintenance personnel are trained in methods.

All carcasses discovered by maintenance personnel are recorded, photographed, and reported to a Project Respondent. The Respondent identifies the fatality and fills out the Casualty Information Form. A fatality is not collected unless it is a federally-listed endangered or threatened species. If the fatality is a federally-listed species, the USFWS is contacted for handling instructions.

Searcher Efficiency Trials

Searcher efficiency studies were conducted in the same areas as carcass searches. Searcher efficiency was estimated for size of carcass, general habitat type, and season. Estimates of searcher efficiency are used to adjust the number of carcasses found, correcting for detection bias.

Personnel conducting the searches did not know the location of the test carcasses. During each trial, approximately 20 bird carcasses of two different size classes (10 each) were placed in the search area. Species such as house sparrows and European starlings were used to represent small-sized birds. Rock doves were the primary species used to represent to represent medium- to large-sized birds. However, in the 2nd year of monitoring, larger birds like red-tailed hawks, hen pheasants and hen mallards will be also be used.

All carcasses were placed at random locations within areas being searched prior to the carcass search on the same day. Immediately following the trial the number and location of the test carcasses found during the carcass search were recorded, along with the number of carcasses not detected.

Carcass Removal Trials

Carcass removal includes removal by predation or scavenging, or removal by other means such as being plowed into a field. Carcass removal studies were conducted throughout the monitoring year. Estimates of carcass removal will be used to adjust carcass counts for removal bias.

During the fall and winter of the first year of monitoring, approximately 20 bird carcasses of two size classes were distributed, resulting in a total of approximately 40 trial carcasses. Species such as house sparrows and European starlings were used to represent small-sized birds. Species such as rock doves were used to represent medium- to large-sized birds. Once permission was obtained from the USFWS, fresh raptor carcasses were also used.

Carcasses generally were checked as follows, although actual intervals varied slightly. Carcasses were checked for a period of 60 days to determine removal rates. They were checked every day for the first 3 days and then typically on day 6, 8, 10, 14, 20, 27, 34, 41, 48, 55 and 62, depending on search schedules. Experimental carcasses were left at the location until the end of the carcass removal trial. Any remaining trial carcasses were removed at the end of the 62-day period.

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 during the 12-month monitoring year for which the cause of death is either unknown or is probably facility-related.

(2) Searcher efficiency expressed as the proportion of test carcasses found by searchers during the entire survey period

(3) Non-removal rates expressed as the estimated average probability a carcass is expected to remain in the study area and be available for detection by the searchers during the entire survey period

Definition of Variables

The following variables are used in the equations below:

c_i	the number of carcasses detected at turbine *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
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 62 days
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

Observed Number of Carcasses

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

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

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 our application, any trial

carcasses still remaining at 62 days are collected, yielding censored observations at 62 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. Removal rates were estimated by carcass size (small and medium/large).

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 medium/large).

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 (from scavenging and other means) 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

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

This formula has been independently verified by Shoenfeld (2004). Fatality estimates were calculated for: (1) all birds, (2) small birds, (3) medium/large birds, and (4) raptors. The all bird estimate was calculated by adding the small bird (2) and medium/large bird (3) estimates together. The final reported estimates of *m* and associated standard errors and 90% confidence intervals will be calculated after the two years of monitoring are complete.

RESULTS

This section summarizes the results of the Diablo Winds monitoring from March 2005 through February 2006.

Avian Use and Behavior Surveys

Species Abundance and Composition

Twenty-two species of birds were observed during point count surveys at the 8 stations in the project area (Tables 1 and 2). Over the course of the study, 1,261 groups comprising 7,539 individual birds were recorded (Table 2). The number of species observed was lowest in the spring (10) followed by the summer (13), fall (14), and winter (19) (Table 3). The number of species per survey was lower in the summer (2.04) and spring (2.25) than in the fall (3.50) and winter (3.92) (Table 3). The mean number of birds observed per survey plot was much higher in the winter (175.47) than in the fall (29.53), summer (14.21), or spring (12.77) (Table 3).

Spring

In spring, passerines were the most abundant group (3.53/survey), followed by raptors (2.53) and waterbirds/waterfowl (2.09) (Table 4a). Similarly, passerines comprised 43.1% of all birds observed, raptors comprised 30.9% and waterbirds/waterfowl comprised 25.6% (Table 4a). Even though passerines were the most abundant in the spring, raptors spent more time on average at the stations during the survey (5.30 minutes/survey) followed by passerines (4.89) and waterbirds/waterfowl (2.563) (Table 4b). Similarly, raptors comprised 41.5% of all of minutes spent at the stations during the surveys, passerines comprised 38.3% and waterbirds/waterfowl comprised 20.1% (Table 4b). Avian groups most frequently occurring were raptors (84.4% of surveys), passerines (78.1%) and waterbirds/waterfowl (15.6%) (Tables 4a and 4b). Species with the highest use in spring were common raven (3.50/survey), unidentified gull (2.00), turkey vulture (1.19), red-tailed hawk (0.78), and golden eagle (0.38) (Table 5a). The top two raptor species in spring were red-tailed hawk and golden eagle. Common raven spent the most time at the stations in the spring (4.84 minutes/survey) followed by unidentified gull (2.52), burrowing owl (2.34), turkey vulture (1.19), and red-tailed hawk (1.09) (Table 5b). Individual species most frequently observed during spring surveys were common raven (78.1% of surveys), turkey vultures (53.1%), red-tailed hawk (37.5%), golden eagle (21.9%) and unidentified gull (12.5%) (Table 6).

Summer

In summer, raptors were the most abundant group (3.94/survey), followed by passerines (1.38) and doves/pigeons (1.08) (Table 4a). Similarly, raptors comprised 58.9% of all birds observed, passerines comprised 20.6% and doves/pigeons comprised 16.2% (Table 4a). During the summer surveys raptors spent the most time at the station (10.52 minutes/survey) followed by passerines (2.93) and doves/pigeons (0.54) (Table 4b). Similarly, raptors comprised 74.1% of all of minutes spent at the stations during the surveys, passerines comprised 20.6% and doves/pigeons comprised 3.8% (Table 4b). Avian groups most frequently occurring were raptors (77.1% of surveys), passerines (52.1%) and waterbirds/waterfowl (6.3%) (Tables 4a and 4b). Species with the highest use in summer were turkey vulture (2.31/survey), common raven (1.19), rock dove (1.08), red-tailed hawk (0.92), and burrowing owl (0.42) (Table 5a). Two raptor species were included in the top five species. Burrowing owl spent the most time at the station in the summer (4.43 minutes/survey) followed by turkey vulture (3.24), red-tailed hawk (2.46), common raven (2.06), and American crow (0.67) (Table 5b). Individual species most frequently observed during summer surveys were turkey vulture (56.3% of surveys), common raven and red-tailed hawk (41.7%), burrowing owl (12.5%), American crow (10.4%) and golden eagle (8.3%) (Table 6).

Fall

In fall, passerines were the most abundant group (7.28/survey), followed by raptors (5.81) and waterbirds/waterfowl (2.16) (Table 4a). Similarly, passerines comprised 45.0% of all birds observed, raptors comprised 35.9% and waterbirds/waterfowl comprised 13.3% (Table 4a). Even though passerines were the most abundant in the fall, raptors spent more time at the station during the survey (15.05 minutes/survey) followed by passerines (12.75) and waterbirds/waterfowl (1.27) (Table 4b). Similarly, raptors comprised 51.0% of all of minutes spent at the stations during the surveys, passerines comprised 43.2% and waterbirds/waterfowl comprised 4.3% (Table 4b). Avian groups most frequently occurring were raptors (96.9% of surveys), passerines (81.2%) and waterbirds/waterfowl (9.4%) (Tables 4a and 4b). Species with

the highest use in fall were common raven (6.25/survey), red-tailed hawk (2.34), unidentified gull (2.00), turkey vulture (1.97), and rock dove (0.94) (Table 5a). The top two raptor species were included in the top five species. Common raven spent the most time at the station in the fall (10.78 minutes/survey) followed by red-tailed hawk (7.16), burrowing owl (4.11), turkey vulture (2.22), and unidentified gull (1.19) (Table 5b). Individual species most frequently observed during fall surveys were common raven (78.1% of surveys), red-tailed hawk (71.9%), turkey vulture (53.1%), golden eagle (28.1%) and American crow and burrowing owl (21.9% each) (Table 6).

Winter

In winter, waterbirds/waterfowl were the most abundant group (124.85/survey, mostly gulls), followed by raptors (5.15) and passerines (3.71) (Table 4a). Similarly, waterbirds/waterfowl comprised 93.1% of all birds observed, raptors comprised 3.8% and passerines comprised 2.8% (Table 4a). During the winter surveys waterbirds/waterfowl spent the most time at the station (154.85 minutes/survey) followed by raptors (15.68) and passerines (4.73) (Table 4b). Similarly, waterbirds/waterfowl comprised 88.3% of all of minutes spent at the stations during the surveys, raptors comprised 8.9% and passerines comprised 2.7% (Table 4b). Avian groups most frequently occurring were raptors (93.8% of surveys), waterbirds/waterfowl (66.7%) and passerines (64.6%) (Tables 4a and 4b). Species with the highest use in winter were unidentified gull (123.63/survey), red-tailed hawk (3.06), common raven (2.81), ring-billed gull (0.77), and American crow (0.71) (Table 5a). The top raptor species was included in the top five species. The second and third highest raptor species were the golden eagle and (0.67) and northern harrier (0.38). Unidentified gull spent the most time at the station in the winter (153.91 minutes/survey) followed by red-tailed hawk (9.21), burrowing owl (3.13), common raven (3.09), and golden eagle (1.26) (Table 5b). Individual species most frequently observed during winter surveys were red-tailed hawk (87.5% of surveys), common raven and unidentified gull (60.4%), golden eagle (33.3%), northern harrier (22.9%) and turkey vulture (20.8% each) (Table 6).

Burrowing Owl Surveys

All burrowing owl observations are summarized in Appendix B. Three active burrows were observed approximately 75m northwest of WTG-12 on 15 February 2005. A burrowing owl fatality was found near WTG-14 on 14 November 2005, and an active burrow was also found near the same turbine at that time.

During avian observations, burrowing owls were observed from observation points T6, T7, and T8, most often around turbines 12-15.

Bird Casualty Finds

Bird fatalities found between March 2005 and February 2006 are listed in Appendix A. This list includes fatalities observed on standardized search plots and other fatalities that were not observed on standardized search plots (WRRS and incidental finds). Between 7 March 2005 and 22 February 2006, 16 avian fatalities were found and are plotted in Figure 2. Of the 16, 4 were reported by Diablo Winds maintenance personnel incidentally through the WRRS reporting program. Seven raptors were found (5 red-tailed hawks, 1 golden eagle, 1 burrowing owl), with 3 raptors reported by Diablo Winds through the WRRS. Two red-tailed hawk fatalities were found incidentally by Diablo Winds personnel on the same day very close to one another. An injured golden eagle was found on the site near turbine 13. According to the veterinarian report, the eagle was missing a wing, the bird was very thin, and the exposed humerus bone was dead, suggesting the collision had not occurred recently. The burrowing owl fatality (feathers and bones) was found along a barbed wire fence and overhead power poles more than 75 m from the nearest turbine. We cannot be sure whether some of the fatalities described above, or some other fatalities were killed by Diablo turbines, given the condition of the fatalities. However, to be conservative (potentially overestimate mortality) we included them, since we do not have estimates of background mortality at this site. Because some fatalities were found incidental (i.e., not during standardized searches), we calculated fatality rates twice, once by including all the fatalities, and once by excluding the incidental finds.

Bat Casualty Finds

Four bat carcasses were found. Two of the bat fatalities were hoary bats, and two were Mexican free-tailed bats. All 4 bat carcasses were reported via the WRRS reporting program. The four bats were found in mid August (17^{th} and 18^{th}) along the same turbine string (near turbines 15 and 16).

Observer Detection Bias Experimental Trials

Detection bias trials were conducted on 10-11 May 2005, 4-5 October 2005 and 17-18 January 2006. A total of 70 trial carcasses were used during these trials. Observer detection rates were 44% for small birds (house sparrows), and 76% for medium–sized birds (rock doves, Table 7). No raptors were used in searcher efficiency trials, but they will be used in the 2^{nd} monitoring year.

Carcass Removal Bias Experimental Trials

Two carcass removal trials were conducted. They were conducted between 5 October-5 December 2005 and 18 January-20 March 2006 using a total of 43 trial birds (Table 8, Figure 3). Small bird carcasses used were house sparrows. Medium-sized birds were primarily rock doves, with three red-tailed hawks. All carcasses had been frozen, but were considered fresh when they were frozen. Small birds (house sparrows) were removed at a much quicker rate than the medium/large size birds (mostly rock doves, with 3 red-tailed hawks). Small carcasses averaged 10.2 days in the fall and 8.6 days in the spring before considered removed. Medium/large-sized

carcasses averaged 44.1 in the fall and 39.8 days in the spring before being considered removed. These estimates represent mean number of days carcasses remain in the search areas before removal (removal of entire carcass, or reduction to a feather spot that does not meet the definition of a casualty). Approximately 9 of the 22 medium/large-sized trial carcasses still remained at the end of the trial period (62 days). None of the 20 small trial carcasses remained at the end of the 62-day trial period. Two of the three red-tailed hawks remained the entire survey period, and the other was considered removed on day 45.

A larger sample size will be used in year 2.

Fatality Estimates

Both unadjusted and adjusted fatality estimates were made based on the results of the first year of fatality monitoring (Table 9 and Table 10). The unadjusted fatality estimates were calculated by dividing the number of fatalities found by the number of turbines (or MW) searched for the one year period. These estimates were calculated two ways, one by including the all raptors, including incidental finds, and another by excluding incidental finds. We do not have background mortality estimates, but it is possible some of our fatalities we included were not turbine related (e.g., the burrowing owl).

The observed raptor fatality rate was 0.23/turbine/year and 0.34/MW/year when including all raptor fatalities. If we exclude the incidental finds, the observed raptor fatality rate was 0.13/turbine/year and 0.20/MW/year.

The observed all bird fatality rate was 0.52/turbine/year and 0.78/MW/year when including all fatalities. If we exclude the incidental finds, the observed all bird fatality rate was 0.42/turbine/year and 0.64/MW/year.

When the data are adjusted for carcass removal bias and searcher detection bias, the adjusted raptor fatality rate was 0.37/turbine/year and 0.56/MW/year when including all raptor fatalities (all fatalities including the incidental finds). If we exclude the incidental finds, the adjusted raptor fatality rate was 0.21/turbine/year and 0.32/MW/year. Note that the adjustments are based primarily on search detection and carcass removal of rock doves, which we believe are less detectable than most of the raptors observed as casualties (red-tailed hawk, golden eagle) and based on our small dataset, may be scavenged and removed faster than larger raptors.

When the data are adjusted for carcass removal bias and searcher detection bias, the adjusted all bird fatality rate was 1.4/turbine/year and 2.1/MW/year when including all raptor fatalities (all fatalities including the incidental finds). If we exclude the incidental finds, the adjusted all bird fatality rate was 1.2/turbine/year and 1.8/MW/year. Note that the adjustments for all birds are based primarily on search detection and carcass removal of house sparrows and rock doves, which we believe are less detectable than most of the carcasses observed and are scavenged faster. Empirical data collected in the 2nd year of monitoring at Diablo Winds, and from other studies in the Altamont will help to understand these differences.

Discussion

The avian use estimates suggest relatively high raptor use in the vicinity of the Diablo Winds project. Raptor use estimates standardized to a 30 minute count were higher during this study than reported in Smallwood and Thelander (2004b), and similar to that reported by Orloff and Flannery (1992).

Preliminary estimates of bird fatality at the Diablo Winds Project suggest lower unadjusted fatality than for unadjusted fatalities calculated by Smallwood and Thelander (2004b) for the smaller existing wind turbines in the Altamont Pass. The unadjusted mortality estimate for raptors provided by Smallwood and Thelander (2004b, Table 3.9 page 70) was between 0.95 raptors/MW/year and 1.23 raptors/MW/year[2], which is approximately 3 to 6 times higher than estimates from this study for Diablo Winds. We caution against drawing strong conclusions from these differences relative to the risk of collision comparing the newer turbines to the older turbines. First, this is the first year of a multi-year study, and previous studies at this and other facilities (e.g. Smallwood and Thelander 2004b) have shown a relatively high degree of inter-annual variation in raptor mortality. The protocol by which the data are collected could affect the magnitude of differences between the Smallwood and Thelander (2004b) mortality estimates from the older turbines and the results of this study. For example, the observed mortality estimates from the previous study are based on search intervals averaging approximately 50 or 90 days, depending on the year of study. Our searches were conducted approximately 30 days apart. Thus, with everything else being equal (e.g., carcass removal etc.) the estimates of Smallwood and Thelander (2004b) may be lower than what would have been expected had they searched on 30 day intervals.

Our searches were conducted out to a minimum of 75m from the turbine tower, which is approximately tip height of the Diablo Winds turbines. Searches during the previous studies were conducted out to a minimum of 50 m from the turbines, which exceed tip height for the majority of turbines within the APWRA. These differences could affect the observed mortality estimates.

The newer large turbines operating time likely differs from the previous studies. For example, this new 20 MW nameplate project may produce more or less actual MWs of production compared to 20 MW nameplate of existing smaller turbines. Ideally, a calculation of mortality per index to actual production would help to address these differences and more clearly answer the question whether newer larger turbines are less risky on a per MW produced basis.

The adjusted estimates were calculated assuming rates of carcass removal and search detection for the trial carcasses are representative rates for actual turbine related fatalities. The rock doves that were used in the searcher efficiency trials to represent the medium to large sized birds are likely less detectable that most of the raptor species found as fatalities (red-tailed hawks and golden eagles). This factor alone could lead to an overestimate of raptor mortality. Based on an admittedly very small sample, the three red-tailed hawk fatalities used in the carcass removal trials lasted a minimum of 45 days prior to being removed by scavengers. The only red-tailed hawk that was found fresh and was left in the field was not removed at the end of the 62 day trial. This very small sample suggests lower carcass removal rates of red-tailed hawks compared

[2] The low and the high estimates in this range were calculated with different assumptions regarding detection and scavenging biases

to rock doves. We hope to increase the sample size for raptors in the 2nd monitoring year to provide more conclusive evidence.

We included a few carcasses in the fatality estimates that were found outside the search plot. There may be other carcasses that land outside our search plots, that we do not find. This may especially be true for smaller birds that may fall farther from the wind turbines. For this report, we did not attempt to adjust the observed fatality estimates for this factor, due to the difficulty in coming up with an accurate estimate for this factor based on the small sample sizes (i.e. number of fatalities). For this study, most of the adjustments we made for raptors appear to lead to a conservative overestimate of fatality, such as including fatalities where cause of death may not be wind turbine related, and using primarily rock doves to represent larger raptors for the adjustment of carcass removal and search detection. However, we will address the issues and possible adjustments for carcasses that land outside the search plot in more detail after the completion of the 2nd year of monitoring.

We did not calculate bat fatality rates. Four bats were found incidentally, and no bats were found during standardized searches. Comparisons of observed bat fatality rates will be calculated during the 2nd year of monitoring.

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West 2004. Avian Collision and Electrocution Risk Reduction: Alternative Draft Management Plan for the Altamont Pass Wind Resource Area. Technical Protocol.

Table 1. List of avian species observed during fixed-point surveys on the Diablo Winds Project site.

Species/Group	Scientific Name
great blue heron	*Ardea herodias*
ring-billed gull	*Larus delawarensis*
American white pelican	*Pelecanus erythrorhyncos*
double-crested cormorant	*Phalacrocorax auritus*
mallard	*Anas platyrhynchos*
black-necked stilt	*Himantopus mexicanus*
sharp-shinned hawk	*Accipter striatus*
prairie falcon	*Falco mexicanus*
American kestrel	*Falco sparverius*
burrowing owl	*Athene cunicularia*
ferruginous hawk	*Buteo regalis*
red-tailed hawk	*Buteo jamaicensis*
turkey vulture	*Cathartes aura*
white-tailed kite	*Elanus leucurus*
golden eagle	*Aquila chrysaetos*
northern harrier	*Circus cyaneus*
American crow	*Corvus brachyrhynchos*
common raven	*Corvus corax*
loggerhead shrike	*Lanius ludovicianus*
yellow-billed magpie	*Pica nuttalli*
mourning dove	*Zenaida macroura*
rock dove	*Columba livia*
unidentified gull	

Table 2. Avian species observed while conducting fixed-point surveys (April 11, 2005 - February 8, 2006) on the Project Site.

	Spring		Summer		Fall		Winter		Grand Total	
Species/Group	# obs.	# groups	# obs.	# groups	# obs.	# groups	# obs.	# groups	# obs.	# groups
Waterbirds/Waterfowl	**67**	**9**	**14**	**4**	**69**	**10**	**5993**	**150**	**6143**	**173**
American white pelican	0	0	0	0	0	0	12	1	12	1
double-crested cormorant	0	0	0	0	0	0	3	1	3	1
great blue heron	0	0	1	1	0	0	0	0	1	1
mallard	3	1	0	0	0	0	7	2	10	3
ring-billed gull	0	0	0	0	5	3	37	12	42	15
unidentified gull	64	8	13	3	64	7	5934	134	6075	152
Shorebirds	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**
black-necked stilt	1	1	0	0	0	0	0	0	1	1
Raptors	**81**	**81**	**189**	**176**	**186**	**180**	**247**	**247**	**703**	**684**
Kites	*0*	*0*	*0*	*0*	*0*	*0*	*1*	*1*	*1*	*1*
white-tailed kite	0	0	0	0	0	0	1	1	1	1
Accipiters	*0*	*0*	*0*	*0*	*1*	*1*	*0*	*0*	*1*	*1*
sharp-shinned hawk	0	0	0	0	1	1	0	0	1	1
Buteos	*25*	*25*	*44*	*44*	*77*	*77*	*154*	*154*	*300*	*300*
ferruginous hawk	0	0	0	0	2	2	7	7	9	9
red-tailed hawk	25	25	44	44	75	75	147	147	291	291
Northern Harriers	*1*	*1*	*2*	*2*	*4*	*4*	*18*	*18*	*25*	*25*
northern harrier	1	1	2	2	4	4	18	18	25	25
Eagles	*12*	*12*	*6*	*6*	*14*	*14*	*32*	*32*	*64*	*64*
golden eagle	12	12	6	6	14	14	32	32	64	64
Falcons	*0*	*0*	*6*	*6*	*11*	*11*	*14*	*14*	*31*	*31*
American kestrel	0	0	4	4	5	5	9	9	18	18
prairie falcon	0	0	2	2	6	6	5	5	13	13
Owls	*5*	*5*	*20*	*17*	*16*	*15*	*13*	*13*	*54*	*50*
burrowing owl	5	5	20	17	16	15	13	13	54	50
Vultures	*38*	*38*	*111*	*101*	*63*	*58*	*15*	*15*	*227*	*212*
turkey vulture	38	38	111	101	63	58	15	15	227	212

Table 2. Avian species observed while conducting fixed-point surveys (April 11, 2005 - February 8, 2006) on the Project Site.										
	Spring		Summer		Fall		Winter		Grand Total	
Species/Group	# obs.	# groups	# obs.	# groups	# obs.	# groups	# obs.	# groups	# obs.	# groups
Passerines	**113**	**110**	**66**	**65**	**233**	**116**	**178**	**106**	**590**	**397**
American crow	1	1	6	6	25	13	34	14	66	34
common raven	112	109	57	56	200	95	135	83	504	343
loggerhead shrike	0	0	3	3	8	8	8	8	19	19
yellow-billed magpie	0	0	0	0	0	0	1	1	1	1
Doves/Pigeons	**0**	**0**	**52**	**2**	**30**	**1**	**20**	**3**	**102**	**6**
mourning dove	0	0	0	0	0	0	1	1	1	1
rock dove	0	0	52	2	30	1	19	2	101	5
Subtotal	**262**	**201**	**321**	**247**	**518**	**307**	**6438**	**506**	**7539**	**1261**

Table 3. Mean use, mean # species/survey, total number of species, and total number of fixed-point surveys conducted by season and overall for the Project site.

Season	Mean Use[a]	Mean use by time[b]	# Species/ Survey[c]	# Species	# Surveys Conducted[d]
Spring	8.188	12.766	2.250	10	32
Summer	6.688	14.208	2.042	13	48
Fall	16.188	29.531	3.500	14	32
Winter	134.125	175.469	3.917	19	48
Overall	47.119	65.363	2.938	22	160

[a] # observations per 30-minute survey
[b] # of minutes per 30-minute survey
[c] mean number of bird species observed during each 30-minute survey
[d] 8 stations surveyed twice per visit

Table 4a. Mean use, percent composition and percent frequency of occurrence for avian groups for the Diablo Winds Project site.

Species/Group	Mean Use (#/30 min. survey)				Group Composition (%)				% Frequency			
	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter
Waterfowl/Waterbirds	2.094	0.292	2.156	124.854	25.57	4.36	13.32	93.09	15.63	6.25	9.38	66.67
Shorebirds	0.031	0.000	0.000	0.000	0.38	0.00	0.00	0.00	3.13	0.00	0.00	0.00
Raptors	2.531	3.938	5.813	5.146	30.92	58.88	35.91	3.84	84.38	77.08	96.88	93.75
Kites	0.000	0.000	0.000	0.021	0.00	0.00	0.00	0.02	0.00	0.00	0.00	2.08
Accipiters	0.000	0.000	0.031	0.000	0.00	0.00	0.19	0.00	0.00	0.00	3.13	0.00
Buteos	0.781	0.917	2.406	3.208	9.54	13.71	14.86	2.39	37.50	41.67	75.00	87.50
Northern Harriers	0.031	0.042	0.125	0.375	0.38	0.62	0.77	0.28	3.13	4.17	9.38	22.92
Eagles	0.375	0.125	0.438	0.667	4.58	1.87	2.70	0.50	21.88	8.33	28.13	33.33
Falcon	0.000	0.125	0.344	0.292	0.00	1.87	2.12	0.22	0.00	8.33	25.00	25.00
Owls	0.156	0.417	0.500	0.271	1.91	6.23	3.09	0.20	9.38	12.50	21.88	6.25
Vultures	1.188	2.313	1.969	0.313	14.50	34.58	12.16	0.23	53.13	56.25	53.13	20.83
Passerines	3.531	1.375	7.281	3.708	43.13	20.56	44.98	2.76	78.13	52.08	81.25	64.58
Doves/Pigeons	0.000	1.083	0.938	0.417	0.00	16.20	5.79	0.31	0.00	4.17	3.13	6.25
Overall	8.188	6.688	16.188	134.125	100.00	100.00	100.00	100.00				

Table 4b. Mean use, percent composition and percent frequency of occurrence for avian groups for the Diablo Winds Project site.

Species/Group	Mean Use by time (# of minutes/30 min. survey)				Group Composition (%)				% Frequency[a]			
	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter
Waterfowl/Waterbirds	2.563	0.219	1.266	154.854	20.07	1.54	4.29	88.25	15.63	6.25	9.38	66.67
Shorebirds	0.016	0.000	0.000	0.000	0.12	0.00	0.00	0.00	3.13	0.00	0.00	0.00
Raptors	5.297	10.521	15.047	15.677	41.49	74.05	50.95	8.93	84.38	77.08	96.88	93.75
Kites	0.000	0.000	0.000	0.010	0.00	0.00	0.00	0.01	0.00	0.00	0.00	2.08
Accipiters	0.000	0.000	0.063	0.000	0.00	0.00	0.21	0.00	0.00	0.00	3.13	0.00
Buteos	1.094	2.458	7.188	9.990	8.57	17.30	24.34	5.69	37.50	41.67	75.00	87.50
Northern Harriers	0.016	0.094	0.203	0.375	0.12	0.66	0.69	0.21	3.13	4.17	9.38	22.92
Eagles	0.656	0.188	0.953	1.260	5.14	1.32	3.23	0.72	21.88	8.33	28.13	33.33
Falcon	0.000	0.115	0.313	0.594	0.00	0.81	1.06	0.34	0.00	8.33	25.00	25.00
Owls	2.344	4.427	4.109	3.125	18.36	31.16	13.92	1.78	9.38	12.50	21.88	6.25
Vultures	1.188	3.240	2.219	0.323	9.30	22.80	7.51	0.18	53.13	56.25	53.13	20.83
Passerines	4.891	2.927	12.750	4.729	38.31	20.60	43.17	2.70	78.13	52.08	81.25	64.58
Doves/Pigeons	0.000	0.542	0.469	0.208	0.00	3.81	1.59	0.12	0.00	4.17	3.13	6.25
Overall	12.766	14.208	29.531	175.469	100.00	100.00	100.00	100.00				

[a] Same as the values in table 4a given that % frequency is not effected by # individuals or # of minutes.

Table 5a. Avian species observed within 800m of the observer and estimated mean use (#/30-minute survey) on the Project site.

Large Birds

Spring		Summer		Fall		Winter	
Species/Group	Use	Species/Group	Use	Species/Group	Use	Species/Group	Use
common raven	3.500	turkey vulture	2.313	common raven	6.250	unidentified gull	123.625
unidentified gull	2.000	common raven	1.188	red-tailed hawk	2.344	red-tailed hawk	3.063
turkey vulture	1.188	red-tailed hawk	0.917	unidentified gull	2.000	common raven	2.813
red-tailed hawk	0.781	burrowing owl	0.417	turkey vulture	1.969	ring-billed gull	0.771
golden eagle	0.375	unidentified gull	0.271	American crow	0.781	American crow	0.708
burrowing owl	0.156	American crow	0.125	burrowing owl	0.500	golden eagle	0.667
mallard	0.094	golden eagle	0.125	golden eagle	0.438	Northern harrier	0.375
American crow	0.031	American kestrel	0.083	prairie falcon	0.188	turkey vulture	0.313
black-necked stilt	0.031	northern harrier	0.042	American kestrel	0.156	burrowing owl	0.271
northern harrier	0.031	prairie falcon	0.042	ring-billed gull	0.156	American white pelican	0.250
		great blue heron	0.021	northern harrier	0.125	American kestrel	0.188
				ferruginous hawk	0.063	ferruginous hawk	0.146
				sharp-shinned hawk	0.031	Mallard	0.146
						prairie falcon	0.104
						double-crested cormorant	0.063
						white-tailed kite	0.021
						yellow-billed magpie	0.021

Small Birds

Spring		Summer		Fall		Winter	
Species/Group	Use	Species/Group	Use	Species/Group	Use	Species/Group	Use
		rock dove	1.083	rock dove	0.938	rock dove	0.396
		loggerhead shrike	0.063	loggerhead shrike	0.250	loggerhead shrike	0.167
						mourning dove	0.021

Table 5b. Avian species observed within 800m of the observer and estimated mean use by time (# of minutes/30-minute survey) on the Project site.

Large Birds							
common raven	4.844	burrowing owl	4.427	common raven	10.781	unidentified gull	153.906
unidentified gull	2.516	turkey vulture	3.240	red-tailed hawk	7.156	red-tailed hawk	9.208
burrowing owl	2.344	red-tailed hawk	2.458	burrowing owl	4.109	burrowing owl	3.125
turkey vulture	1.188	common raven	2.063	turkey vulture	2.219	common raven	3.094
red-tailed hawk	1.094	American crow	0.667	unidentified gull	1.188	golden eagle	1.260
golden eagle	0.656	unidentified gull	0.208	American crow	1.094	American crow	1.021
American crow	0.047	golden eagle	0.188	golden eagle	0.953	ferruginous hawk	0.781
Mallard	0.047	northern harrier	0.094	northern harrier	0.203	American kestrel	0.500
black-necked stilt	0.016	American kestrel	0.063	prairie falcon	0.172	ring-billed gull	0.469
northern harrier	0.016	prairie falcon	0.052	American kestrel	0.141	American white pelican	0.375
		great blue heron	0.010	ring-billed gull	0.078	Northern harrier	0.375
				sharp-shinned hawk	0.063	turkey vulture	0.323
				ferruginous hawk	0.031	prairie falcon	0.094
						mallard	0.073
						double-crested cormorant	0.031
						yellow-billed magpie	0.031
						white-tailed kite	0.010
Small Birds							
		rock dove	0.542	loggerhead shrike	0.875	loggerhead shrike	0.583
		loggerhead shrike	0.198	rock dove	0.469	rock dove	0.198
						mourning dove	0.010

Table 6. Avian species observed within 800m of the observer and estimated frequency of occurrence on the Project site.

Large Birds

Spring		Summer		Fall		Winter	
Species/Group	Use	Species/Group	Use	Species/Group	Use	Species/Group	Use
common raven	78.13	turkey vulture	56.25	common raven	78.13	red-tailed hawk	87.50
turkey vulture	53.13	common raven	41.67	red-tailed hawk	71.88	Common raven	60.42
red-tailed hawk	37.50	red-tailed hawk	41.67	turkey vulture	53.13	unidentified gull	60.42
golden eagle	21.88	burrowing owl	12.50	golden eagle	28.13	golden eagle	33.33
unidentified gull	12.50	American crow	10.42	American crow	21.88	Northern harrier	22.92
burrowing owl	9.38	golden eagle	8.33	burrowing owl	21.88	turkey vulture	20.83
American crow	3.13	American kestrel	4.17	prairie falcon	15.63	American crow	16.67
black-necked stilt	3.13	northern harrier	4.17	American kestrel	9.38	American kestrel	14.58
mallard	3.13	prairie falcon	4.17	northern harrier	9.38	ferruginous hawk	14.58
northern harrier	3.13	unidentified gull	4.17	unidentified gull	9.38	ring-billed gull	14.58
		great blue heron	2.08	ferruginous hawk	6.25	prairie falcon	10.42
				ring-billed gull	6.25	burrowing owl	6.25
				sharp-shinned hawk	3.13	Mallard	4.17
						American white pelican	2.08
						double-crested cormorant	2.08
						white-tailed kite	2.08
						yellow-billed magpie	2.08

Small Birds

Spring		Summer		Fall		Winter	
Species/Group	Use	Species/Group	Use	Species/Group	Use	Species/Group	Use
		loggerhead shrike	6.25	loggerhead shrike	12.50	loggerhead shrike	10.42
		rock dove	4.17	rock dove	3.13	rock dove	4.17
						mourning dove	2.08

Table 7. Results of searcher efficiency trials.

	Medium/Large Birds	
Date	# Placed	% Found
May 2005	9	44%
Oct 2005	10	80%
Jan 2006	15	93%
Subtotal	34	76%
	Small Birds	
	# Placed	% Found
May 2005	11	36%
Oct 2005	10	50%
Jan 2006	15	47%
Subtotal	36	44%

Table 8. Results of scavenger trials.

	Medium/Large Birds					Small Birds				
			% remaining					% remaining		
Date	# birds	Mean	Day 40	Day 30	Day 14	# birds	Mean	Day 40	Day 30	Day 14
Fall 2005	10	44.1	60.0%	60.0%	70.0%	10	10.2	10.0%	10.0%	10.0%
Winter 2006	12	39.8	58.3%	66.7%	91.7%	10	8.6	0%	0%	30.0%
Overall	22	41.8	59.1%	63.6%	81.8%	20	9.4	5.0%	5.0%	20.0%

Table 9. Observed fatality estimates from the first year of monitoring at Diablo Winds. These estimates are not adjusted for biases such as carcass removal and searcher detection rates.

	Number of Fatalities		Observed Fatality Estimates[a] #/turbine/year		#/MW/year	
Bird Group	A[b]	B[c]	A	B	A	B
Raptors	7	4	0.23	0.13	0.34	0.20
Other moderate/large sized birds	6	5	0.19	0.16	0.29	0.24
All moderate/large sized birds	13	9	0.42	0.29	0.64	0.44
Small birds	3	3	0.10	0.10	0.15	0.15
Total	16	12	0.52	0.39	0.78	0.59

[a] Fatality estimates are unadjusted for biases such as carcass removal and search detection.
[b] A includes all fatalities, including the incidental finds.
[c] B does not include the incidental finds

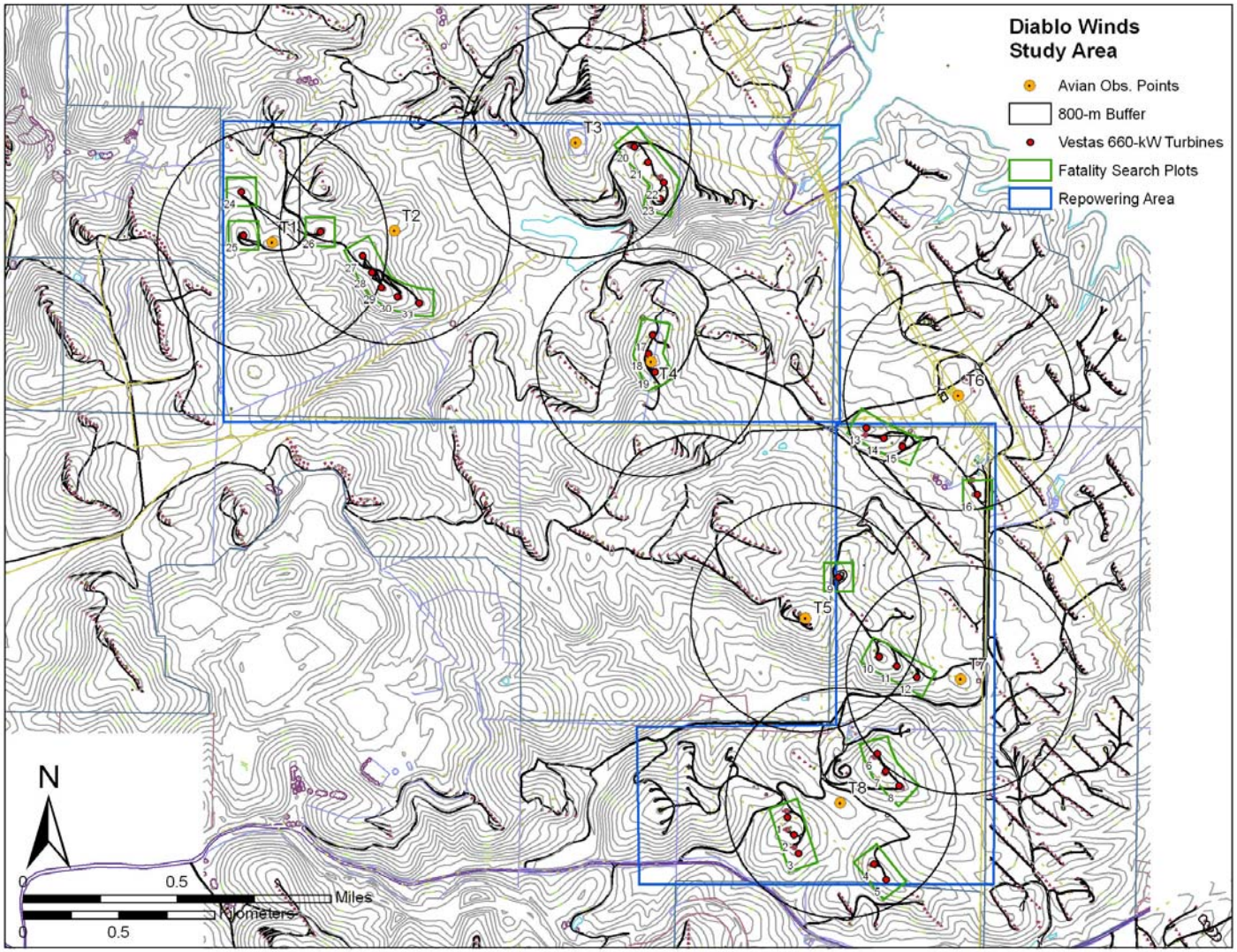

Figure 1. Location of avian observation points and 800-m viewsheds in the Diablo Winds repowering area.

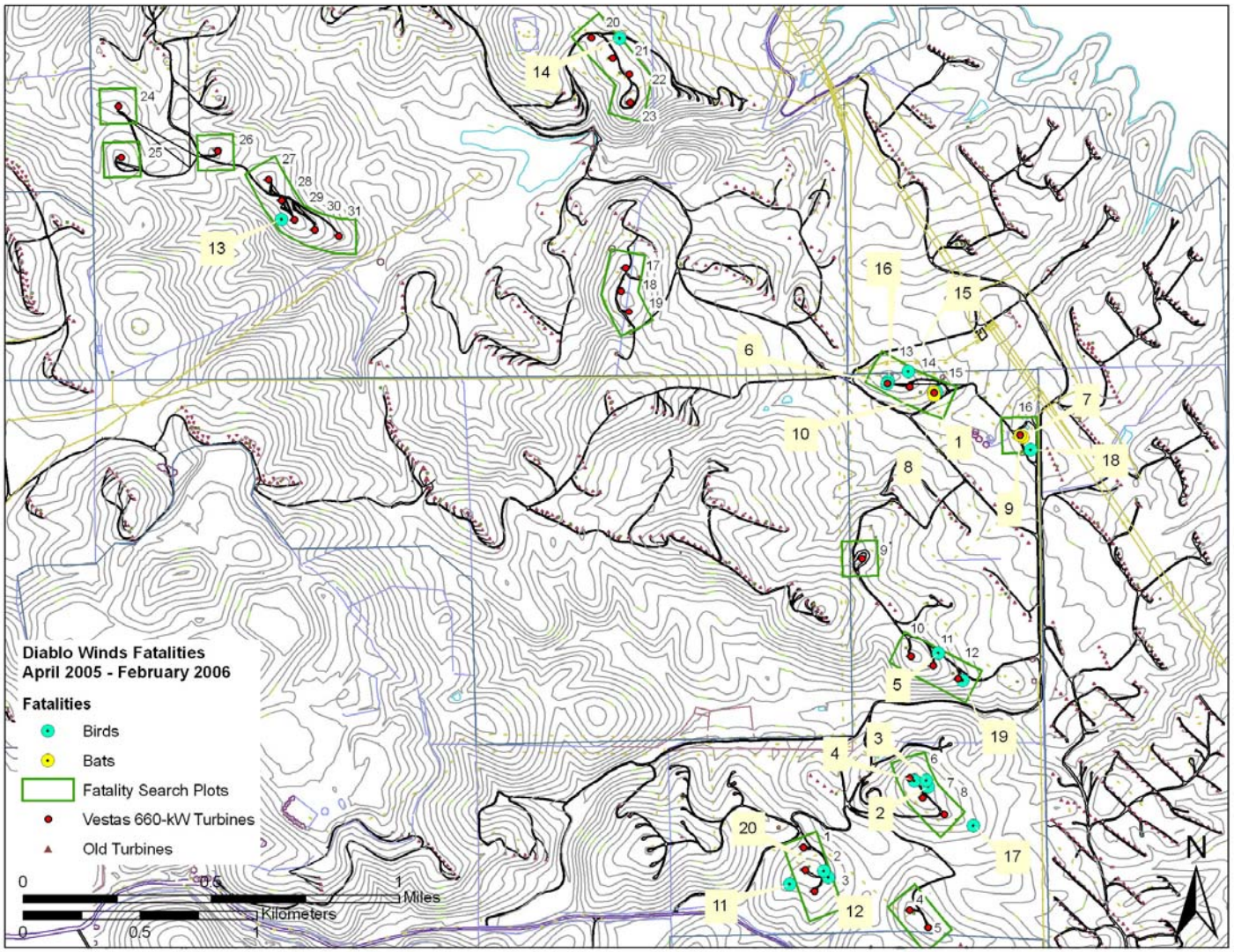

Figure 2. Locations of avian fatalities found as part of standardized searches in the Diablo Winds repowering area.

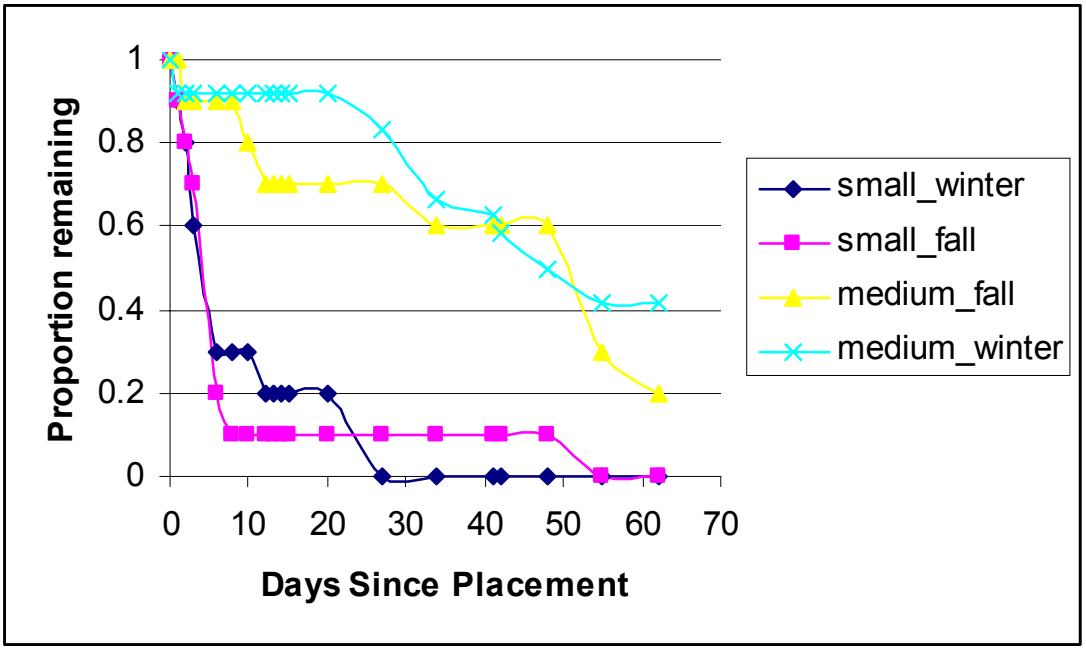

Figure 3. Results of the fall and winter carcass removal trials for small birds (house sparrows) and medium/large birds (rock doves and 3 red-tailed hawks).

APPENDIX A. Avian and bat fatalities found in the Diablo Winds repowering area between March 2005 and February 2006.

Number	Fatality ID	Date	Species	Turbine	Search Type
1	20050411-01	4/11/2005	Rock dove	15	Standard
2	DW05-02	5/3/2005	Red-tailed hawk	06	WRRS
3	DW05-03	5/3/2005	Red-tailed hawk	06	WRRS
4	20050622-01	6/22/2005	Loggerhead shrike	06	Standard
5	20050802-01	8/2/2005	Turkey vulture	12	Standard
6	DW05-06	8/12/2005	Golden eagle	13	WRRS
7	DW05-07	8/17/2005	Hoary bat	16	WRRS
8	DW05-08	8/17/2005	Mexican free-tailed bat	15	WRRS
9	DW05-09	8/17/2005	Mexican free-tailed bat	16	WRRS
10	DW05-10	8/18/2005	Hoary bat	15	WRRS
11	20050831-01	8/31/2005	Unk. Gull	02	Standard
12	20050919-02	9/19/2005	Red-tailed hawk	03	Standard
13	20051020-01	10/20/2005	Western meadowlark	29	Standard
14	20051114-03	11/14/2005	Red-tailed hawk	21	Standard
15	20051114-04	11/14/2005	Burrowing owl	14	Standard
16	DW05-16	12/8/2005	Unk. Gull	13	WRRS
17	20051219-01	12/19/2005	Red-tailed hawk	03	Standard
18	20060117-01	01/17/06	Rock dove	16	Standard
19	20060117-02	01/17/06	House finch	12	Standard
20	20060117-03	01/17/06	Unk. Medium Bird	3	Standard

APPENDIX B. Summary of burrowing owl observations in the Diablo Winds repowering area.

Fatalities

BUOW found 11/14/05 at WTG-14 – near barbed wire fence and overhead line
Burrow found near WTG-14 (UTM NAD 83 621589e 4180694n)

Avian Observations

2 BUOW 4/18/05 on the ground approx. 100m WNW of WTG-1, observed from obs. pt. T8
2 BUOW 4/26/05 on the ground approx. 150m W of WTG-1, observed from obs. pt. T8
1 BUOW 5/26/05 on the ground approx. 150m W of WTG-1, observed from obs. pt. T8
2 BUOW 6/22/05 on the ground approx. 150m W to N of WTG-1, observed from obs. pt. T8
2 BUOW 6/28/05 on the ground approx. 150m W of WTG-1, observed from obs. pt. T8
6 BUOW 8/25/05 on the ground; group of 4 (2 adult, 2 juv.) approx. 200m WNW of WTG-2; group of 2 approx. 200m N of WTG-4; observed from obs. pt. T8
4 BUOW 9/12/05 on the ground approx. 150-300m W to N of WTG1-3, from obs. pt. T8
1 BUOW 9/14/05 on the ground approx. 300m NW of WTG-14, from obs. pt. T6
1 BUOW 9/20/05 on the ground approx. 300m NW of WTG-13&14, from obs. pt. T6
2 BUOW 9/21/05 on the ground approx. 200m NNW of WTG-4, from obs. pt. T8
1 BUOW 10/13/05 on the ground approx. 200-300m NW of WTG-15, from obs. pt. T6
1 BUOW 10/14/05 on the ground approx. 300m NW of WTG-12, from obs. pt. T7
Up to 5 BUOW 10/14/05 on the ground and moving around within 100-300m N to S of WTG-1-3, from obs. pt. T8
3 BUOW 11/15/05 on the ground approx. 200m NW of WTG-10-12, observed from obs. pt. T7
1 BUOW 1/4/06 from obs. pt. T7
1? BUOW 2/8/06 from obs. pt. T8 (observation IDs for up to 8 birds, but only one seen each time)

BUOW Observations

Active burrows (3) approx. 75m NW of WTG-12, observed 2/15/05