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Post-Construction Avian Monitoring Study
for the
Shiloh I Wind Power Project
Solano County, California

Final Report

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EXECUTIVE SUMMARY

The Shiloh I Wind Power Project Area is situated on roughly 6,800 acres of agricultural land in the Montezuma Hills, near Rio Vista in Solano County, California. The project consists of 100 wind turbines rated at 1.5 MW each for a total capacity of up to 150 MW. Seventy-six of the turbines are mounted on 80 meter towers and twenty-four are on 65 meter towers. The rotor diameter is 77 m (253 feet). The height of the rotor when in the 12 o'clock for turbines with the 80 m towers position is 118.5 m (390 feet). These turbines are arrayed on similar landscape and habitat as that in which approximately 510 turbines of an older, smaller technology are deployed along with more than 200 turbines of the newer, larger technology.

The Collinsville-Montezuma Hills Wind Resource Area (CMHWRA) consists of approximately 40,300 acres and existing wind plants including Shiloh I, occupy approximately 17,300 acres. The landscape consists of rolling hills with elevations ranging from just above sea level adjacent to the Sacramento River to about 250 - 300 feet (61-91 m). Turbines are placed on the highest ground. Moving from south to north the terrain becomes more uniform with less elevation differential between the ridges and the valleys. On the west is the Suisun Marsh.

The land is private and largely agricultural, mostly rotating crop varieties and grazed pastures. There are isolated wetlands (mostly cattail marsh) and one small reservoir within the project boundaries, but not within the project footprint. Treed areas within the project are limited to the areas close to homes and in a few valleys, consisting of non-native eucalyptus, olive, and some native oaks and junipers.

This report details the three-year post-construction study of the Shiloh I wind power project, the third study of the newer turbine technology in the CMHWRA the previous two year study was conducted at the adjacent High Winds project from August, 2003 through July, 2004 and from August, 2004 through July, 2005). During the first eighteen months (April 10, 2006 to October 15, 2007) of this three-year study, carcass surveys were conducted once per week at every other wind turbine, for a total of 78 rounds at 50 turbines. After this period (October 15, 2007 to April 11, 2009), carcass surveys were conducted at the second half of wind turbines, for a total of 78 complete rounds. Thus, during the 36 month study all turbines were searched at the same search interval and an equal number of times. In addition to reporting the results of the study, we provide details regarding the fulfillment of the Solano County Use Permit U-03-06, specifically Condition 40.

A total of 511 wind turbine related avian incidents were recorded over three years by searchers during standardized surveys, representing 54 species and 22 unidentified birds (of those that could be identified as to species: two of these were blackbirds; three were sparrows; a swallow; and, 14 were only identified as passerines). Of the 54 avian species, 9 were raptor species including American Kestrel (N = 27), Merlin (1), Peregrine Falcon (1), Red-tailed Hawk (15), Ferruginous Hawk (2), Northern Harrier (2), Golden Eagle (1), Barn Owl (2), and Great Horned Owl (4), comprising a total of 55 raptor incidents during the three years. The largest number of carcasses found were songbirds, representing 247 incidents (48.3%) identified to, at least, 32 species. There were six waterfowl incidents, (5 Mallards and 1 unknown goose spp.), 19 waterbird incidents (10 American Coots, 1 Sora, 2 Virginia Rails, 4 Killdeer, and 1 Black-crowned Night-Heron), as well as some other species.

None of the carcasses or injured birds found is listed as federally or state threatened or endangered. One Peregrine Falcon, currently a state candidate for delisting was found. Eight fatalities involved California Species of Special Concern (SCS): Northern Harrier; Tricolored Blackbirds; Yellow Warblers; and, a Yellow-breasted Chat. Two SCS Watch list species, Golden Eagle and Merlin were found within the standardized search area. A vast majority of individuals killed were common species. Nearly one-half (47.5%) of carcasses found represented five very common species: Western Meadowlark, Red-winged Blackbird, Mourning Dove, Horned Lark, and Brewer's Blackbird.

One hundred thirty-two (132) bat carcasses of four species were found: Hoary Bat (N = 64); Mexican Free-tailed Bat (63); Silver-haired Bat (3); and Western Red Bat (2).

The number of wind turbine associated incidents found during standardized surveys was calculated per month for each species grouping.

The greatest number of bird incidents occurred during the month of January of 2007, with a total of 40 (~8% of the total) incidents in that month alone, 34 (85%) of them passerine species (Table 4 and Figure 3). Sixteen raptor incidents found during year one (~67% of that year's total) were found during the fall migration and pre-breeding seasons, between and including October 2006 and January 2007. The number of raptor incidents found during those same months in the following years only comprised 46% of the raptors for the second year and 43% raptors for the third year. Waterfowl and waterbird incidents were rare and incidents of species within these groups were sporadically distributed throughout the seasons. Thirty-five out of 51 of all "other" bird incidents (~69%) were recorded in the later period of the three years (August to December).

The great majority of bat incidents occurred during the fall migration months, with 115 out of 132 carcasses recorded between August and October of the three years, representing ~87% of bats found during the entire three year study period.

The data suggested that the distribution of bird incidents was somewhat disproportionately greater at searched sites north versus south of Bird Landing Road, only for passerines as a group and American Kestrels as an individual species, but not for any other groups of birds or bats.. These two regions (north and south) differ in both topography and crop types. In comparison to the north, the southern area consists of steeper hills of higher elevations, which open up to a broad plain extending south to the Sacramento River and Suisun Marsh. The southern portion of the project more closely resembles the topography of the Altamont with higher ridges and deeper valleys, whereas, the northern portion is more uniform with gentler slopes and a gentler relief.

With respect to individual turbines, there were 4 out of 100 searched towers (for birds) and 1 out of 100 searched towers (for bats) where fatalities deviated significantly from the average. By chance, five (5) of 100 statistical tests should have shown significance for each category. Therefore we conclude that, individually and with respect to general location (north vs. south), there is no evidence to conclude that any turbines had fatalities that deviated significantly from the average and thus, per permit condition 40 (b) merit consideration for relocation.

Fatalities of night migrating birds and bat fatalities were not disproportionately greater at turbines with flashing red FAA lights as opposed to turbines without such lights. Thus, red flashing FAA lights do not attract night migrants.

Avian carcasses tended to be located somewhat evenly over a wider range of distances from wind turbine bases than bat carcasses, which were located closer to the towers. Seventy-four percent (74%) of bat carcasses were found within 60 meters of towers as compared to thirty-eight percent (38%) for birds.

Among the different bird species groups fatalities were not disproportionately greater at turbines with 80 m towers as opposed to turbines with 65 m towers.

The vegetative cover of the wind farm consists entirely of agricultural land, roughly sorted into two types of cover, pasture and crop land. The percentage of incidents found was higher in pasture, lower in crop and fallow and approximately the same in till than would be expected based on the percentage of ground cover. Pasture is short vegetative cover, so carcass visibility by the surveyor could be an explanation for this difference in incident distribution. When comparing the species grouped by size to cover height, the smallest percentage of incidents was found in tall vegetation, with the most noticeable differences between the numbers of incidents found in tall versus short vegetation occurring in the small and medium bird and bat groups.

After adjusting for scavenging and searcher efficiency, the estimated annual number of avian fatalities at Shiloh I were as follows for each of the three years:

- Year 1-11.97 bird incidents/MW (17.96 incidents/tower) and 5.24 bat incidents/MW (7.86 incidents/tower)
- Year 2- 8.6 bird incidents/MW (12.9 incidents/tower) and 5.75 bat incidents/MW (8.63 incidents/tower).
- Year 3-2.82 bird incidents/MW (4.23 incidents/tower) and 2.14 bat incidents/MW (3.21 incidents/tower).

These results show significant annual variation. However, efforts in Years 2 and 3 were calculated using a more robust number of search efficiency and scavenge rate tests. While we did not discount Year 1 results, we feel that results from subsequent years reflect a more thorough analysis and more plausible results.

In addition, there was a substantial disparity in the size of the area searched between the Shiloh I project and the adjacent High Winds Project. The area searched per tower at Shiloh I was nearly 2 times the amount searched per tower at High Winds and was not adjusted for. If we only count the number of carcasses found in search areas of comparable size, the rates between the two areas are not so different. Moreover, the Shiloh I fatality rates are within the ranges of fatality rates reported at other wind farms. The per year estimates of fatality rates for each of the three years, adjusted for area searched, are as follows:

- Year 1- 6.51 bird incidents/MW (9.76 incidents/tower) and 4.24 bat incidents/MW (6.35 incidents/tower)
- Year 2 - 4.82 bird incidents/MW (7.23 incidents/tower) and 3.03 bat incidents/MW (4.54 incidents/tower).
- Year 3 - 1.63 bird incidents/MW (2.45 incidents/tower) and 1.84 bat incidents/MW (2.75 incidents/tower).

When the three years are combined and the difference in search areas is not accounted for the estimated number of fatalities (averaged over 3 years) was 1,044 birds/year or 6.96 bird incidents/Mw/year (10.44 bird incidents/tower/year). 95% CI for these three metrics were ± 74 birds/year, ± 0.49 bird incidents/MW/year and 0.74 bird incidents/tower/year.

A total of 588 bat fatalities per year (3.92 bat incidents/Mw/year, 5.88 bat incidents/tower/year) was estimated for the Shiloh project. 95% CI for these three metrics were ± 37 bats/year, ± 0.25 bats incidents/MW/year and 0.37 bat incidents/tower/year. This estimate of bat incidents is greater than the average bat fatality rate at High Winds (2.02 bat incidents/Mw/year), but is less than or similar to that found at most wind farms in North America.

When examining differences between species groups at the two adjacent projects we see that the adjusted number of raptors at Shiloh I (0.44 incidents/Mw/year) is only slightly greater than at High Winds (0.41 incidents/Mw/year). The major difference in fatality rates derived from the smaller carcasses (i.e. bats, mentioned previously, as well as small birds). Passerine bird incidents at Shiloh (5.82 incidents/Mw/year) were ~8 times greater than at High Winds (0.71 incidents/Mw/year). The initial low searcher efficiency rating in year one for small birds magnified the effect of the larger number of passerines found at Shiloh I on the adjusted rates. Nevertheless, on a species-by-species examination of fatalities over the three years of the study, there is no species that has sustained a disproportionate number of fatalities at the Shiloh I project.

There are small differences in the number of bird and bat fatalities for most species at the Shiloh I project in comparison with the adjacent High Winds project. Moreover, there is nothing to suggest that a turbine or group of turbines in the Shiloh I project is substantially out of line with other projects.

The abundance of carcasses of five very common species at Shiloh accounts for a large portion of the difference between the sites. These species (listed above) accounted for 47.5% of carcasses found at Shiloh, but only 23.3% of carcasses found at High Winds.

The numbers of fatalities found at Shiloh I do not suggest biologically significant impacts to birds or bats. With respect to birds, it is important to remember that the numbers of fatalities, both estimated and actual carcasses found represent extremely small proportions of the North American and regional populations of these animals, suggesting that the impact to these species' populations will not cause declines that could potentially threatened the populations of these species. Even species for which larger numbers of carcasses were found, North American populations are in the tens to hundreds of millions of individuals, so it is highly unlikely that the fatalities at the Project site will result in declines of any species. In addition, several of the species that were found dead at Shiloh I are harvested in the thousands to tens of thousands (and more than a million birds for Mourning Doves), reinforcing our argument that the fatalities are not biologically significant. The fact that no endangered and, or threatened species were killed during three years of this study strongly suggests that the turbines at Shiloh I are not a significant risk to these species.

We reviewed the data provided herein to determine whether conditions of Solano County Use Permit 03-06, item 40, were met. The fact that three years of intensive study equal to and in some cases exceeding standard protocols have been completed satisfies condition 40a. With respect to subsections 40bi, ii and iii, we could find no evidence that:

- There were large comparative differences in the number of mortalities per turbine to indicate the need for relocation
- the number of fatalities of any species would result in population impacts to any species.
- the number of mortalities at particular turbines or group of turbines was substantially out of line in comparison with the experience of other wind farms in the Solano County Wind Resource Area.

Therefore, mitigation in the form of relocating turbines would not be supported by the data presented herein.

1.0 INTRODUCTION

The Collinsville-Montezuma Hills Wind Resource Area (WRA) consists of approximately 40,300 acres of area. The current development area of all of the existing wind plants including Shiloh I, consists of approximately 17,300 acres. The WRA in which the turbines are arrayed is situated about 3 miles west of Rio Vista in Solano County, California. The landscape consists of rolling hills with elevations ranging between near sea level adjacent to the Sacramento River to about 250 - 300 feet (61-91 m) in elevation above sea level. Turbines are placed on the highest ground and do not run through low-lying valleys. The northern boundary of the WRA for the present is California State Highway 12. The southern boundary is the Sacramento River Deep Water Ship Channel. The Sacramento River Deep Water Ship Channel is about 1.5 miles to the south of the southernmost location where turbines are located and most turbines are more than 4.5 miles from this waterway. Moving from south to north the terrain becomes more uniform with less elevation differential between the ridges and the valleys. On the west is the Suisun Marsh. The Suisun Marsh is a minimum of 1.25 miles from where the nearest turbine is located, with most turbines being located more than 1.5 miles from these wetlands. The terrain is generally uniform along the east-west axis.

The Shiloh I Wind Power Project Area (hereafter, the “Project”), operated by Shiloh Wind Partners, LLC, encompasses approximately 6,800 acres of agricultural land in the Montezuma Hills, near Rio Vista in Solano County, California. The project is within the Collinsville Montezuma Hills Wind Resource Area (CMHWRA) and is west of the 90 turbine High Winds, LLC project which became operational in 2003. The wind turbines installed in that project are the Vestas V80 model capable of generating 1.8 megawatts.

The Shiloh I project is also adjacent to the 426 turbine EnXco V wind farm originally constructed by Kenetech Windpower in the early 1990s (currently operated by EnXco). Four hundred-twenty of the turbines in this project are the Kenetech Model KCS-56, each one capable of generating 100 kilowatts. Ninety turbines of this same model have been replaced by 6 of the newer 1.5 MW turbines as part of a repowering process which will substantially reduce the number turbine structures on this site. The Shiloh I project is north and west of this project area. The other major development in the CMHWRA includes the 52 turbines of the Sacramento Municipal Utility District (SMUD) Phase I and II projects (Figure 1.).

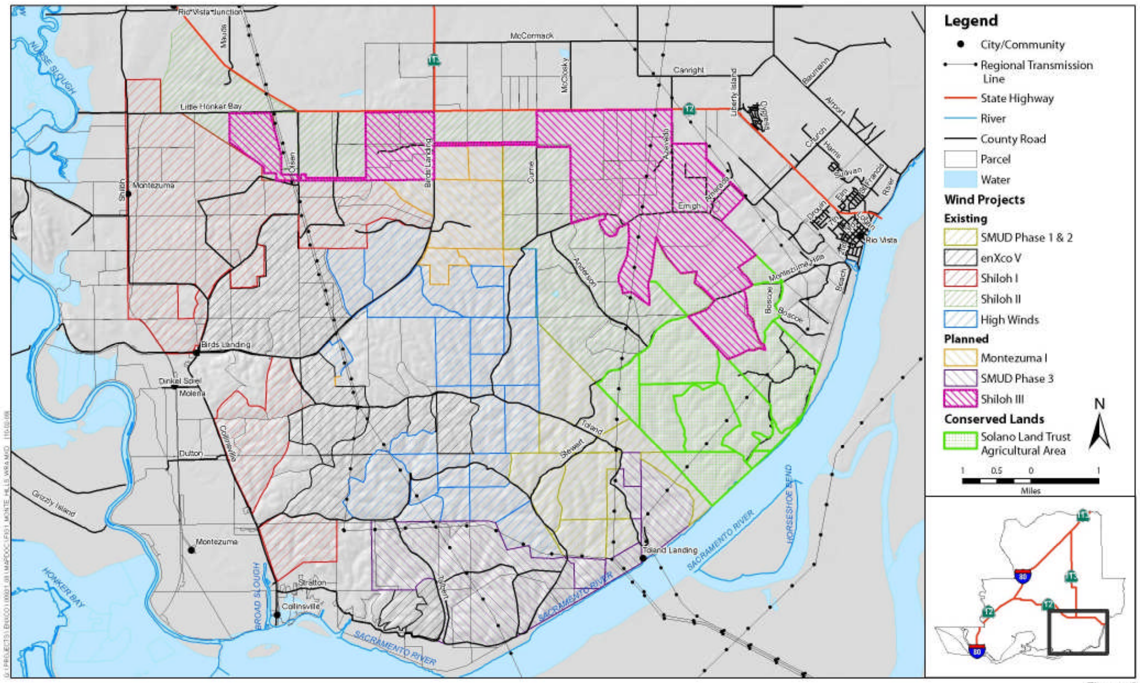

Figure 1
Montezuma Hills Wind Resource Area

Figure 1. Projects Map

The Shiloh I project utilizes 100 General Electric 1.5 MW wind turbines, for a total capacity of up to 150 MW. The hub height of twenty four (24) of the turbines is 65 meters (213 feet) and the rotor diameter is 77 meters (253 feet), for a total height of approximately 103.5 meters (339.5 feet) above ground level (AGL) when the rotors are in the 12 o'clock position. At the 6 o'clock position the tip of the rotors are approximately 26 meters (85 feet) AGL. Seventy-six (76) of the turbines are mounted on 80 meter towers . The hub height is 263 feet and using the same rotor diameter, the tip of the blade in the 12 O'clock position is 118.5 meters (390 feet) AGL and when the tip of the blade is in the 6 O'clock position, it is 51.5 meters (166 feet) AGL.

The project is dissected by Shiloh Road, Birds Landing Road, Montezuma Hills Road and Talbert lane. These roads are bounded by narrow weedy (mostly grasses) strips and a few homesteads complete with houses, yards, barns, driveways, and other structures necessary for farming. The land is privately owned and is largely agricultural. Where turbines and project roads are located the land use is rotating agricultural crops and grazed pastures. Crops include wheat, barley, hay, safflower and fallow fields. A multi-year rotation is the norm with wheat, fallow, and grazing alternating being the regime used most often. There are some isolated wetlands (mostly cattail marsh) and one small reservoir within the project boundaries, but they are not within the project footprint.

Treed areas within the project are limited to the areas close to homes and in a few valleys. No trees were removed to construct the project. Many of the trees are non-native eucalyptus, olive, and other species, although some native oaks and junipers are present near homes. There is a large olive grove to the east of the project area. These treed habitats provide havens and nesting substrate for birds that do not use farmland and other birds that forage in tilled fields.

2.0 METHODS

2.1 Clean Sweep Surveys

Prior to the start of the carcass surveys, a "clean sweep" was conducted at all newly installed and operational wind turbine towers to remove all carcasses and remains of carcasses from the survey area. Clean sweeps were conducted using the same protocol as used in the standardized carcass surveys (see below), except that virtually all (99 of 100) of the installed towers were searched during the clean sweeps while only every other tower (n=50) was searched during standardized surveys. The thoroughness of the sweep was adopted to increase the likelihood that all carcasses found during the subsequent surveys would be associated with incidents that occurred during the course of the systematic surveys, and remove the possibility that scavengers or wind could relocate remains between towers. The clean sweep for 99 of all 100 towers was executed March 28 through April 8, 2006. The one tower not surveyed (A16) during the clean sweeps was not part of the set of towers surveyed during subsequent standardized surveys, and was unable to be surveyed during clean sweeps due to road construction and the presence of heavy equipment surrounding the tower. Standardized surveys of every other tower started two days following the clean sweeps, on April 10, 2006.

In October, 2007 (the halfway point of the three year study cycle), we began to survey the set of 50 turbines which were not surveyed during the first 18 months, maintaining the same seven day interval cycle. Clean sweeps at these towers were conducted on three days between October 8 and 10th, 2007, and standardized surveys at these towers commenced on October 15, 2007.

2.2 Standardized Surveys

During the first 18 months of this on-going three-year project, carcass surveys were conducted approximately once per week at the same fifty (every other tower of the 100) wind turbine towers between April 10, 2006 and October 3, 2007, for a total of approximately 78 total rounds. During the second half of the study , the other set of 50 towers were surveyed once per week between October 15, 2007 and April 11, 2009, for a total of 78 total rounds. A total of nearly 156 rounds (n=155.4) have been conducted (Figure 2).

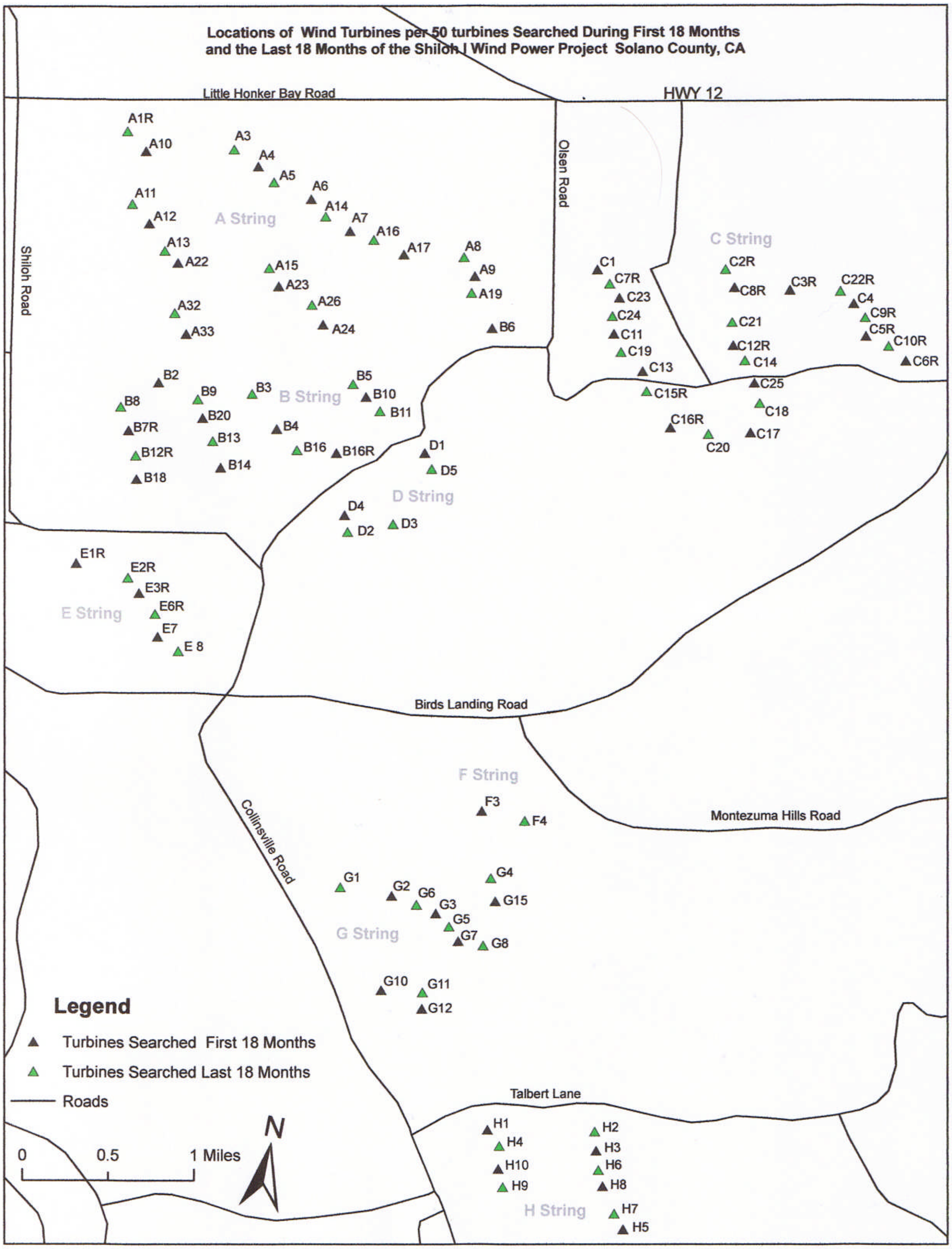

Figure 2. Locations of wind turbine towers per 50 turbines searched during the first 18 months and the last 18 months of the Shiloh I Wind Power Project.

There are towers of two different heights in the project area: 65 meter and 80 meter towers. In the entire study region of 100 turbine towers, there are 76 -80 meter towers and 24 – 65 meter towers. Of these, an average of 12 – 65m towers were surveyed per round (of 50 tower surveys), and 38 – 80m towers surveyed per round.

The first two years of the survey consisted of searchers walking in concentric circles around the tower's base at distances of 15, 30, 40, 50, 60, 70, 80, 90 and 100 meters, and also around the base of each tower (Figure 3).

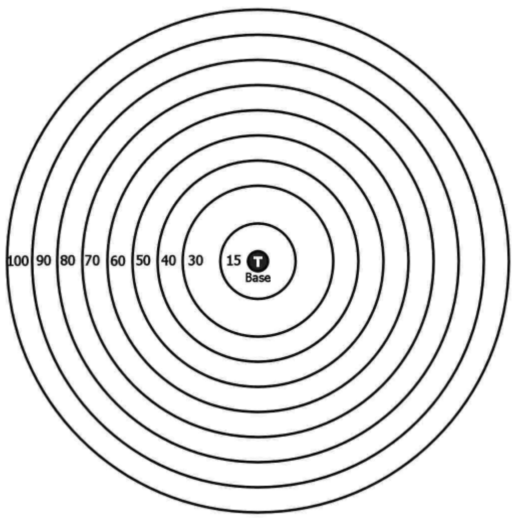

Figure 3. Search pattern for wind turbine tower carcass survey (distance in meters)

It was decided for year 3 to decrease the distance between circles under 30 meters to 5 meter apart concentric circles. While walking around each ring, the searcher using the unaided eye, alternately scans an area that extends for 5m in either side of his track (7-1/2 m on one side of the 15 and 30-meter circles), yielding a total of 105 meters scanned. The surveyors use range finders to initially establish and periodically check the distance of each circular route from the tower. Data recorded at the beginning of the surveys includes meteorological data (cloud cover, temperature, and wind velocity) and ground cover information (crop type and height). In addition, the start and finish times are recorded for each tower searched (see Appendix A). In order to avoid having the towers continually surveyed during the same time of day, each round started 3 towers beyond where the previous survey was started.

When a carcass or injured bird or bat is found, the searchers perform a thorough investigation and documentation of the incident using the protocols listed in the Wildlife Response and Reporting System (WRRS). An incident report number is assigned and an incident report form filled out for each find (Appendix B). A GPS is used to determine geographic coordinates, and a range finder and compass are used to determine distance and bearing from the tower. The carcass is photographed in the position in which it is found (in situ) using a digital camera. After identifying the animal by species (including age and sex when possible), an examination is performed to determine the nature and extent of any injuries, and whether any scavenging or insect infestation has occurred. The time since death is estimated and recorded. In case of dismemberment, the surveyors search the vicinity to locate all body parts. Loose feathers are only considered fatalities if enough feathers are found to represent a dead bird. All loose feathers are collected in order to avoid identifying the feathers as an additional kill during the next survey of the tower. The carcass is then placed in a plastic bag labeled with date, species, tower number, and incident report number, and taken to a freezer to be stored in accordance with the FWS permit requirements. When carcasses are found at times and locations outside of one of the standardized surveys conducted as part of this study, such as during avian surveys or while driving between sites, the carcass is processed as above but it is classified as an "incidental" find.

When an injured animal is found, the searchers record the same data collected for a carcass (noting however, that it is an injury and not a fatality). The searchers then capture and restrain the animal in a manner to avoid either further injury to the animal or injury to the survey crew. Once the animal is secured it is transported to a wildlife rehabilitator or veterinarian. The hospital accession number and the final disposition of the animal are recorded on the report form.

Only in those cases where the injury to the animal can be linked to a specific tower is a tower number recorded as the location in the report. When no corroborating information that the injury is linked to a tower is available, the animal is simply recorded as having been found "ON SITE". For instance, if a bird is found injured with a broken wing but is still mobile, it would not be associated with a specific wind turbine tower because it could have moved.

If the carcass or injured animal found is listed as a threatened or endangered species, the Avian Respondent, listed in the WRRS, is notified immediately by phone, and collection of the dead animal is delayed until specific direction for proceeding is received from the U.S. Fish and Wildlife Service. All Golden Eagle fatalities are reported to the U.S. Fish and Wildlife Service.

2.3 Searcher Efficiency and Scavenger Removal

It is recognized that the number of carcasses found under the towers is lower than the total number of birds and bats likely to have been killed. There are at least three factors that need to be accounted for. The first is the possibility that the searchers will miss carcasses due to the amount of ground cover or the size and coloration of the species making it difficult to spot them. A second possibility is that the carcasses are removed prior to the time the searchers arrive on location after the collision event occurred. Finally, the estimate of incidents must be adjusted by the ratio of the number of towers searched to the number of operational towers in the wind project area. Applying these correction factors to the actual number of carcasses found during standardized surveys reduces underestimation of mortality due to these factors. Several scavenger removal and searcher efficiency studies conducted throughout the study duration in 2006, 2007, 2008 and 2009 estimated the proportion of carcasses missed by the searchers and the proportion removed by scavengers within 7-day search cycles.

We made the following adjustments to extrapolate the mortality counts to estimated mortality for the entire Shiloh I Project Area (the Project). We adjusted the number of incidents found, previously corrected for Project Set-up Period and Area Searched, (C), for Scavenger efficiency (Sc), Search efficiency (Se) and Proportion of towers searched to the total of 100 operational towers in the Project (Ps).

a) Proportion of test carcasses left by scavengers within the search period (*Sc*). Scavenger efficiency (*Sc*) was measured in May-06, Oct-07, Feb-08 Mar-08, May-08, Jun-08, Jul-08, Oct-08, Dec-08, Feb-09, Mar 09, by placing 95 small bird carcasses (European Starling size), 52 medium bird carcasses (Rock Pigeon size), 33 large bird carcasses (Red-tailed Hawk sized), and 134 bat carcasses, on searched areas in the Shiloh I Project. We monitored carcasses daily for two weeks, for evidence of scavenging. The status of each carcass was reported as intact, scavenged or completely removed, and the extent of scavenging was described. The probability of a collision event is equally distributed over all days of the search cycle (7 days). Thus, the overall duration between carcass fall and discovery is approximately half the actual search cycle (3.5 days). For example, if a carcass was discovered at a 7-day search site, it had an equal probability of having hit the tower on each of the previous 7 nights. The average time between impact and discovery is (1 + 2 + 3 + 4 + 5 + 6)/6 = 3.5 days (rounded to 4 days). Thus, the scavenge rate was calculated for the number of test carcasses that remained visible (body of carcass removed/severely scavenged) after 4 days. We designed and executed scavenge tests to encompass all vegetation types and heights, so as to accurately replicate actual search conditions on the ground. Tests were also performed across all seasons, and occurred at most of the searched towers. Finally, carcasses were located at random distances and directions from the individual tower bases to further encompass all likely locations where searchers were likely to encounter actual collision fatalities.

b) Proportion of carcasses not missed by observers in the search efficiency trials (*Se*). Search efficiency trials were conducted for each observer by having an independent technician place carcasses (total 96 small birds, 52 medium birds, 33 large birds and 134 bats under towers in the Project, without the knowledge of the searcher. The search efficiency trials were a subset of the scavenge trials, involving the use of the same carcasses. The searchers recorded all carcasses that they discovered during standardized surveys, including carcasses planted by the independent wildlife technician. Planted evidence of collisions was later removed from the database and a mean search efficiency rate (*Se*) was calculated. In the first half of the project (April 10, 2006 to October 3, 2007), the *Se* rate was determined by the number of carcasses found during the first search after the carcass was placed. Subsequently, the searcher was made aware of the carcass in order to maintain records on its condition for the scavenge rate data. However, to more closely model actual search conditions, in the second half of the project (October 15, 2007 and April 11, 2009), we made the following change: Searchers remained unaware of *Se* test carcasses if they did not find them during the initial search. There was a possibility of a carcass being found in a subsequent search, if it had not been scavenged before then. Prior experience at other wind projects showed that a proportion of carcasses found had obviously been on the ground for more than one search cycle (i.e. had been missed in the initial search, only to be found in the next search). Our new methodology allowed for this possibility.

c) Proportion of towers searched to the total of 100 operational towers in the windfarm (*Ps*). *Ps* for the 50 7-day sites was 50:100, as we searched 50 towers in the first 18 months of the project and the remaining 50 towers in the second month and a half of the project.

Thus, $\hat{C} = \dfrac{C}{Sc \times Se \times Ps}$

Where $\hat{C}$ = Adjusted total number of kills estimated in the project area.

The variance of the number of kills found was first calculated per tower using standard methods. Then, we calculated the variance due to the correction factors *Sc* and Se, using the variance of a product formula (Goodman, 1960). The variance of the product of *R*, *E* and *P* is:

$$\mathrm{Var}(\hat{C}) = \hat{C}^2 \times \left[\frac{\mathrm{var\ C}}{\mathrm{C}^2} + \frac{\mathrm{var}(Sc \times Se)}{(Sc \times Se)^2} \right]$$

2.4 Prey Observations

Potential prey species for raptors, such as rodents, rabbits, other larger mammals, reptiles and amphibians, were recorded when seen. These observations were generally made during standardized wind turbine carcass surveys, Though we recorded anecdotal evidence of potential raptor prey species in all years, data were insufficient for statistical analysis in the Years 1 and 3 of the project. Data collected for each observation included species name, the number of individuals seen, their approximate location, and the survey tower number.

2.5 Vegetative Cover

Ground cover data was recorded at the beginning of the standardized surveys. Data recorded included vegetation/crop type and height. Vegetation types included: crop (wheat, hay, oat, rye, safflower) fallow, pasture and tilled soil. Vegetation height was classified as short (<6"), medium (6"-12"), or tall (>12").

3.0 RESULTS

3.1 Clean Sweep Surveys

For the first 18 months of this three-year survey, a total of 99 clean sweep surveys were conducted March 28 through April 8, 2006, totaling 2 rounds of virtually 50 (n=49.5) tower surveys (50 tower searches being the standard unit of tower searches per round) at every tower except one (A16) of the project area's 100 wind turbine towers. Heavy equipment and construction personnel surrounded A16 preventing surveys. Carcasses found included: 1 European Starling, 3 Red-tailed Hawks, 1 Western Meadowlark, and 1 Hoary Bat. In October 2007 (the halfway point of the three year study cycle), clean sweeps were conducted at the set of 50 turbines which were not surveyed during the first 18 months between October 8th and 10th. There were a total of 7 carcasses found, including: 2 American Kestrels, 1 Turkey Vulture, 1 Rock Pigeon, 1 Western Meadowlark, 1 unidentified species of blackbird, and 1 Hoary Bat (see Appendix C for data on these incidents). Clean sweeps at all 100 towers were considered searched during this second set of clean sweep surveys, as standardized surveys at the first set of

50 towers was conducted within 2 weeks prior to commencing with surveys at the second set of 50 towers.

3.2 Standardized Surveys

3.2.1 Summary of Search Effort

A total of 78 near-complete rounds (n = 77.42) of standardized searches were conducted between April 10, 2006 and October 3, 2007 (Table 1) on 362 days (66% of the days of the 18 month period), for a total of nearly 3871 complete individual turbine searches. For various reasons, some towers could not be completely surveyed every week. The reasons towers were not surveyed or were only partially surveyed included: presence of impenetrable tall and thorny safflower groundcover, application of bio-solids/manure or pesticides/herbicides, presence of heavy equipment present near tower, or temporary loss of permission from landowner to be on the land. Bio-solids refer to sewage treatment plant solid waste used as a fertilizer. The details of the rounds and dates towers were surveyed is shown in Table 1. The average number of wind turbine towers surveyed during the first 18 months of this project was 49.63. For the purposes of our analyses and discussion, we have rounded this number up to 50 wind turbine towers. For the last 18 months of the study at the other set of 50 wind turbines, a total of 78 complete rounds were surveyed at 50 wind turbine towers, on 355 days (65% of the days during that period), for a total of 3900 individual turbine surveys. The average number of days between successive searches for each tower was 7.04 days (Standard Deviation = 1.48).

Table 1. Summary of rounds of fatality searches during 3 years of Shiloh I carcass surveys at wind turbine towers: clean sweeps and standardized surveys

Year	Round No.	Dates Surveyed
Clean Sweep of 99 Wind Turbine Towers		
2006	Round 1 & 2	March 28, 29, 30, 31 & April 1, 2, 5, 6, 7, 8 *(T#A16 not surveyed*)*
Carcass Surveys of 50 Wind Turbine Towers		
2006	Round 1	April 10, 11, 12, 13, 14
	Round 2	April 17, 18, 19, 20, 21
	Round 3	April 24, 25, 26, 27, 28, 29
	Round 4	May 1, 2, 3, 4, 5
	Round 5	May 8, 9, 10, 11, 12, 13
	Round 6	May 15, 16, 17, 18, 19
	Round 7	May 21, 22, 23, 24, 25 *(T#C3R, C8R, C23 not surveyed*)*
	Round 8	May 30, 31 & June 1, 2, 3
	Round 9	June 5, 6, 7, 8
	Round 10	June 10, 11, 12, 13, 14, 15 *(T#A9, A23, A24 partially surveyed **)*
	Round 11	June 17, 18, 19, 21, 22, 23, 24 *(T#A9, A23, A24 partially surveyed **)*
	Round 12	June 26, 27, 28, 29, 30 *(T#A9, A23, A24 partially surveyed **)*
	Round 13	July 3, 5, 6, 7 *(T#A9, A23, A24 partially surveyed **)*
	Round 14	July 10, 11, 12, 13, 14 *(T#A9, A23, A24 partially surveyed **)*
	Round 15	July 17, 18, 19, 20, 21 *(T#A9, A23, A24 partially surveyed **)*
	Round 16	July 24, 25, 26, 27, 28 *(T#A9, A23, A24 partially surveyed **)*

Year	Round No.	Dates Surveyed
	Round 17	July 31 & August 1, 2, 3, 4 *(T#A9, A23, A24 partially surveyed **)*
2006	Round 18	August 7, 8, 9, 10, 11 *(T#A9, A23, A24 partially surveyed **)*
	Round 19	August 14, 15, 16, 17, 18 *(T#A9, A23, A24 partially surveyed **)*
	Round 20	August 21, 22, 23, 24, 25 *(T#A23 partially surveyed **)*
	Round 21	August 28, 29, 30, 31 & September 1
	Round 22	September 5, 6, 7, 8, 9
	Round 23	September 11, 12, 13, 14, 15 *(T#B16R partially surveyed***)*
	Round 24	September 18, 19, 20, 21, 22 *(T#B10 not surveyed*)*
	Round 25	September 25, 26, 27, 28, 29 *(T#A23 not surveyed*)*
	Round 26	October 1, 2, 3, 4, 5, 6, 7
	Round 27	October 9, 10, 11, 12, 13
	Round 28	October 16, 17, 18, 19, 20, 21
	Round 29	October 23, 24, 25, 26, 27
	Round 30	October 30, 31 & November 1, 2, 3, 4
	Round 31	November 6, 7, 8, 9
	Round 32	November 13, 14, 15, 16, 17
	Round 33	November 19, 20, 21, 22
	Round 34	November 27, 28, 29, 30 & December 1, 2
	Round 35	December 4, 5, 6, 7
	Round 36	December 11, 13, 14, 15
	Round 37	December 18, 19, 20, 22
	Round 38	December 26, 27, 28, 29, 30
2007	Round 39	January 2, 3, 4, 5
	Round 40	January 6, 8, 9, 10, 11
	Round 41	January 15, 16, 17, 18 *(T#C3R not surveyed*)*
	Round 42	January 22, 23, 24, 25, 26, 27 *(T#B20 not surveyed*)*
	Round 43	January 29, 30, 31 & February 1, 2
2007	Round 44	February 5, 6, 7, 8
	Round 45	February 12, 13, 14, 15, 16
	Round 46	February 18, 19, 20, 21, 22, 23, 24
	Round 47	February 27, 28 & March 1, 2
	Round 48	March 5, 6, 8, 9, 10
	Round 49	March 12, 13, 14, 15
	Round 50	March 19, 20, 21, 22
	Round 51	March 26, 27, 28, 29
	Round 52	April 2, 3, 4, 5
	Round 53	April 9, 10, 12, 13
	Round 54	April 16, 17, 18, 19
	Round 55	April 23, 24, 25, 26
	Round 56	April 30 & May 1, 2, 3, 4
	Round 57	May 7, 8, 9, 10
	Round 58	May 14, 15, 16, 17
	Round 59	May 21, 22, 23, 24, 25
	Round 60	May 29, 30, 31 & June 1
	Round 61	June 4, 5, 6, 7
	Round 62	June 11, 12, 13, 14
	Round 63	June 18, 19, 21, 22
	Round 64	June 25, 26, 27, 28
	Round 65	July 2, 3, 4, 5

Year	Round No.	Dates Surveyed
	Round 66	July 9, 10, 11
	Round 67	July 16, 17, 18, 19
	Round 68	July 23, 24, 25, 26
	Round 69	July 30, 31 & August 1
	Round 70	August 6, 7, 8, 10
	Round 71	August 13, 14, 15, 16
	Round 72	August 20, 21, 22, 23, 24
	Round 73	August 27, 28, 29, 30
	Round 74	September 3, 4, 5, 6, 7
	Round 75	September 10, 11, 12, 13
	Round 76	September 17, 18, 19, 20
	Round 77	September 24, 25, 26
	Round 78	October 1, 2, 3
Clean Sweep of Second Set of 50 Wind Turbine Towers (not surveyed during first 18 months)		
2007	Complete Round	October 8, 9, 10
Carcass Surveys of Second Set of 50 Wind Turbines Towers (not surveyed during first 18 months)		
2007	Round 1	October 15, 16, 17, 18, 19
	Round 2	October 22, 23, 24, 25
	Round 3	October 29, 30, 31 & November 1
	Round 4	November 5, 6, 7, 9, 10
	Round 5	November 12, 13, 14, 15
	Round 6	November 19, 20, 21
2007	Round 7	November 26, 27, 28, 29
	Round 8	December 3, 4, 6, 7
	Round 9	December 10, 11, 12
	Round 10	December 17, 19, 20, 21
	Round 11	December 23, 24, 26, 27, 28
2008	Round 12	December 29, 30, 31 & January 2, 3
	Round 13	January 7, 9, 10, 11, 12, 13
	Round 14	January 14, 15, 16, 17
	Round 15	January 21, 22, 23, 24, 25, 26
	Round 16	January 28, 29, 30 & February 1
	Round 17	February 4, 5, 6
	Round 18	February 11, 12, 13
	Round 19	February 18, 19, 20, 21
	Round 20	February 25, 26, 27, 28
	Round 21	March 3, 4, 5
	Round 22	March 10, 11, 12, 13
	Round 23	March 17, 18, 19, 21
	Round 24	March 24, 25, 26, 27
	Round 25	March 31 & April 1, 2, 3, 5
	Round 26	April 7, 8, 9, 10
	Round 27	April 14, 15, 16, 17
	Round 28	April 21, 22, 23, 24
	Round 29	April 28, 29, 30 & May 1, 2, 3

Year	Round No.	Dates Surveyed
	Round 30	May 5, 6, 7, 8, 9
	Round 31	May 12, 13, 14, 15, 16
	Round 32	May 19, 20, 21, 22, 23
	Round 33	May 26, 27, 28, 29, 30
	Round 34	June 2, 3, 4, 5
	Round 35	June 9, 10, 11, 12, 13
	Round 36	June 16, 17, 18, 19, 20
	Round 37	June 23, 24, 25, 26
	Round 38	June 30 & July 1, 2
	Round 39	July 7, 8, 9, 10
	Round 40	July 14, 15, 16
	Round 41	July 21, 22, 23
	Round 42	July 28, 29, 30
	Round 43	August 2, 3, 5, 6, 7
	Round 44	August 11, 12, 13, 14, 15
	Round 45	August 18, 19, 20
	Round 46	August 25, 26, 27, 28, 29
	Round 47	August 31 & September 2, 3, 4, 5, 7
	Round 48	September 8, 9, 10, 11, 13
	Round 49	September 15, 16, 17, 18
	Round 50	September 22, 23, 24, 25, 26, 27
	Round 51	September 29, 30 & October 1, 2
	Round 52	October 6, 7, 8, 9
	Round 53	October 11, 13, 14, 15, 16, 17
	Round 54	October 19, 20, 21, 22, 23, 24
	Round 55	October 27, 28, 29, 30
	Round 56	November 3, 4, 5, 6
2008	Round 57	November 10, 11, 12
	Round 58	November 17, 18, 19, 20, 21
	Round 59	November 22, 23, 24, 25, 26
	Round 60	December 2, 3, 4, 5
	Round 61	December 8, 9, 10, 11, 12
	Round 62	December 15, 16, 17, 18, 19
	Round 63	December 19, 20, 21, 22, 23, 24, 26
2009	Round 64	December 27, 28, 29, 30, 31 & January 3, 4
	Round 65	January 5, 6, 7, 8, 9, 10
	Round 66	January 12, 13, 14, 15, 16
	Round 67	January 19, 20, 21, 22, 23, 24
	Round 68	January 26, 27, 28, 29
	Round 69	February 2, 3, 4, 5, 6, 7
	Round 70	February 9, 10, 11, 12, 13
	Round 71	February 18, 19, 20, 21
	Round 72	February 24, 25, 26, 27, 28
	Round 73	March 2, 3, 4, 5, 6, 7
	Round 74	March 9, 10, 11, 12, 13
	Round 75	March 16, 17, 18, 19
	Round 76	March 23, 24, 25, 26, 27
	Round 77	March 30, 31 & April 1, 2, 3
	Round 78	April 6, 7, 8, 9, 10, 11

Year Round No. Dates Surveyed				
Survey Summary		**First 18 Months**	**Last 18 Months**	**Total (3 YEARS)**
Standardized Surveys	Total # Field Days	362	355	717
	Total # of Rounds	77.4	78	255.4
	Average # of Towers Surveyed / Round	49.62	50	49.71
	Total # of Individual Surveys	3840.6	3900	7740.6
	Total # Searcher-Hours in Field	3779.7	3868.5	7648.2
	Average # Searcher-Hours / Survey	0.98	0.99	0.99
	Average # Searcher-Minutes / Survey	59.0	59.5	59.3
Clean Sweep Surveys	Total # Field Days	10	3	13
	Total # of Rounds	2	1	2.98
	Average # of Towers Surveyed / Round	49.5	50	50
	Total # of Individual Surveys	49.5	50	149
	Total # Searcher-Hours in Field	132.05	45.33	177.38
	Average # Searcher-Hours per Survey	1..33	0..91	1.19
	Average # Searcher-Minutes per Survey	80	54.4	71.3

* The reasons surveys at specified towers were not conducted include: application of bio-solids/manure or pesticides/herbicides, heavy equipment present near tower, or temporary loss of permission from landowner to be on the land.

** Partial surveys of wind turbine towers A9, A23, and A24 were due to tall, thorny safflower ground cover preventing all survey area to be searched. The proportions of the area surveyed for each of these towers are as follows: A9 ~ 50% (Rounds 10-19), A23 ~ 15% (Rounds 10-20), and A24 ~ 30% (Rounds 10-19).

*** Partial survey of wind turbine tower B16R was due to the spreading of manure/bio-solids, allowing only 30% of the survey area to be searched for Round 23.

3.2.2 Incident Species Composition and Unadjusted Fatality Rates

During the three years of this study, a grand total of 559 incidents were recorded. Of 559 wind turbine related incidents, 511 incidents were found during standardized surveys, and an additional 48 were found in between surveys, or “incidentally”, and all of these latter incidents were classified as “incidental” finds (Table 2; Appendix D and E). In addition to these wind turbine related incidents, a total of 21 incidents were collected which were deemed caused by something other than wind turbines based on their locations and/or conditions. “Other” possible causes include: predators, barbed wire fence, or harvesting equipment. Nine of these “Other” cause related incidents were found during standardized surveys of operating wind turbines, eight of theses were found during standardized surveys at non-operating wind turbines, and 4 were incidental (see Appendix F).

Table 2. Unadjusted number of incidents per species during the 3 years of surveys per total installed megawatt capacity* per year, and per turbine per year, at the Shiloh I Project Area, April 2006 – April 2009, found during standardized surveys

Species Name	Total	# Incidents per Mw/Year	# Incidents per Turbine/Year	Incidental**
Bird Species				
American Coot	10	0.0444	0.066	
American Goldfinch	1	0.0044	0.006	
American Kestrel	27	0.12	0.18	1
American Pipit	9	0.04	0.06	
Barn Owl	2	0.0088	0.013	5
Black-crowned Night Heron	1	0.0044	0.006	
Black-headed Grosbeak	1	0.0044	0.006	
Black-throated Gray Warbler	4	0.0177	0.026	
Brewer's Blackbird	15	0.0666	0.1	
Chukar	4	0.0177	0.027	
Common Moorhen	1	0.0044	0.006	
Dark-eyed Junco, slate	1	0.0044	0.006	
European Starling	6	0.0266	0.04	
Ferruginous Hawk	2	0.0088	0.013	
Golden Eagle	1	0.0044	0.006	2
Golden-crowned Kinglet	1	0.0044	0.006	
Golden-crowned Sparrow	1	0.0044	0.006	
Great Horned Owl	4	0.0177	0.027	
Hammond's Flycatcher	1	0.0044	0.006	
Horned Lark	21	0.0933	0.14	1
House Finch	1	0.0044	0.006	
House Sparrow	1	0.0044	0.006	
Killdeer	4	0.0177	0.027	2
Lincoln's Sparrow	2	0.0088	0.013	
MacGillivray's Warbler	2	0.0088	0.013	1
Mallard	5	0.0222	0.033	
Merlin***	1	0.0044	0.006	
Mourning Dove	26	0.1155	0.173	2
Northern Flicker	2	0.0088	0.013	
Northern Harrier***	2	0.0088	0.013	
Northern Mockingbird	1	0.0044	0.006	
Orange-crowned Warbler	1	0.0044	0.006	1
Pacific Slope Flycatcher	3	0.0133	0.02	
Peregrine Falcon	1	0.0044	0.006	
Prairie Falcon***		0	0	1
Red-tailed Hawk	15	0.0666	0.1	8

Species Name	Total	# Incidents per Mw/Year	# Incidents per Turbine/Year	Incidental**
Red-winged Blackbird	42	0.1866	0.28	5
Ring-necked Pheasant	8	0.0355	0.0533	2
Rock Pigeon	9	0.04	0.06	2
Ruby-crowned Kinglet	1	0.0044	0.006	
Savannah Sparrow	7	0.0311	0.047	
Sora	1	0.0044	0.006	1
Swainson's Thrush	1	0.0044	0.006	1
Townsend's Warbler	3	0.0133	0.02	
Tree Swallow	4	0.0177	0.027	1
Tricolored Blackbird***	2	0.0088	0.013	
Turkey Vulture	2	0.0088	0.013	1
Virginia Rail	2	0.0088	0.013	
Warbling Vireo	3	0.0133	0.02	1
Western Meadowlark	76	0.3377	0.51	1
Western Wood Pewee		0	0	1
White-crowned Sparrow	2	0.0088	0.013	
White-throated Swift	2	0.0088	0.013	
Wilson's Warbler	7	0.0311	0.047	1
Winter Wren		0	0	1
Yellow Warbler***	4	0.0177	0.027	
Yellow-breasted Chat***	1	0.0044	0.006	
Yellow-rumped Warbler				1
Unidentified Blackbird spp.	2	0.0088	0.013	1
Unidentified Goose spp.	1	0.0044	0.006	
Unidentified Passerine spp.	14	0.0622	0.093	
Unidentified Sparrow spp.	3	0.0133	0.02	
Unidentified Swallow spp.	1		0.006	
Unknown bird spp.	1	0.0044	0.006	
Subtotal Avian Species	**379**	**1.6768**	**2.5113**	**44**
Bat Species				
Hoary Bat	64	0.2844	0.436	2
Mexican Free-tailed Bat	63	0.28	0.42	2
Silver-haired Bat	3	0.0133	0.02	
Western Red Bat	2	0.0088	0.0133	
Subtotal Bat Species	**132**	**0.5865**	**0.8893**	**4**
Grand Total	**511**	**2.2633**	**3.4006**	**48**

* A total installed megawatt capacity of 75.0 MW was calculated by multiplying individual turbine MW of 1.5 by the number of wind turbine towers surveyed per round
**Number of individuals found incidentally and not during standardized surveys. NOT included in the Total for that species
******* Denotes California Species of Special Concern (CSC)

A total of 379 wind turbine-related avian incidents were recorded by searchers during standardized surveys, representing 54 species and 22 unidentified birds (2 of these were blackbirds, 3 were sparrows, 1 a swallow, and 14 were not identified to species but classified as passerines, and 1 unknown bird species; Table 2). Of the 54 avian species, 9 were raptor species including American Kestrel (27), Merlin (1), Peregrine Falcon (1), Red-tailed Hawk (15), Ferruginous Hawk (2), Northern Harrier (2), Golden Eagle (1), Barn Owl (2), and Great Horned Owl (4), comprising a total of 55 raptor incidents found during the 3 year study period. The largest number of carcasses found were songbirds, this group comprised 247 incidents identified to 32 different species plus unidentified species. There were a total of 6 waterfowl incidents, (4 Mallards and 1 unidentified Goose spp.). Water bird species comprised 19 incidents, including 10 American Coots, 1 Sora, 2 Virginia Rails, 4 Killdeer, 1 Common Moorhen and 1 Black-crowned Night-Heron. Other avian species included a mixed group of Mourning Doves, Rock Pigeons, Turkey Vultures, Ring-necked Pheasants, a Chukar, and Northern Flickers (Tables 2 and 3), comprising 6 species involved in 51 incidents. There was 1 unidentified bird, classified as a large non-passerine. One hundred thirty-two (132)) bat carcasses were found by searchers, representing 4 different species including Hoary Bat (64), Mexican Free-tailed Bat (63), Silver-haired Bat (3), and Western Red Bat (2).

The number of wind turbine related incidents found per total installed megawatt capacity per year was calculated to provide a comparable metric between different wind power projects. The individual wind turbine MW of 1.5 was multiplied by the number of wind turbine towers (50) searched during the course of this three year study to yield a total installed megawatt capacity of 75.0 MW for turbines being searched. Another unit for comparison purposes, the number of incidents per turbine tower per year, was also calculated (Table 2). The highest fatality rates occurred in the Western Meadowlark and Hoary Bat, followed by Mexican Free-tailed Bat, Red-winged Blackbird , American Kestrel, and Mourning Dove. About 2.5 birds and 0.9 bats per tower per year were found at wind turbine towers during this project.

The wind turbines were shut down from approximately January 5, 2009 to February 6, 2009. This included four round of surveys in which eight (8) incidents were found: 3 Mourning Doves, 3 Ring-necked Pheasants and 2 Killdeer. All of these bird carcasses were partially/mostly scavenged and it could not be determined if these birds collided with the non-operating wind turbines or not and are classified as incidental finds (Appendix F)

The number of wind turbine related incidents found per total installed megawatt capacity per year, and per turbine per year was calculated for each species grouping (Table 3). The greatest unadjusted rate of fatality occurred in passerines (1.65 incidents/turbine/year, 1.1 incidents/Mw/year) followed by bats (0.88incidents/turbine/year, 0.59 incidents/Mw/year) and raptors (0.37 incidents/turbine/year, 0.24 incidents/Mw/year).

Table 3. Unadjusted number of incidents per species group during the 3 years of surveys per total installed megawatt capacity* per year, and per turbine per year, at the Shiloh I Project Area, April 2006 – April 2009, found during standardized surveys

Species Group	# Incidents	# Incidents per Mw/Year	# Incidents per Turbine/Year
Bird Species			
Raptor	55	0.2444	0.3666
Passerine	247	1.0977	1.6466
Waterfowl	6	0.0266	0.04
Water Bird	19	0.0844	0.1266
Other Bird	51	0.2266	0.34
Unknown	1	0.0044	0.0066
Bat species	132	0.5866	0.88
Grand Total	**511**	**2.2707**	**3.4064**

* A total installed megawatt capacity of 75.0 MW was calculated by multiplying individual turbine MW of 1.5 by the number of wind turbine towers surveyed per round

For easy reference, Table 4 presents the data for the third and final year of the study.

Table 4. Unadjusted number of incidents per species during the 3rd year of surveys per total installed megawatt capacity* per year, and per turbine per year, at the Shiloh I Project Area, April 2008 – April 2009, found during standardized surveys

	# Incidents (3 years)	Unadjusted # Incidents/Mw/year	Unadjusted # Incidents/Tower/year	Incidental Finds
Species Name				
Birds (Large)				
Goose spp.	1	0.01	0.01	0
Great Horned Owl	1	0.01	0.01	0
Mallard	1	0.01	0.01	0
Red-tailed Hawk	2	0.01	0.02	1
Ring-necked Pheasant	4	0.03	0.04	1
Total Large Birds	**9**	**0.06**	**0.09**	**2**
Birds (Medium)				
American Coot	1	0.01	0.01	0
American Kestrel	5	0.03	0.05	1
Brewer's Blackbird	3	0.02	0.03	0
Chukar	3	0.02	0.03	0
Common moorhen	1	0.01	0.01	0
Killdeer	3	0.02	0.03	1
Mourning Dove	7	0.05	0.07	2
Rock Pigeon	2	0.01	0.02	0
Sora	0	0.00	0.00	1
Western Meadowlark	10	0.07	0.10	0

Total Medium Birds	**35**	**0.23**	**0.35**	**5**
Birds (Small)				
American Pipit	4	0.03	0.04	0
Blackbird spp.	1	0.01	0.01	0
Black-throated Gray Warbler	1	0.01	0.01	0
European Starling	1	0.01	0.01	0
Horned Lark	8	0.05	0.08	0
Lincoln's Sparrow	1	0.01	0.01	0
MacGillivray's Warbler	0	0.00	0.00	1
Orange-crowned warbler	1	0.01	0.01	0
Pacific-Slope Flycatcher	2	0.01	0.02	0
Passerine spp.	2	0.01	0.02	0
Red-winged Blackbird	5	0.03	0.05	1
Savannah Sparrow	2	0.01	0.02	0
Swainson's thrush	2	0.01	0.02	0
Townsend's Warbler	1	0.01	0.01	0
Tree Swallow	1	0.01	0.01	0
Tri-colored Blackbird*	1	0.01	0.01	0
Warbling Vireo	2	0.01	0.02	0
White-throated swift	2	0.01	0.02	0
Wilson's Warbler	1	0.01	0.01	0
Yellow-rumped Warbler	0	0.00	0.00	1
Total Small Birds	**38**	**0.25**	**0.38**	**3**
Total Birds	**82**	**0.55**	**0.82**	**10**
Bats				
Hoary Bat	25	0.17	0.25	1
Mexican Free-tailed Bat	16	0.11	0.16	1
Silver-Haired Bat	1	0.01	0.01	0
Western Red Bat		0.00	0.00	0
Total Bats	**42**	**0.28**	**0.42**	**2**
Total (Birds & Bats)	**124**	**---**		**---**

* Denotes California Species of Special Concern (CSC).

For purpose of our analyses, "raptors" included all eagles, hawks, kites, falcons, harriers, and owls (predatory birds). Non-protected non-native species including Rock Pigeon and European Starling were included in analyses, fatality maps and data tables.

All but six of the incidents found during the three year study during standardized surveys were fatalities. Six injured birds were found, including an American Kestrel, American Pipit, Horned

Lark, Western Meadowlark, Savannah Sparrow, and Red-tailed Hawk, all of which were semi-mobile and therefore were considered “ON SITE” and not associated with a specific wind turbine tower. Their injuries were, however, consistent with collision with a wind turbine. Three of the four injured birds were taken to Lindsay Wildlife Hospital, and one, the Red-tailed Hawk, was very mobile and not captured. The American Kestrel was euthanized on site after consulting with the California Raptor Center in Davis, CA. The following information details these incidents:

1. April 12, 2006. A juvenile American Pipit was found with a broken right wing 46 meters north of Tower C1.
2. June 23, 2006. A juvenile Western Meadowlark was found 99 meters WSW of Tower C17. It appeared to be trying to fly, with its left wing was severed at the elbow.
3. February 28, 2007. An adult Savannah Sparrow was found unable to fly, 90 meters south of Tower A9.
4. June 5, 2007. An adult Red-tailed Hawk was observed approximately 100 meters west of Tower H1. Its left wing appeared to be injured, however it was still mobile and unable to be captured.
5. April 22, 2008. An adult Horned Lark was observed at approximately 60 meters East of Tower A5. The bird was unable to fly due to a broken humerus.
6. November 6, 2008. An adult American Kestrel was observed approximately 35 meters west of Tower A11, laying ventral on the ground with wings spread out. All tail feathers were missing and right lower leg was broken.

In addition to the six injured birds found during standardized surveys, one Golden Eagle was found far outside the study range, and was thus categorized as an incidental find.

1. March 10, 2007. One adult male Golden Eagle was found incidentally 200 meters WSW of Tower F3. Its primaries on its left wing were gone, it had fractured metacarpals and could not fly but was still mobile. As per our protocols, the bird was transferred to the Lindsay Wildlife Hospital, Walnut Creek, CA, for treatment. We were subsequently informed that it was euthanized.

None of the carcasses or injured birds found is listed as federally or state threatened or endangered; however one juvenile male Peregrine Falcon was found 102 meters southeast of tower E2R on November 13, 2007. The status of the Peregrine Falcon, previously federally and state endangered, is currently “delisted”, and classified as “SDC”, or a state delisting candidate species. Nine incidents were California Species of Special Concern, including: 2 Northern Harriers, 2 Tricolored Blackbirds, 4 Yellow Warblers and a Yellow-breasted Chat. Two Burrowing Owl incidents were also found during standardized searches, but were considered caused by “Other” means, and not deemed wind turbine tower (or met tower) related. Three SCS Watch List species: one Merlin; one Prairie Falcon (found incidentally, at tower C12R) and one Golden Eagle, a Protected Species, was found during the second year of this study within the standardized search area. Two other Golden Eagles were found incidentally outside the standardized search area. Both were found outside the prescribed search area. One Golden Eagle, found injured on March 10, 2007, is described above. The other was found on August 14, 2007, dead at 155m away from the towers.) The March 2007 golden eagle incident was wrongly included as a turbine incident in the Year 1 report but moved to "incidental" in this report as it was found outside the search area.

Three incidents found during standardized surveys were banded birds. These birds were processed like other incidents, the band number was recorded, and the incident was reported to the appropriate banding group. These incidents included one Red-tailed Hawk, and two Mallards. The following information details these incidents:

1. April 12, 2006. An adult female Mallard was found 22 meters east southeast of Tower C11. Its estimated date of death was April 10, 2006. This bird was banded in Benicia California (on July 14, 2004. ID# SH-004-06, Band # 1737-75069.
2. April 27, 2006. A second adult female Mallard was found 13 meters south southeast of Tower H1. Its estimated date of death was April 25, 2006. This bird was banded in California (exact location unknown) on July 23, 2005. ID# SH-008-06, Band # 1757-36370.
3. May 24, 2007. A juvenile male Red-tailed Hawk was found 56 meters east northeast of Tower B7R. Its estimated date of death was May 18, 2007. This bird was born in Pittsburg, California in 2006, and had been banded on December 15, 2006 near Birds Landing, California. ID# SH-104-07, Band # 1177-54423.

3.2.3 Seasonal Distribution of Incidents

The number of wind turbine associated incidents found during standardized surveys was calculated per month for each species grouping.

The greatest number of bird incidents occurred during the month of January of 2007, with a total of 40 (~8% of the total) incidents in that month alone, 34 (85%) of them passerine species (Table 5 and Figure 4). Sixteen raptor incidents found during year one (~67% of that year's total) were found during the fall migration and pre-breeding seasons, between and including October 2006 and January 2007. The number of raptor incidents found during those same months in the following years only comprised 46% of the raptors for the second year and 43% raptors for the third year. Waterfowl and waterbird incidents were rare and incidents of species within these groups were sporadically distributed throughout the seasons. Thirty-five out of 51 of all "other" bird incidents (~69%) were recorded in the later period of the three years (August to December).

The great majority of bat incidents occurred during the fall migration months, with 115 out of 132 carcasses recorded between August and October of the three years, representing ~87% of bats found during the entire three year study period.

Table 5. Number of wind turbine related incidents per species grouping per month*

		Species Group	Raptor	Passerine	Waterfowl	Water Bird	Other Bird	Unknown Bird	*Total Birds*	*Bats*	Total Birds & Bats
		Mar-06	0	1	0	0	0	0	1	0	1
		Apr-06	0	3	3	0	0	0	6	1	7
		May-06	0	3	0	0	2	0	5	0	5
		Jun-06	1	5	0	0	1	0	7	2	9
		Jul-06	4	7	0	0	1	0	12	0	12
		Aug-06	0	6	0	1	3	0	10	15	25
		Sep-06	0	4	0	0	1	0	5	23	28
		Oct-06	8	14	0	0	2	0	24	9	33
		Nov-06	1	10	0	0	1	0	12	0	12
	2006	Dec-06	4	8	0	0	1	0	13	0	13
		Jan-07	3	34	0	0	3	0	40	0	40
Year 1		Feb-07	0	10	0	0	0	0	10	0	10
		Mar-07	3	9	0	2	1	0	15	2	17
		Apr-07	1	3	0	0	1	0	5	0	5
		May-07	4	14	0	0	0	0	18	1	19
		Jun-07	3	4	0	2	1	0	10	1	11
		Jul-07	0	7	0	0	1	0	8	1	9
		Aug-07	0	3	0	1	4	1	9	7	16
		Sep-07	2	8	0	1	6	0	17	18	35
		Oct-07	3	9	0	0	3	0	15	7	22
		Nov-07	5	7	0	2	1	0	15	2	17
	2007	Dec-07	3	5	0	3	1	0	12	0	12
		Jan-08	1	7	0	1	1	0	10	0	10
Year 2		Feb-08	1	8	0	1	0	0	10	0	10
		Mar-08	0	3	0	0	0	0	3	1	4
		Apr-08	1	4	0	0	2	0	7	0	7
		May-08	0	10	0	2	0	0	12	2	14
		Jun-08	1	4	0	0	0	0	5	2	7
		Jul-08	2	4	0	0	1	0	7	0	7
		Aug-08	0	1	2	0	2	0	5	12	17
		Sep-08	0	4	0	0	1	0	5	18	23
		Oct-08	0	4	0	0	3	0	7	6	13
		Nov-08	2	6	0	1	2	0	11	0	11
	2008	Dec-08	1	10	0	2	4	0	17	0	17
		Jan-09	0	1	0	0	0	0	1	0	1
		Feb-09	0	1	0	0	1	0	2	0	2
Year 3	2009	Mar-09	0	0	0	0	0	0	0	2	2
		Total	**54**	**241**	**5**	**19**	**51**	**1**	**371**	**132**	**503**

*Estimated month of death or injury was calculated by subtracting estimated number of days since death or injury from the report date. These numbers include incidents with known estimated month of death or injury, found during standardized surveys only.

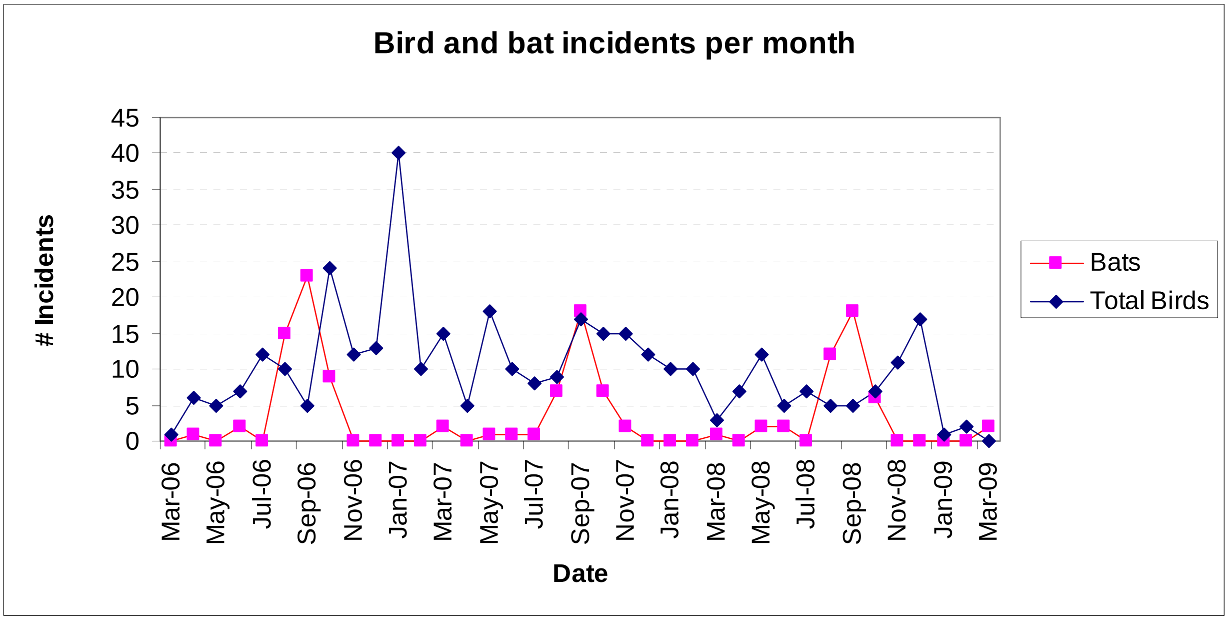

Figure 4. Number of wind turbine related incidents (birds and bats) per month, from March 2006-March 2009*

*Estimated month of death or injury was calculated by subtracting estimated number of days since death or injury from the report date. These numbers include incidents with known estimated month of death or injury, found during standardized surveys only.

Raptor fatalities were lower in Year 3 compared to Years 1 and 2. Twenty-seven out of a total of 54 Raptor fatalities (~50%) of all raptor incidents found during the three years of study were recorded during the fall migration periods between and including October and December (Table 6), though this peak was less prominent in Year 3. Raptor incidents were largely American Kestrels (n=27) and Red-tailed Hawks (n=15). Other species found in smaller numbers included the Barn Owl, Ferruginous Hawk, Great Horned Owl, Merlin, Northern Harrier, Peregrine Falcon and Golden Eagle (Table 5).

Table 6. Number of wind turbine related raptor incidents per species per month*

		Raptor Species	Golden Eagle	Red-tailed Hawk	Ferruginous Hawk	American Kestrel	Merlin	Peregrine Falcon	Northern Harrier	Barn Owl	Great Horned Owl	Total
Year 1	**2006**	**Mar-06**	0	0	0	0	0	0	0	0	0	**0**
		Apr-06	0	0	0	0	0	0	0	0	0	**0**
		May-06	0	0	0	0	0	0	0	0	0	**0**
		Jun-06	0	0	0	0	0	0	1	0	0	**1**
		Jul-06	0	1	0	3	0	0	0	0	0	**4**
		Aug-06	0	0	0	0	0	0	0	0	0	**0**
		Sep-06	0	0	0	0	0	0	0	0	0	**0**
		Oct-06	0	2	0	6	0	0	0	0	0	**8**
		Nov-06	0	0	0	1	0	0	0	0	0	**1**
		Dec-06	0	2	0	2	0	0	0	0	0	**4**
	2007	**Jan-07**	0	0	0	2	0	0	0	1	0	**3**
		Feb-07	0	0	0	0	0	0	0	0	0	**0**
Year 2		**Mar-07**	0	1	0	1	0	0	1	0	0	**3**
		Apr-07	0	0	0	0	1	0	0	0	0	**1**
		May-07	0	3	0	1	0	0	0	0	0	**4**
		Jun-07	0	1	0	2	0	0	0	0	0	**3**
		Jul-07	0	0	0	0	0	0	0	0	0	**0**
		Aug-07	0	0	0	0	0	0	0	0	0	**0**
		Sep-07	0	1	0	1	0	0	0	0	0	**2**
		Oct-07	0	0	0	2	0	0	0	0	1	**3**
		Nov-07	0	1	1	0	0	1	0	1	1	**5**
		Dec-07	1	0	1	1	0	0	0	0	0	**3**
	2008	**Jan-08**	0	0	0	0	0	0	0	0	1	**1**
		Feb-08	0	1	0	0	0	0	0	0	0	**1**
Year 3		**Mar-08**	0	0	0	0	0	0	0	0	0	**0**
		Apr-08	0	1	0	0	0	0	0	0	0	**1**
		May-08	0	0	0	0	0	0	0	0	0	**0**
		Jun-08	0	0	0	1	0	0	0	0	0	**1**
		Jul-08	0	0	0	1	0	0	0	0	1	**2**

		Raptor Species	Golden Eagle	Red-tailed Hawk	Ferruginous Hawk	American Kestrel	Merlin	Peregrine Falcon	Northern Harrier	Barn Owl	Great Horned Owl	Total
		Aug-08	0	0	0	0	0	0	0	0	0	**0**
		Sep-08	0	0	0	0	0	0	0	0	0	**0**
		Oct-08	0	0	0	0	0	0	0	0	0	**0**
		Nov-08	0	0	0	2	0	0	0	0	0	**2**
		Dec-08	0	1	0	0	0	0	0	0	0	**1**
	2009	**Jan-09**	0	0	0	0	0	0	0	0	0	**0**
		Feb-09	0	0	0	0	0	0	0	0	0	**0**
		Mar-09	0	0	0	0	0	0	0	0	0	**0**
		Total	**1**	**15**	**2**	**26**	**1**	**1**	**2**	**2**	**4**	**54**

*Estimated month of death or injury, calculated by subtracting estimated number of days since death or injury from the report date. These numbers include incidents with known estimated month of death or injury, which were associated with wind turbine towers and found during standardized surveys only.

3.2.4 Age Classes of Raptors

The majority (77%) of raptor incidents which could be identified to age were adults (Table 7), however ~50% of American Kestrels were not identified to age because of missing feathers or body parts. Of those that were identifiable, 11 were adults and 2 were first year birds. Of 15 Red-tailed Hawk incidents, 9 were adults, 4 were first year birds, and 2 were of unknown age. The Golden Eagle was an adult. The majority of other raptor incidents which could be identified to age were adults, with the exception of 1 of 2 Ferruginous Hawks and 1 Peregrine Falcon.

Table 7. Age classes of raptor wind turbine tower related incidents

Species	Adult	First Year	Unknown	Total
American Kestrel	11	2	14	27
Barn Owl			2	2
Ferruginous Hawk	1	1		2
Golden Eagle	1			1
Great Horned Owl	2		2	4
Merlin	1			1
Northern Harrier	2			2
Peregrine Falcon		1		1
Red-tailed Hawk	9	4	2	15
Total	27	8	20	55

3.2.5 Spatial Distribution of Incidents

To determine if there are a statistically greater number of incidents occurring in one area than another, we divided the wind project area into two areas for spatial distribution analyses. These two areas are defined as follows: 1) north of Birds Landing Road, which encompasses 76 wind turbine towers (rows A, B, C, D, and E), hereafter referred to as “the North”; and 2) south of Birds Landing Road, with 24 wind turbine towers (rows F, G, and H), referred to as “the South”. In comparison to the north, the southern area consists of steeper hills of higher elevations, which open up to a broad plain running south to the Sacramento River and Suisun Marsh. Based on observations,, there also appears to be less variety of crops in the south, with the land used for growing mostly wheat, and to a lesser degree hay and oats.

If the incidents are randomly spread throughout the area, with no difference between the north and the south, the number of incidents would be proportionate to the number of wind turbines in each of these areas. There are 76 wind turbines north of Bird Landing Road, and 24 in the south. Therefore the number of incidents would be expected to reflect a 3.2 to 1 ratio (76 to 24 ratio) in these two regions if there is no difference between the north and south regions

3.2.5.1 Raptors

Raptor incidents were distributed widely throughout the project area (Figure 5), with 5.9 times more incidents north of Birds Landing Road than south, (Table 8). Distribution of individual species' incidents (using only standardized survey incident data) showed moderate evidence of disproportionately greater numbers of American Kestrel incidents north of Bird Landing Road than south (Chi-square test, $\chi^2 = 3.60$, df = 1, p = 0.06) than expected in a random distribution). Nearly three times as many Red-tailed Hawks were found in the north than south, however, this was not a significant difference from the expected proportion (Chi-Square test, $\chi^2 = 0.01$, df = 1, p = 0.92, ns). Incidents of all other species of raptors combined were slightly more numerous north of Birds Landing Road than south (5.5:1), however the number of incidents of these species is too small at the end of three years to draw any statistically valid conclusions. There were several (12) wind turbine towers with 2 or more raptor incidents in the north. Tower A4 had 3 American Kestrel incidents.

Raptor incident numbers were low, and where tests were possible, we did not discern any evident pattern of fatality (or injury) between north and south sites.

Note: Maps include incidents considered to be associated with a wind turbine only, and not those found "ON SITE" (injured birds).

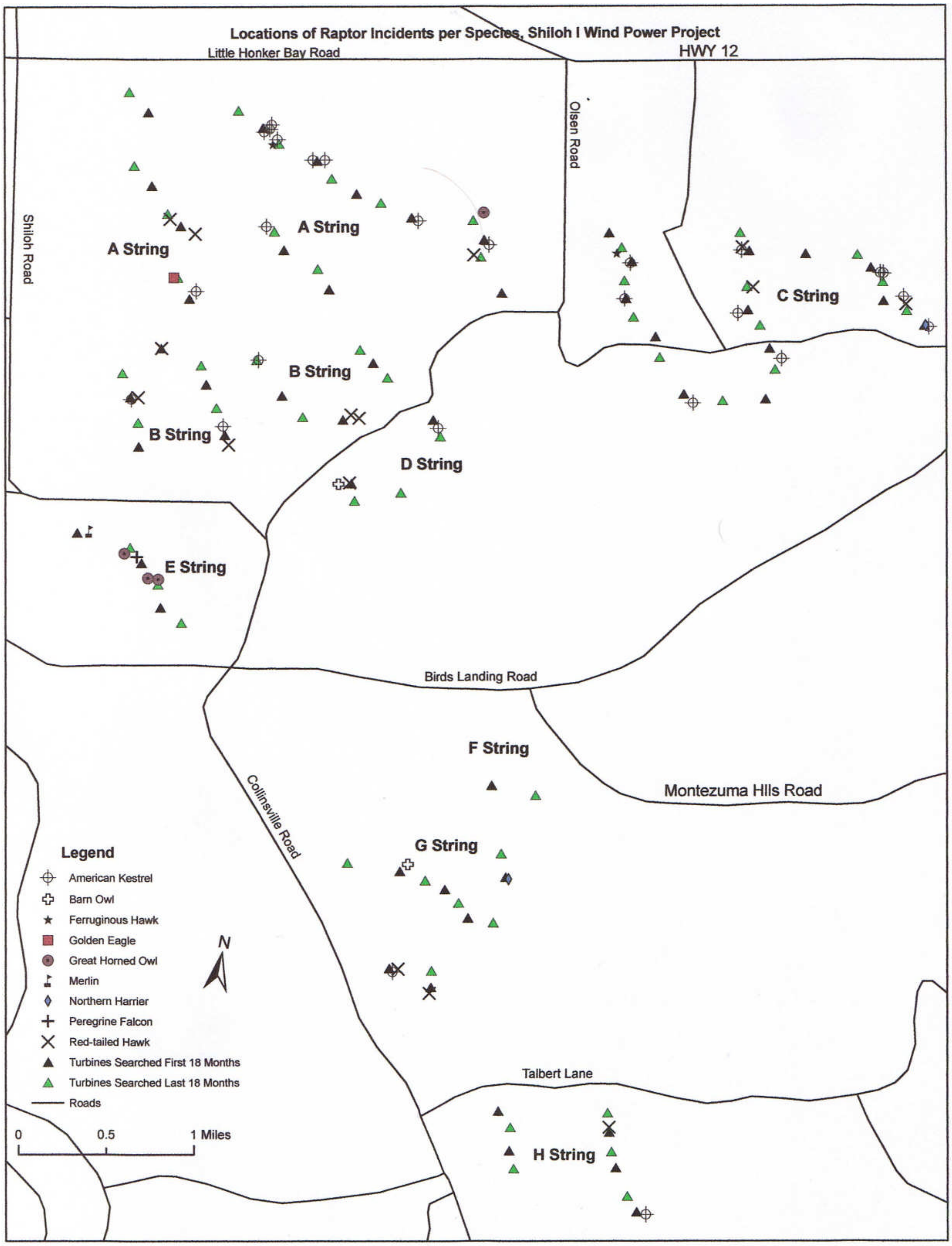

Figure 5 Locations of raptor incidents (found during standardized surveys) in the Shiloh I Project Site, April 2006 through April 2009.

Table 8. Comparison of raptor incident distribution to wind turbine tower distribution*

	Number			Ratio	
	North	South	Total	North	South
Number of Turbines	76	24	100	3.2	1
Incidents					
American Kestrel	25	2	27	12.5	1
Red-tailed Hawk	11	4	15	2.8	1
Golden Eagle	1	0	1	1	0
Merlin	1	0	1	1	0
Peregrine Falcon	1	0	1	1	0
Ferruginous Hawk	2	0	2	2	0
Northern Harrier	1	1	2	1	1
Barn Owl	1	1	2	1	1
Great Horned Owl	4	0	4	4	0
Total Raptors	**47**	**8**	**55**	**5.9**	**1**

*Project area divided into two regions, North and South of Birds Landing Road. Note: Includes data from standardized surveys only

3.2.5.2 Non-Raptors

Incidents of non-raptor species appeared to be concentrated in the northern region of the project area (Figures 6 and 7). Passerine species accounted for the majority of incidents in the north, with 5.3 times greater songbird fatalities in the north than the south (Table 9) showing moderate evidence of being significantly greater than expected (Chi-square Test, $\chi^2 = 3.23$, df = 1, p = 0.07). Western Meadowlarks and mixed species of blackbirds (n = 120) comprised ~fifty-eight percent of passerine incidents found in the north, and were found in ratios of 4.4 to 1 and 19.3 to 1, north to south, respectively. Twenty-eight (45%) of 62 meadowlark incidents found in the north were found in the C grouping of towers, with 5 incidents found at tower C25 alone. A large proportion of blackbird incidents found in the north were also found within the C towers (n=24, 41%), with 9 incidents occurring at a single tower, C5R.

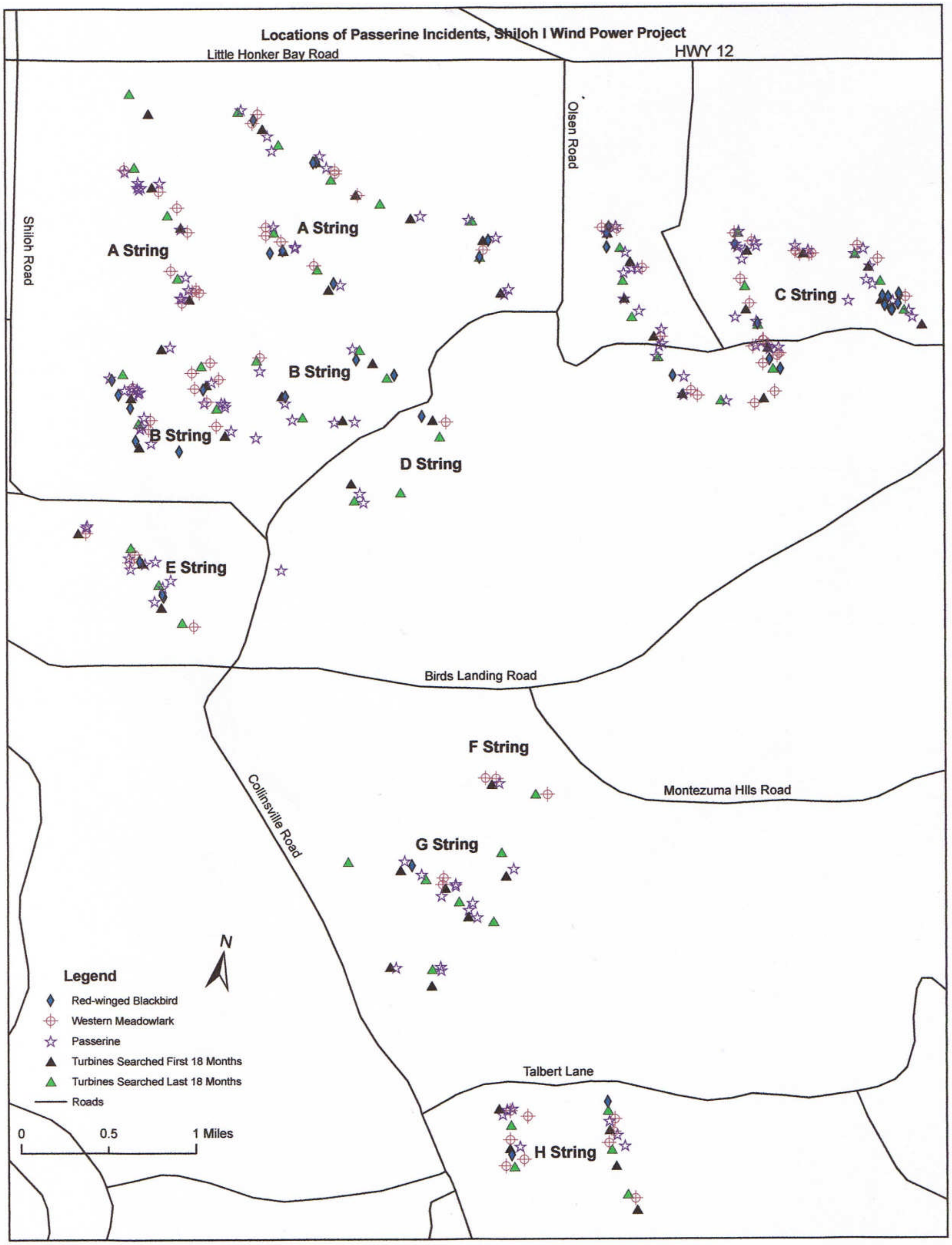

Figure 6. Locations of passerine avian incidents found during standardized surveys in the Shiloh I Project Site, April 2006 through April 2009.

Note: Maps include incidents considered to be associated with a wind turbine only, and not those found "ON SITE" (injured birds).

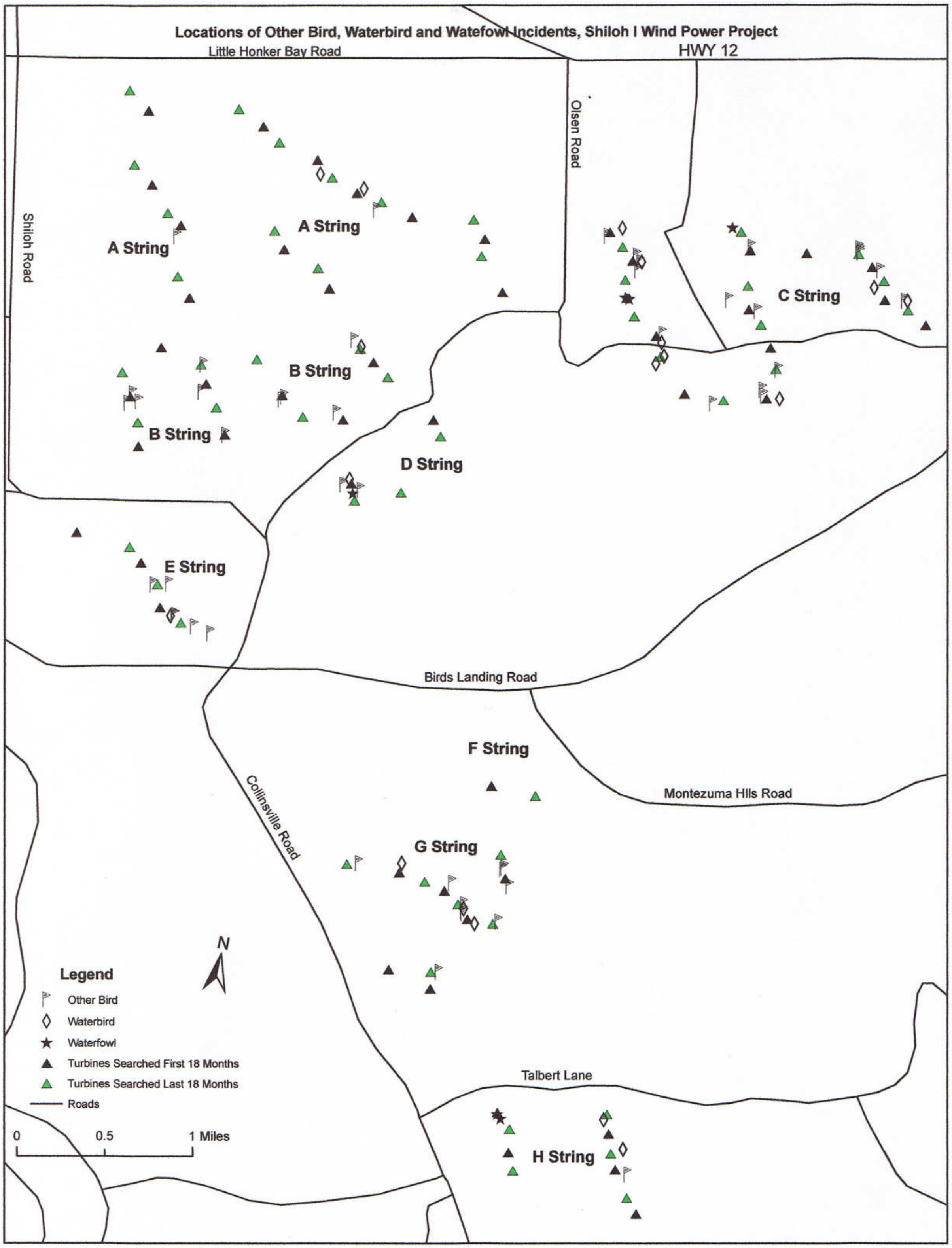

Figure 7. Locations of other (non-raptor, non-passerine) avian species incidents found during standardized surveys in the Shiloh I Project Site, April 2006 through April 2009.

Note: Maps include incidents considered to be associated with a wind turbine only, and not those found "ON SITE" (injured birds).

Table 9. Comparison of all non-raptor avian incident distribution (by species group) to wind turbine tower distribution*

	Number			**Ratio**	
	North	South	Total	North	South
Number of Turbines	76	24	100	3.2	1
Incidents					
Passeriformes (songbird)	208	39	247	5.3	1
Waterfowl	4	2	6	2	1
Water Birds (rail, coot, heron)	13	6	19	2.2	1
Other (dove, pheasant, flicker, etc.)	38	13	51	2.9	1
Unid. bird spp. (non-passerine)	1	0	1	1	0
Total Non-Raptor Avian Species	**264**	**60**	**324**	**4.4**	**1**

*Project area divided into two regions, North and South of Birds Landing Road. Note: Includes data from standardized surveys only.

The numbers of incidents of all other non-raptor, non-passerine avian species groups, or “Other Birds” (Table 10 and Figure 8), showed no significant difference from expected proportions (Chi-square test, $\chi^2 = 0.04$, df = 1, p = 0.84). Preliminary results appear to show a cluster of water bird and waterfowl in the north in the C grouping of towers, with 11 of 25 (44%) of these incidents occurring in this region. Interestingly, there is a stock pond located between towers C8 and C23, and the majority of water bird and waterfowl incidents were located not far from this region (to the west, southwest, or south of tower C8).

Table 10. Comparison of bat incident distribution to wind turbine tower distribution*

	Number			**Ratio**	
	North	South	Total	North	South
Number of Turbines	76	24	100	3.2	1
Incidents					
Hoary Bat	53	11	64	4.8	1
Mexican Free-tailed Bat	57	6	63	9.5	1
Silver-haired Bat	3	0	3	3	0
Western Red Bat	2	0	2	2	0
Total Bat Species	**115**	**17**	**132**	**6.8**	**1**

*Project area divided into two regions, North and South of Birds Landing Road. Note: Includes data from standardized surveys only.

3.2.5.3 Bats

Bat incidents were nearly 7 times more numerous in the north than the south of Birds Landing Road (Figure 8). Looking at species individually, the Mexican Free-tailed Bat incidents were concentrated in the north (9.5:1), and showed evidence of a significant difference in fatality distribution (Chi-square test, $\chi^2 = 5.39$, df = 1, p = 0.02). However, the numbers of incidents of the other bat species with a large number of incidents, the Hoary Bat, were distributed as would be expected (Chi-square test, $\chi^2 = 1.08$, df = 1, p = 0.30) based on wind turbine numbers in the north and south (Table 10). Thirty (30) towers had 2 or more bat fatalities each. Seventy-two percent (72%, n=95) of all bat fatalities were found at these 30 towers, which comprised only 60% of the towers surveyed during the study. Twenty-six of these towers were on the north side (A12 alone had 10 bat fatalities, 5 of them Mexican Free-tailed, 5 Hoary). Figure 6 provides a map of the locations of bat incidents (found during standardized surveys) in the Shiloh I Project Site, April 10, 2006 through April 11, 2009.

3.2.6 Location in turbine string

Previous studies at the Altamont Pass Wind Resource Area indicated that turbines at the ends of turbine strings may have been associated with higher collision fatalities. We examined the number of fatalities at each turbine over three years, to determine whether these sites conformed with permit clauses that required relocation of high mortality turbines. We hypothesized that any such turbines unusually high fatalities may be associated with the ends of turbine strings. We plotted the distribution of the number of bird incidents per turbine using JMP ® 7.0.1 statistical software (© 2007 SAS Institute Inc.), to determine the presence of outliers in the data. There were four outlier turbines (where the number of incidents exceeded the boundaries defined as [upper quartile + 1.5*(interquartile range)]. Out of these four turbines, only one was at the end of a turbine string.

Similar to birds, we plotted the distribution of the number of bat incidents per turbine using JMP ® 7.0.1 statistical software (© 2007 SAS Institute Inc.), to determine the presence of outliers in the data. There was one outlier turbine (where the number of incidents exceeded the boundaries defined as [upper quartile + 1.5*(interquartile range)]. This turbine was not at the end of a turbine string.

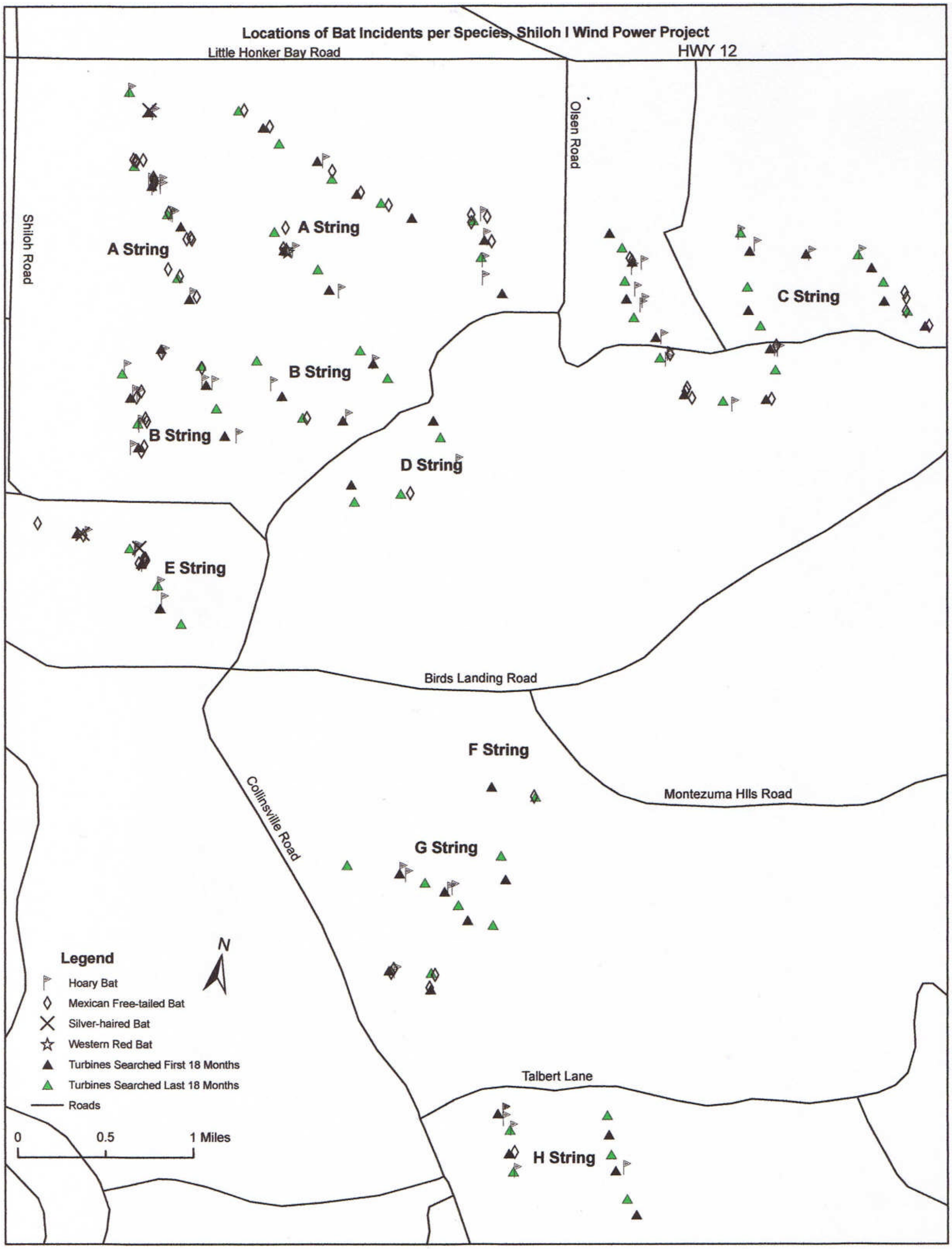

Figure 8. Locations of bat incidents found during standardized surveys in the Shiloh I Project Site, April 2006 through April 2009.

3.2.7 Distance from Turbine Bases

Species were divided into size groupings (Table 11) to determine if surveying a 105 meter radius area is an effective method for finding the majority of carcasses.

Table 11. Species size groupings used in analyses

Category	Description
Small Bird	≤ 8” length (most smaller passerines)
Medium Bird	8” < X ≤ 14” length (kestrels, flickers, starlings, blackbirds, doves)
Large Bird	> 14” length (most raptors, coots, ducks, pheasants)
Bats	All small size

The number of incidents of species (found during standardized surveys only) falling into each size grouping were then tabulated based on distance (range) from the wind turbine tower (Table 12).

Of the 511 bird and bat incidents found during standardized surveys, 505 could be assigned distances from a wind turbine. Forty-eight percent were located within 60 meters of a wind turbine, 58% were within 70 meters, 73% within 80 meters, 81% within 90 meters, and 95% were within 100 meters (Table 12).

Table 12. Number of incidents per size grouping versus distance from wind turbine tower (Shiloh I)

	# Incidents				Fall Density		
Range	Small & Medium	Large	Bats	Ring Area	Small & Medium	Large	Bats
0-10	23	4	6	314.29	0.07	0.01	0.02
11-20	12	1	8	942.86	0.01	0.0011	0.01
21-30	12	5	16	1571.43	0.01	0.0032	0.01
31-40	20	1	18	2200	0.01	0.0005	0.01
41-50	18	6	25	2828.57	0.01	0.0021	0.01
51-60	34	6	25	3457.14	0.01	0.0017	0.01
61-70	43	2	7	4085.71	0.01	0.0005	0.0017
71-80	54	6	16	4714.29	0.01	0.0013	0.0034
81-90	32	2	6	5342.86	0.01	0.0004	0.0011
91-100	63	4	4	5971.43	0.01	0.0007	0.0007
101-105	20	5	1	3221.43	0.01	0.0016	0.0003

Avian carcasses of all size groups tended to be located somewhat evenly over a larger distance range than bat carcasses, which tended to be located closer to the towers. The average distance to the tower for bat incidents was ~50m, while the average distance to tower base for bird incidents was ~65m.

Scavengers may move carcasses, affecting carcass distance analyses. Our previous analysis of the location of birds found at projects using the newest turbine technology (Erickson, et al., 2001, Erickson, et al, 2003), and the Orloff and Flannery (1992) experience searching under older turbine technology supported the judgment that 90% of the carcasses would be located within a circle having a 65 meter radius therefore we expected a 75 meter radius to be sufficient for finding nearly 100% of all carcasses. 64% of the incidents found at Shiloh I were within 75m of the tower base.

The number of incidents of species (found during standardized surveys only) falling into the size groups: Large birds; Small and Medium birds (combined); and, Bats (Table 11) was tabulated based on distance (range) from the base of wind turbines. We divided the number of incidents found within each 10m annulus by the total area of that annulus to arrive at an incident density (Table 12).

These densities were plotted (Figures 9, 10 and 11) along with the best fitting trend line to approximate the distance at which density drops to zero, indicating no more incidents would be found at that distance. The R^2 (goodness-of-fit) value for the trend lines are shown (R^2= 1.0 indicates perfect fit – 100% of variance explained). The R^2 for Large bird incidents was 0.56, the R^2 for Small and Medium birds was 0.53 and for the R^2 for bat incidents was 0.88.

The trend-line derived from that data was in accordance with our expectation that bird incidents approximate zero at a point farther out than bat incidents. Densities of bat incidents were very low (approached zero) after ~65m from the turbine base and bird incidents approached zero at ~85m from the turbine base (Figures 8, 9 and 10). The current available data indicate that the current search area of 105m radius was adequate to detect most bird and bat collision fatalities, but a negligible number of bat fatalities and, perhaps, a very small number of bird fatalities may have been overlooked.

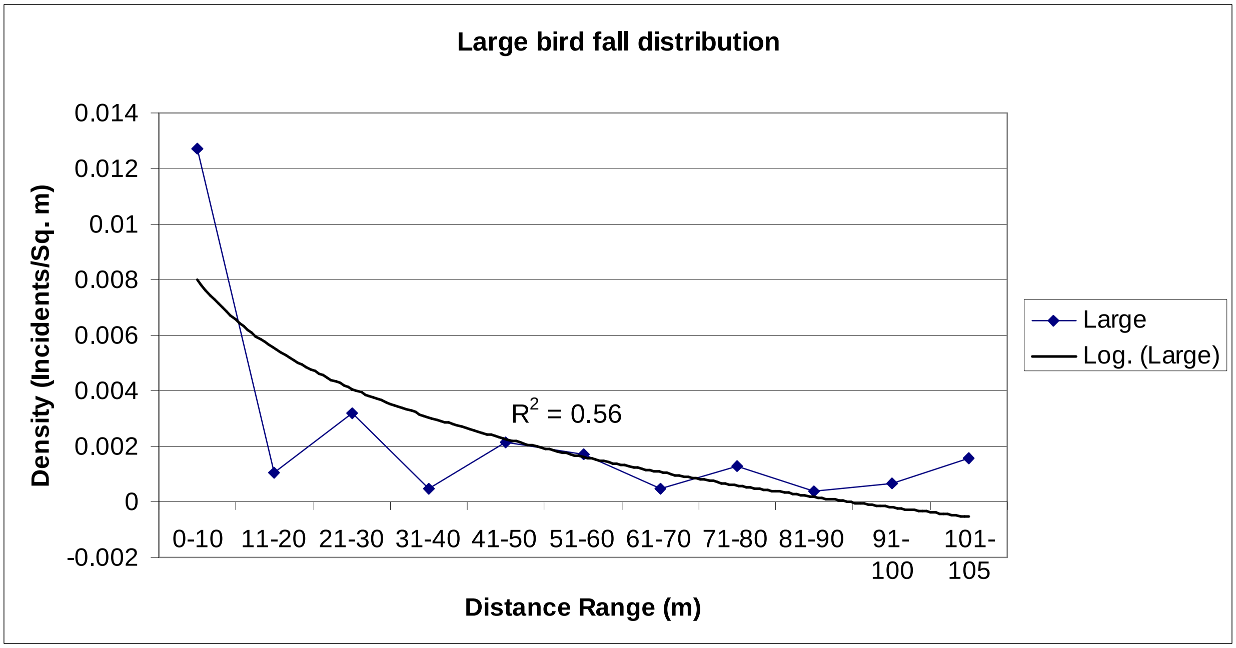

Figure 9. Density of Large bird incidents at 7-Day sites in relation to distance from towers.

Note: Polynomial trend line approximates distance at which density crosses zero.

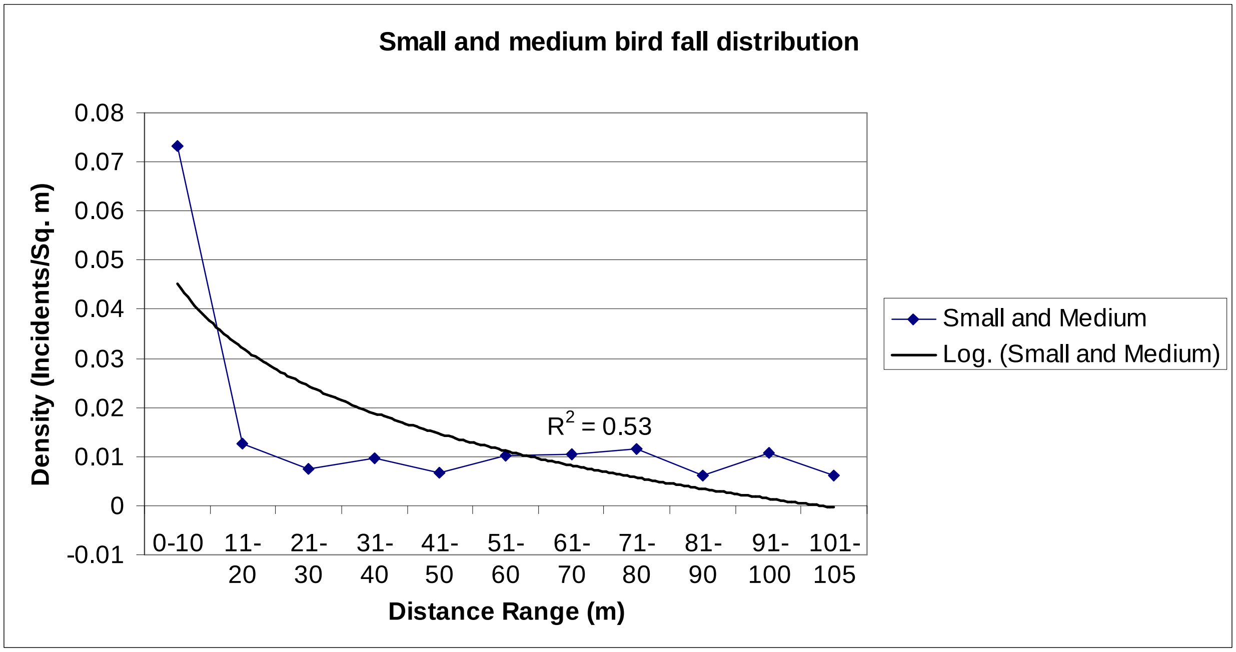

Figure 10. Density of small and medium bird incidents at 7-Day sites in relation to distance from towers.

Note: Polynomial trend line approximates distance at which density crosses zero.

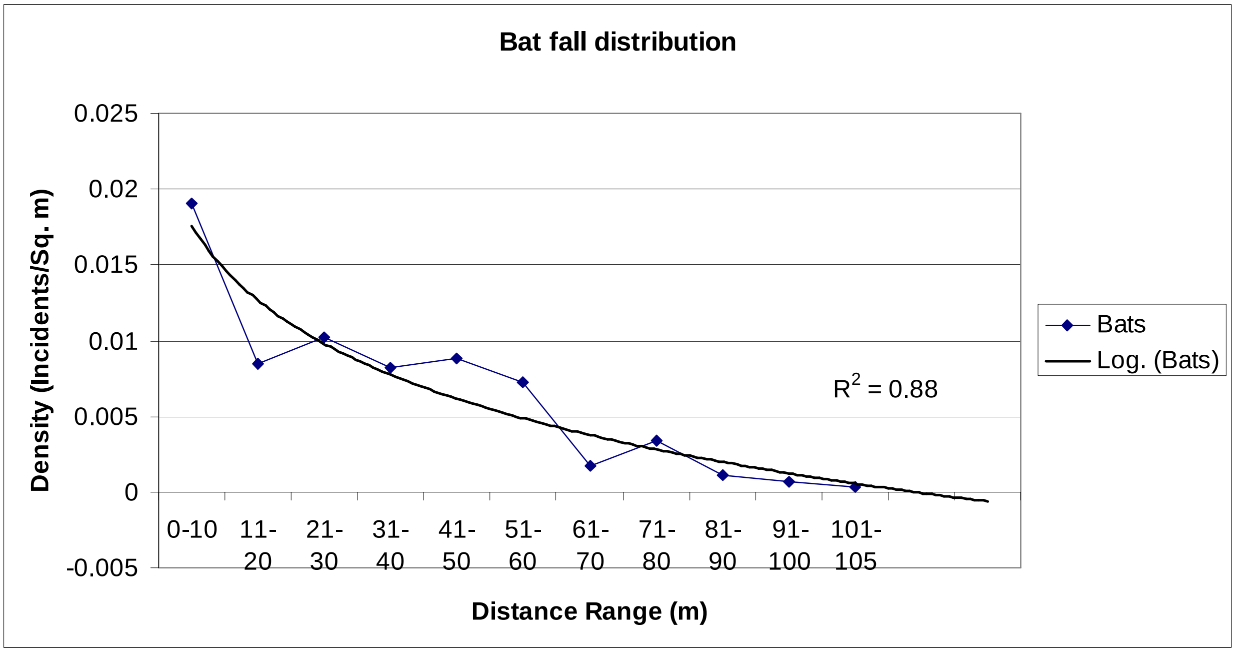

Figure 11. Density of Bat incidents at 7-Day sites in relation to distance from towers.

Note: Polynomial trend line approximates distance at which density crosses zero.

3.3 Tower Height and Incident Distribution

Analysis of incidents by species groups and tower height (65 meters versus 80 meters) showed no difference from what would be expected based on distribution of towers of each height surveyed (Table 13). With the exception of bats, all species groups (all avian) either did not have large enough numbers to detect trends, or were almost identical to what would be expected based on a random distribution. Nearly twice as many bats were found at 80 meters towers than would be expected based on the number of 80 meter towers searched. However, this result was not significant (Chi-square test, $\chi^2 = 0.77$, $df = 1$, P = 0.38, ns).

Table 13. Comparison of incident distribution (by species group) to wind turbine tower height

	Tower Height			Ratio	
	65m	**80m**	**Total**	**65m**	**80m**
Number of Turbines* surveyed per round	12	38	50	1	3.2
Bird Species					
Raptor	16	39	55	1	2.4
Passerine	52	195	247	1	3.75
Waterfowl	4	2	6	2	1
Water Bird	4	15	19	1	3.75
Other Bird	11	40	51	1	3.6
Unknown bird spp.	1		1	1	0
Subtotal Bird Species	**88**	**291**	**379**	**1**	**3.3**
Bat Species	24	108	132	1	4.5
Subtotal Bat Species	**24**	**108**	**132**	**1**	**4.5**
Grand Total	**112**	**399**	**511**	**1**	**3.6**

3.4 Prey Observations

3.4.1 Recorded Prey Observations

Potential prey species, such as rodents, rabbits, other larger mammals, reptiles and amphibians, were recorded incidentally when seen. These observations were made predominantly during carcass surveys. Though we recorded anecdotal evidence of potential raptor prey species in all years, data were insufficient for statistical analysis in the Years 1 and 3 of the project (Table 14). However, we were able to make the following analyses in year 2.

Observations recorded during year two of the study period included 40 Black-tailed Jackrabbits, 4 California Ground Squirrels, and 2 Pacific Gopher Snakes and 1 Racer (Table 12 and Appendix G).

Table 14. Prey observations year 2 at Shiloh I, April 2007 – March 2008

Prey Species	**# of Prey Observations** YEAR 2
California Ground Squirrel	4
Black-tailed Jackrabbit	40
Pacific Gopher Snake	2
Racer	1
Total Prey Observations	**47**

3.4.2 Raptor Incidents – Prey Distribution

Year two (April 2007 through March 2008) prey observations were distributed widely throughout the project area (Table 15), with 4.2 times more prey individuals north of Birds Landing Road than south. This is not significantly different from what is expected based on the numbers of wind turbine towers surveyed in each of these two areas (Chi-Square test, $\chi^2 = 0.34$, df = 1, p = 0.56). Mammalian prey (Black-tailed Jackrabbits and California Ground Squirrels) constituted most of the prey observations.

Table 15. Comparison of prey observations recorded in year 2 (April 2007 – March 2008) to wind turbine tower distribution*

	Number			**Ratio**	
	North	South	Total	North	South
Number of Turbines	38	12	50	3.2	1
Incidents					
California Ground Squirrel	4	0	4	4	0
Black-tailed Jackrabbit	32	8	40	4	1
Pacific Gopher Snake	1	1	2	1	1
Racer	1	0	1	1	0
Total	**38**	**9**	**47**	**4.2**	**1**

*Project area divided into two regions, North and South of Birds Landing Road. Note: Includes data from standardized surveys only.

Similarly, the proportion of raptor incidents as a group (6.7:1, North: South, Table 16), using Year 2 data only was not significantly different from what would have been expected based on a random distribution (3.2:1), (Chi-Square Test, Yates' $\chi^2 = 0.58$ df = 1, p = 0.58, ns). Therefore preliminary analyses do not show a correlation between the locations of observed prey and raptor wind turbine strikes, though numbers may still be too low for patterns to be statistically detectable.

Table 16. Comparison of raptor incidents recorded in year 2 (April 2007 – March 2008) to wind turbine tower distribution*

	Number			**Ratio**	
	North	South	Total	North	South
Number of Turbines	38	12	50	3.2	1
Incidents					
American Kestrel	6	1	7	6	1
Red-tailed Hawk	5	2	7	2.5	1
Golden Eagle	1	0	1	1	0
Merlin	1	0	1	1	0
Peregrine Falcon	1	0	1	1	0
Ferruginous Hawk	2	0	2	2	0
Barn Owl	1	0	1	1	0
Great Horned Owl	3	0	3	3	0
Total Raptors	**20**	**3**	**23**	**6.7**	**1**

We performed an additional analysis, based upon one discernible pattern in prey distribution. Prey observations were concentrated north of Birds Landing Road, with the greatest numbers recorded in the C turbine grouping in the northeast (Table 17). Forty-five percent (n=18) of jackrabbit observations were recorded at towers in the C grouping. This is nearly twice what would be expected if jackrabbits were distributed randomly, as these towers only comprise 25% of the towers surveyed (Chi-square test, $\chi^2 = 3.97$, df = 1, p = 0.05, sig.).

Raptor species observed at Shiloh that were most likely to prey upon jackrabbits include large raptors, such as Golden Eagles, Red-tailed Hawks, Ferruginous Hawks, Barn Owls and Great Horned Owls. Looking at data collected in year two only, we examined the distribution of these raptor species, contrasting turbine grouping C with the remaining turbine groupings, to test if jackrabbit preying raptors were also found in greater numbers than expected at C group turbines. These species of raptor incidents were not noted in greater proportions at C turbine groupings, compared to the remaining turbine groupings (Chi-square test, Yates' $\chi^2 = 0.24$, df = 1, p = 0.62, ns).

Table 17. Comparison of prey observations to raptor incidents recorded within each wind turbine tower grouping in year two (April 2007 – March 2008)

YEAR TWO	Turbine Grouping								
April 07 - March 08	A	B	C	D	E	F	G	H	Grand Total
Average # of Turbines Searched Per Round	11.5	8.5	12.5	2.5	3.0	1.0	6.0	5.0	50.0
Prey Species									
Black-tailed Jackrabbit	9	5	18				6	2	40
California Ground Squirrel		2	2						4
Pacific Gopher Snake			1				1		2
Racer					1				1
Grand Total	**9**	**7**	**21**		**1**		**7**	**2**	**47**

YEAR TWO	Turbine Grouping								
April 07 - March 08	A	B	C	D	E	F	G	H	Grand Total
Raptor Species									
Golden Eagle	1								1
Red-tailed Hawk	2	1	1	1			1	1	7
Ferruginous Hawk	1		1						2
American Kestrel	4		1	1				1	7
Merlin					1				1
Peregrine Falcon					1				1
Barn Owl				1					1
Great Horned Owl	1				2				3
Grand Total	**9**	**1**	**3**	**3**	**4**	**0**	**1**	**2**	**23**

3.5 Vegetative Cover

3.5.1 Vegetative Composition of Study Area

The vegetative cover of the wind farm consists entirely of agricultural land. It can roughly be sorted into two types of cover, pasture and crop land.

Pasture is land which is permanently used for the grazing of sheep, horses, and cattle. The vegetation consists of mixed grasses along with a lesser amount of Mustard family plants, various thistles, among others, and is generally kept short by the grazing. While the horse pastures are continuously grazed, those areas used exclusively for sheep are only periodically grazed, with the sheep being moved from field to field as the grass becomes too short. Twenty-two of the surveyed tower locations are designated as pasture land.

Crop land is land that goes through cycles of cultivation, crop production, fallow and grazing, and back to crop. The crops consist mostly of grass crops – wheat, barley, oats, hay and safflower. When a grass crop is to be planted, the soil will generally be cultivated in late May or June, while the soil is still moist. The soil will remain in the tilled state throughout the summer with periodic re-tilling to break up the clumps further. In the fall the soil is fertilized, usually with liquid ammonia, although "Bio-solids" (sewage treatment plant solid waste) was used on some fields during the study. In November or December, just prior to the start of the winter rains, the fields are seeded. Harvesting of the crops usually occurs in July, but is determined by when the seed reaches the right moisture level. By the time the wheat, barley or oats are harvested the soil is usually too dry and hard to disc, so the field will be fallow the following winter, unless safflower is to be planted. Hay is usually mowed around the end of May, and allowed to dry in the field before baling and gathering. Like the other grass crops, by the time the hay is gathered, it is too late to disc in time to plant the following winter, so the field will be fallow.

Safflower is planted later in the season, around March. Since the soil is still quite moist, a less aggressive technique of cultivating is used to loosen up the soil. Harvesting of safflower usually occurs in August or September.

Vegetative cover was divided into four separate categories: crop (which includes: wheat, oats, barley, hay and safflower), pasture, fallow and till. Throughout the three year study, crop represented 36% of the ground cover, pasture 22%, fallow 14.4% and till 22%. Crop vegetation goes through several stages: emergent growth, growing season (approximately from December through July) and harvested crop (approximately from July to December). Once the winter rains arrive and the field is not tilled, grasses start to emerge and vegetation cover is designated fallow.

Although several towers had more than one kind of vegetative cover due to fence lines running through the survey area, for the purposes of this analysis each tower was considered to have a single type of vegetation cover, that which occupied more than 50% of the survey area and surrounded the base of the tower. Vegetation height was classified as short (<6"), medium (6"-12"), or tall (>12"). At less than 6", vegetation does not obscure the surveyor's vision, while a height of more than 12" could potentially obscure the view sufficiently that the surveyor could miss some carcasses, including larger birds. Between 6" and 12" there is some possibility of missing small birds and bats, but not the larger birds.

Throughout the three year study, short vegetation accounted for 67.6% of the surveyed towers, medium for 18.1%, and high for 14.3%. Comparing the percentage of incidents found on each vegetation cover type, it is clear that the percentages are not equal. For all of our vegetation-incident comparisons, we analyzed standardized data of wind-turbine related fatalities only, as injured birds were all semi-mobile and could have moved between areas of different vegetation types.

3.5.2 Incidents and Vegetation Type

Although there were somewhat fewer fatalities found on crop ground than would be expected by the extensive number of towers classified with this type of ground cover, the proportion of incidents found at each vegetation type did not differ greatly (Chi-Square Test, $\chi^2 = 1.49$, df = 3, p = 0.68, ns.) from the proportion of towers searched with that primary vegetation type (Table 18).

Table 18. Number of towers and incidents by vegetative cover

Crop Type	# of Towers	# Incidents
Crop	36	154
Fallow	28	149
Pasture	22	133
Till	14	72
Totals	**100.0**	**508**

Comparing vegetative cover to species group shows that bats were found in lower than expected numbers in till and greater than expected numbers in fallow (Chi Square Test, $\chi^2 = 7.02$, df = 3, p = 0.07), (Table 19). One possible explanation for this is the increased density of insects associated with grazed pastures and the lack of insects over tilled soil. Another factor could be that the coloration of the tilled soil is closer to the coloration of the bat carcasses. Spotting the carcasses is more difficult due to the fact that there may be little or no contrast between the carcass and the exposed soil upon which it is laying.

The 'other bird' (Chi Square test, $\chi^2 = 2.63$, df = 3, p = 0.45) and passerine categories (Chi Square test, $\chi^2 = 3.78$, df = 3, p = 0.29) did not show greater than expected proportions in any vegetation type. These numbers are noticeably different than the 1 year report, which could be related to the fact that the 2005-2006 rainy season was extraordinarily wet, while 2006-2007 was unusually dry which would affect vegetation and food abundance. Raptor incidents did not show a greater than expected proportion in any vegetation type (Chi Square test, $\chi^2 = 0.26$, df = 3, p = 0.97.

Table 19. Comparison of species group to vegetative cover type

Species Group	Crop	Pasture	Fallow	Till	Total
Raptor	20	16	10	8	54
Passerine	64	71	65	45	245
Other Bird	29	14	22	12	77
Total Birds	113	101	97	65	376
Bat	41	48	36	7	132
% of Fatalities (Birds + Bats)	**30.3%**	**29.3%**	**26.2%**	**14.2%**	**100.0%**
Percentage					
Raptor	12.9%	10.7%	7.5%	11.1%	
Passerine	41.5%	47.6%	48.8%	62.5%	
Other Bird	18.8%	9.5%	16.6%	16.7%	
Bat	26.8%	32.2%	27.1%	9.7%	

3.5.3 Incidents and Vegetation Height

A comparison of species group to cover height indicates that there seems to be a visibility factor involved, with more than two-thirds of the incidents occurring in short vegetation, about one-fifth in medium vegetation, and only one-sixteenth in high vegetation (Table 20). Bats, passerines and raptors all followed this pattern.

Table 20. Comparison of species group to vegetative cover height

Species Group	High	Medium	Short	Total	% High	% Medium	% Low
Raptor	4	16	34	54	7.5%	47.1%	62.9%
Passerine	17	55	173	245	6.9%	22.4%	70.6%
Other Bird	6	10	61	77	7.7%	12.9%	79.2%
Bat	7	21	104	132	5.3%	15.9%	78.7%
Totals	34	102	372	508			
% Totals	**6.7%**	**20.1%**	**73.2%**				

Comparing the species size groups to cover height further supports the idea that visibility might be an underlying factor influencing why carcasses were found more heavily in short and medium height vegetation than in tall (high) vegetation. The smallest percentages of incidents were found in tall vegetation, with the most noticeable difference being in the small and medium bird and bat groups (Table 21). This all seems to suggest that vegetation height plays an important part in the visibility of the fatalities, that there may be fatalities which are simply not visible to the surveyors.

Table 21. Comparison of species size to vegetative cover height

Size Group	High	Medium	Short	Total	% High	% Medium	% Low
Large	5	10	26	41	12.2%	24.3%	63.4%
Medium	10	38	131	179	5.6%	21.2%	73.1%
Small	12	33	111	156	7.6%	21.2%	71.2%
Bat	7	21	104	132	5.3%	15.9%	78.8%
Totals	34	102	372	508			
% Totals	**6.7%**	**20.1%**	**73.2%**				

3.5.4 Feeding Niche of Incidents and Vegetation

The incident species were categorized by their principle diet into 5 categories: carnivore, insectivore, omnivore, seed eaters, and vegetation eaters.[1] There was no attempt to categorize those incidents listed as unknown species, except where some taxa was suggested (e.g. “Unknown Sparrow”). A total of 493 incidents were able to be classified by feeding niche. Insectivores have a higher fatality rate than represented by the percentage of species, and both

[1] Source: Ehrlich, Paul R., David S. Dobkin & Darryl Wheye, 1988, *The Birder’s Handbook: A Field Guide to the Natural History of North American Birds*, Simon & Schuster.

the carnivores and seed eaters have a lower fatality rate than the percentage of species would indicate (Table 22). However, none of the differences from expected percentage were significant (Chi-Square Test, $\chi^2 = 2.53$, df = 4, p = 0.64)

Table 22. Number of species and incidents by feeding niche

Feeding Niche	Number of Species	Percentage of Total Species	Number of Incidents	Percentage of Incidents
Carnivore	10	16.4%	60	12.2%
Insectivore	37	60.7%	342	69.3%
Omnivore	1	1.6%	8	1.6%
Seeds	10	16.3%	70	14.2%
Vegetation	3	4.9%	13	2.6%

We then compared the number of incidents of species within each feeding niche to the cover type and found no significant evidence of deviation from expected frequencies (Chi-Square Test, Yate's $\chi^2 = 12.50$, df = 12, p = 0.41) (Table 23).

Table 23. Comparison of feeding niche to vegetative cover type

Cover	Carnivore	Insectivore	Omnivore	Seeds	Vegetation	Total	% of Incidents
Crop	23	101	0	25	3	152	30.8%
Pasture	16	109	0	17	2	144	29.2%
Fallow	13	85	5	18	6	127	25.8%
Till	8	47	3	10	2	70	14.2%
Total	**60**	**342**	**8**	**70**	**13**	**493**	

We also compared the percentage of incidents within each feeding niche to vegetative cover type (Table 24).

Table 24. Percentage of incidents within each feeding niche versus vegetative cover type

Cover		Birds					Bats
Type	**Percent**	**Carnivore**	**Insectivore**	**Omnivore**	**Seeds**	**Vegetation**	**Insectivore**
Crop	36.0%	38.3%	28.5%	0.0%	35.7%	23.1%	31.1%
Fallow	28.0%	21.6%	23.3%	62.5%	25.7%	46.2%	27.2%
Pasture	22.0%	26.6%	29.1%	0.0%	24.3%	15.4%	36.4%
Till	14.0%	13.3%	19.1%	37.5%	14.3%	15.4%	5.3%

3.6 Searcher Efficiency and Scavenger Removal

A scavenger removal and searcher efficiency study, conducted at different times of year over the three year period (May-06, Oct-07, Feb-08 Mar-08, May-08, Jun-08, Jul-08, Oct-08, Dec-08, Feb-09, Mar 09,) has estimated the proportion of incidents missed by the searchers and the proportion removed by scavengers within the 7 day search cycle.. Accounting for scavenging and searcher efficiency, an adjusted estimate of the total number of kills at the wind farm was calculated. The number of incidents/tower and incidents/megawatt (MW) were calculated using the estimated number of avian and bat incidents found during this three year study. These rates are readily comparable between wind farms of different sizes (different numbers of turbines and different generational capacities per turbine).

3.6.1 Adjusting Fatality Estimates

This section presents data for year three of the study followed by aggregate data for all three years during which the study was conducted.

Table 25 shows the results of the scavenger study as described in the Methods for year three. The proportion of birds not scavenged (*Sc*) within 4 days was used to adjust the number of incidents that were discovered by our searchers, in each size class (small, medium, and large birds, and bats).

Table 25. Shiloh scavenger removal study data Study Year 3 (April 10, 2008 –April 11, 2009)

Species Size Group	# of Carcasses	# Scavenged	Proportion not scavenged (Sc)
Small Birds	37	20	0.46
Medium Birds	27	10	0.63
Large Birds	16	1	0.94
Bats	66	33	0.50

Table 26 shows the results of the scavenger study as described in the Methods for all three years. The proportion of birds not scavenged (*Sc*) within 4 days was used to adjust the number of incidents that were discovered by our searchers, in each size class (small, medium, and large birds, and bats)

Table 26. Shiloh scavenger removal study data All Years (April 10, 2006 –April 11, 2009)

Species Size Group	# of Carcasses	# Scavenged	Proportion not scavenged (Sc)
Small Birds	95	57	0.40
Medium Birds	52	20	0.62
Large Birds	33	3	0.91
Bats	136	78	0.43

Table 27 shows the results of the search efficiency study as described in the Methods for year three, using bird carcasses only. The proportion of birds found (*Se*) was used to adjust the number of incidents that were discovered by our searchers, in each size class (small, medium, and large birds, and bats). Carcasses were placed in fields where searches were ongoing. Field conditions and vegetative height were a shifting mosaic, as different vegetation grew and was harvested or grazed at differing periods of time. However, by spreading our tests over many fields and several seasons, we attempted to roughly approximate search conditions. We did not gather data on vegetative height in 2006. However, in later years, out of 253 individual test carcasses, 207 (82%) were placed in short substrate fields, 11 (4%) were placed in medium substrate fields and 35 (14%) were placed in tall substrate fields.

Table 27. Shiloh searcher efficiency study data Study Year 3 (April 10, 2008 –April 11, 2009)

Species Size Group	# of Carcasses	# Not Found	Prop. Found (Se)
Small Birds	37	15	0.59
Medium Birds	27	3	0.89
Large Birds	16	0	1.00
Bats	65	31	0.52

Table 28 shows the aggregated results for all three years of search efficiency studies as described in the Methods, using both bird carcasses as well as artificial birds. The proportion of birds found (*Se*) was used to adjust the number of incidents that were discovered by our searchers, in each size class (small, medium, and large birds, and bats).

Table 28. Shiloh searcher efficiency study data All Years (April 10, 2006 – April 11, 2009)

Species Size Group	# of Carcasses	# Not Found	Prop. Found (Se)
Small Birds	96	62	0.35
Medium Birds	52	16	0.69
Large Birds	33	0	1.00
Bats	134	87	0.35

Table 29 contains estimates of the number of bird and bat fatalities attributed to collisions with the total number of wind turbines at the Shiloh Project, in the third year of the project. They reflect corrections for *Sc*, *Se* as determined in tables 12 and 13, as well as *Ps*, the number of birds/bats found during searches and the subsequent estimate adjustment made using the formula described in the Methods.

The total number of bird incidents estimated for the project area for the third year of this study is 422 (Table 31). Raptors accounted for ~24 raptors out of 422 incidents (~5.7%), 0.24 raptor incidents/tower/year. Passerines were 325 passerines out of 422 incidents (~77.0%), 3.3 passerine incidents/tower/year. Bats accounted for 321 bats/year (3.21 bats/tower/year). Hoary bats (~60.0%) and Mexican Free-tailed bats (38.0%) accounted for the majority of the adjusted bat incidents of this study.

Table 29. Estimates for bird and bat collision mortality under 100 turbines of the Shiloh Project, Year 3 (April 10, 2008 –April 11, 2009), corrected for searcher efficiency, scavenger removal rate and proportion of towers searched

	Birds				Total
Correction Factors	**Small**	**Medium**	**Large**	**Bats**	**Carcasses**
# Found	38	35	9	42	124
% Not Scavenged **(Sc)**	46%	63%	94%	50%	
Search Efficiency **(Se)**	59%	89%	100%	52%	
Proportion Searched Turbines **(Ps)**	50.00%	50.00%	50.00%	50.00%	
Adjusted Total	**278**	**125**	**19**	**321**	**744**
95% CI (±)	26	8	1	23	

By dividing the estimated number (adjusted for searcher efficiency and scavenger losses) of birds/bats by the number of towers searched in each year of this study, a rate of incidents/tower and incidents/megawatt (MW) can be calculated, allowing comparisons between wind farms of different sizes (different numbers of turbines and different generational capacities per turbine).

Table 30 contains estimates of the number of bird and bat fatalities attributed to collisions with the total number of wind turbines at the Shiloh Project, in all three years of the project combined. They reflect corrections for *Sc*, *Se* as determined in tables 12 and 13, as well as *Ps*, the number of birds/bats found during searches and the subsequent estimate adjustment made using the formula described in the Methods.

The total number of incidents estimated for the project area per year of this study is 1629 (Table 30). Raptors accounted for ~67 raptors/year out of 1044 birds/year (~6.4%), 0.67 raptor incidents/tower/year. Passerines were 873 passerines/year out of 1044 birds/year (~83.6%), 8.7 passerine incidents/tower/year. Bats accounted for 588 bats/year (5.88 bats/tower/year) Hoary bats (~48.5%) and Mexican Free-tailed bats (47.7%) accounted for the majority of the adjusted bat incidents of this study.

Table 30. Estimates for bird and bat collision mortality under 100 turbines of the Shiloh Project, All Years (April 10, 2006 –April 11, 2009), corrected for searcher efficiency, scavenger removal rate and proportion of towers searched

	Birds				Total
Correction Factors	**Small**	**Medium**	**Large**	**Bats**	**Carcasses**
# Found	155	181	43	132	511
% Not Scavenged **(Sc)**	40%	62%	91%	43%	
Search Efficiency **(Se)**	35%	69%	100%	35%	
Proportion Searched Turbines **(Ps)**	50.00%	50.00%	50.00%	50.00%	
Adjusted Total (per yr)	**729**	**283**	**32**	**588**	**1629**
95% CI (±)	169	50	2	112	

By dividing the estimated number (adjusted for searcher efficiency and scavenger losses) of birds/bats by the number of towers searched in each year of this study, a rate of incidents/tower and incidents/megawatt (MW) can be calculated, allowing comparisons between wind farms of different sizes (different numbers of turbines and different generational capacities per turbine).

3.6.2 Species Fatality Estimates

Table 31 shows the estimated number of incidents and fatality rates per species within each size

Table 31. Adjusted number of incidents per species per turbine and per total installed megawatt capacity at Shiloh I, found during standardized surveys Study Year 3 (April 10, 2008 –April 11, 2009)

	# Incidents (Year 3)	**Estimated # Incidents/Mw/year**	**Estimated # Incidents/Tower/year**		**Estimate of mortality (Incidents/year)**	**Incidental Finds**
Species Name						
Birds (Large)						
Goose spp.	1	0.00	0.01		2	0
Great Horned Owl	1	0.00	0.01		2	0
Mallard	1	0.00	0.01		2	0
Red-tailed Hawk	2	0.01	0.01		4	1
Ring-necked Pheasant	4	0.02	0.03		9	1
Total Large Birds	**9**	**0.04**	**0.06**	**Total Estd. Large**	**19**	**2**
Birds (Medium)						
American Coot	1	0.01	0.01		4	0
American Kestrel	5	0.04	0.06		18	1

Brewer's Blackbird	3	0.02	0.04		11	0
Chukar	3	0.02	0.04		11	0
Common moorhen	1	0.01	0.01		4	0
Killdeer	3	0.02	0.04		11	1
Mourning Dove	7	0.06	0.08		25	2
Rock Pigeon	2	0.02	0.02		7	0
Sora	0	0.00	0.00		0	1
Western Meadowlark	10	0.08	0.12		36	0
Total Medium Birds	**35**	**0.28**	**0.42**	**Total Estd. Medium Birds**	**125**	**5**
Birds (Small)						
American Pipit	4	0.07	0.10		29	0
Blackbird spp.	1	0.02	0.02		7	0
Black-throated Gray Warbler	1	0.02	0.02		7	0
European Starling	1	0.02	0.02		7	0
Horned Lark	8	0.13	0.20		59	0
Lincoln's Sparrow	1	0.02	0.02		7	0
MacGillivray's Warbler	0	0.00	0.00		0	1
Orange-crowned warbler	1	0.02	0.02		7	0
Pacific-Slope Flycatcher	2	0.03	0.05		15	0
Passerine spp.	2	0.03	0.05		15	0
Red-winged Blackbird	5	0.08	0.12		37	1
Savannah Sparrow	2	0.03	0.05		15	0
Swainson's thrush	2	0.03	0.05		15	0
Townsend's Warbler	1	0.02	0.02		7	0
Tree Swallow	1	0.02	0.02		7	0
Tri-colored Blackbird*	1	0.02	0.02		7	0
Warbling Vireo	2	0.03	0.05		15	0
White-throated swift	2	0.03	0.05		15	0
Wilson's Warbler	1	0.02	0.02		7	0
Yellow-rumped Warbler	0	0.00	0.00		0	1
Total Small Birds	**38**	**0.62**	**0.93**	**Total Estd. Small Birds**	**278**	**13**
Total Birds	**82**	**0.94**	**1.41**	**Total Estd. Birds**	**422**	**15**
Bats						
Hoary Bat	25	0.42	0.64		191	1
Mexican Free-tailed Bat	16	0.27	0.41		122	1
Silver-Haired Bat	1	0.02	0.03		8	0
Western Red Bat		0.00	0.00		0	0
Total Bats	**42**	**0.71**	**1.07**	**Total Estd. Bats**	**321**	**2**
Total (Birds & Bats)	**124**	**---**	**---**	**Total Estd. (Birds & Bats)**	**744**	**---**

* Denotes California Species of Special Concern (CSC).

The estimated fatality rate over the third year for birds is 4.22 birds/tower/year (2.82 birds/MW/year), and for bats is 3.21 bats/tower/year (2.14 bats/MW/year).

Table 32 shows the estimated number of incidents and fatality rates per species within each size

Table 32. Adjusted number of incidents per species per turbine and per total installed megawatt capacity at Shiloh I, found during standardized surveys All Years (April 10, 2006 –April 11, 2009)

	# Incidents (3 years)	**Estimated # Incidents/Mw/year**	**Estimated # Incidents/Tower/year**		**Estimate of mortality (Incidents/year)**
Species Name					
Birds (Large)					
Black-crowned Night Heron	1	0.00	0.01		1
Ferruginous Hawk	2	0.01	0.01		1
Golden Eagle*	1	0.00	0.01		1
Goose spp.	1	0.00	0.01		1
Great Horned Owl	4	0.02	0.03		3
Mallard	5	0.02	0.04		4
Northern Harrier*	2	0.01	0.01		1
Peregrine Falcon	1	0.00	0.01		1
Red-tailed Hawk	15	0.07	0.11		11
Ring-necked Pheasant	8	0.04	0.06		6
Turkey Vulture	2	0.01	0.01		1
Unknown bird spp.	1	0.00	0.01		1
Total Large Birds	**43**	**0.21**	**0.32**	**Total Estd. Large**	**32**
Birds (Medium)					
American Coot	10	0.10	0.16		16
American Kestrel	27	0.28	0.42		42
Barn Owl	2	0.02	0.03		3
Brewer's Blackbird	15	0.16	0.23		23
Chukar	4	0.04	0.06		6
Common moorhen	1	0.01	0.02		2
Killdeer	4	0.04	0.06		6
Merlin	1	0.01	0.02		2
Mourning Dove	26	0.27	0.41		41
Northern Flicker	2	0.02	0.03		3
Northern Mockingbird	1	0.01	0.02		2
Rock Pigeon	9	0.09	0.14		14
Sora	1	0.01	0.02		2
Virginia Rail	2	0.02	0.03		3
Western Meadowlark	76	0.79	1.19		119
Total Medium Birds	**181**	**1.89**	**2.83**	**Total Estd. Medium Birds**	**283**
-					
Birds (Small)					
American Goldfinch	1	0.03	0.05		5
American Pipit	9	0.28	0.42		42
Blackbird spp.	2	0.06	0.09		9
Black-Headed Grosbeak	1	0.03	0.05		5
Black-throated Gray Warbler	4	0.13	0.19		19
Dark-eyed Junco, slate	1	0.03	0.05		5
European Starling	6	0.19	0.28		28
Golden-Crowned Kinglet	1	0.03	0.05		5

Golden-Crowned Sparrow	1	0.03	0.05		5
Hammond's Flycatcher	1	0.03	0.05		5
Horned Lark	21	0.66	0.99		99
House Finch	1	0.03	0.05		5
House Sparrow	1	0.03	0.05		5
Lincoln's Sparrow	2	0.06	0.09		9
MacGillivray's Warbler	2	0.06	0.09		9
Orange-crowned warbler	1	0.03	0.05		5
Pacific-Slope Flycatcher	3	0.09	0.14		14
Passerine spp.	14	0.44	0.66		66
Red-winged Blackbird	42	1.32	1.98		198
Ruby-crowned Kinglet	1	0.03	0.05		5
Savannah Sparrow	7	0.22	0.33		33
Sparrow spp.	3	0.09	0.14		14
Swainson's thrush	1	0.03	0.05		5
Swallow spp.	1	0.03	0.05		5
Townsend's Warbler	3	0.09	0.14		14
Tree Swallow	4	0.13	0.19		19
Tri-colored Blackbird*	2	0.06	0.09		9
Warbling Vireo	3	0.09	0.14		14
Western Wood Pewee	**0**	0.00	0.00		0
White-crowned Sparrow	2	0.06	0.09		9
White-throated swift	2	0.06	0.09		9
Wilson's Warbler	7	0.22	0.33		33
Yellow Warbler*	4	0.13	0.19		19
Yellow-breasted Chat*	1	0.03	0.05		5
Unknown bird spp.	0	0.00	0.00		0
Total Small Birds	**155**	**4.86**	**7.29**	**Total Estd. Small Birds**	**729**
Total Birds	**379**	**6.96**	**10.44**	**Total Estd. Birds**	**1044**
Bats					
Hoary Bat	64	1.90	2.85		285
Mexican Free-tailed Bat	63	1.87	2.81		281
Silver-Haired Bat	3	0.09	0.13		13
Western Red Bat	2	0.06	0.09		9
Total Bats	**132**	**3.92**	**5.88**	**Total Estd. Bats**	**588**
Total (Birds & Bats)	**511**	**---**		**Total Estd. (Birds & Bats)**	**1632**

* Denotes California Species of Special Concern (CSC).

The estimated average fatality rate over three years for birds is 10.44 birds/tower/year (6.96 birds/MW/year), and for bats is 5.88 bats/tower/year (3.92 bats/MW/year).

4.0 DISCUSSION

This report details the results of a three-year post-construction study of the Shiloh I wind power project. This is the third fatality study conducted for the newer turbine technology installed in the CMHWRA. These newer turbines are arrayed on generally the same type of lands (topography, habitat and land use patterns) in which approximately 510 of the older technology Kenetech 56-100 turbines are deployed along with more than 200 turbines of the newer technology. The older turbine technology in the CMHWRA is the same as that currently used in much of the Altamont Pass Wind Resource Area which has been studied extensively (Howell and DiDonato 1991; Orloff and Flannery 1992, 1996; Howell 1997; Kerlinger 1997; Thelander and Rugge (2000); Smallwood and Thelander 2004). Many of the newer turbines in the Shiloh I and the High Winds projects are interspersed with older turbines.

The completion of this three year cycle of post-construction studies results in nine years of continuous and comparative documentation of the impacts of wind plant development in the CMHWRA. Comparable pre-construction and post-construction surveys have been completed over that period of time using data collection protocols that enable us to better understand the impact of wind plant development on a large scale. The first study in this series was commenced on August 17, 2000 (High Winds).

Due to the similarity of terrain and land use practices throughout the CMHWRA we would expect to find a similar species composition and abundance among the wind projects developed areas of the WRA. If this is so, we would also expect to find comparable post-construction risk to avian and bat species because the new turbines in these areas are similar in structure (tower hub height, blade length and FAA lighting requirements), operating characteristics and spacing. Region specific sources of variation and error should be relatively constant among these different surveys. Thus, the data collected at these projects may be compared (Table 33) in an effort to determine if there are differences in mortality trends between these projects.

Table 33. Comparison of High Winds and Shiloh I attributes or metrics (unadjusted data)

Attribute or Metric	Shiloh I	High Winds
Number of Turbines	50 (of 100 towers)	87.92 (of 90 towers)
Nameplate Capacity of Turbines	1.5 M	1.8 MW
Total Installed Megawatt Capacity*	75.0	158.3
Total Height of Rotor (AGL)	103.5 m	100 m
Duration of Study (years)	3	2
Study Dates	April 2006 – April 2009	August 2003 – July 2005
Search Interval (in days)	7 days	15 days
Number of Birds Found	379	163

Attribute or Metric	Shiloh I	High Winds
Number of Raptors Found	57	71
Number of Songbirds Found	247	64
Number of Bats Found	132	116
Number of Birds Killed Per Turbine Per Year (unadjusted data)	2.53	0.93
Number of Birds Killed Per Megawatt* Per Year (unadjusted data)	1.69	0.51
Number of Bats Killed Per Turbine Per Year (unadjusted data)	0.88	0.66
Number of Bats Killed Per Megawatt* Per Year (unadjusted data)	0.59	0.37

* Number of incidents per megawatt per year was calculated by dividing the number of incidents (within the species group) by the total installed megawatt capacity (which was calculated by multiplying the average number of wind turbines surveyed throughout the 3 year survey period by the individual tower MW), then dividing this number by 3 years.

4.1 Night Migrant Fatalities

As with most other turbine facilities across the United States, the fatality rate of night migrants was low at the Shiloh I facility during the three years of study. The numbers were especially small in comparison with fatality rates of these birds at taller, guyed communication towers in the Midwestern and eastern United States where fatalities involving hundreds or even thousands of birds in a single night have been found dead in a single migration season. Those towers are usually equipped with two types of Federal Aviation Administration (FAA) lighting (steady burning and flashing lights), multiple sets of guy wires, and are almost always in excess of 500 feet (152 m). For example, a study in Michigan demonstrated that fatalities at guyed communication towers in excess of 305 m (1,000 feet) in height revealed that such towers kill 300+ birds per tower per year (calculated from data in Gehring et al. 2009). For guyed towers 450-475 feet in height, the data in Gehring et al. (2009) suggest that fatality rates are about 65-70 birds per tower per year. A vast majority of these birds are night migrants, so most guyed communication towers have been shown to kill orders of magnitude more birds on a per structure basis than wind turbines. Thus, guyed communication towers of the same height or taller kill about 13 or 14 times per structure to more than 60 times more per structure than do the wind turbines at Shiloh.

An examination of the fatality rates of night migrating bird (songbirds, rails, common moorhen, coots, and herons) and bat fatalities found during fall (August through November) and spring (mid-February through May) at turbines with flashing red FAA lights versus turbines without such lights did not reveal a significant difference (Table 34). There was also almost no difference between the fatality rates of incidents of night migrant species and non-night migrant species at lit towers versus those that were not lit. Of the 50 night migrating bird species (39 songbirds and 11 waterfowl and water birds), 34% were found dead at turbines equipped with flashing red lights as opposed to 66% being found at turbines that did not have FAA lights. These percentages are close to the percentages of towers with and without FAA lights (36% had

FAA lights and 64% did not have lights). A chi-square test revealed no deviation from expected numbers of night migrant fatalities at lit turbines as opposed to unlit turbines (Chi-square test, $\chi^2 = 0.005$, *df* = 1, P = 0.94, ns). If the red flashing lights attracted birds to turbines, a disproportionately greater number of these fatalities would have been found at turbines with lights, which was not the case.

A similar examination of the numbers of bat fatalities at turbines with FAA lights versus turbines without such lights reveals a similar relation. Of all wind turbine related bat fatalities which occurred during fall or spring migrations, 38% were found at turbines with FAA lights and 62% were found at turbines without such lights. These proportions do not deviate from those expected if bats collided with towers randomly (Chi-square test, $\chi^2 = 0.04$, *df* = 1, P = 0.84, ns).

Table 34. The number of incidents of night migrating birds and bats, and non-migrating birds, found during fall (August - November) and spring (mid-February - May) migrations during the three years of standardized surveys, at towers with and without FAA red-blinking lights

	NO LIGHT		RED BLINKING LIGHT		Total
	#	%	#	%	#
Wind Turbines Surveyed*	**32**	**64%**	**18**	**36%**	**50***
Night Migrant Incidents					
Bats	78	62%	47	38%	125
Passerine	26	67%	13	33%	39
Waterbird/Waterfowl	7	64%	4	36%	11
Night Migrant Subtotal	**111**	**63%**	**64**	**37%**	**175**
Non-Night Migrant Incidents	112	67%	54	33%	166
Non-Night Migrant Subtotal	**112**	**67%**	**54**	**33%**	**166**
Total # Incidents	**223**	**65%**	**118**	**35%**	**341**

* The number of wind turbines searched during the 3 years of this study with and without lights was calculated based on the proportion of rounds conducted at each tower type (lit or not).

For both bats and birds, there is no evidence that FAA lighting in the form of L-864 and L-810 flashing red lights attracted birds to towers and that the presence of those lights cause large scale fatality events at wind turbines.

The fact that the Shiloh I and most other western turbines are only 339.5 feet (103.5 m) in height, do not have guy wires, and have only flashing red strobe-like lights may explain the low rate of night migrant fatalities at those turbines. Gehring et al. 2009 has recently demonstrated that flashing red, strobe-like lights (L-864) of the type recommended by FAA and used most often on wind turbines do not appear to attract night migrants like the utilization of the same lights (L-864) in combination with L-810 steady burning red lights. In the Shiloh I project, the L-810 units were modified from steady burning to blinking lights. These results continue to suggest that wind turbines in the western United States do not appear to kill large or significant numbers of night migrants. Determining the exact number of night migrants is difficult, however, as some of the birds involved may have been resident breeders.

4.2 Spatial Distribution of Incidents

4.2.1 Raptors

The data suggested that the distribution of bird incidents was disproportionately slightly greater (exceeded the roughly 3:1 ratio of North towers to South towers) at searched sites north versus south of Bird Landing Road, for passerines as a group and American Kestrels as an individual species. These two regions (north and south) differ in both topography and crop types. In comparison to the north, the southern area consists of steeper hills of higher elevations, which open up to a broad plain extending south to the Sacramento River and Suisun Marsh. The southern portion of the project more closely resembles the topography of the Altamont with higher ridges and deeper valleys, whereas, the northern portion is more uniform with gentler slopes and a gentler relief. However, it should be noted that preventive actions were taken in the siting of these turbines in an attempt to avoid the types of risky topographic related situations identified in the Altamont.

Raptor incidents were distributed widely throughout the project area with nearly six times as many incidents north of Birds Landing Road than south. The concentration of American Kestrel incidents in the north was significantly different from what was expected based on a random distribution. There were thirteen wind turbine towers with 2 or more raptor incidents in the north, and one tower in the south. Tower A4 had 3 American Kestrel incidents. For raptor species other than the American Kestrel data, raptor incident numbers were low, and where tests were possible, we did not discern any pattern of fatality (or injury) between north and south sites.

4.2.2 Non-Raptors

Incidents of non-raptor species appeared to be concentrated in the northern region of the project area. Passerine species accounted for the majority of incidents in the north, with 5.3 times greater songbird fatalities in the north than the south. The difference in proportion of passerine incidents between northern and southern sites was significantly somewhat greater than that expected from the numbers of towers in each area. The numbers of incidents of all other non-raptor, non-passerine avian species groups, or “Other Birds,” showed no significant difference from expected proportions.

4.2.3 Bats

Bat incidents were seven times more numerous in the north than the south of Birds Landing Road. Looking at species individually, the Mexican Free-tailed Bat incidents were concentrated in the north (9.5:1), and this species showed evidence of a significantly different fatality distribution than what would be expected based on wind turbine numbers in the north and south. Twenty-nine towers had two or more bat fatalities each. Seventy percent (70%, n=92) of all bat fatalities were found at these 29 towers, which comprised only 29% of the towers surveyed during the study. Twenty-five of these towers were on the north side, and one tower alone (A12) had 10 bat fatalities. Six turbines in the same row, A11-A33 had 25 fatalities or 19% of all bat fatalities. These towers are located in the most northwesterly corner of the wind project, and all but 15 of the bat incidents were found during the months of fall migration. Influences such as topographic features, vegetative cover, searcher visibility, availability of insect prey, presence of roosting trees or structures, or possibly light sources could have influenced the presence or absence of bats in different regions. There are both trees and barns located within 1/4-1 mile of the A string turbines.

4.2.4 Turbine location assessment

With respect to individual turbines, there were 4 out of 100 searched towers (for birds) and 1 out of 100 searched towers (for bats) where fatalities deviated significantly from the average (the outliers referenced above). By chance five (5) of 100 statistical tests should have shown significant deviation from the average for each category. Therefore we conclude that, with respect to individual turbines and strings and with respect to general location (North vs. South), there is no evidence to support the relocation of any turbines.

4.3 Seasonal Distribution of Incidents

Based on estimated month of death (or injury), the greatest number of bird incidents occurred during the month of January of 2007, with ~eight percent of all bird incidents found during that month alone. The majority (85%) of these were passerines. Seventy-six percent of the Year 1 raptor incidents occurred during the fall migration and pre-breeding seasons, between and including October 2006 and January 2007. The number of raptor incidents found during those same months the following years only comprised 46% and 43% of the raptors found that year.. The greatest number of bat incidents occurred during the fall migration period, with 87% of all bat carcasses found between and including August and October of all three years. For the convenience of the reader Figure 4 is presented here as well.

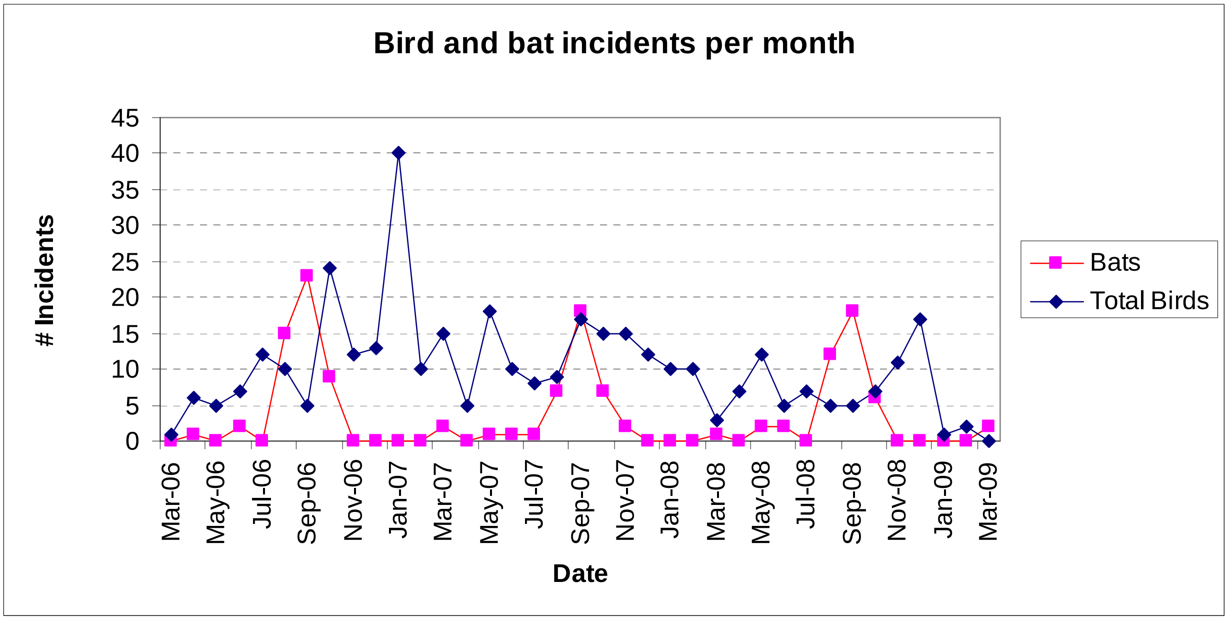

Figure 12. Number of wind turbine related incidents (birds and bats) per month, from March 2006-March 2009*

*Estimated month of death or injury was calculated by subtracting estimated number of days since death or injury from the report date. These numbers include incidents with known estimated month of death or injury, found during standardized surveys only.

4.4 Distribution of Incidents and Energy Production

At the Technical Advisory Committee meeting there was interest in the relationship between fatalities and power output at Shiloh I. Table 35 shows the monthly generation of energy (expressed in MW-hrs) at Shiloh I during the post construction study. With the exception of May, 2006, the four top production months were May, June, July and August. In 2006, September production exceeded that of May. In Table 36 and Figure 13, we show the number of incidents per MW-hr for each month of the project. The months of peak energy production were some of the months with the lowest number of incidents.

Table 35: Shiloh I Monthly Generation (MW-hr)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2006			20,400	25,114	44,119	54,173	51,412	57,463	47,111	27,488	13,802	17,978
2007	21,940	21,001	31,740	44,642	67,550	61,984	72,206	65,569	46,975	24,660	20,359	22,890
2008	29,461	21,287	33,391	40,398	58,708	56,993	70,078	61,390	43,969	27,913	15,976	17,261
2009	1,715	16,297	30,513									

NOTE:

(1) Test Energy for March 2006

(2) Bird's Landing substation outage (i.e. PG&E directed) from 1/5/2009 through 2/6/2009

Table 36: Incidents per Megawatt-hour per Month at the Shiloh I Wind Power Project, Solano County, California. Incidents include both birds and bats.

MONTH	Incidents/MW -hr	MONTH	Incidents/MW -hr	MONTH	Incidents/MW -hr
Apr-06	0.000279	Apr-07	0.000112	Apr-08	0.000173
May-06	0.000113	May-07	0.000281	May-08	0.000238
Jun-06	0.000148	Jun-07	0.000161	Jun-08	0.000161
Jul-06	0.000214	Jul-07	0.000111	Jul-08	0.000128
Aug-06	0.000365	Aug-07	0.000213	Aug-08	0.000147
Sep-06	0.000722	Sep-07	0.000639	Sep-08	0.000682
Oct-06	0.001309	Oct-07	0.001217	Oct-08	0.000466
Nov-06	0.000725	Nov-07	0.000835	Nov-08	0.000563
Dec-06	0.000834	Dec-07	0.000481	Dec-08	0.000926
Jan-07	0.001687	Jan-08	0.000204	Jan *2009	turbines not operating
Feb-07	0.000619	Feb-08	0.000658	Feb-09	0.0001227
Mar-07	0.000536	Mar-08	0.000119	Mar-09	0.000066

Project operation began with start up at end of March 2006. The highest incidents per MW-hr during 2006 were September through December (Table 36, Figure 13). In 2007, the top four months of incidents per MW-hr were January, and September through November. The months of highest number of incidents per MW-hr in 2008 were February, September, November and December. In 2009, the study was concluded in the first quarter with turbines not operating from January 5 through February 6. The overall trend in the incidents per MW-hr shows a decline during the three years of the study (Figure 13).

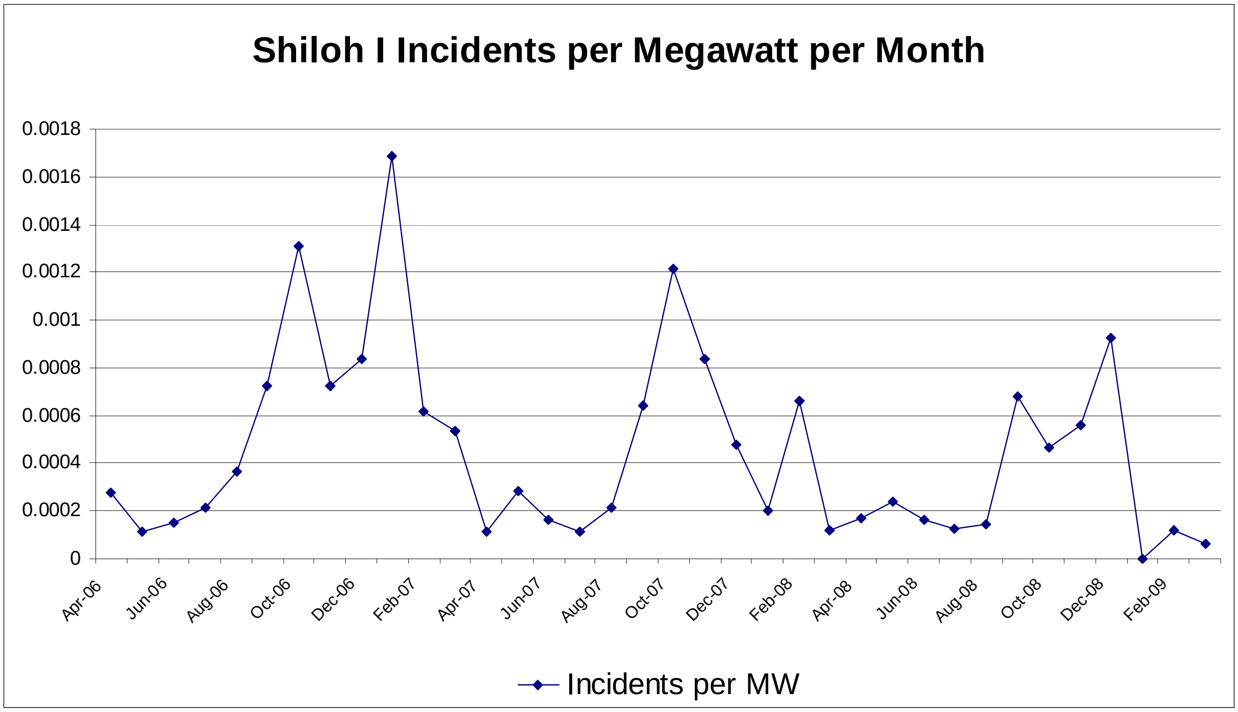

Figure 13. Shiloh I Incidents per MW-hr per Month (from Table 36)

4.5 Adjusted Fatality Rates

4.5.1 Site Comparison: Shiloh I and High Winds

As mentioned in section 1.0 (Introduction) the Shiloh I Wind Power Project is within the (CMHWRA) and is west of the 90 turbine High Winds, LLC project which became operational in 2003. The wind turbines installed in that project are the Vestas V80 model capable of generating 1.8 megawatts. We compare unadjusted and adjusted results between the two adjacent wind projects to gain a more comprehensive understanding of turbine related collision events in the region (Table 37).

Table 37: Adjusted number of incidents per species per total installed megawatt capacity* per year at Shiloh I (April 2006 – April 2009) and High Winds (August 2003 - July 2005), from standardized surveys

		Unadjusted incidents		Adjusted Incidents (Corrected for Sc, Se, Ps)			
Size	**Species**	**HW incidents (2yrs, 90 turbines, 1.8MW)**	**SH incidents (3 yrs, 100 turbines, 1.5MW)[1]**	**HW est. # incidents/MW/yr**	**SH1 est. # incidents/MW/yr**	**HW estimate of mortality/yr**	**SH1 estimate of mortality/yr**
Medium	American Coot	2	10	0.0065	0.10	1	16
Small	American Goldfinch	--	1	--	0.03	--	5
Medium	American Kestrel	45	27	0.2127	0.28	32.5	42
Small	American Pipit	2	9	0.0217	0.28	3.5	42
Medium	Barn Owl *	2	2	0.0155	0.02	2.5	3
Large	Black-crowned Night Heron	--	1	--	0.005	--	1
Small	Black-Headed Grosbeak	--	1	--	0.03	--	5
Small	Black-throated Gray Warbler	--	4	--	0.13	--	19
Medium	Brewer's Blackbird	2	15	0.0236	0.16	3.5	23
Medium	Chukar	--	4	--	0.04	--	6
Medium	Common Moorhen	1	1	0.0034	0.01	0.5	2
Small	Common Yellowthroat ***	1	--	0.0101	--	1.5	--
Small	Dark-eyed Junco, slate	--	1	--	0.03	--	5
Large	Double-crested Cormorant	1	--	0.0067	--	1	--
Small	*Empidonax* species	1	--	0.0101	--	1.5	--
Small	European Starling	6	6	0.0655	0.19	10	28
Large	Ferruginous Hawk ***	1	2	0.0067	0.01	1	1
Large	Golden Eagle ***	1	1	0.0067	0.005	1	1
Small	Golden-crowned Kinglet	--	1	--	0.03	--	5

		Unadjusted incidents		Adjusted Incidents (Corrected for Sc, Se, Ps)			
Size	Species	HW incidents (2yrs, 90 turbines, 1.8MW)	SH incidents (3 yrs, 100 turbines, 1.5MW)[1]	HW est. # incidents/MW/yr	SH1 est. # incidents/MW/yr	HW estimate of mortality/yr	SH1 estimate of mortality/yr
Small	Golden-crowned Sparrow	--	1	--	0.03	--	5
Large	Great Horned Owl	--	4	--	0.02	--	3
Small	Hammond's Flycatcher	--	1	--	0.03	--	5
Small	Horned Lark	17	21	0.1824	0.66	28	99
Small	House Finch	--	1	--	0.03	--	5
Small	House Sparrow	--	1	--	0.03	--	5
Medium	Killdeer	--	4	--	0.04	--	6
Small	Lincoln's Sparrow	1	2	0.0101	0.06	1.5	9
Small	MacGillivray's Warbler	--	2	--	0.06	--	9
Large	Mallard	--	5	--	0.02	--	4
Medium	Merlin*	--	1	--	0.01	--	2
Medium	Mourning Dove	2	26	0.0236	0.27	3.5	41
Medium	Northern Flicker	2	2	0.0194	0.02	3	3
Large	Northern Harrier	--	2	--	0.01	--	1
Medium	Northern Mockingbird	--	1	--	0.01	--	2
Small	Orange-crowned Warbler	1	1	0.0101	0.03	1.5	5
Small	Pacific Slope Flycatcher	--	3	--	0.09	--	14
Large	Peregrine Falcon*	--	1	--	0.005	--	1
Large	Red-tailed Hawk *	18	15	0.1363	0.07	21	11
Small	Red-winged Blackbird	14	42	0.1476	1.32	23.5	198
Large	Ring-necked Pheasant	2	8	0.0101	0.04	1.5	6
Medium	Rock Pigeon	2	9	0.0217	0.09	3.5	14
Large	Rough-legged Hawk	1	--	0.0062	--	1	--

		Unadjusted incidents		Adjusted Incidents (Corrected for Sc, Se, Ps)			
Size	**Species**	**HW incidents (2yrs, 90 turbines, 1.8MW)**	**SH incidents (3 yrs, 100 turbines, 1.5MW)[1]**	**HW est. # incidents/MW/yr**	**SH1 est. # incidents/MW/yr**	**HW estimate of mortality/yr**	**SH1 estimate of mortality/yr**
Small	Ruby-crowned Kinglet	2	1	0.0236	0.03	3.5	5
Small	Savannah Sparrow	--	7	--	0.22	--	33
Medium	Sora	3	1	0.0318	0.01	5	2
Small	Swainson's Thrush		1		0.03		5
Small	Townsend's Warbler	3	3	0.0329	0.09	5	14
Small	Tree Swallow	1	4	0.0093	0.13	1.5	19
Small	Tricolored Blackbird*	--	2	--	0.06	--	9
Large	Turkey Vulture	2	2	0.0129	0.01	2	1
Large	Unidentified Duck	--	--	--	--	--	--
Small	Unidentified Bird	6	--	0.0673	--	10	--
Large	Unidentified Bird	--	1	--	0.005	--	1
Small	Unidentified Blackbird	1	2	0.0101	0.06	1.5	9
Large	Unidentified Goose	--	1	--	0.005	--	1
Small	Unidentified Passerine spp.	--	14	--	0.44	--	66
Small	Unidentified Sparrow spp.	--	3	--	0.09	--	14
Small	Unidentified Swallow spp.	--	1	--	0.03	--	5
Small	Unidentified Warbler	3	--	0.0329	--	5	--
Medium	Virginia Rail	3	2	0.0318	0.02	5	3
Small	Warbling Vireo	2	3	0.0194	0.09	3	14
Medium	Western Meadowlark	3	76	0.0329	0.79	5	119
Small	Western Wood-Pewee	1	--	0.0101	--	1.5	--
Small	White-crowned Sparrow	--	2	--	0.06	--	9
Large	White-tailed Kite	3	--	0.023	--	3.5	--

		Unadjusted incidents		Adjusted Incidents (Corrected for Sc, Se, Ps)			
Size	**Species**	**HW incidents (2yrs, 90 turbines, 1.8MW)**	**SH incidents (3 yrs, 100 turbines, 1.5MW)[1]**	**HW est. # incidents/MW/yr**	**SH1 est. # incidents/MW/yr**	**HW estimate of mortality/yr**	**SH1 estimate of mortality/yr**
Small	White-throated Swift	2	2	0.0236	0.06	3.5	9
Small	Wilson's Warbler	1	7	0.0093	0.22	1.5	33
Small	Yellow Warbler ***	2	4	0.0194	0.13	3	19
Small	Yellow-breasted Chat*	--	1	--	0.03	--	5
	TOTAL	**163**	**379**	**1.36**	**6.96**	**419**	**1044.18**
Bat	Hoary Bat	62	64	1.0902	1.90	165.5	285
Bat	Mexican Free-tailed Bat	48	63	0.8249	1.87	128	281
Bat	Silver-haired Bat	2	3	0.0341	0.09	5.5	13
Bat	Western Red Bat	4	2	0.0694	0.06	10.5	9
	TOTAL*	**116**	**90**	**2.02**	**3.92**	**309.5**	**588**

1. Fifty turbines searched per round

Adjusted fatality rates and numbers of carcasses found were slightly greater at the Shiloh I project as compared to High Winds when examined on a yearly basis. After adjusting for scavenging and searcher efficiency, the estimated annual number of avian fatalities at Shiloh I were as follows for each of the three years:

- Year 1-11.97 bird incidents/MW (17.96 incidents/tower) and 5.24 bat incidents/MW (7.86 incidents/tower)
- Year 2- 8.6 bird incidents/MW (12.9 incidents/tower) and 5.75 bat incidents/MW (8.63 incidents/tower).
- Year 3-2.82 bird incidents/MW (4.23 incidents/tower) and 2.14 bat incidents/MW (3.21 incidents/tower).

These results show significant annual variation. However, efforts in Years 2 and 3 were calculated using a more robust number of search efficiency and scavenge rate tests. While we did not discount Year 1 results, we feel that results from subsequent years reflect a more thorough analysis and more plausible results.

When the three years are combined the estimated number of fatalities (averaged over 3 years) was 1,044 birds/year or 6.96 bird incidents/Mw/year (10.44 bird incidents/tower/year). 95% CI were ± 74 birds/year, ± 0.49 bird incidents/MW/year and 0.74 bird incidents/tower/year. Thus, (see table 35) the average bird fatality rate per year for Shiloh I is greater than the average bird fatality rate at the nearby High Winds WRA (1.36 bird incidents/Mw/year). Similarly, the average estimate of bat incidents per turbine at Shiloh I, 3.92 bat incidents/Mw/year is slightly greater than the average bat fatality rate at High Winds (2.02 bat incidents/Mw/year).

Subsequent paragraphs will examine differences between species groups and search practices at the two projects, in order to explain the differences in these numbers. However, an important fact to consider when comparing Shiloh I to other wind projects is the very wide year to year variation in Shiloh I fatality estimates. The three year average fatality rate at Shiloh I was heavily influenced by Year 1 search efficiency and scavenge rate testing, where carcass availability limited the number of tests. We believed that the Year 1 tests may have lead to an anomalously high fatality rate and made improvements to our search efficiency and scavenge rate testing in subsequent years. With a greater number of carcasses spread out over several test dates each year, we covered all seasons and all vegetative substrates at the Project. Finally, we made an improvement to our search efficiency model in the latter half of the project (detailed in Methods, Section 2.3), which more closely modeled real-world search conditions. Our Year 3 estimate, with the most robust search efficiency and scavenge rate testing, yielded 2.82 bird incidents/MW (4.23 incidents/tower) and 2.14 bat incidents/MW (3.21 incidents/tower). These results are almost identical to those of High Winds.

We continue to compare the averages across all three years at Shiloh I, in order not to ignore results when they show higher fatality rates. However, we stress to the reader that the 3-Year average is influenced higher by Year 1 efficiency and scavenge rate testing. It is very likely that differences between High Winds and Shiloh I fatality rates are smaller than the averages indicate.

When examining differences between species groups at the two projects, the situation becomes clearer. The number of raptors (consisting of large and medium sized birds) at Shiloh I (0.44 incidents/Mw/year) is only slightly greater than at High Winds (0.41 incidents/Mw/year). The major difference in fatality rates were contributed by the smaller carcasses (i.e. bats, mentioned previously, as well as small birds). Passerine bird incidents at Shiloh (5.82 incidents/Mw/year) were greater than at High Winds (0.71 incidents/Mw/year).

Finally, there was a substantial disparity in the size of the area searched between the Shiloh 1 and High Winds projects. The area searched per tower at Shiloh was nearly 2 times the amount searched per tower at High Winds and was not adjusted for. If we only count the number of carcasses found in search areas of comparable size, the rates between the two areas are not so different. Moreover, the Shiloh I fatality rates are within the ranges of fatality rates reported at other wind farms. The per year estimates of fatality rates for each of the three years, adjusted for search area are as follows:

- Year 1- 6.51 bird incidents/MW (9.76 incidents/tower) and 4.24 bat incidents/MW (6.35 incidents/tower)
- Year 2 - 4.82 bird incidents/MW (7.23 incidents/tower) and 3.03 bat incidents/MW (4.54 incidents/tower).
- Year 3 - 1.63 bird incidents/MW (2.45 incidents/tower) and 1.84 bat incidents/MW (2.75 incidents/tower).

These numbers are more comparable to High Winds estimates of both bird and bat fatalities per year.

The difference in numbers of carcasses found and adjusted fatality rates between Shiloh and High Winds can be attributed largely to a very few species (Table 38) that dominated the fatalities at these sites. Five common species (Table 38) accounted for 23.3% of the carcasses found at High Winds, but accounted for 47.5% of carcasses found at Shiloh. These birds are very common birds in North America, with continental populations being in the tens to hundreds of millions of individuals (Table 38). Some of these species are so common as to be considered agricultural pests in California or they are common enough for large numbers to be taken by hunters in California.

Slightly greater numbers of carcasses of other species, such as American Coot, American Pipit, Chukar, Great Horned Owl, Killdeer, Mallard, Ring-necked Pheasant, Tree Swallow, and Wilson's Warbler, were found at Shiloh as opposed to High Winds. None of these species are rare and the numbers killed at Shiloh are not large from an absolute perspective.

With respect to the remaining species found at Shiloh and High Winds, the numbers of carcasses found and fatality rates are not that different between sites. The differences in numbers of carcasses found between these sites for these species appear to mostly be a very few individuals of a given species. The differences tend to be less than 2-3 individuals for most species.

Overall, with the exception of the five species listed in Table 38, there do not appear to be significant differences in numbers of individuals found at Shiloh as opposed to High Winds, when considered on a species specific basis.

If the fatalities of the five species listed in Table 38 are not included in the overall estimates of fatalities per megawatt or per turbine per year, the rate at Shiloh would be about one-half what we report. These fatality rates are much closer to those found for High Winds. Thus, it is important when comparing these sites to consider species composition of fatalities in addition to the pooled species fatality rates.

Table 38: Summary of numbers of carcasses of the most commonly killed birds at the Shiloh and High Winds projects site during three and two years of study, respectively

Species	**Number of Carcasses - % of Total**		**North American Population**
	Shiloh	**High Winds**	
Western Meadowlark	76 – 20.1%	3 – 1.8%	32 million
Red-winged Blackbird	42 – 11.1%	14 – 10.4%	210 million
Mourning Dove	26 – 6.9%	2 – 1.2%	130 million
Horned Lark	21 – 5.5%	17 – 10.4%	140 million
Brewer's Blackbird	15 – 4.2%	2 – 1.2%	35 million
Total Carcasses Found	379	163	
Total	180 – 47.5%	38 – 23.3%	

Differences in search protocol may also explain some of the observance differences in fatalities per turbine and per MW. The search radius at each turbine in the High Winds project was 75 m from the base of the tower, compared to 105m at the Shiloh I project. Thus, the area searched per tower (34,636m^2) at Shiloh was nearly 2 times the amount searched per tower at High Winds (17,671m^2). Thirty-six percent (184 out of 505 incidents over 3 years, Table 11) of incidents at Shiloh were noted outside the 75m search area. Because some of these carcasses were found so far from turbines, they may not all be attributable to turbines. The current comparison does not account for this difference in total search area or any potential differences in fall patterns at the two sites. While the search interval and search efficiency rates differed between these two sites, these two factors were adjusted when estimating total fatality rates.

Overall, we believe that two factors explain the greater numbers of carcasses and higher fatality rate found at Shiloh as compared to High Winds. Most important is that fatalities of five, very common, species accounted for a disproportionately greater number of fatalities at Shiloh as compared to High Winds. Second, the larger search area at Shiloh may explain the greater numbers of carcasses found at Shiloh. These additional carcasses may or may not have been turbine fatalities. If the carcasses found outside 75m were discounted, the following are the estimates for the average annual fatality rate over the three years of the study: Birds/MW/year: 3.89, birds/tower/year: 5.84, bats/MW/year: 3.21, bats/tower/year: 4.81.

4.5.2 Shiloh I Comparison with Regional Averages

The estimated fatality rate, averaged over all three years of the study, for birds at Shiloh I (6.96 birds/MW/year), and for bats (3.92 bats/MW/year). These per megawatt rates **for birds** are slightly greater, but within the range reported from other post-construction wind project surveys in the U.S. Results presented by the National Research Council (NRC 2007) review described avian mortality studies with estimated incidents ranging from 0 to 11.67 birds/MW/year (Table 39). While most results from collision fatality studies tend to range between 0 and 3 bird incidents/MW/year, the results at Shiloh I are comparable to those at eastern and Midwestern studies such as Buffalo Mountain, TN (Nicholson 2001, 2002) and Buffalo Ridge, MN, Phase II (Johnson et al. 2002).

Table 39: Bird mortality reported at U.S. wind-energy projects (from NRC 2007 with additions)

					All Bird Mortality		
Wind Project	**Study Period**	**# Turbines**	**Turbine MW**	**Project MW**	**Turbine per period**	**MW per period**	**Reference**
Pacific Northwest							
Stateline, OR/WA[1]	July 2001 – Dec 2003	454	0.66	300	1.93	2.92	Erickson *et al*. 2004
Vansycle, OR[1]	Jan 1999 – Dec 1999	38	0.66	25	0.63	0.95	Erickson *et al*. 2004
Combine Hills, OR[1]	Not Available	41	1.00	41	2.56	2.56	Young *et al*. 2005
Klondike, OR[1]	Feb 2002 – Feb 2003	16	1.50	24	1.42	0.95	Johnson *et al*. 2003
Nine Canyon, WA[1]	Sep 2002 – August 2003	37	1.30	62	3.59	2.76	Erickson *et al*. 2003
Rocky Mountain							
Foote Creek Rim, WY, Phase I[2]	Nov 1998 – Dec 2000	72	0.60	43	1.50	2.50	Young *et al*. 2001

					All Bird Mortality		
Wind Project	**Study Period**	**# Turbines**	**Turbine MW**	**Project MW**	**Turbine per period**	**MW per period**	**Reference**
Foote Creek Rim, WY, Phase II[2]	June 2001 – June 2002	33	0.75	25	1.49	1.99	Young *et al*. 2003
Upper Midwest							
Wisconsin[3]	Late July 1999 –May 2001	31	0.66	20	1.30	1.97	Howe *et al*. 2002
Buffalo Ridge, MN, Phase I[3]	Apr 1994–Dec 1995; 15 Mar–15 Nov 1996–1999	73	0.30	33	0.98	3.27	Johnson *et al*. 2002
Buffalo Ridge, MN, Phase I[3]	15 Mar 1998 – 15 Nov 1999; 15 Jun 2001–15 Sep 2002	143	0.75	107	2.27	3.03	Johnson *et al*. 2002
Buffalo Ridge, MN, Phase II[3]	15 Mar 1999 – 15 Sep 1999; 15 Jun 2001 – 15 Sep 2002	139	0.75	104	4.45	5.93	Johnson *et al*. 2002
Top of Iowa[3]	15 Mar 2003 – 15 Dec 2004	89	0.90	80	1.29	1.44	Koford *et al*. 2005
East							
Buffalo Mountain, TN[4]	1 Sep 2000 – 30 Sep 2003	3	0.66	2	7.70	11.67	Nicholson 2001, 2002
Mountaineer, WV[4]	4 Apr 2003 – 22 Nov 2003	44	1.50	66	4.04	2.69	Kerns and Kerlinger 2004
Maple Ridge, NY[3,4]	30 Apr 2007 - 14 Nov 2007	195	1.65	322	3.87-4.61	2.34-2.80	Jain *et al*. 2007
California (West)							
Shiloh I, CA	April 10, 2006 – April 11, 2009	100	1.5	150	10.44	6.96	Jain *et al*. 2009 – This Study
High Winds, CA	August 4, 2003 - July 30, 2005	90	1.8	162	2.45	1.36	Kerlinger *et al.* 2006

1 Agricultural/grassland/Conservation Reserve Program (CRP) lands
2 Short-grass prairie 3 Agricultural 4 Forest
* Note: Where studies include more than one year, final estimates were reported on a per year basis.

However, additional insight is gained by examining Years 1, 2 and 3 at Shiloh I, separately. Search efficiency and scavenge rate testing were limited by non-availability of test carcasses in Year 1. Adjustments to raw data resulted in estimates of fatality that were very high for birds. We estimated 11.97 bird incidents/MW (17.96 incidents/tower) and 5.24 bat incidents/MW (7.86 incidents/tower) in Year 1. Taking these unusually high rates into consideration, we redoubled efforts in subsequent years to conduct more robust search efficiency and scavenge rate testing. We reviewed testing practices to ensure that more frequent testing occurred and that a greater total number of carcasses were used in the subsequent two years. Also, we reviewed testing protocols to ensure that carcasses were placed over a wide variety of substrates and vegetation heights to mimic conditions in the field. While these protocols were in effect in Year 1, distribution of all sizes of carcasses in all types of substrates and vegetation heights was difficult due to low test carcass numbers. Finally, in Year 3, we intensified the search within the 30 meter diameter radius around each tower by searching every 5 meters rather than every 10 meters. This step was taken in order to increase confidence in our findings and verify the large numbers seen in Year 1.

However, in Years 2 and 3, the increased search effort and search efficiency and scavenge rate testing resulted in lower year-end estimates. Year 2 (April 10, 2007 to April 9, 2008) rates showed 8.6 bird incidents/MW (12.9 incidents/tower) and 5.75 bat incidents/MW (8.63 incidents/tower). Finally, Year 3 (April 10, 2008 to April 11, 2009) estimates showed 2.82 bird incidents/MW (4.23 incidents/tower) and 2.14 bat incidents/MW (3.21 incidents/tower). These rates were more in line with national averages.

It is noteworthy that, as described above, nearly one-half of the carcasses of small birds found at Shiloh are from five, very common species. At no other site in the U.S. have these species, with the exception of Horned Lark, accounted for such a large proportion of fatalities. Without these birds, the average annual fatality rate at Shiloh would be about 3.5 birds/MW/year, which is well within the range of fatality rates across the U.S. and lower than some fatality rates in the eastern and Midwestern U.S. Thus, fatality rates of night migrants and other species, such as raptors, are similar rates reported from other parts of the U.S.

The range of bat mortality as reviewed at wind projects across the US, is much greater than that of birds, from 0.2 bats/MW/year to 53.3 bats/MW/year (Arnett et al. 2008). The fatality rates of bats at the Shiloh I project are at the low end of this range.

4.6 Biological Significance of Fatalities

The numbers of fatalities found at Shiloh I do not suggest biologically significant impacts to birds or bats. With respect to birds, it is important to remember that the numbers of fatalities, both estimated and actual carcasses found represent extremely small proportions of the North American and regional populations of these animals. Overall fatalities of the species of birds we found dead total only a very few birds during the three years of study at Shiloh, suggesting that the impact to these species' populations will not cause declines that could potentially threaten the populations of these species.

As noted above, fatalities were not distributed evenly among species killed at the Shiloh project. Although we included birds not protected by law in our overall fatality estimates, it is important to remember that these species (Rock Pigeons, European Starlings, and House Sparrows) accounted for 16 (4.2%) of the carcasses found during the three years of study. What was more striking was the fact that these five species (Table 38) accounted for nearly one-half (N = 180) of the 379 carcasses (47.5%) found during the three years of study. These species are extremely common throughout their enormous ranges, with populations of each in the multiple tens of millions of individuals. As mentioned earlier, these five species are often considered agricultural pests, or in the case of Mourning Doves, considered game birds by wildlife managers. Even with the greater numbers of fatalities of these five species, there is little likelihood that the impact would be biologically significant.

To provide perspective on the significance of the fatality rates for the species killed at Shiloh, we provide hunting harvest statistics. These statistics demonstrate that state and federal trust agencies allow the taking of large numbers of many game species. The magnitude of these takings sheds light on the likelihood that impacts to game and other species from the Shiloh turbines are biologically significant. The legal harvest of game birds in California provides interesting perspective regarding the significance of fatalities at the Shiloh I project, especially when the game species killed at Shiloh I turbines are compared to overall numbers shot by hunters. The numbers of carcasses of seven game birds that were found dead under the Shiloh I turbines are provided in Table 40. Note that for two waterfowl species alone, the annual harvest is between about 45,500 and 309,000 individuals shot annually by hunters in California as opposed to an average of two carcasses found annually at Shiloh I. It is also important to remember that for species such as Mallard and Mourning Dove, the margin of error for hunting statistics is immense in comparison to the numbers killed by wind turbines. The margin of error for Mallard, for example, is about 15%, which means that the harvest estimate may be 45,000 per year below the actual number shot. For Mourning Doves the annual margin of error amounts to more than 100,000 birds per year. Likewise, for other hunted species that were also killed by turbines, including American Coot and Moorhen, the margins of error amount to thousands of birds.

Table 40: Game Bird Carcasses found at Shiloh I Turbines and Annual Harvest Data

Species	Carcasses Found at Shiloh I	California Hunting Harvest (2006-7 Average)	California Bag Limit /Possession Limit
Mallard	5	309,000 ± 15%	7/day; 14 possession
Goose (Canada)	1	45,500 ± 25%	4-6/day; 8-12 possession
American Coot	10	18,350 ± 59%	3/day; 6 possession
Common Moorhen	1	2,000 ± 116%	3/day; 6 possession
Ring-necked Pheasant	8	N/A	2-3/day; 4-6 possession
Chukar	4	N/A	6/day; 12 possession
Mourning Dove	26	1.08 million ± 11%	10/day; 20 possession

Mourning Dove was one of the five most common species killed by turbines at Shiloh I, but it is also one of the most commonly harvested birds in California with more than 1 million shot per year. The margin of error for that harvest estimate is more than 100,000 birds, more than all birds killed at all wind turbines in the United States.

Note that the daily harvest limits of all game species listed in Table 39 are not that dissimilar from the total numbers of individuals recorded for most species that were killed by wind turbines. In other words, a single hunter in a single day or two is permitted by the state of California to shoot about the same number of individuals of a species as are killed by the 100 Shiloh turbines. And, there are tens of thousands of hunters in California. These harvest statistics strongly suggest that the small numbers of birds killed by turbines at Shiloh I are not likely to cause undue adverse or biologically significant impacts.

The fact that no endangered and, or threatened species were killed during three years of this study strongly suggests that the turbines at Shiloh I are not a significant risk to these species.

With respect to other bird species killed at Shiloh I, an examination of the North American populations, also suggests that the turbine impacts are not significant. For example, we estimate that 19 Black-throated Gray Warblers are killed each year at Shiloh I. This species has a North American population of about 2.9 million birds. Therefore, this harvest represents 0.0007% of the entire North American population and is not likely to cause a decline in the population of this species. Even if there were twenty other wind plants causing similar fatality numbers for this species, the impact would not be cumulatively significant. There are many other examples that are similar and for no species were the impacts at Shiloh I likely to be biologically significant.

4.7 Study Results and Conditions for Solano County Use Permit U-03-06 – Item 40

According to the Solano County Use Permit for the Shiloh I project, the following conditions must be met.

40. Mitigation Measure BIO-9: Post-construction Monitoring. The Permittee shall conduct post-construction avian and bat mortality monitoring, as follows:

a) Once the Project begins operation, the Permittee shall monitor the site to determine avian and bat mortality rates and the causes of mortality on the site itself for a period of three years. The monitoring shall be conducted by an independent biologist, and reports shall contain sufficient information (e.g. the location of dead birds relative to turbine location; the availability of raptor prey species) to allow evaluation of turbine design characteristics and location effects that contribute to mortality. This monitoring shall follow standardized guidelines outlined by the National Wind Coordinating Committee (Anderson et al. 1999).The Permittee shall prepare and provide reports from the monitoring to the County, USF&WS and CDFG, and shall also participate in the Solano County Technical Advisory Committee (TAC) for the term of the monitoring effort, and shall share the results of this research with the TAC.

b) After three years of post-construction monitoring data has been obtained, the County will review the permit and, in consultation with the California Department of Fish and Game and the USFWS, determine if any specific turbines should be relocated due to disproportionately high levels [e.g. more than at other turbines] of avian mortalities and no other mitigation measures are deemed appropriate. The County will determine whether turbines shall be relocated, based on consideration of the following factors:

i) Number of Annual Mortalities Per Turbine. Large comparative differences in the number of mortalities per turbine might indicate the need for relocation. In the absence of such large differences, however, this factor probably cannot be considered alone due to limited statistical basis upon which to estimate the number of avian mortalities at each turbine.

ii) Disproportionate Representation of a Particular Species. A large number of mortalities of a particular species must also be factored into the relocation decision due to enhanced concern for potential effects on that species population and further support for theories that something in that species' behavior, foraging strategy or flight mechanics make collision avoidance with that particular turbine configuration problematic.

iii) Comparison to other Windfarms in the Area. In light of the total body of knowledge accumulated about bird strikes on windfarms, an additional relocation factor is the number of mortalities at particular turbines or group of turbines which is substantially out of line in comparison with the experience of other windfarms in the Solano County Wind Resource Area.

In fulfillment of 40a, three years of monitoring for bird and bat fatalities have been completed at the Shiloh I wind power project site. The research was conducted in accordance with standardized guidelines. With three years of post-construction fatality searches completed, this study represents one of the most thorough studies conducted at a wind power facility in North America. The Solano County Technical Advisory Committee (TAC) was established and has reviewed the reports from years one and two and will review the final report. The protocols have equaled and in some instances exceeded standardized guidelines.

With respect to 40b, the review of the data by the county will take place in consultation with the California Department of Fish and Game and the Fish and Wildlife Service to determine whether turbines shall be relocated. There are three factors to be considered:

The first is the number of annual fatalities per turbine. We did not find disproportionately high levels of avian mortality at wind turbines generally, with perhaps the exception of fatalities of two very common species. In examining the number of incidents on an individual turbine and species-specific basis, a vast majority of fatalities at turbines for individual species were spread over many different turbines with most turbines that were involved killing only a single individual.

The second element of condition 40 (b) is the number of fatalities per species. During any given year, it was extremely rare to have two fatalities of a given species at a single turbine. Some exceptions include American Coot where two birds were killed at a single turbine in 2007 (turbine G7) and two at another turbine in 2008 (turbine H6). Similarly, three kestrels were killed at a single turbine with one being killed in 2007 (turbine A4) and two being killed at this turbine in 2006. Two Brewer's Blackbird were killed at turbine B16, but not in the same year. The fatalities were recorded at turbine B 16 in 2006 and 2008, but not in 2007. There are several other similar examples including Great Horned Owls and Mourning Dove (Appendix D). These fatalities do not represent large-scale fatalities or patterns of fatalities at specific locations. Instead, they are likely to be random events. Certainly, these instances of multiple fatalities involving a single species were too few to be considered significant impacts to any of the species involved.

For three species, slightly larger numbers of fatalities were logged at individual turbines. In the case of Ring-necked Pheasant, four fatalities were found at turbine E8, all in 2008, but no multiple fatalities were logged at this or other turbines in 2006 or 2007. With respect to Western Meadowlark, the 76 carcass finds involved several multiple fatalities at individual turbines (Appendix D). For this species, there were about 10 turbines for which multiple fatalities were identified. Six of these involved two birds and most of these involved individual birds killed at a turbine in a single year. There was one turbine that incurred three fatalities and three that accounted for four fatalities. Again, these multiple fatalities were spread over the three years of the study, such that during a given year only single, or in some cases two birds were killed at one of these turbines.

Of the 42 Red-winged Blackbird carcasses located, nine were found at turbine C5R. These birds were all found during January 2007. No carcasses of these species were found in 2006 or 2008 at this turbine. Four other turbines were involved in two fatalities each (turbine A19, C18, B18, and B7R; Appendix D). Because no fatalities were found at C5R in two of the three years, it appears to be a random event. As was stated in a previous section of this report, this species, as well as Western Meadowlark and the other species for which we identified multiple fatalities at a single turbine, are extremely common. The numbers of these species involved are likely to be in consonance with their numbers observed on the site and their general population numbers.

Even with these numbers of multiple fatalities at individual turbines, the impacts to these three species are highly unlikely to be biologically significant. In addition, we did not identify any characteristics of these turbines that could have led to multiple fatality events.

Finally, clause 40b iii regards comparison with other wind projects in the area. This clause was discussed earlier in the report (Sections 4.5.1 and 4.5.2) and is summarized here. Higher numbers at Shiloh I were found compared to High Winds, an adjacent wind project. However, these differences can be explained by a variety of factors:

- Approximately two times area was searched at Shiloh I turbines compared to High Winds turbines.
- First Year estimates at Shiloh I were limited due to lack of availability of *Se/Sc* test carcasses, probably causing an estimate that was higher than the reality. This led to a higher average per-year estimate.
- Third Year estimates contained the most robust *Se/Sc* testing effort, as well as an improvement to the *Se* calculation model (Methods Section 2.3) resulting in a low estimation of fatality rates that did not differ greatly from High Winds or national averages.

On the basis of the data cited above, we conclude, that in no case does mitigation, in the form of moving turbines as suggested in the County conditions, seem warranted. No species were killed in numbers actually found or projected to possibly be found to constitute even a remote concern for potential effects on that species population. Neither is there any statistical evidence in any of the cases of multiple fatalities of a single species at a specific turbine to suggest support for theories that something in that species' behavior, foraging strategy or flight mechanics make collision avoidance with that particular turbine configuration problematic.

On a turbine by turbine basis and on a species specific basis we did not find any statistically valid data to conclude that the number of mortalities at particular turbines or group of turbines was substantially out of line in comparison with the experience of other wind farms in the Solano County Wind Resource Area.

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