Pacific Wind Energy Project

Year 1 Avian and Bat Fatality Monitoring Report

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EDF Renewable Energy (EDF-RE) constructed the 140-megawatt (MW) Pacific Wind Energy Project (project), located in south-central Kern County, California in 2012. Avian and bat fatality monitoring was conducted within the project boundary during the first year of operation, beginning in October 2012. The surveys summarized here constitute the first year of the postconstruction monitoring for Years 1, 3, and 5, as required pursuant to the mitigation measures included in the project's Environmental Impact Report (EIR).[1] Methods used to conduct the avian and bat fatality monitoring were adapted from California Energy Commission (CEC) and California Department of Fish and Wildlife (CDFW) Guidelines.[2]

From October 1, 2012 to September 20, 2013, a total of 17 avian fatalities (14 identified during scheduled carcass searches and three recorded incidentally within the project boundary) representing 12 distinct species in addition to two unknown species (feather spots) were documented. Additionally, two bat fatalities (one identified during scheduled carcass searches and one identified incidentally within the project boundary) were documented. The Schoenfeld Fatality Estimator[3] was used to develop the fatality estimates of birds and bats at the project site. The U.S. Geological Survey (USGS) Fatality Estimator[4] was also used to generate fatality estimates, and the results from this estimator are provided for comparative purposes.

The estimated project-wide fatality rate, using the Schoenfeld Fatality Estimator was 2.6 birds per megawatt (MW) per year for all birds including raptors, 4.28 birds/MW per year for non-raptor birds, and 0.15 bird/MW per year for all raptors. The estimated project-wide bat fatality rate was 0.14 bat/MW per year. These estimated levels of fatality are slightly high for non-raptors, but are in many cases much lower for bats and raptors than those documented at other wind energy facilities of comparable size and habitat in the western United States. No bird or bat species listed as threatened, endangered, or candidate under the federal Endangered Species Act (ESA) were identified as fatalities in the first year of postconstruction surveys. In addition, no bald or golden eagle fatalities were identified in the first year. Based on the results of the initial year of this bird and bat fatality monitoring study, it is unlikely that project operations are having any measurable impact on bird or bat populations in the project boundary or regional vicinity. A second year of postconstruction fatality monitoring will take place during the third year of operations (beginning in October 2014). Results of this work will provide additional data upon which any patterns and/or the extent of avian or bat fatality at the project can be evaluated.

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[1] Kern County. October 2010. *Pacific Wind Energy Project Final Environmental Impact Report*. SCH 2009091127. Prepared by: Kern County Planning Department, Bakersfield, CA.

[2] California Energy Commission, and California Department of Fish and Game. 2007. *California Guidelines for Reducing Impacts to Birds and Bats from Wind Energy Development*. Commission Final Report. CEC-700-2007-008-CMF. Sacramento, CA: California Energy Commission, Renewables Committee, and Energy Facilities Siting Division; and California Department of Fish and Game, Resources Management and Policy Division.

[3] Schoenfeld, P.S. 2004. Suggestions Regarding Avian Mortality Extrapolation. Unpublished report to West Virginia Highlands Conservancy, Davis, WV.

[4] Huso, M., N. Som, and L. Ladd. 2012. *Fatality Estimator User's Guide*. U.S. Geological Survey Data Series 729. Reston, VA: U.S. Geological Survey.

EDF Renewable Energy (EDF-RE) constructed the 140-MW Pacific Wind Energy Project (project), located in south-central Kern County, California in 2012 (Figure 1, *Project Location Map*). The project consists of 70 2-MW wind turbine generators (WTGs) with a maximum rotor tip height of 124.7 meters and is composed of turbine strings A, B, C, and D (Figure 2, *As Built Project and Plant Community Map*). EDF-RE retained Sapphos Environmental, Inc. to conduct the first year of post-construction bird and bat fatality surveys on the project site, pursuant to the mitigation measure developed in the approved EIR.[5] The purpose of the avian and bat fatality study is to document fatalities associated with wind turbines at the project site. As specified in Mitigation Measure (MM) 4.4-17 of the project EIR, postconstruction fatality monitoring will be conducted in "years 1, 3, and 5 following the initial operation of the project to demonstrate the level of incidental injury and fatalities to populations of avian or bat species in the vicinity of the project site."[6,7] The study is being conducted in accordance with voluntary guidelines set forth in the CEC Guidelines,[8] as well as the U.S. Fish and Wildlife Service (USFWS) Land-Based Wind Energy Guidelines.[9]

1.1 Study Area

The project property consists of approximately 9,576 acres located south of the southern foothills of the Tehachapi Mountains, in the western portion of the Mojave Desert, in the south-central portion of Kern County, California (Figure 1). The project is located in unincorporated portions of Kern County and is approximately 9 miles from the ridgeline of the Tehachapi Mountains to the northwest. The project is approximately 15 miles south of the city of Tehachapi, 43 miles southeast of the city of Bakersfield, and 29 miles north of the city of Santa Clarita. State Route (SR) 58 (Blue State Memorial Highway) is located approximately 13.5 miles to the north of the project property, SR 14 (Antelope Valley Freeway) is approximately 15 miles to the east, SR 138 (West Avenue D) is approximately 5 miles to the south, and Interstate 5 (Golden State Freeway) is approximately 22 miles to the west. The project property is located primarily within the USGS 7.5-minutes series, Tylerhorse Canyon, topographic quadrangle (Township 9 North, Range 15 West, Sections 1–5, 8–17, and 22–24 and Township 10 North, Range 15 West, Sections 25 and 36),[10] with elements of the project property occurring on USGS 7.5-minute series, Fairmont Butte, Neenach School, and

[5] Kern County. October 2010. *Pacific Wind Energy Project Final Environmental Impact Report*. SCH 2009091127. Prepared by: Kern County Planning Department, Bakersfield, CA.

[6] Kern County. June 2010. *Pacific Wind Energy Project Draft Environmental Impact Report*. Prepared by: Kern County Planning Department, Bakersfield, CA, with technical assistance by Aspen Environmental Group, Agoura Hills, CA.

[7] Kern County. October 2010. *Pacific Wind Energy Project Final Environmental Impact Report*. SCH 2009091127. Prepared by: Kern County Planning Department, Bakersfield, CA.

[8] California Energy Commission, and California Department of Fish and Game. 2007. *California Guidelines for Reducing Impacts to Birds and Bats from Wind Energy Development*. Commission Final Report. CEC-700-2007-008-CMF. Sacramento, CA: California Energy Commission, Renewables Committee, and Energy Facilities Siting Division; and California Department of Fish and Game, Resources Management and Policy Division.

[9] U.S. Fish and Wildlife Service. 2012. *U.S. Fish and Wildlife Service Land-Based Wind Energy Guidelines*. Arlington, VA.

[10] U.S. Geological Survey. [1965] Revised 1995. *7.5-Minute Series, Tylerhorse Canyon, CA, Topographic Quadrangle*. Reston, VA.

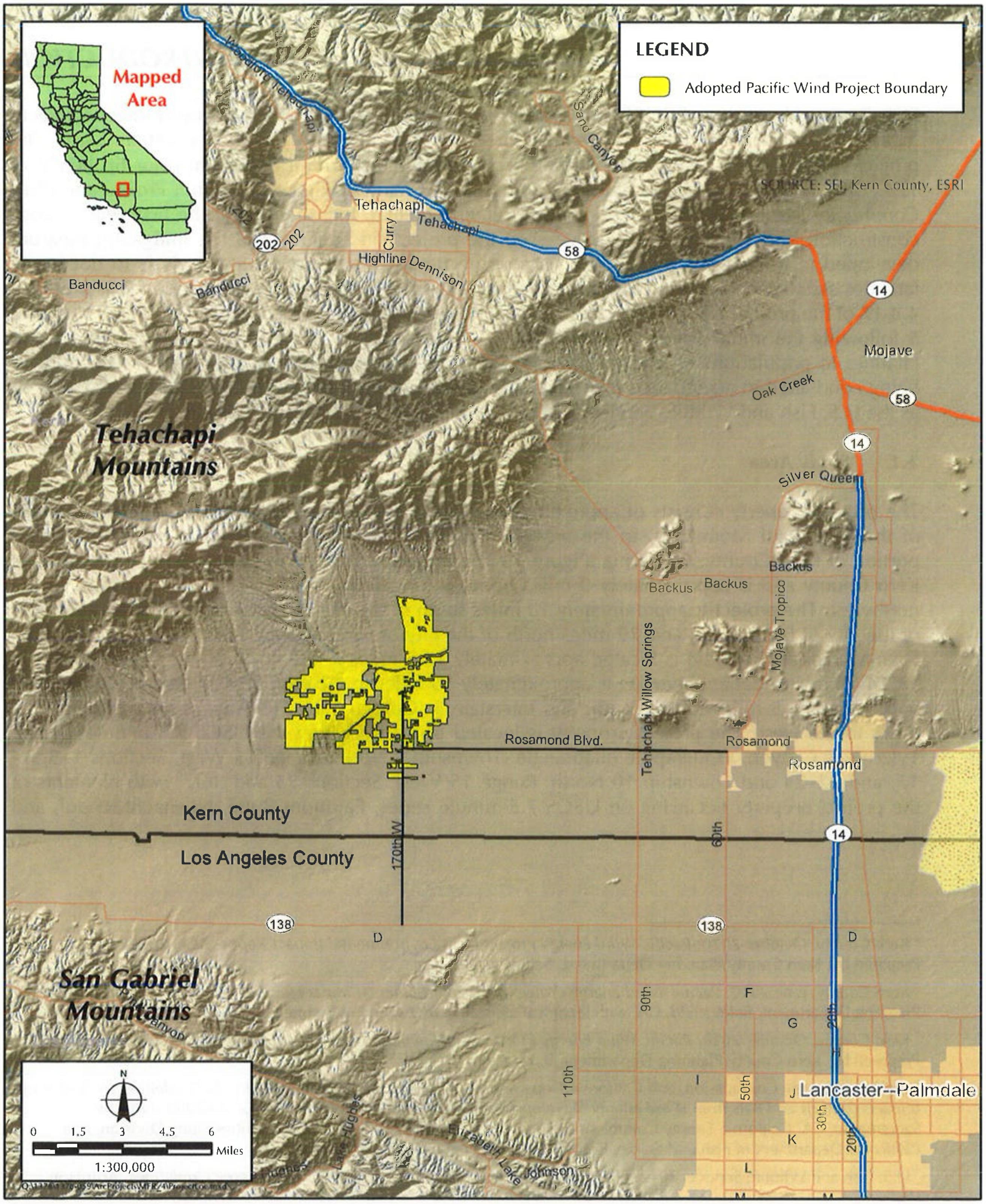

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FIGURE 1

Project Location Map

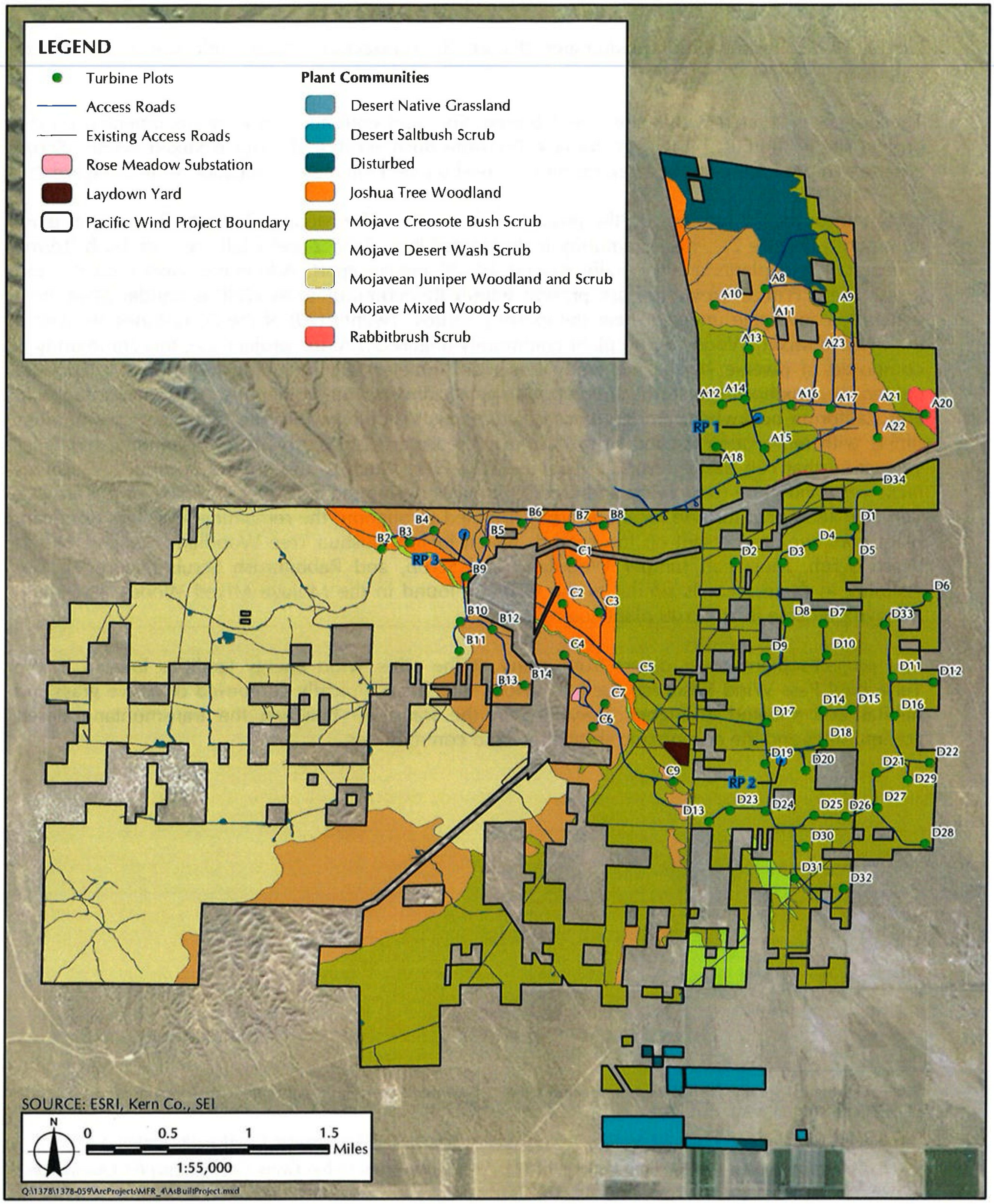

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FIGURE 2
As Built Project and Plant Community Map

Liebre Twins, topographic quadrangles (Figure 3, *Topographic Map with USGS 7.5-Minute Quadrangle Index*).[11,12,13]

The project is located within the desert biome. Six plant communities were documented on the project site in the EIR;[14] however, Mojave Creosote Bush Scrub and Mojave Mixed Woody Scrub are the two predominant plant communities, based on the Holland classification system (Figure 2).

Forty (40) of the 70 turbines on the project site are within the Mojave Creosote Bush Scrub plant community (Figure 2). This community is dominated by 1.5- to 2-meter-tall creosote bush (*Larrea tridentata*), and plants are generally spaced 10–20 meters apart. Additional shorter shrubs and Joshua trees (*Yucca brevifolia*) are present within this community as well as annual plants that generally congregate under or near the existing shrubs. Twenty (20) of the 70 turbines are within the Mojave Mixed Woody Scrub plant community (Figure 2). At the project site, this community is composed of diverse shrubs, generally less than 1 meter tall, including Mormon tea (*Ephedra califonica*), boxthorn species (*Lycium copperi* and *L. andersonii*), goldenbush (*Ericameria cooperi*), and California buckwheat (*Eriogonum fasciculatum*). Visibility within the two plant communities differ, with more open ground in the Mojave Creosote Bush Scrub plant community, but taller vegetation that can easily obstruct visibility. However, much of the ground around the turbines lacks vegetation due to mowing and grading impacts during the construction phase of the project. Ten (10) additional turbine locations are distributed throughout the remaining four, less dominant plant communities present on the project, which include Joshua Tree Woodland, Mojave Desert Wash Scrub, Mojavean Juniper Woodland and Scrub, and Rabbitbrush Scrub (Figure 2). The visibility in these areas is similar to the visibility found in the Mojave Mixed Woody Scrub and Mojave Creosote Bush Scrub plant communities.

The project's plant cover differs from many of the other wind energy facilities located in the Tehachapi Pass Wind Resource Area (TPWRA), which are typically composed of native grassland habitat and situated at higher elevations in the transition between the transmontane desert communities and the cismontane shrub/grassland communities.

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[11] U.S. Geological Survey. [1965] Photo Inspected 1974. *7.5-Minute Series, Fairmont Butte, CA, Topographic Quadrangle*. Reston, VA.

[12] U.S. Geological Survey. 1995. *7.5-Minute Series, Neenach School, CA, Topographic Quadrangle*. Reston, VA.

[13] U.S. Geological Survey. [1965] Photo Inspected 1973. *7.5-Minute Series, Liebre Twins, CA, Topographic Quadrangle*. Reston, VA.

[14] Kern County. October 2010. *Pacific Wind Energy Project Final Environmental Impact Report*. SCH 2009091127. Prepared by: Kern County Planning Department, Bakersfield, CA.

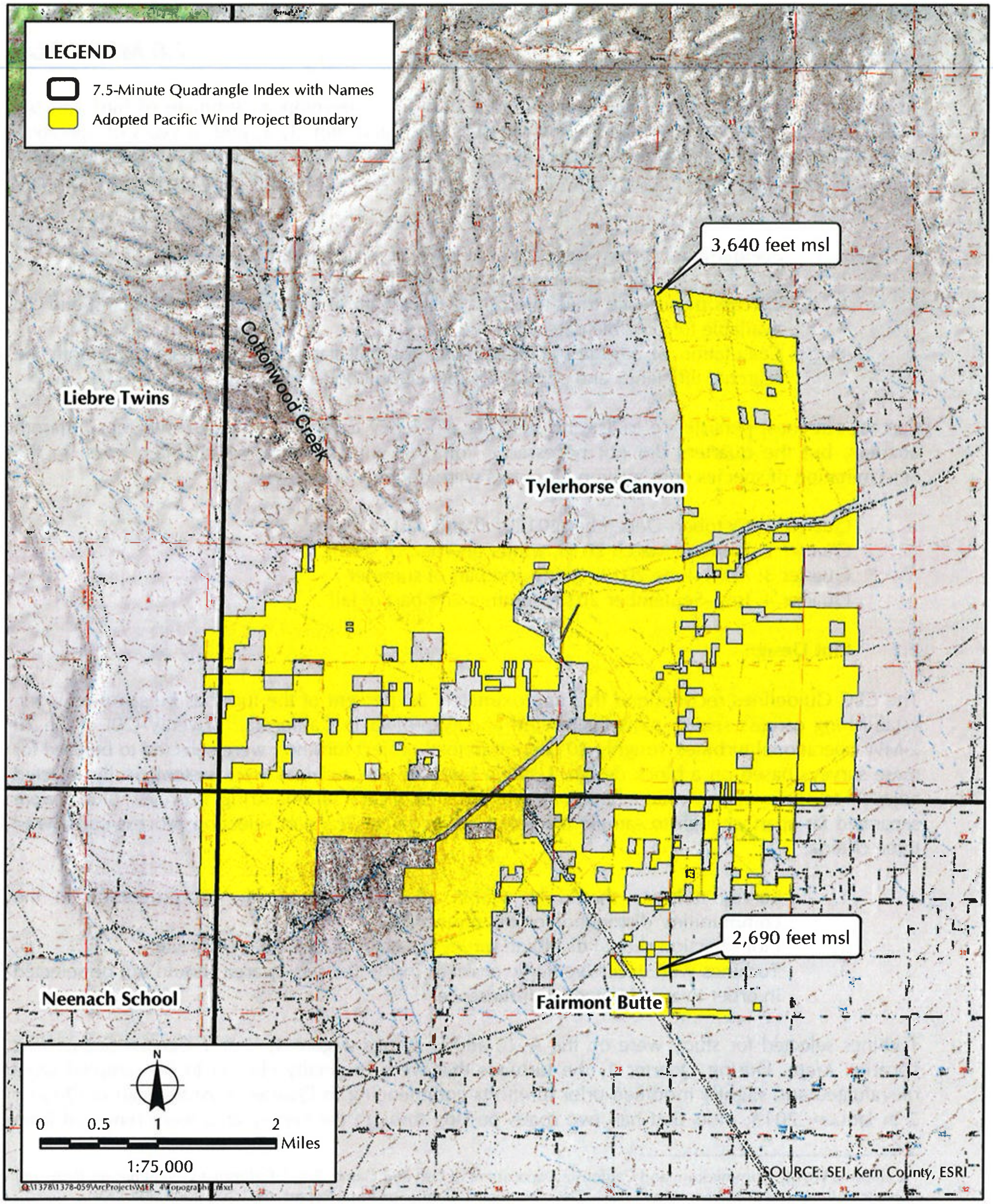

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FIGURE 3

Topographic Map with USGS
7.5-Minute Quadrangle Index

The primary objective of the fatality monitoring study is to develop an estimate of bird and bat fatalities attributable to the project during the first, third, and fifth (1, 3, and 5) years of operation while following the most current standard design, survey, and analysis practices to ensure the highest degree of accuracy and comparability to other studies. The study consisted of four (4) primary elements:

1) Standardized carcass searches of a subset of project turbines;
2) Searcher efficiency trials to assess observer efficiency in finding carcasses;
3) Carcass persistence trials to estimate the length of time that carcasses persist and are available for possible detection; and
4) Calculation of adjusted annual fatality estimates for birds and bats using both the searcher efficiency and persistence rate correction factors.

Carcass searches, persistence trials, and searcher efficiency trials were divided into four 3-month quarters, but the quarters did not necessarily coincide with seasons, which often assist in the determination of species composition. Quarters were defined as follows:

Quarter 1: October–December 2012, fall and part of winter
Quarter 2: January–March 2013, winter and part of spring
Quarter 3: April–June 2013, spring and part of summer
Quarter 4: July–September 2013, summer and part of fall

2.1 Plot Design

The CEC Guidelines recommend that approximately 30 percent of the turbines be sampled when establishing carcass search plots for a wind energy project in California.[15] Twenty (20) of the 70 2-MW operational turbines, roughly 30 percent of total project turbines, were selected to be used for these surveys based on a block design. Using a block design, turbines were systematically selected adjacent to one another within a randomly selected area of each turbine string; however, blocks were separated far apart enough to sample the entire project area. The plot selection process considered three criteria:

1. Survey turbines should be within all plant communities in proportion to the communities' distribution on the project site.
2. Plot selection should distribute surveys spatially across the project site.
3. Turbines with excessive traffic or roads inside the survey area should not be selected in order to avoid potential disturbance.

Turbines selected for study were on the A, B, and D strings (Figure 4, *Year 1 Carcass Search Plot Location Map*). During Quarter 1, the turbines that were originally chosen to be sampled were reevaluated and slightly modified prior to efforts commencing in Quarter 2. At the start of Quarter 2 in January 2013, plots that had two roads passing through the survey area were removed from

[15] California Energy Commission, and California Department of Fish and Game. 2007. *California Guidelines for Reducing Impacts to Birds and Bats from Wind Energy Development*. Commission Final Report. CEC-700-2007-008-CMF. Sacramento, CA: California Energy Commission, Renewables Committee, and Energy Facilities Siting Division; and California Department of Fish and Game, Resources Management and Policy Division.

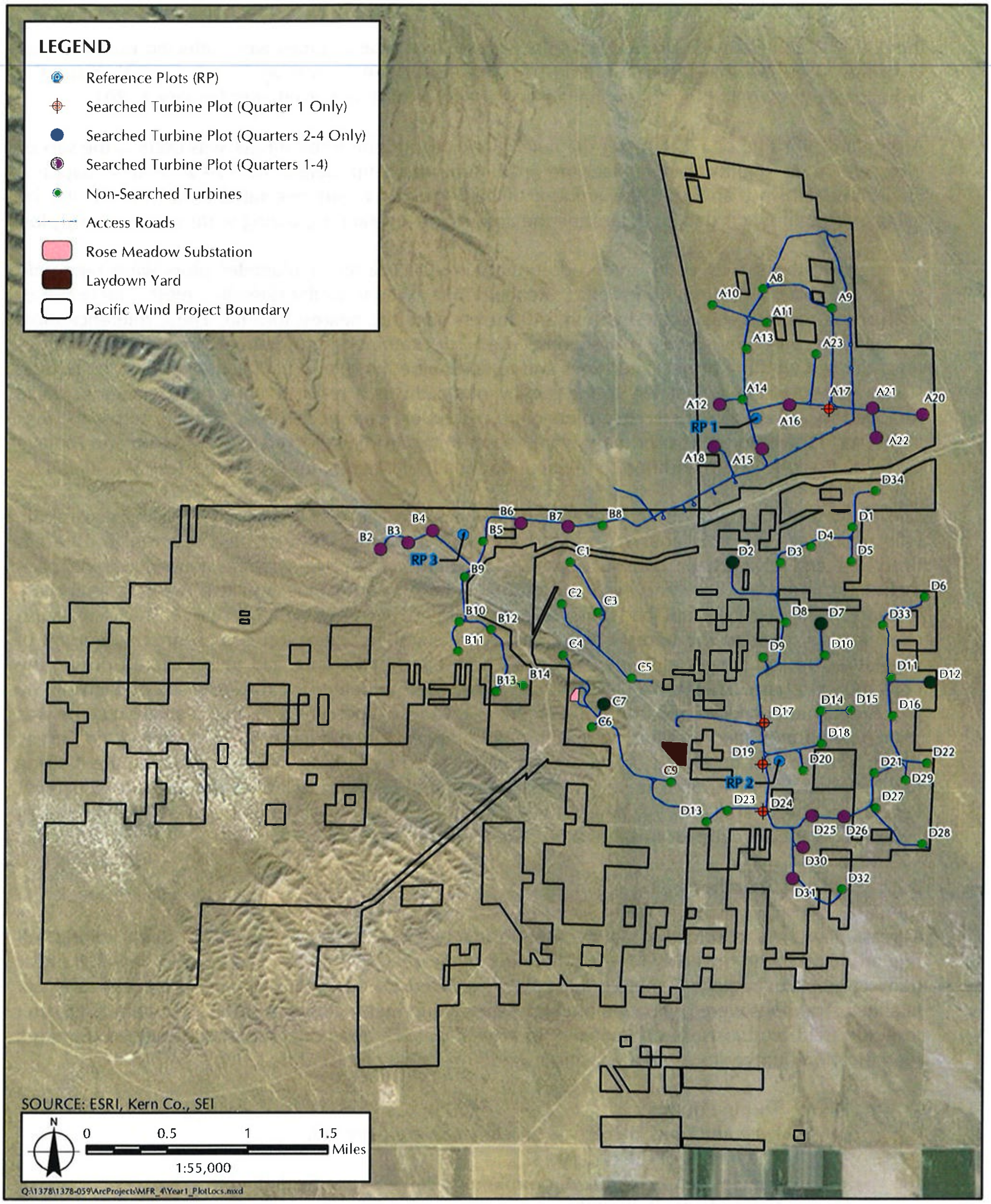

FIGURE 4
Year 1 Carcass Search Plot Location Map

the A ($n=1$) and D ($n=3$) strings. To replace these, four total turbines were selected on the C and D strings to ensure that the distribution of surveyed turbines was more evenly spread across the project area (Figure 4). No further changes to the survey plots occurred after January 1, 2013.

A standard plot size of a 126-meter diameter circle around the turbine base was used as the survey plot, which is slightly larger than the maximum rotor tip height of 124.7 meters. Sapphos Environmental, Inc. analyzed the amount of bare ground versus vegetated area in each plot by using existing impacts data to determine the amount of vegetation growing within each survey plot.

To augment the survey plots, three additional circular 126-meter diameter plots were randomly selected without a turbine in the center, henceforth referred to as the reference plots. The center of each reference plot was located within 250 meters from the nearest turbine. These reference plots served two purposes. These plots were used to examine the potential for natural fatalities unassociated with the project's turbines and to determine if bird and bat fatalities caused by turbine strikes were detectable outside of the survey plot radii as a result of thrown carcasses or those removed by scavengers. Reference plots were placed on each of the three primary turbine strings (A, B, and D) within the two primary plant communities (Mojave Mixed Woody Scrub and Mojave Creosote Bush Scrub) in addition to the next dominant plant community, Joshua Tree Woodland.

The amount of bare ground and vegetation on the survey plots was determined using geographic information system (GIS) analysis prior to the start of surveys. Bare ground referred to all areas disturbed and cleared for construction (i.e., temporary impacts), whereas fenced turbine pads included the turbine base and electrical equipment (i.e., permanent impacts). Areas of temporary impacts were reseeded but had not yet demonstrated any regrowth in Year 1. The vegetation classification refers to the undisturbed areas where standing vegetation is present. The amount of vegetation on the survey plots depended on how large of an area had to be altered during the construction phase. The above classifications were used to determine the substrate of each survey plot. Vegetation cover varied from 2.9 percent (A17) to 44.6 percent (C7), but vegetation cover was 16.1 percent at all survey plots, with reference plots excluded (Figure 5, *Substrate within Survey Plots*). The amount of vegetation present on plots varied by turbine string. Plots along the A-string had between 2- and 12-percent vegetation cover, B- and C-strings had between 34- and 45-percent vegetation cover, and D-string had between 4- and 38-percent vegetation cover; the amount of vegetation varied greatly for turbines along the D-string.

2.2 Carcass Searches

Carcass searchers conducted fatality monitoring twice a week for the first month during fall migration, and then biweekly for the remainder of the year. Within each survey plot, parallel linear transects, approximately 6 meters apart, were walked by surveyors to search for bird and bat fatalities. Transects were preloaded onto an Ashtech sub-meter global positioning system (GPS) unit to guide field biologists. If any avian or bat remains were observed, surveyors assigned a unique identification number to each observation. Additional data collected included:

1) Turbine number.
2) Date and time the carcass or feathers were detected.
3) The names of the observers.
4) Species name, if known, or unknown carcass specification.
5) Sex and age, if possible.

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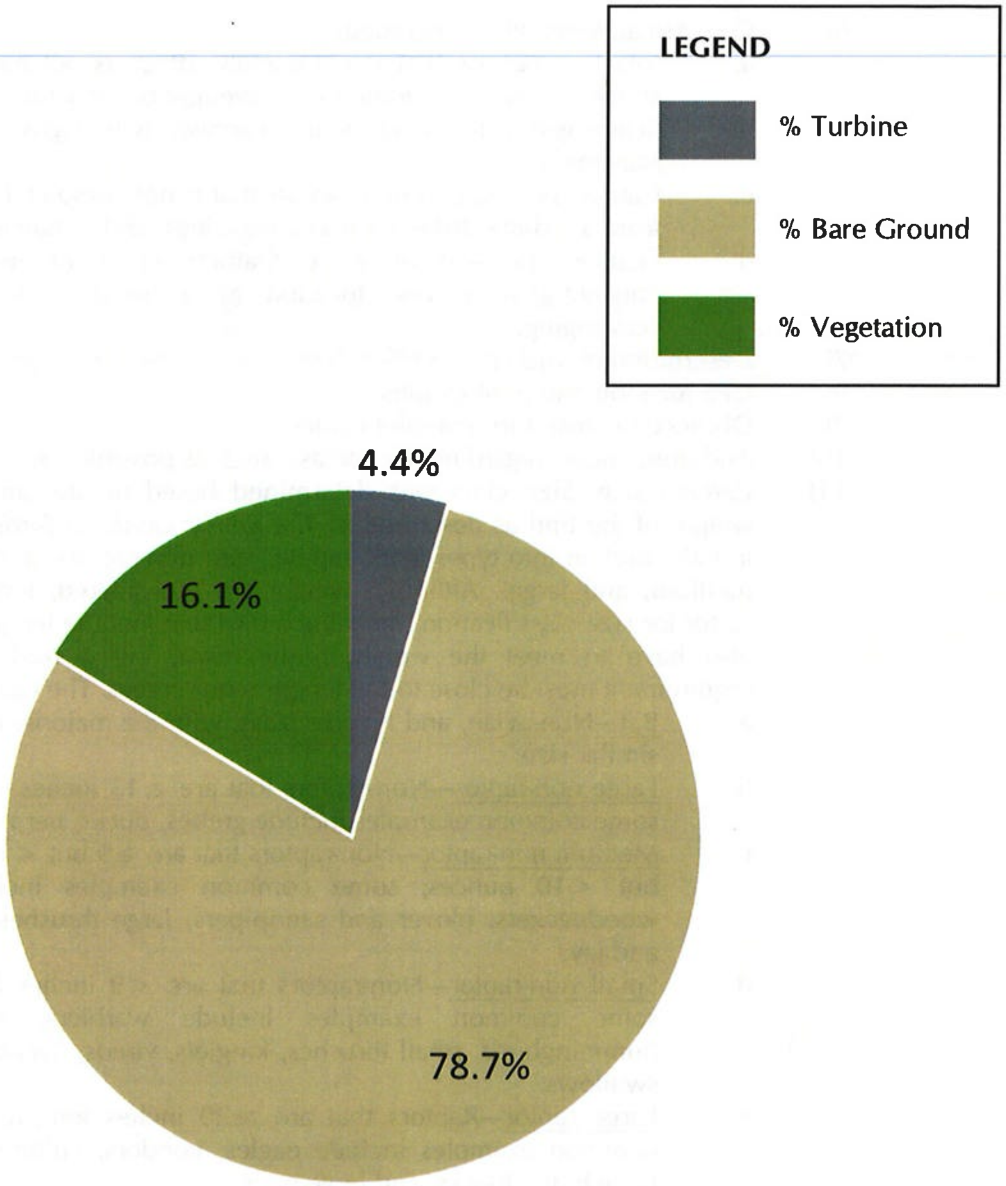

FIGURE 5
Substrate within Survey Plots

6) Carcass category, which included:
   a. Intact—a carcass that is completely intact, is not badly decomposed, and shows no sign of alteration by scavenger or predator.
   b. Scavenged carcass—an entire carcass, with signs of predator marks or scavenging.
   c. Carcass part—a part of a carcass that is not completely intact likely resulting from a turbine strike, such as wings, legs, and/or halved torsos.
   d. Feather spot—10 or more feathers or 3 or more primary feathers concentrated in one location as a result of extended predation or scavenging.
7) Description of injury.
8) GPS location and photographs.
9) Distance to closest turbine/plot center.
10) Additional notes regarding the carcass, such as possible cause of death.
11) Carcass size. Size class was determined based on the approximate length and weight of the find as described in *The Sibley Guide to Birds*.[16] Observations were initially broken into types (bats, raptors, and non-raptors) and then into size (small, medium, and large). Although weight was considered, length was the deciding factor for size classification, meaning a bird that met the length requirement did not also have to meet the weight requirement, but a bird that met the weight requirement must be close to the length requirement. The categories are as follows:
   a. <u>Bat</u>—Non-avian, and no size class, with the majority of bat species being of similar size.
   b. <u>Large non-raptor</u>—Non-raptors that are ≥13 inches long and ≥10 ounces; some common examples include grebes, ducks, herons, ravens, and crows.
   c. <u>Medium non-raptor</u>—Non-raptors that are ≥9 but <13 inches long and ≥6 but <10 ounces; some common examples include doves, pigeons, woodpeckers, plover and sandpipers, large thrushes, meadowlarks, quail, and jays.
   d. <u>Small non-raptor</u>—Non-raptors that are <9 inches long and <6 ounces; some common examples include warblers, sparrows, blackbirds, hummingbirds, small thrushes, kinglets, vireos, flycatchers, nuthatches, and swallows.
   e. <u>Large raptor</u>—Raptors that are ≥20 inches long and ≥2 pounds; some common examples include eagles, condors, vultures, ospreys, goshawks, large buteo hawks, and large owls.
   f. <u>Medium raptors</u>—Raptors that are ≥12 but <20 inches long and ≥1 but less than <2 pounds; some common examples include large falcons, harriers, kites, small buteo hawks, owls (*Tyto* and *Asio* sp.), and Cooper's hawk.
   g. <u>Small raptor</u>—Raptors that are <12 inches long and <1 pound; some common examples include small falcons, sharp-shinned hawk, and owls (*Otus*, *Athene*, and *Glaucidium*).

[16] Sibley, D.A. 2000. *The Sibley Guide to Birds*. Washington, DC: National Audubon Society; New York, NY: Alfred A. Knopf.

The condition of each fatality was examined for signs of scavenging upon discovery, as described above. There are many avian and mammalian species that are capable of and are likely to prey on or scavenge bird and bat carcasses from beneath turbines in the project vicinity. The primary scavengers that have the highest potential to consume and/or remove carcasses from the search area of each turbine pad include desert kit fox (*Vulpes macrotis*), coyote (*Canis latrans*), common raven (*Corvus corax*), and turkey vulture (*Cathartes aura*).

2.3 Searcher Efficiency Trials

Estimates of bird and bat fatalities on wind projects are biased by the detection rate of the searchers; therefore, searcher efficiency trials were conducted on the project to quantify the percentage of known carcasses that were able to be found by searchers, so that this detection rate bias could be later corrected in the fatality estimates. Sapphos Environmental, Inc. periodically conducted searcher efficiency trials concurrent with regularly scheduled carcass searches during the first year of fatality monitoring. Although searcher efficiency did not occur within each quarter, the trials were conducted in various seasons to ensure that seasonal changes in shrub foliage, ground cover of annual plants, and cloud cover were accounted for. Seasonal changes in plants and weather inevitably effect searcher visibility and detectability. Generally, annual plant cover at the project site is only present from February through April/May and leaves of shrubs from between February and June, with the duration and abundance of vegetative matter dependent on precipitation.

During Year 1, a total of 35 carcasses were placed for searcher efficiency trials on 10 days, (approximately 3 trials per quarter). Sapphos Environmental, Inc. conducted searcher efficiency trials by randomly placing carcasses, carcass pieces, or feather spots of various sizes under randomly selected turbines. Carcass placement was assigned through a random number generator that determined distance and direction a carcass would be placed from the selected turbine. Searcher efficiency trials tested field biologists who regularly conducted carcass searches. To eliminate searcher bias, searchers were unaware if carcasses were part of the searcher efficiency trails, and therefore were to assume all carcasses encountered were potential turbine-related fatalities.

Ducks and brown-headed cowbirds (*Molothrus ater*) were most often used to simulate large and small birds, respectively, for searcher efficiency. Brown-headed cowbirds were also used as a surrogate for bats for searcher efficiency because of the paucity of bat carcasses and because the feather color of cowbirds is similar to bat skin and fur color. By using these readily available species, the results are comparable to other fatality studies that used common surrogates, such as chickens, chicks, pigeons, cowbirds, ducks, exotic quail, starlings, and house sparrows in searcher efficiency trials.[17,18,19,20]

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[17] BioResource Consultants, Inc. 14 October 2010. *2009/2010 Annual Report Bird and Bat Mortality Monitoring, Pine Tree Wind Farm, Kern County, CA*. Prepared for: Los Angeles Department of Water and Power. Ojai, CA.

[18] Western EcoSystems Technology, Inc. 2009. *Final Report: Fatality Study Summary at the Alite and Oak Creek Systems Wind Facilities, Alta–Oak Creek Wind Resource Area, Kern County, CA*. Prepared for: Alta Windpower Development, LLC and CH2M Hill, Cheyenne, WY.

[19] Insignia Environmental. 4 September 2009. *2008/2009 Annual Report for the Buena Vista Avian and Bat Monitoring Project*. Prepared for: Contra Costa County, CA. Palo Alto, CA.

[20] Brown, K., K.S. Smallwood, and B. Karas. 2013. *Final: 2012–2013 Annual Report Avian and Bat Monitoring Project Vasco Winds, LLC*. Prepared for: NextEra Energy Resources. Portland, OR.

Between three and five carcasses were placed for searchers to detect on a given day, and no more than two carcasses were placed per survey plot. Given that turbine-related bird fatalities do not reliably result in whole carcass remains, Sapphos Environmental, Inc. used wings, carcasses without wings, and feather spots for some of the trials to mimic what observers may actually find naturally. Carcasses were placed in the morning, prior to searchers arriving on site, and then checked again at the end of each survey day. If a carcass was missing and was not detected by the searcher, then the carcass was assumed to have been removed by a scavenger prior to the searchers arriving on the survey plot; therefore, these carcasses were used for persistence data but excluded from searcher efficiency analysis.

2.4 Carcass Persistence Trials

The objective of the carcass persistence trials was to determine the average length of time that carcasses persisted on search plots before they were removed by scavengers and thus to determine the proportion of carcasses that would be expected to remain between the scheduled search intervals. This proportion was then used to adjust for the carcass removal bias when estimating the total annual number of fatalities that occurred on the project.

Sapphos Environmental, Inc. conducted carcass persistence trials throughout three quarters, in conjunction with searcher efficiency trials, in order to assess changes in scavenger behavior across seasons. Initially in Quarter 2, carcasses of various sizes were placed in proximity to turbines and in vegetation at the edges of disturbed areas to test if locational placement and carcass size affected persistence. Also in Quarter 2, remote cameras were placed within 5 meters of each carcass to help determine the type of scavengers removing carcasses. In Quarters 3 and 4, the use of cameras was discontinued, and a random number table was used to determine the distances and directions that carcasses were to be placed from the selected turbine. All carcasses were placed within 70 meters of the turbines.

Overall, 36 carcasses were placed on 12 days for persistence trials. Carcasses were composed of nine species belonging to three different size categories: bat, non-raptor, and raptor (Table 1, *Carcasses Used during Persistence Trials, Year 1*). Carcasses used for persistence were predominantly frozen ducks and brown-headed cowbirds, but freshly killed carcasses were also used in the locations in which they were first observed since there was no salvage permit obtained in Year 1. Freshly killed carcasses used included sparrows, a hoary bat (*Lasiurus cinereus*), and red-tailed hawk (*Buteo jamaicensis*). The types of carcasses used in persistence trials were readily available and also correspond to species commonly used in other fatality monitoring studies allowing the possibility for direct comparisons.[21,22,23,24] However, one study found that using non-

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[21] BioResource Consultants, Inc. 14 October 2010. *2009/2010 Annual Report Bird and Bat Mortality Monitoring, Pine Tree Wind Farm, Kern County, CA.* Prepared for: Los Angeles Department of Water and Power. Ojai, CA.

[22] Western EcoSystems Technology, Inc. 2009. *Final Report: Fatality Study Summary at the Alite and Oak Creek Systems Wind Facilities, Alta–Oak Creek Wind Resource Area, Kern County, CA.* Prepared for: Alta Windpower Development, LLC and CH2M Hill, Cheyenne, WY.

[23] Insignia Environmental. 4 September 2009. *2008/2009 Annual Report for the Buena Vista Avian and Bat Monitoring Project.* Prepared for: Contra Costa County, CA. Palo Alto, CA.

[24] Brown, K., K.S. Smallwood, and B. Karas. 2013. *Final: 2012–2013 Annual Report Avian and Bat Monitoring Project Vasco Winds, LLC.* Prepared for: NextEra Energy Resources. Portland, OR.

raptor carcasses as surrogates for raptor carcasses may not be sufficient because large raptor carcasses have been shown to persist longer than non-raptor carcasses.[25]

All carcasses were rechecked within 12 hours of placement, and subsequent rechecks primarily occurred daily for the first week and then one to two times per week after the first week, with a few exceptions due to weekend days, weather conditions, or scheduling conflicts. Carcass presence was monitored until no sign of the carcass remained. If a carcass was removed between rechecks, the removal date of the carcass was considered to be the last day the carcass was observed. Taking an average of the dates between rechecks has been reported to be inaccurate and affect the fatality estimates by introducing excess bias.[26] A single day was the lowest possible duration of carcass persistence. For example, if a carcass was removed on the same day the carcass was placed (i.e., less than 12 hours), then the carcass was said to have been removed on Day 1. The results of the persistence trials contributed to the overall annual fatality estimates with regard to the availability of carcasses (refer to the *Fatality Modeling* section below).

TABLE 1
CARCASSES USED DURING PERSISTENCE TRIALS, YEAR 1

Carcass Size Class	Species	Total Number of Carcasses Used	Season Carcass Placed (Quarter)
Large raptor	Red-tailed hawk (1)	1	Winter (Quarter 2)
Non-raptor (Large and small)	Northern pintail (3) Northern shoveler (6) Green-winged teal (4) American coot (1)	14	Winter, Spring, Summer, Fall (Quarters 2–4)
	Brown-headed cowbird (17) House finch (2) White-crowned sparrow (1)	20	Winter, Spring, Summer, Fall (Quarters 2–4)
Bat	Hoary bat (1)	1	Fall (Quarter 4)
Total	**9 Species**	**36**	

2.5 Searcher Efficiency and Persistence Covariate Analysis

2.5.1 Searcher Efficiency

Sapphos Environmental, Inc. systematically evaluated searcher efficiency (found/not found) by considering all potential covariates, graphing the raw data, and then performing an analysis to determine what potential covariates should be included in the fatality model. Factors that could potentially influence searchers included the substrate that the carcass was found on, the carcass size, the carcass category, the time of day, and the time of year. Substrate was grouped into two categories, turbine pads or vegetation, which is essentially clear bare ground or undisturbed vegetation. This was analyzed as a covariate because visibility on turbine pads was much different than in vegetation, which potentially influenced the probability of detection. The date of carcass

[25] Smallwood, K.S. 2006. *Biological Effects of Repowering a Portion of the Altamont Pass Wind Resource Area, California: The Diablo Winds Energy Project.* Available at: http://www.altamontsrc.org/alt_doc/r34_biological_effects_diablo_winds_smallwood_07_2006.pdf

[26] Smallwood, K.S. 2006. *Biological Effects of Repowering a Portion of the Altamont Pass Wind Resource Area, California: The Diablo Winds Energy Project.* Available at: http://www.altamontsrc.org/alt_doc/r34_biological_effects_diablo_winds_smallwood_07_2006.pdf

placement was used to determine if searcher efficiency may have improved with searcher experience, given that searchers used at the beginning of the study continued monitoring through to the end of the project. The time of day has the potential to influence observers due to favorable or unfavorable light conditions.[27] Carcass size could influence the ability of an observer to detect the bird or bat, since it is probable that larger birds are easier to detect than smaller ones. Carcass category could influence the observer's ability to recognize the object as a bird or bat, meaning a whole carcass appears differently than a feather spot.

Sapphos Environmental, Inc. ran analyses using both contingency tables and generalized linear regressions using JMP[28] software to determine which, if any, covariates were of significant interest. Contingency tables are typically used in studies to help display the frequency distribution of the given variables in a matrix format. In this case, if the expected value was less than 5 in more than 20 percent of the table cells, then all categories were combined in the contingency table analysis. Sapphos Environmental, Inc. explored three different combinations to determine the most appropriate use of substrate categories and determined that the most logical combination was combining the bare ground and turbine substrate categories since the comparison was between disturbed areas with minimal visual obstructions, versus undisturbed vegetation with substantial visual obstructions. "Carcass category" included the combination of whole bird carcass or carcass parts, which included feather spots and bat carcasses. Due to the relatively small sample size ($n = 29$) for all searcher efficiency trials, a two-tailed Fisher's exact test was applied to the analysis to determine if there were differences between the substrate categories. The null hypothesis of the Fisher's exact test was that treatments do not affect outcome. Fisher's exact tests are especially effective for small sample sizes and are utilized to determine statistical significance when analyzing contingency tables. In addition, the significance of the deviation from a null hypothesis, or a *p*-value, is calculated exactly, instead of as an approximation like many other statistical tests. To analyze changes in searcher efficiency over time, Sapphos Environmental, Inc. used a logistic regression with a logit link, which is a standard link function used to analyze continuous data when performing regressions.

2.5.2 Persistence

Factors that could influence persistence include distance from turbine, carcass size, carcass category, and season. For the purposes of the persistence analysis, distance was selected to be analyzed rather than substrate because some scavengers are known to spend more time searching edges of vegetation, avoid man-made structures, or not spend much time foraging in large, bare areas without adequate cover from predators. Therefore, small mammalian scavengers, such as foxes, may forage longer on the edges rather than at the center of the cleared areas, which could result in differences in persistence based on placement of the carcass (Note: distance and substrate were correlated variables). In addition, season rather than date was selected because scavengers may be more active during one season over another based on their species-specific biological energy requirements (i.e., less likely to change across linear time and more likely to vary between categorical time periods).

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[27] Kunz, T.H., E.B. Arnett, B.M. Cooper, W.P. Erickson, R.P. Larkin, T. Mabee, M.L. Morrison, M.D. Strickland, and J.M. Szewczak. 2007. "Assessing Impacts of Wind-Energy Development on Nocturnally Active Birds and Bats: A Guidance Document." *Journal of Wildlife Management, 71*(8): 2449–2486.

[28] JMP Software. 2014. SAS Institute Inc., Cary, NC.

Carcass size class, carcass category, and season were all analyzed with a one-way analysis of variance (ANOVA), which is a way to test the equality of at least three variables at once by using variances. The same variables that were combined for the searcher efficiency contingency table analysis were also combined and used for the persistence ANOVAs. Sapphos Environmental, Inc. used a generalized linear regression with a normal distribution and an identity link to analyze changes in persistence with regard to distance, using the natural log of persistence.

2.6 Fatality Modeling

Sapphos Environmental, Inc. performed statistical analysis using two different models to estimate fatality rates and investigate possible covariates for the searcher efficiency and persistence annual trials. The Schoenfeld model is an older model that had been used by many other wind energy facilities in fatality estimation, making it a good choice for comparing estimates to past studies. Given its historical use, this model was selected to be used as the primary model for estimating fatality so that fatality estimates could be directly compared to other wind energy facilities. However, all fatality models inevitably have some level of bias, which can be perpetuated in unusual circumstances, such as having very low persistence rates.[29] Therefore, a second and newer fatality model, the USGS Fatality Estimator, was used for comparative purposes because the Schoenfeld model is more likely to underestimate fatality rates, whereas the USGS Fatality Estimator is more likely to overestimate fatality rates. Both sets of results are presented given the fact that the short persistence rates at the project site can result in highly biased estimates for both models.[30]

Fatality estimates were generated separately for all birds, non-raptors, raptors, and bats because of reported differences in searcher efficiency and/or persistence rates with regard to the carcass types.[31] Although some studies have separated non-raptor fatality estimates into different size classes due to differences in persistence and searcher detection,[32,33,34,35,36] fatality estimates for non-raptors were grouped together based on preliminary persistence covariate results, which indicated

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[29] Warren-Hicks, W., J. Newman, R. Wolpert, B. Karas, and L. Tran. 2013. *Improving Methods for Estimating Fatality of Birds and Bats at Wind Energy Facilities*. Publication Number: CEC-500-2012-086. Sacramento, CA: California Energy Commission.

[30] Warren-Hicks, W., J. Newman, R. Wolpert, B. Karas, and L. Tran. 2013. *Improving Methods for Estimating Fatality of Birds and Bats at Wind Energy Facilities*. Publication Number: CEC-500-2012-086. Sacramento, CA: California Energy Commission.

[31] Smallwood, K.S. 2006. *Biological Effects of Repowering a Portion of the Altamont Pass Wind Resource Area, California: The Diablo Winds Energy Project*. Available at: http://www.altamontsrc.org/alt_doc/r34_biological_effects_diablo_winds_smallwood_07_2006.pdf

[32] BioResource Consultants, Inc. 14 October 2010. *2009/2010 Annual Report Bird and Bat Mortality Monitoring, Pine Tree Wind Farm, Kern County, CA*. Prepared for: Los Angeles Department of Water and Power. Ojai, CA.

[33] Western EcoSystems Technology, Inc. 2009. *Final Report: Fatality Study Summary at the Alite and Oak Creek Systems Wind Facilities, Alta–Oak Creek Wind Resource Area, Kern County, CA*. Prepared for: Alta Windpower Development, LLC and CH2M Hill, Cheyenne, WY.

[34] Insignia Environmental. 4 September 2009. *2008/2009 Annual Report for the Buena Vista Avian and Bat Monitoring Project*. Prepared for: Contra Costa County, CA. Palo Alto, CA.

[35] Brown, K., K.S. Smallwood, and B. Karas. 2013. *Final: 2012–2013 Annual Report Avian and Bat Monitoring Project Vasco Winds, LLC*. Prepared for: NextEra Energy Resources. Portland, OR.

[36] Smallwood, K.S. 2006. *Biological Effects of Repowering a Portion of the Altamont Pass Wind Resource Area, California: The Diablo Winds Energy Project*. Available at: http://www.altamontsrc.org/alt_doc/r34_biological_effects_diablo_winds_smallwood_07_2006.pdf

that carcass size did not alter persistence rates. One study has reported that small raptor persistence is more similar to small non-raptors than large raptors;[37] however, the data for small non-raptors come from a single study and these results have not been reported in more recently published studies. Therefore, for the purposes of this study, raptors were grouped together.

Bat, non-raptor, raptor, and all bird fatality were estimated separately in the Schoenfeld model and USGS Fatality Estimator. The bat fatality model included searcher efficiency data from 1 bat and 17 small birds that were used as bat surrogates ($n = 18$) and persistence from a single bat ($n = 1$). Small birds were used as surrogates for bat searcher efficiency because size and color of the birds are comparable to bats. Due to the lack of availability of bat carcasses, only one bat was included in the model for bat persistence; small bird carcasses were not used as bat surrogates for persistence due to the potential differences between bird and bat persistence rates. The fatality model for non-raptors included searcher efficiency for all bird carcasses and feather spots ($n = 28$) and persistence of all non-raptors ($n = 34$). The fatality model for raptors included searcher efficiency of large non-raptors (i.e., whole ducks; $n = 6$), because they are of comparable size to raptor carcasses, and persistence from a red-tailed hawk carcass ($n = 1$). Large non-raptor carcasses were not used as raptor surrogates for persistence due to the reported differences between duck and raptor persistence rates.[38] The fatality model for all birds included searcher efficiency of all bird carcasses ($n = 34$) and persistence of all bird carcasses ($n = 35$), as well as all observed bird carcasses including non-raptors and the raptor ($n = 14$). Search interval was averaged across the entire year to include average time between searches for the Schoenfeld model.

The searcher efficiency included in the Schoenfeld model and USGS Fatality Estimator was the percent of carcasses found from all carcasses available to be found. If searcher efficiency rates differed with covariates, they could be included in the USGS Fatality Estimator only if there were at least 10 observations within each category; the Schoenfeld model does not account for variation, and thus potential covariates were excluded from the model. Persistence for the Schoenfeld model was averaged prior to being included within the model. However the USGS Fatality Estimator calculates the persistence based on raw data, including the last day the carcass was seen, the day to carcass was observed to be missing, and whether the carcass was actually observed to have been removed. As such, the USGS Fatality Estimator needs at least 10 carcasses to calculate persistence. Given that bat and raptor fatality estimates have been calculated based on one carcass for persistence, only the Schoenfeld model can be used to generate estimates for these class categories. Therefore, the USGS Fatality Estimator will only be able to provide a comparison to the non-raptor fatality estimate.

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[37] Smallwood, K.S. 2006. *Biological Effects of Repowering a Portion of the Altamont Pass Wind Resource Area, California: The Diablo Winds Energy Project*. Available at: http://www.altamontsrc.org/alt_doc/r34_biological_effects_diablo_winds_smallwood_07_2006.pdf

[38] Smallwood, K.S. 2006. *Biological Effects of Repowering a Portion of the Altamont Pass Wind Resource Area, California: The Diablo Winds Energy Project*. Available at: http://www.altamontsrc.org/alt_doc/r34_biological_effects_diablo_winds_smallwood_07_2006.pdf

2.6.1 *Schoenfeld Fatality Estimate*

The Schoenfeld Fatality Estimator[39] was used to develop an estimate of bird and bat fatalities at the project site. In this model, mortality *m* was modeled as:

$$m = \frac{\bar{c}}{\pi}$$

$$\text{where } \pi = \frac{\bar{t}p}{I}\left[\frac{exp\left({}^{I}/_{\bar{t}}\right)-1}{exp\left({}^{I}/_{\bar{t}}\right)-1+p}\right]$$

and is defined as the estimated probability that a carcass is both available to be found during a search and is actually found, as determined by the persistence trials and the searcher efficiency trials

and where $\bar{c}$ is the average number of carcasses observed per turbine over the monitoring period calculated as:

$$\sum\nolimits_i c_i/k$$

where *k* is the number of turbines

Given the Poisson distribution for a counting trial, the standard deviation of this estimate is calculated as:

$$\sqrt{\bar{c}}/k$$

and where *I* is the average interval between searches

and where $\bar{t}$ is the average persistence period for test carcasses where uncertainty is estimated as the standard error in the average

and where *p* is the fractional searcher efficiency calculated as:

$$N_f/N_p$$

where the subscripts *f* and *p* correspond to carcasses found and carcasses placed, respectively.

[39] Schoenfeld, P.S. 2004. Suggestions Regarding Avian Mortality Extrapolation. Unpublished report to West Virginia Highlands Conservancy, Davis, WV.

Uncertainty in this fraction comes from the Poisson statistics of counting experiments as:

$$(N_f/N_t)\sqrt{(1/N_f)+(1/N_t)}$$

Uncertainty in the fatality estimate was estimated using a parametric bootstrapping technique that randomly varied three model variables ($\bar{c}$, $\bar{t}$, and p) according to their individual uncertainty estimates. The parametric uncertainty estimate of each variable was assumed to follow a normal distribution using the uncertainty values described above. A total of 10,000 bootstrapping estimates were found to obtain convergent results.

2.6.2 USGS Fatality Estimate

Sapphos Environmental, Inc. also used the USGS Fatality Estimator to develop an estimate of bird and bat fatality rates at the project site. Results were used for comparison to the Schoenfeld model only. Only categorical covariates with more than 10 samples per category could be included into the model. If covariates were included into the models, the model with the lowest Akaike Information Criterion (AIC) value was selected as the best-fit estimate. AICs act as a means for statistical model selection. Given that 100 percent of each survey plot was surveyed, density-weighted proportion (DWP) was not used. Bird and bat fatalities for Year 1 were expressed as fatalities per turbine, fatalities per MW, and fatalities on the project site across the year.

Incidental Fatalities

Carcasses found by biologists and operations and maintenance staff within the formal search plots but outside of the scheduled carcass search times; carcasses found on reference plots; and carcasses found outside of the search plots, but within the project boundary, during other activities were treated as incidental finds. All such incidental finds were photographed, their locations noted using a GPS receiver, and any other relevant information was recorded on an Incidental Wildlife Reporting Form. Carcasses attributable to turbine collision discovered within the formal search plots, but outside the regular search times, were included within the fatality analysis, as it is assumed that these carcasses would have been subsequently discovered during the following carcass search. Carcasses discovered outside the formal search plots during the course of other maintenance or survey activities, no matter where they were located within the project boundary or the apparent cause of death, were not included in the fatality analysis, but were nonetheless reported in the total fatality results presented below.

3.1 Carcass Searches

Searchers observed and documented the remains of 14 separate individual birds and 1 bat carcass during standardized carcass searches across the entire year (Figure 6, *Fatality Locations, Year 1*; Table 2, *Carcass Search Results at the Pacific Wind Energy Project, Year 1*). All finds were conservatively assumed to be turbine-related, although the specific cause of death was not confirmed by necropsy or direct observation. Two (2) instances occurred where multiple finds were detected at the same two turbines (2 finds at A21 and 3 finds at B3) across the year, and all other observations were individually detected at different turbines. The feathers of 115 additional birds were observed during the carcass searches across the year, but due to the 10-feather definition of a feather spot, they were not considered to be carcass finds. Carcasses were found almost the same number of times on bare ground as in vegetation (8 on bare ground and 7 in vegetation out of 15 carcasses) between 17–77 meters from the turbine (average = 48.5). Only 3 of 15 (20 percent) were whole carcass observations, including 2 birds and 1 bat. Eighty percent of the carcass finds were feather spots, although half of a red-tailed hawk and a western screech-owl (*Megascops kennicottii*) leg were also documented on survey plots.

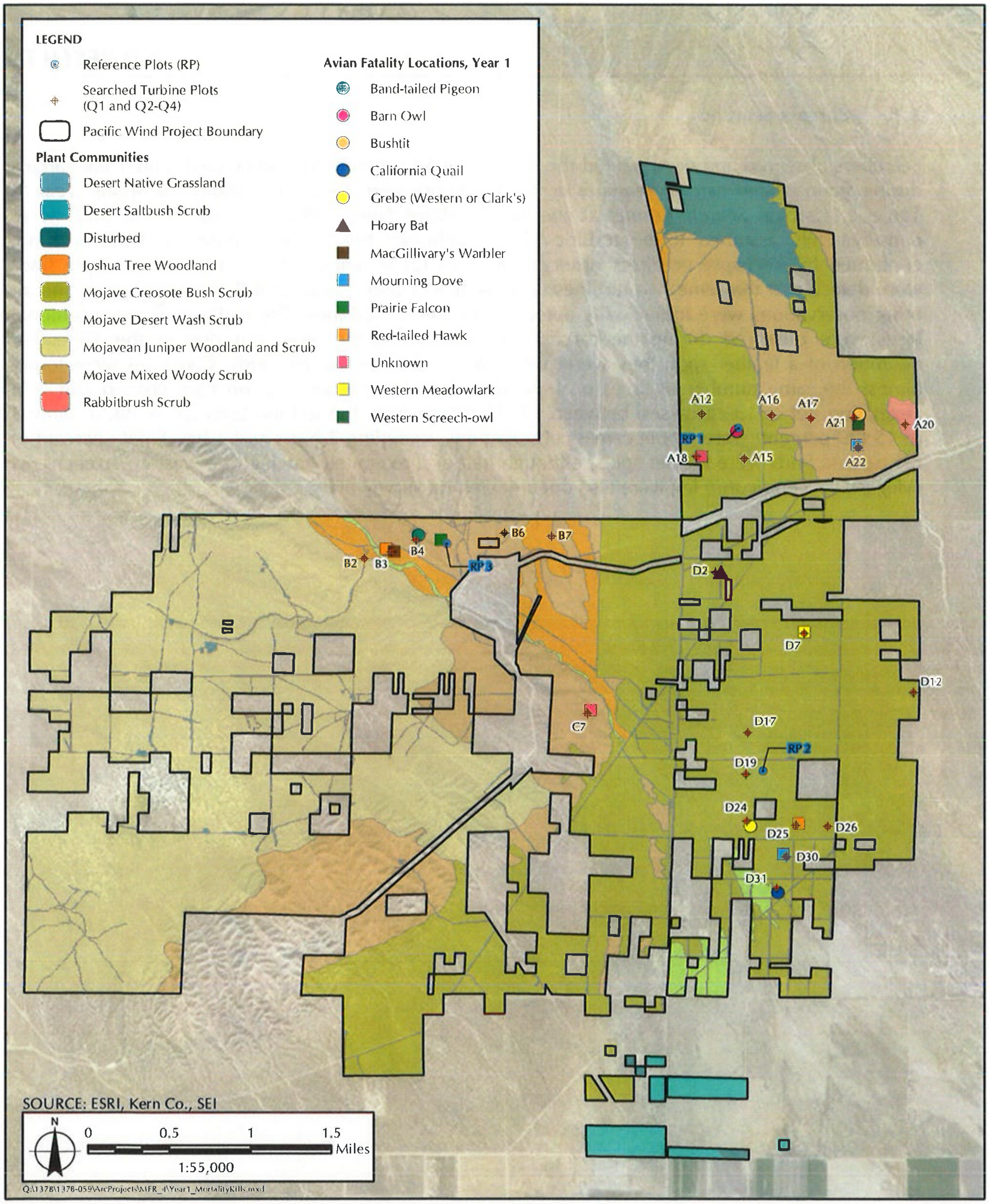

FIGURE 6

Fatality Locations, Year 1

TABLE 2
CARCASS SEARCH RESULTS AT THE PACIFIC WIND ENERGY PROJECT, YEAR 1

Quarter (Season)	Observation Type	Species	Special Status	Closest Turbine	Distance from Turbine (m)	Carcass Size Class	Carcass Category	Substrate
Quarter 1 (Fall)	Carcass search	Red-tailed hawk	None	D25	37	Large raptor	Bird carcass	Bare ground
Quarter 1 (Fall)	Carcass search	Western/ Clark's grebe	None	D24	68	Large non-raptor	Feather spot	Bare ground
Quarter 1 (Fall)	Carcass search	Band-tailed pigeon	None	B4	53	Medium non-raptor	Feather spot	Vegetation
Quarter 1 (Winter)	Carcass search	Mourning dove	None	D30	43	Medium non-raptor	Feather spot	Bare ground
Quarter 1 (Winter)	Carcass search	California quail	None	D31	45	Medium non-raptor	Feather spot	Vegetation
Quarter 2 (Winter)	Carcass search	Western meadowlark	None	D7	17	Medium non-raptor	Feather spot	Bare ground
Quarter 2 (Winter)	Carcass search	Unknown	None	B3	41	Unknown	Feather spot	Bare ground
Quarter 2 (Spring)	Carcass search	Western screech-owl	None	A21	77	Small raptor	Carcass part	Vegetation
Quarter 2 (Spring)	Carcass search	Unknown	None	C7	47	Unknown	Feather spot	Bare ground
Quarter 2 (Spring)	Carcass search	Unknown	None	A18	57	Unknown	Feather spot	Vegetation
Quarter 3 (Spring)	Carcass search	Bushtit	Unknown	A21	59	Small non-raptor	Feather spot	Vegetation
Quarter 3 (Spring)	Carcass search	Hoary bat	None	D2	55	Bat	Bat carcass	Vegetation
Quarter 3 (Spring)	Carcass search	Red-tailed hawk	None	B3	64	Large raptor	Carcass part	Vegetation
Quarter 3 (Summer)	Carcass search	Mourning dove	None	A22	31	Medium non-raptor	Feather spot	Bare ground
Quarter 4 (Fall)	Carcass search	MacGillivray's warbler	None	B3	34	Small non-raptor	Bird carcass	Bare ground

A total of three birds and one bat were recorded incidentally on the project in Year 1. Two bird carcasses were detected on references plots; these carcasses were excluded from the fatality model and are considered to be incidental finds (Table 3, *Incidental Finds at the Pacific Wind Energy Project, Year 1*). These finds consisted of feather spots of a prairie falcon (*Falco mexicanus*) and a barn owl (*Tyto alba*), located 271 and 252 meters from the closest turbine, respectively. Finally, a red-tailed hawk was incidentally reported at a non-search turbine prior to the start of Year 1 carcass searches, and a Mexican free-tailed bat (*Tadarida brasiliensis*) was observed during plant restoration surveys during Quarter 1 at a non-search turbine plot; these observations were not included in the fatality model, since they were not found during standard surveys (Table 3).

TABLE 3
INCIDENTAL FINDS AT THE PACIFIC WIND ENERGY PROJECT, YEAR 1

Quarter (Season)	Observation Type	Species	Special Status	Closest Turbine	Distance from Turbine (m)	Carcass Size Class	Carcass Category	Substrate
Quarter 1 (Fall)	Incidental observation	Red-tailed hawk	None	A14	32	Large raptor	Bird carcass	Bare ground
Quarter 1 (Fall)	Incidental observation	Mexican free-tailed bat	None	C9	10	Bat	Bat carcass	Bare ground
Quarter 1 (Winter)	Reference plot	Prairie falcon	None	B5	271	Medium raptor	Feather spot	Vegetation
Quarter 2 (Winter)	Reference plot	Barn owl	None	A14	252	Medium raptor	Feather spot	Vegetation

3.2 Searcher Efficiency Trials

Only 29 of the 35 carcasses placed for searcher efficiency trials were analyzed. It was determined that 6 of the 35 placed carcasses were not available for searchers to find, as they were potentially removed by a scavenger prior to the searchers arriving at the survey plots (Table 4, *Searcher Efficiency Results, Year 1*). Searchers did not report seeing these six carcasses, and these carcasses were missing when rechecked by the biologist that placed them. Overall, searchers detected test carcasses 55 percent of the time. Searchers found 67 percent of the carcasses used for the bat fatality estimate, 57 percent of the carcasses used for the non-raptor fatality estimate, and 17 percent of the carcasses used for the raptor fatality estimate.

TABLE 4
SEARCHER EFFICIENCY RESULTS, YEAR 1

Season	Species	Carcass Category	Carcass Size	Turbine No.	Substrate	Detected by Searchers
Winter	Green-winged teal	Feather spot	Large non-raptor	D31	Vegetation	No
Winter	Green-winged teal	Carcass part	Large non-raptor	D26	Bare ground	Yes
Winter	Green-winged teal	Carcass part	Large non-raptor	D12	Turbine	No
Spring	Northern pintail	Bird carcass	Large non-raptor	D30	Vegetation	No
Spring	Green-winged teal	Bird carcass	Large non-raptor	A18	Turbine	No
Spring	Green-winged teal	Bird carcass	Large non-raptor	D7	Turbine	Yes
Spring	Green-winged teal	Carcass part	Large non-raptor	D25	Bare ground	Yes
Spring	Brown-headed cowbird	Bird carcass	Small non-raptor	D31	Turbine	Yes
Spring	Brown-headed cowbird	Bird carcass	Small non-raptor	D26	Vegetation	No
Spring	House finch	Bird carcass	Small non-raptor	D25	Bare ground	No
Spring	House finch	Bird carcass	Small non-raptor	A18	Vegetation	Yes
Spring	House finch	Bird carcass	Small non-raptor	A21	Vegetation	No
Spring	Northern shoveler	Bird carcass	Large non-raptor	A15	Vegetation	No
Spring	Northern shoveler	Bird carcass	Large non-raptor	A18	Vegetation	No
Spring	Northern shoveler	Bird carcass	Large non-raptor	A12	Vegetation	No
Summer	Brown-headed cowbird	Bird carcass	Small non-raptor	A16	Bare ground	Yes
Summer	Brown-headed cowbird	Bird carcass	Small non-raptor	D25	Bare ground	Yes
Summer	Brown-headed cowbird	Bird carcass	Small non-raptor	B4	Bare ground	No
Summer	Brown-headed cowbird	Bird carcass	Small non-raptor	C7	Bare ground	Yes
Summer	Brown-headed cowbird	Bird carcass	Small non-raptor	D12	Bare ground	Yes
Summer	Brown-headed cowbird	Bird carcass	Small non-raptor	D2	Bare ground	Yes
Summer	Brown-headed cowbird	Bird carcass	Small non-raptor	D7	Bare ground	Yes
Summer	Green-winged teal	Bird carcass	Large non-raptor	D12	Bare ground	Yes
Summer	Green-winged teal	Feather spot	Large non-raptor	D25	Vegetation	Yes
Fall	Brown-headed cowbird	Bird carcass	Small non-raptor	D25	Turbine	No
Fall	Brown-headed cowbird	Bird carcass	Small non-raptor	D7	Vegetation	Yes
Fall	House finch	Bird carcass	Small non-raptor	A20	Turbine	Yes
Fall	Hoary bat	Bat carcass	Bat	B2	Turbine	No
Fall	Green-winged teal	Feather spot	Large non-raptor	B3	Bare ground	Yes

3.3 Carcass Persistence Trials

The average persistence was 1.26 days for non-raptors ($n = 11$), 64 days for raptors ($n = 1$), 3.06 days for all birds ($n = 14$), and 3 days for bats ($n = 1$). All non-raptor carcasses were removed within 5 days, with the bat carcass persisting 3 days, and the red-tailed hawk persisting for 64 days. Of the non-raptor carcasses, 83 percent were removed within 1 day, and approximately half of them were removed within 12 hours of placement (Figure 7, *Carcasses Persistence through Time*).

A desert kit fox was photographed and videotaped taking several trial carcasses (Figure 8, *Desert Kit Fox Scavenging a Duck Carcass*). Ravens were observed at the red-tailed hawk carcass, but scavengers did not immediately remove the carcass. Several carcasses that were removed in broad daylight were assumed to be scavenged by ravens with the exception of a northern pintail (*Anas acuta*) carcass. The pintail carcass may have been scavenged by a coyote given the time of day and carcass size class. One carcass part, a wing, appeared to have been scavenged by a small mammal

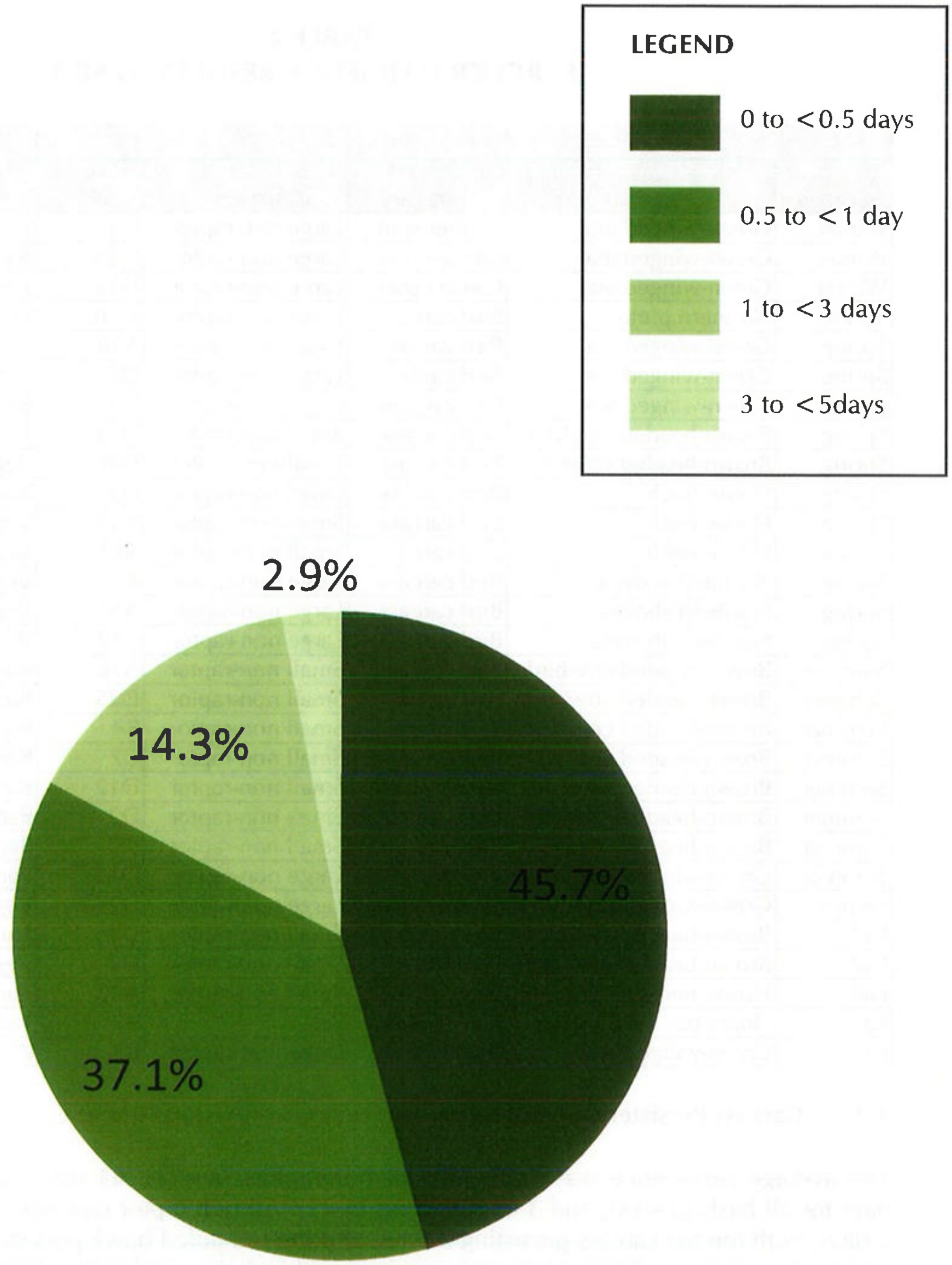

FIGURE 7
Carcass Persistence Through Time

FIGURE 8
Desert Kit Fox Scavenging a Duck Carcass

because plucked feathers were found observed at the entrance of a ground-squirrel burrow less than 8 hours following carcass placement.

3.4 Searcher Efficiency and Persistence Covariates

3.4.1 Searcher Efficiency Covariates

The percentage of carcasses placed that were detected by searchers varied by substrate and date only. Only 13 percent of the carcasses placed in dense vegetation were found compared to 71 percent found on turbine pads and surrounding bare ground ($df = 1$, $p = 0.01$; Table 5, *Contingency Table Analysis of Searcher Efficiency Covariates*). Searcher efficiency rates increased 0.0028 percent [95 percent confidence interval (CI): 0.0062 to 0 percent] from January 9 to September 6, 2013, which is statistically but not biologically significant ($\chi^2 = 3.73$, $p = 0.05$). Searcher detection rates did not change based on the time of day, carcass categories, or size class (Table 5). Therefore, substrate could be a covariate within the USGS Fatality Estimator; however, this covariate could not be included in the fatality estimates for Year 1 because there were fewer than 10 carcasses in the vegetation category.

TABLE 5
CONTINGENCY TABLE ANALYSIS OF SEARCHER EFFICIENCY COVARIATES

Potential Covariates	Category	Found	Not Found	Total	Percent Found
Substrate	Turbine pads / bare ground	15	6	21	71%*
	Vegetation	1	7	8	13%*
Carcass size class	Non-raptor	16	12	28	57%
	Raptor	1	5	6	17%
	Bat	12	6	18	67%
Carcass category	Bird carcass	13	10	23	56%
	Carcass part / feather spot / bat carcass	3	3	6	50%

NOTE:
*Indicates a significant difference between categories.

3.4.2 Persistence Covariates

In exploring potential covariates, the hoary bat and red-tailed hawk carcasses were not included because only non-raptor carcasses had enough samples to analyze potential persistence covariates. For every 10-meter increase in distance from turbines, overall persistence rates decreased 6.5 percent (95% CI: 4 to 11.4 percent, $\chi^2 = 5.91$, $p = 0.015$). Persistence did not differ across season, size class, or carcass categories (Table 6, *Analysis of Search Persistence Covariates*). Therefore, distance could be a potential covariate in the USGS Fatality Estimator if grouped categorically, given the requirement to include a minimum of 10 carcasses per category to ensure model assumptions are not being violated.

TABLE 6
ANALYSIS OF SEARCH PERSISTENCE COVARIATES

Potential Covariates	Category	Number of Carcasses	Mean (days)	Lower-Upper CI (days)	Test Statistic	*p*
Season	Winter	5	1.8	0.7–2.9	$F_{3,30}=0.48$	0.7
	Spring	8	1.3	0.4–2.1		
	Summer	16	1.3	0.7–1.9		
	Fall	5	0.9	0–2.0		
Carcass size class	Large non-raptor	14	0.9	0.3–1.5	$F_{1,32}=2.53$	0.1
	Small non-raptor	20	1.5	1.0–2.1		
Carcass category	Bird carcass	28	1.4	0.9–1.8	$F_{1,32}=0.87$	0.4
	Carcass part	6	0.9	0–1.9		

3.5 Fatality Modeling

Using the Schoenfeld model, the estimated non-raptor bird fatality rate in the first year at the project was 8.56 birds/turbine (95% CI: 6.93 to 10.74 to birds/turbine), or 4.28 birds/MW (95% CI: 3.46 to 5.37 non-raptor birds/MW) (Table 7, *Fatality Estimator Results*). The estimated raptor fatality rate was 0.3 raptor/turbine (95% CI: 0.008 to 0.58), or 0.15 raptor/MW (95% CI: 0.004 to 0.29). The estimated fatality rate for all birds was 5.2 birds/turbine (95% CI: –12.4 to 40.2 to birds/turbine), or 2.6 birds/MW (95% CI: –6.2 to 20.1 all birds/MW). The estimated bat fatality rate was 0.28 bat/turbine (95% CI: 0.17 to 0.40), or 0.14 bat/MW (95% CI: 0.09 to 0.20). Overall, the project is expected to result in approximately 599 non-raptor bird fatalities/year (95% CI: 485 to 752), 21 raptor fatalities/year (95% CI: 0.56 to 39.9), 364 total bird fatalities/year (95% CI: –868 to 2,814), and 20 bat fatalities/year (95% CI: 11.9 to 280). The estimated non-raptor bird fatality rate using the USGS Fatality Estimate for the first year was 8.53 birds/turbine (95% CI: 4.93 to 17.64), or 4.27 birds/MW (95% CI: 2.47 to 8.82). The Schoenfeld model and USGS Fatality Estimator produced similar fatality estimates for non-raptors, but the USGS Fatality Estimator estimate was slightly lower and exhibited greater uncertainty.

TABLE 7
FATALITY ESTIMATOR RESULTS

Variable	Bats	Non-raptors	Raptors	All Birds
Schoenfeld Model				
Average survey interval in days*	11.2	11.2	11.2	11.2
Searcher efficiency* (%)	66.7	57.1	17.0	55.8
Carcass persistence in days*	3	1.26	64	3.05
Observed fatalities	1	11	3	14
Estimated annual fatality rate (carcasses/turbine) [95% CI]	0.28 [0.17 to 0.40]	8.56 [6.93 to 10.74]	0.3 [0.008 to 0.58]	5.2 [–12.4 to 40.2]
Estimated annual fatality rate (carcasses/MW) [95% CI]	0.14 [0.09 to 0.20]	4.28 [3.46 to 5.37]	0.15 [0.004 to 0.29]	2.6 [–6.2 to 20.1]
Total estimated annual fatality rate (carcasses/year) [95% CI]	19.6 [11.9 to 280]	599.2 [485 to 752]	21 [0.56 to 39.9]	364 [–868 to 2,814]
USGS Estimator				
Searcher efficiency (%) [95% CI]**	NA	57 [39 to 75]	NA	57
Carcass persistence in days [95% CI]**	NA	1.56 [1 to 1.96]	NA	2.04 [1 to 2.37]
Observed fatalities	NA	11	NA	14
Estimated annual fatality rate (carcasses/turbine)	NA	8.53 [4.93 to 17.64]	NA	5.79 [3.09 to 18.68]
Estimated annual fatality rate (carcasses/MW)	NA	4.27 [2.47 to 8.82]	NA	2.9 [1.55 to 9.34]
Total estimated annual fatality rate (carcasses/year)	NA	597 [345 to 1,235]	NA	406 [217 to 1,308]

NOTE:

Using the Schoenfeld model, bat and raptor fatality estimates were generated using a single sample for each category for persistence; therefore, the accuracy of these estimates and CIs may be unreliable and not recommended to be shared publicly.

* These values were calculated from the raw data collected from the surveys, not generated by the Schoenfeld Estimator.

** These values were generated from the USGS Estimator.

Based on size class, medium non-raptor carcasses were the most likely finds (Table 8, *Estimated Distribution of Carcasses by Size Class at Pacific Wind, Year 1*, and Table 9, *Estimated Distribution of Carcasses by Species at Pacific Wind, Year 1*). California quail were detected more frequently than any other species ($n = 3$) across Year 1. The majority of the species were only found once (Table 9).

TABLE 8
ESTIMATED DISTRIBUTION OF CARCASSES BY SIZE CLASS AT PACIFIC WIND, YEAR 1

Size class	Estimated distribution of Carcasses by Size Class
Unknown	20%
Medium non-raptor	33.3%
Small non-raptor	13.3%
Large raptor	13.3%
Bat	6.7%
Small raptor	6.7%
Large non-raptor	6.7%

TABLE 9
ESTIMATED DISTRIBUTION OF CARCASSES BY SPECIES AT PACIFIC WIND, YEAR 1

Species	Estimated Distribution of Carcasses by Species	Number Found
California quail	20%	3
Mourning dove	13.3%	2
Red-tailed hawk	13.3%	2
Unknown	6.7%	1
MacGillivray's warbler	6.7%	1
Bushtit	6.7%	1
Hoary bat	6.7%	1
Western screech-owl	6.7%	1
Grebe species	6.7%	1
Band-tailed pigeon	6.7%	1
Western meadowlark	6.7%	1

During Year 1 surveys, only 15 total carcasses (1 bat and 14 birds) were detected during standardized carcass searches at turbines. In addition, four carcasses were recorded incidentally (one bat and three birds). There were no federal or state threatened or endangered species observed on the project site during surveys or incidentally across the year as a result of the fatality monitoring. Only 3 of the observations were intact carcasses, and 12 were feather spots consisting of 10 or more feathers or 3 or more primary feathers. The single hoary bat detected during the surveys may have been the result of barotrauma due to the proximity of the carcass to the turbine and the lack of visual external injury; however, a necropsy was not preformed and therefore cause of death could not be confirmed.

In addition to the 14 birds and 1 bat fatalities previously discussed, there were 2 additional feather spots detected on reference plots and therefore excluded from the fatality model. One of these feather spots, a prairie falcon, was detected in a depression approximately 271 meters from the closest turbine, and the other was a barn owl found 252 meters from the closest turbine. Based on studies conducted at other sites, nearly all bird fatalities are found within the area equivalent to the total distance from the turbine's rotor tip height to the ground,[40,41] which for this project is 124.7 meters, and more than 80 percent of bat fatalities are typically found within half the maximum distance from the turbine's rotor tip height to the ground,[42] which for this project is 63 meters, using the standard plot size. Therefore, these reference plot finds were classified as incidental due to their distances from the search plots and turbines.

The overall searcher efficiency rates (57 percent for non-raptors-sized; 17 percent for raptor-sized; 56 percent for all birds; and 67 percent for bat-sized carcasses placed) was comparable to other projects in California, which have reported slightly higher[43,44] and lower[45] searcher efficiency rates. The searcher efficiency results indicated that observers improved their carcass detection skills with experience. This trend became apparent within the raw data in the third quarter, prior to the data analysis (Figure 9, *Searcher Efficiency Improvements through Time*). Substrate type also affected searcher efficiency detection rates, where detection rates on vegetated areas (22 percent were

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[40] Young, D.P., Jr., W.P. Erickson, J. Jeffrey, and V.K. Poulton. 2007. *Puget Sound Energy Hopkins Ridge Wind Project Phase 1 Post-Construction Avian and Bat Monitoring First Annual Report, January–December 2006*. Technical report. Prepared for: Puget Sound Energy, Dayton, WA, and Hopkins Ridge Wind Project Technical Advisory Committee, Columbia County, WA. Prepared by: Western EcoSystems Technology, Inc., Cheyenne, WY, and Walla Walla, WA.

[41] Johnson, G.D., W.P. Erickson, and J. White. 2003. *Avian and Bat Mortality at the Klondike, Oregon Phase I Wind Plant*. Technical report. Prepared for: Northwestern Wind Power. Prepared by: Western EcoSystems Technology, Inc., Cheyenne, WY, and Walla Walla, WA.

[42] Kerns, J., W.P. Erickson, and E.B. Arnett. 2005. "Bat and Bird Fatality at Wind Energy Facilities in Pennsylvania and West Virginia." In *Relationships between Bats and Wind Turbines in Pennsylvania and West Virginia: An Assessment of Bat Fatality Search Protocols, Patterns of Fatality, and Behavioral Interactions with Wind Turbines*, pp. 24–95. Edited by E.B. Arnett. A final report prepared for the Bats and Wind Energy Cooperative. Bat Conservation International. Austin, TX.

[43] BioResource Consultants, Inc. 14 October 2010. 2009/2010 *Annual Report Bird and Bat Mortality Monitoring, Pine Tree Wind Farm, Kern County, CA*. Prepared for: Los Angeles Department of Water and Power. Ojai, CA.

[44] Smallwood, K.S. 2007. "Estimating Wind Turbine-Caused Bird Mortality." *Journal of Wildlife Management*, *71*: 2781–2791.

[45] Western EcoSystems Technology, Inc. 12 September 2012. *Avian and Bat Mortality Monitoring at the Alta–Oak Creek Mojave Project Kern County, California, Final Report for the First Year of Operation March 22, 2011–June 15, 2012*. Prepared for: Alta Windpower Development, LLC, Mojave, CA. Cheyenne, WY.

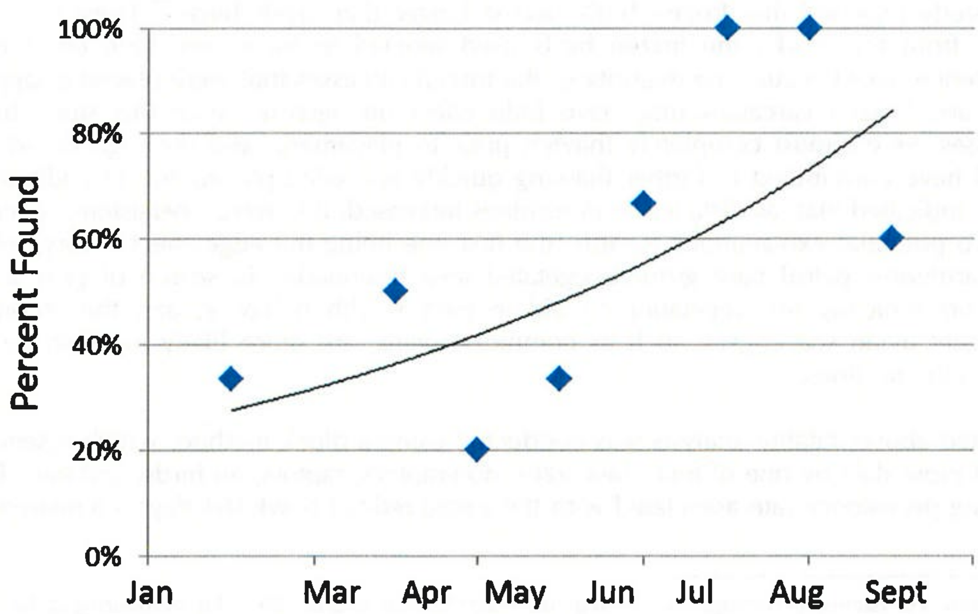

FIGURE 9
Searcher Efficiency Improvements Through Time

detected) were significantly lower than on bare ground (82 percent were detected); this was evident in all four survey quarters.

The persistence trials resulted in extremely low persistence rates, which reflected an extremely high scavenger rate. Overall, the majority of the carcasses placed for persistence were scavenged in less than 2 days, which is likely the primary factor driving the relatively high fatality estimates. Other studies in the TPWRA have also reported extremely low persistence rates for non-raptors, indicating that this particular WRA is expected to have high scavenger activity.[46,47,48] In addition, those same studies have shown that persistence rates for large birds and raptors are substantially higher than persistence rates for small birds.[49,50,51] For this reason, these data (class sizes) were analyzed separately to ensure the highest level of accuracy in the estimates.

One study reported that frozen birds persist longer than fresh birds.[52] However, based on the results from this study, the frozen birds used seemed to have very little effect on increasing persistence rates because the majority of the frozen carcasses that were placed disappeared within 12 hours. Frozen carcasses may have little effect on persistence in this study because many carcasses were almost completely thawed prior to placement, and the high desert temperatures would have contributed to further thawing quickly following placement. In addition, persistence results indicated that, as distance from turbines increased, the overall persistence decreased. There are two potential explanations for this: the first one being the edge-effect theory, which suggests that carnivores patrol bare ground/vegetated area boundaries in search of prey and that these predators typically use vegetation to aid in their stealth behavior; and the second being that intelligent avian scavengers, such as common ravens, are more likely to avoid the rotor-sweep zone of the turbines.

As stated above, fatality analysis was conducted using a block method, which essentially grouped model input data by one of four class sizes: non-raptors, raptors, all birds, and bats. By doing this, the long persistence rate associated with the single red-tail hawk (64 days, compared to 1.26 days

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[46] Western EcoSystems Technology, Inc. 12 September 2012. *Avian and Bat Mortality Monitoring at the Alta–Oak Creek Mojave Project Kern County, California, Final Report for the First Year of Operation March 22, 2011–June 15, 2012.* Prepared for: Alta Windpower Development, LLC, Mojave, CA. Cheyenne, WY.

[47] Chatfield, A., and K. Bay. 2014. *Post-Construction Studies for the Mustang Hills and Alta VIII Wind Energy Facilities, Kern County, California. Final Report for the First Year of Operation: July 2012–October 2013.* Prepared for: EverPower Wind Holdings, Inc. and Brookfield Renewable Energy Group. Prepared by: Western EcoSystems Technology, Inc., Cheyenne, WY.

[48] BioResource Consultants, Inc. 14 October 2010. *2009/2010 Annual Report Bird and Bat Mortality Monitoring, Pine Tree Wind Farm, Kern County, CA.* Prepared for: Los Angeles Department of Water and Power. Ojai, CA.

[49] Western EcoSystems Technology, Inc. 12 September 2012. *Avian and Bat Mortality Monitoring at the Alta–Oak Creek Mojave Project Kern County, California, Final Report for the First Year of Operation March 22, 2011–June 15, 2012.* Prepared for: Alta Windpower Development, LLC, Mojave, CA. Cheyenne, WY.

[50] Chatfield, A., and K. Bay. 2014. *Post-Construction Studies for the Mustang Hills and Alta VIII Wind Energy Facilities, Kern County, California. Final Report for the First Year of Operation: July 2012–October 2013.* Prepared for: EverPower Wind Holdings, Inc. and Brookfield Renewable Energy Group. Prepared by: Western EcoSystems Technology, Inc., Cheyenne, WY.

[51] BioResource Consultants, Inc. 14 October 2010. *2009/2010 Annual Report Bird and Bat Mortality Monitoring, Pine Tree Wind Farm, Kern County, CA.* Prepared for: Los Angeles Department of Water and Power. Ojai, CA.

[52] Smallwood, K.S. 2006. *Biological Effects of Repowering a Portion of the Altamont Pass Wind Resource Area, California: The Diablo Winds Energy Project.* Available at: http://www.altamontsrc.org/alt_doc/r34_biological_effects_diablo_winds_smallwood_07_2006.pdf

for non-raptors) was unable to influence the persistence rates for birds and bats across the overall project. Instead, fatality estimates were produced with a higher level of accuracy and tighter confidence intervals for each class category. The high level of uncertainty and inflated and negative confidence intervals that resulted from running the Schoenfeld model to include all bird fatality inputs (including the single red-tail hawk with the 64 day persistence) is precisely the reason for separating the class categories. The all bird estimates are not reliable due to insufficient data and are not recommended to be used for comparative purposes; instead, it is recommended that the categorically grouped estimates (bats, non-raptor birds, and raptors) be used. It should be noted that bat and raptor estimates were generated using a single sample in persistence inputs for each category; therefore, due to the lack of sufficient data, these results may be inaccurate.

The estimated annual per turbine and per MW fatality rates for the project was 8.56 and 4.28, respectively, for non-raptors; 0.3 and 0.15, respectively, for raptors; 5.2 and 2.6, respectively, for all birds; and 0.28 and 0.14, respectively, for bats. In comparison, the mean annual bird fatality rate per turbine for monopole turbines (excludes older lattice tower turbines) across California is 7.85 (95% CI: 4.05 to 11.65).[53] On an annual per MW basis, California had a mean annual bird fatality rate of 18.76 birds per MW (95% CI: 9.68 to 27.84).[54] Compared to fatality rates per MW at other wind projects in California, the results from this project were substantially lower than the State's reported average. Based on the single bat detection, fatality rates per MW when compared to previous studies in California were significantly lower than the projects that reported bat survey results (Table 10, *Fatality Results from Projects in California*).

[53] Loss, Scott R., Tom Will, Peter P. Marra. December 2013. "Estimates of Bird Collision Mortality at Wind Facilities in the Contiguous United States." *Biological Conservation*, *168*: 201–209. Available at: http://dx.doi.org/10.1016/j.biocon.2013.10.007

[54] Loss, Scott R., Tom Will, Peter P. Marra. December 2013. "Estimates of Bird Collision Mortality at Wind Facilities in the Contiguous United States." *Biological Conservation*, *168*: 201–209. Available at: http://dx.doi.org/10.1016/j.biocon.2013.10.007

TABLE 10
FATALITY RESULTS FROM PROJECTS IN CALIFORNIA

Wind Facility	Survey Years	Estimated Mean All Bird Fatality/ MW/Year	Estimated Mean Bat Fatality/ MW/Year	Reference
Pacific Wind, Kern County	2012–2013	2.6* all bird; 4.28** non-raptors	0.14*	This report
Pine Tree, Kern County	2009–2010	8.3	n.d.	BioResource Consultants, Inc. 14 October 2010. *2009/2010 Annual Report: Bird and Bat Mortality Monitoring, Pine Tree Wind Farm, Kern County, California*. Ojai, CA.
Alta-Oak Creek Mojave, Kern County	2011–2012	4.0	0.61	Chatfield, A., M. Sonnenberg, and K. Bay. 2012. Avian and Bat Mortality Monitoring at the Alta–Oak Creek Mojave Project, Kern County, California. Final Report for the First Year of Operation: March 22, 2011–June 15, 2012. Prepared for: Alta Windpower Development, LLC, Mojave, CA. Prepared by: Western EcoSystems Technology, Inc., Cheyenne, WY.
Mustang Hills and Alta VIII, Kern County	2012–2013	1.66**	0.10	Chatfield, A. and K. Bay. 2014. Post-Construction Studies for the Mustang Hills and Alta VIII Wind Energy Facilities, Kern County, California. Final Report for the First Year of Operation: July 2012 – October 2013. Prepared for EverPower Wind Holdings, Inc. and Brookfield Renewable Energy Group. Prepared by: Western EcoSystems Technology, Inc., Cheyenne, WY.
Shiloh I, Solano County	Year 3: 2008–2009	6.96	3.92	Kerlinger, P., R. Curry, L. Culp, A. Hasch, and A. Jain. 2010. *Post-Construction Avian Monitoring Study for the Shiloh I Wind Power Project, Solano County, California. Final Report: October 2009. Third Year Report (Revised)*. Prepared for Iberdrola Renewables, Inc. (IRI). Prepared by Curry and Kilinger, LLC., McLean, VA.
Diablo Winds, Alameda County	2005–2006	4.29	n.d.	Western EcoSystems Technology, Inc. August 2008. *Diablo Winds Wildlife Monitoring Progress Report: March 2005–February 2007*. Cheyenne, WY.
Dillon, Riverside County	2008–2009	4.71	2.17	Chatfield, A., W. Erickson, and K. Bay. 3 June 2009. *Avian and Bat Fatality Study, Dillon Wind-Energy Facility, Riverside County, California. Final Report: March 26, 2008–March 26, 2009*. Prepared for Iberdrola Renewables, Portland, OR. Prepared by Western EcoSystems Technology, Inc., Cheyenne, WY.
High Winds, Solano County	2003–2005	2004: 1.62 2005: 1.1	2004: 2.51 2005: 1.52	Kerlinger, P., R. Curry, L. Culp, A. Jain, C. Wilkerson, B. Fischer, and A. Hasch. April 2006. *Post-Construction Avian and Bat Fatality Monitoring for the High Winds Wind Power Project, Solano County, California: Two Year Report*. Prepared for High Winds LLC, FPL Energy. Prepared by Curry and Kerlinger, LLC.

TABLE 10
FATALITY RESULTS FROM PROJECTS IN CALIFORNIA, Continued

Wind Facility	Survey Years	Estimated Mean All Bird Fatality/ MW/Year	Estimated Mean Bat Fatality/ MW/Year	Reference
Altamont, Alameda County	2005–2007	1.56	n.d.	Smallwood, K.S., and B. Karas. 2009. "Avian and Bat Fatality Rates at Old-Generation and Repowered Wind Turbines in California." *Journal of Wildlife Management, 73*(7): 1062–1071.

NOTES:
* Results were generated with insufficient data (only one sample for persistence input for bats and raptors).
** Analysis excluded raptor data.
[1] Project data listed above as "n.d." did not have publicly available data for that particular fatality parameter, or not enough information was available to facilitate conversion between MW/year and turbine/year. The mean calculated for each of the two parameters was only made with projects for which data were available for that parameter.
[2] The fatality estimator used was not presented for the majority of the above studies; therefore, this information was not included.
[3] Unless otherwise noted with (**) fatality results presented in this table include all bird data (including raptors).

Project-wide annual fatality estimates for bats and raptors are relatively high (19.6, and 21 respectively) compared to the low number of carcasses detected across the year (n = 1 for both bats and raptors). Sapphos Environmental, Inc. expects that the low persistence rates are driving the relatively high annual estimates, and that by shortening the search interval on future studies, this will become less of a driving influence. Based on available reports, the persistence rates for non-raptors on the project may be the lowest reported of any wind energy project reviewed (Table 11, *Comparison of Persistence Rates*). This project had the lowest average persistence rate (1.26 days) for non-raptors of published wind energy project in the vicinity, which ranges from 2.18 to 6.98 days, with projects outside of California ranging from 10.9 to 26.3 days. Because raptors often have longer persistence rates than non-raptors, this could be driving the project's short persistence time (compared to the others, which may have included raptors in their persistence results). The results of this project's raptor persistence was much higher than raptor fatality rates observed at other projects, which can be explained by two potential reasons: 1) for this project, there was only one raptor used which was monitored until it disappeared completely (64 days), instead of many other studies that capped their survey period at 28 days and then monitoring for the raptors was terminated; and 2) for this project, surrogates were not used for persistence, whereas large ducks and other species that have been reported to be scavenged at faster rates than raptors were used (Table 11). The species of the carcasses used in persistence trials for many other projects (Table 11) are unknown because, in general, only size class data were presented. However, a few studies reported the utilization of chickens, chicks, pigeons, brown-headed cowbirds, ducks, quail, mallards, and European starlings (Table 11).[55,56,57,58]

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[55] BioResource Consultants, Inc. 14 October 2010. *2009/2010 Annual Report Bird and Bat Mortality Monitoring, Pine Tree Wind Farm, Kern County, CA*. Prepared for: Los Angeles Department of Water and Power. Ojai, CA.

[56] Western EcoSystems Technology, Inc. 2009. *Final Report: Fatality Study Summary at the Alite and Oak Creek Systems Wind Facilities, Alta–Oak Creek Wind Resource Area, Kern County, CA*. Prepared for: Alta Windpower Development, LLC, and CH2M Hill, Cheyenne, WY.

[57] Insignia Environmental. 4 September 2009. *2008/2009 Annual Report for the Buena Vista Avian and Bat Monitoring Project*. Prepared for: Contra Costa County, CA. Palo Alto, CA.

[58] Brown, K., K.S. Smallwood, and B. Karas. 2013. *Final: 2012–2013 Annual Report Avian and Bat Monitoring Project Vasco Winds, LLC*. Prepared for: NextEra Energy Resources. Portland, OR.

TABLE 11
COMPARISON OF PERSISTENCE RATES

Project Name(s)	Biome	Year	Species Used for Persistence	Average Persistence Rate (days)		
				Small Bird	Large Bird/Raptor	Combined
Tehachapi Pass Wind Resource Area, Kern County, CA						
Pacific Wind	**Desert**	**2012/2013**	**Ducks, brown-headed cowbird, and 4 turbine-killed carcasses**	**1.26 (3.00)†**	**64**	**3.05**
Undisclosed Kern County Project 1	Unreported	Unreported	Unreported	1.57 (2.09)†	18.59–67.68**	
Pine Tree[1]	Grassland, shrubland, forest	2009/2010	Unreported	1.92 (1.00)*	2.00 (2.86)‡	
Alta–Oak Creek[4]	Desert and grassland	2011/2012	Exotic quail, mallard, house sparrow, and 17 turbine-killed carcasses	2.43	15.07	
Undisclosed Kern County Project 2	Unreported	Unreported	Unreported	2.50	10.79–27.79**	
Mustang Hill and Alta VIII	Desert, grassland, shrubland	2012/2013	Exotic quail, mallard, house sparrow, and 9 turbine-killed carcasses	3.31	7.5–27.2**	2.62
Altamont Pass Area, Contra Costa County, CA						
Buena Vista Wind Farm[3]	Grassland	2008/2009	Exotic quail, rock pigeon	2.50	10.79–27.79**	
Diablo Wind[10]	Grassland	2005/2006	House sparrow, rock pigeon, and red-tailed hawk	8.6–10.2**	39.8–44.1**	
Oregon/Washington Projects (Columbia and Sherman Counties, OR; Benton County, WA)						
Biglow Canyon Wind[8]	Grassland and cultivated cropland	2008	Exotic quail, house sparrow, chicks, mallard, pheasant, and rock pigeon	10.1	17.8	
Nine Canyon Wind[12]	Grassland and shrubland	2002/2003	Diverse variety	11	33	
Biglow Canyon Wind II	Grassland and shrubland	2010/2011	Mallard, pheasant, rock pigeon, and house sparrow	13.1	27.7	
Klondike Wind I[5]	Grassland and shrubland	2002/2003	Western meadowlark, house sparrow, rock pigeons, mallard, and chukar	14.2	19.9	
Hopkins Ridge[13]	Grassland and forest	2006	European starling, house sparrow, chicks, mallard, and rock pigeon	26.6	19.9	

TABLE 11
COMPARISON OF PERSISTENCE RATES, Continued

Project Name(s)	Biome	Year	Species Used for Persistence	Average Persistence Rate (days)		
				Small Bird	Large Bird/Raptor	Combined
Montana/Wyoming Projects (Glacier, Toole, and Wheatland Counties, MT; Carbon County, WY)						
Judith Gap Wind[7]	Grassland and cultivated cropland	2006/2007	Pheasant and quail	5.3–13.2**	14.7–16.3**	
Glacier Wind Farm I & II[9]	Grassland and cultivated cropland	2010	Quail, rabbit, guinea pig			5–14††
Glacier Wind Farm I[6]	Grassland and cultivated cropland	2009	Ducks, quail, rabbit, guinea pig			13
Foote Creek Rim Wind[15]	Grassland and shrubland	1998–2002	Unreported	13	29 (37)‡	29

NOTES:
* Persistence of very small birds calculated separately.
‡ Persistence of medium birds calculated separately.
† Bat persistence calculated separately from small birds.
** Mean persistence varied by season.
†† Mean persistence varied by season and plant community.

SOURCES:

1. AECOM. 2010. *2009/2010 Annual Report Bird and Bat Mortality Monitoring Pine Tree Wind Farm Kern County, California*. Prepared by: BioResource Consultants, Inc. Ojai, CA.
2. Anderson, R., N. Neumann, J. Tom, W.P. Erickson, M.D. Strickland, M. Bourassa, K.J. Bay, and K.J. Sernka. 2004. *Avian Monitoring and Risk Assessment in the Tehachapi Pass Wind Resource Area*. Golden, CO: National Renewable Energy Laboratory.
3. Contra Costa County. 2009. *2008/2009 Annual Report for the Buena Vista Avian and Bat Monitoring Project*. Prepared by: Insignia Environmental, Palo Alto, CA.
4. Chatfield, A., M. Sonnenberg, and K. Bay. 2012. *Avian and Bat Mortality Monitoring at the Alta–Oak Creek Mojave Project, Kern County, California. Final Report for the First Year of Operation: March 22, 2011–June 15, 2012*. Prepared for: Alta Windpower Development, LLC, Mojave, CA. Prepared by: Western EcoSystems Technology, Inc., Cheyenne, WY.
5. Gritski, B., S. Downes, and K. Kronner. 2011. *Klondike IIIa (Phase 2) Wind Power Project Wildlife Monitoring Study*. Prepared by: Northwest Wildlife Consultants, Inc., Pendleton, OR.
6. NatureEner USA. 2011. *2010 Bird and Bat Mortality Survey Results*. Prepared by: AMEC Earth & Environmental, Inc., Helena, MT.
7. Judith Gap Energy, LLC. 2008. *Post-construction Avian and Bat Fatality Monitoring and Grassland Bird Displacement Surveys at the Judith Gap Wind Energy Project Wheatland, County, Montana*. Prepared by: TRC Environmental Corporation, Laramie, WY.
8. Enl, T., K. Bay, and J.R. Boehrs. 2012. *Year 2 Avian and Bat Monitoring Report Biglow Canyon Wind Farm Phase II Sherman County, Oregon*. Prepared by: Western EcoSystems Technology, Inc., Cheyenne, WY.
9. NatureEner USA. 2010. *2009 Bird and Bat Mortality Survey Results*. Prepared by: AMEC Earth & Environmental, Inc., Helena, MT.
10. Western EcoSystems Technology, Inc. 2006. *Diablo Winds Wildlife Monitoring Progress Report*. Cheyenne, WY.
11. Erickson, W.P., J.D. Jeffrey, and V.K. Poulton. 2008. *Puget Sound Energy Wild Horse Wind Facility Post-construction Avian and Bat Monitoring First Annual Report*. Prepared by: Western EcoSystems Technology, Inc., Cheyenne, WY.
12. Erickson, W., K. Kronner, and B. Gritski. 2013. *Nine Canyon Wind Power Project Avian and Bat Monitoring Report*. Prepared by: Western EcoSystems Technology, Inc., Cheyenne, WY.
13. Young, D.P., Jr., W.P. Erickson, J.D. Jeffrey, and V.K. Poulton. 2007. *Puget Sound Energy Hopkins Ridge Wind Project Phase 1 Post-construction Avian and Bat Monitoring First Annual Report*. Prepared by: Western EcoSystems Technology, Inc., Cheyenne, WY.
14. Erickson, W., G.D. Johnson, M.D. Strickland, and K. Kronner. 2000. *Final Report Avian and Bat Mortality Associated with the Vansycle Wind Project, Umatilla County, Oregon*. Prepared by: Western EcoSystems Technology, Inc., Cheyenne, WY.
15. Young, D.P., Jr., W.P. Erickson, R.E. Good, M.D. Strickland, and G.D. Johnson. 2003. *Avian and Bat Mortality Associated with the Initial Phase of the Foote Creek Rim Windpower Project, Carbon County, Wyoming*. Prepared by: Western EcoSystems Technology, Inc., Cheyenne, WY.

5.1 Recommendations

Sapphos Environmental, Inc. recommends the following modifications in Year 3 (2014–2015) monitoring to address the conditions observed in the 2012–2013 survey period.

1) **Conduct searches weekly.** The unusually low carcass persistence rate observed in Year 1 should be addressed by increasing the turbine search frequency from the weekly and bi-weekly intervals used in Year 1 to weekly throughout the year in order to reduce bias introduced by the short carcass persistence and provide a more robust estimate of fatality.

2) **Deploy smaller pool of biological monitors.** When planning future carcass surveys, Sapphos Environmental, Inc. will deploy a smaller pool of biologists (i.e., 4–5 individuals) to complete the year of surveys. According to the data, having a more survey-specific experienced team to conduct the surveys will likely increase the overall searcher efficiency detection rate.

3) **Use three size classes for placed carcasses in searcher efficiency trials.** Over the first year of monitoring, predominantly smaller sized birds were used, potentially making them more difficult to be detected, especially in vegetated areas. It is recommended that small, medium, and large birds be used equally, if possible. In order to avoid artificially increasing scavenger activity at the site and to increase the number of samples, high-quality surrogates such as artificial birds and bats could be placed in searcher efficiency trials at search turbines.

4) **Increase the number of placed carcasses for persistence trials.** Sapphos Environmental, Inc. recommends that more carcasses be placed for testing so that the fatality model can incorporate covariates that may improve the overall estimate, resulting in a more robust data set following Year 3. If available, scavenger trial carcasses should attempt to use species similar to species likely to be encountered at the site.

5) **Conduct persistence trials on turbines away from regular search plots.** Preforming persistence trials using bird or bat carcasses at different turbine plots than the ones that are being used for searcher efficiency is recommended because it is likely that scavengers are training themselves to return to the same search turbines for their meals (i.e., carcasses placed for searcher efficiency and persistence).

BioResource Consultants, Inc. 14 October 2010. *2009/2010 Annual Report Bird and Bat Mortality Monitoring, Pine Tree Wind Farm, Kern County, CA*. Prepared for: Los Angeles Department of Water and Power. Ojai, CA.

Brown, K., K.S. Smallwood, and B. Karas. 2013. *Final: 2012–2013 Annual Report Avian and Bat Monitoring Project Vasco Winds, LLC*. Prepared for: NextEra Energy Resources. Portland, OR.

California Energy Commission, and California Department of Fish and Game. 2007. *California Guidelines for Reducing Impacts to Birds and Bats from Wind Energy Development*. Commission Final Report. CEC-700-2007-008-CMF. Sacramento, CA: California Energy Commission, Renewables Committee, and Energy Facilities Siting Division; and California Department of Fish and Game, Resources Management and Policy Division.

Chatfield, A., and K. Bay. 2014. *Post-Construction Studies for the Mustang Hills and Alta VIII Wind Energy Facilities, Kern County, California. Final Report for the First Year of Operation: July 2012–October 2013*. Prepared for: EverPower Wind Holdings, Inc. and Brookfield Renewable Energy Group. Prepared by: Western EcoSystems Technology, Inc., Cheyenne, WY.

Huso, M., N. Som, and L. Ladd. 2012. *Fatality Estimator User's Guide*. U.S. Geological Survey Data Series 729. Reston, VA: U.S. Geological Survey.

Insignia Environmental. 4 September 2009. *2008/2009 Annual Report for the Buena Vista Avian and Bat Monitoring Project*. Prepared for: Contra Costa County, CA. Palo Alto, CA.

JMP Software. 2014. SAS Institute Inc., Cary, NC.

Johnson, G.D., W.P. Erickson, and J. White. 2003. *Avian and Bat Mortality at the Klondike, Oregon Phase I Wind Plant*. Technical report. Prepared for: Northwestern Wind Power. Prepared by: Western EcoSystems Technology, Inc., Cheyenne, WY, and Walla Walla, WA.

Kern County. June 2010. *Pacific Wind Energy Project Draft Environmental Impact Report*. Prepared by: Kern County Planning Department, Bakersfield, CA, with technical assistance by Aspen Environmental Group, Agoura Hills, CA.

Kern County. October 2010. *Pacific Wind Energy Project Final Environmental Impact Report*. SCH 2009091127. Prepared by: Kern County Planning Department, Bakersfield, CA.

Kerns, J., W.P. Erickson, and E.B. Arnett. 2005. "Bat and Bird Fatality at Wind Energy Facilities in Pennsylvania and West Virginia." In *Relationships between Bats and Wind Turbines in Pennsylvania and West Virginia: An Assessment of Bat Fatality Search Protocols, Patterns of Fatality, and Behavioral Interactions with Wind Turbines*, pp. 24–95. Edited by E.B. Arnett. A final report prepared for the Bats and Wind Energy Cooperative. Bat Conservation International. Austin, TX.

Kunz, T.H., E.B. Arnett, B.M. Cooper, W.P. Erickson, R.P. Larkin, T. Mabee, M.L. Morrison, M.D. Strickland, and J.M. Szewczak. 2007. "Assessing Impacts of Wind-Energy Development on Nocturnally Active Birds and Bats: A Guidance Document." *Journal of Wildlife Management*, *71*(8): 2449–2486.

Loss, Scott R., Tom Will, Peter P. Marra. December 2013. "Estimates of Bird Collision Mortality at Wind Facilities in the Contiguous United States." *Biological Conservation*, *168*: 201–209. Available at: http://dx.doi.org/10.1016/j.biocon.2013.10.007

Schoenfeld, P.S. 2004. Suggestions Regarding Avian Mortality Extrapolation. Unpublished report to West Virginia Highlands Conservancy, Davis, WV.

Sibley, D.A. 2000. *The Sibley Guide to Birds*. Washington, DC: National Audubon Society; New York, NY: Alfred A. Knopf.

Smallwood, K.S. 2006. *Biological Effects of Repowering a Portion of the Altamont Pass Wind Resource Area, California: The Diablo Winds Energy Project*. Available at: http://www.altamontsrc.org/alt_doc/r34_biological_effects_diablo_winds_smallwood_07_2006.pdf

Smallwood, K.S. 2007. "Estimating Wind Turbine-Caused Bird Mortality." *Journal of Wildlife Management*, *71*: 2781–2791.

U.S. Fish and Wildlife Service. 2012. *U.S. Fish and Wildlife Service Land-Based Wind Energy Guidelines*. Arlington, VA.

U.S. Geological Survey. [1965] Photo Inspected 1973. *7.5-Minute Series, Liebre Twins, CA, Topographic Quadrangle*. Reston, VA.

U.S. Geological Survey. [1965] Photo Inspected 1974. *7.5-Minute Series, Fairmont Butte, CA, Topographic Quadrangle*. Reston, VA.

U.S. Geological Survey. [1965] Revised 1995. *7.5-Minute Series, Tylerhorse Canyon, CA, Topographic Quadrangle*. Reston, VA.

U.S. Geological Survey. 1995. *7.5-Minute Series, Neenach School, CA, Topographic Quadrangle*. Reston, VA.

Warren-Hicks, W., J. Newman, R. Wolpert, B. Karas, and L. Tran. 2013. *Improving Methods for Estimating Fatality of Birds and Bats at Wind Energy Facilities*. Publication Number: CEC-500-2012-086. Sacramento, CA: California Energy Commission.

Western EcoSystems Technology, Inc. 2009. *Final Report: Fatality Study Summary at the Alite and Oak Creek Systems Wind Facilities, Alta–Oak Creek Wind Resource Area, Kern County, CA*. Prepared for: Alta Windpower Development, LLC and CH2M Hill, Cheyenne, WY.

Western EcoSystems Technology, Inc. 12 September 2012. *Avian and Bat Mortality Monitoring at the Alta–Oak Creek Mojave Project Kern County, California, Final Report for the First Year of Operation March 22, 2011–June 15, 2012*. Prepared for: Alta Windpower Development, LLC, Mojave, CA. Cheyenne, WY.

Young, D.P., Jr., W.P. Erickson, J. Jeffrey, and V.K. Poulton. 2007. *Puget Sound Energy Hopkins Ridge Wind Project Phase 1 Post-Construction Avian and Bat Monitoring First Annual Report, January–December 2006*. Technical report. Prepared for: Puget Sound Energy, Dayton, WA, and Hopkins Ridge Wind Project Technical Advisory Committee, Columbia County, WA. Prepared by: Western EcoSystems Technology, Inc., Cheyenne, WY, and Walla Walla, WA.