Post-Construction Avian and Bat Mortality Study at the Lower West Wind Energy Project Kern County, California

Final Report for the Third Year of Operation

July 2014 – July 2015

Prepared for:
Brookfield Renewable Energy Partners, LP

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EXECUTIVE SUMMARY

In 2012, Western Wind, LLC (WW) contracted Western Ecosystems Technology, Inc. (WEST) to conduct mortality surveys at the Lower West Wind Energy Project (Project) in Kern County, California, during the first, third, and fifth years of operation for the purpose of estimating the impacts of the wind energy facility on birds and bats. In 2013, Brookfield Renewable Energy Partners, LP (BREP) purchased the Project from WW, at which time it was decided that WEST would continue the monitoring effort. The following document contains the results of the second year of mortality monitoring (third year of operation) conducted at the Project.

The primary objective of the mortality monitoring study was to determine the level of bird and bat mortality (high, moderate, low levels compared to other facilities in the region) attributable to collisions with wind turbines for the entire facility on an annual basis. The monitoring study consisted of four components: 1) standardized carcass surveys of selected turbines; 2) searcher efficiency trials to estimate the percentage of carcasses found by searchers; 3) carcass removal trials to estimate the length of time that a carcass remained in the field for possible detection; and 4) adjusted mortality estimates for birds and bats, calculated using the results from searcher efficiency trials and carcass removal trials to estimate the approximate level of bird and bat mortality within the Project.

Avian and bat monitoring at the Project was conducted from July 12, 2014 – July 30, 2015. The original study design for the Project called for monitoring plots surrounding four randomly selected turbines. Each of the four sampled turbine plots was searched approximately twice per month during the monitoring year for a total of 25 visits to each plot and a grand total of 100 turbine plot searches. Search plots consisted of 120-meter (m; 394-foot [ft]) radius circles centered on each sampled turbine. Surveyors walked parallel transects within the search plots while scanning the ground for carcasses or injured birds or bats. During the study, one bird carcass, a house finch, and one bat carcass, a Mexican free-tailed bat, were found. Both carcasses were found during the winter period.

To determine searcher efficiency rates for the Project, data from Lower West and three other nearby BREP wind facilities (Windstar, Coram, and Alta Vlll; Coram has since been sold to RET Capital) were used. A total of 311 bird carcasses and 17 brown mice carcasses (bat surrogates) were included in the searcher efficiency trials analysis. Overall searcher efficiency rates were 96.7% for large birds, 76.6% for small birds, and 76.5% for bats (mouse surrogates). To determine carcass removal rates for the Project, data from Lower West and three other nearby BREP wind facilities, Windstar, Coram, and Alta Vlll were used. Twenty-four carcass removal trials were conducted during which 330 carcasses were used for the trials (including 94 large birds, 214 small birds, and 22 brown mice (bat surrogates]); by Day 10, roughly 8% of small birds and 5% of bats (mouse surrogates) remained where they were placed, compared to roughly 50% of large birds. The mean carcass removal time for large birds during the annual period was 24.1 days. The mean carcass removal time for small birds during summer was 4.7

days, and 2.5 days during the remaining seasons. The mean carcass removal time for bats (mouse surrogates) was 2.0 days during all seasons.

Mortality estimates were adjusted based on the corrections for carcass removal and observer detection bias. For small birds, the probability that a carcass would remain in the search plot and be found by a searcher was 0.14 in spring, winter, and fall, and 0.22 in summer. For large birds, the probability that a carcass would remain in the search plot and be found by a searcher was 0.72 in all seasons, while the same probability for bats (mouse surrogates) was 0.11 in all seasons. Overall mortality estimates were calculated for five categories: 1) small birds, 2) large birds, 3) diurnal raptors, 4) all birds, and 5) bats. The estimated Project-wide mortality rate for all bird species was 0.90 birds per megawatt (MW) per year and the estimated Project-wide mortality rate for bats was 1.13 bats per MW per year. Because no large bird or diurnal raptor fatalities were found during the study, the estimated mortality rate for large birds and diurnal raptors was zero birds per MW per year.

STUDY PARTICIPANTS

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INTRODUCTION

In 2013, Brookfield Renewable Energy Partners, LP (BREP) purchased from Western Wind, LLC (WW), a wind energy facility in Kern County, California, referred to as the Lower West Wind Energy Project (Project; Figure 1). Previously, in 2012, pursuant to a permit requirement to perform three years of post-construction fatality monitoring, WW contracted Western EcoSystems Technology, Inc. (WEST) to develop and implement a standardized protocol for the mortality monitoring study with the purpose of estimating the impacts of the wind energy facility on birds and bats. The study protocol is similar to those used at other wind energy facilities throughout California and the US. Data collection and analysis follows the recommendations presented in the US Fish and Wildlife Service (USFWS) Wind Turbine Guidelines Advisory Committee (USFWS 2012) and the California Wind Energy Guidelines (California Energy Commission [CEC] and California Department of Fish and Game [CDFG] 2007), and is based on WEST's experience studying wildlife at wind energy projects throughout the US. Following BREP's purchase of the Project from WW, BREP opted to have WEST continue the monitoring effort. This report presents the results of avian and bat mortality studies conducted at the Project during the third year of operation, from July 2014 to July 2015.

The primary objective of the mortality monitoring study was to estimate the level of bird and bat mortality attributable to interactions with wind turbines at the Project on an annual basis. The methods for the mortality study are broken into four primary components: 1) standardized carcass surveys of selected turbines; 2) searcher efficiency trials to estimate the percentage of carcasses found by searchers; 3) carcass removal trials to estimate the length of time that a carcass remained in the field for possible detection; and 4) adjusted mortality estimates for bird and bat species, calculated using the results from searcher efficiency trials and carcass removal trials to estimate the total number of bird and bat mortalities within the Project area.

Post-construction mortality monitoring at the Project was conducted from July 12, 2014, through July 30, 2015. In addition to site-specific data, this report presents existing information and results from post-construction studies conducted at other wind energy facilities in California and the Pacific Northwest. Where possible, comparisons with local studies were made.

STUDY AREA

The Project lies on approximately 185 acres (0.29 square miles [mi^2]) located one mile (1.6 kilometers [km]) east of Tehachapi Willow Springs Road, and three miles (five km) south of Oak Creek Road in the Tehachapi Wind Resource Area (TWRA) of southeastern Kern County at the base of the Tehachapi Mountains in the Western Mojave Desert (Figure 1).

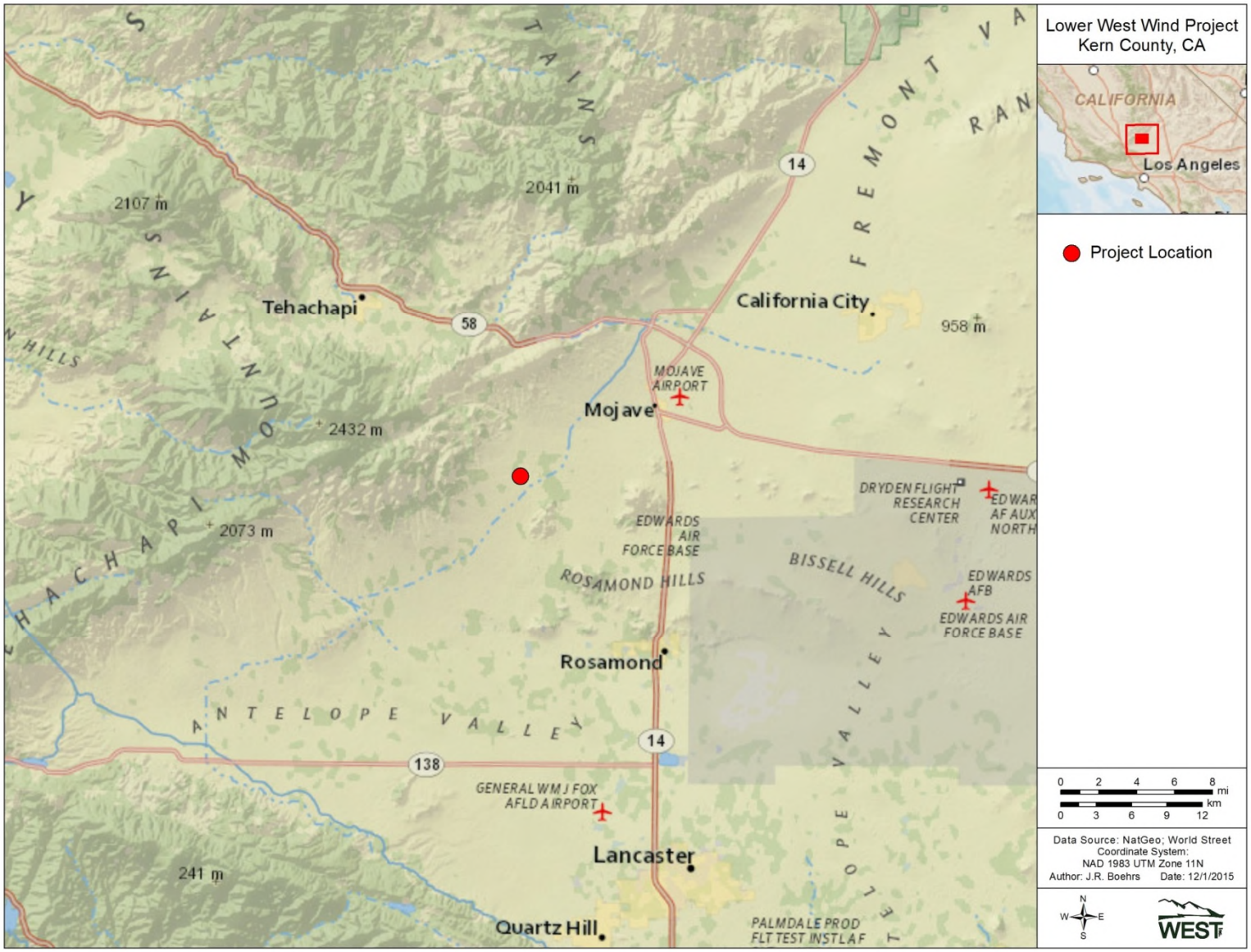

Figure 1. Location of the Lower West Wind Energy Project.

The Project vicinity is generally characterized as sparsely developed and rural. Land uses in and around the Project area consist of open space with scattered residences, off-highway vehicle use, livestock grazing, and numerous wind energy facilities. The nearest populated area is located east of the Project in the outskirts of the unincorporated community of Mojave. Existing developments surrounding the Project area include right-of-ways (ROWs) for underground pipelines, underground portions of the Los Angeles Aqueduct, Southern California Edison (SCE) electric transmission lines, and a Los Angeles Department of Water and Power (LADWP) electric transmission line easement. The existing, permitted, and proposed wind energy and transmission projects proximate to the Project area include: the Windstar Wind Project, Alta Oak Creek Mojave Wind Project, Mustang Hills Wind Farm, Pinyon Pines I and II, Alta VIII, Alta X Wind Energy Projects, the Rising Tree Wind Project, the Avalon Wind Project, Pacific Wind Energy Project, the Manzana Wind Power Project, the Catalina Renewable Energy Project, and SCE's Tehachapi Renewable Transmission Line Project (TRTP).

The Project is located at the intersection of two ecological regions; the western Mojave Desert to the southeast, and the Tehachapi Mountains in the southern Sierra Nevada to the northwest (US Environmental Protection Agency [USEPA] 2013). Topography of the Project site consists of nearly level alluvial plains and pediments. The Project site sits at an elevation of about 3,000 feet (ft; 914 meters [m]). Project vegetation is composed of xeric desert scrub with scattered stands of Joshua tree (*Yucca brevifolia*).

METHODS

Avian and Bat Mortality Study

The primary objective of the mortality monitoring study was to estimate the level (high, moderate, or low, relative to other projects) of bird and bat mortality for the entire facility on an annual basis. The methods for the mortality study were broken into four primary components: 1) standardized carcass surveys of selected turbines; 2) searcher efficiency trials to estimate the percentage of carcasses found by searchers; 3) carcass removal trials to estimate the length of time that a carcass remained in the field for possible detection; and 4) adjusted mortality estimates for bird and bat species, calculated using the results from searcher efficiency trials and carcass removal trials to estimate the total number of bird and bat mortalities within the Project.

There were three scenarios under which carcasses were found in the Project: 1) during the standardized carcass searches for the study; 2) while study personnel were on site, but not conducting a standardized search (i.e., an incidental find); and 3) by facility personnel or others on site for other purposes. Carcasses found by study personnel regardless of timing (i.e., during a standardized survey or not) were recorded by the methods described below. All carcasses found within a search plot, even if outside of the standard survey period, were included in the dataset under the broad assumption that they would have been found during standardized surveys.

The total number of bird and bat carcasses was estimated by adjusting for search frequency, removal bias (length of stay in the field), searcher efficiency bias (percent found), and proportion of the survey plot searched. For carcasses where the cause of death was not apparent, the assumption that the mortality was the result of collision or interaction with a wind turbine was made for the analysis. This approach likely led to an overestimate of the true number of facility-related mortalities, but most wind energy facilities have used this conservative approach because of the relative high costs associated with obtaining accurate estimates of natural or reference mortality (see Johnson et al. 2000).

Field Methods

Standardized carcass searches were conducted at the Project from July 12, 2014, through July 30, 2015. Searches were conducted by WEST Field Technicians and overseen by the Project Manager. Turbines were selected for sampling using a systematic design with a random start.

The study plan called for systematic carcass searches of 120-m (394-ft) radius circular plots centered around four randomly selected turbines, resulting in approximately 57% coverage of the Project's seven turbines. Studies at facilities with other large turbines (e.g., Johnson et al. 2003b, Young et al. 2006, Kerlinger et al. 2007) indicate most of the casualties are found within the area that is roughly equivalent to the height of the turbine tower. The plot size at the Project encompassed a larger area, as all sampled turbines within the Project (Figure 2) are 110.5-m (362.5-ft) tall Gamesa 2.0-megawatt [MW]) turbines.

Standardized carcass surveys were conducted approximately every two weeks during the spring (March 1 to May 31), summer (June 1 to August 31), fall (September 1 to November 31), and winter (December 1 to February 28) at each of the sampled turbines.

Standardized Carcass Surveys

The objective of the standardized carcasses surveys was to systematically search the wind energy facility for bird and bat carcasses. Each carcass found was recorded using the following categories:

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

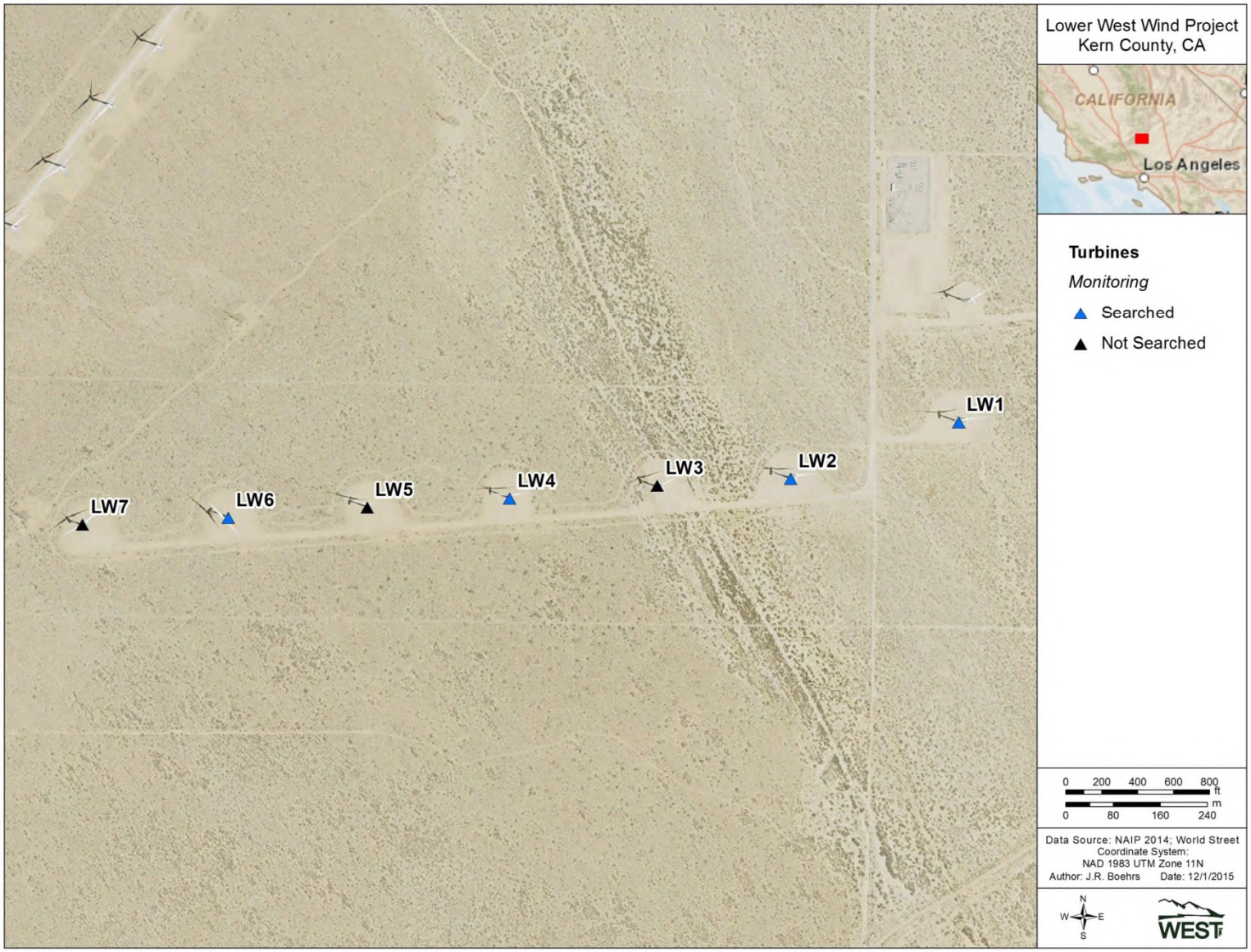

Figure 2. Lower West Wind Energy Project turbine layout.

For all carcasses found, data recorded included: species, sex and age when possible, date and time encountered, Global Positioning System (GPS) location, condition (intact, scavenged, feather spot), and any comments that indicated possible cause of death. All carcasses were photographed as found, including detailed close-up photos of the carcass for identification purposes, as well as photos showing location of the carcass in relation to the closest wind turbine or other Project facilities, such as overhead power lines or meteorological (met) towers. In addition to carcasses, any injured bird or bat observed in the search plots was recorded and treated as a fatality.

The Project does not have a Special Utility Permit from the USFWS, nor does it have a Scientific Collecting Permit from the California Department of Fish and Wildlife [CDFW], formerly the CDFG). As a result, study personnel were not permitted to possess any carcasses of native migratory birds encountered during searches, and all bird and bat carcasses were left in the field as found. Because of this, care was taken in photographing carcasses for purposes of identification and in accurately recording the condition and location of all carcasses so as to avoid double-counting in the event that a carcass' appearance changed or it was moved by a scavenger.

Carcasses found outside the formal search area by study personnel were treated following the above protocol as closely as possible. Carcasses observed in non-search areas (e.g., near a turbine not included in the search area), or observed within search areas but outside of the standard search period, were coded as incidental discoveries and were documented in a similar fashion as those found during standardized searches. Carcasses found by maintenance personnel and other personnel not conducting the formal searches were similarly documented and included in the overall dataset.

Searcher Efficiency Trials

The objective of the searcher efficiency trials was to estimate the percentage of carcasses found by searchers. Searcher efficiency trials were conducted in the same areas as standardized carcass surveys. Personnel conducting carcass surveys did not know when searcher efficiency trials were being conducted or the location of the trial carcasses. To determine searcher efficiency rates for the Project, data from Lower West and three other nearby BREP wind facilities, Windstar, Coram, and Alta Vlll (Coram has since been sold to RET Capital), were used. Searcher efficiency was estimated by the size of carcass (large versus small), and season. In addition, brown mice were used as surrogates for bats. Estimates of searcher efficiency were used to adjust the total number of carcasses found for those missed by searchers, correcting for detection bias.

Searcher efficiency trials were conducted 20 times from November 2012 through July 2015, during which time, the trial results were found to not differ significantly between years. A total of 328 carcasses (91 large birds, 220 small birds, and 17 brown mice [*Mus musculus;* bat surrogates]) were placed. Carcasses used for searcher efficiency trials were primarily non-native/non-protected and/or commercially available species (Coturnix quail [*Coturnix* spp.], mallard [*Anas platyrhynchos*], and house sparrows [*Passer domesticus*]). Because bat

carcasses were not available for the trials, brown mouse carcasses were used to simulate bat carcasses.

All searcher efficiency trial carcasses were placed at random locations within search areas prior to a day's scheduled carcass survey. Each trial carcass was discreetly marked with electrical tape so that it could be identified as a study carcass after it was found. The number and location of the searcher efficiency carcasses found during the carcass survey were recorded. The number of carcasses available for detection during each trial was determined immediately after the trial by the person responsible for distributing the carcasses. Carcasses determined to have been scavenged before a searcher had a chance to locate them were excluded from the analysis.

Carcass Removal Trials

Twenty-four carcass removal trials were conducted during which 330 carcasses were used for the trials including 94 large birds, 214 small birds, and 22 brown mice (bat surrogates). The objective of carcass removal trials was to estimate the average length of time a carcass remained in the study area and was potentially detectable. Carcasses used for carcass removal trials were non-native/non-protected or commercially available species (Coturnix quail, mallard, rock pigeon [*Columba livia*], house sparrows, and brown mice [bat surrogates]). Carcass removal included removal by predation or scavenging, or could include removal by other less likely means, such as burial by wind-blown sand. Turbines, including searched and non-searched turbines, were randomly selected for inclusion in the removal trials. Estimates of carcass removal were used to adjust the total number of carcasses found for those removed from the study area, correcting for removal bias. Trials were spread throughout the year to incorporate the effects of varying weather, climatic conditions, and scavenger densities.

Trial carcasses were randomly placed at selected turbines within a plot of similar size to the actual search plots. Personnel conducting carcass searches monitored the trial birds over a 40-day period, checking the carcasses every day for the first four days of the trial, and then again on days seven, 10, 14, 18, 25, and 30. This schedule varied somewhat depending on weather and coordination with the other survey work. Removal trial carcasses were marked discreetly (e.g., with dark electrical tape around one or both legs) for recognition by searchers and other personnel, and left at the location until the end of the carcass removal trial. At the end of the 40-day period, any remaining evidence of the carcass was removed.

Statistical Analysis

Quality Assurance and Quality Control

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

identified in later stages of analysis were traced back to the raw data forms, and appropriate changes in all steps were made.

Data Compilation and Storage

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

Mortality Surveys

Estimates of mortality are based on:

(1) Observed number of carcasses found during standardized searches during the monitoring year, for which the cause of death was either unknown or was probably facility-related;

(2) Non-removal rates, expressed as the estimated average probability a carcass was expected to remain in the study area and be available for detection by the searchers during removal trials; and

(3) Searcher efficiency, expressed as the proportion of planted carcasses found by searchers during searcher efficiency trials.

The number of bird and bat mortalities of unknown cause and those probably attributable to operation of the wind energy facility were reported together. All carcasses located within areas surveyed or incidentally throughout the Project site, regardless of species, were recorded. Total number of bird and bat carcasses was estimated by adjusting for removal and searcher efficiency bias. If the cause of death was not apparent, a "worst case" estimate was made by attributing mortality to the operation of the wind energy facility. Necropsies were not performed so causes of mortality were not conclusive.

Overall mortality estimates are provided for five categories: 1) small birds, 2) large birds, 3) raptors, 4) all birds, and 5) bats. Seasonal mortality estimates were calculated when possible and to calculate the annual project-wide mortality rate for each of the above bird/bat categories, the seasonal average, weighted by the number of searched turbines was calculated and summed across seasons.

Definition of Variables

The following variables are used in the equations below:

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

n the number of search plots

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

Observed Number of Carcasses

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

$$\bar{c} = \frac{\sum_{i=1}^{n} c_i}{k \cdot A} \quad (1)$$

Estimation of Carcass Non-Removal Rates

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

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

Estimation of Searcher Efficiency Rates

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

Estimation of Facility-Related Mortality Rates

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

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

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

$\hat{\pi}$ is calculated as follows:

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

This formula has been independently verified by Shoenfeld (2004). The final reported estimates of *m* and associated standard errors and 90% confidence intervals were calculated using bootstrapping (Manly 1997). Bootstrapping is a computer simulation technique that is useful for calculating point estimates, variances, and confidence intervals for complicated test statistics. For each bootstrap sample, $\bar{c}$, $\bar{t}$, p, $\hat{\pi}$, and *m* were calculated. A total of 1,000 bootstrap samples were used. The reported estimates are the mathematical means of the 1,000 bootstrap estimates. The standard deviation of the bootstrap estimates is the estimated standard error. The lower 5th and upper 95th percentiles of the 1,000 bootstrap estimates are estimates of the lower limit and upper limit of 90% confidence intervals.

RESULTS

Avian and Bat Mortality Surveys

A sample of four turbines out of a total of seven turbines at the Project was searched during the study. Each of the sampled turbines/turbine strings was searched approximately every two weeks for a full year (25 visits over the course of 12 consecutive months), for a total of 100 plot searches.

A total of one bird and one bat were found during standardized carcass surveys; no carcasses were found incidentally (Table 1). The number, species, location, other characteristics of the

bird and bat carcasses, and the mortality estimates adjusted for searcher efficiency and carcass removal biases are discussed below, and a full listing of finds is presented in Appendix A.

Table 1. Total number of bird and bat carcasses and the composition of carcasses discovered at the Lower West Wind Energy Project from July 12, 2014 – July 30, 2015.

	Fatalities during Scheduled Searches		Incidental Fatalities at Search Plots		Other Incidentals		Total	
Species	**Total**	**% Comp.**	**Total**	**% Comp.**	**Total**	**% Comp.**	**Total**	**% Comp.**
house finch	1	100	0	0	0	0	1	100
Mexican free-tailed bat	1	100	0	0	0	0	1	100

Bird and Bat Mortalities

During the study, one bird (house finch [*Carpodacus mexicanus*]) and one bat (Mexican free-tailed bat [*Tadarida brasiliensis*]) were found during scheduled searches (Table 1, Figures 3 and 4).

The house finch carcass was found during a scheduled search at Turbine LW2 (Figure 4) during the winter (Figures 5 and 6; Appendix A). The Mexican free-tailed bat carcass was found at Turbine LW1, also during the winter (Figures 7 and 8; Appendix A). The bird carcass was found within 60 m (197 ft) of the turbine while the bat was found within 20 m (66 ft) of the turbine (Table 2).

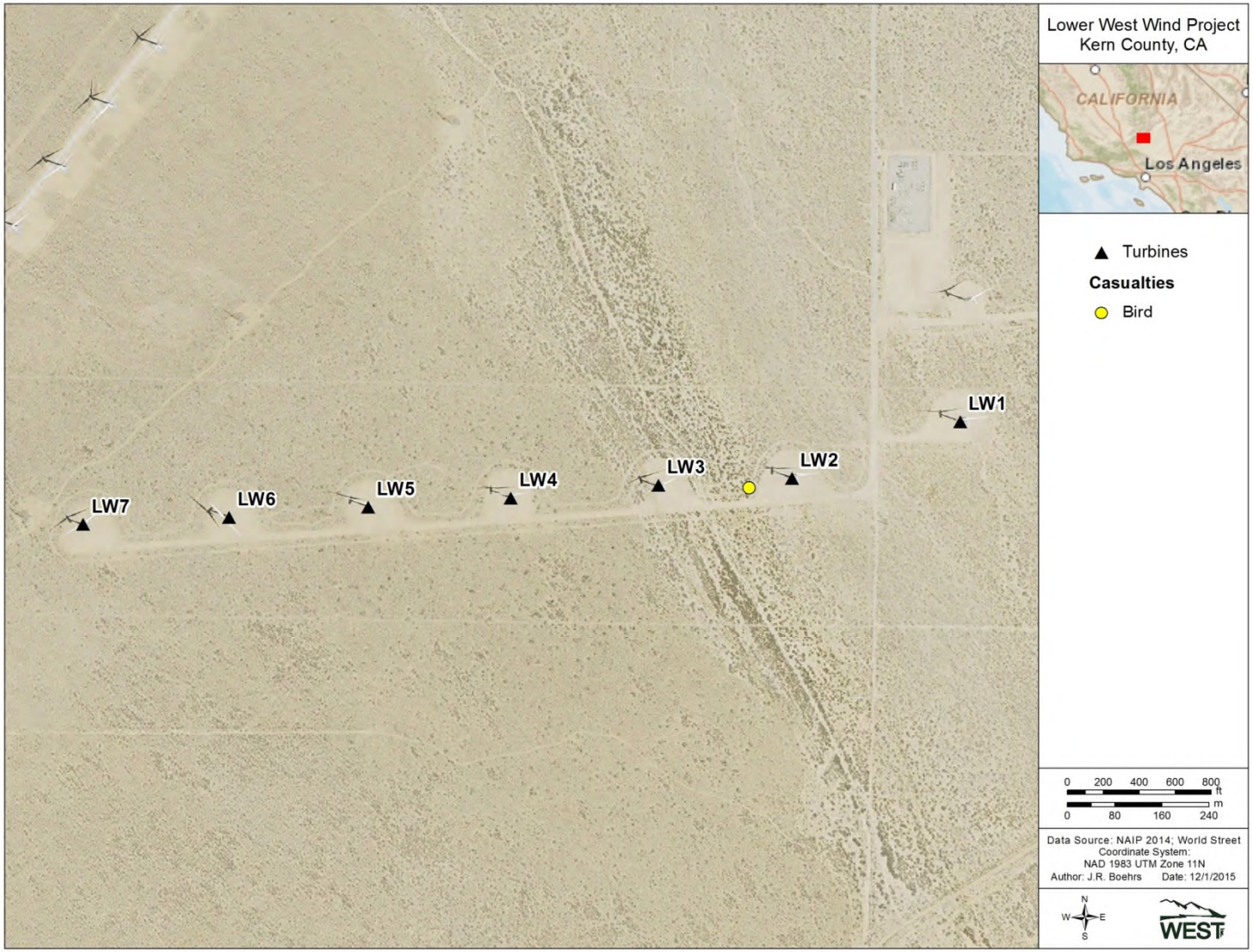

Figure 3. Location of bird carcass found during standardized carcass searches within the Lower West Wind Energy Project. No carcasses were found incidentally.

Figure 4. Location of bat carcass found during standardized carcass searches within the Lower West Wind Energy Project. No carcasses were found incidentally.

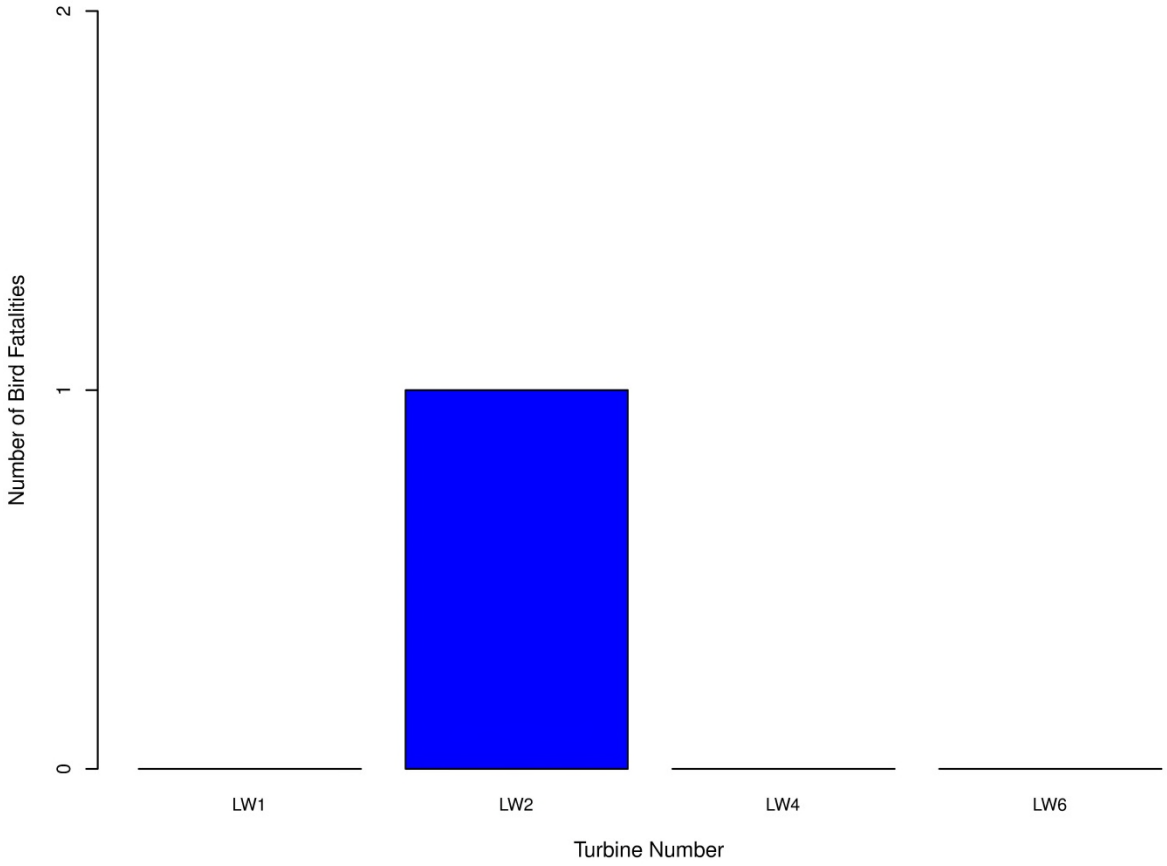

Figure 5. Number of bird carcasses by turbine found during scheduled searches on turbine search plots at the Lower West Wind Energy Facility. No carcasses were found incidentally.

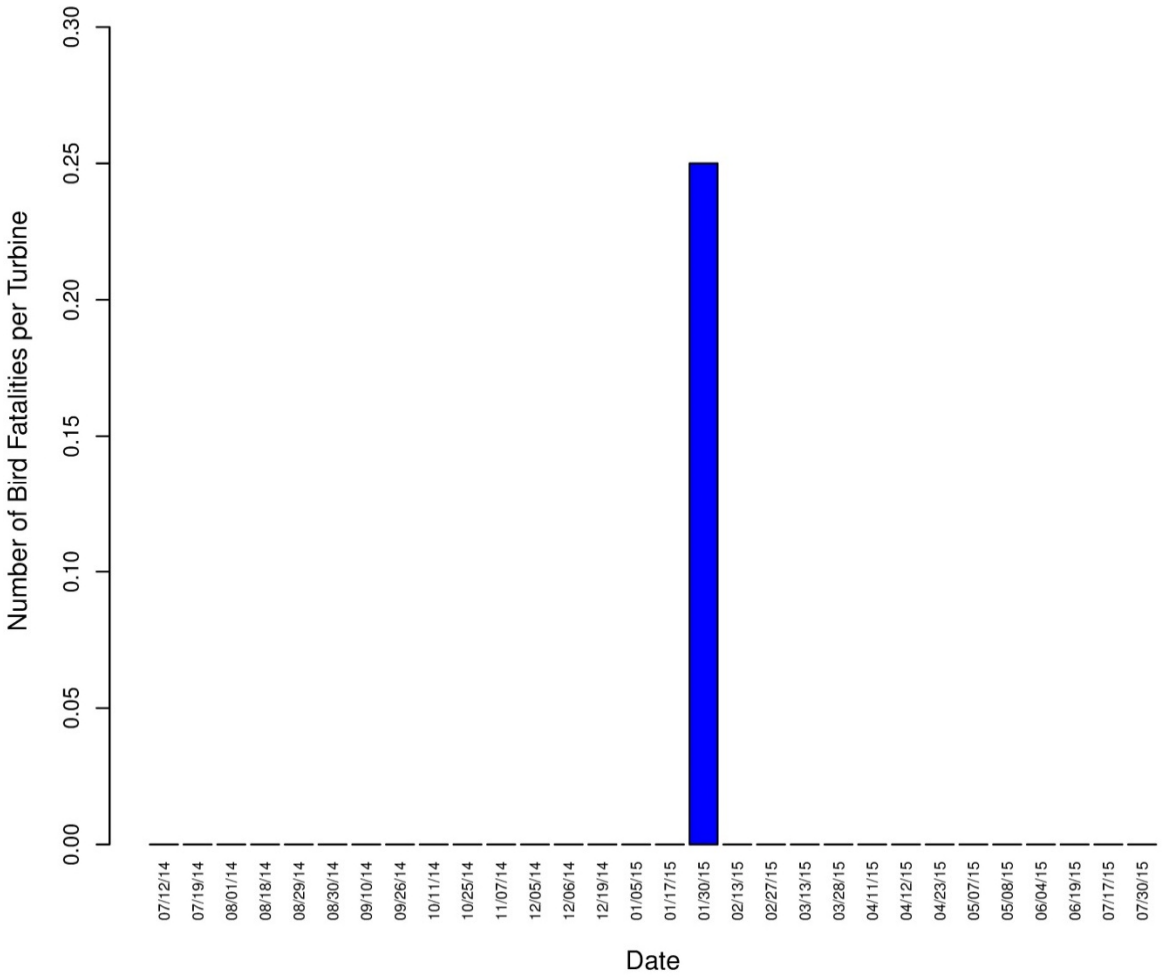

Figure 6. Timing of bird finds during standardized carcass searches at the Lower West Wind Energy Project. No carcasses were found incidentally.

Table 2. Distribution of distances from turbines of bird and bat casualties found during scheduled searches on turbine search plots at the Lower West Wind Energy Project. No carcasses were found incidentally.

Distance to Turbine (m)	% Bird Casualties	% Bat Casualties
0 to 10	0	0
10 to 20	0	100
20 to 30	0	0
30 to 40	0	0
40 to 50	0	0
50 to 60	100	0
60 to 70	0	0
70 to 80	0	0
80 to 90	0	0
>90	0	0

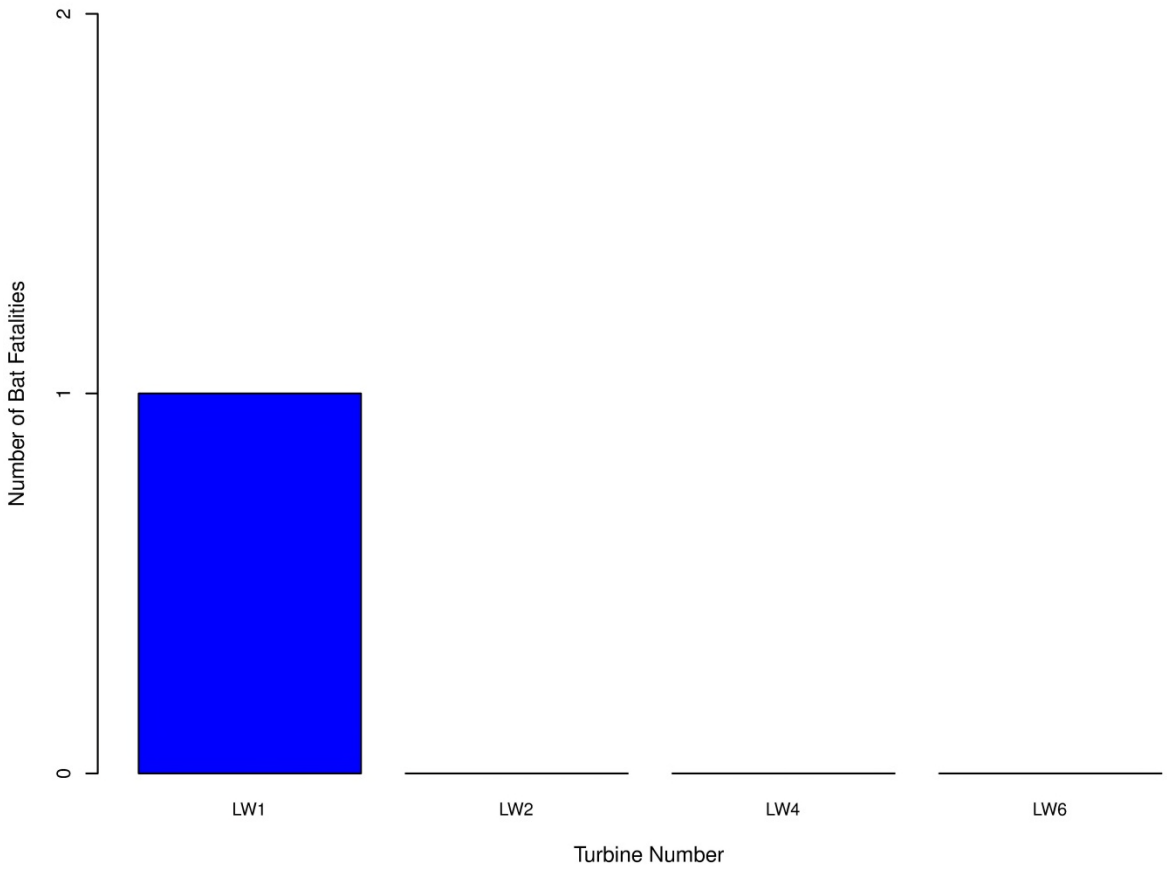

Figure 7. Number of bat carcasses by turbine found during scheduled searches on turbine search plots at the Lower West Wind Energy Facility. No carcasses were found incidentally.

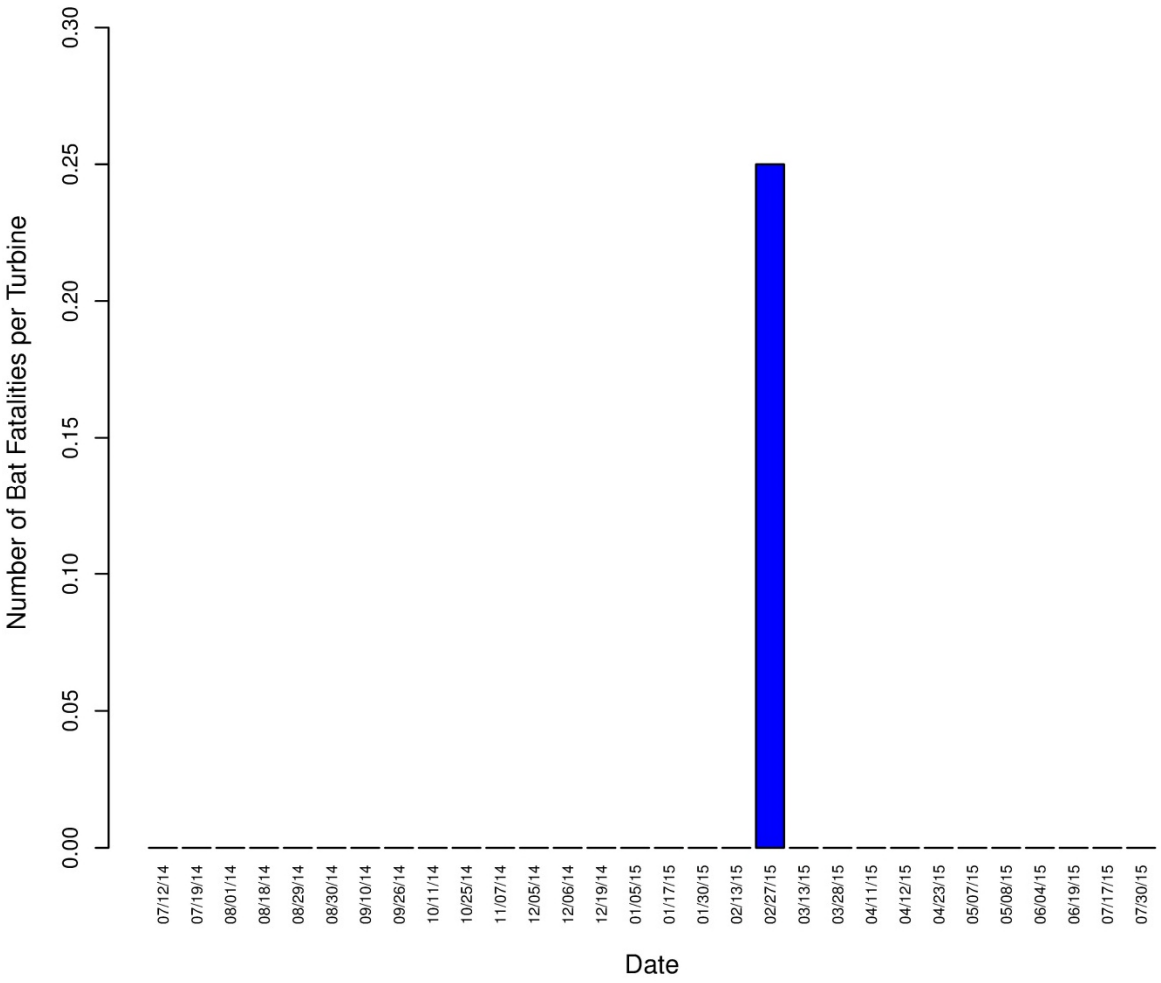

Figure 8. Timing of bat finds during standardized carcass searches at the Lower West Wind Energy Project. No carcasses were found incidentally.

Searcher Efficiency Trials

A total of 328 carcasses (91 large birds, 220 small birds, and 17 brown mice [bat surrogates]) were placed during searcher efficiency trials (Table 3). The trials were conducted at the Project, two other nearby Brookfield projects (Alta Vlll and Windstar), and Coram. The overall searcher efficiency rate was 76.6% for small birds, 96.7% for large birds, and 76.5% for bats/mice.

Table 3. Searcher efficiency results for the Lower West Wind Energy Project by date as a function of carcass size or type.

Size	Date	# Placed	# Available	# Found	% Found
Small Birds	11/1/2012	13	9	6	66.7
	11/13/2012	18	12	8	66.7
	12/18/2012	14	12	7	58.3
	3/13/2013	5	5	4	80.0
	3/14/2013	13	10	8	80.0
	5/10/2013	16	16	13	81.3
	9/13/2013	15	14	11	78.6
	12/5/2013	16	12	10	83.3
	2/7/2014	15	11	10	90.9
	3/7/2014	15	15	13	86.7
	10/27/2014	5	5	5	100.0
	11/6/2014	6	5	4	80.0
	11/7/2014	15	15	11	73.3
	11/11/2014	6	6	5	83.3
	1/27/2015	7	7	6	85.7
	1/29/2015	5	5	4	80.0
	1/30/2015	10	9	6	66.7
	2/18/2015	7	7	5	71.4
	6/3/2015	8	6	4	66.7
	7/30/2015	11	11	7	63.6
Overall Small Birds		**220**	**192**	**147**	**76.6**
Large Birds	11/1/2012	2	2	2	100.0
	11/13/2012	3	3	3	100.0
	12/18/2012	4	4	4	100.0
	3/13/2013	2	2	2	100.0
	3/14/2013	5	5	4	80.0
	5/10/2013	6	6	6	100.0
	9/13/2013	5	5	5	100.0
	12/5/2013	9	8	8	100.0
	2/7/2014	7	7	7	100.0
	3/7/2014	8	8	8	100.0
	10/27/2014	3	3	3	100.0
	11/6/2014	3	3	3	100.0
	11/7/2014	5	5	5	100.0
	11/11/2014	3	3	3	100.0
	1/27/2015	4	4	4	100.0
	1/30/2015	5	5	5	100.0
	2/18/2015	4	4	4	100.0
	6/3/2015	4	4	4	100.0
	7/30/2015	9	9	7	77.8
Overall Large Birds		**91**	**90**	**87**	**96.7**
Bats (mouse surrogates)	10/27/2014	3	3	1	33.3
	11/6/2014	3	3	3	100.0
	11/11/2014	3	3	3	100.0
	1/27/2015	2	2	1	50.0
	2/18/2015	3	3	2	66.7
	6/3/2015	3	3	3	100.0
Overall Bats		**17**	**17**	**13**	**76.5**

Carcass Removal Trials

Twenty-four carcass removal trials were conducted during which 330 carcasses were used for the trials including 94 large birds, 214 small birds, and 22 brown mice [bat surrogates]. The trials were conducted at the Project, two additional nearby Brookfield projects (Windstar and Alta VIII), and Coram. The trial carcasses were of similar composition to those used for searcher efficiency trials. By Day 10, roughly 8% of small birds and 5% of bats (mouse surrogates) remained where they were placed, compared to roughly 50% of large birds (Figure 9). By Day 20, roughly 5% of small birds and no bats (mouse surrogates) remained, while roughly 40% of large bird carcasses remained (Figure 9). The mean carcass removal time (and corresponding 90% confidence interval) for large birds during the annual period was 24.1 days (18.8 – 31.7 days). The mean carcass removal time for small birds during summer was 4.7 days (2.9 – 7.1 days) and 2.5 days (1.9 – 3.4 days) during the remaining seasons. Lastly, the mean carcass removal time for bats (mouse surrogates) was 2.0 days (1.1 – 3.1 days; Appendix B) during all seasons.

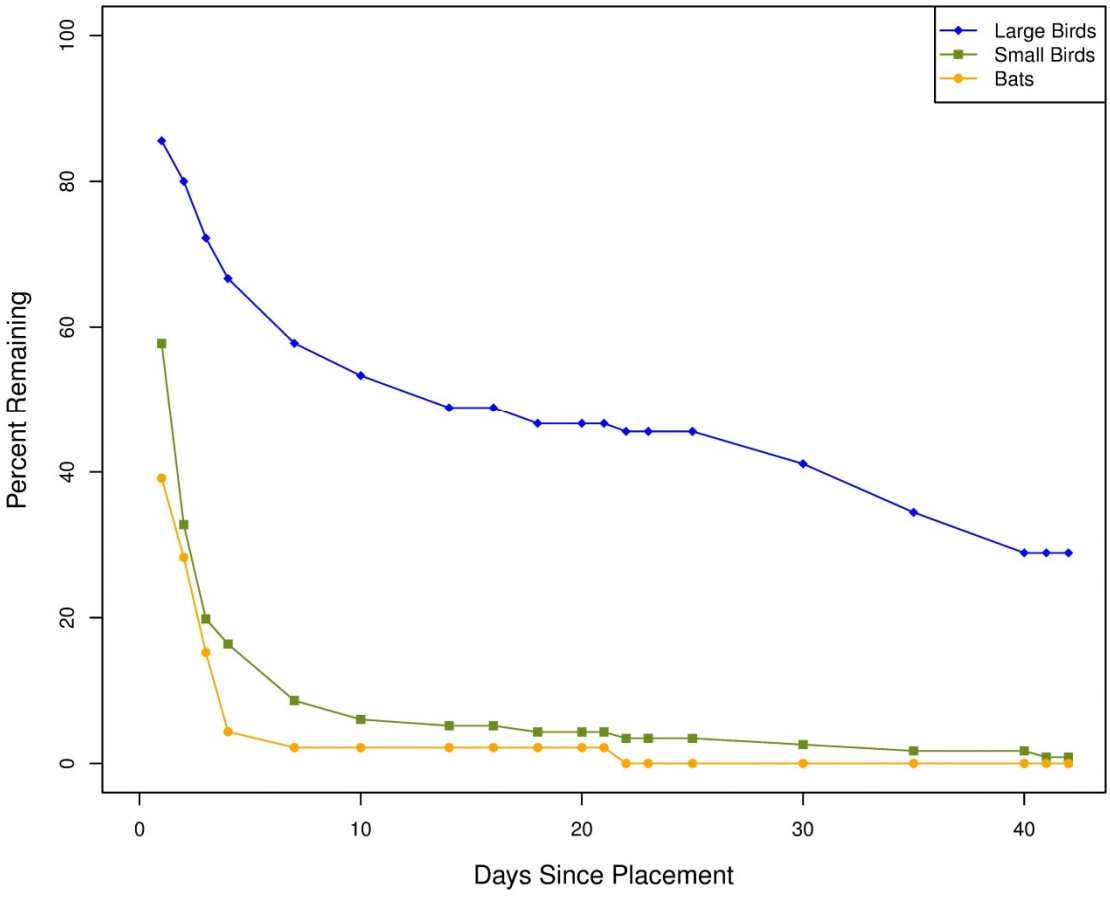

Figure 9. Carcass removal rates at the Lower West Wind Energy Project.

Adjusted Mortality Estimates

Overall project-wide mortality estimates were calculated for each bird/bat category on a per MW basis (Table 4; Appendix B; 90% confidence intervals are not reported due to low sample sizes). Mortality estimates were calculated for the winter study period as no mortalities were encountered during any other season (Appendix B). The mortality estimates were adjusted based on the corrections for carcass removal and observer detection bias (Appendix B). Because 100% of each search plot was surveyed, no search area correction factor was applied. For small birds, the probability that a carcass would remain in the search plot and be found by a searcher was 0.14 in spring, winter, and fall, and 0.22 in summer. For large birds, the probability that a carcass would remain in the search plot and be found by a searcher was 0.72 in all seasons, while the same probability for bats (mouse surrogates) was 0.11 in all seasons. (Appendix B).

Table 4. Adjusted overall bird and bat fatality estimates for turbines within the Lower West Wind Energy Project from July 12, 2014 to July 30, 2015. Ninety-percent Confidence Intervals are not reported due to low sample sizes.

	Adjusted Overall Fatality Estimate and 90% Confidence Intervals	
	Mean	CI
	# fatalities/turbine/year	
small birds	1.80	--
large birds	0	--
raptors	0	--
all birds	1.80	--
bats	2.26	--
	# fatalities/MW/year	
small birds	0.90	--
large birds	0	--
raptors	0	--
all birds	0.90	--
bats	1.13	--

Small Birds

The estimated Project-wide mortality rate for small birds was 0.90 birds per MW per year (Table 4).

Large Birds

Because no large birds were encountered during the study, the estimated Project-wide mortality rate for large birds was zero birds per MW per year (Table 4).

Raptors

Because no raptors were found during the study, the estimated Project-wide mortality rate for raptors was zero birds per MW per year (Table 4).

All Birds

The estimated Project-wide mortality rate for all birds was 1.80 birds per MW per year (Table 4).

Bats

The estimated Project-wide mortality rate for bats was 1.13 bats per MW per year (Table 4).

DISCUSSION AND IMPACT ASSESSMENT

The approach used for calculating adjusted mortality estimates is consistent with the approach outlined by Shoenfeld (2004) and Erickson et al. (2005a), and accounted for search interval, searcher efficiency rates, and carcass removal rates. It is hypothesized that scavenging could change through time at a given site and must be accounted for when attempting to estimate mortality rates. We accounted for this by conducting scavenging trials throughout the year. We also estimated searcher efficiency rates throughout the study period to account for any biases associated with changes in conditions.

There are numerous factors that could contribute to both positive and negative biases in estimating mortality rates (Erickson 2006). The overall design of this study incorporates assumptions or factors that affect the results of the mortality estimates. First, it was assumed that carcasses found during the study were due to collision with wind turbines. True cause of death is unknown for most carcasses. It is possible that a bird carcass encountered was the result of predation or some other natural cause (background mortality). This factor would lead to an overestimate of avian mortality rates. It is unlikely that the bat carcass encountered died as a result of factors not related to interactions with wind turbines.

Another example of potential negative bias could occur because no adjustments were made for carcasses possibly occurring outside of the plot boundaries. Plot boundaries were established a minimum distance of 120 m from the turbines. The search plot distance for this study was selected based on results of other studies (Higgins et al. 1996; Johnson et al. 2002, 2003a, 2004; Young et al. 2003, 2005b; Erickson et al. 2004; Kerlinger et al. 2007) in which a distance equal to the approximate height of the turbine appeared to capture a very large percentage of carcasses. Based on the distribution of carcasses as a function of distance from turbines (Table 2), a comparatively small percentage of bird carcasses possibly fell outside the search plots and may have been missed. This factor would lead to an underestimate of mortality rates.

Other potential biases are associated with the experimental carcasses used in searcher efficiency and carcass removal trials and whether or not they were representative of actual carcasses. This may occur if the types of birds used were larger or smaller than the carcasses of turbine-related casualties, or more or less cryptic in color than the actual casualties, etc. Mallard hens, rock pigeons, Coturnix quail, and house sparrows were used to represent the range of bird carcasses expected and brown mice were used as bat surrogates. It is believed that this range captures the range of sizes and other characteristics of actual casualties and should be a reasonable representation of scavenging rates and detection rates of the birds as a group. It is generally not practical or feasible to obtain many of the native bird species in fresh condition for these trials.

Concern has also been raised regarding how the number of carcasses placed in the field for carcass removal trials on a given day could lead to biased estimates of scavenging rates (e.g.,Smallwood et al. 2010). Hypothetically, this would lead to underestimating true scavenging rates if the scavenger densities are low enough such that scavenging rates for these placed carcasses are lower than for actual casualties. The logic is that if the trials are based on too many carcasses on a given day, scavengers are unable to access all trial carcasses, whereas they could access all wind turbine collisions. If this is the case, and the trial carcass density is much greater than actual turbine mortality density, the trials would underestimate scavenging rates compared to rates on actual casualties. The contrary is also possible, where placing carcasses may draw in more scavengers and carcasses could be removed more quickly than normal.

Bird Mortality

The range of overall bird mortality estimates at wind energy facilities across California ranges from 0.55 to 17.44 birds/MW/year (Appendix C1). The estimated annual bird mortality rate for the Project in 2015 (0.90 birds/MW/year) is low compared to other wind energy facilities in California; Figure 10). There were no large bird mortalities at the Project, diurnal raptor or otherwise, but raptor fatality rates across California are generally low (Figure 11; Appendix C2).

The single bird carcass was encountered at turbine 2 during the winter period. The seven project turbines occur on a generally east-west axis at the same elevation, in the same habitat, and within a distance of one mile; therefore, it is unlikely that any single project turbine would present a higher risk to birds than any other project turbine.

Bat Mortality

Bat mortality estimates at wind energy facilities in California have ranged from zero to 3.92 bats/MW/year (Figure 12; Appendix C2). The estimated annual bat mortality rate for the Project (1.13 bats/MW/year) is low to moderate compared to other wind energy facilities in California and the Pacific Northwest (Figure 12).

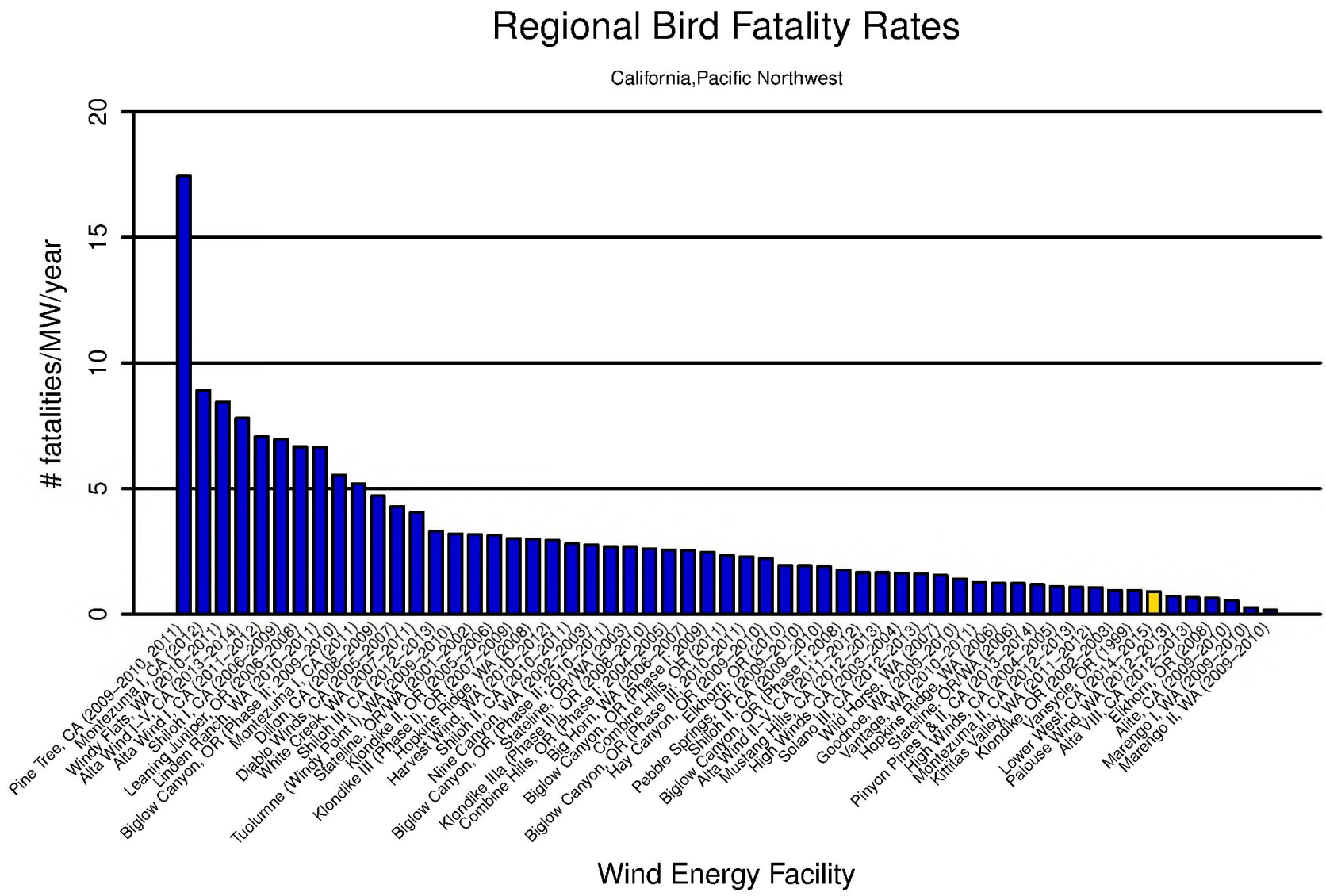

Figure 10. Mortality rates for birds (number of birds per megawatt per year) at the Lower West Wind Energy Project (shown in yellow) compared with mortality rates from publicly available studies at wind energy facilities in California, Oregon, and Washington.

Figure 10 (*continued*). Mortality rates for birds (number of birds per megawatt per year) at the Lower West Wind Energy Project compared with mortality rates from publicly available studies at wind energy facilities in California, Oregon, and Washington.

Data from the following sources:

Wind Energy Facility	Reference	Wind Energy Facility	Reference	Wind Energy Facility	Reference
Lower West, CA	This study.				
Windy Flats, WA	Enz et al. 2011	Nine Canyon, WA	Erickson et al. 2003b	High Winds, CA (04)	Kerlinger et al. 2006
Pine Tree, CA	BioResource Consultants 2010	Biglow Canyon, OR (Phase II; 10-11)	Enk et al. 2012b	Dry Lake II, AZ	Thompson and Bay 2012
Alta Wind I, CA (11)	Chatfield et al. 2012	Stateline, OR/WA (03)	Erickson et al. 2004	Wild Horse, WA	Erickson et al. 2008
Shiloh I, CA	Kerlinger et al. 2010a	Klondike IIIa, OR	Gritski et al. 2011	Shiloh II, CA	Kerlinger et al. 2010b
Leaning Juniper, OR	Kronner et al. 2007	Combine Hills, OR	Young et al. 2006	Goodnoe, WA	URS Corporation 2010a
Linden Ranch, WA	Enz and Bay 2011	Big Horn, WA	Kronner et al. 2008	Vantage, WA	Ventus 2012
Biglow Canyon, OR (Phase II; 09-10)	Enk et al. 2011a	Biglow Canyon, OR (Phase I; 09)	Enk et al. 2010	Hopkins Ridge, WA (06)	Young et al. 2007
Dillon, CA	Chatfield et al. 2009	Foote Creek Rim, WY (Phase I; 00)	Young et al. 2003b	Stateline, OR/WA (06)	Erickson et al. 2007
Diablo Winds, CA	WEST 2006, 2008	Combine Hills, OR (11)	Enz et al. 2012	High Winds, CA (05)	Kerlinger et al. 2006
White Creek, WA (07-11)	Downes and Gritski 2012b	Biglow Canyon, OR (Phase III; 10-11)	Enk et al. 2012a	Kittitas Valley, WA (11-12)	Stantec 2012
Foote Creek Rim, WY (Phase I; 99)	Young et al. 2003b	Hay Canyon, OR	Gritski and Kronner 2010a	Summerview, Alb (06)	Brown and Hamilton 2006b
Tuolumne (Windy Point I), WA	Enz and Bay 2010	Dry Lake I, AZ	Thompson et al. 2011	Klondike, OR	Johnson et al. 2003b
Stateline, OR/WA (02)	Erickson et al. 2004	Elkhorn, OR (10)	Enk et al. 2011b	Vansycle, OR	Erickson et al. 2000b
Klondike II, OR	NWC and WEST 2007	Foote Creek Rim, WY (Ph. I; 01-02)	Young et al. 2003b	Elkhorn, OR (08)	Jeffrey et al. 2009b
Klondike III, OR	Gritski et al. 2010	Pebble Springs, OR	Gritski and Kronner 2010b	Alite, CA	Chatfield et al. 2010
Hopkins Ridge, WA (08)	Young et al. 2009c	Biglow Canyon, OR (Phase I; 08)	Jeffrey et al. 2009a	Marengo I, WA (09)	URS Corporation 2010b
Harvest Wind, WA (10-12)	Downes and Gritski 2012a	Alta Wind II-V, CA (11)	Chatfield et al. 2012	Marengo II, WA (09)	URS Corporation 2010c

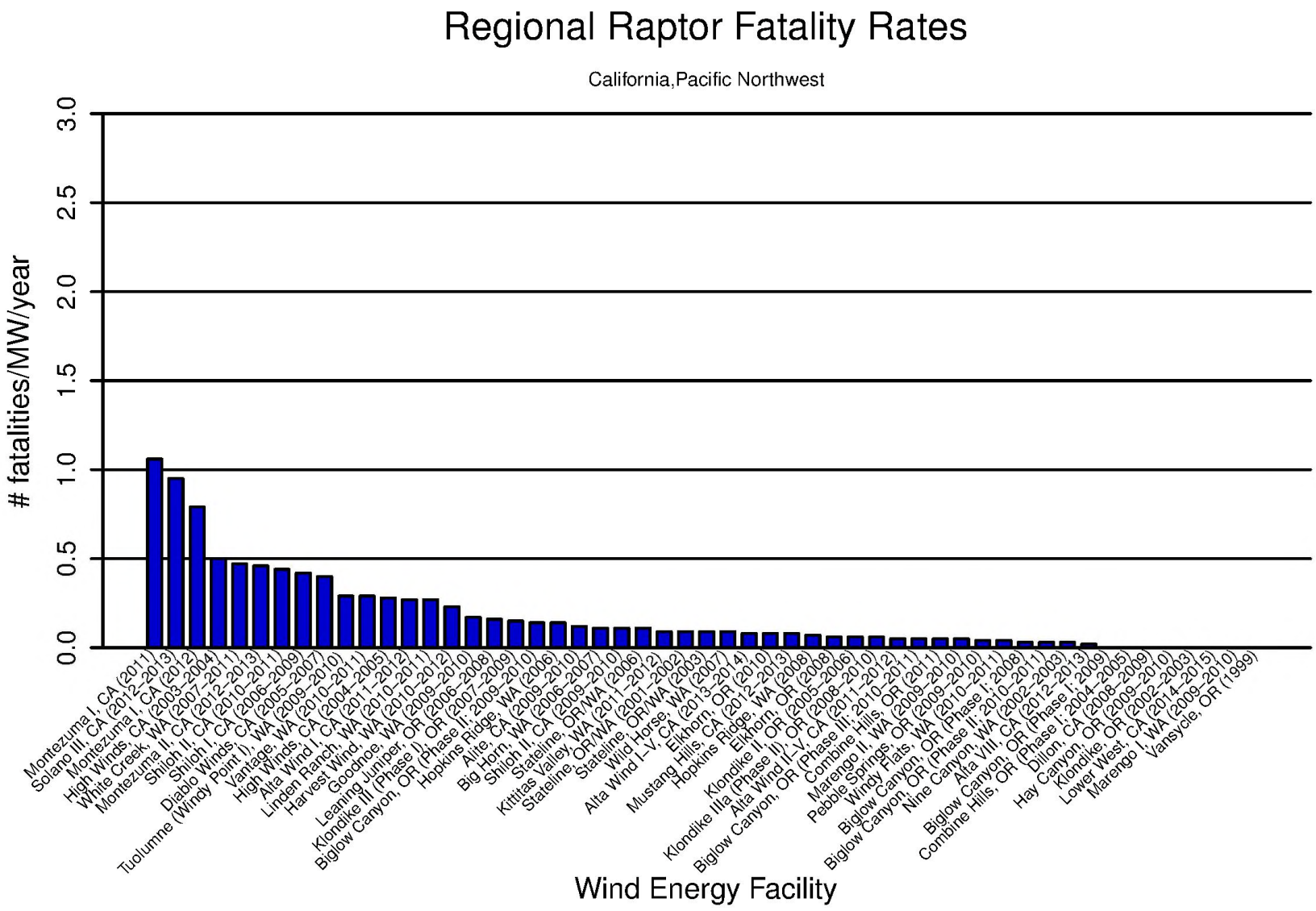

Figure 11. Mortality rates for raptors (number of raptors per megawatt per year) at the Lower West Wind Energy Project compared with mortality rates from publicly available studies at wind energy facilities in California, Oregon, and Washington.

Figure 11 (*continued*). Mortality rates for raptors (number of raptors per megawatt per year) at the Lower West Wind Energy Project compared with mortality rates from publicly available studies at wind energy facilities in California, Oregon, and Washington.

Data from the following sources:

Wind Energy Facility	Reference	Wind Energy Facility	Reference	Wind Energy Facility	Reference
Lower West, CA (14-15)	This study.				
High Winds, CA (04)	Kerlinger et al. 2006	Shiloh II, CA	Kerlinger et al. 2010b	Foote Creek Rim, WY (Phase I; 00)	Young et al. 2003b
White Creek, WA (07-11)	Downes and Gritski 2012b	Big Horn, WA	Kronner et al. 2008	Marengo II, WA (09)	URS Corporation 2010c
Shiloh I, CA	Kerlinger et al. 2010a	Stateline, OR/WA (06)	Erickson et al. 2007	Pebble Springs, OR	Gritski and Kronner 2010b
Diablo Winds, CA	WEST 2006, 2008	Summerview, Alb (06)	Brown and Hamilton 2006b	Windy Flats, WA	Enz et al. 2011
Tuolumne (Windy Point I), WA	Enz and Bay 2010	Kittitas Valley, WA (11-12)	Stantec 2012	Biglow Canyon, OR (Phase I; 08)	Jeffrey et al. 2009a
Vantage, WA	Ventus 2012	Stateline, OR/WA (02)	Erickson et al. 2004	Biglow Canyon, OR (Phase II; 10-11)	Enk et al. 2012b
High Winds, CA (05)	Kerlinger et al. 2006	Stateline, OR/WA (03)	Erickson et al. 2004	Nine Canyon, WA	Erickson et al. 2003b
Alta Wind I, CA (11)	Chatfield et al. 2012	Wild Horse, WA	Erickson et al. 2008	Biglow Canyon, OR (Phase I; 09)	Enk et al. 2010
Linden Ranch, WA	Enz and Bay 2011	Elkhorn, OR (10)	Enk et al. 2011b	Combine Hills, OR	Young et al. 2006
Harvest Wind, WA (10-12)	Downes and Gritski 2012a	Foote Creek Rim, WY (Phase I; 99)	Young et al. 2003b	Dillon, CA	Chatfield et al. 2009
Goodnoe, WA	URS Corporation 2010a	Hopkins Ridge, WA (08)	Young et al. 2009c	Dry Lake I, AZ	Thompson et al. 2011
Leaning Juniper, OR	Kronner et al. 2007	Elkhorn, OR (08)	Jeffrey et al. 2009b	Dry Lake II, AZ	Thompson and Bay 2012
Klondike III, OR	Gritski et al. 2010	Klondike II, OR	NWC and WEST 2007	Foote Creek Rim, WY (Ph. I; 01-02)	Young et al. 2003b
Biglow Canyon, OR (Phase II; 09-10)	Enk et al. 2011a	Klondike IIIa, OR	Gritski et al. 2011	Hay Canyon, OR	Gritski and Kronner 2010a
Hopkins Ridge, WA (06)	Young et al. 2007	Alta Wind II-V, CA (11)	Chatfield et al. 2012	Klondike, OR	Johnson et al. 2003b
Pine Tree, CA	BioResource Consultants 2010	Biglow Canyon, OR (Phase III; 10-11)	Enk et al. 2012a	Marengo I, WA (09)	URS Corporation 2010b
Alite, CA	Chatfield et al. 2010	Combine Hills, OR (11)	Enz et al. 2012	Vansycle, OR	Erickson et al. 2000b

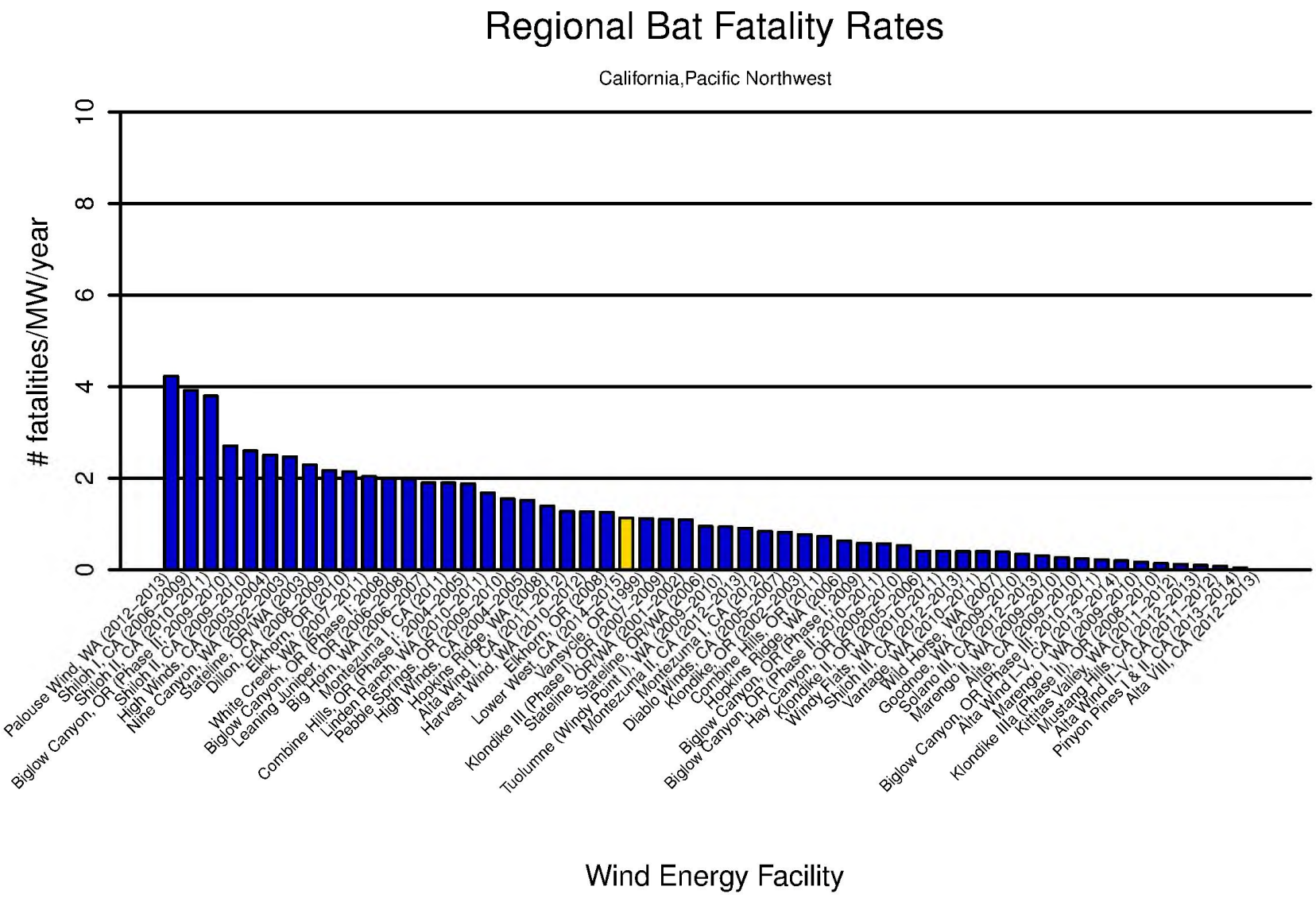

Figure 12. Mortality rates for bats (number of bats per megawatt per year) at the Lower West Wind Energy Project (shown in yellow) compared with mortality rates from publicly available studies at wind energy facilities in California, Oregon, and Washington.

Figure 12 (*continued*). Mortality rates for bats (number of bats per megawatt per year) at the Lower West Wind Energy Project compared with mortality rates from publicly-available studies at wind energy facilities in California, Oregon, and Washington.

Data from the following sources:

Wind Energy Facility	Reference	Wind Energy Facility	Reference	Wind Energy Facility	Reference
Lower West, CA (14-15)	This study.				
Summerview, Alb (08)	Baerwald 2008	Combine Hills, OR	Young et al. 2006	Combine Hills, OR (11)	Enz et al. 2012
Summerview, Alb (06)	Brown and Hamilton 2006b	Linden Ranch, WA	Enz and Bay 2011	Hopkins Ridge, WA (06)	Young et al. 2007
Judith Gap, MT (06-07)	TRC 2008	Dry Lake II, AZ	Thompson and Bay 2012	Biglow Canyon, OR (Ph. I; 09)	Enk et al. 2010
Foote Creek Rim, WY (Ph. I; 99)	Young et al. 2003b	Foote Creek Rim, WY (Ph. I; 01-02)	Young et al. 2003b	Biglow Canyon, OR (Ph. II; 10/ 11)	Enk et al. 2012b
Shiloh I, CA	Kerlinger et al. 2010a	Pebble Springs, OR	Gritski and Kronner 2010b	Hay Canyon, OR	Gritski and Kronner 2010a
Dry Lake I, AZ	Thompson et al. 2011	High Winds, CA (05)	Kerlinger et al. 2006	Klondike II, OR	NWC and WEST 2007
Judith Gap, MT (09)	Poulton and Erickson 2010	Hopkins Ridge, WA (08)	Young et al. 2009c	Windy Flats, WA	Enz et al. 2011
Shiloh II, CA	Kerlinger et al. 2010b	Alta Wind I, CA (11)	Chatfield et al. 2012	Vantage, WA	Ventus 2012
Biglow Canyon, OR (Ph. II; 09/10)	Enk et al. 2011a	Harvest Wind, WA (10-12)	Downes and Gritski 2012a	Wild Horse, WA	Erickson et al. 2008
High Winds, CA (04)	Kerlinger et al. 2006	Elkhorn, OR (08)	Jeffrey et a. 2009b	Goodnoe, WA	URS Corporation 2010a
Nine Canyon, WA	Erickson et al. 2003b	Vansycle, OR	Erickson et al. 2000a	Marengo II, WA (09)	URS Corporation 2010c
Stateline, OR/WA (03)	Erickson et al. 2004	Klondike III (Phase I), OR	Gritski et al. 2010	Alite, CA	Chatfield et al. 2010
Dillon, CA	Chatfield et al. 2009	Stateline, OR/WA (02)	Erickson et al. 2004	Biglow Canyon, OR (Ph. III; 10/ 11)	Enk et al. 2012a
Elkhorn, OR (10)	Enk et al. 2011b	Foote Creek Rim, WY (Ph. I; 00)	Young et al. 2003b	Marengo I, WA (09)	URS Corporation 2010b
White Creek, WA (07-11)	Downes and Gritski 2012b	Stateline, OR/WA (06)	Erickson et al. 2007	Klondike IIIa (Phase II), OR	Gritski et al. 2011
Biglow Canyon, OR (Ph. I; 08)	Jeffrey et al. 2009a	Tuolumne (Windy Point I), WA	Enz and Bay 2010	Kittitas Valley, WA (11-12)	Stantec Consulting Services 2012
Leaning Juniper, OR	Gritski et al. 2008	Diablo Winds, CA	WEST 2006, 2008	Alta Wind II-V, CA (11)	Chatfield et al. 2012
Big Horn, WA	Kronner et al. 2008	Klondike, OR	Johnson et al. 2003a		

CONCLUSIONS

Results of mortality monitoring at the Project further contribute to our understanding of the effects of wind energy on birds and bats, particularly in the TWRA. The level of avian and bat mortality observed was low compared to other wind energy projects in California and the Pacific Northwest, and the level of estimated mortality at the Project was low, it is highly unlikely that the Project would result in significant impacts to bird populations in the region. We did not observe any site conditions or data that suggested the results were atypical of mortality patterns of a low risk site. These factors along with the mortality patterns observed across seasons (one bird and one bat found during the winter), the species composition of (very common bird and bat species), the distribution of finds within search plots and across the site, and the high percentage of turbine plots searched support the conclusion that the risk from this Project to golden eagles (*Aquila chrysaetos*) and other raptors, as well as non-raptor bird species and bats, is relatively low.

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Appendix A. Complete Fatality Listing for the Lower West Wind Energy Project during Surveys Conducted from July 12, 2014 – July 30, 2015

Appendix A. Complete fatality listing for the Lower West Wind Energy Project during surveys conducted from July 12, 2014 – July 30, 2015.

Date	Common Name	Location	Distance from Turbine	Type of Find	Condition
1/30/2015	house finch	LW2	67	carcass search	feather spot
2/27/2015	Mexican free-tailed bat	LW1	20	carcass search	intact

Appendix B. Correction Factors and Bird and Bat Fatality Rates by Season and Turbine Type for Studies Conducted within the Lower West Wind Energy Project from July 12, 2014 – July 30, 2015

Appendix B. Correction factors and bird and bat fatality rates by season and turbine type for studies conducted within the Lower West Wind Energy Project from July 12, 2014 to July 30, 2015.

	Spring (4 turbines searched)		Summer (4 turbines searched)		Winter (4 turbines searched)		Fall (4 turbines searched)	
Parameter	**Mean**	**CI**	**Mean**	**CI**	**Mean**	**CI**	**Mean**	**CI**
Search Area Adjustment								
A (small birds)	*1*	*--*	*1*	*--*	*1*	*--*	*1*	*--*
A (large birds)	*1*	*--*	*1*	*--*	*1*	*--*	*1*	*--*
A (bats)	*1*	*--*	*1*	*--*	*1*	*--*	*1*	*--*
Observer Detection Rate								
p (small birds)	*0.77*	*0.72 – 0.81*	*0.77*	*0.72 – 0.81*	*0.77*	*0.72 – 0.81*	*0.77*	*0.72 – 0.81*
p (large birds)	*0.97*	*0.93 – 0.99*	*0.97*	*0.93 – 0.99*	*0.97*	*0.93 – 0.99*	*0.97*	*0.93 – 0.99*
p (bats)	*0.76*	*0.59 – 0.94*	*0.76*	*0.59 – 0.94*	*0.76*	*0.59 – 0.94*	*0.76*	*0.59 – 0.94*
Mean Carcass Removal Time (Days)								
$\bar{t}$ *(small birds)*	*2.54*	*1.86 – 3.44*	*4.68*	*2.87 – 7.11*	*2.54*	*1.86 – 3.44*	*2.54*	*1.86 – 3.44*
$\bar{t}$ *(large birds)*	*24.1*	*18.8 – 31.7*	*24.1*	*18.8 – 31.7*	*24.1*	*18.8 – 31.7*	*24.1*	*18.8 – 31.7*
$\bar{t}$ *(bats)*	*2.02*	*1.14 – 3.09*	*2.02*	*1.14 – 3.09*	*2.02*	*1.14 – 3.09*	*2.02*	*1.14 – 3.09*
Observed Fatality Rates (Fatalities/Turbine/Season(s))								
small birds	*0*	*--*	*0*	*--*	*0.25*	*--*	*0*	*--*
large birds	*0*	*--*	*0*	*--*	*0*	*--*	*0*	*--*
raptors	*0*	*--*	*0*	*--*	*0*	*--*	*0*	*--*
bats	*0*	*--*	*0*	*--*	*0.25*	*--*	*0*	*--*
Average Probability of Carcass Availability and Detected								
small birds	*0.14*	*0.10 – 0.19*	*0.22*	*0.14 – 0.32*	*0.14*	*0.10 – 0.19*	*0.14*	*0.10 – 0.19*
large birds	*0.72*	*0.66 – 0.78*	*0.72*	*0.66 – 0.78*	*0.72*	*0.66 – 0.78*	*0.72*	*0.66 – 0.78*
bats	*0.11*	*0.06 – 0.18*	*0.11*	*0.06 – 0.18*	*0.11*	*0.06 – 0.18*	*0.11*	*0.06 – 0.18*
Observed Adjusted Fatality Rates (Fatalities/Turbine/Seasons(s))								
small birds	*0*	*--*	*0*	*--*	*1.80*	*--*	*0*	*--*
large birds	*0*	*--*	*0*	*--*	*0*	*--*	*0*	*--*
raptors	*0*	*--*	*0*	*--*	*0*	*--*	*0*	*--*

Appendix B. Correction factors and bird and bat fatality rates by season and turbine type for studies conducted within the Lower West Wind Energy Project from July 12, 2014 to July 30, 2015.

bats	*0*	*--*	*0*	*--*	*2.26*	*--*	*0*	*--*

Overall Adjusted Fatality Rates (Fatalities/Turbine/Study Period)

	Mean	**CI**
small birds	1.80	--
large birds	0	--
raptors	0	--
all birds	1.80	--
bats	2.26	--

Appendix C. North American Mortality Summary Tables

Appendix C1. Wind energy facilities in California and the Pacific Northwest with mortality data for all bird species. Mortality estimate is number of mortalities per megawatt (MW) per year.

Wind Energy Facility	Mortality Estimate	No. of Turbines	Total MW
Lower West, CA (2014-2015)	**0.90**	**4**	**0.90**
Lower West, CA (2013-2014)	**3.50**	**4**	**0.90**
California			
Pine Tree, CA (2009-2010, 2011)	17.44	90	135
Montezuma I, CA (2012)	8.91	16	36.8
Alta Wind I-V, CA (2013-2014)	7.80	290	720 (150 GE, 570 Vestas)
Alta Wind I, CA (2011-2012)	7.07	100	150
Shiloh I, CA (2006-2009)	6.96	100	150
Montezuma I, CA (2011)	5.19	16	36.8
Dillon, CA (2008-2009)	4.71	45	45
Diablo Winds, CA (2005-2007)	4.29	31	20.46
Shiloh III, CA (2012-2013)	3.30	50	102.5
Shiloh II, CA (2010-2011)	2.80	75	150
Shiloh II, CA (2009-2010)	1.90	75	150
Mustang Hills, CA (2012-2013)	1.66	50	150
Alta Wind II-V, CA (2011-2012)	1.66	190	570
High Winds, CA (2003-2004)	1.62	90	162
Solano III, CA (2012-2013)	1.60	55	128
Pinyon Pines I & II, CA (2013-2014)	1.18	100	NA
High Winds, CA (2004-2005)	1.10	90	162
Montezuma II, CA (2012-2013)	1.08	34	78.2
Alta VIII, CA (2012-2013)	0.66	50	150
Alite, CA (2009-2010)	0.55	8	24
Pacific Northwest			
Windy Flats, WA (2010-2011)	8.45	114	262.2
Leaning Juniper, OR (2006-2008)	6.66	67	100.5
Linden Ranch, WA (2010-2011)	6.65	25	50
Biglow Canyon, OR (Phase II; 2009-2010)	5.53	65	150
White Creek, WA (2007-2011)	4.05	89	204.7
Tuolumne (Windy Point I), WA (2009-2010)	3.2	62	136.6
Stateline, OR/WA (2001-2002)	3.17	454	299
Klondike II, OR (2005-2006)	3.14	50	75
Klondike III (Phase I), OR (2007-2009)	3.02	125	223.6
Hopkins Ridge, WA (2008)	2.99	87	156.6
Harvest Wind, WA (2010-2012)	2.94	43	98.9
Nine Canyon, WA (2002-2003)	2.76	37	48.1
Biglow Canyon, OR (Phase II; 2010-2011)	2.68	65	150
Stateline, OR/WA (2003)	2.68	454	299
Klondike IIIa (Phase II), OR (2008-2010)	2.61	51	76.5
Combine Hills, OR (Phase I; 2004-2005)	2.56	41	41
Big Horn, WA (2006-2007)	2.54	133	199.5
Biglow Canyon, OR (Phase I; 2009)	2.47	76	125.4
Combine Hills, OR (2011)	2.33	104	104
Biglow Canyon, OR (Phase III; 2010-2011)	2.28	76	174.8
Hay Canyon, OR (2009-2010)	2.21	48	100.8
Elkhorn, OR (2010)	1.95	61	101
Pebble Springs, OR (2009-2010)	1.93	47	98.7
Biglow Canyon, OR (Phase I; 2008)	1.76	76	125.4
Wild Horse, WA (2007)	1.55	127	229
Goodnoe, WA (2009-2010)	1.4	47	94

Appendix C1. Wind energy facilities in California and the Pacific Northwest with mortality data for all bird species. Mortality estimate is number of mortalities per megawatt (MW) per year.

Wind Energy Facility	Mortality Estimate	No. of Turbines	Total MW
Vantage, WA (2010-2011)	1.27	60	90
Hopkins Ridge, WA (2006)	1.23	83	150
Stateline, OR/WA (2006)	1.23	454	299
Kittitas Valley, WA (2011-2012)	1.06	48	100.8
Klondike, OR (2002-2003)	0.95	16	24
Vansycle, OR (1999)	0.95	38	24.9
Palouse Wind, WA (2012-2013)	0.72	58	104.4
Elkhorn, OR (2008)	0.64	61	101
Marengo I, WA (2009-2010)	0.27	78	140.4
Marengo II, WA (2009-2010)	0.16	39	70.2

Appendix C1 (*continued*). Wind energy facilities in California and the Pacific Northwest with mortality data for all bird species.

Data from the following sources:

Wind Energy Facility	Estimate Reference	Wind Energy Facility	Estimate Reference
Lower West, CA (14-15)	This study.		
Lower West, CA (13-14)	Levenstein and Bay 2013		
Alite, CA (09-10)	Chatfield et al. 2010	Klondike IIIa (Phase II), OR (08-10)	Gritski et al. 2011
Alta Wind I, CA (11-12)	Chatfield et al. 2012	Leaning Juniper, OR (06-08)	Gritski et al. 2008
Alta Wind I-V, CA (13-14)	Chatfield and Bay 2014	Linden Ranch, WA (10-11)	Enz and Bay 2011
Alta Wind II-V, CA (11-12)	Chatfield et al. 2012	Marengo I, WA (09-10)	URS Corporation 2010b
Alta VIII, CA (12-13)	Chatfield and Bay 2014	Marengo II, WA (09-10)	URS Corporation 2010c
Big Horn, WA (06-07)	Kronner et al. 2008	Montezuma I, CA (11)	ICF International 2012
Biglow Canyon, OR (Phase I; 08)	Jeffrey et al. 2009a	Montezuma I, CA (12)	ICF International 2013
Biglow Canyon, OR (Phase I; 09)	Enk et al. 2010	Montezuma II, CA (12-13)	H.T. Harvey & Associates 2013
Biglow Canyon, OR (Phase II; 09-10)	Enk et al. 2011a	Mustang Hills, CA (12-13)	Chatfield and Bay 2014
Biglow Canyon, OR (Phase II; 10-11)	Enk et al. 2012b	Nine Canyon, WA (02-03)	Erickson et al. 2003
Biglow Canyon, OR (Phase III; 10-11)	Enk et al. 2012a	Palouse Wind, WA (12-13)	Stantec 2013
Combine Hills, OR (Phase I; 04-05)	Young et al. 2006	Pebble Springs, OR (09-10)	Gritski and Kronner 2010b
Combine Hills, OR (11)	Enz et al. 2012	Pine Tree, CA (09-10, 11)	BioResource Consultants 2012
Diablo Winds, CA (05-07)	WEST 2006, 2008	Pinyon Pines I&II, CA (13-14)	Chatfield and Russo 2014
Dillon, CA (08-09)	Chatfield et al. 2009	Shiloh I, CA (06-09)	Kerlinger et al. 2009
Elkhorn, OR (08)	Jeffrey et a. 2009b	Shiloh II, CA (09-10)	Kerlinger et al. 2010, 2013a
Elkhorn, OR (10)	Enk et al. 2011b	Shiloh II, CA (10-11)	Kerlinger et al. 2013a
Goodnoe, WA (09-10)	URS Corporation 2010a	Shiloh III, CA (12-13)	Kerlinger et al. 2013b
Harvest Wind, WA (10-12)	Downes and Gritski 2012a	Solano III, CA (12-13)	AECOM 2013
Hay Canyon, OR (09-10)	Gritski and Kronner 2010a	Stateline, OR/WA (01-02)	Erickson et al. 2004
High Winds, CA (03-04)	Kerlinger et al. 2006	Stateline, OR/WA (03)	Erickson et al. 2004
High Winds, CA (04-05)	Kerlinger et al. 2006	Stateline, OR/WA (06)	Erickson et al. 2007
Hopkins Ridge, WA (06)	Young et al. 2007	Tuolumne (Windy Point I), WA (09-10)	Enz and Bay 2010
Hopkins Ridge, WA (08)	Young et al. 2009	Vansycle, OR (99)	Erickson et al. 2000
Kittitas Valley, WA (11-12)	Stantec Consulting 2012	Vantage, WA (10-11)	Ventus Environmental Solutions 2012
Klondike, OR (02-03)	Johnson et al. 2003a	White Creek, WA (07-11)	Downes and Gritski 2012b
Klondike II, OR (05-06)	NWC and WEST 2007	Wild Horse, WA (07)	Erickson et al. 2008
Klondike III (Phase I), OR (07-09)	Gritski et al. 2010	Windy Flats, WA (10-11)	Enz et al. 2011

Appendix C2. Mortality estimates for California and Pacific Northwest wind energy facilities.

Project	Bird Mortality (birds/MW/ year)	Raptor Mortality (raptors/MW/ year)	Bat Mortality (bats/MW/ year)	Predominant Habitat Type	Citation
Alite, CA (2009-2010)	0.55	0.12	0.24	Shrub/scrub & grassland	Chatfield et al. 2010
Alta Wind I, CA (2011-2012)	7.07	0.27	1.28	Woodland, grassland, shrubland	Chatfield et al. 2012
Alta Wind I-V, CA (2013-2014)	7.8	0.08	0.2	Desert scrub	Chatfield and Bay 2014
Alta Wind II-V, CA (2011-2012)	1.66	0.05	0.08	Desert scrub	Chatfield et al. 2012
Alta VIII, CA (2012-2013)	0.66	0.02	0	Grassland and riparian	Chatfield and Bay 2014
Big Horn, WA (2006-2007)	2.54	0.11	1.9	Agriculture/grassland	Kronner et al. 2008
Biglow Canyon, OR (Phase I; 2008)	1.76	0.03	1.99	Agriculture/grassland	Jeffrey et al. 2009a
Biglow Canyon, OR (Phase I; 2009)	2.47	0	0.58	Agriculture/grassland	Enk et al. 2010
Biglow Canyon, OR (Phase II; 2009-2010)	5.53	0.14	2.71	Agriculture	Enk et al. 2011a
Biglow Canyon, OR (Phase II; 2010-2011)	2.68	0.03	0.57	Grassland/shrub-steppe, agriculture	Enk et al. 2012b
Biglow Canyon, OR (Phase III; 2010-2011)	2.28	0.05	0.22	Grassland/shrub-steppe, agriculture	Enk et al. 2012a
Combine Hills, OR (Phase I; 2004-2005)	2.56	0	1.88	Agriculture/grassland	Young et al. 2006
Combine Hills, OR (2011)	2.33	0.05	0.73	Grassland/shrub-steppe, agriculture	Enz et al. 2012
Diablo Winds, CA (2005-2007)	4.29	0.4	0.82	NA	WEST 2006, 2008
Dillon, CA (2008-2009)	4.71	0	2.17	Desert	Chatfield et al. 2009
Elkhorn, OR (2008)	0.64	0.06	1.26	Shrub/scrub & agriculture	Jeffrey et a. 2009b
Elkhorn, OR (2010)	1.95	0.08	2.14	Shrub/scrub & agriculture	Enk et al. 2011b
Goodnoe, WA (2009-2010)	1.4	0.17	0.34	Grassland and shrub-steppe	URS Corporation 2010a
Harvest Wind, WA (2010-2012)	2.94	0.23	1.27	Grassland/shrub-steppe	Downes and Gritski 2012a
Hay Canyon, OR (2009-2010)	2.21	0	0.53	Agriculture	Gritski and Kronner 2010a
High Winds, CA (2003-2004)	1.62	0.5	2.51	Agriculture/grassland	Kerlinger et al. 2006
High Winds, CA (2004-2005)	1.1	0.28	1.52	Agriculture/grassland	Kerlinger et al. 2006
Hopkins Ridge, WA (2006)	1.23	0.14	0.63	Agriculture/grassland	Young et al. 2007
Hopkins Ridge, WA (2008)	2.99	0.07	1.39	Agriculture/grassland	Young et al. 2009
Kittitas Valley, WA (2011-2012)	1.06	0.09	0.12	Sagebrush-steppe, grassland	Stantec Consulting 2012

Appendix C2. Mortality estimates for California and Pacific Northwest wind energy facilities.

Project	Bird Mortality (birds/MW/ year)	Raptor Mortality (raptors/MW/ year)	Bat Mortality (bats/MW/ year)	Predominant Habitat Type	Citation
Klondike, OR (2002-2003)	0.95	0	0.77	Agriculture/grassland	Johnson et al. 2003a
Klondike II, OR (2005-2006)	3.14	0.06	0.41	Agriculture/grassland	NWC and WEST 2007
Klondike III (Phase I), OR (2007-2009)	3.02	0.15	1.11	Agriculture/grassland	Gritski et al. 2010
Klondike IIIa (Phase II), OR (2008-2010)	2.61	0.06	0.14	Grassland/shrub-steppe and agriculture	Gritski et al. 2011
Leaning Juniper, OR (2006-2008)	6.66	0.16	1.98	Agriculture	Gritski et al. 2008
Linden Ranch, WA (2010-2011)	6.65	0.27	1.68	Grassland/shrub-steppe, agriculture	Enz and Bay 2011
Lower West, CA (2014-2015)	0.90	0	1.13	Desert scrub	This study
Lower West, CA (2013-2014)	3.50	0	2.17	Desert scrub.	Levenstein and Bay 2013
Marengo I, WA (2009-2010)	0.27	0	0.17	Agriculture	URS Corporation 2010b
Marengo II, WA (2009-2010)	0.16	0.05	0.27	Agriculture	URS Corporation 2010c
Montezuma I, CA (2011)	5.19	1.06	1.9	Agriculture and grasslands	ICF International 2012
Montezuma I, CA (2012)	8.91	0.79	0.84	Agriculture and grasslands	ICF International 2013
Montezuma II, CA (2012-2013)	1.08	0.46	0.91	Agriculture	H.T. Harvey & Associates 2013
Mustang Hills, CA (2012-2013)	1.66	0.08	0.1	Grasslands and Riparian	Chatfield and Bay 2014
Nine Canyon, WA (2002-2003)	2.76	0.03	2.47	Agriculture/grassland	Erickson et al. 2003
Palouse Wind, WA (2012-2013)	0.72	NA	4.23	Agriculture and grasslands	Stantec 2013
Pebble Springs, OR (2009-2010)	1.93	0.04	1.55	Grassland	Gritski and Kronner 2010b
Pine Tree, CA (2009-2010, 2011)	17.44	NA	NA	Grassland	BioResource Consultants 2012
Pinyon Pines I & II, CA (2013-2014)	1.18	NA	0.04	NA	Chatfield and Russo 2014
Shiloh I, CA (2006-2009)	6.96	0.42	3.92	Agriculture/grassland	Kerlinger et al. 2009
Shiloh II, CA (2009-2010)	1.9	0.11	2.6	Agriculture	Kerlinger et al. 2010, Kerlinger et al. 2013a
Shiloh II, CA (2010-2011)	2.8	0.44	3.8	Agriculture	Kerlinger et al. 2013a
Shiloh III, CA (2012-2013)	3.3	NA	0.4	NA	Kerlinger et al. 2013b
Solano III, CA (2012-2013)	1.6	0.95	0.31	NA	AECOM 2013
Stateline, OR/WA (2001-2002)	3.17	0.09	1.09	Agriculture/grassland	Erickson et al. 2004
Stateline, OR/WA (2003)	2.68	0.09	2.29	Agriculture/grassland	Erickson et al. 2004
Stateline, OR/WA (2006)	1.23	0.11	0.95	Agriculture/grassland	Erickson et al. 2007
Tuolumne (Windy Point I), WA (2009-2010)	3.2	0.29	0.94	Grassland/shrub-steppe, agriculture and forest	Enz and Bay 2010

Appendix C2. Mortality estimates for California and Pacific Northwest wind energy facilities.

Project	Bird Mortality (birds/MW/ year)	Raptor Mortality (raptors/MW/ year)	Bat Mortality (bats/MW/ year)	Predominant Habitat Type	Citation
Vansycle, OR (1999)	0.95	0	1.12	Agriculture/grassland	Erickson et al. 2000
Vantage, WA (2010-2011)	1.27	0.29	0.4	Shrub-steppe, grassland	Ventus Environmental Solutions 2012
White Creek, WA (2007-2011)	4.05	0.47	2.04	Grassland/shrub-steppe, agriculture	Downes and Gritski 2012b
Wild Horse, WA (2007)	1.55	0.09	0.39	Grassland	Erickson et al. 2008
Windy Flats, WA (2010-2011)	8.45	0.04	0.41	Grassland/shrub-steppe, agriculture	Enz et al. 2011

Appendix C3. All post-construction monitoring studies, project characteristics, and select study methodology for California and Pacific Northwest wind energy facilities.

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Alite, CA (2009-2010)	8	24	80	8	200 m x 200 m	1 year	Weekly (spring, fall), bi-monthly (summer, winter)
Alta Wind I, CA (2011-2012)	100	150	80	25	120-m radius circle	12.5 months	Every two weeks
Alta Wind I-V, CA (2013-2014)	290	720 (150 GE, 570 vestas)	80	55 (25 at Alta I, 30 at Alta II-V)	120 m radius circles	NA	Monthly or bi-weekly
Alta Wind II-V, CA (2011-2012)	190	570	80	41	120-m radius circle	14.5 months	Every two weeks
Alta VIII, CA (2012-2013)	50	150	90	12 plots (equal to 15 turbines	240 x 240 m	1 year	Bi-weekly
Big Horn, WA (2006-2007)	133	199.5	80	133	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Biglow Canyon, OR (Phase I; 2008)	76	125.4	80	50	110 m x 110 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Biglow Canyon, OR (Phase I; 2009)	76)	125.4	80	50	110 m x 110 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Biglow Canyon, OR (Phase II; 2009-2010)	65	150	80	50	250 m x 250 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Biglow Canyon, OR (Phase II; 2010-2011)	65	150	80	50	252 m x 252 m	1 year	Bi-weekly(spring, fall), monthly (summer, winter)
Biglow Canyon, OR (Phase III; 2010-2011)	76	174.8	80	50	252 m x 252 m	1 year	Bi-weekly(spring, fall), monthly (summer, winter)
Buena Vista, CA (2008-2009)	38	38	45-55	38	75-m radius	1 year	Monthly to bi-monthly starting in September 2008

Appendix C3. All post-construction monitoring studies, project characteristics, and select study methodology for California and Pacific Northwest wind energy facilities.

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Combine Hills, OR (Phase I; 2004-2005)	41	41	53	41	90-m radius	1 year	Monthly
Combine Hills, OR (2011)	104	104	53	52 (plus 1 MET tower)	180 m x 180 m	1 year	Bi-weekly(spring, fall), monthly (summer, winter)
Condon, OR	84	NA	NA	NA	NA	NA	N/a
Diablo Winds, CA (2005-2007)	31	20.46	50 and 55	31	75 m x 75 m	2 years	Monthly
Dillon, CA (2008-2009)	45	45	69	15	200 m x 200 m	1 year	Weekly, bi-monthly in winter
Elkhorn, OR (2008)	61	101	80	61	220 m x 220 m	1 year	Monthly
Elkhorn, OR (2010)	61	101	80	31	220 m x 220 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Goodnoe, WA (2009-2010)	47	94	80	24	180 m x 180 m	1 year	14 days during migration periods, 28 days during non-migration periods
Harvest Wind, WA (2010-2012)	43	98.9	80	32	180 m x 180 m & 240 m x 240 m	2 years	Twice a week, weekly and monthly
Hay Canyon, OR (2009-2010)	48	100.8	79	20	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
High Winds, CA (2003-2004)	90	162	60	90	75-m radius	1 year	Bi-monthly
High Winds, CA (2004-2005)	90	162	60	90	75-m radius	1 year	Bi-monthly
Hopkins Ridge, WA (2006)	83	150	67	41	180 m x 180 m	1 year	Monthly, weekly (subset of 22 turbines spring and fall migration)

Appendix C3. All post-construction monitoring studies, project characteristics, and select study methodology for California and Pacific Northwest wind energy facilities.

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Hopkins Ridge, WA (2008)	87	156.6	67	41 - 43	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Kittitas Valley, WA (2011-2012)	48	100.8	80	48	100 m x 102 m	1 year	Bi-weekly from Aug 15 - Oct 31 and March 16 - May 15; every 4 weeks from Nov 1 - March 15 and May 16 - Aug 14
Klondike, OR (2002-2003)	16	24	80	16	140 m x 140 m	1 year	Monthly
Klondike II, OR (2005-2006)	50	75	80	25	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (summer, winter)
Klondike III (Phase I), OR (2007-2009)	125	223.6	GE = 80; Siemens = 80, Mitsubishi = 80	46	240 m x 240 m (1.5MW) 252 m x 252 m (2.3MW)	2 year	Bi-monthly (spring, fall migration), monthly (summer, winter)
Klondike IIIa (Phase II), OR (2008-2010)	51	76.5	GE = 80	34	240 m x 240 m	2 years	Bi-monthly (spring, fall), monthly (summer, winter)
Leaning Juniper, OR (2006-2008)	67	100.5	80	17	240 m x 240 m	2 years	Bi-monthly (spring, fall), monthly (winter, summer)
Linden Ranch, WA (2010-2011)	25	50	80	25	110 m x 110 m	1 year	Bi-weekly(spring, fall), monthly (summer, winter)
Marengo I, WA (2009-2010)	78	140.4	67	39	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Marengo II, WA (2009-2010)	39	70.2	67	20	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Montezuma I, CA (2011)	16	36.8	80	16	105 m radius	1 year	Weekly and bi-Weekly

Appendix C3. All post-construction monitoring studies, project characteristics, and select study methodology for California and Pacific Northwest wind energy facilities.

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Montezuma I, CA (2012)	16	36.8	80	16	105 m radius	1 year	Weekly and bi-Weekly
Montezuma II, CA (2012-2013)	34	78.2	80	17	105 m radius	1 year	Weekly
Mustang Hills, CA (2012-2013)	50	150	90	13 plots (equal to 15 turbines)	240 x 240 m	1 year	Bi-weekly
Nine Canyon, WA (2002-2003)	37	48.1	60	37	90-m radius	1 year	Bi-monthly (spring, summer, fall), monthly (winter)
Nine Canyon II, WA (2004)	12	15.6	60	12	90 m x 90 m	3 months	Once every two weeks
Pacific, CA (2012-2013)	70	140	78.5	20	126 m radius	NA	Twice weekly (fall), and biweekly
Palouse Wind, WA (2012-2013)	58	104.4	80, 90, or 105 M (according to the Vestas website)	19	120m x 120m	1 year	Montly (Winter) and Weekly (Spring-Fall)
Pebble Springs, OR (2009-2010)	47	98.7	79	20	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Pine Tree, CA (2009-2010, 2011)	90	135	65	40	100 m radius	1.5 year	Bi-weekly, weekly
Pinyon Pines I & II, CA (2013-2014)	100	NA	90	25 plots (approx. 31 turbines)	240x240 m	NA	Bi-weekly
San Gorgonio, CA (1997-1998; 1999-2000)	3000	n/a	24.4-42.7	NA	50-m radius	2 years	Quarterly
Shiloh I, CA (2006-2009)	100	150	65	100	105-m radius	3 years	Weekly

Appendix C3. All post-construction monitoring studies, project characteristics, and select study methodology for California and Pacific Northwest wind energy facilities.

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Shiloh II, CA (2009-2010)	75	150	80	25	100m radius	1 year	Weekly
Shiloh II, CA (2010-2011)	75	150	80	25	100 m radius	1 year	Weekly
Shiloh III, CA (2012-2013)	50	102.5	78.5	25	100 m radius	Na	Weekly
SMUD Solano, CA (2004-2005)	22	15	65	22	60-m radius	1 year	Bi-monthly
Solano III, CA (2012-2013)	55	128	80	19	100 m radius	NA	Bi-Weekly
Stateline, OR/WA (2001-2002)	454	299	50	124	minimum 126 m x 126 m	17 months	Bi-weekly, monthly
Stateline, OR/WA (2003)	454	299	50	153	minimum 126 m x 126 m	1 year	Bi-weekly, monthly
Stateline, OR/WA (2006)	454	299	50	39	variable turbine strings	1 year	Bi-weekly
Tehachapi, CA (1996-1998)	3300	NA	14.7 to 57.6	201	50-m radius	20 months	Quarterly
Tuolumne (Windy Point I), WA (2009-2010)	62	136.6	80	21	180 m x 180 m	1 year	Monthly throughout the year, a sub-set of 10 turbines were also searched weekly during the spring, summer, and fall
Vansycle, OR (1999)	38	24.9	50	38	126 m x 126 m	1 year	Monthly
Vantage, WA (2010-2011)	60	90	80	30	240 m x 240 m	1 year	Monthly, a subset of 10 searched weekly during migration

Appendix C3. All post-construction monitoring studies, project characteristics, and select study methodology for California and Pacific Northwest wind energy facilities.

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Vasco, CA (2012-2013)	34	78.2	80	34	105 m radius	1 year	Weekly, monthly
White Creek, WA (2007-2011)	89	204.7	80	89	180 m x 180 m & 240 m x 240 m	4 years	Twice a week, weekly and monthly
Wild Horse, WA (2007)	127	229	67	64	110 m from two turbines in plot	1 year	Monthly, weekly (fall, spring migration at 16 turbines)
Windy Flats, WA (2010-2011)	114	262.2	80	36 (plus 1 MET tower)	180 m x 180 m (120m at MET tower)	1 year	Monthly (spring, summer, fall, and winter), weekly (spring and fall migration)

Appendix C3 (*continued*). All post-construction monitoring studies, project characteristics, and select study methodology for California and Pacific Northwest wind energy facilities.

Data from the following sources:

Project, Location	Reference	Project, Location	Reference
Alite, CA (09-10)	Chatfield et al. 2010	Linden Ranch, WA (10-11)	Enz and Bay 2011
Alta Wind I, CA (11-12)	Chatfield et al. 2012	Marengo I, WA (09-10)	URS Corporation 2010b
Alta Wind I-V, CA (13-14)	Chatfield and Bay 2014	Marengo II, WA (09-10)	URS Corporation 2010c
Alta Wind II-V, CA (11-12)	Chatfield et al. 2012	Montezuma I, CA (11)	ICF International 2012
Alta VIII, CA (12-13)	Chatfield and Bay 2014	Montezuma I, CA (12)	ICF International 2013
Big Horn, WA (06-07)	Kronner et al. 2008	Montezuma II, CA (12-13)	H.T. Harvey & Associates 2013
Biglow Canyon, OR (Phase I; 08)	Jeffrey et al. 2009a	Mustang Hills, CA (12-13)	Chatfield and Bay 2014
Biglow Canyon, OR (Phase I; 09)	Enk et al. 2010	Nine Canyon, WA (02-03)	Erickson et al. 2003
Biglow Canyon, OR (Phase II; 09-10)	Enk et al. 2011a	Nine Canyon II, WA (04)	Erickson et al. 2005b
Biglow Canyon, OR (Phase II; 10-11)	Enk et al. 2012b	Pacific, CA (12-13)	Sapphos Environmental 2014
Biglow Canyon, OR (Phase III; 10-11)	Enk et al. 2012a	Palouse Wind, WA (12-13)	Stantec 2013
Buena Vista, CA (08-09)	Insignia Environmental 2009	Pebble Springs, OR (09-10)	Gritski and Kronner 2010b
Combine Hills, OR (Phase I; 04-05)	Young et al. 2006	Pine Tree, CA (09-10, 11)	BioResource Consultants 2012
Combine Hills, OR (11)	Enz et al. 2012	Pinyon Pines I&II, CA (13-14)	Chatfield and Russo 2014
Condon, OR	Fishman Ecological Services 2003	San Gorgonio, CA (97-98; 99-00)	Anderson et al. 2005
Diablo Winds, CA (05-07)	WEST 2006, 2008	Shiloh I, CA (06-09)	Kerlinger et al. 2009
Dillon, CA (08-09)	Chatfield et al. 2009	Shiloh II, CA (09-10)	Kerlinger et al. 2010, 2013a
Elkhorn, OR (08)	Jeffrey et a. 2009b	Shiloh II, CA (10-11)	Kerlinger et al. 2013a
Elkhorn, OR (10)	Enk et al. 2011b	Shiloh III, CA (12-13)	Kerlinger et al. 2013b
Goodnoe, WA (09-10)	URS Corporation 2010a	SMUD Solano, CA (04-05)	Erickson and Sharp 2005
Harvest Wind, WA (10-12)	Downes and Gritski 2012a	Solano III, CA (12-13)	AECOM 2013
Hay Canyon, OR (09-10)	Gritski and Kronner 2010a	Stateline, OR/WA (01-02)	Erickson et al. 2004
High Winds, CA (03-04)	Kerlinger et al. 2006	Stateline, OR/WA (03)	Erickson et al. 2004
High Winds, CA (04-05)	Kerlinger et al. 2006	Stateline, OR/WA (06)	Erickson et al. 2007
Hopkins Ridge, WA (06)	Young et al. 2007	Tehachapi, CA (96-98)	Anderson et al. 2004
Hopkins Ridge, WA (08)	Young et al. 2009	Tuolumne (Windy Point I), WA (09-10)	Enz and Bay 2010
Kittitas Valley, WA (11-12)	Stantec Consulting 2012	Vansycle, OR (99)	Erickson et al. 2000
Klondike, OR (02-03)	Johnson et al. 2003a	Vantage, WA (10-11)	Ventus Environmental Solutions 2012
Klondike II, OR (05-06)	NWC and WEST 2007	Vasco, CA (12-13)	Brown et al. 2013
Klondike III (Phase I), OR (07-09)	Gritski et al. 2010	White Creek, WA (07-11)	Downes and Gritski 2012b
Klondike IIIa (Phase II), OR (08-10)	Gritski et al. 2011	Wild Horse, WA (07)	Erickson et al. 2008
Leaning Juniper, OR (06-08)	Gritski et al. 2008	Windy Flats, WA (10-11)	Enz et al. 2011