Post-Construction Bird and Bat Fatality Monitoring Study

Pointwind and Oasis Wind Projects

Kern County, California

Year 1 Report

June 2021 – May 2022

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WEST

EXECUTIVE SUMMARY

Terra-Gen, LLC (Terra-Gen) has developed the Pointwind and Oasis Wind Projects (Pointwind and Oasis or, collectively, the Projects), located in Kern County, California. Following the start of commercial operations in early 2021, Terra-Gen contracted Western EcoSystems Technology, Inc. to develop and implement a standardized protocol for post-construction fatality monitoring to estimate the level of bird and bat mortality attributable to collisions with wind turbines at the Projects on an annual basis. The fatality monitoring study follows guidance described in Tier 4 of the US Fish and Wildlife Service *Land-Based Wind Energy Guidelines* and the California Wind Energy Guidelines. This report presents the methods and results of the first year of monitoring at the Projects, conducted from June 1, 2021 to May 27, 2022. The full study will consist of three years of monitoring with an anticipated date of completion in May 2024.

The fatality monitoring study detailed in this report consists of five components: 1) standardized carcass searches of selected turbines, 2) searcher efficiency (SEEF) trials to estimate the probability that a carcass is found by searchers, 3) carcass persistence (CP) trials to estimate the length of time that a carcass remains in the field for possible detection, 4) search area adjustment to account for fatalities that fall outside of search areas, and 5) calculation of adjusted fatality estimates for birds and bats.

Standardized carcass searches were conducted to systematically search the ground beneath 13 of the Project's 40 turbines (33%), including six of the 19 Pointwind turbines and seven of the 21 Oasis turbines. The Oasis turbines were not fully operational until October 2021; therefore, all six Pointwind turbines were searched for the full year while the seven Oasis turbines were searched in winter and spring only. Searches at each sampled turbine were conducted approximately every two weeks within a 120-meter (394-foot) radius plot centered on the turbine. Twenty-eight bird fatalities, representing 19 identifiable species, and two bat fatalities, representing a single species (hoary bat) were documented during the yearlong study. Six of the bird fatalities were found either outside of defined search areas or outside of the defined study period and were, therefore, excluded from the fatality estimates. No fatalities of state- or federal-listed bird or bat species or other species of concern were encountered. Bird fatalities were found at 11 of the 13 search turbines, with the greatest number of bird fatalities documented during the late summer/early fall and spring periods. The two bat fatalities were both found in spring at adjacent Oasis turbines.

During SEEF trials, 78 carcasses or decoys (30 large birds, 30 small birds, and 18 bats or bat surrogates [i.e., mice]) were placed throughout the Project, resulting in overall searcher efficiency rates of 90.0% for large birds, 90.0% for small birds, and 83.3% for bats. During CP trials, 79 carcasses (30 large birds, 30 small birds, and 19 bat surrogates) were placed within the Project. The top carcass persistence models indicated that the probability of a carcass persisting through the search interval was 0.43 for large birds, 0.15 for small birds, and 0.10 for bats during all seasons. Given the average search interval (14 days) and estimates of SEEF and CP, the annual probability that a carcass would remain in a search plot and be found by a searcher was 0.35 for large birds, 0.10 for small birds, and 0.06 for bats.

Based on the 3.60-megawatt (MW), 3.45-MW, and 2.30-MW capacities of the turbines at the Projects, the estimated fatality rate for all birds was 3.82 birds/MW/year, with an estimated fatality rate of 3.06 small birds/MW/year and 0.30 diurnal raptor fatalities/MW/year. The estimated bat fatality rate was 0.50 bats/MW/year.

Fatality rates for large birds, diurnal raptors, and bats estimated during the first year of monitoring at the Projects are generally consistent with those recorded at nearby wind energy facilities in the region. The results presented in this report represent the first of a three-year study. A detailed discussion of impacts and risk analysis will be prepared at the conclusion of the three-year study.

STUDY PARTICIPANTS

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REPORT REFERENCE

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ACRONYM LIST

Acronym	Definition
AIC_c	Corrected Akaike Information Criteria
CDFW	California Department of Fish and Wildlife
CP	Carcass Persistence
CPT	Carcass Persistence Trial
GenEst	Generalized Estimator
k	Detection reduction factor
QA/QC	Quality Assurance/Quality Control
MW	megawatt
SEEF	Searcher Efficiency
TWRA	Tehachapi Wind Resource Area
USFWS	US Fish and Wildlife Service
WEST	Western EcoSystems Technology, Inc.

INTRODUCTION

Terra-Gen, LLC (Terra-Gen), has developed the Pointwind and Oasis Wind Projects (Pointwind and Oasis or, collectively, the Projects), located in Kern County, California (Figure 1). Following the start of commercial operations in early 2021, Terra-Gen contracted Western EcoSystems Technology, Inc. (WEST) to develop and implement a standardized protocol for post-construction fatality monitoring to estimate the level of bird and bat mortality attributable to collisions with wind turbines at the Project on an annual basis. The fatality monitoring study (or study) follows guidance described in Tier 4 of the US Fish and Wildlife Service (USFWS) *Land-Based Wind Energy Guidelines* (USFWS 2012) and the California Wind Energy Guidelines (California Energy Commission and California Department of Fish and Wildlife [CDFW] 2007).

The primary objectives of the study are to 1) document species-specific fatalities, 2) estimate annual bird and bat fatality rates, 3) evaluate spatial and temporal patterns of bird and bat fatalities qualitatively, 4) determine whether any species of concern are experiencing fatalities as a result of collisions at the Projects, and 5) compare results with fatality monitoring studies conducted at other regional wind energy facilities. This report presents the methods and results of the first year (Year 1) of monitoring at the Projects, conducted from June 1, 2021 to May 27, 2022. The full study will consist of three years of monitoring with an anticipated date of completion in May 2024.

STUDY AREA

The Pointwind and Oasis Projects are located in the Tehachapi Wind Resource Area (TWRA), a region of high-density wind energy development in south-central Kern County, California. Both Projects are infill and repower developments sited on private property within the central portion of the TWRA and are located between 10 and 15 kilometers (km; six and nine miles [mi]) southeast of the City of Tehachapi (Figure 1). The Pointwind Project comprises 16 V136 3.60-megawatt (MW) wind turbine generators (WTGs) and three GE116 2.3-MW WTGs providing a total installed nameplate capacity of 64.6 MW. The Oasis Project, located approximately 3.2 km (2.0 mi) southeast of Pointwind, comprises 15 V136 3.6-MW WTGs and six V112 3.45-MW WTG for a total nameplate capacity of 74.7 MW. To accommodate the repowered Projects, approximately 209 older Vestas WTG were decommissioned and removed from the Pointwind site and 60 MHI 1000 WTGs were decommissioned and removed from the Oasis site. The Projects are surrounded on all sides by other operating wind energy facilities (Figure 2).

The Projects are located within the high desert plains and hills on the western edge of the Mojave Desert, and contain a diverse, hilly topography with elevations ranging from about 1,108 to 1,604 meters (m; 3,635 to 5,262 feet [ft]) above mean sea level. No permanent water exists within the Projects; however, several canyons and washes with intermittent water flow drain the site primarily from the northwest to southeast. The majority of the Projects is composed of desert scrub and grassland communities including California juniper (*Juniperus californica*) shrubland and creosote bush (*Larrea tridentata*) and brittlebush (*Encelia farinosa*) scrub.

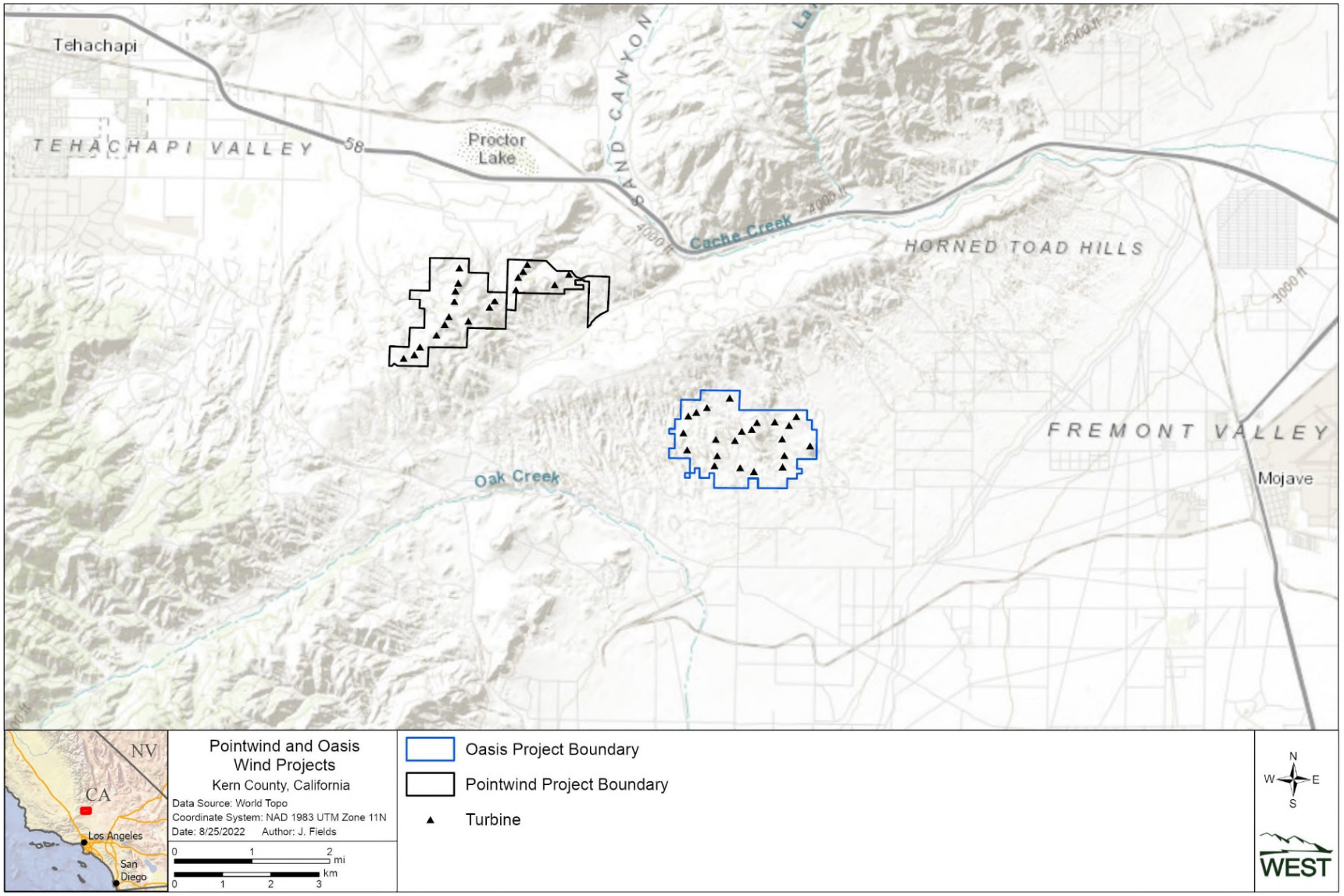

Figure 1. Location of the Pointwind and Oasis Wind Projects, Kern County, California.

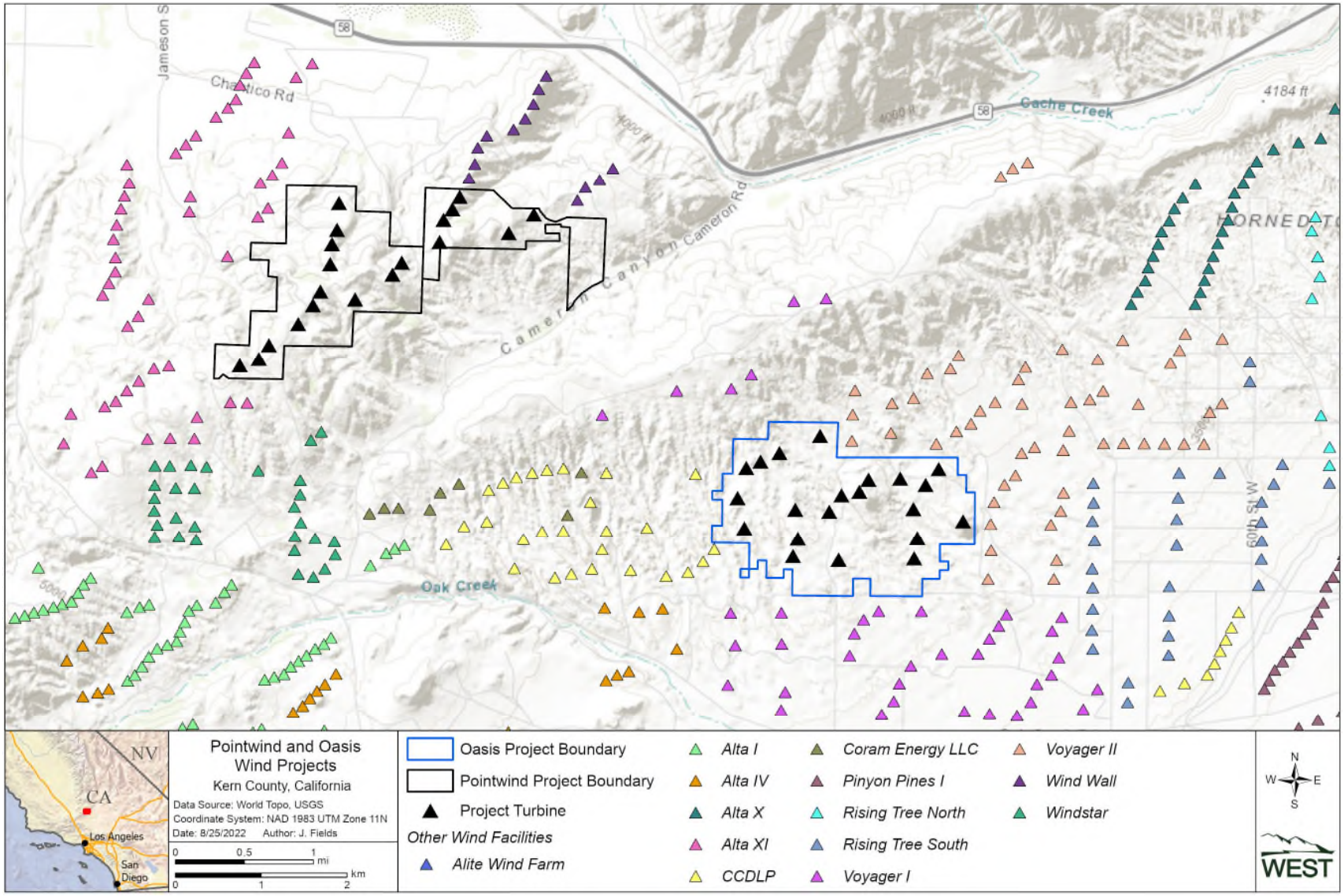

Figure 2. Location of the Pointwind and Oasis Wind Projects and other nearby modern wind energy facilities within the Tehachapi Wind Resource Area, Kern County, California.

METHODS

The fatality monitoring study consists of five primary components: 1) standardized carcass searches of selected turbines, 2) searcher efficiency (SEEF) trials to estimate the probability a carcass is found by searchers, 3) carcass persistence (CP) trials to estimate the average length of time a carcass remains in the search area for possible detection, 4) search area adjustment to account for fatalities that fall outside of search areas, and 5) calculation of adjusted fatality estimates for birds and bats. The methodologies of each of these components and associated analysis are described below.

Study Design

Search Turbines

Search turbines were a subset (33%) of the total number of turbines within the Projects, including six turbines at Pointwind and seven turbines at Oasis (Figure 3). Turbines were selected for sampling using a random, spatially balanced design to ensure search effort was spread throughout the Projects (Figure 3). At Pointwind, all six sampled turbines were searched for the full year. At Oasis, turbines were not fully operational until October 2021; therefore the seven sampled turbines at Oasis were searched only during the second half of the Year 1 study period (winter and spring).

Search areas

Search areas, also known as plots, were the areas beneath turbines within which carcass searches and SEEF trials were conducted. Search areas consisted of a 120-m (394-ft) radius plot centered on each search turbine (Figure 3). To the extent possible, searches were rotated throughout the day so individual search areas were surveyed during varying daylight periods (i.e., morning, mid-day, and afternoon).

Search Frequency

Search areas were surveyed every two weeks during summer (June 1 – August 31), fall (September 1 – October 31), winter (November 1 – February 28), and spring (March 1 – May 31).

Standardized Carcass Searches

Carcass searches are surveys where searchers look for bird and bat carcasses in selected search areas. Personnel trained in proper search techniques conducted searches for bird and bat carcasses, parts of carcasses, or injured birds or bats from June 1, 2021, to May 27, 2022. Within the search areas, searchers walked transects spaced six to 10 m apart, walking at a pace of approximately 45–60 m (about 150–200 ft) per minute and scanning both sides of the transect out to approximately 3–5 m (10–16 ft). All bird and bat carcasses (or parts thereof) found were recorded and assumed to be from collision with turbines. Data recorded for each carcass included:

- an identification (ID) code

- species, sex, age, and reproductive condition (when possible)
- date and time
- Universal Transverse Mercator location
- measured distance and direction from turbine
- estimated time since death
- any comments that indicated possible cause of death
- photograph(s) of carcass as found
- location of carcass plotted on map
- cover type (e.g., grave, bare ground, shrub, grasslands)
- visibility index (easy, moderate, difficult, very difficult; based on based on average vegetation height and percent of bare ground within a 1.0- × 1.0-m [3.3- × 3.3-ft] square area surrounding the carcass).
- condition (i.e., intact, scavenged, dismembered, feather spot, injured):
    - 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 that showed signs of scavenging or was heavily infested by insects, or portion(s) of a carcass in one location (e.g., wings);
    - Dismembered – a carcass with missing limbs;
    - Feather Spot – 10 or more feathers (or two or more primary feathers) at one location that indicated predation or scavenging; or
    - Injured – a live bird or bat that was harmed, damaged, or impaired in some way.

Carcasses found outside of the standardized search areas, or within a search area but outside of a scheduled search, were recorded following the above protocol. However, any carcasses found outside the search areas or having an estimated time of death prior to the start of the study were not included in the fatality estimates. All carcasses found inside search areas, but outside standardized search times, were included in the analysis under the assumption these carcasses would have been found during the next scheduled search. All carcasses found in the Project were left in place. Biologists experienced in identifying birds and their feathers, and bats, verified all carcass identifications.

Searcher Efficiency Trials

The objective of SEEF trials was to collect data to estimate the probability searchers detected bird and bat carcasses. This effort accounted for any biases associated with changes in conditions such as vegetation, topography, and searcher variability that could have affected detection of bird and bat carcasses. SEEF trials were stratified by carcass type (large bird, small bird or bat), and season. A bias trial administrator placed SEEF carcasses in search areas to keep searchers

unaware of when and where the SEEF trial carcasses were placed. Bird carcasses used for the trials included non-native/non-protected or commercially available species, including adult, female mallards (*Anas platyrhynchos*) for large birds and two-week old quail (*Coturnix spp.*) for small birds. For small birds, dark-colored avian decoys with real feathers were also used for trials. Brown-colored house mice (*Mus musculus*) and dark-colored plastic bat decoys were used as surrogates for bats.

To conduct each trial, the bias trial administrator placed SEEF carcasses at random locations within search areas before that day's scheduled search. Prior to placement, each SEEF carcass was marked discreetly with black electrical tape around one leg so it could be identified as a SEEF carcass. The administrator dropped SEEF carcasses from waist height or higher and allowed them to land in a random posture. Searchers conducting SEEF trials recorded the location and time of the SEEF carcasses found during the subsequent carcass search. Immediately following the trial, the bias trial administrator determined the number of SEEF carcasses available for detection during the trial.

Carcass Persistence Trials

The objective of CP trials was to collect data to estimate the average probability that a bird or bat carcass remained available to be found during the search interval. The data collected were used to adjust for the potential bias of carcasses being removed before searchers had the opportunity to find them. Possible means of carcass removal included predators, scavengers, or insects. CP trials were conducted throughout the year to incorporate the effects of varying weather, climatic conditions, and scavenger densities. Trial carcasses were of similar composition to those used for SEEF trials as described above (i.e., mallards for large birds, quail for small birds, and mice as surrogates for bats).

During each trial, CP carcasses were randomly placed at selected non-search turbines within a plot of similar size to the actual search areas. Trial carcasses were marked discreetly with dark electrical tape for recognition by searchers and other personnel, and then dropped from waist height or higher and allowed to land in a random posture within the search area. CP trial carcasses were monitored over a 30-day period according to the following schedule: every day for the first four days, then on day seven, day 10, day 14, day 20, and day 30. The condition of carcasses was recorded each time the CP trial carcasses were checked. The schedule varied slightly depending on weather and coordination with other survey work. Following the 30-day trial period, any remaining evidence of the carcasses was removed.

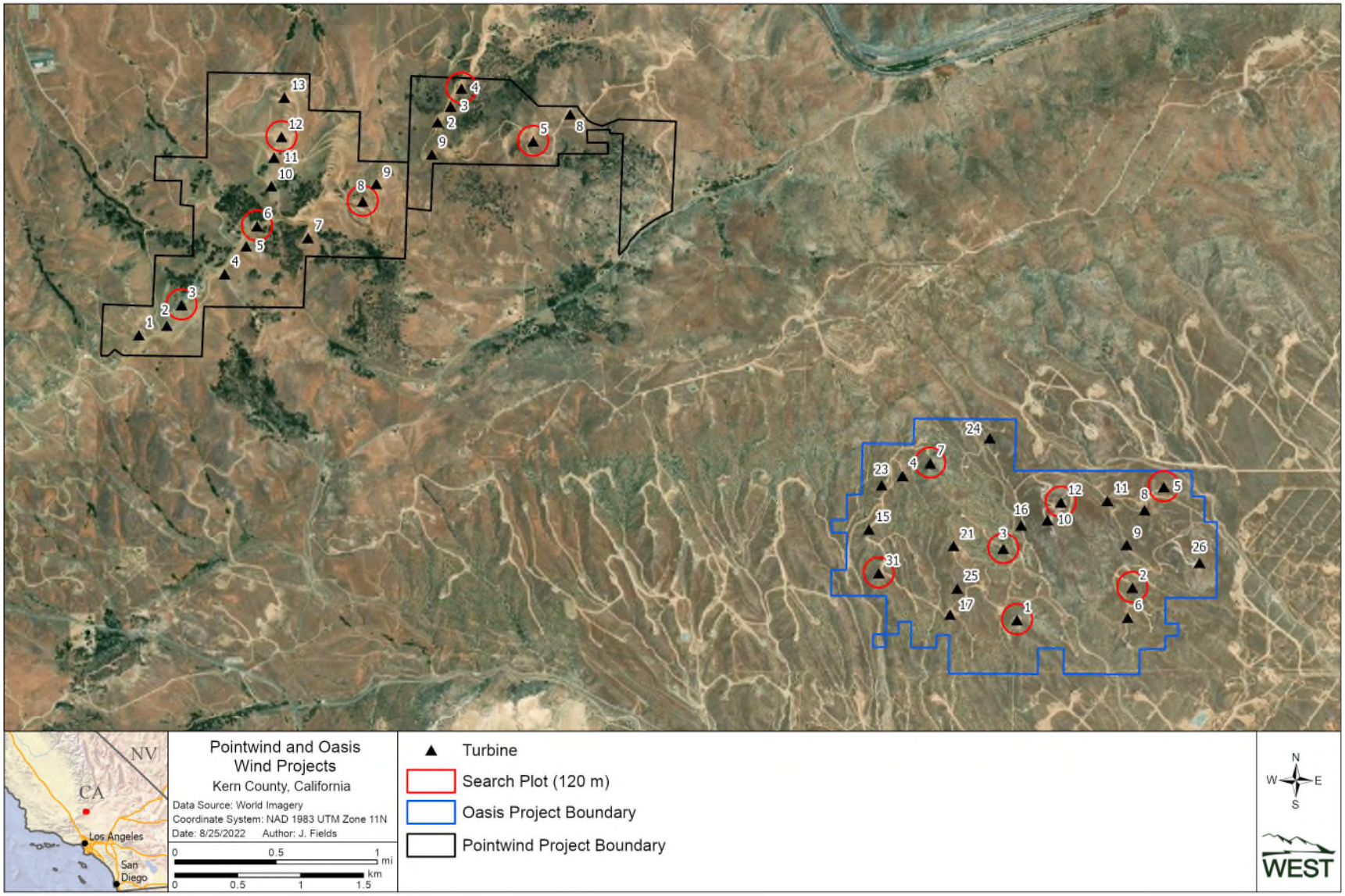

Figure 3. Location of carcass search plots at the Pointwind and Oasis Wind Projects, Kern County, California, June 1, 2021 to May 27, 2022.

Data Management

Quality Assurance and Quality Control

WEST implemented quality assurance and quality control (QA/QC) measures at all stages of the study, including in the field, during data entry and analysis, and report writing. Following surveys, searchers were responsible for inspecting data forms for completeness, accuracy, and legibility. If errors or anomalies were found within the data, follow-up measures were implemented including discussions and review of field data with searchers and/or Project managers. Errors, omissions, or problems identified in later stages of analysis were traced back to the raw data, and appropriate changes in all steps were made.

Data Compilation and Storage

A Microsoft SQL database was specifically developed to store, organize, and retrieve Project data. Project data were keyed into the electronic database using a pre-defined format to facilitate subsequent QA/QC and data analysis. WEST retained all data forms and electronic data files for reference.

Statistical Analysis

Fatality Rate Estimation

Carcasses included in fatality rate estimations were found within the search areas (circular plots) and had an estimated time of death within the study period. WEST calculated fatality estimates for all birds, large birds, diurnal raptors, small birds, and bats. WEST classifies bird sizes by body length and, if necessary, wingspan. Large birds are defined as birds greater than 30 centimeters (cm; 12 inches) in length, or between 23 cm (nine inches) and 30 cm in length and having a wingspan of more than 46 cm (18 inches). Within the large bird class, diurnal raptors are further defined as all kites, accipiters, buteos, eagles, falcons, northern harrier [*Circus hudsonius*], and osprey [*Pandion haliaetus*]. Small birds are defined as birds less than or equal to 23 cm in length, or between 23 cm and 30 cm in length and having a wingspan less than or equal to 46 cm.

For all species groups, WEST calculated fatality estimates by season and overall using GenEst (a generalized estimator of fatality; Dalthorp et al. 2018, Simonis et al. 2018). To obtain fatality estimates, each carcass included in the analysis was adjusted for SEEF, a detection reduction factor (also referred to as "*k*"; see below), CP, and a search area adjustment. Estimates and confidence intervals (CIs) were calculated using a parametric bootstrap (Dalthorp et al. 2018) for each individual category listed above, assuming more than five fatalities were detected.

Searcher Efficiency Estimation

SEEF estimated the probability of a carcass being detected by a searcher given the carcass was available to be found. SEEF estimates were calculated separately for each size class as the proportion of available trial carcasses/decoys found by searchers. Given the relatively small number of trials conducted during each season (five to 10 carcasses per size class per season), a single SEEF estimate was used throughout the year for each carcass size class.

Detection Reduction Factor

The change in SEEF between successive searches is defined by a parameter called the detection reduction factor (k) that ranges from zero to one. When k is zero it implies that if a carcass was missed on the first search then that carcass would never be found. A k of one implies SEEF remains constant no matter how many times a carcass was missed. The detection reduction factor is a required parameter for GenEst; however, data were not collected to estimate k. A value for k of 0.67 has been estimated for bats (Huso et al. 2017) and this value was assumed in this study for birds and bats.

Carcass Persistence Estimation

The CP adjustment estimated the average probability a carcass persisted through the search interval (i.e., the time between scheduled searches). The persistence of a carcass was modeled using an interval-censored survival regression for each size class using exponential, log-logistic, lognormal, and Weibull distributions (Kalbfleisch and Prentice 2002, Dalthorp et al. 2018). The best model was selected as the most parsimonious model within two Corrected Akaike Information Criteria (AICc) units of the model with the lowest AICc value. Given the relatively small number of CP trials conducted during each season (five to 10 carcasses per size class per season) a single CP rate was used throughout the year for each carcass size class.

Search Area Adjustment Estimate

The search area adjustment accounted for the unsearched area beneath turbines where turbine-caused fatalities could potentially have landed and was calculated as a probability that ranged from zero to one. For example, an area adjustment of 0.75 meant that an estimated 75% of fatalities fell within the search area. Unsearched areas were due to survey obstacles, such as steep terrain, or areas where carcasses could have fallen outside the search area (e.g., a carcass landed 125 m [410 ft] away from the turbine on a plot searched out to 120 m). The area adjustment was estimated as the product of the unsearched area around each turbine and a carcass-density distribution. The carcass-density distribution predicts the likelihood a carcass will fall a given distance from the turbine base. Separate area adjustments were estimated for large birds, diurnal raptors, small birds, and bats.

There was not a sufficient number of bird or bat carcasses found during the study to allow for development of a site-specific carcass-density distribution. Therefore, to calculate the search area adjustment for large birds, small birds, and bats, the maximum fall distance of carcasses for a given turbine height and rotor radius was calculated using a physics-based model (Hull and Muir 2013) where the relative carcass-density distribution was assumed to follow a linear decrease from the turbine base out to the maximum predicted fall distance (Huso and Dalthorp 2014). While three different turbines types with slightly different tip heights are present at the Projects, the turbine type with the largest overall dimension (3.6-MW) was used in the calculation of search area adjustment because this turbine type composes the majority of the Projects' turbines (78%) and also provides the most conservative calculation of the search area adjustment. To calculate the search area adjustment for diurnal raptors, the carcass-density distribution from Hallingstad et al. (2018) was utilized.

RESULTS

The number, species, location, and other characteristics of the bird and bat carcasses found during searches and included in the analysis, as well as the fatality estimates are discussed below. A full listing of carcasses found during Year 1 study are presented in Appendix A.

Standardized Carcass Searches

In total, 253 carcass searches were conducted from June 1, 2021 to May 27, 2022, including 148 searches at Pointwind and 105 searches at Oasis. The Oasis turbines were not fully operational until October 2021; therefore, all six Pointwind turbines were searched for the full year while the seven Oasis turbines were searched only in winter and spring. The average search interval across the year-long study period was 14 days. Over the course of the study, 28 bird carcasses and two bat carcasses were found within the Project. Of these, six bird carcasses were found outside the search areas or outside the study period (i.e., estimated to have died prior to the study period) and, therefore, were not included in the analysis (Table 1). According to the criteria outlined above, 22 bird carcasses and two bat carcasses were included in the analysis (Table 1).

Table 1. Total number of carcasses and percent composition of carcasses discovered at the Pointwind and Oasis Wind Projects, Kern County, California, from June 1, 2021 to May 27, 2022.

	Included in Fatality Estimate		Outside Search Area*		Outside Study Period*		Total	
Species	**Total**	**%**	**Total**	**%**	**Total**	**%**	**Total**	**%**
Bird								
California scrub-jay	3	13.6	0	0	0	0	3	10.7
American kestrel	2	9.1	0	0	0	0	2	7.1
Bullock's oriole	2	9.1	0	0	0	0	2	7.1
common raven	1	4.6	1	33.3	0	0	2	7.1
unidentified small bird	1	4.6	1	33.3	0	0	2	7.1
northern flicker	1	4.6	0	0	1	33.3	2	7.1
red-tailed hawk	1	4.6	0	0	1	33.3	2	7.1
black-headed grosbeak	1	4.6	0	0	0	0	1	3.6
black-throated gray warbler	1	4.6	0	0	0	0	1	3.6
California quail	1	4.6	0	0	0	0	1	3.6
great horned owl	1	4.6	0	0	0	0	1	3.6
green-tailed towhee	1	4.6	0	0	0	0	1	3.6
hermit warbler	1	4.6	0	0	0	0	1	3.6
mourning dove	1	4.6	0	0	0	0	1	3.6
western kingbird	1	4.6	0	0	0	0	1	3.6
western meadowlark	1	4.6	0	0	0	0	1	3.6
western tanager	1	4.6	0	0	0	0	1	3.6
Wilson's warbler	1	4.6	0	0	0	0	1	3.6
ruby-crowned kinglet	0	0	1	33.3	0	0	1	3.6
European starling	0	0	0	0	1	33.3	1	3.6
Overall Birds	**22**	**100**	**3**	**100**	**3**	**100**	**28**	**100**
Bat								
hoary bat	2	100	0	0	0	0	2	100
Overall Bats	**2**	**100**	**0**	**0**	**0**	**0**	**2**	**100**

* Carcasses not included in analysis

Sums can differ from values shown due to rounding.

Bird Carcasses

Nineteen identifiable bird species were documented as fatalities during the Year 1 study. The species most commonly documented as a fatality was California scrub-jay (*Aphelocoma californica*; three fatalities; Table 1, Appendix A). Four diurnal raptor fatalities (two American kestrels [*Falco sparverius*] and two red-tailed hawk [*Buteo jamaicensis*]) and one owl fatality (great horned owl [*Bubo virginianus*]) were recorded during searches (Table 1, Appendix A). No state or federal species of concern were documented as fatalities during the Year 1 study.

Bird carcasses were located within 11 of the 13 search areas, with the greatest number of fatalities found at Pointwind Turbine P4 (five fatalities) in the northern-most portion of the Projects (Figure 4). The remaining turbine search areas had between zero and two fatalities each (Figure 4). The number of bird carcasses found per turbine search area peaked in late summer/early fall with a smaller increase observed in spring, coinciding with the peak of spring and fall migration (Figure 5). Substantially fewer bird carcasses were found in winter (Figure 5). These rates are based on raw counts of carcasses found and not adjusted for SEEF and CP.

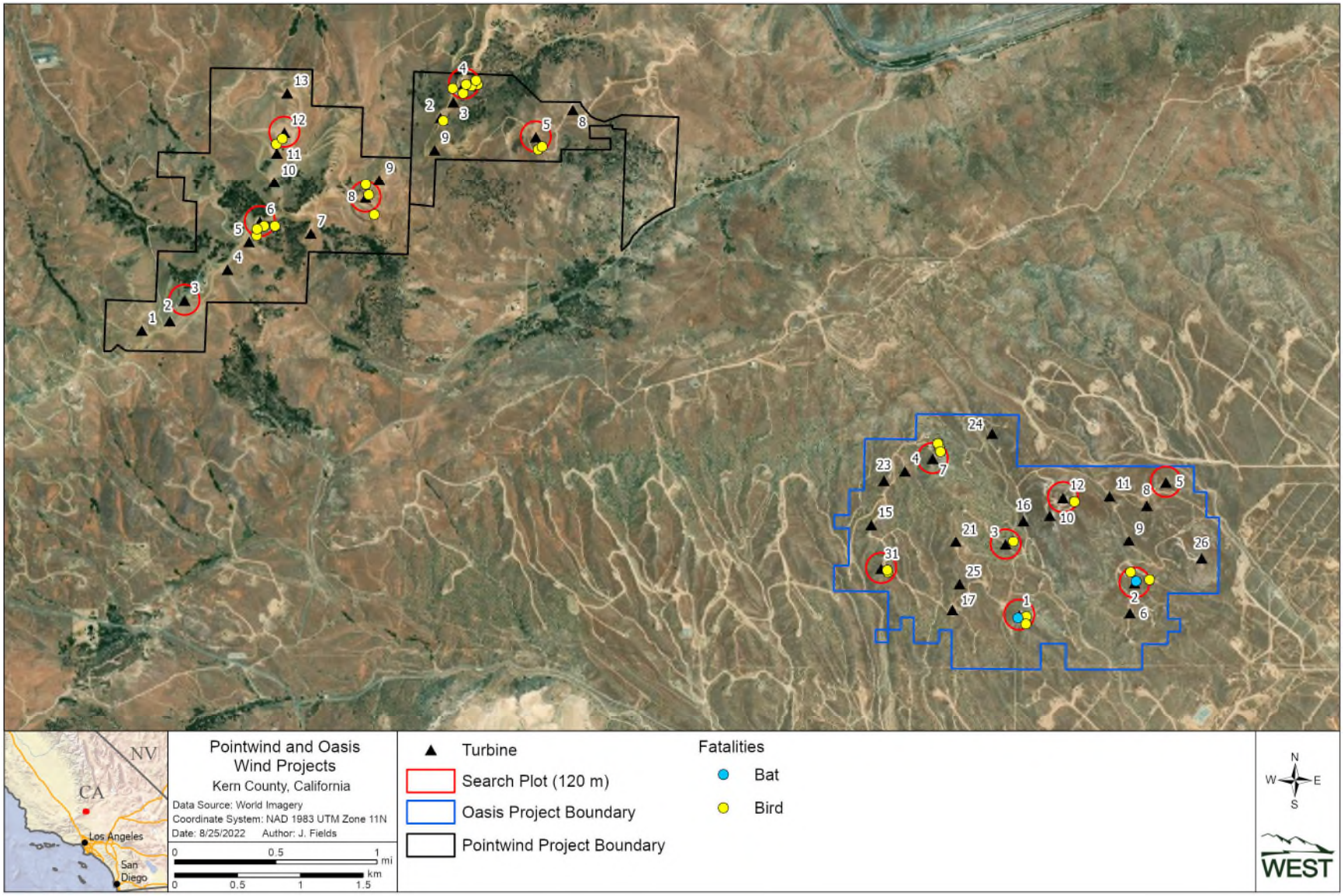

Figure 4. Location of all bird and bat carcasses found at the Pointwind and Oasis Wind Projects, Kern County, California, from June 1, 2021 to May 27, 2022.

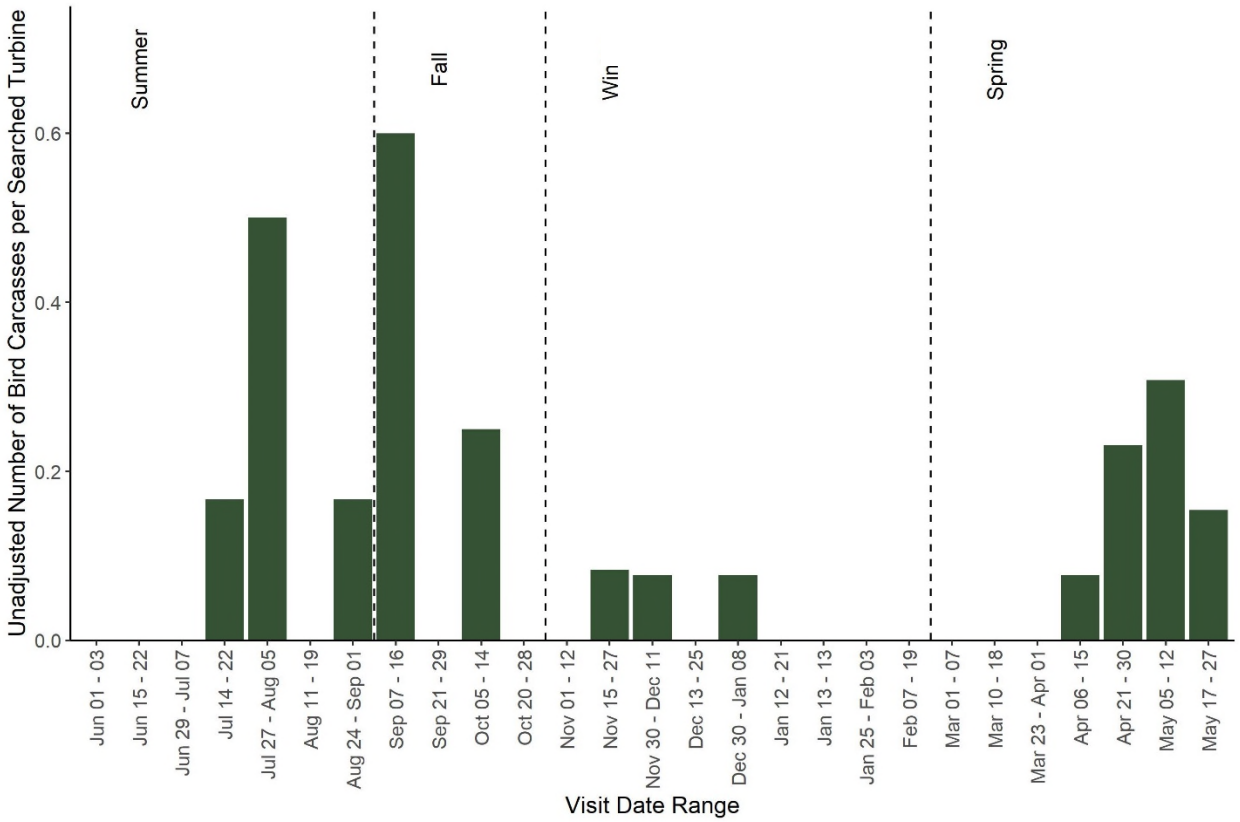

Figure 5. Temporal distribution of bird carcasses found at the Pointwind and Oasis Wind Projects in Kern County, California from June 1, 2021 to May 27, 2022.

Bat Carcasses

The two bat fatalities, both hoary bats (*Lasiurus cinereus*), were found within a search area and during the study period and were, therefore, included in the analysis. (Table 1, Appendix B). The two bats were found at Oasis Turbine O2 on March 23, 2022 and at Oasis Turbine O1 on April 28, 2022 (Figure 4). Hoary bat is not currently considered a species of concern at the California state or federal level.

Searcher Efficiency Rates

In total, 78 carcasses (30 large bird carcasses, two small bird carcasses, 30 small bird decoys, 11 bat decoys, and seven mice [used as surrogates for bats]) were placed during Year 1 SEEF trials at the Projects (Table 2). Searchers found 90.0% of all available large bird trial carcasses, 90.0% of small bird carcasses/decoys, and 83.3% of mice carcasses/bat decoys (Table 2).

Table 2. Searcher efficiency results at the Pointwind and Oasis Wind Projects, Kern County, California, from June 1, 2021 to May 27, 2022 as a function of season and carcass size.

Size Class	Season	# Placed	# Available	# Found	% Found
Large Bird	Summer	5	5	5	100
	Fall	10	10	7	70.0
	Winter	5	5	5	100
	Spring	10	10	10	100
	Overall	**30**	**30**	**27**	**90.0**
Small Bird	Summer	10	10	8	80.0
	Fall	7	5	5	100
	Winter	10	10	9	90.0
	Spring	5	5	5	100
	Overall	**32**	**30**	**27**	**90.0**
Bat	Summer	6	6	4	66.7
	Fall	7	7	6	85.7
	Spring	5	5	5	100
	Overall	**18**	**18**	**15**	**83.3**

A value for *k* of 0.67 has previously been estimated for bats (Huso et al. 2017), and this value was used in this study for both birds and bats as Project-specific data were not collected to estimate *k*. However, given the relatively high searcher efficiency rates, as well as the relatively low probability a carcass would persist through more than one search interval, particularly for small birds and bats (see Carcass Persistence in following section), the assumed value for *k* had very little influence on the overall bird and bat fatality estimates.

Carcass Persistence

In total, 79 CP trial carcasses (30 large birds, 30 small birds, and 19 mice [used as surrogates for bats]) were placed in the search areas throughout the duration of the Year 1 study (Appendix B1). The lognormal model provided the best support for large bird persistence, while the loglogistic model provided the best support for small bird persistence, and the exponential model provided the best support for bat persistence (Table 3, Appendices B2-B4). Based on the modeling results, the average probability of a carcass persisting through the 14-day search interval was 0.43 for large birds, 0.15 for small birds, and 0.10 for bats (Figure 6; Appendix D1).

Table 3. Carcass persistence top models with covariates, distributions, and model parameters for the Pointwind and Oasis Wind Projects, Kern County, California, from June 1, 2021 to May 27, 2022.

Size Class	Distribution	Predicted Removal Time (days)	Parameter 1	Parameter 2
Large Bird	lognormal*	3.79	meanlog = 1.333	sdlog = 2.086
Small Bird	loglogistic**	1.18	shape = 0.672	scale = 0.162
Bat	exponential*	0.95	rate = 0.732	–

* Parameterization follows the base R parameterization for this distribution.

** Parameterization follows the FAdist parameterization for this distribution.

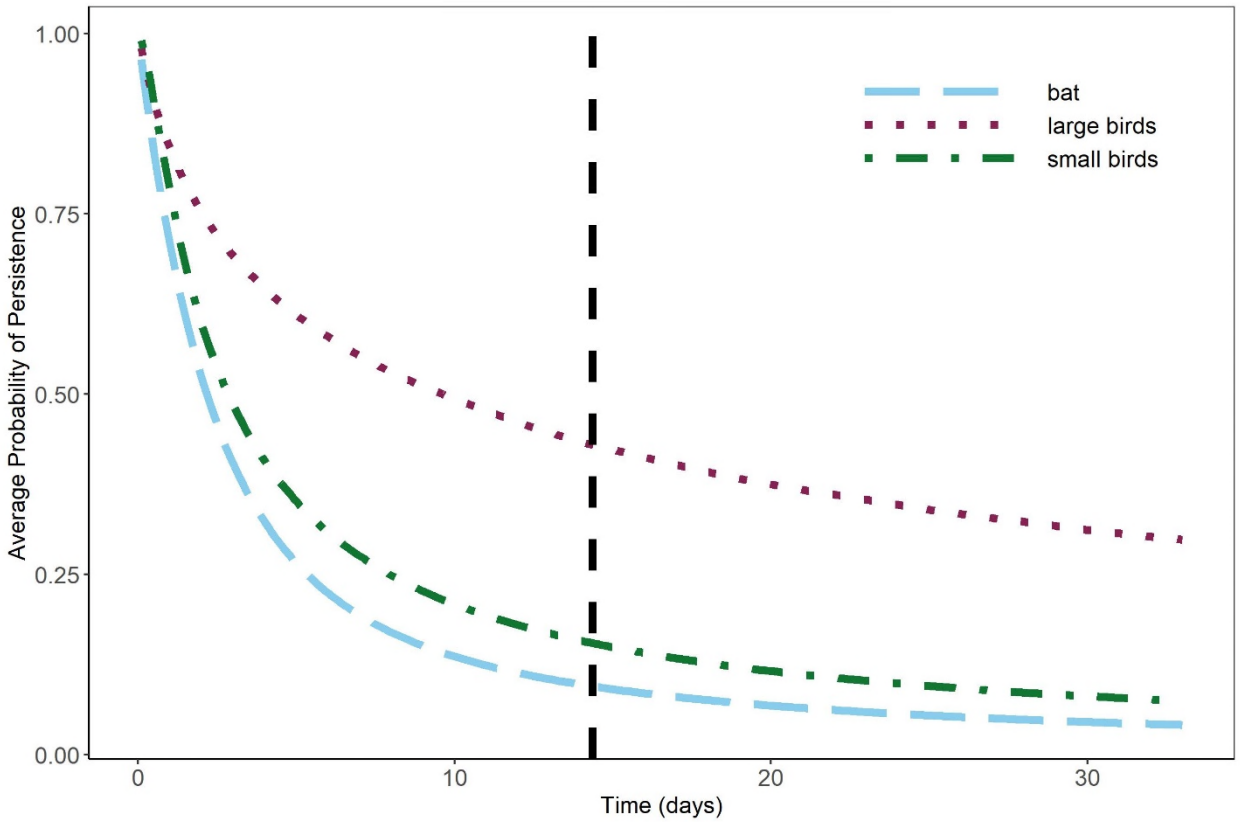

Figure 6. Carcass persistence for large bird, small bird, and mice carcasses placed at the Pointwind and Oasis Wind Projects in Kern County, California from June 1, 2021 to May 27, 2022. Carcass persistence trials were conducted for a 30-day period. Average search interval was 14 days (indicated by the vertical dashed line).

Search Area Adjustment

The estimated search area adjustment for large birds was 0.99 (Table 4, Figure 7a). For both small birds and bats, the estimated area adjustment was 1.00 (Table 4, Figure 7a). For diurnal raptors the estimated area adjustment was 0.97 (Table 4, Figure 7b).

Table 4. Search area adjustment estimates by size class and turbine type for the Pointwind and Oasis Wind Projects, Kern County, California, from June 1, 2021 to May 27, 2022.

Size Class	Hub Height (m)	Blade Radius (m)	Search Area Adjustment (120-m radius plot)
Large Bird[1]	82	68	0.99
Small Bird[1]	82	68	1.00
Bat[1]	82	68	1.00
Raptors[2]	na	na	0.97

1 Estimated area adjustments based on Hull and Muir (2013).

2 Estimated area adjustment based on Hallingstad et al. (2018) model.

m = meter, na = not applicable

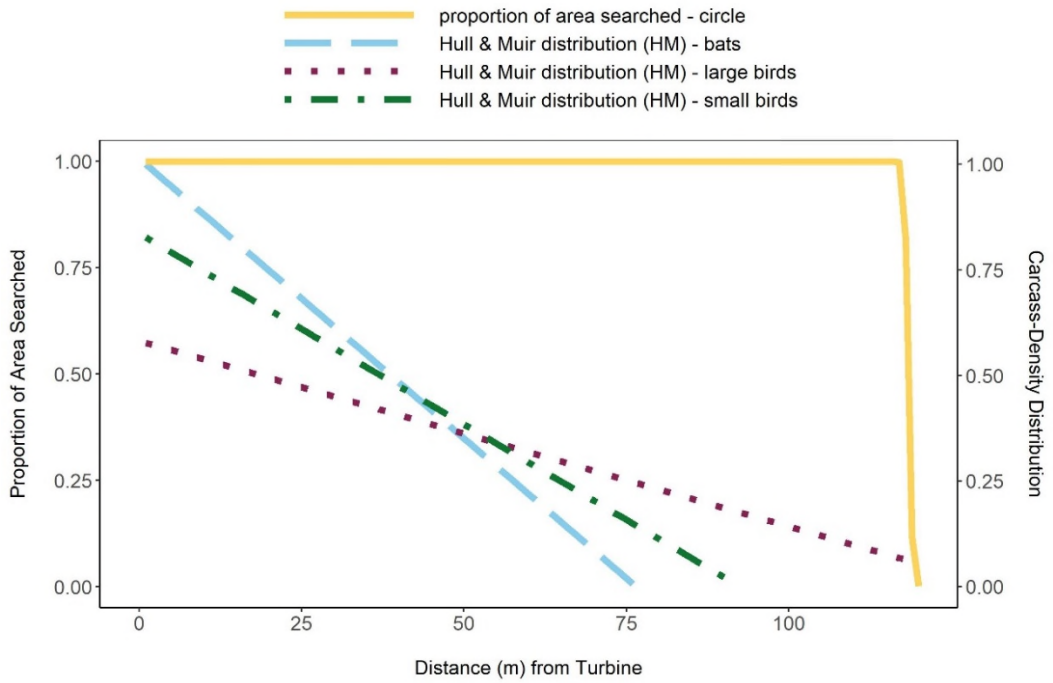

Figure 7a. Estimated large bird, small bird, and bat carcass-density distribution and proportion of area searched by distance from the turbine at the Pointwind and Oasis Wind Projects, Kern County, California, from June 1, 2021 to May 27, 2022.

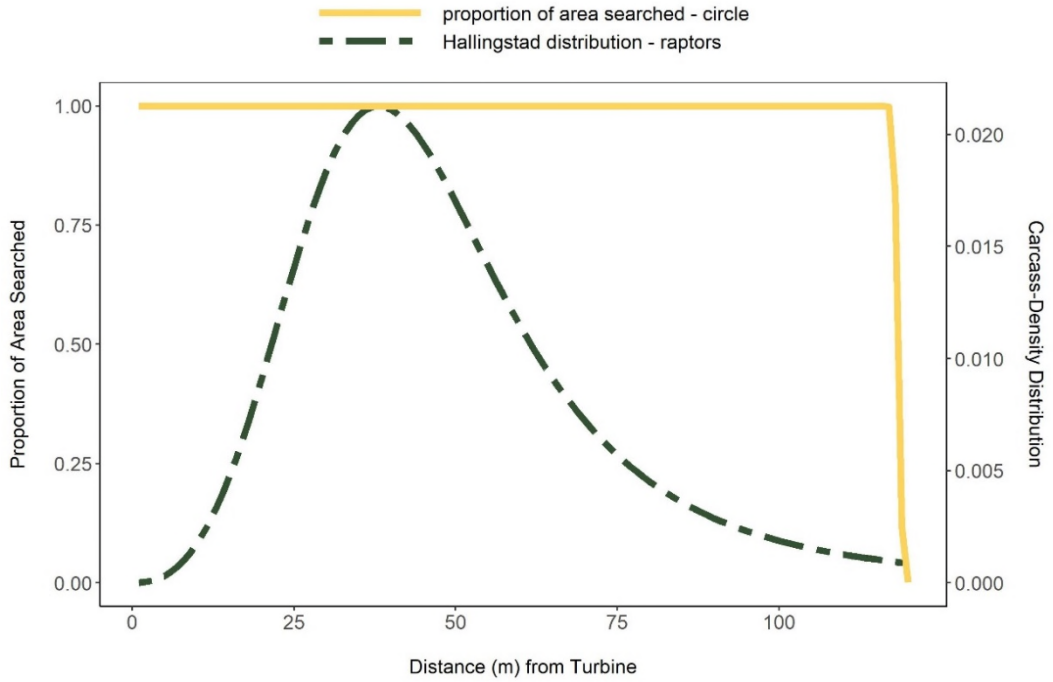

Figure 7b. Estimated raptor carcass-density distribution and proportion of area searched by distance from the turbine at the Pointwind and Oasis Wind Projects, Kern County, California, from June 1, 2021 to May 27, 2022.

Estimated Fatality Rates

Adjusted fatality estimates and 90% CI were calculated on a per-turbine and per-MW basis for bird and bat categories (Table 5, Appendix C)[1]. The fatality estimates were calculated based on the estimated SEEF, average probability of CP, and search area adjustment (Appendix C). For large birds, including diurnal raptors, the average probability a carcass remained in the search area and was found by searchers was 0.35 (90% CI: 0.23–0.46) across all seasons (Appendix C). For small birds and bats, the probability a carcass remained in the search area and was found by searchers was 0.10 (90% CI: 0.07–0.16) and 0.06 (90%: 0.04–0.09), respectively, across all seasons (Appendix C).

Table 5. Overall fatality rates and associated 90% Confidence Intervals (CIs) per turbine and per MW for studies conducted at the Pointwind and Oasis Wind Projects, Kern County, California, from June 1, 2021 to May 27, 2022.

	Per Turbine Estimates		Per MW Estimates	
	Estimate	**90% CI**	**Estimate**	**90% CI**
All Bird	**13.76**	**7.82 - 23.03**	**3.82**	**2.17 - 6.40**
Large Bird	2.59	1.16 - 5.22	0.72	0.32 - 1.45
Large Bird Non-Diurnal Raptor	*1.57*	*0.48 - 3.54*	*0.44*	*0.14 - 0.98*
Diurnal Raptor	*1.06*	*n/a**	*0.30*	*n/a**
Small Bird	11.01	5.55 - 19.04	3.06	1.54 - 5.29
Bat	**1.81**	**n/a***	**0.50**	**n/a***

* CIs were not estimated in cases where five or fewer fatalities were found because fatality estimators are known to be imprecise when the count of observed carcasses is low.

All Birds

The overall estimated bird fatality rate was 3.82 bird fatalities/MW/year (Table 5). The estimated fatality rate for all birds combined was highest during spring with 1.13 bird fatalities/MW/season, and lowest in the winter with 0.34 bird fatalities/MW/season (Appendix C).

Diurnal Raptors

The overall estimated diurnal raptor fatality rate was 0.30 fatalities/MW/year (Table 5). The estimated diurnal raptor fatality rate was highest during summer (0.24 fatalities/MW/season) followed by spring (0.05 raptor fatalities/MW/season); no diurnal raptor fatalities were found in summer or winter (Appendix C).

Small Birds

The overall estimated fatality rate for small birds was 3.06 fatalities/MW/year (Table 5). The small bird fatality rate was highest in spring (0.97 fatalities/MW/season) and lowest in winter (0.29 fatalities/MW/season; Appendix C).

[1] CI were not calculated when less than five carcasses were observed, as CI from Horvitz-Thompson estimators (Horvitz and Thompson 1952) are unreliable when carcass counts are low (Korner-Nievergelt et al. 2011).

Bats

The overall estimated bat fatality rate was 0.50 bat fatalities/MW/year (Table 5; Appendix C). The two bat fatalities recorded during the study both occurred in spring.

DISCUSSION

Birds

During Year 1 of the study, WEST biologists recorded a total of 28 bird fatalities represented by 19 identifiable species. Passerines represented the majority (60.7%) of bird fatalities recorded, with diurnal raptors and owls representing another 17.9% of bird fatalities. Of the 19 bird species documented as fatalities during Year 1, none are state- or federally listed or candidate species or other species of conservation concern (CDFW 2022). Temporally, bird fatalities occurred in all seasons, with the fewest fatalities found in winter through early spring. Spatially, bird fatalities were generally dispersed throughout the Projects with the greatest number of fatalities (five fatalities) found at Pointwind Turbine P4, in the northern-most part of the Projects.

To evaluate bird fatality rates at the Project in a regional context, fatality rates at the Project were compared with publicly available fatality data from other wind energy facilities in the TWRA maintained in WEST's internal Renew database (WEST 2021; Appendix D). The estimated Project-wide bird fatality rate of 3.82 bird fatalities/MW/year falls within the range of fatality rates documented at these other regional facilities, which have ranged from 0.17 to 12.05 fatalities/MW/study period (Figure 8; Appendix D). The majority of the overall bird fatality rate at the Project is attributed to small birds, which had an estimated fatality rate of 3.06 fatalities/MW/year, while the estimated fatality rate for large birds was 0.73. The Project's estimated overall diurnal raptor fatality rate of 0.30 fatalities/MW/year falls near the upper end of the range of diurnal raptor fatality rates documented at other wind energy facilities in the TWRA where estimates have ranged from zero to 0.28 diurnal raptor fatalities/MW/study period (Figure 9; Appendix D). Although evaluation of regional data can provide context for fatality rates at the Project, caution should be exercised when making direct comparisons of fatality estimates among studies at regional facilities because of the differences in study design and data analysis methods that have varied and evolved over the years (Appendix D).

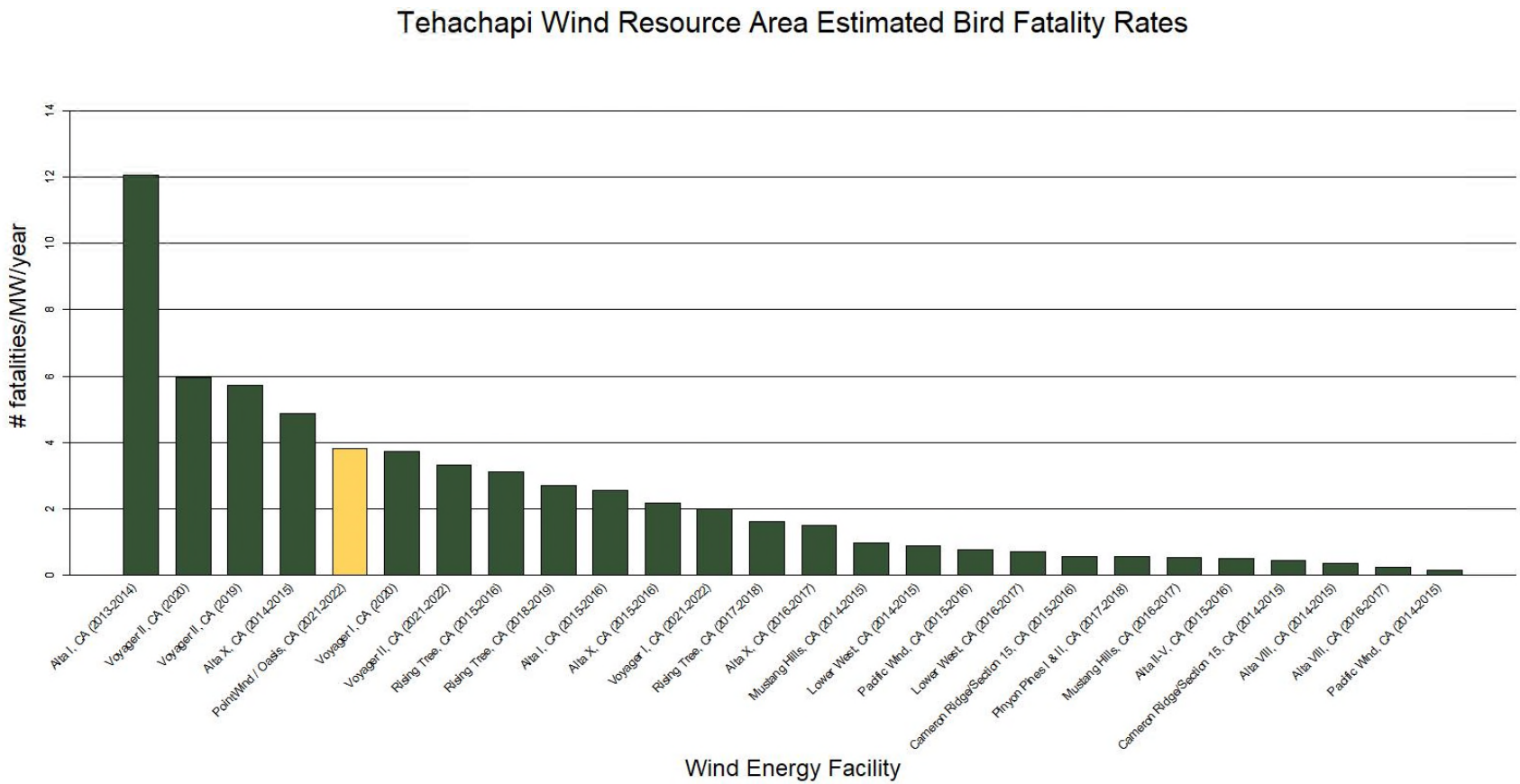

Figure 8. Estimated fatality rates for all birds (number of birds per megawatt per study period) from publicly available wind energy facilities throughout California. The Pointwind and Oasis Wind Projects are indicated in gold.

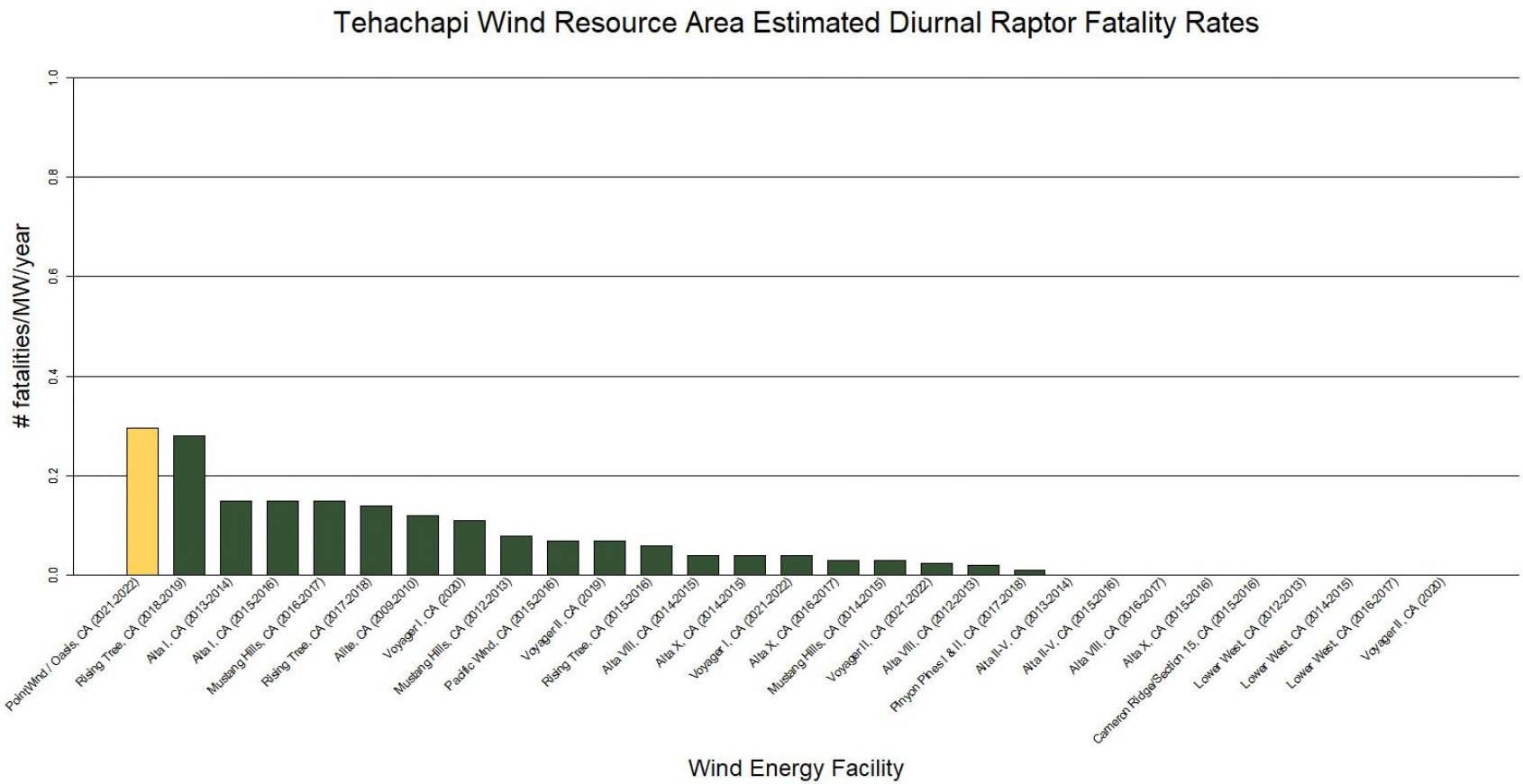

Figure 9. Estimated fatality rates for diurnal raptor (number of diurnal raptor per megawatt per year) from publicly available wind energy facilities throughout California. The Pointwind and Oasis Wind Projects are indicated in gold.

Bats

The two bat fatalities documented during the first year of the study were attributed to a single species, hoary bat. Hoary bats are not currently considered sensitive at the state or federal level (CDFW 2022). The two bat fatalities were found at two adjacent Oasis turbines and both fatalities occurred in spring, a period which coincides with the species' migration through the region.

The estimated overall bat fatality rate for the Project of 0.50 bat fatalities/MW/year is relatively low and well within the range of fatality rates reported from other facilities in TWRA, which have ranged from zero to 2.17 bat fatalities/MW/study period (Figure 10; Appendix D).

CONCLUSION

The information presented in this report represents the first year of a three-year study of avian and bat mortality at the Project. During this initial year of monitoring, both bird and bat fatality rates were estimated to be relatively low and well within the range of those reported at nearby facilities in the TWRA (e.g., CCDLP, Voyager I, and Voyager II). Two additional years of monitoring are planned, the results of which will help to clarify the potential long-term impacts of the Projects on birds and bats. A more detailed discussion of impacts and risk analysis will be provided following the completion of the three-year study.

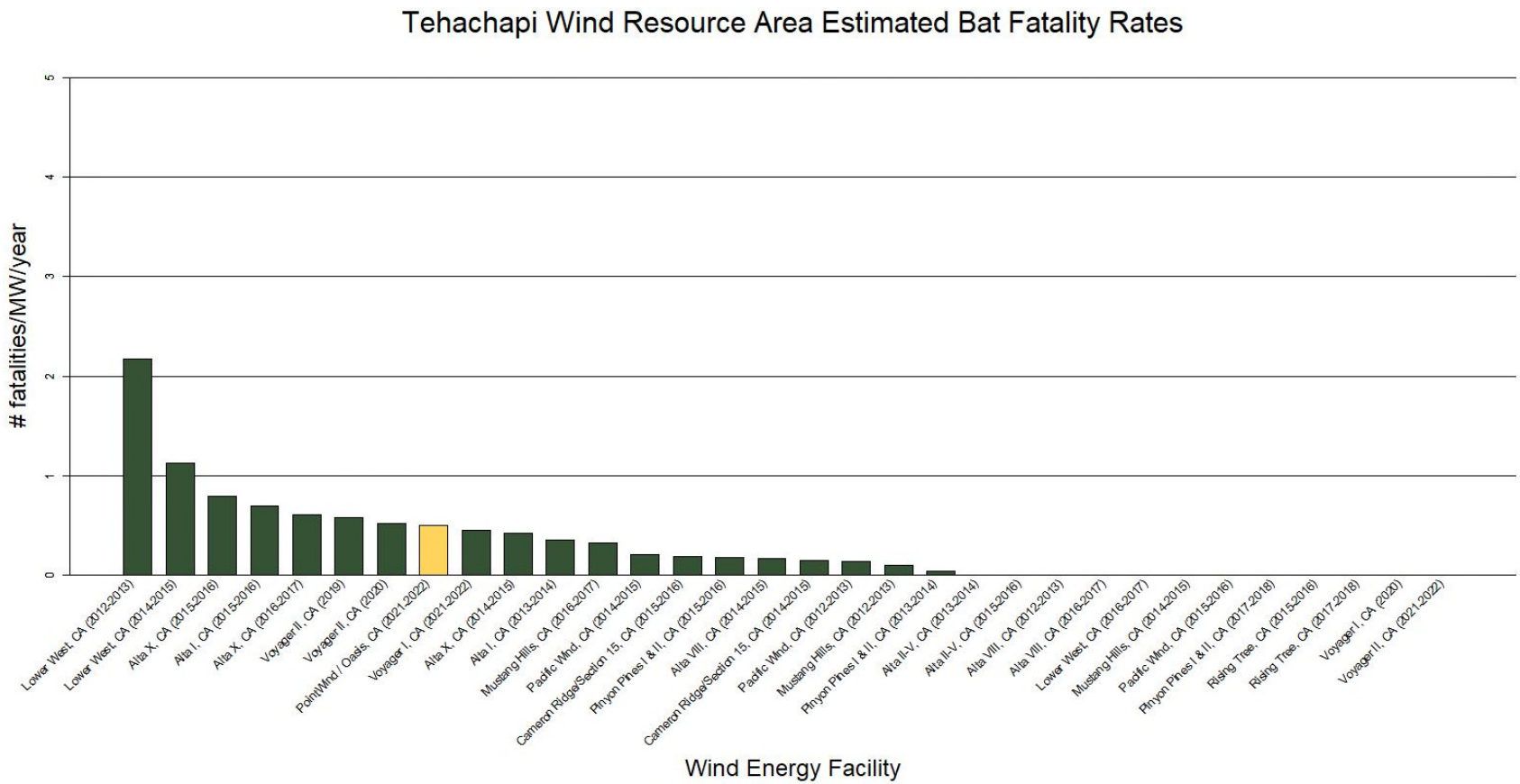

Figure 10. Estimated fatality rates for bats (number of bats per megawatt per year) from publicly available wind energy facilities throughout California. The Pointwind and Oasis Wind Projects are indicated in gold.

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Appendix A. Bird and Bat Fatalities found at the Pointwind and Oasis Wind Projects in Kern County, California from June 1, 2021 to May 27, 2022

Appendix A. Complete listing of fatalities found at the Pointwind and Oasis Wind Projects, Kern County, California, from June 1, 2021 to May 27, 2022.

Found Date	Species	Distance from Turbine	Turbine	Search Type	Physical Condition
06/01/2021	European starling	116	P06	carcass search*	scavenged
06/03/2021	red-tailed hawk	92	W04	carcass search*	feather spot
06/15/2021	common raven	138	P06	carcass search*	feather spot
07/22/2021	common raven	79	W04	carcass search	feather spot
08/03/2021	American kestrel	131	W04	carcass search	feather spot
08/03/2021	black-throated gray warbler	115	W05	carcass search	intact
08/05/2021	American kestrel	99	P08	carcass search	feather spot
09/01/2021	California scrub-jay	110	W04	carcass search	feather spot
09/09/2021	western kingbird	66	P06	carcass search	feather spot
09/14/2021	unidentified small bird	27	P08	carcass search	feather spot
09/16/2021	California quail	72	W04	carcass search	feather spot
10/05/2021	California scrub-jay	49	P06	carcass search	feather spot
10/14/2021	unidentified small bird	159	P08	carcass search*	feather spot
10/19/2021	ruby-crowned kinglet	36	W02	incidental*	intact
11/09/2021	northern flicker	117	O07	carcass search*	feather spot
11/27/2021	northern flicker	83	O07	carcass search	feather spot
12/04/2021	western meadowlark	87	O02	carcass search	feather spot
12/31/2021	California scrub-jay	112	O07	carcass search	feather spot
03/23/2022	hoary bat	21	O02	carcass search	scavenged
04/14/2022	Bullock’s oriole	60	O01	carcass search	feather spot
04/28/2022	green-tailed towhee	66	O03	carcass search	feather spot
04/28/2022	hermit warbler	90	O01	carcass search	scavenged
04/28/2022	hoary bat	30	O01	incidental	injured
04/29/2022	red-tailed hawk	118	P12	carcass search	dismembered
05/05/2022	black-headed grosbeak	119	O02	carcass search	feather spot
05/05/2022	Bullock’s oriole	63	O31	carcass search	feather spot
05/06/2022	great horned owl	16	W04	carcass search	feather spot
05/11/2022	mourning dove	101	O12	carcass search	feather spot
05/17/2022	western tanager	51	O31	carcass search	dismembered
05/20/2022	Wilson’s warbler	103	W05	carcass search	intact

*Carcass was found outside the search area or outside the study period and, therefore, not included in the analysis

Appendix B. Carcass Persistence Trial Information for the Pointwind and Oasis Wind Projects in Kern County, California from June 1, 2021 to May 27, 2022

Appendix B. All carcasses placed for carcass persistence trials by date, season, and species at the Pointwind and Oasis Wind Projects, Kern County, California, from June 1, 2021 to May 27, 2022.

Date Placed	Season	Species	Turbine	Before Removal*	After Removal**
06/28/2021	Summer	coturnix quail	P01	06/29/2021	06/29/2021
06/28/2021	Summer	coturnix quail	W02	07/01/2021	07/02/2021
06/28/2021	Summer	house mouse	P07	07/01/2021	07/02/2021
06/28/2021	Summer	house mouse	P09	06/29/2021	06/30/2021
06/28/2021	Summer	house mouse	W09	06/30/2021	07/01/2021
06/28/2021	Summer	mallard	P04	06/30/2021	07/01/2021
06/28/2021	Summer	mallard	P07	07/08/2021	07/19/2021
06/28/2021	Summer	mallard	P09	07/02/2021	07/08/2021
06/28/2021	Summer	mallard	W02	07/19/2021	07/28/2021
06/28/2021	Summer	mallard	W09	07/01/2021	07/02/2021
08/02/2021	Summer	coturnix quail	P04	08/02/2021	08/03/2021
08/02/2021	Summer	coturnix quail	P10	08/02/2021	08/03/2021
08/02/2021	Summer	coturnix quail	P11	08/02/2021	08/03/2021
08/02/2021	Summer	house mouse	P05	08/02/2021	08/03/2021
08/02/2021	Summer	house mouse	P07	08/02/2021	08/03/2021
08/02/2021	Summer	house mouse	P09	08/02/2021	08/03/2021
08/02/2021	Summer	mallard	P05	08/11/2021	08/22/2021
08/02/2021	Summer	mallard	P07	08/11/2021	08/22/2021
08/02/2021	Summer	mallard	P09	08/05/2021	08/11/2021
08/02/2021	Summer	mallard	P10	08/04/2021	08/05/2021
08/02/2021	Summer	mallard	P11	08/04/2021	08/05/2021
10/12/2021	Fall	coturnix quail	P01	10/13/2021	10/13/2021
10/12/2021	Fall	coturnix quail	P02	10/13/2021	10/13/2021
10/12/2021	Fall	coturnix quail	P04	10/13/2021	10/13/2021
10/12/2021	Fall	coturnix quail	P05	10/13/2021	10/14/2021
10/12/2021	Fall	coturnix quail	P07	10/13/2021	10/13/2021
10/12/2021	Fall	coturnix quail	P09	11/10/2021	11/10/2021
10/12/2021	Fall	coturnix quail	P10	10/13/2021	10/13/2021
10/12/2021	Fall	coturnix quail	W02	10/13/2021	10/13/2021
10/12/2021	Fall	coturnix quail	W08	10/14/2021	10/14/2021
10/12/2021	Fall	coturnix quail	W09	10/13/2021	10/13/2021
10/12/2021	Fall	house mouse	P01	10/13/2021	10/13/2021
10/12/2021	Fall	house mouse	P02	10/13/2021	10/13/2021
10/12/2021	Fall	house mouse	P05	10/13/2021	10/13/2021
10/12/2021	Fall	house mouse	P07	10/13/2021	10/13/2021
10/12/2021	Fall	house mouse	P10	10/13/2021	10/13/2021
10/12/2021	Fall	house mouse	W08	10/13/2021	10/14/2021
10/12/2021	Fall	house mouse	W09	10/13/2021	10/13/2021
10/12/2021	Fall	mallard	P01	11/09/2021	11/09/2021
10/12/2021	Fall	mallard	P04	10/13/2021	10/13/2021
10/12/2021	Fall	mallard	P09	10/13/2021	10/13/2021
10/12/2021	Fall	mallard	P10	10/21/2021	10/31/2021
10/12/2021	Fall	mallard	W02	11/10/2021	11/10/2021
01/24/2022	Winter	coturnix quail	O06	01/27/2022	01/30/2022
01/24/2022	Winter	coturnix quail	O08	01/24/2022	01/24/2022
01/24/2022	Winter	coturnix quail	O17	01/24/2022	01/24/2022
01/24/2022	Winter	coturnix quail	O23	01/25/2022	01/26/2022
01/24/2022	Winter	coturnix quail	O24	01/26/2022	01/27/2022
01/24/2022	Winter	mallard	O06	02/24/2022	02/24/2022
01/24/2022	Winter	mallard	O08	01/24/2022	01/24/2022
01/24/2022	Winter	mallard	O11	01/24/2022	01/24/2022

Appendix B. All carcasses placed for carcass persistence trials by date, season, and species at the Pointwind and Oasis Wind Projects, Kern County, California, from June 1, 2021 to May 27, 2022.

Date Placed	Season	Species	Turbine	Before Removal*	After Removal**
01/24/2022	Winter	mallard	O11	01/24/2022	01/24/2022
01/24/2022	Winter	mallard	O15	01/24/2022	01/25/2022
01/24/2022	Winter	mallard	O15	01/24/2022	01/25/2022
01/24/2022	Winter	mallard	O16	02/02/2022	02/14/2022
01/24/2022	Winter	mallard	O17	02/25/2022	02/25/2022
01/24/2022	Winter	mallard	O23	01/24/2022	01/25/2022
01/24/2022	Winter	mallard	O24	01/24/2022	01/24/2022
04/04/2022	Spring	coturnix quail	O04	04/05/2022	04/05/2022
04/04/2022	Spring	coturnix quail	O06	04/05/2022	04/07/2022
04/04/2022	Spring	coturnix quail	O08	04/05/2022	04/06/2022
04/04/2022	Spring	coturnix quail	O09	04/11/2022	04/14/2022
04/04/2022	Spring	coturnix quail	O11	04/05/2022	04/06/2022
04/04/2022	Spring	coturnix quail	O15	04/05/2022	04/07/2022
04/04/2022	Spring	coturnix quail	O21	04/05/2022	04/05/2022
04/04/2022	Spring	coturnix quail	O23	04/05/2022	04/05/2022
04/04/2022	Spring	coturnix quail	O25	04/05/2022	04/07/2022
04/04/2022	Spring	coturnix quail	O26	04/05/2022	04/06/2022
04/04/2022	Spring	house mouse	O06	04/07/2022	04/07/2022
04/04/2022	Spring	house mouse	O11	04/07/2022	04/07/2022
04/04/2022	Spring	house mouse	O15	04/05/2022	04/07/2022
04/04/2022	Spring	house mouse	O21	04/05/2022	04/05/2022
04/04/2022	Spring	house mouse	O23	04/05/2022	04/05/2022
04/04/2022	Spring	house mouse	O25	04/05/2022	04/05/2022
04/04/2022	Spring	mallard	O04	04/05/2022	04/05/2022
04/04/2022	Spring	mallard	O08	04/05/2022	04/06/2022
04/04/2022	Spring	mallard	O09	05/05/2022	05/05/2022
04/04/2022	Spring	mallard	O25	04/05/2022	04/05/2022
04/04/2022	Spring	mallard	O26	04/05/2022	04/06/2022

* Last date checked before removal

** Date checked after removal

Appendix B2. Carcass persistence models and covariates for large birds at the Pointwind and Oasis Wind Projects, Kern County, California, from June 1, 2021 to May 27, 2022 (n = 30).

Shape Covariates	Scale Covariates	Distribution	AICc	Delta AICc
No Covariates	No Covariates	lognormal	126.13	0*
No Covariates	No Covariates	loglogistic	126.27	0.14
No Covariates	No Covariates	Weibull	127.61	1.48
No Covariates	NULL	exponential	141.74	15.61

* Selected model

Appendix B3. Carcass persistence models and covariates for small birds at the Pointwind and Oasis Wind Projects, Kern County, California, from June 1, 2021 to May 27, 2022 (n = 30).

Shape Covariates	Scale Covariates	Distribution	AICc	Delta AICc
No Covariates	No Covariates	loglogistic	98.41	0*
No Covariates	No Covariates	lognormal	100	1.77
No Covariates	No Covariates	Weibull	104.45	6.04
No Covariates	NULL	exponential	112.04	13.63

* Selected model

Appendix B4. Carcass persistence models and covariates for bats at the Pointwind and Oasis Wind Projects, Kern County, California, from June 1, 2021 to May 27, 2022 (n = 19).

Shape Covariates	Scale Covariates	Distribution	AICc	Delta AICc
No Covariates	NULL	exponential	50.66	0*
No Covariates	No Covariates	Weibull	52.59	1.93
No Covariates	No Covariates	lognormal	52.93	2.27
No Covariates	No Covariates	loglogistic	53.75	3.09

* Selected model

Appendix C. Bird and Bat Adjustment Factors and Estimated Fatality Rates Tables for the Pointwind and Oasis Wind Projects in Kern County, California from June 1, 2021 to May 27, 2022

Appendix C1. Estimated fatality rates and adjustment factors, with 90% confidence intervals, for birds for studies conducted at the Pointwind and Oasis Wind Projects, Kern County, California, from June 1, 2021 to May 27, 2022.

	Spring 13 turbines searched		Summer 6 turbines searched		Fall 5 turbines searched		Winter 13 turbines searched	
	Estimate	90% CI	Estimate	90% CI	Estimate	90% CI	Estimate	90% CI
Search Area Adjustment								
Large Bird	0.99	0.99 - 0.99	0.99	0.99 - 0.99	0.99	0.99 - 0.99	0.99	0.99 - 0.99
Diurnal Raptor	0.97	0.97 - 0.97	0.97	0.97 - 0.97	0.97	0.97 - 0.97	0.97	0.97 - 0.97
Small Bird	1.00	1.00 - 1.00	1.00	1.00 - 1.00	1.00	1.00 - 1.00	1.00	1.00 - 1.00
Bat	1.00	1.00 - 1.00	1.00	1.00 - 1.00	1.00	1.00 - 1.00	1.00	1.00 - 1.00
Searcher Efficiency								
Large Bird	0.90	0.77 - 0.96	0.90	0.77 - 0.96	0.90	0.77 - 0.96	0.90	0.77 - 0.96
Diurnal Raptor	0.90	0.77 - 0.96	0.90	0.77 - 0.96	0.90	0.77 - 0.96	0.90	0.77 - 0.96
Small Bird	0.90	0.77 - 0.96	0.90	0.77 - 0.96	0.90	0.77 - 0.96	0.90	0.77 - 0.96
Bat	0.83	0.64 - 0.93	0.83	0.64 - 0.93	0.83	0.64 - 0.93	0.83	0.64 - 0.93
Average Probability of a Carcass Persisting Through the Search Interval								
Large Bird	0.43	0.33 - 0.55	0.43	0.33 - 0.55	0.43	0.32 - 0.55	0.43	0.32 - 0.54
Diurnal Raptor	0.43	0.33 - 0.55	0.43	0.33 - 0.55	0.43	0.32 - 0.55	0.43	0.32 - 0.54
Small Bird	0.15	0.11 - 0.22	0.15	0.11 - 0.22	0.15	0.11 - 0.22	0.15	0.11 - 0.22
Bat	0.10	0.06 - 0.14	0.10	0.07 - 0.14	0.10	0.06 - 0.14	0.10	0.06 - 0.14
Probability of Available and Detected								
Large Bird	0.35	0.23 - 0.46	0.35	0.23 - 0.46	0.35	0.23 - 0.46	0.35	0.23 - 0.46
Diurnal Raptor	0.35	0.23 - 0.46	0.35	0.23 - 0.46	0.35	0.23 - 0.46	0.35	0.23 - 0.46
Small Bird	0.10	0.07 - 0.16	0.10	0.07 - 0.16	0.10	0.07 - 0.16	0.10	0.07 - 0.16
Bat	0.06	0.04 - 0.09	0.06	0.04 - 0.09	0.06	0.04 - 0.09	0.06	0.04 - 0.09
Estimated Fatality Rates (Fatalities/Turbine/Season)								
All Bird	4.06	2.01 - 7.70	4.02	1.05 - 8.63	4.03	n/a*	1.24	n/a*
Large Bird	0.55	n/a*	1.36	n/a*	0.49	n/a*	0.19	n/a*
Large Bird Non-Raptor	0.36	n/a*	0.49	n/a*	0.49	n/a*	0.19	n/a*
Diurnal Raptor	0.19	n/a*	0.86	n/a*	0	n/a*	0	n/a*
Small Bird	3.51	1.48 - 6.98	2.49	n/a*	3.43	n/a*	1.05	n/a*
Bat	1.81	n/a*	0	n/a*	0	n/a*	0	n/a*

Appendix C1. Estimated fatality rates and adjustment factors, with 90% confidence intervals, for birds for studies conducted at the Pointwind and Oasis Wind Projects, Kern County, California, from June 1, 2021 to May 27, 2022.

	Spring 13 turbines searched		Summer 6 turbines searched		Fall 5 turbines searched		Winter 13 turbines searched	
	Estimate	90% CI	Estimate	90% CI	Estimate	90% CI	Estimate	90% CI
Estimated Fatality Rates (Fatalities/MW/Season)								
All Bird	1.13	0.56 - 2.14	1.12	0.29 - 2.40	1.12	n/a*	0.34	n/a*
Large Bird	0.16	n/a*	0.38	n/a*	0.13	n/a*	0.05	n/a*
Large Bird Non-Raptor	0.10	n/a*	0.14	n/a*	0.13	n/a*	0.05	n/a*
Diurnal Raptor	0.05	n/a*	0.24	n/a*	0	n/a*	0	n/a*
Small Bird	0.97	0.41 - 1.94	0.69	n/a*	0.95	n/a*	0.29	n/a*
Bat	0.50	n/a*	0	n/a*	0	n/a*	0	n/a*

[1] Confidence interval (CI) not calculated because less than five carcasses were observed.

NA = not applicable, MW = megawatt

Appendix D. Regional Fatality Rate Comparison Tables

Appendix D1. Fatality rates for all birds, diurnal raptors, and bats (number of fatalities per megawatt per study period) from publicly available wind energy facilities in California.

Project	*Bird	*Diurnal Raptor	*Bat	Plot Size	Estimator	Project Cover Types	Citation
Pointwind and Oasis (2021-2022)	*3.82*	*0.44*	*0.50*	120 m radius plot	*GenEst*	Joshua Tree, Shrub Steppe, Desert Creosote	*This Study*
Alite, CA (2009-2010)	0	0.12	0.24	200 m x 200 m plot	Shoenfeld	Grassland, scrub	Chatfield et al. 2010
Alta I, CA (2013-2014)	12.05	0.15	1.28	120 m radius plot	Shoenfeld	Grassland, Shrub Steppe	Thompson et al. 2016a
Alta I, CA (2015-2016)	2.57	0.15	0	120 m radius plot	Shoenfeld	Grassland, Shrub Steppe	Chatfield et al. 2014
Alta II-V, CA (2011-2012)	0	0	0.08	120 m radius plot	Shoenfeld	desert scrub	Chatfield et al. 2012
Alta II-V, CA (2013-2014)	2.79	0	0	120 m radius plot	Shoenfeld	Grassland, Shrub Steppe	Thompson et al. 2016a
Alta II-V, CA (2015-2016)	0.51	0	0	120 m radius plot	Shoenfeld	Grassland, Riparian	Chatfield and Bay 2014
Alta VIII, CA (2012-2013)	0.66	0.02	0	240 m x 240 m plot	Shoenfeld	Grassland, Joshua Tree, Desert Creosote	WEST 2016c
Alta VIII, CA (2014-2015)	0.38	0.04	0.17	240 m x 240 m plot	Shoenfeld	Joshua Tree, Shrub Steppe	WEST 2018
Alta VIII, CA (2016-2017)	0.25	0	0	240 m x 240 m plot	Shoenfeld	Forest/Woodlot, Shrub Steppe	Chatfield et al. 2015
Alta X, CA (2014-2015)	4.88	0.04	0.42	240 m x 240 m plot	Shoenfeld	Shrub Steppe	Thompson et al. 2016b
Alta X, CA (2015-2016)	2.17	0	0.8	240 m x 240 m plot	Shoenfeld	Joshua Tree, Pinyon Pine/ Juniper, Rocky Outcrop, Shrub Steppe, Desert Creosote	Thompson and Chatfield 2017
Alta X, CA (2016-2017)	1.52	0.03	0.61	240 m x 240 m plot	Shoenfeld	Grassland, Pasture	ICF International 2016
Cameron Ridge/Section 15, CA (2014-2015)	0.45	0	0.15	62.5 m radius plot	Shoenfeld	Shrub Steppe	Rintz and Thompson 2017
Cameron Ridge/Section 15, CA (2015-2016)	0.57	0	0.19	62.5 m radius plot	Shoenfeld	Forest/Woodlot	Tetra Tech 2014
Lower West, CA (2012-2013)	3.5	0	2.17	120 m radius plot	Shoenfeld	Joshua Tree, Shrub Steppe	Levenstein and DiDonato 2015

Appendix D1. Fatality rates for all birds, diurnal raptors, and bats (number of fatalities per megawatt per study period) from publicly available wind energy facilities in California.

Project	*Bird	*Diurnal Raptor	*Bat	Plot Size	Estimator	Project Cover Types	Citation
Lower West, CA (2014-2015)	0.9	0	1.13	120 m radius plot	Shoenfeld	Joshua Tree, Shrub Steppe	WEST 2017b
Lower West, CA (2016-2017)	0.73	0	0	120 m radius plot	Shoenfeld	Agriculture	Harvey & Associates 2013
Mustang Hills, CA (2012-2013)	1.66	0.08	0.1	240 m x 240 m plot	Shoenfeld	Grassland, Joshua Tree, Desert Creosote	WEST 2016c
Mustang Hills, CA (2014-2015)	0.97	0.03	0	240 m x 240 m plot	Shoenfeld	Joshua Tree, Shrub Steppe	WEST 2018
Mustang Hills, CA (2016-2017)	0.54	0.15	0.33	240 m x 240 m plot	Shoenfeld	Joshua Tree, Pinyon Pine/ Juniper, Desert Creosote	Sapphos Environmental 2014
Pacific Wind, CA (2012-2013)	2.6	0	0.14	126 m radius plot	Shoenfeld	Joshua Tree, Pinyon Pine/ Juniper, Desert Creosote	WEST 2016a
Pacific Wind, CA (2014-2015)	0.17	0	0.21	63 m radius plot	Huso	Joshua Tree, Pinyon Pine/ Juniper, Desert Creosote	WEST 2017a
Pacific Wind, CA (2015-2016)	0.77	0.07	0	63 m radius plot	Huso	Joshua Tree, Desert Creosote	Chatfield and Russo 2014
Pinyon Pines I & II, CA (2013-2014)	1.18	0	0.04	240 m x 240 m plot	Shoenfeld	Joshua Tree, Desert Creosote	Rintz and Starcevich 2016
Pinyon Pines I & II, CA (2015-2016)	0.5	0.02	0.18	240 m x 240 m plot	Shoenfeld	Joshua Tree, Desert Creosote	Rintz and Pham 2018
Pinyon Pines I & II, CA (2017-2018)	0.56	0.01	0	240 m x 240 m plot	Shoenfeld	Joshua Tree, Shrub Steppe, Desert Creosote	Rintz et al. 2016
Rising Tree, CA (2015-2016)	3.13	0.06	0	280 m x 280 m plot	Huso	Joshua Tree, Shrub Steppe, Desert Creosote	Chatfield et al. 2018
Rising Tree, CA (2017-2018)	1.63	0.14	0	280 m x 280 m plot	Huso	NA	Chatfield et al. 2018
Voyager I, CA (2020)	3.33	0.11	0	300 m x 300 m square plot	GenEst	Joshua Tree, Shrub Steppe, Desert Creosote	Chatfield et al. 2021a
Voyager I, CA (2021)	2.60	0.04	0.45	300 m x 300 m square plot	GenEst	Joshua Tree, Shrub Steppe, Desert Creosote	Chatfield et al. 2022a
Voyager II, CA (2019)	5.73	0.07	0.58	300 m x 300 m square plot	GenEst	Joshua Tree, Shrub Steppe, Desert Creosote	Chatfield et al. 2020
Voyager II, CA (2020)	5.96	0	0	300 m x 300 m square plot	GenEst	Joshua Tree, Shrub Steppe, Desert Creosote	Chatfield et al. 2021b

Appendix D1. Fatality rates for all birds, diurnal raptors, and bats (number of fatalities per megawatt per study period) from publicly available wind energy facilities in California.

Project	*Bird	*Diurnal Raptor	*Bat	Plot Size	Estimator	Project Cover Types	Citation
Voyager II, CA (2021)	3.41	0.02	0	300 m x 300 m square plot	GenEst	Joshua Tree, Shrub Steppe, Desert Creosote	Chatfield et al. 2022b

* fatality/MW/year

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