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Post-Construction Avian and Bat Fatality at the Horse Butte Wind Facility, Years 1–3

Prepared for

Horse Butte Wind I, LLC

Prepared by

SWCA Environmental Consultants

November 2015

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EXECUTIVE SUMMARY

The Horse Butte Wind Facility in Bonneville County, Idaho, developed by Utah Associated Municipal Power Systems (UAMPS) and operated by Horse Butte Wind I, LLC, became operational in August 2012. During the first three years of operation, SWCA Environmental Consultants (SWCA) conducted avian and bat carcass searches to document fatalities potentially attributable to turbine collision. This report presents observed (unadjusted) fatalities and adjusted fatality estimates for each of the survey years. Adjusted fatality estimates were calculated using an industry-accepted statistical estimator that corrects for carcass persistence and searcher efficiency (seasonal trials conducted during the first two survey years), search interval, and the proportion of turbines searched to the total number of turbines at the site.

Avian and bat fatalities are presented in the context of the project's bird and bat conservation strategy (BBCS) and the project's eagle conservation plan (ECP); both documents, which are currently under revision, present fatality thresholds developed as criteria for implementing phased operational and non-operational mitigation. The thresholds, as currently written, are based on observed (unadjusted) fatalities.

Carcass searches were conducted every 2 weeks in Year 1 and, in Years 2 and 3, every 2 weeks during the winter and breeding seasons and weekly during the spring and fall migration seasons. These searches were conducted at 10 of 32 turbines during any one survey period, with nine turbines searched on a constant basis throughout the study. During searches, 18 birds and 26 bats were found in Year 1, nine birds and 17 bats were found in Year 2, and nine birds and 12 bats were found in Year 3. An additional six birds and two bats were found incidentally. No federally listed bird or bat was found during the formal searches or incidentally in any survey year. Two golden eagles (*Aquila chrysaetos*), protected under the Bald and Golden Eagle Protection Act of 1940, as amended, were found in Year 3 (one incidentally and one during searches). Five bird species—black rosy-finch (*Leucosticte atrata*), Brewer's sparrow (*Spizella breweri*), eared grebe (*Podiceps nigricollis*), sharp-tailed grouse (*Tympanuchus phasianellus*), and Swainson's hawk (*Buteo swainsoni*)—were considered "sensitive" under the project's BBCS threshold categories because of their federal (birds of conservation concern) and/or state (Idaho species of greatest conservation need) sensitivity designations. However, none of the BBCS or ECP thresholds were met or exceeded in any survey year.

Avian and bat species composition and seasonal distribution patterns generally mirrored those observed at other wind energy facilities in the United States, with the exception that avian fatalities peaked in fall migration (42%) and in *winter* (33%; the majority of these winter fatalities were recorded in Year 1). Avian fatalities were distributed among several species (17 species were identified during this study), with passerines (33%) constituting more than other groups (waterbirds/waterfowl, 24%; diurnal birds of prey, 18%; upland gamebirds, 15%). More bat (55) than bird (36) fatalities were recorded. Bat fatalities were limited to specific species (four species were identified during this study and comprised 91% of all bat fatalities); these species were migratory tree bats, and most (82%) were found during late summer and fall migration.

Eared grebe (5) was the most common species found, followed by gray partridge (*Perdix perdix*; 4), and common redpoll (*Acanthis flammea*; 3). The two migratory tree bat species found during searches were hoary (*Lasiurus cinereus*; 26) and silver-haired bat (*Lasionycteris noctivagans*; 22). Among fatalities that could be identified to species, most have been commonly documented as fatalities at other wind energy facilities; however, some of the bird species have been infrequently (rough-legged hawk and Swainson's hawk), rarely (Brewer's sparrow, common redpoll, eared grebe, golden eagle, and sharp-tailed grouse), or never (black rosy-finch and gray-crowned rosy-finch) reported to our knowledge. One of the bats species (western small-footed myotis) has also never been reported to our knowledge.

Adjusted fatality estimates were comparably low for birds in Years 1 and 2 (1.9 and 2.6 birds/MW/year, respectively) and moderate for birds in Year 3 (3.5 birds/MW/year) and bats in all years (7.8, 9.3, and 5.1 bats/MW/years in Years 1-3, respectively) relative to other wind energy facilities in the United States. In this report, we discuss findings in the context of the project's BBCS and ECP and in the context of data reported at other United States wind energy facilities (including the utility of comparing such data).

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1. INTRODUCTION

1.1. Project Overview

The Horse Butte wind energy generation project (hereafter, project or Horse Butte Wind Facility) located near Idaho Falls in Bonneville County, Idaho (Figure 1) became operational in August 2012. The project was developed by Utah Associated Municipal Power Systems (UAMPS) who sold it to Horse Butte I, LLC (HBW); UAMPS is the sole purchaser of the power generated by the project. The project, a 57.6-megawatt (MW) nameplate capacity facility located within 17,897 acres (72 square kilometers [km^2]; 28 square miles) of privately owned land, includes 32 Vestas V-100 1.8-MW turbines (Figure 2)—each with a rotor diameter of 100 meters (m; 328 feet), or rotor-swept area (RSA) of 7,854 m^2.

Prior to operation, UAMPS coordinated with Bonneville County, the U.S. Fish and Wildlife Service (USFWS), the Idaho Department of Fish and Game (IDFG), and the East Idaho Uplands Sage-grouse Local Working Group regarding construction and operation of the project. UAMPS contracted SWCA Environmental Consultants (SWCA) to conduct studies throughout and adjacent to the project area to evaluate potential risk to wildlife, particularly avian, bat, and sensitive species, and their habitats. Field survey methods for pre-construction avian and bat use studies and risk analyses were based on agency guidance documents (USFWS 2012, 2013a) and were fine-tuned through coordination with IDFG and USFWS. The methods and results of pre-construction studies, which began in 2009, are summarized in the documents *Bird and Bat Conservation Strategy for the Horse Butte Wind Facility* (BBCS; SWCA 2013a) and *Eagle Conservation Plan for the Horse Butte Wind Facility* (ECP; SWCA 2013b). The goal of these adaptive documents, which are currently under revision, is to avoid, minimize, and otherwise mitigate project-related impacts to birds and bats, and particularly to bald (*Haliaeetus leucocephalus*) and golden eagles (*Aquila chrysaetos*) to ensure no net loss to eagle populations.

In September 2012, formal avian and bat carcass searches were initiated at approximately one-third (10, or 31%) of the 32 turbines (see Figure 2 and Section 2.1). The objective of this study was to assess avian and bat fatality during the first three years of project operation. The study was designed to effectively answer the USFWS's *Land-Based Wind Energy Guidelines* (WEG; USFWS 2012) Tier 4A questions and to meet the USFWS's *Eagle Conservation Plan Guidance* (ECPG; USFWS 2013a) Stage 5 recommendations.

Findings for the first two years of fatality monitoring are presented in SWCA (2013c) and (2015). This report presents a summary of the first three years of study (Year 1: September 27, 2012–September 12, 2013; Year 2: September 25, 2013–September 24, 2014; Year 3: October 1, 2014–September 23, 2015). It evaluates observed fatalities and adjusted fatality rates (using an industry-accepted statistical estimator) in the context of the project's BBCS and ECP (SWCA 2013a, b). These documents include project-specific fatality thresholds developed as criteria for implementing phased mitigation measures. This report also evaluates species composition and spatial and temporal attributes of fatalities at the facility.

1.2. Legal Drivers and Permit Compliance

The project is subject to all relevant federal, state, and local statutes, regulations, and plans. The federal regulatory framework for protecting birds includes the Endangered Species Act of 1973, as amended (ESA); the Migratory Bird Treaty Act of 1918, as amended (MBTA); the Bald and Golden Eagle Protection Act of 1940, as amended (Eagle Act); and Executive Order 13186 *Responsibilities of Federal Agencies to Protect Migratory Birds*. No birds or bats listed under the ESA occur in the project area. All migratory birds are covered under the MBTA, whereas the Eagle Act specifically protects bald and golden eagles. There are no federal regulatory protections for bat species occurring in the project area; however,

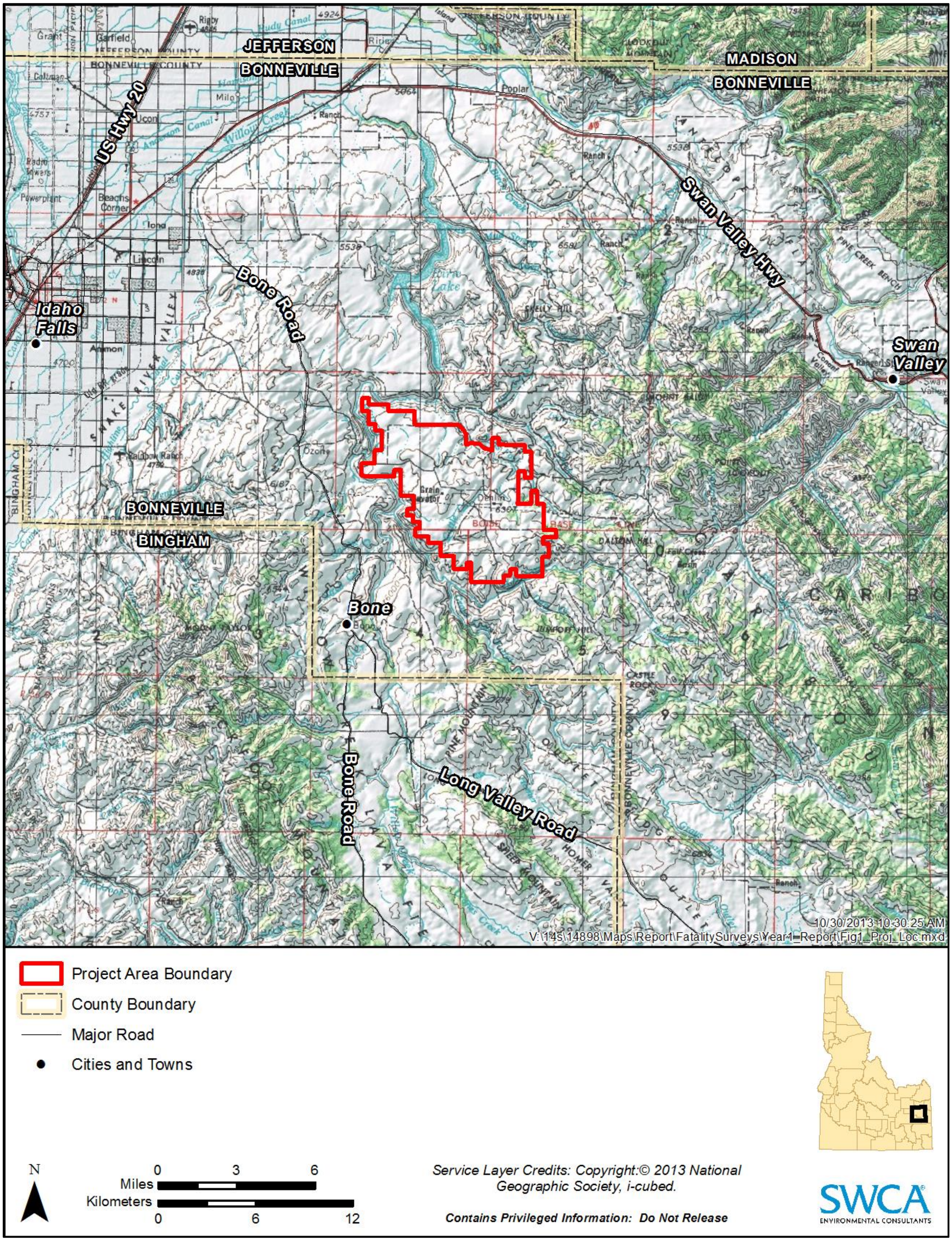

Figure 1. Horse Butte Wind Facility project location.

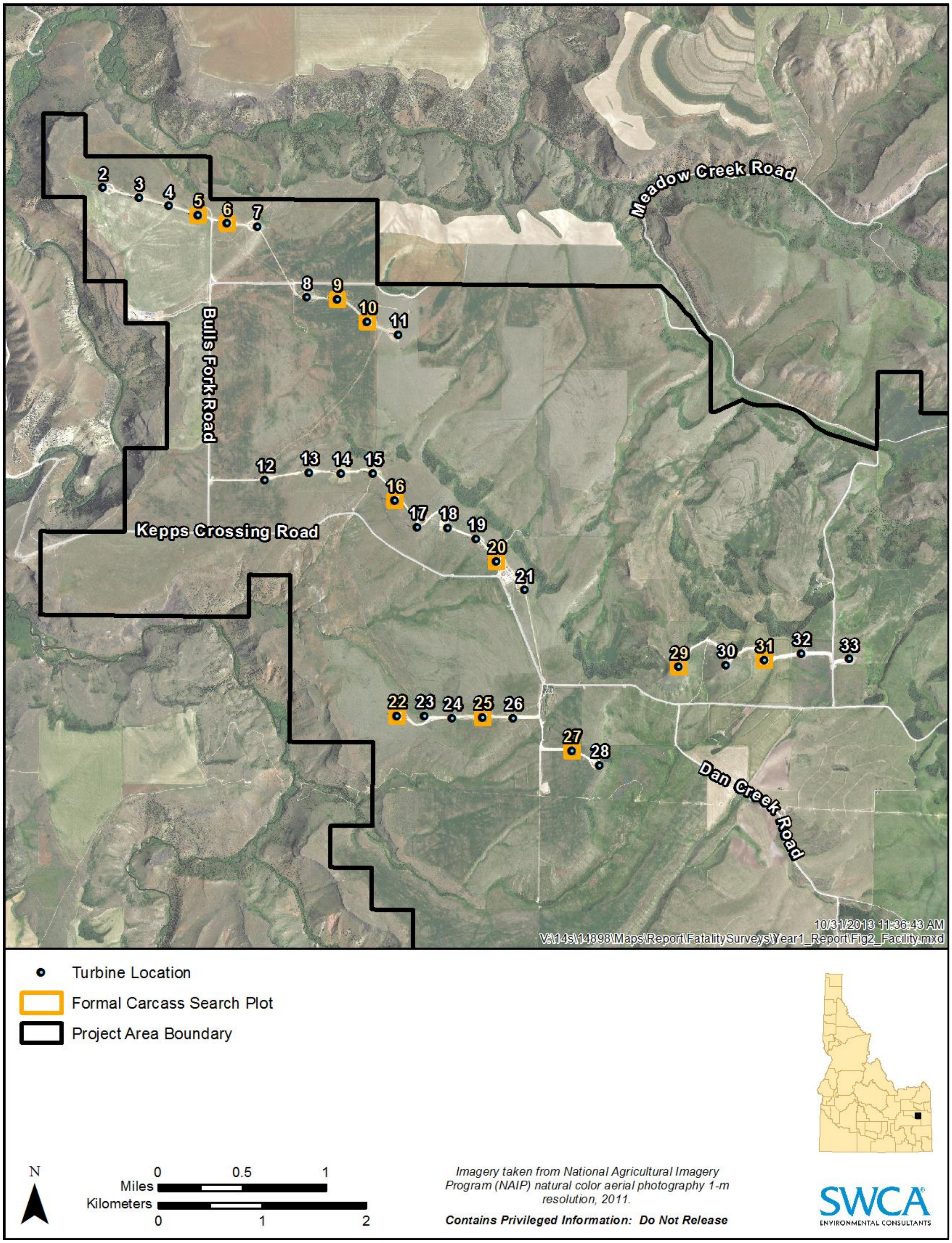

Figure 2. Horse Butte Wind Facility; 32 1.8-MW turbines. Post-construction avian and bat fatality searches were conducted at 11 of the 32 turbines (orange boxes) over the course of the study; 10 were searched during any one survey week (see Section 2.1).

the State of Idaho has statutes and codes governing the protection of wildlife species, including bats.

The ESA protects imperiled (threatened and endangered) species and their habitats, prohibiting anyone without a permit to “take” these species; permits are generally available for conservation and scientific purposes. *Take* is defined by the ESA as “to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct.” *Harm* may include significant habitat modification or degradation that results in killing or injuring listed species by significantly impairing essential behavioral patterns. Section 7 of the ESA requires federal agencies to consult with the USFWS ensuring that actions they authorize, fund, or carry out are not likely to jeopardize the continued existence of listed species or result in destruction or adverse modification of designated critical habitat—the result of such conference is a concurrence letter or “biological opinion” addressing the proposed action.

The MBTA prohibits incidental “take” of migratory birds—more than 1,000 species (50 Code of Federal Regulations [CFR] 10 and 21)—their parts, eggs, or nests. *Take* is defined by the MBTA as “to pursue, hunt, shoot, wound, kill, trap, capture, or collect, or any attempt to carry out these activities.” Unlike the ESA, there are no provisions or permits that allow for incidental “take” under the MBTA. The USFWS recommends that wind energy project proponents develop a BBCS, in collaboration with the USFWS, to avoid, minimize, and mitigate for potential impacts to migratory birds (and bats) (USFWS 2012).

The Eagle Act prohibits anyone without a permit from “taking” eagles, their parts, eggs, or nests. *Take* is defined by the Eagle Act as “to pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest, or disturb;” the Eagle Act’s definition of “take” differs from the definition in the ESA in that it does not include habitat destruction or alteration, unless such damage “disturbs” an eagle. *Disturb* is defined as “to agitate or bother to a degree that causes, or is likely to cause, based on the best scientific information available, (1) injury to an eagle, (2) a decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior, or (3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior.”

The 2009 Eagle Permit Rule authorizes limited issuance of permits to incidentally “take” eagles under certain, specified conditions (USFWS 2009). The regulations established by the rule provide for both standard (to address one-time effects from projects) and programmatic (to authorize recurring take from projects) permits—the latter being the most germane for wind energy operators. Under these regulations, programmatic take must be “compatible with preservation” of eagles and unavoidable even after the implementation of avoidance, minimization, and mitigation measures. In 2013, the USFWS extended the maximum term for programmatic permits from 5 years to 30 years (USFWS 2013b); this extension included a new 5-year review process, public disclosures, and requirements to implement phased mitigation, including Advanced Conservation Practices (ACPs). Stemming from a federal lawsuit, the 30-year duration rule has been remanded by a federal judge for further consideration by USFWS. For eagles, the USFWS recommends that wind energy project proponents prepare both a BBCS and an ECP, in collaboration with the USFWS, to avoid, minimize, and mitigate potential impacts to ensure no net loss to eagle populations (USFWS 2012, 2013a).

Title 36 of the Idaho Statute sets forth laws governing the management of wildlife in the State of Idaho (Idaho Legislature 2014). Section 103 of the title authorizes the Idaho Fish and Game Commission to administer wildlife policy in the state and mandates that “all wildlife, including all wild animals, wild birds, and fish, within the state of Idaho, is hereby declared to be the property of the state of Idaho. It shall be preserved, protected, perpetuated, and managed.” Title 36-202 IC defines *wildlife* as “any form of animal life, native or exotic, generally living in a state of nature.” As such, IDFG maintains a statewide *Comprehensive Wildlife Conservation Strategy* (IDFG 2005). Under Title 36 Chapter 11, it is unlawful, with few exceptions, for a person to take any game animals, birds, or “fur-bearing animals” in Idaho.

1.3. About UAMPS

UAMPS is a political subdivision of the State of Utah that provides comprehensive wholesale electric energy, on a nonprofit basis, to community-owned power systems throughout the Intermountain West. UAMPS membership consists of 45 members from Utah, Arizona, California, Idaho, Nevada, New Mexico, Oregon, and Wyoming. UAMPS partners with its members to provide affordable and reliable electricity to their customers.

Upon the direction of its members, UAMPS sought development of the Horse Butte Wind Facility to provide its members with a form of renewable energy generation. The project is one of 16 projects that UAMPS members may participate in and is UAMPS' first renewable energy project. UAMPS is the sole purchaser of power generated by the project. The output from the project provides renewable energy for 24 UAMPS members in five states.

1.4. Study Site and Environmental Setting

The project is located in Bonneville County, Idaho, approximately 14 miles (23 km) southeast of the city of Idaho Falls, 13 miles (21 km) south of Swan Valley Highway, and 3 miles (5 km) east of Bone Road (see Figure 1).

The project area is on the eastern edge of the Columbia Plateau and the western edge of the Middle Rocky Mountains physiographic provinces. It is located in Bird Conservation Region (BCR) 9. Elevation in the project area ranges from 5,500 to 6,700 feet above mean sea level. Topography at and adjacent to the site is generally characterized by rolling hills and plains, buttes, and canyons. Willow Creek Canyon located north and west of the project area, Tex Creek Canyon located northeast of the project area, and the associated perennial waterways Willow Creek and Tex Creek are characterized by large vertical cliff faces and ledges and riparian vegetation dominated by cottonwoods and willows.

Vegetation communities in the project area include agricultural land (pasture/hay), annual and perennial grassland, intermountain basins big sagebrush (basin and Wyoming big sagebrush; *Artemisia tridentata* ssp. *tridentata* and *Artemisia tridentata* ssp. *wyomingensis*, respectively) steppe, and intermountain basins curl-leaf mountain mahogany (*Cercocarpus ledifolius*) woodland and shrubland. Lesser amounts of Rocky Mountain aspen forest and woodland, Rocky Mountain lower montane riparian woodland and shrubland, and northern Rocky Mountain lower montane, foothill, and valley grassland are present. The project's BBCS (SWCA 2013a) and ECP (SWCA 2013b) provide further detail regarding the project's environmental setting.

2. METHODS

2.1. Observed Avian and Bat Fatalities

2.1.1. Carcass Searches

Avian and bat carcass searches were initiated in September 2012 after the project became operational in August 2012. Searches were conducted every two weeks in Year 1 (26 survey weeks), and in Years 2 and 3, they were conducted every week during peak fall and spring migration (August 16–November 15 and March 16–May 15, respectively), and every 2 weeks during other times of the year (November 16–March 15 and May 16–August 15) (36 survey weeks in each of those years). Searches were conducted at approximately one-third (10, or 31%) of the 32 turbines (see Figure 2). Sampled turbines were selected randomly and represented all areas of the facility. One of the initial turbines (T29) selected for searches was deemed hazardous for searchers in Year 1 and was replaced by a different nearby turbine (T31), at first intermittently (from early November 2012 to mid-April 2013), and then for the remainder of the study (starting in late April 2013). In Year 1, both turbines were searched during one survey period (week 15): 10 searches were conducted at T29, whereas 17 were conducted at T31 that year.

Searches were conducted by teams of one to three biologists—trained and tested in proper search techniques—within a north–south axis square plot centered on the turbine mast. A 126 × 126–m (3.9-acre) plot was surveyed in Year 1 and, in Years 2 and 3, it was increased to a 134 × 134–m (4.4-acre) plot. The 126-m distance was initially selected based on the finding by other researchers that most birds and bats killed by wind turbines are found within 63 m (207 feet) of the turbine mast (Higgins et al. 1996; Johnson et al. 2002; Orloff and Flannery 1992; Young et al. 2003; but see also Smallwood 2013; Strickland et al. 2011; USFWS 2012). The plot size was increased in Year 2 based on a USFWS recommendation. Search transects were spaced at 6-m (20-foot) intervals. One lead surveyor, designated for each turbine, followed east–west transect lines on a handheld global positioning system (GPS) unit and set the pace of the search: approximately 20 to 40 m/minute (66 to 132 feet/minute). On average, two searchers spent approximately 45 minutes searching each 126 × 126–m plot and approximately 50 minutes searching each 134 × 134-m plot. Pin flags were placed at the eastern and western edges of each plot to assist surveyors with orientation. Each surveyor scanned for carcasses out to approximately 3 m (10 feet), with occasional scans out to approximately 10 m (33 feet). The lead surveyor scanned the GPS screen as infrequently as possible, and slowed the survey pace as necessary to survey effectively while maintaining straight line transects.

Data collected for each carcass found included species, date and time, search start and end time, date since the turbine was last searched, distance (m) and direction (compass bearing) from the nearest turbine mast, distances to nearest road and nearest structure, substrate, location (recorded with a handheld GPS unit), field marks used for identification to species, age and sex (if possible), estimated time since death, condition, and type of injury (if possible) (Appendix A provides a sample data form). Carcasses were categorized as complete, parts/dismembered, feathers, or bones. Feather piles comprising 10 or more total feathers or two or more primaries were recorded as a fatality (Young et al. 2003). Carcass type (large bird, small bird, or bat) and size (small [i.e., small bird and bat] or large [i.e., large bird]) categories (corresponding to searcher efficiency trial size classes; see Section 2.2.1), whether the carcass was a bird or bat, and the season were recorded.

Large and small birds were defined as follows:

- Large birds (roughly >12.5 inches in length and 14 ounces in weight)
  - Large diurnal birds of prey and vultures (Accipitriformes)
  - Large corvids (e.g., raven; Passeriformes>Corvidae>*Corvus*)
  - Waterfowl (ducks, geese, and swans; Anseriformes)
  - Other large waterbirds (e.g., bitterns, coots, cranes, egrets, grebes, herons; Gruiformes, Podicipediformes, Pelecaniformes)
  - Large upland gamebirds (e.g., grouse, turkey; Galliformes)
- Small birds (roughly <12.5 inches in length and 14 ounces in weight)
  - Primarily passerines (Passeriformes)
  - Doves (Columbiformes)
  - Small diurnal birds of prey (e.g., American kestrel [*Falco sparverius*], merlin [*Falco columbarius*]; Falconiformes)
  - Small upland gamebirds (e.g., partridge, quail; Galliformes)

Seasons (as described by Erickson et al. 2003) were defined as follows:

- Winter: November 1–March 15
- Spring migration: March 16–May 15
- Breeding season: May 16–August 15
- Fall migration: August 16–October 31

Fatalities found outside of the search plots or while conducting other activities unrelated to formal carcass searches were also recorded and were considered incidentals. Incidentals were not used for the adjusted fatality estimates; they are accounted for indirectly through estimation of the error estimate in the model (see Section 2.3).

All carcasses, parts, or feathers were photo-documented and removed from the search plots, but, with the exception of eagles, were left on-site. Eagles were collected by the USFWS Office of Law Enforcement (OLE). Photographs documented all injuries, possible injuries, or lack of injuries; signs of scavenging; and identifying characteristics. All carcasses were identified to the lowest taxonomic level possible using expert opinion and, primarily, the following resources: *The Sibley Guide to Birds* (Sibley 2000), *The Feather Atlas* (USFWS 2013c), and *A Field Guide to Mammals of North America* (Reid 2006).

SWCA, on UAMPS' behalf, reported all avian and bat fatalities potentially attributable to project operation within five business days to the USFWS Bird Injury and Mortality Reporting System (BIMRS), maintained by the OLE. Eagles were also verbally reported to the USFWS Eastern Idaho Field Office and OLE within 24 hours, or sooner, to determine best course of action.

2.1.2. Fatality Locations within Search Areas

Using the 3-year combined data set, the distances at which carcasses were located from turbine masts were examined (Appendix B). Distances were calculated using Point Distance analysis in ArcGIS.

2.2. Carcass Search Correction Factors

Using surrogate carcasses, searcher efficiency and carcass persistence studies were conducted to quantify the following carcass detection biases: 1) imperfect detection by searchers and 2) removal by scavengers or other means (Arnett et al. 2007; Huso 2011; Morrison 2002). The objective of these trials was to develop correction factors to estimate avian and bat fatalities for each of the first 3 years of operation (see Section 2.3). Trials were conducted in Years 1 and Year 2; correction factors for Year 3 were developed by combining the Years 1 and 2 data.

2.2.1. Searcher Efficiency

Searcher efficiency was calculated as the proportion of surrogate carcasses found by a search team relative to the total number of surrogate carcasses placed for the team's trial. The searcher efficiency trials were conducted simultaneously to formal carcass searches one day per season at a subset (five) of the 10 carcass-search turbines. Each trial was conducted by a team of two searchers, using the same methods as described above for carcass searches (see Section 2.1.1). The trials were conducted seasonally to account for different field conditions (e.g., snow, dense spring vegetation, dry summer vegetation) that may have affected the ability of the surveyors to locate carcasses.

For each trial, carcasses were placed in the morning (on the same day as searches) before searches were conducted. An average of seven carcasses per turbine (range: 6–8 carcasses per turbine) were distributed among the selected search plots. Each search team searched for surrogate large birds (adult chickens), small birds (1-week-old quail), and bats (14- to 18-day-old dark hopper mice) (see Section 2.1.1 for definition of "large" and "small" birds). At least 10 carcasses per carcass type (i.e., small bird, large bird, and bat) were placed over all searched turbines per season. At least two carcasses of each size class (i.e., small [small birds and bats] and large [large birds]), and no more than three of each carcass type, were placed at each search plot. All carcasses were handled with nitrile gloves or a plastic bag to avoid leaving human scent and interfering with scavenging (Arnett et al. 2009). Carcasses were placed at randomly generated locations and dropped from waist level to ensure they landed in a random position and location. The locations of the placed carcasses were recorded with a handheld GPS unit. Search teams distinguished "marked" surrogates from carcasses potentially attributable to turbine collision as appropriate. "Marked" locations were directly compared with locations of placed carcasses.

Carcasses that were not detectable were excluded from analysis—these included any carcasses that may have been scavenged prior to the search, were accidentally placed outside the search plots, or were associated with a data collection error. Carcasses placed within search plots were deemed undetectable if they were not present immediately after the trial (on day 1 of carcass persistence; see Section 2.2.2) and were confirmed to be absent on the following day (day 2 of carcass persistence trials).

Per USFWS (2012), an effort was made to make these trials "blind" to the searchers. Searchers were aware of the specific dates that searcher efficiency trials would be conducted, but did not know the number of carcasses placed at each sampling plot or the specific location of placed carcasses.

Searcher efficiency rates were pooled for all search teams and grouped by carcass type, size, where the carcass was a bird or bat (bat/bird), and season for the adjusted fatality estimates (see Section 2.3).

2.2.2. Carcass Persistence

The length of time (in days) a carcass persisted was calculated as the midpoint between the day the carcass was known to be present and the day it was no longer observable; average carcass persistence and the proportion of carcasses persisting to the end of the interval were used for the fatality estimates (see Section 2.3).

Carcasses placed as part of searcher efficiency trials (Section 2.2.1) were revisited on days 1 through 7, 14, 21, and 28, or until they were all removed, for each of the four seasons, with day 1 being the same day as the searcher efficiency trial (Erickson et al. 2003; Young et al. 2003). Seasonal carcass persistence trials accounted for the effects of weather, scavenger densities, and scavenger behavior across seasons.

During days 2–7, biologists revisited carcasses approximately 24 hours after the initial placement or previous revisit, and recorded presence or absence of each carcass and any relevant notes (e.g., signs of scavenging or partial scavenging). If a carcass was recorded as absent on any of days 1 through 6 and no obvious signs of scavenging were apparent (e.g., feathers), it was revisited the next day to confirm absence. Given such factors as GPS accuracy on a given day, carcass desiccation, and partial scavenging, biologists took care in relocating carcasses—especially quail and mice—by walking concentric circles from the marked location out to approximately 5 m (16 feet) and back again for as long as 5 minutes.

Carcass persistence was grouped by carcass type, size, bat/bird, and season for the adjusted fatality estimates (see Section 2.3).

2.3. Adjusted Avian and Bat Fatality Estimates

Because raw fatality counts may underestimate true mortality, adjusted fatality estimates were calculated to produce unbiased estimates of fatality for the first three years of project operation. These estimates were calculated using an industry-accepted statistical estimator (Huso 2011; Huso et al. 2012), which corrects for carcass persistence, searcher efficiency, and the proportion of turbines searched to the total number of turbines at the site. Per-turbine per year and total-site fatality per year estimates were calculated for the following groups: 1) overall, 2) bird/bat, 3) carcass type, and 4) season (see Section 2.1.1).

The conceptual framework associated with the Huso estimator can be found in Huso (2011), Huso et al. (2012), Strickland et al. (2011), and Warren-Hicks et al. (2013). The effective search interval $\hat{\hat{I}}_{ijk}$ is a key element of the Huso estimator and is explained in further detail in Huso (2011) and Warren-Hicks et al. (2013). The Huso estimator calculates fatality from observations grouped into *k* sets (carcasses with similar detection or persistence probabilities [i.e., factors such as size, season, and visibility class]). Fatality estimated for a *k* set at turbine *i* at the end of interval *j* can be denoted $\hat{f}_{ijk}$. The total-site fatality (*F*) that has occurred over time *T* at a facility with *N* turbines from a random sample of *n* search plots is estimated from the equation:

$$\hat{F} = \sum_{i=1}^{n} \frac{1}{\hat{\pi}_i} \sum_{j=1}^{S_i} \sum_{k=1}^{K_{ij}} \frac{c_{ijk}}{\hat{r}_{ijk}\hat{p}_{ijk}\hat{e}_{ijk}}$$

Where

$$\hat{r}_{ijk} = \frac{\hat{\bar{t}}_{ijk}\,(1-e^{-\min(\hat{\bar{I}}_{ijk}, I_{ijk})/\hat{\bar{t}}_{ijk}})}{\min(\hat{\bar{I}}_{ijk}, I_{ijk})}\text{ , } \hat{\bar{I}}_{ijk} = -\log(0.01) * \hat{\bar{t}}_{ijk}\text{ , and } \hat{e}_{ijk} = \min(1, \hat{\bar{I}}_{ijk}, I_{ijk})$$

The following variables are used in the equation:

$\hat{F}$	= the estimated number of total-site fatalities over all intervals in time *T*
n	= the number of turbines sampled
$\hat{\pi}_i$	= the product of the proportion of actual fatality at turbine *i* that is contained in the searchable area of the plot and the probability of inclusion of turbine *i* in the sample
S_i	= the total number of intervals at turbine *i* in time *T*
K_{ij}	= the total number of sets defined for turbine *i* in interval *j*
c_{ijk}	= the number of carcasses observed during surveys for a *k* set at turbine *i* at the end of interval *j*

$\hat{r}_{ijk}$ = the estimated proportion of carcasses that persist unscavenged (i.e., animals that died in the previous interval and are observable) for a *k* set at search plot *i* through the interval *j*

$\hat{p}_{ijk}$ = the estimated proportion of carcasses present (i.e., animals that died in the previous interval and were not scavenged) that are actually observed for a *k* set at search plot *i* through the interval *j*

$\hat{e}_{ijk}$ = the effective search interval, which is a function of the interval length and the average carcass persistence time, for a *k* set at search plot *i* through the interval *j*

$\hat{\hat{I}}_{ijk}$ = the effective search interval (interval between searches)—the length of time beyond which the probability of a carcass persisting is ≤1%—in the *j*th interval at turbine *i* for a *k* set

I_{ijk} = the number of days preceding the *j*th interval at turbine *i* for a *k* set

$\hat{\hat{t}}_{ijk}$ = the estimated mean carcass persistence time (in days) for a *k* set at search plot *i* through the interval *j*

r is dependent on the search interval (the time elapsed between the animal's death and the time of the search), as well as other potential covariates, such as carcass type and season (i.e., data collected during carcass persistence trials). p is a function of potential covariates such as carcass type, season, surrounding vegetation, and observer skill/experience (i.e., data collected during searcher efficiency trials). The Huso estimator relies on assumptions common to other estimators (reviewed in Warren-Hicks et al. 2013) and is nearly unbiased under this assumption: each period begins with no discoverable carcasses (i.e., carcasses that are not found and continue to persist are not discoverable in subsequent visits; 0% bleed-through).

The Huso estimator software (Huso et al. 2012) allows the user to model categorical covariates that may affect p and r. Models incorporating different covariates are compared using Akaike's information criterion, corrected for small data sets (AIC*c*), which is a commonly used measure of the relative goodness of fit of a statistical model. Covariates that significantly improve the fit of the searcher efficiency or carcass persistence models (defined as those that decrease the AIC*c* ≥ 10 units and result in a ≥ 10% difference in estimates among categories [Huso et al. 2012]) are used in the fatality estimate and define the number of *k* sets used. Where differences in AIC*c* between the top models were less than two units, the model with the fewest parameters was selected in order to maximize sample size. This study tested carcass type, size, bat/bird, and season as potential covariates. The number of parameters varies by covariates (2-4).

AIC*c* was compared between a searcher efficiency model with no explanatory variables (searcher efficiency never varied) and models that allowed searcher efficiency to vary by carcass type, size, bat/bird, or season. Individual covariates, pairs of independent covariates with an additive effect, and pairs of independent covariates with an interaction effect were tested. This same model building process was repeated for carcass persistence. In addition, different failure time distributions were tested and compared for the carcass persistence model: Weibull, exponential, loglogistic, and lognormal distributions.

Fatality estimates were generated for each year of the study separately, with the best fitting model for each year's data set used to estimate fatality. Resampling techniques were used to calculate empirical 95% confidence intervals (CI) around fatality estimates. Reported estimates were computed using 5,000 bootstrap iterations.

Carcasses found during the first survey in Year 1 were excluded from the analyses if their estimated time since death was greater than 14 days (i.e., the average search interval); thus, the study period for the Year 1 analysis began 2 weeks before the first survey. This was done because an error message is generated if the date of the previous search is greater than or equal to the date the carcass was found (Huso et al. 2012); that is, a non-estimable function for the survival estimate is produced. Thus, rather than excluding all data from the first survey week of Year 1, the last search date for that first survey was modified to 2 weeks prior (i.e., the average search interval). In Year 3, separate analyses were performed for inclusion and exclusion of an incidental golden eagle. The eagle was found under a regularly-searched turbine during an activity unrelated to formal carcass searches; searches were conducted two days prior and five days after the find (see Section 3.1.1.1). Separate analyses were performed because 1) the eagle was removed from the search plot by USFWS prior to the next formal searches and 2) there is a high probability it would have been found during the next searches (e.g., Smallwood [2007] reported 99% of large raptors persisted for one week).

With the exception of the Year 1 first survey finds, all carcasses found in the sampling plots during formal carcass searches were included in the fatality estimates, unless clear evidence indicated that the event was not caused by turbine collision (e.g., an avian carcass directly under a nest, a juvenile too young to fly) (Erickson et al. 2000; TRC Environmental Corporation [TRC] 2008; Young et al. 2003). Including carcasses for which the cause of death was unknown may overestimate the true number of project-related fatalities; however, this conservative approach has been used at other wind energy facilities (e.g., Johnson et al. 2000; Thompson et al. 2011). Incidental carcasses were excluded from the fatality estimates; they are accounted for indirectly through the error estimate of the model.

Following the BBCS (SWCA 2013a), adjusted fatality estimates are reported per MW per year, per turbine per year, and per 100,000 m^2 RSA per year (see Section 3.3). With the exception of golden eagle, adjusted fatality estimates are not provided on a species-specific basis; they are calculated for fatality groups (i.e., carcass type, season), because there are no current analytical methods, including a simple surveyed to un-surveyed turbine ratio, that can meaningfully adjust fatality rates on a species-specific level. While the project's ECP (SWCA 2013b) fatality thresholds are based on actual observed fatalities, rather than adjusted fatality estimates (see Section 2.4), golden eagle estimates are reported to provide a reference point given that the ECP document is currently under revision. Results of the golden eagle estimates should be interpreted with caution considering the limitations disclosed herein (and see Table 11).

2.4. Years 1–3 Fatalities Relative to BBCS and ECP Thresholds

Before Year 2 of operation, fatality thresholds for birds and bats were developed, as part of the project's BBCS (SWCA 2013a) and ECP (SWCA 2013b), as criteria for implementing phased mitigation measures. The fatality thresholds were developed such that the more sensitive a species is to population declines (based on listing status), the lower the fatality threshold for that species. These thresholds (Tables 1 and 2) do not permit "take" under any legal protections but were developed to address the greater concern posed by potential population impacts to these species in order to ensure impacts are not substantial. Thresholds were developed for implementing non-operational mitigation (to address fatality that occurs more or less randomly over time) as well as operational mitigation (to address episodic mortality events). Fatality thresholds are based on actual observed fatalities (correction factors are not applied; see Section 2.3).

The project's BBCS (SWCA 2013a) presents further detail regarding specific mitigation measures and adaptive management that would be implemented if thresholds are exceeded for non-eagle birds and bats. For eagles, assuming permit issuance, UAMPS agreed to up-front mitigation, associated with project-specific eagle fatality estimates totaling 15.5 golden eagles and 10.6 bald eagles over a 5-year permit term. Additional mitigation measures would be implemented for each eagle take beyond the permitted amount (SWCA 2013b).

Table 1. Annual Non-Operational Mitigation Fatality Thresholds for Avian and Bat Species

Sensitivity	Threshold Category	Threshold Value Large Birds (non-eagles)	Threshold Value Small Birds	Threshold Value Bats
High	Threatened or endangered species under the Endangered Species Act	1†	1†	1†
Moderate	USFWS candidate species or Idaho SRank(S)1 or S2 species of greatest conservation need	5	15	15
Low	*Birds only:* USFWS birds of conservation concern for Bird Conservation Region 9 species *and* not listed as candidate, Idaho S1 or S2 species of greatest conservation need, *or* S3 or S4 species of greatest conservation need	10	30	N/A
	Bats only: Idaho S3 or S4 species of greatest conservation need	N/A	N/A	30

Note: The list of USFWS birds of conservation concern can be found in USFWS (2008). Idaho species of greatest conservation need can be found in IDFG (2005). N/A = not applicable.

Note: For a given species, the number of individuals found killed or injured and non-releasable during formal carcass searches, correction factors are not applied. In the project's BBCS (SWCA 2013a), thresholds values are proposed to be converted to fatalities per 50 MW of nameplate capacity per year, rounded to the nearest integer. The intention in the BBCS (SWCA 2013a) is that such conversions/correction factors would be calculated if the project was expanded in the future.

† Does not authorize take. Take of a listed species requires formal consultation with the USFWS under Section 10 of the ESA.

S1 = Critically imperiled: at high risk because of extreme rarity (often five or fewer occurrences), rapidly declining numbers, or other factors that make it particularly vulnerable to rangewide extinction or extirpation.

S2 = Imperiled: at risk because of restricted range, few populations (often 20 or fewer), rapidly declining numbers, or other factors that make it vulnerable to rangewide extinction or extirpation.

S3 = Vulnerable: at moderate risk because of restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors that make it vulnerable to rangewide extinction or extirpation.

S4 = Apparently secure: uncommon but not rare; some cause for long-term concern due to declines or other factors.

Table 2. Annual Operational Mitigation Fatality Thresholds for Avian and Bat Species

Sensitivity	Threshold Value* Large Birds (non-eagles)	Threshold Value* Small Birds	Threshold Value* Bats
High	2 individuals at a single turbine or group (< 5) of adjacent turbines over a short time period *or* 2 individuals at the facility in a given season in consecutive years (i.e., spring 2013 and spring 2014)	2 individuals at a single turbine or group (< 5) of adjacent turbines over a short time period *or* 2 individuals at the facility in a given season in consecutive years (i.e., spring 2013 and spring 2014)	2 individuals at a single turbine or group (< 5) of adjacent turbines over a short time period *or* 2 individuals at the facility in a given season in consecutive years (i.e., spring 2013 and spring 2014)
Moderate	5 individuals at a single turbine or group (< 5) of adjacent turbines over a short time period *or* 5 individuals at the facility in a given season in consecutive years (i.e., spring 2013 and spring 2014)	15 individuals at a single turbine or group (< 5) of adjacent turbines over a short time period *or* 15 individuals at the facility in a given season in consecutive years (i.e., spring 2013 and spring 2014)	15 individuals at a single turbine or group (< 5) of adjacent turbines over a short time period *or* 15 individuals at the facility in a given season in consecutive years (i.e., spring 2013 and spring 2014)
Low	10 individuals at a single turbine or group (< 5) of adjacent turbines over a short time period *or* 10 individuals at the facility in a given season in consecutive years (i.e., spring 2013 and spring 2014)	30 individuals at a single turbine or group (< 5) of adjacent turbines over a short time period *or* 30 individuals at the facility in a given season in consecutive years (i.e., spring 2013 and spring 2014)	30 individuals at a single turbine or group (< 5) of adjacent turbines over a short time period *or* 30 individuals at the facility in a given season in consecutive years (i.e., spring 2013 and spring 2014)

Note: For a given species, the number of individuals found killed or injured and non-releasable during formal carcass searches, correction factors are not applied. In the project's BBCS (SWCA 2013a), thresholds values are proposed to be converted to fatalities per 50 MW of nameplate capacity per year, rounded to the nearest integer. The intention in the BBCS (SWCA 2013a) is that such conversions/correction factors would be calculated if the project was expanded in the future.

2.5. Comparison with Other Wind Energy Facilities

Synthesis documents (e.g., Hayes 2013; Hein et al. 2013; Kunz et al. 2007; National Wind Coordinating Collaborative [NWCC] 2010) and other readily/publicly available studies in the United States were reviewed to compare bird and bat adjusted fatality (i.e., fatalities/MW/year) reported at these facilities to the Horse Butte Wind Facility.

3. RESULTS

3.1. Observed Avian and Bat Fatalities

3.1.1. Carcass Searches

From September 27, 2012, to September 23, 2015, 36 birds and 55 bats were found during formal carcass searches, and their deaths were considered to be potentially the result of turbine collision (Tables 3 and 4). Among these, 18 birds and 26 bats were found in Year 1, nine birds and 17 bats were found in Year 2, and nine birds and 12 bats were found in Year 3. Tables 3 and 4 present the avian and bat species that constituted these fatalities by year. An additional six birds (three in Year 1; one in Year 2; two in Year 3) and two bats (one in Year 1; one in Year 3) were found incidentally (see Tables 3 and 4).

Table 3. Bird Fatalities Attributed to Potential Turbine Collision, Years 1–3 of Operation

Species*	Scientific Name	Found During Formal Carcass Searches			Found Incidentally		
		Year 1	Year 2	Year 3	Year 1	Year 2	Year 3
American coot	*Fulica americana*	1	0	0	0	0	0
American kestrel	*Falco sparverius*	0	0	1	0	0	0
Black rosy-finch	*Leucosticte atrata*	1	0	0	0	0	0
Brewer's sparrow	*Spizella breweri*	0	0	1	0	0	0
Common redpoll	*Acanthis flammea*	3	0	0	0	0	0
Eared grebe	*Podiceps nigricollis*	4	1	0	0	0	0
European starling	*Sturnus vulgaris*	0	0	0	1	0	0
Golden eagle	*Aquila chrysaetos*	0	0	1	0	0	1
Gray-crowned rosy-finch	*Leucosticte tephrocotis*	0	0	1	0	0	0
Gray partridge	*Perdix perdix*	2	1	1	0	1	0
Horned lark	*Eremophila alpestris*	0	1	1	0	0	0
Red-tailed hawk	*Buteo jamaicensis*	0	0	0	2	0	0
Rock pigeon	*Columba livia*	0	1	0	0	0	0
Rough-legged hawk	*Buteo lagopus*	2	0	0	0	0	0
Sharp-tailed grouse	*Tympanuchus phasianellus*	1	0	0	0	0	0
Swainson's hawk	*Buteo swainsoni*	0	0	1	0	0	1
Yellow-rumped warbler	*Setophaga coronata*	0	2	0	0	0	0
Unidentified accipiter	*Accipiter* sp.	1	0	0	0	0	0
Unidentified grebe	*Podiceps* sp.	1	0	0	0	0	0
Unidentified goldfinch	*Carduelis* sp.	0	0	1	0	0	0
Unidentified rosy-finch	*Leucosticte* sp.	1	0	0	0	0	0
Unidentified small bird	–	0	2	1	0	0	0

Table 3. Bird Fatalities Attributed to Potential Turbine Collision, Years 1–3 of Operation

Species*	Scientific Name	Found During Formal Carcass Searches			Found Incidentally		
		Year 1	Year 2	Year 3	Year 1	Year 2	Year 3
Unidentified warbler	–	0	1	0	0	0	0
Unidentified waterbird	–	1	0	0	0	0	0
Total		**18**	**9**	**9**	**3**	**1**	**2**

Note: Carcasses were categorized as complete, parts/dismembered, feathers, or bones. Feathers spots were recorded if 10 or more total feathers or two or more primaries were present (Young et al. 2003).

* American Ornithologists' Union (2015)–recognized common names.

† Separate adjusted fatality estimate analyses were performed for exclusion and inclusion of this golden eagle (see Sections 2.3 and 3.3)

Table 4. Bat Fatalities Attributed to Potential Turbine Collision, Years 1–3 of Operation

Species*	Scientific Name	Found During Formal Carcass Searches			Found Incidentally		
		Year 1	Year 2	Year 3	Year 1	Year 2	Year 3
Big brown bat	*Eptesicus fuscus*	0	0	1	0	0	0
Hoary bat	*Lasiurus cinereus*	13	7	6	0	0	1
Silver-haired bat	*Lasionycteris noctivagans*	10	8	4	1	0	0
Western small-footed myotis	*Myotis ciliolabrum*	0	0	1	0	0	0
Unidentified myotis	*Myotis* sp.	2	0	0	0	0	0
Unidentified vesper bat	*Eptesicus or Myotis* sp.	1	0	0	0	0	0
Unidentified bat	--	0	2	0	0	0	0
Total		**26**	**17**	**12**	**1**	**0**	**1**

Note: Carcasses were categorized as complete, parts/dismembered, or bones.

* NatureServe (2015)–recognized common names.

3.1.1.1. AVIAN FATALITIES

Formal Carcass Searches

Among the 36 avian fatalities found during formal carcass searches in all survey years, 27 could be identified to species. Among the nine remaining fatalities, six could be categorized to a species group, while three could not be identified (unidentified small birds). Avian fatalities comprised four species groups including passerines (33%), waterbirds/waterfowl (24%), diurnal birds of prey (18%), and upland gamebirds (15%); one (3%) pigeon fatality was recorded. The maximum number of fatalities recorded for any one species was five (eared grebes [*Podiceps nigricollis*]), followed by four (gray partridge [*Perdix perdix*]), and three (common redpoll [*Acanthis flammea*]. Tables 3 and 5 present bird fatalities found by year and by season by year. Bird carcasses were categorized as complete (14), feathers (11), or parts/dismembered (11) (see Appendix B).

Seasonal Timing of Avian Fatalities

Combining all survey years, 15 birds (42%) were found during fall migration, 12 (33%) were found in the winter, and five (14%) were found during the breeding season, and four (11%) were found in spring migration (Table 5; see Appendix B). In Year 1 more birds were found in winter than in other seasons, while in Years 2 and 3 more birds were found in fall migration than in other seasons (see Table 5). The maximum number of avian fatalities found during any one survey week was four, found during the last week of September 2012 (Year 1 fall migration; the first week of surveys). Three avian fatalities were found during the last week of January 2013 (Year 1 winter), and two were found on multiple occasions, including during the second week of March 2013 (Year 1 winter), the fourth week of September 2013 (Year 2 fall migration), the second week of October 2013 (Year 2 fall migration), the third week of October 2013 (Year 2 fall migration), and the first week of August 2015 (Year 3 breeding season). Table 5 presents the number of fatalities per avian species groups per season by year.

Table 5. Fatalities per Avian Species Grouping per Season, Years 1–3 of Operation

Species Group	Fall Migration			Winter					Spring Migration			Breeding Season				Total
	August 16	September	October 31	November 1	December	January	February	March 15	March 16	April	May 15	May 16	June	July	August 15	
Year 1																
Diurnal birds of prey					1			1				1				3
Passerines				1		3		1								5
Upland gamebirds							1				1			1		3
Waterbirds/waterfowl		4	1	1	1											7
Year 2																
Diurnal birds of prey																0
Passerines			3							1						4
Upland gamebirds		1														1
Waterbirds/waterfowl		1														1
Other*			1							1				1		3
Year 3																
Diurnal birds of prey										1					2	3
Passerines	1		1		1		1									4
Upland gamebirds	1															1
Waterbirds/waterfowl																0
Other*			1													1
Total		**15**				**12**				**4**			**5**			**36**

Note: Fatalities found during formal carcass searches.

* Unidentified small birds and Year 2 rock pigeon.

Spatial Distribution of Avian Fatalities

Avian fatalities—among those found during formal carcass searches in both survey years—were located at nine of the 11 searched turbines (Table 6; see Appendix B). The maximum number found at any one turbine was seven found at each of T10 and T27 (see Appendix B). These fatalities were distributed, from most to fewest fatalities, in the northern (T2–T11; 53%), southern (T22–T28; 28%), and central (T12–T21 and T29–T33; 19%) turbine strings (see Figure 2). Table 6 presents the avian fatality spatial distribution among turbine strings and turbines by year.

Table 6. Spatial Distribution of Avian Fatalities by Year, Years 1–3 of Operation

Turbine String	Turbine	Year 1	Year 2	Year 3	Total
North (*n* = 4)	5	3	1	2	**6**
	6	0	0	1	**1**
	9	4	1	0	**5**
	10	4	2	1	**7**
Central (*n* = 4)	16	0	0	1	**1**
	20	0	2	1	**3**
	31	0	2	1	**3**
South (*n* = 3)	25	2	0	1	**3**
	27	5	1	1	**7**
Total		**18**	**9**	**9**	**36**

Note: Fatalities found during formal carcass searches. *n* refers to the number of turbines searched in each sample area. In Year 1, T29—initially selected for searches—was replaced by a different nearby turbine, T31 (see Section 2.1.1).

Incidentals

Three incidentals were found in Year 1 (two red-tailed hawks and a European starling [*Sturnus vulgaris*]), one incidental was found in Year 2 (a gray partridge), and two incidentals were found in Year 3 (a golden eagle and a Swainson's hawk [*Buteo swainsoni*]). Their carcass condition and spatial (sample area and turbine) and temporal (season) attributes are presented in Appendix B. The golden eagle was found on April 16, 2015 by a Vestas employee. It was known that it was killed 24-48 hours before being detected because the turbine (T5) where it was found had been formally searched two days prior and it was not present at that time. After being contacted on April 16, 2015, the USFWS OLE recovered the eagle on April 17, 2015.

3.1.1.2. BAT FATALITIES

Formal Carcass Searches

Among the 55 bat fatalities found during formal carcass searches in all survey years, 50 could be identified to species. Among the five remaining fatalities, three could be categorized to a species group, while two could not be identified. Bat fatalities comprised two species groups: tree bats[1] (91%) and other vesper bats[1] (9%). Most fatalities comprised two species, both tree bats: hoary bat (*Lasiurus cinereus*; 26 fatalities) and silver-haired bat (*Lasionycteris noctivagans*; 22 fatalities). Tables 4 and 7 present bat fatalities found by year and by season by year. Bat carcasses were categorized as complete (50), parts/dismembered (4), or bones (1).

[1] A distinction is made here between tree bats (family Vespertilionidae) and other vesper bats (also family Vespertilionidae) for ease in comparing Horse Butte Wind Facility data with patterns observed at other wind energy facilities (see Section 4 Discussion).

Seasonal Timing of Bat Fatalities

Combining all survey years, 35 bats (64%) were found during fall migration, 18 (33%) were found during the breeding season, and two (4%) were found during spring migration (Table 7; see Appendix B). In all three years, more bats were found during fall migration (17 in Year 1, 12 in Year 2, 6 in Year 3) than during the breeding season (8 in Year 1, 5 in Year 2, 5 in Year 3). The maximum number of bat fatalities found during any one survey week was seven, found during the second week of August 2013 (Year 1 breeding season). Six bat fatalities were found during the second week of October 2012 (Year 1 fall migration); five were found during the last week of August 2013 (Year 1 fall migration); four were found during the third week of October 2013 (Year 2 fall migration); and three were found on three occasions: during the last week of September 2012 (Year 1 fall migration), the second week of September 2013 (Year 1 fall migration), and the first week of August 2015 (Year 3 breeding season).

Table 7. Fatalities per Bat Species Grouping per Season, Years 1–3 of Operation

Species Group	Fall Migration			Winter					Spring Migration			Breeding Season				Total
	August 16	September	October 31	November 1	December	January	February	March 15	March 16	April	May 15	May 16	June	July	August 15	
Year 1																
Migratory tree bat*	4	6	5								1			1	6	23
Other vesper bat†	1		1												1	3
Year 2																
Migratory tree bat*		2	8										1	3	1	15
Other vesper bat†																0
Unidentified		2														2
Year 3																
Migratory tree bat*	2	1	2							1				3	1	10
Other vesper bat†			1												1	2
Total		**35**				**0**				**2**			**18**			**55**

Note: Fatalities found during formal carcass searches.

* Includes hoary bat and silver-haired bat.

† Includes big brown bat, western small-footed myotis, and unidentified myotis and vesper bats

Spatial Distribution of Bat Fatalities

Bat fatalities—among those found during formal carcass searches in both survey years—were located at each of the 11 searched turbines (see Appendix B). The maximum number found at any one turbine was 12 found at T10 (Table 8; see Appendix B). Most of the bat fatalities were found in the northern (T2–T11; 51%) turbine string, with fewer found in the central (T12–T21 and T29–T33; 29%) and southern (T22–T28; 20%) turbine strings (see Figure 2). Table 8 presents the spatial distribution of bat fatalities among turbine strings and turbines by year.

Table 8. Spatial Distribution of Bat Fatalities by Year, Years 1–3 of Operation

Turbine String	Turbine	Year 1	Year 2	Year 3	Total
North (*n* = 4)	5	3	2	1	**6**
	6	1	1	0	**2**
	9	5	3	0	**8**
	10	5	5	2	**12**
Central (*n* = 4)	16	1	0	0	**1**
	20	1	2	2	**5**
	29	2	0	0	**2**
	31	1	2	5	**8**
South (*n* = 3)	22	3	2	0	**5**
	25	2	0	0	**2**
	27	2	0	2	**4**
Total		**26**	**17**	**12**	**55**

Note: Fatalities found during formal carcass searches. *n* refers to the number of turbines searched in each sample area. In Year 1, T29—initially selected for searches—was replaced by a different nearby turbine, T31 (see Section 2.1.1).

Incidentals

One silver-haired bat, categorized as complete, was found incidentally in Year 1 during fall migration at T18, and one hoary bat, categorized as complete, was found incidentally in Year 3 during the breeding season at T24 (see Appendix B). No incidental bats were found in Year 2.

3.1.2. Fatality Locations within Search Areas

Among fatalities found during formal carcass searches in all survey years, the average distance carcasses were found from turbine masts varied by carcass type (ANOVA, $F_{2,87} = 4.22$, $P = 0.0178$). Paired comparisons indicated that large birds were detected significantly further from the turbine mast than bats (Tukey HSD, $P = 0.0206$). Large birds, small birds, and bats were located a mean distance of 48.93 m ($N = 14$, standard error [SE] = 4.38, 95% CI: 39.46–58.39), 41.41 m ($N = 22$, SE = 5.05, 95% CI: 30.90–51.92), and 33.84 m ($N = 54$, SE = 2.23, 95% CI: 29.38–38.31) from the turbine mast, respectively.

In Years 1 and 3, more carcasses (84% and 76%, respectively) were found in the northern half of the survey plots, whereas in Year 2, there was no identifiable spatial pattern for carcass locations (cardinal and inter-cardinal directions) within sampling plots (Figure 3; see Appendix B). Combining data from all survey years, 64% of bird carcasses and 80% of bat carcasses were located in the northern half of the survey plots (see Figure 3; see Appendix B).

3.2. Carcass Search Correction Factors

3.2.1. Searcher Efficiency

Searcher efficiency trials were not conducted in Year 3; instead, the results of Years 1 and 2 combined were used for the Year 3 adjusted fatality estimates (see Sections 2.2, 2.3, and 3.3). In Years 1 and 2, 140 (40 large birds, 50 small birds, and 50 bats) and 145 (40 large birds, 53 small birds, and 52 bats) surrogate carcasses were placed for the searcher efficiency trials, respectively. Ten of these carcasses (five in each year) were deemed unavailable for detection (i.e., they did not persist on day 1, were placed outside of the search plots, or detection was unclear during the trial) and were excluded from the searcher efficiency trial data.

The overall detection rate for all carcass types combined across seasons was 44% (Year 1: 50%; Year 2: 37%). Table 9 presents searcher efficiency rates by carcass type, carcass size, and season by year.

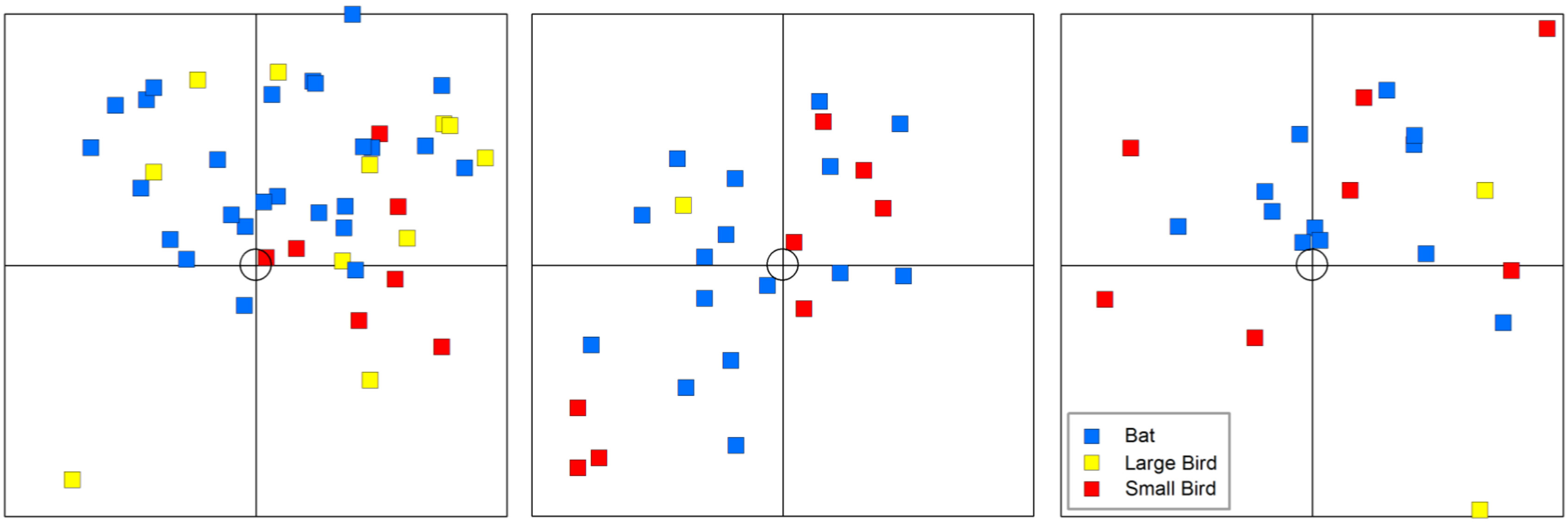

Figure 3. Graphical depiction of the locations of bats, large birds, and small birds found during formal carcass searches at the Horse Butte Wind Facility, Years 1 (left), 2 (center), and 3 (right) of operation. Note: sample plot size changed from 126 × 126 m (left) in Year 1 to 134 × 134 m (right) in Years 2 and 3.

Table 9. Searcher Efficiency Summary Data, Years 1 and 2 of Operation

Group	Level	Year 1 (%)	Year 2 (%)	Years 1 and 2 Combined (%)
Overall		**50**	**37**	**44**
Carcass type	Small bird	35	15	25
	Large bird	98	90	94
	Bat	26	19	22
Carcass size	Small	31	17	23
	Large	98	90	94
Season	Fall migration	44	42	43
	Winter	56	39	48
	Spring migration	55	39	46
	Breeding season	47	29	38

3.2.2. Carcass Persistence

3.2.2.1. CARCASS PERSISTENCE

As with the searcher efficiency trials, the carcass persistence trial results for Years 1 and 2 combined were used for the Year 3 adjusted fatality estimates (see Sections 2.2, 2.3, and 3.3). In Years 1 and 2, the same carcasses placed for searcher efficiency trials (140 in Year 1; 145 in Year 2) were used to determine carcass persistence. One carcass was excluded from the Year 1 carcass persistence trial data because of location data error. Also in Year 1, five carcasses were observed only through day 21, rather than day 28, because they were buried under snow on day 28.

The annual mean length of time that carcasses persisted at the study area for all carcass types across seasons was 13 days (Year 1: 14 days; Year 2: 11 days). Sixty-seven carcasses persisted for the entire trial period (through day 21 or day 28). Table 10 presents carcass persistence by carcass type, carcass size, and season by year.

Table 10. Carcass Persistence Summary Data, Years 1 and 2 of Operation

Group	Level	Year 1 (days)	Year 2 (days)	Years 1 and 2 Combined (days)
Overall		**14**	**11**	**13**
Carcass type	Small bird	14	10	12
	Large bird	19	18	18
	Bat	11	7	9
Carcass size	Small	12	9	11
	Large	19	18	18

Table 10. Carcass Persistence Summary Data, Years 1 and 2 of Operation

Group	Level	Year 1 (days)	Year 2 (days)	Years 1 and 2 Combined (days)
Season	Fall migration	24	10	16
	Winter	17	14	15
	Spring migration	5	10	8
	Breeding season	12	12	12

3.3. Adjusted Avian and Bat Fatality Estimates

In Year 1, four of the seven carcasses found during the first formal carcass search were excluded from the adjusted fatality estimate analyses presented in this section because their estimated time since death was determined to be greater than 14 days (the average search interval) (see Section 2.3 and SWCA 2013c for more detail). In Year 3, separate analyses were performed for inclusion and exclusion of the incidental golden eagle because it was removed from the search plot prior to the next formal search (see Section 2.3). Warranting this approach, the daily carcass persistence rate (r) for large birds (chickens) in Years 1 and 2 was 0.93 (95% C.I.: 0.90–0.96), thus the eagle had a 70% (95% C.I. 59-82%) probability of persisting five days to the next formal survey if it had been left on site. Large raptors may persist, on average, longer than the chickens persisted in our study. For example, Smallwood (2007) reported 100% of large raptors persisted for five days; 99% persisted for one week.

In Year 1, for the searcher efficiency model, the minimum AIC*c* model was searcher efficiency as a function of carcass type (AIC*c*: 131.60). Because the difference in AIC*c* between this and the next best model (season + carcass type; AIC*c*: 135.77) was greater than 2 units, searcher efficiency was modeled as a function of carcass type. For the carcass persistence model, the minimum AIC*c* model was carcass persistence as a function of season + carcass type using the lognormal failure time distribution (AICc: 514.13). Because the difference in AIC*c* between this and the next best model (bat or bird + season using the lognormal distribution; AIC*c*: 528.80) was greater than 2 units, carcass persistence was modeled as a function of season + carcass type using the lognormal distribution.

In Year 2, for the searcher efficiency model, the minimum AIC*c* model was searcher efficiency as a function of carcass size (AIC*c*: 121.43), with the carcass type model a close second (AIC*c*: 123.28). Because the difference in AIC*c* was less than 2 units and the carcass size (2) had fewer parameters than carcass type (3), searcher efficiency was modeled as a function of carcass size. For the carcass persistence model, the minimum AIC*c* model was carcass persistence as a function of carcass type using the lognormal distribution (AICc: 645.83). Because the difference in AIC*c* between this and the next best model (carcass size using the lognormal distribution; AIC*c*: 649.15) was greater than 2 units, carcass persistence was modeled as a function of carcass type using the lognormal distribution.

In Year 3, for the searcher efficiency model (using combined Year 1 and Year 2 data), the minimum AIC*c* model was searcher efficiency as a function of carcass size (AIC*c*: 254.92), with the carcass type model a close second (AIC*c*: 256.83). Because the difference in AIC*c* was less than 2 units and the carcass size (2) had fewer parameters than carcass type (3), searcher efficiency was modeled as a function of carcass size. For the carcass persistence model (again, using combined Year 1 and Year 2 data), the minimum AIC*c* model was carcass persistence as a function of carcass type using the lognormal distribution (AICc:

1234.68). Because the difference in AIC*c* between this and the next best model (carcass size using the lognormal distribution; AIC*c*: 1239.49) was greater than 2 units, carcass persistence was modeled as a function of carcass type using the lognormal distribution.

For each survey year, per-turbine and total-site adjusted fatality estimates were calculated for the following groups: 1) overall, 2) bat or bird, 3) carcass type, and 4) season (Table 11). Golden eagle estimates are also provided (see Section 2.3). Adjusted fatality for Year 1 was 1.9 birds/MW/year and 7.8 bats/MW/year and, for Year 2, it was 3.5 birds/MW/year and 9.3 bats/MW/Year, and for Year 3, it was 2.6 birds/MW/year and 5.1 bats/MW/Year.

Table 12 presents adjusted fatality per MW per year, per turbine per year, and per 100,000 m^2 RSA per year by bird and bat groups (i.e., all birds combined, small birds, large birds, and bats). Estimates are presented with 95% CIs.

Table 11. Adjusted Fatality Estimates by Summary Groups, Years 1–3 of Operation

Group	Level	Year 1			Year 2			Year 3 Excluding Incidental Eagle			Year 3 Including Incidental Eagle		
		Observed Fatality*	Total-Site Adjusted Fatality Estimate (95% CI)	Per-Turbine Adjusted Fatality Estimate (95% CI)	Observed Fatality	Total-Site Adjusted Fatality Estimate (95% CI)	Per-Turbine Adjusted Fatality Estimate (95% CI)	Observed Fatality	Total-Site Adjusted Fatality Estimate (95% CI)	Per-Turbine Adjusted Fatality Estimate (95% CI)	Observed Fatality	Total-Site Adjusted Fatality Estimate (95% CI)	Per-Turbine Adjusted Fatality Estimate (95% CI)
Overall		40	561 (301–1,088)	17.50 (9.38–33.97)	26	733 (380–1,396)	22.88 (11.89–43.60)	21	444 (220–736)	13.87 (6.88–22.97)	22	448 (228–760)	13.98 (7.14–23.74)
Bird or bat	Bird	16	112 (11–258)	3.49 (0.34–8.03)	9	199 (82–398)	6.21 (2.58–12.41)	9	150 (88–236)	4.66 (2.76–7.35)	10	153 (87–243)	4.77 (2.74–7.57)
	Bat	24	449 (224–949)	14.01 (6.97–29.64)	17	534 (279–1,029)	16.66 (8.72–32.13)	12	295 (98–569)	9.21 (3.08–17.78)	12	295 (98–569)	9.21 (3.08–17.78)
Carcass type	Small bird	7	81 (18–193)	2.52 (0.54–6.02)	8	195 (79–393)	6.09 (2.49–12.28)	7	142 (71–233)	4.42 (2.24–7.28)	7	142 (71–233)	4.42 (2.24–7.28)
	Large bird	9	31 (7–65)	0.97 (0.20–2.01)	1‡	4 (3–13)	0.12 (0.11–0.40)	2‡	8 (3–19)	0.24 (0.11–0.59)	3‡	12 (3–23)	0.35 (0.11–0.69)
	Bat	24	449 (224–949)	14.01 (6.97–29.64)	17	534 (279–1,029)	16.66 (8.72–32.13)	12	295 (98–569)	9.21 (3.08–17.78)	12	295 (98–569)	9.21 (3.08–17.78)
Season†	Fall migration	18	197 (114–377)	6.14 (3.54–11.78)	18	466 (214–905)	14.55 (6.71–28.27)	10	203 (77–380)	6.32 (2.43–11.87)	10	203 (77–380)	6.32 (2.43–11.87)
	Winter	10	78 (25–163)	2.43 (0.78–5.07)	0	0	0	2‡	48 (19–118)	1.47 (0.61–3.66)	2‡	48 (19–118)	1.47 (0.61–3.66)
	Spring migration	2‡	58 (5–222)	1.79 (0.15–6.93)	2‡	46 (32–175)	1.43 (1.00–5.44)	2‡	26 (3–78)	0.80 (0.11-2.42)	3‡	30 (3–78)	0.91 (0.11–2.43)
	Breeding season	10	229 (69–538)	7.13 (2.13–16.78)	6	221 (63–490)	6.89 (1.98–15.31)	7	170 (47–345)	5.29 (1.49–10.77)	7	170 (47–345)	5.29 (1.49–10.77)
Golden eagle		0	0	0	0	0	0	1‡	4 (3–12)	0.11 (0.11–0.36)	2‡	8 (3–17)	0.22 (0.10–0.53)

Note: Table data from formal carcass searches, with the exception of "Year 3 Including Incidental Eagle", which includes a dead eagle found incidentally between formal searches at a turbine that is regularly searched (see this Section; explanation above).

* Four fatalities found during the first formal carcass search of the study year were excluded from the Year 1 analyses because their estimated time since death was determined to be > 14 days (see Section 2.3). These comprised 2 bats and 2 large birds found during fall migration.

† Breakdown of observed carcass type by season in Year 1 was as follows: fall migration (3 large birds and 15 bats), winter (4 large birds and 6 small birds), spring migration (1 large bird and 1 bat), and breeding season (1 large bird, 1 small bird, and 8 bats). Breakdown of carcass type by season in Year 2 was as follows: fall migration (1 large bird, 6 small birds, and 12 bats), spring migration (2 small birds), and breeding season (1 small bird and 5 bats). Year 3 was as follows: fall migration (4 small birds and 6 bats), winter (2 small birds), spring migration (1 large bird and 1 bat), and breeding season (1 large bird, one small bird, and 5 bats).

‡ Caution should be used when interpreting estimates for groups with fewer than five observed fatalities (Huso et al. 2012).

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Table 12. Adjusted Fatality Metrics by Bird and Bat Groups, Years 1–3 of Operation

Group By Year	Fatality/MW/Year (95% CI)	Fatality/Turbine/Year (95% CI)	Fatality/100,000 m^2 RSA/Year (95% CI)
Year 1			
Total birds	1.94 (0.19–4.48)	3.49 (0.34–8.03)	44.56 (4.38–102.65)
Small birds	1.41 (0.31–3.35)	2.52 (0.54–6.02)	32.23 (7.16–76.79)
Large birds	0.54 (0.12–1.13)	0.97 (0.20–2.01)	12.33 (2.79–25.86)
Bats	7.80 (3.89–16.48)	14.01 (6.97–29.64)	178.65 (89.13–377.59)
Year 2			
Total birds	3.45 (1.42–6.91)	6.21 (2.58–12.41)	79.18 (32.63–158.36)
Small birds	3.39 (1.37–6.82)	6.09 (2.49–12.28)	77.59 (31.43–156.37)
Large birds	0.07 (0.05–0.23)*	0.12 (0.11–0.40)*	1.59 (1.19–5.17)*
Bats	9.27 (4.84–17.86)	16.66 (8.72–32.13)	212.47 (111.01–409.43)
Year 3			
Total birds	2.60 (1.53–4.10)	4.66 (2.76–7.35)	59.68 (35.01–93.90)
Small birds	2.47 (1.23–4.05)	4.42 (2.24–7.28)	56.50 (28.25–92.71)
Large birds	0.14 (0.05–0.33)*	0.24 (0.11–0.59)*	3.18 (1.19–7.56)*
Bats	5.12 (1.70–9.88)	9.21 (3.08–17.78)	117.38 (38.99–226.40)

Note: Table data from formal carcass searches. Estimates exclude four fatalities found during the first formal carcass search in Year 1 (see Table 11 and Section 2.3) and incidental golden eagle found in Year 3 (see this section; explanation above). 95% CI = 95% confidence interval.

* Caution should be used when interpreting estimates for groups with fewer than five observed fatalities (see Table 11; Huso et al. 2012).

3.4. Years 1–3 Fatalities Relative to BBCS and ECP Thresholds

Among the project's BBCS and ECP thresholds (see SWCA 2013a and b)—developed for triggering operational and non-operational mitigation—none were exceeded in any survey year. Tables 13–15 present observed fatalities in relation to annual operational and non-operational thresholds for large birds (non-eagles) and small birds; these tables correspond to Tables 1 and 2 (see Section 2.4). Similar tables for bat species are not included below because none of the species were categorized as high, moderate, or low sensitivity (see Table 1). For eagles, compensatory mitigation has already been applied for projected take of 15.5 golden eagles and 10.6 bald eagles over a five year permit term. Any eagle take beyond that would trigger additional mitigation measures (SWCA 2013b).

No federally listed avian or bat species was found during formal carcass searches or incidentally during the three years of study. Five bird species—black rosy-finch (*Leucosticte atrata*), Brewer's sparrow (*Spizella breweri*), eared grebe, sharp-tailed grouse (*Tympanuchus phasianellus*), and Swainson's hawk—were considered "sensitive" under the project's BBCS threshold categories because of their federal (birds of conservation concern [BCC]; USFWS 2008) and/or state (Idaho species of greatest conservation need; IDFG 2005) sensitivity designations (see Tables 13–15). All other avian species found during formal carcass searches and incidentally are protected under the MBTA, but were not categorized as high, moderate, or low sensitivity in the BBCS (SWCA 2013a). Two golden eagles were found in Year 3, one incidentally and one during formal searches. Golden eagles are protected under the Eagle Act and the MBTA; they are designated as a BCC for BCR 9. None of the bats found are designated under the Idaho species of greatest conservation need. Under the Western Bat Working Group (WBWG 2015), big brown bat is designated as "low"; hoary bat, silver-haired bat, and western small-footed myotis are designated as "medium".

Table 13. Avian Species Fatalities in Relation to Annual Non-Operational Mitigation Thresholds, Years 1–3 of Operation

Sensitivity (Species; Species Code†)	Observed Fatalities		Threshold Value*		Threshold Value Exceeded?
	Large Birds (non-eagles)	Small Birds	Large Birds (non-eagles)	Small Birds	
Year 1					
High	0	0	1	1	No
Moderate (Sharp-tailed grouse; STGR)	1	N/A	5	15	No
Low (Black rosy-finch; BLRF) (Eared grebe; EAGR)	N/A 4	1 N/A	10	30	No
Year 2					
High	0	0	1	1	No
Moderate	0	0	5	15	No
Low (EAGR)	1	N/A	10	30	No

Table 13. Avian Species Fatalities in Relation to Annual Non-Operational Mitigation Thresholds, Years 1–3 of Operation

Sensitivity (Species; Species Code†)	Observed Fatalities		Threshold Value*		Threshold Value Exceeded?
	Large Birds (non-eagles)	Small Birds	Large Birds (non-eagles)	Small Birds	
Year 3					
High	0	0	1	1	No
Moderate	0	0	5	15	No
Low (Brewer's sparrow; BRSP) (Swainson's hawk; SWHA)	 N/A 1	 1 N/A	10	30	No

Note: Table corresponds to Table 1. N/A = Not applicable. Table data from formal carcass searches. See Table 1 for sensitivity definitions.

* For a given species, the number of individuals found killed or injured and non-releasable during formal carcass searches; correction factors were not applied (see Section 2.4).

† American Ornithologists' Union–recognized four-letter alpha code (Pyle and DeSante 2014)

Black rosy-finch and Brewer's sparrow designated as a BCC for BCR 9 (USFWS 2008) and S3 under the Idaho species of greatest conservation need (IDFG 2005).

Eared grebe designated as a BCC for BCR 9 (USFWS 2008).

Sharp-tailed grouse designated as S1 under the Idaho species of greatest conservation need (IDFG 2005).

Swainson's hawk designated as S3 under the Idaho species of greatest conservation need (IDFG 2005).

Table 14. Annual Operational Mitigation Fatality Thresholds Associated with Spatial Episodic Mortality Events for Avian Species, Years 1–3 of Operation

Sensitivity (Species Code†)	Max. Number of Observed Fatalities at a Single Turbine or Group (< 5) of Adjacent Turbines Over A Short Period (≤ 2 Weeks)		Threshold Value*		Threshold Value Exceeded?
	Large Birds (non-eagles)	Small Birds	Large Birds (non-eagles)	Small Birds	
Year 1					
High	0	0	2 individuals at a single turbine or group (< 5) of adjacent turbines over a short time period	2 individuals at a single turbine or group (< 5) of adjacent turbines over a short time period	No
Moderate (STGR)	 1	 N/A	5 individuals at a single turbine or group (< 5) of adjacent turbines over a short time period	15 individuals at a single turbine or group (< 5) of adjacent turbines over a short time period	No
Low (BLRF) (EAGR)	 N/A 2‡	 1 N/A	10 individuals at a single turbine or group (< 5) of adjacent turbines over a short time period	30 individuals at a single turbine or group (< 5) of adjacent turbines over a short time period	No

Table 14. Annual Operational Mitigation Fatality Thresholds Associated with Spatial Episodic Mortality Events for Avian Species, Years 1–3 of Operation

Sensitivity (Species Code†)	Max. Number of Observed Fatalities at a Single Turbine or Group (< 5) of Adjacent Turbines Over A Short Period (≤ 2 Weeks)		Threshold Value*		Threshold Value Exceeded?
	Large Birds (non-eagles)	Small Birds	Large Birds (non-eagles)	Small Birds	
Year 2					
High	0	0	2 individuals at a single turbine or group (< 5) of adjacent turbines over a short time period	2 individuals at a single turbine or group (< 5) of adjacent turbines over a short time period	No
Moderate	0	0	5 individuals at a single turbine or group (< 5) of adjacent turbines over a short time period	15 individuals at a single turbine or group (< 5) of adjacent turbines over a short time period	No
Low (EAGR)	1	N/A	10 individuals at a single turbine or group (< 5) of adjacent turbines over a short time period	30 individuals at a single turbine or group (< 5) of adjacent turbines over a short time period	No
Year 3					
High	0	0	2 individuals at a single turbine or group (< 5) of adjacent turbines over a short time period	2 individuals at a single turbine or group (< 5) of adjacent turbines over a short time period	No
Moderate	0	0	5 individuals at a single turbine or group (< 5) of adjacent turbines over a short time period	15 individuals at a single turbine or group (< 5) of adjacent turbines over a short time period	No
Low (BRSP) (SWHA)	 N/A 1	 1 N/A	10 individuals at a single turbine or group (< 5) of adjacent turbines over a short time period	30 individuals at a single turbine or group (< 5) of adjacent turbines over a short time period	No

Note: Table corresponds to Table 2. N/A = Not applicable. Table data from formal carcass searches. See Table 1 for Sensitivity definitions.

* For a given species, the number of individuals found killed or injured and non-releasable during formal carcass searches; correction factors were not applied (see Section 2.4).

† See Table 13 for species codes and agency designations.

‡ 2 of 4 individuals found in Year 1 (see Tables 3 and 13) were found over a short period (≤ 2 weeks).

Table 15. Annual Operational Mitigation Fatality Thresholds Associated with Consecutive Season Episodic Mortality Events for Avian Species, Years 1 and 2 of Operation

Sensitivity (Species Code†)	Fall Migration			Winter			Spring Migration			Breeding Season			Threshold Value*		Threshold Value Exceeded?
	Year 1	Year 2	Year 3	Year 1	Year 2	Year 3	Year 1	Year 2	Year 3	Year 1	Year 2	Year 3	Large Birds (non-eagles)	Small Birds	
High	0	0	0	0	0	0	0	0	0	0	0	0	2 individuals at the facility in a given season in consecutive years (i.e., spring 2013 and spring 2014)	2 individuals at the facility in a given season in consecutive years (i.e., spring 2013 and spring 2014)	N
Moderate (STGR)‡	0	0	0	0	0	0	1	0	0	0	0	0	5 individuals at the facility in a given season in consecutive years (i.e., spring 2013 and spring 2014)	15 individuals at the facility in a given season in consecutive years (i.e., spring 2013 and spring 2014)	N
Low													10 individuals at the facility in a given season in consecutive years (i.e., spring 2013 and spring 2014)	30 individuals at the facility in a given season in consecutive years (i.e., spring 2013 and spring 2014)	N
(BLRF)§	0	0	0	1	0	0	0	0	0	0	0	0			
(BRSP)§	0	0	1	0	0	0	0	0	0	0	0	0			
(EAGR)‡	3	1	0	1	0	0	0	0	0	0	0	0			
(SWHA)‡	0	0	0	0	0	0	0	0	0	0	0	1			

Note: Table corresponds to Table 2. Table data from formal carcass searches. See Table 1 for Sensitivity definitions.

* For a given species, the number of individuals found killed or injured and non-releasable during formal carcass searches; correction factors were not applied (see Section 2.4).

† See Table 13 for species codes and agency designations.

‡ Large bird (non-eagle)

§ Small bird

3.5. Comparison with Other Wind Energy Facilities

Adjusted Years 1 and 3 fatality estimates were comparably low for birds (1.9 and 2.6 birds/MW/year, respectively), whereas adjusted Year 2 fatality estimates were moderate for birds (3.5 birds/MW/year) relative to other U.S. wind energy facilities (Appendix C, Figures C1 and C2; and see Section 4.2). Fatality estimates for bats in all years were moderate (7.8, 9.3, and 5.1 bats/MW/year in Year 1, 2, and 3, respectively) (Appendix C, Figures C1 and C2; and see Section 4.2).

Table 16. Adjusted Avian and Bat Fatality Estimates (Fatalities/MW/Year) Reported at Western United States Wind Energy Facilities, Including the Statistical Estimator Used

Project Name, State	(Fatality/MW/Year)		Estimator Used
	Bird Fatality	Bat Fatality	
Horse Butte Wind Facility (2012–2013), ID	**1.94**	**7.80**	Huso
Horse Butte Wind Facility (2013–2014), ID	**3.45**	**9.27**	Huso
Horse Butte Wind Facility (2014–2015), ID	**2.60**	**5.12**	Huso
Alite (2009–2010), CA	0.55	0.24	Unknown or unclear
Alta Wind I (2011–2012), CA	7.07	1.28	Unknown or unclear
Alta Wind II-V (2011–2012), CA	1.66	0.08	Unknown or unclear
Altamont Pass (1998–2003), CA	14.22	0.12	Unknown or unclear
Altamont Pass (2005–2007), CA	21.63	0.26	Unknown or unclear
Big Horn, WA	2.54	1.90	Huso
Biglow Canyon (Ph 1; 2008), OR	1.76	1.99	Shoenfeld
Biglow Canyon (Ph 1; 2009), OR	2.47	0.58	Unknown or unclear
Biglow Canyon (Ph 2; 2009–2010), OR	5.53	2.71	Unknown or unclear
Biglow Canyon (Ph 2; 2010–2011), OR	2.68	0.57	Unknown or unclear
Biglow Canyon (Ph 3; 2010–2011), OR	2.28	0.22	Unknown or unclear
Buena Vista, CA	1.15	Unknown	Unknown or unclear
Combine Hills (2004–2005), OR	2.56	1.88	Unknown or unclear
Combine Hills (2011), OR	2.33	0.73	Unknown or unclear
Condon, OR	5.80	Unknown	Unknown or unclear
Diablo Winds (2005–2007), CA	4.29	0.82	Shoenfeld
Dillon (2008–2009), CA	4.71	2.17	Shoenfeld
Dry Lake I (2009–2010), AZ	2.22	4.29	Shoenfeld
Dry Lake II (2011–2012), AZ	1.57	1.66	Shoenfeld
Elkhorn (2008), OR	0.64	1.26	Unknown or unclear
Elkhorn (2010), OR	1.95	2.14	Unknown or unclear
Foote Creek Rim (Ph 1; 1998–2000), WY	2.50	2.23	Naïve
Foote Creek Rim (Ph 1; 1999), WY	3.40	3.97	Naïve
Foote Creek Rim (Ph 1; 2000), WY	2.42	1.05	Naïve
Foote Creek Rim (Ph 1; 2001–2002), WY	1.93	1.57	Naïve
Goodnoe Hills, WA	1.40	0.34	Unknown or unclear

Table 16. Adjusted Avian and Bat Fatality Estimates (Fatalities/MW/Year) Reported at Western United States Wind Energy Facilities, Including the Statistical Estimator Used

Project Name, State	(Fatality/MW/Year)		Estimator Used
	Bird Fatality	**Bat Fatality**	
Harvest Wind (2010–2012), WA	2.94	1.27	Huso
Hatchet Ridge (2012–2013), CA	0.83	5.22	Huso
Hay Canyon, OR	2.21	0.53	Unknown or unclear
High Winds (2003–2004), CA	1.62	2.51	Shoenfeld
High Winds (2004–2005), CA	1.10	1.52	Shoenfeld
Hopkins Ridge (2006), WA	1.23	0.63	Unknown or unclear
Hopkins Ridge (2008), WA	2.99	1.39	Unknown or unclear
Judith Gap (2006–2007), MT	3.01	8.93	Naïve
Judith Gap (2009), MT	Unknown	3.20	Unknown or unclear
Kittitas Valley (2011–2012), WA	1.06	0.12	Unknown or unclear
Klondike I (2002–2003), OR	0.95	0.77	Unknown or unclear
Klondike II (2005–2006), OR	3.14	0.41	Shoenfeld
Klondike III (2007–2009), OR	3.02	1.11	Unknown or unclear
Klondike IIIa (Ph 2; 2008–2010), OR	2.61	0.14	Shoenfeld
Leaning Juniper (2006–2008), OR	6.66	1.98	Huso
Linden Ranch (2010–2011), WA	6.65	1.68	Unknown or unclear
Marengo I (2009–2010), WA	0.27	0.17	Unknown or unclear
Marengo II (2009–2010), WA	0.16	0.27	Unknown or unclear
Nine Canyon (2002–2003), WA	2.76	2.47	Unknown or unclear
Pebble Springs (2009–2010), OR	1.93	1.55	Huso
Pine Tree (2009–2010), CA	8.33	0	Unknown or unclear
San Gorgonio, CA	9.23	unknown	Unknown or unclear
Shiloh I (2006–2009), CA	6.96	0.42	Unknown or unclear
Shiloh II (2009–2010), CA	1.51	0.12	Unknown or unclear
SMUD, CA	0.99	0.07	Unknown or unclear
Stateline (2001–2002), OR/WA	3.17	1.09	Shoenfeld
Stateline (2001–2003), OR/WA	2.92	1.70	Shoenfeld
Stateline (2002), OR/WA	3.48	1.20	Shoenfeld
Stateline (2003), OR/WA	2.68	2.29	Shoenfeld
Stateline (2006), OR/WA	1.23	0.95	Shoenfeld
Tuolumne, WA	3.20	0.94	Shoenfeld
Vansycle (1999), OR	0.95	1.12	Naïve
Vantage (2010–2011), WA	1.27	0.40	Unknown or unclear
Vasco Winds (2012–2013), CA	2.55	1.68	Brown et al.

Table 16. Adjusted Avian and Bat Fatality Estimates (Fatalities/MW/Year) Reported at Western United States Wind Energy Facilities, Including the Statistical Estimator Used

Project Name, State	**(Fatality/MW/Year)**		**Estimator Used**
	Bird Fatality	**Bat Fatality**	
White Creek (2007–2011), WA	4.05	2.04	Huso
Wild Horse, WA	1.55	0.39	Shoenfeld
Windy Flats (2010–2011), WA	8.45	0.41	Unknown or unclear
Western U.S. Average†	**3.32 (range: 0.16–21.63)**	**1.55 (range: 0–8.93)**	

Note: Fatality estimators referenced in table include Huso (2011), Naïve (Johnson, Erickson, Strickland et al. 2003), and Shoenfeld (2004). Brown et al. (2013) developed their own estimator.

* Different adjusted fatality estimate values have been reported for several projects. Estimates presented in this table were gleaned from multiple sources, including those containing synthesis compilations: primary and secondary, peer-reviewed and non-peer-reviewed technical reports. Where differences in values reported for a given project exist, we selected values that appeared to be most reliable (e.g., peer-reviewed sources, values that could be verified using another source).

† Excludes Horse Butte Wind Facility data.

4. DISCUSSION

4.1. Key Findings

- During formal carcass searches, 36 birds and 55 bats were found—18 birds and 26 bats in Year 1, nine birds and 17 bats in Year 2, and nine birds and 12 bats in Year 3. Among those that could be identified to species (27 birds and 50 bats), 17 bird species and four bat species were identified.
- None of the operational or non-operational mitigation thresholds developed in the project's BBCS (SWCA 2013a) and ECP (SWCA 2013b) were met or exceeded in any survey year.
- No federally listed bird or bat was found during formal carcass searches or incidentally. Five bird species—black rosy-finch, Brewer's sparrow, eared grebe, sharp-tailed grouse, and Swainson's hawk—were considered "sensitive" under the project's BBCS threshold categories because of their federal (BCC; USFWS 2008) and/or state (Idaho species of greatest conservation need; IDFG 2005) sensitivity designations.
- Two golden eagle fatalities were recorded (one incidentally and one during formal searches); both in Year 3.
- Avian and bat species composition and seasonal distribution patterns generally mirrored those observed at other U.S. wind energy facilities, with the exception that avian fatalities peaked in fall migration and in *winter* (the majority of these winter fatalities occurred in Year 1).
- Adjusted fatality estimates were low to moderate for birds and moderate for bats, relative to other U.S. wind energy facilities (but see Section 4.2.1).

4.2. Comparison to Other Wind Energy Facilities

For a national and regional comparison, we reviewed adjusted avian and bat fatality rates, species composition, and seasonal distribution patterns reported in synthesis documents (e.g., American Wind Wildlife Institute [AWWI] 2014; Hayes 2013; Hein et al. 2013; Kunz et al. 2007; Loss et al. 2013; NWCC 2010), and other publically available studies. We compare the Horse Butte Wind Facility with other studies in the western United States, including 44 studies from 25 sites in the region (northwestern United States); eight of these studies were publically available as project-specific reports:

- Biglow Canyon (Jeffrey et al. 2009)
- Foote Creek Rim, Wyoming (Young et al. 2003)
- Judith Gap, Montana (TRC 2008)
- Klondike I, Oregon (Johnson, Erickson, White et al. 2003)
- Klondike IIIa, Oregon (Gritski et al. 2011)
- Nine Canyon, Washington (Erickson et al. 2003)
- Vansycle, Oregon (Erickson et al. 2000)
- Wild Horse, Washington (Erickson et al. 2008)

4.2.1. Adjusted Fatality

Because studies of avian and bat fatality at wind energy facilities vary substantially in regard to study design and analytical methods, comparisons of adjusted fatality estimates—commonly made among projects to assess project-specific or policy decisions—may not be valid (Loss et al. 2013; Smallwood 2013; Warren-Hicks et al. 2013). Smallwood (2007) states that all existing fatality estimates at wind energy facilities should be considered highly imprecise. These comparisons are made from adjusted fatality rates generated from different statistical estimators (see Table 16)—some of which consistently underestimate mortality (Huso 2011) and can yield results that differ by a factor of three or four (Warren-Hicks et al. 2013)—and from highly variable carcass persistence and searcher efficiency trial methodology. Other sources of variation include search interval, search plot size, seasonal coverage of searches, whether corrections are made or even necessary for percent of searchable area within search plots, whether bird or bat fatalities, or both, are the focus of the study, inclusion versus exclusion of incidentals, and turbine attributes (e.g., height, lattice versus monopole). Several authors also call for increased transparent reporting; eluding that scarce publicly available fatality estimate data may not be representative of all fatality estimates collected at wind energy facilities in the United States (AWWI 2014; Kunz et al. 2007; Loss et al. 2013; Smallwood 2013). Additionally, fatalities/MW is a common metric used for comparisons; however, the difference between rated and actual outputs can be large and can vary by turbine, season, and site attributes (Smallwood 2007).

In our review, publically available studies have all reported fewer than 22 birds/MW/year, with most studies reporting three to five birds/MW/year (AWWI 2014; Smallwood and Karas 2009) (see Appendix C: Figure C1). While it is unclear to what extent reported regional differences reflect sampling bias (i.e., lack of data from some regions of the United States), Loss et al. (2013) reported some evidence for differences; with California (18.8 [95% CI: 9.7–27.8]) exceeding the eastern states (3.9 [95% CI: 3.1–4.7]), followed by the western states (excludes California; 2.8 [95% CI: 2.1–3.6]) and the Great Plains (1.8 [95% CI: 1.0–2.6]) (Loss et al. 2013). Adjusted avian fatality estimates for the project were within the range reported for the western United States in Loss et al.'s (2013) synthesis study, which derived adjusted estimates for U.S. monopole turbines. Project estimates were also within the reported range for individual facilities in synthesis and project-specific documents for the western United States and for the region (see Table 16 and Figure C1). Studies in the region report low to high adjusted avian fatality estimates (0.2–8.5 birds/MW/year) with extremes reported at the Marengo and Windy Flats facilities (both in Washington), respectively (Enz et al. 2011 as cited in Western Ecosystems Technology, Inc. [WEST] 2014; URS Corporation 2010).

Several studies have reported substantially higher bat than bird fatality rates, especially those along forested ridge tops in the eastern United States and in the upper Midwest, where rates have been reported as high as 41.1 and 30.6 bats/MW/year, respectively (Good et al. 2012; Kunz et al. 2007). Most publically available studies have reported <15 bats/MW/year (NWCC 2010). Similar to regional differences reported for avian fatality rates, it is unclear to what extent interpretations of regional differences for bat fatality rates reflect sample bias (i.e., lack of data from some regions of the United States, including the Southwest and southern states). Bat fatality rates are typically lowest in the western United States (Ellison 2012) ranging from 0.1–8.9 bats/MW/year (see Table 16 and Figure C2); however, there is more variation within than among regions (Arnett et al. 2013; Ellison 2012; Hein et al. 2013). Project estimates were well below those reported at some sites in the eastern United States and upper Midwest and were within the range of most publically available studies. Years 1 and 3 project estimates were within the range, whereas Year 2 estimates were slightly above the range reported for individual facilities in synthesis and project-specific documents for the western United States and for the region. Studies in the region report low to moderate adjusted bat fatality estimates (0.1–8.9 bats/MW/year), with extremes reported at the Kittitas Valley facility in Washington and the Judith Gap facility in Montana, respectively (Stantec 2012 as cited in WEST 2014; TRC 2008). However, analytical and field methods need to be standardized among studies before meaningful project-related conclusions can be made. For example, among the eight studies that are publically available for the region, five used the naïve estimator (Johnson et al. 2003), two used Shoenfeld's (2004) estimator, and one used both Shoenfeld and Huso (2011) to calculate adjusted fatality estimates.

4.2.2. Species Composition and Seasonal Distribution

4.2.2.1. AVIAN FATALITIES

Avian fatalities at wind energy facilities are distributed among many species (e.g., Loss et al. 2013 found fatality records for at least 218 species). Passerines constitute most (roughly 60%) of bird fatalities at facilities in the United States, and these fatalities generally result in spring and fall peaks of avian fatality rates (AWWI 2014; Erickson et al. 2001; Erickson et al. 2004; Johnson et al. 2002; NWCC 2010). There is little current evidence, however, to infer whether specific bird species or, for example, specific families within the passerine group (or other, less abundant groups), are vulnerable to population declines as a result of wind turbine collisions (Loss et al. 2013; Stewart et al 2007).

Though raw counts may not represent actual species-specific fatality (Loss et al. 2013), avian species composition and seasonal distribution patterns observed for the project generally mirrored those observed at other facilities in the United States, with the exception that fatalities peaked in fall migration and in *winter*. The majority of these winter fatalities were found in Year 1 and primarily comprised species (common redpoll, black rosy-finch, and unknown rosy-finch) known to congregate in large, irruptive/nomadic flocks in winter (Johnson 2002; Knox and Lowther 2002). Avian fatalities were distributed among several species (17 species were identified) with passerines (33%) constituting more than other groups; however, waterbirds/waterfowl (24%) were an important group and included the most common species found—eared grebe. Patterns reported for facilities in the region also mirrored those reported at other facilities in the United States, with the exception that Johnson, Erickson, Strickland et al. (2003) similarly reported fall and winter peaks in avian fatality rates for the Klondike I facility (Erickson et al. 2000; Erickson et al. 2003; Erickson et al. 2008; Gritski et al. 2011; Jeffrey et al. 2009; TRC 2008; Young et al. 2003).

Among avian fatalities found at the project that could be identified to species, most have been commonly (i.e., >20 fatalities among 3,605 fatality records) documented as fatalities at other wind energy facilities (Loss et al. 2013). However, some have been infrequently (i.e., <20 fatalities among 3,605 fatality records; rough-legged hawk, and Swainson's hawk), rarely (i.e., <5 fatalities among 3,605 fatality records; Brewer's sparrow, common redpoll, eared grebe, golden eagle, and sharp-tailed grouse) (Loss et al. 2013), or, in our review, never reported (black rosy-finch and gray-crowned rosy-finch).

4.2.2.2. BAT FATALITIES

Several studies have reported high numbers of bat fatalities, limited to specific species, relative to bird fatalities at wind energy facilities—evidence that bat fatalities may be a greater conservation concern (Barclay et al. 2007; Ellison 2012); these fatalities generally occur during specific periods of time and weather conditions (AWWI 2014; Arnett et al. 2008; Johnson, Erickson, White et al. 2003; Hayes 2013; NWCC 2010). Migratory tree-roosting species—hoary bat, silver-haired bat, and eastern red bat (*Lasiurus borealis*)—constitute the majority (>70%) of bat fatalities at other United States wind energy facilities, and most bat fatalities occur during low-wind periods in late summer and early fall migration; some facilities have reported a smaller peak during spring migration for some species (Arnett et al. 2008; Baerwald and Barclay 2009; Johnson 2005; Kunz et al. 2007; NWCC 2010).

More bat (55) than bird (36) fatalities were recorded during the study. Species composition and seasonal distribution patterns of bat fatalities mirrored those reported at other United States wind energy facilities, including those in the region. Bat fatalities were limited to four species, with migratory tree bats comprising the majority (91%) of fatalities, and most were found during late summer (18%) and fall migration (64%). Other facilities in the region similarly report hoary bat and silver-haired bat constituting most of the bat fatalities, and these fatalities occur in late summer and early fall migration (Erickson et al. 2000; Erickson et al. 2003; Erickson et al. 2008; Gritski et al. 2011; Jeffrey et al. 2009; Johnson, Erickson, Strickland et al. 2003; TRC 2008; Young et al. 2003). These regional studies report more bird than bat fatalities, with the exception of Jeffrey et al. (2009; Biglow Canyon) and TRC (2008; Judith Gap).

Among the bat species found at the project, each has been commonly documented at other wind energy facilities (Kunz et al. 2007), with the exception of western small-footed myotis, which, in our review, has never been reported.

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APPENDIX A

Horse Butte Wind Facility Wildlife Incident Data Form

ID# ____________
Species ____________
Date/Time ____________
Turbine# ____________
Observer ____________

Horse Butte Wind
Wildlife Incident Report

SECTION NO. 1 - DISCOVERY DATA

Name, Organization: Thomas Sharp, SWCA Contact Phone #: 801-322-4307 (SWCA-Salt Lake)

Report Date: ____________ Recovery Date, Time: ____________

ID# (Date-Sequential# [######-#]) ____________

Observer (if two observers found at the same time or two observers found multiple parts, list both observers)

____

Search Start Time ____________ Search End Time ____________

Date since last search: ____________

Search method: On Foot ☒ From Vehicle ☐

Injury ☐ Fatality ☐ Complete ☐ Dismembered ☐ Feathers ☐ Bones ☐

SECTION NO. 2 - LOCATION OF FIND

Bearing (Degrees, Cardinal Direction) and Distance (m) from Turbine: ____________

Turbine #: ____________

If multiple parts, list parts by size:

	Distance (m)	Degrees, Cardinal Direction
Part 1:		
Part 2:		
Part 3:		

Location Remarks (e.g., substrate = bare ground, low grass, high grass, juniper, shrub, other): ____________

____

____

UTM (Nad83, Zone 12): E ____________ N ____________ Mark # (if applicable): ______

SECTION NO. 3 - WILDLIFE IDENTIFICATION

Species (Common Name, Scientific Name): ____________

Field marks used: ____________

Age (A, J): ______ Sex: ______

Band: No ☐ Yes ☐ Unknown ☐ (Leg(s) missing)

ID# ____________
Species ____________
Date/Time ____________
Turbine# ____________
Observer ____________

SECTION NO. 4 - OBSERVATIONAL DATA

Describe the physical condition of the find at the time of discovery: ____________

Describe scavenging activity: ____________

Estimated Time Since Death or Injury (days): <1☐ <4☐ <7☐ <14☐ <30☐ >30☐ UNK☐

Photos (Y, N; Photo #s if available): ____________

Carcass Condition:
- ☐ 1-Fresh
- ☐ 2-Decomposing (early stage)
- ☐ 3-Decomposing (late stage)
- ☐ 4-Dessicated
- ☐ 5-N/A

Infestation Activity: Yes ☐ No ☐
- ☐ Fly Larvae (maggots)
- ☐ Adult Flies
- ☐ Beetles
- ☐ Ants
- ☐ Other

Eyes: N/A☐ Round, Fluid Filled☐ Partially Dehydrated☐ Flat☐ Sunken☐ Amorphous/Empty☐

Other Field Notes: ____________

Carcass disposition: Left onsite☐ Placed in Freezer (SWCA-Salt Lake)☐ Placed in Freezer (Horse Butte)☐

Wildlife Incident Report (Supplement)

Carcass Condition:
Check the most appropriate description listed below. The four categories represent an overall pattern of the decomposition process continuum. Selecting a category for a particular carcass often involves a subjective assessment.

1 - Fresh = No putrid odor (or some). Exposed flesh is red, and moist or drying. No maggots present. Carcass body shape is full. Eyes are either smooth, moist and turgid in appearance, dehydrating/losing turgor as evidenced by small wrinkles and indentations, or flattened.

2 - Decomposing (early stage) = Strong putrid odor. Flesh is decomposing. Maggots are present. Whole eye is flat or sunken in appearance, iris and pupil areas may be deeply concave in shape.

3 - Decomposing (late stage) = Flesh remaining is sparse, often liquidous. Maggots may be present. (Maggots at this stage are most likely of later instar (bigger, older). Putrid odor is strong or diminishing (depending on amount of decomposing flesh still present). Eyes are completely gone.

4 - Desiccated = Carcass is light in weight (due to desiccation). Only bones, feathers, and dried remnants of skin and tendons are present. Very little or no odor present. No maggots or carrion beetles.

Eyes:
Mark the category that best describes the condition of the eyes. If the eyelids are closed, make a note of this (in the Other Field Notes section) and carefully lift the eyelids to determine their condition (you must have received authorization from USF&WS to recover the bird prior to this action). If you believe that both eyes have been scavenged such that one of the following categories cannot be determined, leave this section blank and describe the condition in the Scavenging Activity section. If the bird is alive or UTL the head write N/A.

Round, Fluid Filled = Eye should appear the same as in life. Full turgor pressure, No indentations or wrinkles.

Partially Dehydrated = Wrinkles, indentations are present, turgor is lost.

Flat = Further moisture loss causes the corneal surface to fall, giving a flat appearance to the eye.

Sunken = Eye appears sunken, concave in shape, drying or dry.

Amorphous/Empty = Either eye tissue is not present or eye tissue present within the orbital socket is dry or decomposing such that it's appearance is amorphous/indistinguishable as an eye.

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APPENDIX B

Avian and Bat Fatalities, Years 1–3

Table B1. Avian and Bat Fatalities at the Horse Butte Wind Facility, Years 1–3 of Operation

ID*	Species	Date Found	Carcass Type	Season	Plot	Distance (m), Orientation from Turbine Mast	UTM_X‡	UTM_Y‡	Carcass Condition§
Avian Species, Found During Formal Carcass Searches, Year 1									
092712-3	Eared grebe	9/27/2012	Large bird (LB)	Fall migration	T27	48, NW	441461	4803691	Complete
092712-4	Eared grebe	9/27/2012	LB	Fall migration	T27	33, NW	441451	4803667	Complete
092812-1**	Unknown grebe	9/28/2012	LB	Fall migration	T10	59, NE	439550	4807810	Parts/Dismembered
092812-2**	Eared grebe	9/28/2012	LB	Fall migration	T10	40, NE	439542	4807782	Feathers
102412-1	Unidentified waterbird	10/24/2012	LB	Fall migration	T10	71, SW	439457	4807721	Parts/Dismembered
110712-1	Black rosy-finch	11/07/2012	Small bird (SB)	Winter	T5	29, SE	437903	4808787	Complete
111912-1	American coot	11/19/2012	LB	Winter	T27	38, NE	441504	4803670	Complete
120512-1	Eared grebe	12/5/2012	LB	Winter	T9	60, NE	439265	4808027	Parts/Dismembered
121812-1	Rough-legged hawk	12/18/2012	LB	Winter	T25	22, NE	440639	4803966	Complete
011713-1	Unidentified rosy-finch	1/17/2013	SB	Winter	T10	51, SE	439550	4807755	Feathers
011713-2	Common redpoll	1/17/2013	SB	Winter	T9	11, NE	439227	4807996	Complete
011713-3	Common redpoll	1/17/2013	SB	Winter	T9	36, SE	439252	4807987	Feathers
021313-1	Gray partridge	2/13/2013	SB	Winter	T5	4, NE	437880	4808801	Parts/Dismembered
031313-1	Rough-legged hawk	3/13/2013	LB	Winter	T25	40, SE	440646	4803937	Parts/Dismembered
031413-1	Common redpoll	3/14/2013	SB	Winter	T27	45, NE	441506	4803677	Parts/Dismembered
050813-1	Sharp-tailed grouse	5/8/2013	LB	Spring migration	T27	64, NE	441533	4803672	Feathers
052213-1	Unidentified accipiter	5/22/2013	LB	Breeding season	T9	49, NE	439223	4808041	Feathers
071713-1	Gray partridge	7/17/2013	SB	Breeding season	T5	39, NE	437913	4808814	Complete
Avian Species, Incidentals, Year 1**									
092812-3-I	Red-tailed hawk	9/28/2012	LB	Fall Migration	T10	68, SE	439515	4807708	Complete
112012-1-I	European starling	11/20/2012	SB	Winter	T27	23, NW	441461	4803661	Complete
042313-1-I	Red-tailed hawk	4/23/2013	LB	Spring Migration	T15	20, SE	439578	4806310	Complete

Table B1. Avian and Bat Fatalities at the Horse Butte Wind Facility, Years 1–3 of Operation

ID*	Species	Date Found	Carcass Type	Season	Plot	Distance (m), Orientation from Turbine Mast	UTM_X‡	UTM_Y‡	Carcass Condition§
Avian Species, Found During Formal Carcass Searches, Year 2									
092513-2	Eared grebe	9/25/2013	LB	Fall Migration	T27	31, NW	441448	4803660	Complete
092613-1	Gray partridge	9/26/2013	SB	Fall migration	T5	6, NE	437880	4808805	Parts/Dismembered
100913-1	Yellow-rumped warbler	10/9/2013	SB	Fall migration	T20	78, SW	437822	4808745	Complete
100913-2	Yellow-rumped warbler	10/9/2013	SB	Fall migration	T31	67, SW	443271	4804481	Feathers
101613-2	Rock pigeon	10/16/2013	SB	Fall migration	T31	72, SW	443276	4804468	Feathers
101713-1	Unidentified warbler	10/17/2013	SB	Fall migration	T20	31, NE	440777	4805487	Feathers
042214-1	Horned lark	4/22/2014	SB	Spring migration	T10	13, SE	439509	4807763	Complete
042914-1	Unidentified small bird	4/29/2014	SB	Spring migration	T10	40, NE	439514	4807814	Feathers
072114-1	Unidentified small bird	7/21/2014	SB	Breeding season	T9	32, NE	439237	4808016	Feathers
Avian Species, Incidentals, Year 2**									
101013-1-I	Gray partridge	10/10/2013	SB	Fall migration	T20	Not Recorded	Not Recorded		Feathers
Avian Species, Found During Formal Carcass Searches, Year 3									
100214-1	Unidentified small bird	10/2/2014	SB	Fall migration	T20	93, NE	440815	4805537	Parts/Dismembered
101614-1	Unidentified goldfinch	10/16/2014	SB	Fall migration	T16	23, NE	439780	4806076	Complete
122314-1	Gray-crowned rosy-finch	12/23/2014	SB	Winter	T25	59, SW	440560	4803953	Complete
021915-1	Horned lark	2/19/2015	SB	Winter	T27	48, NE	441489	4803690	Parts/Dismembered
040715-1	Golden eagle	4/7/2015	LB	Spring migration	T6	81, SE	438204	4808654	Parts/Dismembered
080115-3	Swainson’s hawk	8/1/2015	LB	Breeding season	T10	49, NE	439548	4807794	Parts/Dismembered
080115-2	American kestrel	8/1/2015	SB	Breeding season	T5	58, NW	437829	4808831	Parts/Dismembered
082315-1	Brewer’s sparrow	8/23/2015	SB	Fall migration	T31	24, SW	443311	4804500	Complete
082815-1	Gray partridge	8/28/2015	SB	Fall migration	T5	55, SE	437932	4808797	Complete
Avian Species, Incidentals, Year 3**									
041615-1	Golden eagle	4/16/2015	LB	Spring migration	T5	11, NE	437888	4808800	Complete
081615-1-I	Swainson’s hawk	8/16/2015	LB	Fall migration	T32	26, NW	443666	4804602	Parts/Dismembered
Bat Species, Found During Formal Carcass Searches, Year 1									
092712-1	Hoary bat	9/27/2012	Bat	Fall migration	T25	16, NE	440619	4803981	Complete

Table B1. Avian and Bat Fatalities at the Horse Butte Wind Facility, Years 1–3 of Operation

ID*	Species	Date Found	Carcass Type	Season	Plot	Distance (m), Orientation from Turbine Mast	UTM_X‡	UTM_Y‡	Carcass Condition§
092712-2**	Silver-haired bat	9/27/2012	Bat	Fall migration	T27	67, NE	441499	4803707	Complete
092812-4**	Hoary bat	9/28/2012	Bat	Fall migration	T9	40, NE	439244	4808021	Complete
100912-1	Silver-haired bat	10/9/2012	Bat	Fall migration	T25	25, SE	440642	4803964	Complete
101012-1	Hoary bat	10/10/2012	Bat	Fall migration	T29	54, NW	442466	4804493	Complete
101012-2	Hoary bat	10/10/2012	Bat	Fall migration	T29	49, NW	442475	4804495	Complete
101012-3	Silver-haired bat	10/10/2012	Bat	Fall migration	T20	41, NE	440779	4805501	Complete
101112-1	Unknown myotis	10/11/2012	Bat	Fall migration	T10	65, NE	439550	4807820	Bones
101112-2	Silver-haired bat	10/11/2012	Bat	Fall migration	T9	25, NE	439240	4808001	Complete
050713-1	Silver-haired bat	5/7/2013	Bat	Spring migration	T22	44, NE	439793	4804027	Complete
073013-1	Hoary bat	7/30/2013	Bat	Breeding season	T10	48, NE	439518	4807820	Complete
081313-1	Unknown myotis	8/13/2013	Bat	Breeding season	T5	19, NE	437883	4808817	Complete
081313-2	Silver-haired bat	8/13/2013	Bat	Breeding season	T5	20, NE	437893	4808812	Complete
081313-3	Hoary bat	8/13/2013	Bat	Breeding season	T6	14, NW	438152	4808734	Complete
081413-1	Hoary bat	8/14/2013	Bat	Breeding season	T22	17, NW	439772	4803985	Complete
081513-1	Hoary bat	8/15/2013	Bat	Breeding season	T10	51, NW	439462	4807805	Complete
081513-2	Hoary bat	8/15/2013	Bat	Breeding season	T9	57, NE	439269	4808016	Complete
081513-3	Hoary bat	8/15/2013	Bat	Breeding season	T9	34, NW	439189	4808011	Complete
082613-1	Hoary bat	8/26/2013	Bat	Fall migration	T22	48, NE	439804	4804029	Complete
082713-4	Unknown vesper bat	8/27/2013	Bat	Fall migration	T5	52, NE	437919	4808829	Parts/Dismembered
082713-2	Hoary bat	8/27/2013	Bat	Fall migration	T31	11, SW	443323	4804509	Complete
082713-3	Silver-haired bat	8/27/2013	Bat	Fall migration	T10	22, NW	439482	4807781	Complete
082713-1	Silver-haired bat	8/27/2013	Bat	Fall migration	T27	51, NW	441451	4803689	Complete
091213-3	Silver-haired bat	9/12/2013	Bat	Fall migration	T9	28, NE	439240	4808006	Parts/Dismembered
091213-2	Silver-haired bat	9/12/2013	Bat	Fall migration	T10	10, NW	439500	4807784	Complete
091213-1	Hoary bat	9/12/2013	Bat	Fall migration	T16	27, NW	439760	4806081	Complete
Bat Species, Incidentals, Year 1**									
082913-1-I	Silver-haired bat	8/29/2013	Bat	Fall migration	T18	68, NW	440233	4805840	Complete

Table B1. Avian and Bat Fatalities at the Horse Butte Wind Facility, Years 1–3 of Operation

ID*	Species	Date Found	Carcass Type	Season	Plot	Distance (m), Orientation from Turbine Mast	UTM_X‡	UTM_Y‡	Carcass Condition§
Bat Species, Found During Formal Carcass Searches, Year 2									
092513-1	Hoary bat	9/25/2013	Bat	Fall migration	T31	29, SW	443313	4804494	Complete
100413-1	Silver-haired bat	10/4/2013	Bat	Fall migration	T22	34, SE	439823	4803981	Complete
100813-1	Silver-haired bat	10/8/2013	Bat	Fall migration	T22	50, NE	439821	4804023	Complete
101613-1	Silver-haired bat	10/16/2013	Bat	Fall migration	T31	27, NW	443313	4804543	Complete
101713-2	Silver-haired bat	10/17/2013	Bat	Fall migration	T5	45, NE	437886	4808843	Complete
101713-3	Silver-haired bat	10/17/2013	Bat	Fall migration	T10	41, NW	439464	4807788	Parts/Dismembered
101713-4	Silver-haired bat	10/17/2013	Bat	Fall migration	T10	56, SW	439451	4807754	Complete
102213-1	Silver-haired bat	10/22/2013	Bat	Fall migration	T5	28, NE	437889	4808825	Complete
102313-1	Silver-haired bat	10/23/2013	Bat	Fall migration	T10	16, SE	437894	4808797	Complete
062614-1	Hoary bat	6/26/2014	Bat	Breeding season	T20	42, SW	440724	4805438	Complete
070814-1	Hoary bat	7/8/2014	Bat	Breeding season	T6	22, SW	438138	4808712	Complete
070814-2	Hoary bat	7/8/2014	Bat	Breeding season	T9	22, NW	439195	4807994	Complete
072114-2	Hoary bat	7/21/2014	Bat	Breeding season	T10	6, SW	439500	4807769	Complete
080414-1	Hoary bat	8/4/2014	Bat	Breeding season	T20	40, NW	440722	4805501	Complete
090314-1	Unidentified bat	9/3/2014	Bat	Fall migration	T9	Not recorded	Not recorded		Parts/Dismembered
091014-1	Unidentified bat	9/10/2014	Bat	Fall migration	T10	50, SW	439491	4807726	Complete
091514-1	Hoary bat	9/15/2014	Bat	Fall migration	T9	17, NW	439203	4808000	Complete
Bat Species, Found During Formal Carcass Searches, Year 3									
100214-2	Hoary bat	10/2/2014	Bat	Fall migration	T10	10, NE	439504	4807784	Complete
101514-1	Big brown bat	10/15/2014	Bat	Fall migration	T27	39, NW	441437	4803654	Complete
101614-2	Hoary bat	10/16/2014	Bat	Fall migration	T10	31, NE	439535	4807777	Complete
043015-1	Silver-haired bat	4/30/2015	Bat	Spring migration	T27	53, NE	441496	4803693	Complete
070515-1	Silver-haired bat	7/5/2015	Bat	Breeding season	T20	45, NE	440778	4805506	Complete
071915-1	Hoary bat	7/19/2015	Bat	Breeding season	T31	7, NE	443328	4804527	Complete
071915-3	Hoary bat	7/19/2015	Bat	Breeding season	T20	46, NE	440779	4805507	Complete

Table B1. Avian and Bat Fatalities at the Horse Butte Wind Facility, Years 1–3 of Operation

ID*	Species	Date Found	Carcass Type	Season	Plot	Distance (m), Orientation from Turbine Mast	UTM_X‡	UTM_Y‡	Carcass Condition§
080115-3	Western small-footed myotis	8/1/2015	Bat	Breeding season	T5	35, NW	437875	4808834	Complete
080215-1	Hoary bat	8/2/2015	Bat	Breeding season	T31	18, NW	443316	4804534	Complete
082315-2	Silver-haired bat	8/23/2015	Bat	Fall migration	T31	24, NW	443314	4804540	Complete
082315-3	Silver-haired bat	8/23/2015	Bat	Fall migration	T31	7, NW	443324	4804526	Complete
091515-1	Hoary bat	9/15/2015	Bat	Fall migration	T31	54, SE	443379	4804505	Complete
Bat Species, Incidentals, Year 3**									
071915-2-I	Hoary bat	7/19/2015	Bat	Breeding season	T24	12, NE	440329	4803973	Complete

* USFWS Incident Report ID

‡ UTM locations in NAD 83 Zone 12. X = Easting, Y = Northing

§ Feather piles were defined as 10 or more total feathers or 2 or more primaries.

** Fatality event was excluded from the adjusted fatality estimate analysis because it was found during the first survey and the estimated date since death was >14 days or it was an incidental find.

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APPENDIX C

Adjusted Fatality Estimates Compared to Other Studies

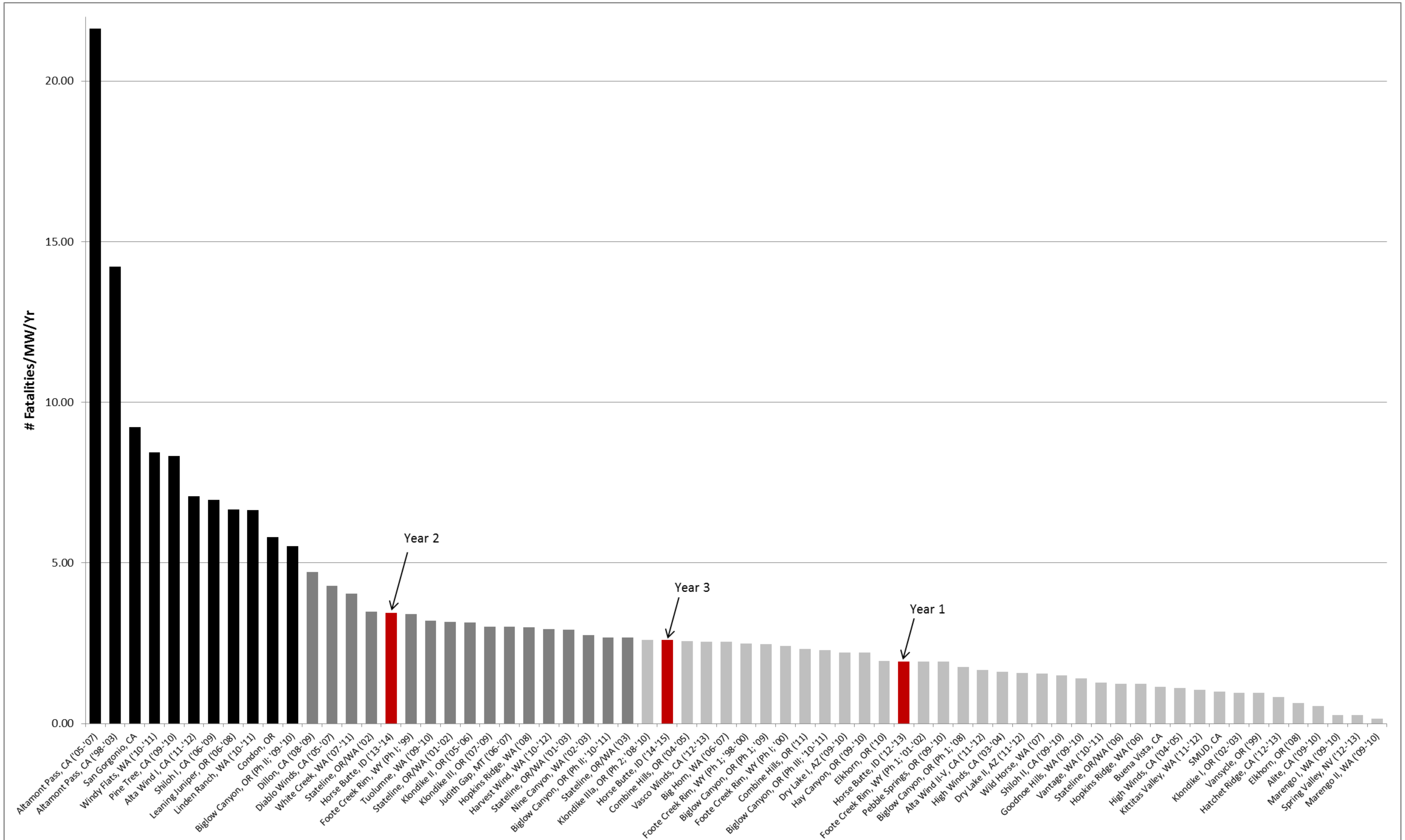

Figure C1. Summary of adjusted bird fatality rates at various western U.S. wind energy facilities. Adapted and updated from NWCC (2010). Additional reports used for this figure include BioResource Consultants (2010), Brown et al. (2013), Chatfield et al. (2009), Derby et al. (2007), Erickson et al. (2003, 2005, 2008, 2014), Gritski et al. (2011), Jain et al. (2009), Jeffrey et al. (2009), Johnson and Erickson (2008), Johnson, Erickson, White, et al. (2003), Smallwood and Karas (2009), Tetra Tech (2012, 2013), Thompson et al. (2011), TRC (2008), Western Ecosystems Technology, llc. (WEST; 2014), and Young et al. (2001). Low, moderate, and high levels have been depicted arbitrarily in the figure, but based on current knowledge of fatality rates throughout the U.S.: from light gray (low) to black (high).

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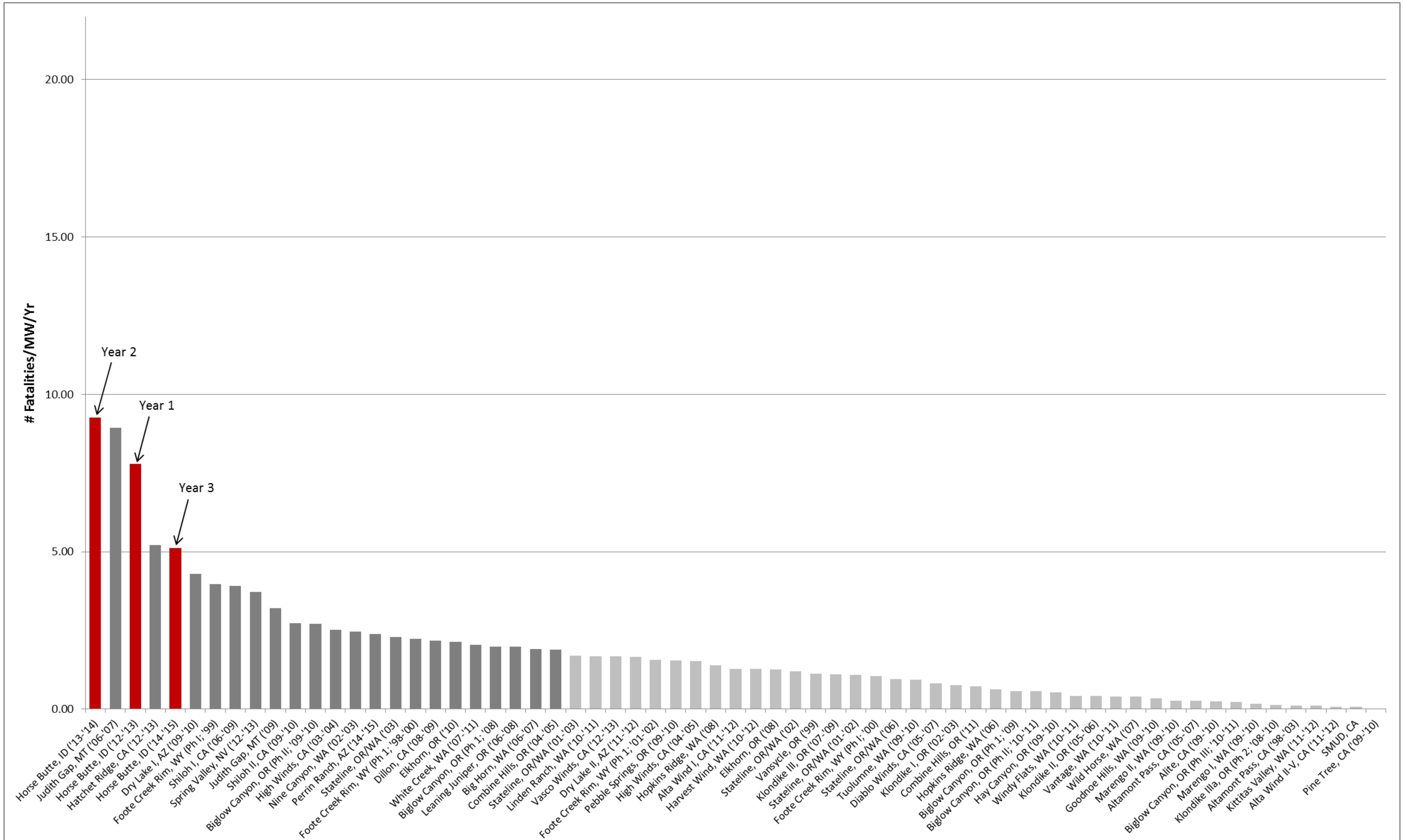

Figure C2. Summary of adjusted bat fatality rates at various western U.S. wind energy facilities. Adapted and updated from NWCC (2010). Additional reports used for this figure include BioResource Consultants (2010), Brown et al. (2013), Chatfield et al. (2009, 2010), Erickson et al. (2003, 2005, 2008), Good et al. (2012), Gritski et al. (2011), Jeffrey et al. (2009), Johnson, Erickson, White, et al. (2003), Poulton (2010), Smallwood and Karas (2009), Tetra Tech (2013), Thompson et al. (2011), TRC (2008), WEST (2014), and Young et al. (2001). Low, moderate, and high levels have been arbitrarily in the figure, but based on current knowledge of fatality rates throughout the U.S.: from light gray (low) to dark gray (moderate).

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