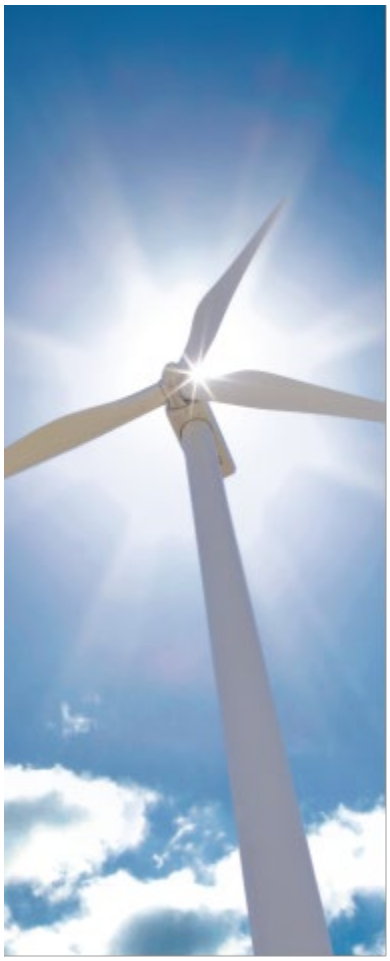
Dunlap Wind Energy Facility

Eagle Conservation Plan

PacifiCorp



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FINAL

June 2020

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1.0 Introduction

PacifiCorp applies the principles in its RESPECT policy to guide the company's corporate commitment to the environment (Appendix A). That commitment is reflected in this Eagle Conservation Plan (ECP) for the Dunlap Wind Energy Project (the "Project" or "Site") located in Carbon County, Wyoming.

Wind energy is one of the fastest growing sources of renewable energy in the United States, and is generally viewed as an environmentally friendly alternative to nuclear and fossil fuel power plants (American Wind Energy Association [AWEA] 2008, National Research Council [NRC] 2007). Development of wind energy is strongly endorsed by the Secretary of the Interior and is one of the Department of Interior's highest priorities (US Fish and Wildlife Service [USFWS] 2003b, Bureau of Land Management [BLM] 2013). Energy from wind-powered generation resources serves an important role in meeting PacifiCorp's loads, which includes Wyoming consumers. In addition, wind energy enables PacifiCorp to meet its renewable portfolio standards, and applicable federal Green House Gas goals and objectives.

PacifiCorp has developed this ECP to meet the recommendations from the USFWS to obtain an incidental take permit for bald and golden eagles and to support the National Environmental Protection Act (NEPA) process at the Project. Additionally, PacifiCorp is required to apply for an eagle take permit under the Project's Migratory Bird Compliance Plan (see section 1.1). The ECP provides detailed information on siting, configuration, construction, and operation for the Project. Actions taken that promote minimization of eagle take are highlighted with the goal of minimizing eagle take to the maximum extent practicable. The ECP supports an application for an incidental take permit for bald and golden eagles and commits to mitigation that meets the statutory preservation standard for golden and bald eagles.

The 2013 USFWS Eagle Conservation Plan Guidance, Version 2 (ECPG, 2013b) provides guidance for conserving bald and golden eagles during siting, construction, and operations of wind energy facilities through a staged approach similar to the tiered approach in the 2012 USFWS Land-based Wind Energy Guidelines (WEG, 2012). Additionally, in 2013 the USFWS Region 6 released a regional guidance memo "Final Outline and Components of an Eagle Conservation Plan (ECP) for Wind Development Recommendations from USFWS Region 6" (Reg. 6 ECPG). Both the USFWS ECPG and the Reg. 6 ECP Guidance were followed in developing the Project ECP. The ECPG emphasizes the importance of implementing avoidance and minimization measures throughout all phases of wind energy development and operations. The ECPG has been developed to assist project developers and operators in complying with regulatory requirements and avoiding incidental take of eagles at wind energy facilities, while also providing guidance to inform the collection of biological data needed to support permit applications for facilities that may pose a risk to eagles.

The Dunlap Project is an operational facility; therefore, the ECP format and information varies slightly from standard guidance provided by U.S. Fish and Wildlife Service (USFWS) and

specifically USFWS – Region 6. In an effort to follow the Reg. 6 ECP Guidance, this ECP presents only pre-construction information in Section 4 – Initial site assessment (ECPG Stage 1), Section 5 – Site-specific survey and assessments (ECPG Stage 2), Section 6 – Avoidance and minimization of risk in project siting, and Section 7 – Predicting eagle fatalities (ECPG Stage 3). Post-construction information is presented in Section 9 – Calibration and updating of the fatality predictions and continued risk assessment. Additionally, the compensatory mitigation and adaptive management sections have been removed from Section 8 (as directed in the Reg. 6 ECP Guidance) and moved to Section 9 after the calibration and updating fatality predictions information is presented. We believe this outline presents information to the reader in a more clear approach, with discussion on mitigation and adaptive management occurring after all current Project information is presented.

1.1 Migratory Bird Compliance Plan

PacifiCorp entered into a plea agreement with the Department of Justice and USFWS in December 2014. As part of the plea agreement, a Migratory Bird Compliance Plan (MBCP) was developed to provide a collaborative framework for PacifiCorp's implementation of measures that will ensure compliance with the requirements of the Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act during the term of the MBCP. A brief summary of the actions required under the MBCP that relate specifically to eagles are provided below:

- Develop protocols for post-construction monitoring and conduct USFWS approved mortality monitoring
- Develop protocols for eagle nest surveys and conduct USFWS approved nest surveys
- Apply for a Special Use – Utility (SPUT) permit and adhere to required reporting standards
- Implement a carrion removal program
- Develop and submit an ECP
- Conduct compensatory mitigation measure for eagle mortalities

The implemented actions are discussed in more detail throughout this ECP. It is understood that the MBCP requirements will remain in effect until an eagle take permit has been issued or termination of the non-prosecution period set forth in the plea agreement.

1.2 Project Background

PacifiCorp's initial evaluation for the Project included a Dunlap Phase 1 and Dunlap Phase 2 (Figure 1 and 2). Only Phase 1 was constructed and is requested for coverage under an eagle take permit. PacifiCorp does not currently have a schedule for the development and construction of Dunlap Phase 2. Due to the 2-phased baseline evaluation, many of the defined survey areas, reported results, maps, turbine layouts, and subsequent evaluations occurred and are presented in this ECP at the 2-phased scale. Efforts have been made in this ECP to clearly identify what data are associated specifically with Dunlap Phase 1. All post-construction information is presented only for Dunlap Phase 1. It should be assumed by the reader that any reference to "Project" or "Dunlap" only refers to Dunlap Phase 1, unless specifically noted.

Evaluation of the Project (Dunlap Phase 1 and 2) for potential wind energy projects began in early 2008 and pre-construction wildlife surveys began on June 4, 2008, and continued to May 27, 2009

(Johnson et al. 2009). These data were used to inform the prediction of eagle fatalities and risk. Three years of standardized post-construction monitoring were completed from 2011 – 2014 (Martinson et al. 2012, 2013 and 2014). Ongoing monitoring occurred from 2014 through the present. Other studies (described below) completed after the Project became operational include eagle nest surveys, prey habitat mapping, eagle attractant, and use assessments. These data were used to update the fatality predictions and continue the risk assessment.

This ECP identifies and describes conservation measures and actions that will be implemented to minimize current and future impacts to eagles at the Project. Technical reports are provided in the Appendices to this ECP for all studies completed and data collected to date.

1.3 Purpose of the ECP

In accordance with the ECPG (USFWS 2013b) this ECP provides information in support of an application for an eagle take permit for the Project. The ECP will assess the risk of the Project to eagles; document eagle specific survey and monitoring work and results, both pre- and post-construction; document avoidance and minimization measures implemented pre- and post-construction; and discuss the Project's adaptive management plan.

The ECP is written to reflect the Project's development history and operations. The ECP is organized to follow the Reg. 6 ECP Guidance as closely as possible, however, the organization is influenced by the availability of data to inform the decision making process. The Project's design phase did pre-date the issuance of the *Eagle Conservation Plan Guidance* (ECPG) and the *U.S. Fish and Wildlife Service Land-based Wind Energy Guidelines* (WEG; USFWS 2012, 2013b; *see* Sections 2.1.3 and 2.1.4 *for more details*). This document reflects recommendations and comments from the Project's Technical Advisory Committee (TAC; Appendix B) and the USFWS. The TAC first met in May 2011, 6 months after the project had become operational. The TAC membership included PacifiCorp, Western EcoSystems Technology, Inc. (WEST), Wyoming Game and Fish Department (WGFD), and USFWS. In addition, this ECP reflects PacifiCorp's commitment to implement an adaptive management program that includes minimization measures, monitoring, experimental advanced conservation practices, and compensatory mitigation. The adaptive management program is designed to support the objective of "no net loss" of golden eagles within the Eagle Management Units (EMU) associated with the Project, so that it is consistent with USFWS's goal of maintaining stable or increasing breeding populations of eagles.

1.4 ECP Term

The ECP will cover the term of any potential eagle take permit PacifiCorp receives. PacifiCorp has and will continue to update this ECP in coordination with the USFWS through an adaptive management program (*see* Sections 8.0). Should operation continue beyond the expected life of the Project, this ECP will be reviewed, updated, and remain in effect until Project decommission.

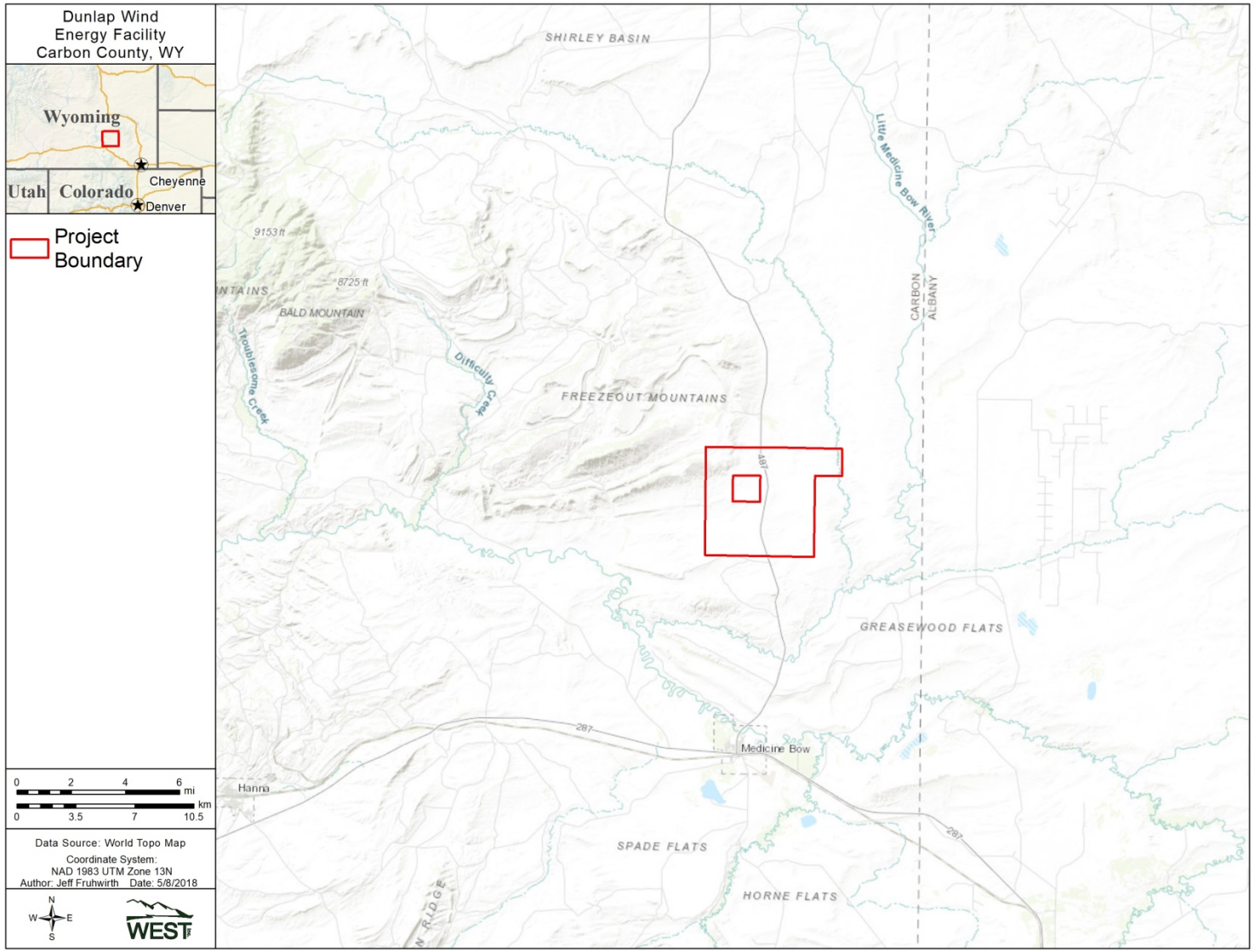

Figure 1. Location of the Dunlap Wind Energy Facility, Carbon County, Wyoming. The Project boundary shown is representative of the constructed wind project.

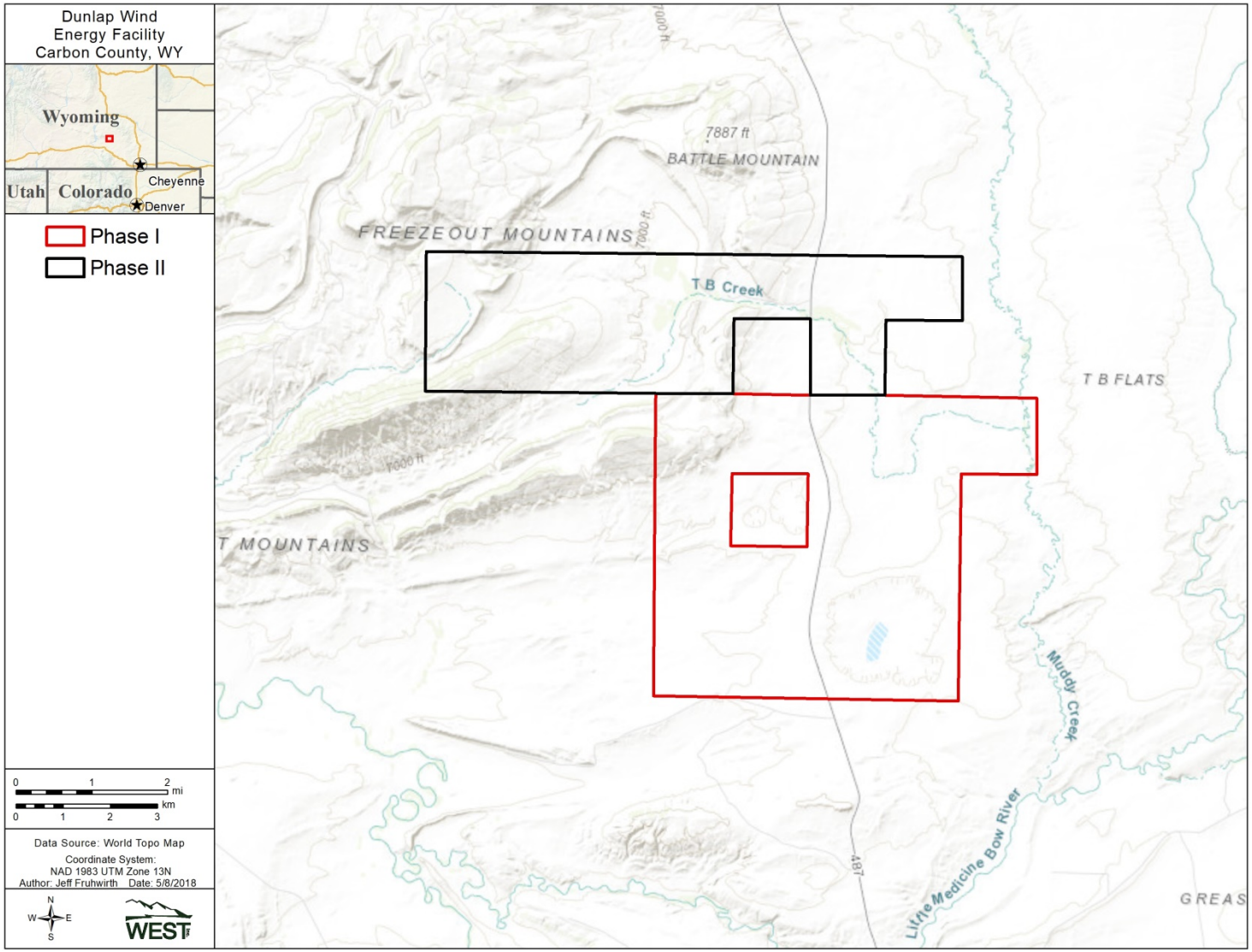

Figure 2. Location of the Dunlap Phase 1 and Phase 2 boundaries, Carbon County, Wyoming. Phase 2 was evaluated as part of the baseline survey effort. Phase 1 is representative of the constructed project.

2.0 Regulatory Framework

This section describes the regulations and guidelines relevant to this ECP.

2.1 Migratory Bird Treaty Act

The Migratory Bird Treaty Act (MBTA; 1918) is the cornerstone of migratory bird conservation and protection in the United States. The MBTA implements four treaties that provide for international protection of migratory birds. The MBTA states, "Unless and except as permitted by regulations… it shall be unlawful at any time, by any means, or in any manner to pursue, hunt, take, capture, kill… possess, offer for sale, sell …purchase … ship, export, import …transport or cause to be transported… any migratory bird, any part, nest, or eggs of any such bird ….[The Act] prohibits the taking, killing, possession, transportation, import and export of migratory birds, their eggs, parts, and nests, except when specifically authorized by the Department of the Interior."16 U.S.C. 703. The word "take" is defined by regulation as "to pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to pursue, hunt, shoot, wound, kill, trap, capture, or collect." 50 CFR 10.12. The Service maintains a list of all species protected by the MBTA at 50 CFR 10.13. This list includes over one thousand species of migratory birds, including eagles and other raptors, waterfowl, shorebirds, seabirds, wading birds, and passerines.

2.2 Bald and Golden Eagle Protection Act

The Bald and Golden Eagle Protection Act (BGEPA; 1940) (16 USC §§ 668-668d) prohibits the take of bald (*Haliaeetus leucocephalus*) and golden eagles (*Aquila chrysaetos*), unless authorized by federal regulation. The BGEPA defines "take" of an eagle to include a broad range of actions, including to pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, destroy, molest, or disturb. The term "disturb" in regulations found at 50 CFR § 22.3 means "to agitate or bother a bald or golden eagle 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."

In 2009, the Service promulgated a final rule on two new permit regulations that specifically authorize under BGEPA the non-purposeful (i.e., incidental) take of eagles and eagle nests in certain situations. See 50 CFR 22.26 & 22.27. The permits authorize limited take of bald and golden eagles; authorizing individuals, companies, government agencies and other organizations to disturb or otherwise take eagles in the course of conducting lawful activities. To facilitate issuance of eagle take permits for wind energy facilities the Service finalized the ECPG. If eagles are identified as a potential risk at a project site, developers are strongly encouraged to follow the ECPG. The ECPG describes specific actions that are recommended to achieve compliance with the regulatory requirements in BGEPA for an eagle take permit, as described in 50 CFR 22.26 and 22.27. The ECPG provides a national framework for assessing and mitigating risk specific to eagles through development of ECPs. In December 2016, the USFWS published notice of a final rule revising its eagle permitting regulations and extended the maximum permit duration to 30

years. In communication with USFWS, PacifiCorp intends to develop this ECP to avoid and minimize to the maximum extent practicable and to support an incidental take permit application.

2.3 USFWS Land-Based Wind Energy Guidelines

In 2003, the USFWS published the *Interim Voluntary Guidelines to Avoid and Minimize Wildlife Impacts from Wind Turbines* (2003a Guidelines).[1] The 2003 guidelines encouraged the "wind energy industry to follow these guidelines and, in cooperation with the Service, to conduct scientific research to provide additional information on the impacts of wind energy development on wildlife." In 2004, USFWS issued *Instructions for Implementation of Service Voluntary Interim Guidelines to Avoid and Minimize Wildlife Impacts from Wind Turbines* (2004 Instructions).

In 2012 USFWS issued the WEG (USFWS 2012). The WEG replaced the 2003 Guidelines.[2] The WEG set out a voluntary and collaborative approach to implement a structured, scientific process for addressing wildlife conservation concerns at all stages of land-based wind energy development. Further the WEG provided a "tiered approach" to assess the "potential adverse effects to species of concern and their habitats." The tiered approach is an iterative decision-making process for collecting information in increasing detail; quantifying the possible risks of proposed wind energy projects to species of concern and their habitats; and evaluating those risks to make siting, construction, and operation decisions. The WEG also provide Best Management Practices (BMPs) for site development, construction, retrofitting, repowering, and decommissioning.

To avoid, minimize, and mitigate impacts to eagles under the MBTA and BGEPA, PacifiCorp is implementing measures described in this ECP document. The specific measures to minimize impacts to eagles are discussed in greater detail in Sections 6.0 and 8.0, additional experimental advanced conservation practices and compensatory mitigation measures are discussed in greater detail in Section 8.0.

2.4 Eagle Conservation Plan Guidance

Originally issued in draft form in January 2011, the ECPG provides a roadmap to wind energy developers and operators for obtaining programmatic eagle take permits in accordance with the Eagle Permit Rule.[3] The ECPG also supplements the WEG.[4] Whereas the WEG provided a broad overview of wildlife considerations at wind energy facilities, the ECPG provides guidance specifically related to bald and golden eagles.

[1] 68 Fed. Reg. 41175 (July 10, 2003).
[2] *See* 77 Fed. Reg. 17496 (March 26, 2012).
[3] 50 CFR. § 22.26.
[4] 77 Fed. Reg. 17496 (March 26, 2012).

The ECPG clarifies the relationship between the tiers of the WEG and the stages of the ECPG process. Because the ECPG stages do not align precisely with the WEG tiers, the new guidance details which ECPG stages occur within each tier.[5] This alignment is illustrated in the table[6] below:

Table 1. Comparison between the USFWS WEG and ECPG step-wise approaches.

Land-based Wind Energy Guideline Tiers		Eagle Conservation Plan Guidance Stages	
Tier 1	Preliminary evaluation or screening of potential sites	Stage 1	Site assessment
Tier 2	Site characterization	Stage 2	Site-specific surveys and assessments
Tier 3	Site characterization	Stage 3	Predicting eagle fatalities
Tier 4	Post-construction surveys to estimate impacts	Stage 4	Avoidance and minimization of risk using ACP's and compensatory mitigation
Tier 5	Other post-construction studies and research	Stage 5	Calibration and updating of the fatality prediction and continued risk-assessment

The conservation practices outlined in the ECPG are intended to offset the short- and long-term negative effects of wind energy facilities on eagle populations.[7] Those practices will also benefit other avian species, and in particular, raptor species. The USFWS recommends "an adaptive management framework predicated, in part, on the precautionary approach for consideration and issuance of programmatic eagle take permits."[8]

Adaptive management techniques "consist of case-specific considerations applied within a national framework" that may include "operational adjustments at individual projects at regular intervals where deemed necessary and appropriate."[9] Ultimately, "[i]mplementation of the final ECP must reduce predicted eagle take, and the population level effect of that take, to a degree compatible with regulatory standards to justify issuance of a programmatic take permit . . . ."[10] Compatibility with regulatory standards means maintaining a stable or an increasing breeding eagle population.

Although the ECPG applies generally to all wind energy facilities with risk of eagle take, the guidance primarily addresses developers and operators in the initial stages of facility siting and development. For wind facilities already operating, the guidance may apply somewhat differently. The ECPG states that "[f]or projects already in the development or operational phase, implementation of all stages of the recommended approach in the ECPG may not be applicable or possible."[11]

[5] ECPG at vii.
[6] ECPG at 18.
[7] ECPG at 4-5.
[8] *Id.* at 9.
[9] *Id*.
[10] *Id*. (emphasis added).
[11] *Id*. at iii.

This ECP was developed in accordance with the ECPG. This ECP also relies on the Reg. 6 ECP Guidance, which provides recommendations about the content and organization of an ECP, and requests supplemental information related to avoidance and minimization measures.

2.5 National Environmental Protection Act

The National Environmental Policy Act (NEPA) [42 U.S.C. 4321 et seq.] establishes national environmental policy and goals for the protection, maintenance, and enhancement of the environment and provides a process for implementing these goals within the federal agencies. The Act requires federal agencies to incorporate environmental considerations in their planning and decision-making through a systematic interdisciplinary approach. All federal agencies are required to prepare detailed statements assessing the environmental impact of and alternatives to major federal actions significantly affecting the environment. Issuance of an eagle take permit by the USFWS constitutes a federal action and thus requires an assessment of the potential environmental impacts associated with the action and alternatives under NEPA. As a result, the USFWS must complete a NEPA analysis before it makes a decision about whether or not to issue an eagle permit.

2.6 Endangered Species Act

The ESA directs the USFWS to identify and protect endangered and threatened species and their critical habitat, and to provide a means to conserve their ecosystems. Among its other provisions, the ESA requires the USFWS to assess civil and criminal penalties for violations of the Act or its regulations. Section 9 of the ESA prohibits take of federally-listed species. Take is defined as “harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct” 16 U.S.C. 1532. The term “harm” includes significant habitat alteration which kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering, 50 CFR 17.3. Projects involving Federal lands, funding or authorizations will require consultation between the Federal agency and the USFWS, pursuant to section 7 of the ESA. Projects without a Federal nexus should work directly with USFWS to avoid adversely impacting listed species and their critical habitats.

2.7 State and Federal Permit Requirements

A Section 109 Permit application was submitted to the Wyoming Industrial Siting Council (WISC) in June 2009. The Industrial Siting Application (ISA), which is part of the state permitting process, addressed a variety of environmental aspects of the Project, including air quality, noise, soil resources/geologic hazards, cultural resources, vegetation resources, surface and groundwater resources, land use/recreation, recreational resources, wetlands/waters of the US, visual/scenic resources, and wildlife resources, including avian resources, bats, and federally listed wildlife species.

As part of the preparation for the WISC permit process, PacifiCorp met with several state, federal, and local agencies, including the Wyoming Department of Environmental Quality (WDEQ) on April

29 and May 15, 2009; the WGFD on April 24 and May 8, 2008, as well as March 13, April 30, and May 22, 2009; and the USFWS office on May 8, 2008, and June 12, 2009. The purpose of these meetings was to provide an overview of the Project and the ISA process, discuss baseline data collected, address any issues and concerns (including pre- and post-construction monitoring), and answer questions. To provide the local public an opportunity to comment on the Project, a public open house was held in Medicine Bow on June 8, 2009. A number of town council meetings also were held in June 2009 in Rock River, Rawlins, Laramie, and Sinclair. Other state and county agency meetings were held in May and June 2009 in the City of Cheyenne and in Carbon and Albany Counties. The public was invited to all state and local agency meetings as well. The Section 109 Permit was approved in September 2009 after a public hearing on August 28, 2009.

In addition to the Section 109 permit, PacifiCorp completed an application for a Certificate of Public Convenience and Necessity to construct the Project. This application was submitted to the Wyoming Public Service Commission on July 24, 2009 and approved.

No other federal, state, or local permits were require or applied for as part of the Project development.

3.0 Project Description

The Project is located on a combination of privately owned fee and State of Wyoming Lands in Township 23 and Ranges 78 and 79 West. PacifiCorp is the landowner of 14,024 acres of private fee lands within the Phase 1 and 2 boundaries (Figures 1 and 2). The Phase 1 boundary encompasses approximately 10,347 acres. A private entity owns 640 acres of private fee land within the Project area. The Project also includes 640 acres of State of Wyoming lands. PacifiCorp has completed the Special Use Lease process with the Wyoming Office of State Lands and Investments and holds a 35-year lease agreement for those State lands.

Project construction began in September 2009 and all Project turbines were completed and commissioned by October 1, 2010. The Project became commercially operational in October 2010 and is currently in operation. The Project will be repowered in 2020 (proposed completion date is October 31, 2020) and continue standard operation.

3.1 Environmental Setting

The Project is located on 10,374 acres of land in Carbon County, Wyoming, approximately eight miles north of Medicine Bow, Wyoming (Figure 1). Wyoming State Highway 487 bisects the Project area. The northwestern boundary of the Project area abuts the Freezeout Mountains and the northeast boundary transitions to the area commonly known as Shirley Basin. At a local-scale, the Project area falls within the drainage system of Muddy Creek and its tributaries, which are tributaries to the Medicine Bow River. Muddy Creek flows along the eastern border of the Project area and TB Creek snakes in and out of the northeast Project area.

The Project occurs in the US Army Corps of Engineers (USACE) designated Arid West Region within the sub-region characterized as Interior Deserts (LRR D; USACE 2008) with elevations

ranging from 2,034-2,293 meters (m; 6,673 – 7,523 feet [ft]; Figure 3). This sub-region is broken into two distinct parts: the “hot desert” and the “cold desert.” The Project area lies within the “cold desert” portion. The area is characterized by arid grasslands and shrublands supporting bunchgrasses and sagebrush, interrupted by high hills and low mountains. The annual average precipitation in the area is less than 12 inches (in). Winter Pacific frontal storms associated with low-pressure systems are an increasingly important source of moisture for this region as storms move from south to north (USACE 2008).

During the initial Project evaluation (Phase 1 and 2) in 2009, the land use/land cover (LULC) was defined and mapped as presented in Johnson et. al 2009. The LULC data was updated for the ECP based on the final Project layout (Figure 4; Table 2). Scrub/shrub (big sagebrush) and herbaceous (grasslands) communities are the most common land cover types in the Project area (Table 2). Most of the infrastructure is sited in grassland, sagebrush, or greasewood communities.

Table 2. The land cover types, coverage, and composition within the Dunlap Project Area, Carbon County, Wyoming.

Habitat	Acres	% Composition
Developed, Open Space	100.5	1.0
Developed, Low Intensity	6.7	0.1
Barren Land	21.6	0.2
Shrub/Scrub	6,979.6	67.5
Herbaceous	3,233.6	31.3
Emergent Herbaceous Wetlands	5.3	0.1
Total	**10,347.3**	**100**

Data from the US Geological Survey National Landcover Database (2011).

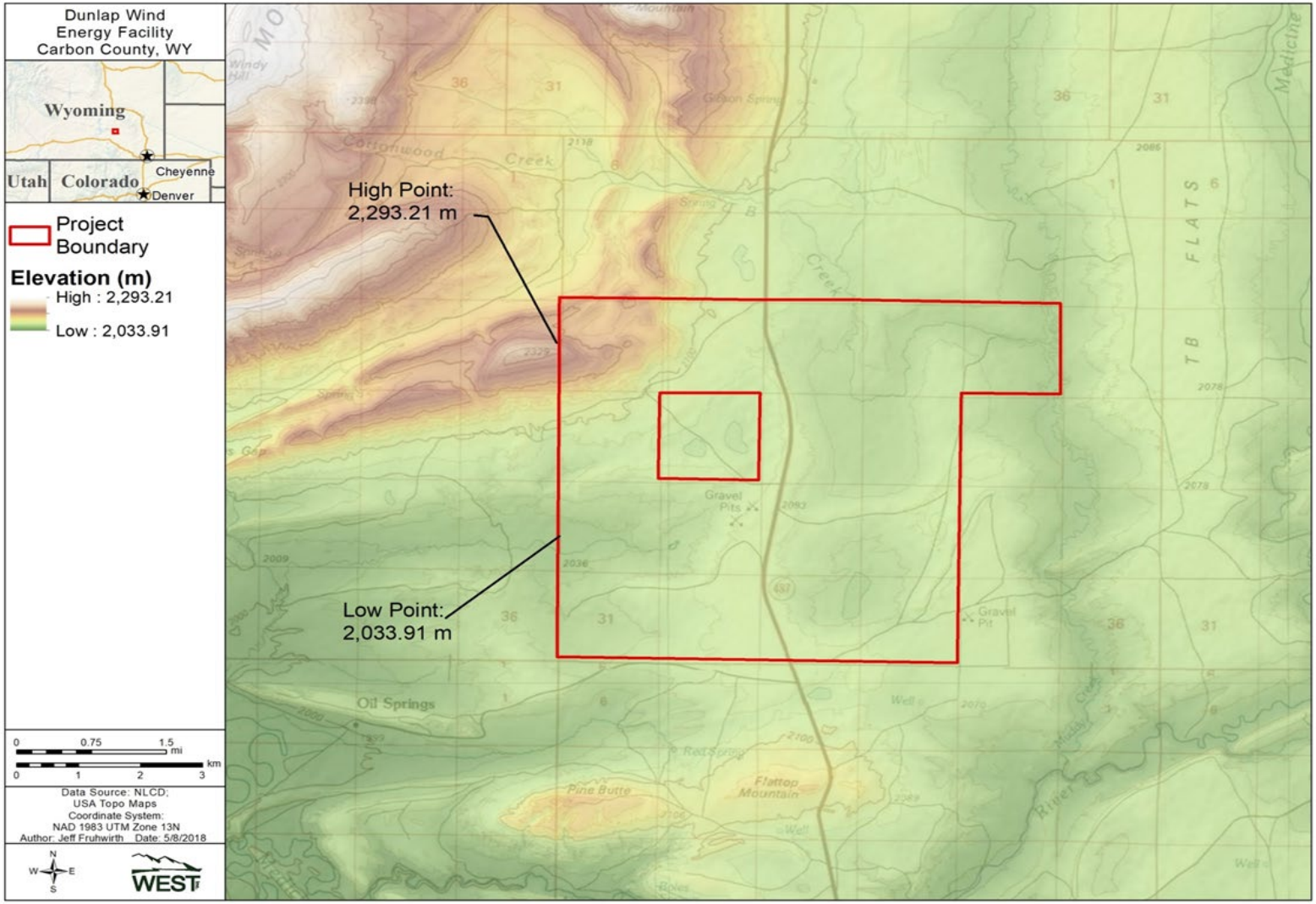

Figure 3. Dunlap Wind Energy Facility, Carbon County, Wyoming – Elevation across the constructed Project. High and low points within the Project boundary are identified.

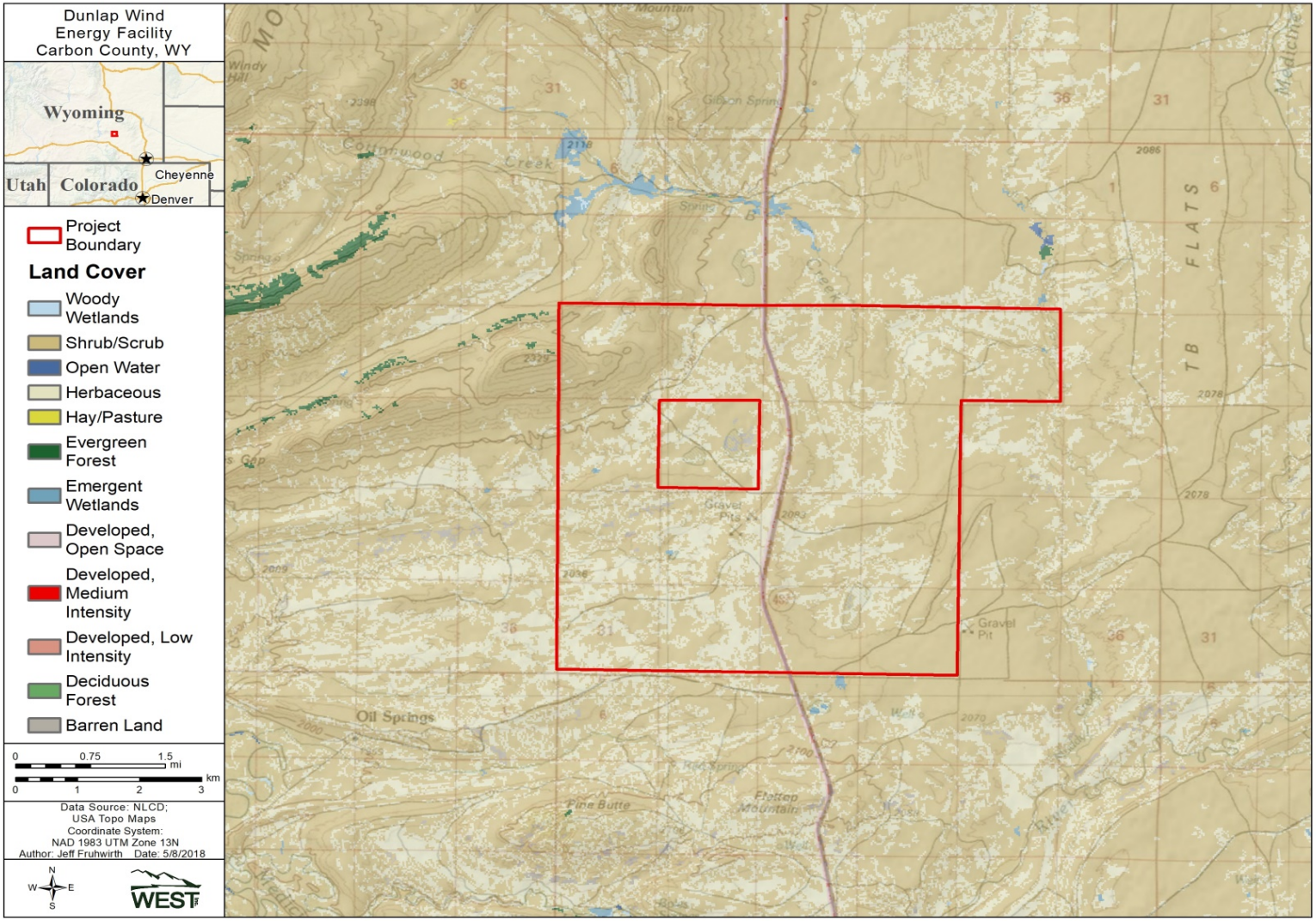

Figure 4. Dunlap Wind Energy Facility, Carbon County, Wyoming – Land Use Land Cover for the constructed Project boundary.

3.2 Project Infrastructure

The Project consists of 74 turbines with a capacity of 111 MW (Figure 5). The GE 1.5-MW turbines have a rotor diameter of 253 ft and the wind turbines are situated on 262-ft tall steel tubular towers secured to concrete foundations. An 11-mile transmission line interconnects the Project with PacifiCorp's Miners to Difficulty transmission line. These lines were built along PacifiCorp- and State of Wyoming-owned property. In addition to the turbines and interconnection line, the Project includes a variety of access roads, crane pads, a laydown area, batch plant, communication/collection systems, substation, operation and maintenance building, transmission lines, and metrological towers. Full descriptions for Project infrastructure are provided below and temporary and permanent impacts are quantified in Table 3.

The Project will be repowered in 2020 and will upgrade the turbine rotors, blades, and nacelles. No towers, foundations, maintenance pads, on-site substations, collector lines, or operation and maintenance buildings will be modified. Each repowered turbine will have a 298.6 ft rotor diameter and 413.4 ft turbine height. Repowered turbines will have a 1.85 MW capacity for total Project nameplate capacity at 136.9 MW.

Table 3. Estimated temporary and permanent acres of impact associated with the Dunlap Wind Energy Project, Carbon County, Wyoming.

Project Feature	Temporary Habitat Acres Impacted	Permanent Habitat Acres Impacted
Wind Turbine Generators and Crane Pads	56.6	17.4
Access Roads (onsite and transmission line associated)	131.8	49.5
Transmission Line	-	<1
Collection Lines	163.6	-
Laydown Area and Batch Plant	10.0	-
O&M Building	2.0	1.0
Substations and Interconnection station	5.0	3.0
Metrological towers	<1	<1
TOTAL	**369.2**	**71.0**

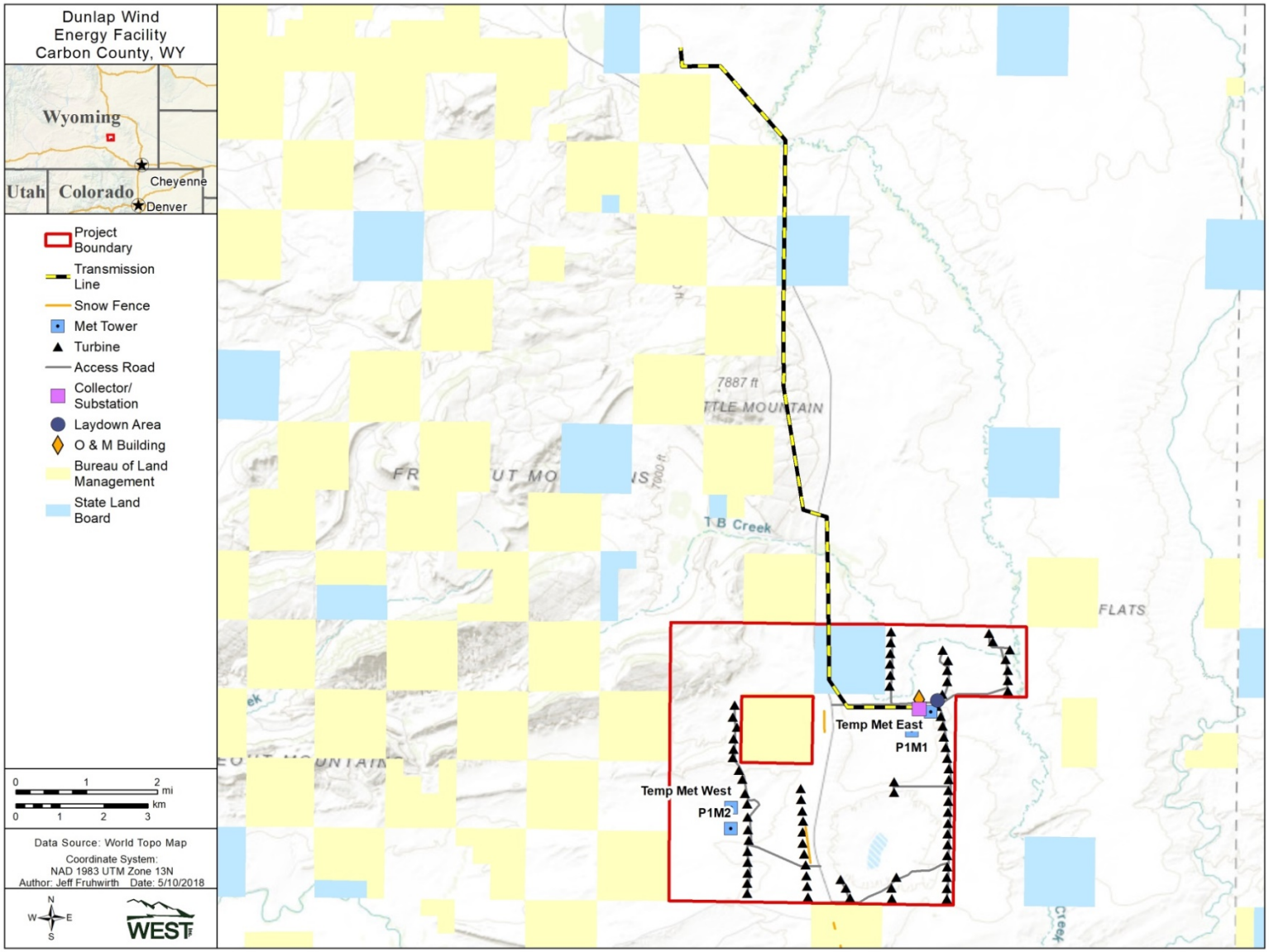

Figure 5. Dunlap Wind Energy Facility, Carbon County, Wyoming – Infrastructure layout.

3.2.1 *Access Roads and Crane Pads*

Access roads were designed to turbine vendor standards and specifications (i.e., 24 foot wide construction roads and six inch minimum gravel depth standards and sited to minimize disturbances, maximize transportation efficiency, and avoid sensitive resources and unsuitable topography to the extent practicable. Existing roads were used whenever possible, though some existing roads were temporarily widened up to a total width of 32 ft to accommodate delivery of wind turbine generator (WTG) equipment. After construction, these private roads were narrowed to 8 to 12 ft wide for operations. Approximately 5.5 miles of existing roads were improved.

Approximately 17 miles of new gravel roads were constructed in areas where existing roads did not provide access to WTG locations and along the length of turbine strings. New roads were typically up to 24 ft wide, and an additional shoulder (up to 32-ft width) was temporarily disturbed during construction. Roads were designed under the direction of a licensed engineer and compacted to meet equipment loading and hauling requirements. In addition, a temporary 11-mile road connecting the collector and interconnect substations was built for access during the construction process.

In conjunction with the access road construction, crane pads were established at each WTG location to provide enough space for a large crane to install the tower sections, nacelle, blades, and other components. The crane pad also provides access to the area for maintenance, if necessary. An approximate 40-ft-by-60-ft crane pad was maintained after construction, in addition to a 100-ft diameter access pad for maintenance procedures.

3.2.2 *Laydown Area and Batch Plant*

An approximately 10-acre laydown area was used during Project construction, which included a 2-acre batch plant within the laydown area. The laydown area was used to stage construction components and store construction supplies and equipment. The laydown area experienced temporary surface disturbance that entailed stripping and stockpiling of both topsoil and subsoil. The area of temporary disturbance was restored and reseeded to pre-construction conditions upon completion of construction.

3.2.3 *Communications and Collection System*

Generated electricity moves through an underground collection system to the Project collector substations. Both power and communication cables were buried in trenches approximately 3-4 ft below the ground surface.

An estimated 27 miles of underground collection system wiring was installed for the 74-turbine Project. The linear disturbance area was approximately 50-ft wide and resulted in approximately 164 acres of temporary ground disturbance through burying lines. No above ground collection lines were constructed for the Project. Only areas that required clearing to construct the lines were impacted and cleared areas were revegetated.

3.2.4 *Substations and O&M Facility*

The Project collector substation is owned by PacifiCorp and operated in accordance with prudent industry practices, such as maintaining a secured facility, installation of avian guarding equipment, and requiring appropriate Personal Protection Equipment at all times. The substation is similar to those used in the region in design (i.e., minimizing snow collection and utilizing avian guarding equipment) and maintenance frequencies. The substation occupies an area of approximately 1.5 acres, and the substation site is surrounded by a graveled, fenced area with transformer and switching equipment and space to park vehicles. The total cleared area associated with construction of the substation site was approximately five acres.

The 5,500-square foot O&M facility, which contains all necessary plumbing and electrical connections needed for typical operation of offices and a maintenance shop, is also located at the Project. The O&M facility, including the facility and parking area, encompasses approximately one acre. Approximately two acres were temporarily impacted during the construction phase. Utilities such as electric service, water service, telephone service, as well as access to a septic system, are required at the Project.

3.2.5 *Transmission Line*

An 11-mile overhead 230-kV transmission line associated with the Project was constructed between December 2009 and March 2010. The line interconnects the Project with PacifiCorp's Miners to Difficulty transmission line at the Shirley Basin switching station. The transmission line was constructed across private fee lands and State of Wyoming lands, and did not cross BLM-managed federal lands. The line traverses approximately nine miles north of the Project and parallel to WYO 487.

The line incorporates features suggested by the Avian Power Line Interaction Committee (APLIC 2006 and APLIC 2012) to minimize collision and electrocution-related avian mortalities.

3.2.6 *Meteorological Towers*

Four guyed meteorological (MET) towers were constructed for the Project. However, two of these structures were temporary and were removed at the end of October 2011, during the first year of post-construction mortality monitoring. The Project currently has two permanent lattice, guyed MET towers that are marked with bird flight diverters. Each MET tower resulted in approximately 0.02 acres of ground disturbance.

3.2.7 *Post-Construction Grading, Erosion Control, and Project Clean-up*

Once construction of the Project was completed, all disturbed areas were graded to their approximate original contour, and areas disturbed during construction were stabilized and reclaimed using erosion control measures, including site-specific contouring, reseeding, or other measures (i.e., hydro-seeding, rock check-dams, straw waddles). Areas were reseeded with native vegetation mixes supplied by construction contractor and included Kentucky bluegrass, spike wheatgrass, and slender wheatgrass. The erosion control measures were implemented in compliance with the Project's construction Storm Water Pollution Prevention Plan (SWPPP).

Areas that were disturbed around each turbine during construction were reverted to the original land use after construction except for a 100 ft diameter maintenance access pad and associated 40 ft by 60 ft crane pad.

3.2.8 *Operations, Maintenance, Decommissioning, and Restoration*

PacifiCorp will perform project O&M for the life of the Project, which is anticipated to be 30 years from the commission date. PacifiCorp and its O&M contractor will control, monitor, operate, and maintain the Project by means of the Supervisory Control and Data Acquisitions (SCADA) system, and regularly scheduled on-site inspections will be conducted.

Maintenance activities typically occur within areas previously disturbed by construction. Abnormal activities may include the need to disturb areas to facilitate crane access. Turbine maintenance is typically performed up-tower, and O&M personnel perform maintenance within the tower or nacelle and access the towers using pick-up trucks.

Each turbine has an associated maintenance pad for activity requiring a heavy operating crane. However, as each turbine has an associated maintenance pad for activity requiring a heavy operating crane, the need for additional disturbance to facilitate crane access is unlikely. No significant construction is required to utilize the crane pads and disturbance is kept to a minimum during maintenance activities.

PacifiCorp will meet or exceed current APLIC standards in the event that any utility poles or power lines are built or retrofitted at the Site for ownership by PacifiCorp. However, third parties provide some electrical service to some PacifiCorp sites, including Dunlap, and as such, own and operate their own utility poles. High Plains Power provides power to the Dunlap Project and PacifiCorp does not own or maintain the lines required to provide power to the Project.

Large scale noxious weed management is performed by a licensed herbicide and pesticide applicator on all turbine pads, roads, substations, and O&M facility infrastructure during the spring and fall, or on an as needed basis. Application amounts and products vary by season, weather conditions, site properties, and target vegetation type and density. Products used at the site may include Krovar, Method 240 SL, Piper, Ranger Pro, Perspective and Esplanade.

Throughout the Project's life, PacifiCorp expects to explore alternatives for decommissioning and/or repowering the Project. At the present time, PacifiCorp is in the process of repowering the Project, and this effort is scheduled to be completed by October 31, 2020. The repower includes upgrading the turbine's nacelles and rotors with new nacelles and rotors that will have a rotor diameter of up to 298.6 ft and an overall height of up to 413.4 ft. Only the turbine rotors, blade, and nacelle (with associated gearbox/generator components) would be upgraded. PacifiCorp is not evaluating modifications to existing ancillary facilities and support structures, such as turbine tower sections, tower foundations, maintenance pads, on-site substations, collector lines, and operations and maintenance buildings. PacifiCorp will continue to engage the USFWS throughout the repower process.

If the Project terminates operations in the future, PacifiCorp would obtain the necessary authorization from the appropriate regulatory agencies to decommission the facilities. Generally, wind energy projects that are decommissioned contain a high “scrap value” due to the materials and equipment contained in the infrastructure (steel infrastructure, electric generators, and copper).

In general, the decommissioning of the Project may result in burial of foundations below an allowed depth, and any unsalvageable material would be disposed of at authorized sites. The soil surface would be restored as close as reasonably possible to its original contour. The Project substations may remain in place post-decommissioning, if required to be utilized for other purposes. If the buried/overhead power lines could not be used by PacifiCorp for other utility purposes, all structures, conductors, and cables would be removed unless otherwise allowed to remain in place.

Demolition or removal of equipment and facilities will meet applicable environmental and health regulations. Additionally, PacifiCorp may salvage economically recoverable materials or recycle Project materials for future uses.

4.0 Initial Site Assessment (ECPG Stage 1)

The Project was designed and developed prior to the issuance of the 2009 Eagle Permit Rule. The Project was constructed and became operational during and immediately after this rule was issued and prior to the release of the WEG (USFWS 2012), ECPG (USFW 2013b), and Final Eagle Rule (USFWS 2016). Due to this timing, this ECP document focuses primarily on the operational phase of the Project.

To support the initial site assessment, PacifiCorp initiated communication with the USFWS in 2008 (Appendix C). As referenced in a May 15, 2008 letter from USFWS, a meeting with PacifiCorp and the USFWS occurred on May 7, 2008 to discuss the Project and potential environmental concerns. The letter identified concern for bald and golden eagles and recommended continued communication with state and federal agencies during the Project development process. All available agency correspondences are provided in Appendix C.

Based on identified environmental concerns, PacifiCorp coordinated site-specific surveys to further assess the Project. Surveys included gathering publically available data on habitat and species presence (specifically greater sage grouse, big game, and eagles), conducting eagle use surveys, and nest surveys.

5.0 Site-specific Surveys and Assessments (ECPG Stage 2)

Information in this section addresses recommendations under Stage 2 of the ECPG (baseline surveys). Site-specific surveys were conducted based on communication with state and federal agencies. The ECPG (USFWS 2013b) was not published prior to initiating site-specific surveys; therefore, the survey methods described below did not meet the survey standards recommended

in the ECPG (USFWS 2013b) and Final Eagle Rule (USFWS 2016). This includes eagle use surveys and nest surveys.

The differences between the actual surveys conducted for the Project and the current USFWS data standards are as follows:

- All point count surveys conducted were all bird surveys (i.e., Avian use) not eagle specific surveys,
- Avian use surveys did not meet the 30% coverage of the minimum convex polygon,
- Survey points were selected using systematic random sample instead of a randomized method,
- Surveys were conducted for 20 min in duration as opposed to 60-min duration,
- Eagle flight data was not collected on a per minute basis,
- Surveys were not conducted for at least once a month for two full years,
- Surveys recorded all birds including both small and large birds instead of only recording eagle and large birds,
- Eagle nest surveys did not include a 10-mile Project buffer
- Data were not collected to specifically assess nest occupation and productivity,
- Surveys were not conducted via helicopters and/or did not included extended four hour ground observations at nests, and
- The number of seasonal nest surveys did not meet current USFWS recommendations in Region 6 which includes up to six nest surveys.

The eagle use standards recommended by the USFWS are required to inform the USFWS Collision Risk Model. As such, application of the baseline eagle data from the Project to the USFWS Collision Risk Model should be cognizant of potential biases (Section 7.0). The methods and results presented below represent the eagle use data collected during avian use surveys at the Project (Phase 1 and 2) and are provided to inform baseline conditions and risk assessments.

Because this is an operational Project, the baseline data are presented in this section to illustrate the available information that was used to inform the risk assessment during Project development, consistent with the ECPG; however, Section 9.0 below includes data from multiple years of post-construction monitoring, and these data are used to inform discussions on actual Project risk and future take predictions.

5.1 Pre-Construction Avian Use Surveys

During the spring, summer, fall, and winter of 2008 and 2009, pre-construction avian studies were conducted that included fixed-point avian use surveys, nest surveys, and prey base surveys (Johnson et al. 2009) to assess potential Project impacts. A summary is provided below to describe the eagle use data collected during the avian use-surveys conducted from June 4, 2008 through May 27, 2009 and the nest surveys conducted in spring 2009. The full technical report is provided in Appendix D.

5.1.1 *Avian Use Surveys*

5.1.1.1 Methods

Fixed point surveys were conducted using methods described by Reynolds et al. (1980). Ten 800-m radius points were selected to survey representative habitats and topography of the study area (Figure 6). The study area included both the Phase 1 and Phase 2 Project areas. The 10 800-m plots provided coverage of 22.9% of the area within one km of constructed turbines. All species of birds observed during surveys were recorded, and large bird flight paths were mapped. Surveys were conducted approximately weekly during the spring migration and early breeding season (March 16 to May 31, 2009; 103 surveys) and fall migration (September 1 to November 15, 2008; 110 surveys), and every two weeks during summer (June 1 to August 31, 2008; 69 surveys) and winter (November 16, 2008, to March 15, 2009; 58 surveys). Point count duration was 20 minutes (e.g., Hoover and Morrison 2005, Smallwood et al. 2009, Strickland et al. 2011). This resulted in approximately 34.33 total hours of survey effort in the spring, 36.67 in the fall, 23 in summer, and 19.33 total hours of survey in winter for a total of 113.33 total hours of survey effort. Surveys were conducted during daylight hours and survey periods were varied to approximately cover all daylight hours during a season. To the extent practical, each point was surveyed about the same number of times; however, the schedule varied in response to adverse weather conditions (e.g., fog and/or rain), which caused delays and/or missed surveys.

Locations of eagles were recorded on field maps by observation number. Flight paths and perched locations were digitized using ArcGIS. Approximate flight height and direction were recorded.

5.1.1.2 Results

A total of 340 20-min fixed point surveys were conducted. There were a total of 179 golden eagle observations in 145 groups and two observations of individual bald eagles (Figure 7). Golden eagles comprised approximately 8.8% of all observations. Golden eagles had the highest overall use of all raptor species observed in all seasons: summer 0.31, fall 0.25, winter 0.33, and spring 0.21 birds/800-m plot/20-min survey. At a spatial scale, Point 2 had the highest recorded eagle use (0.66 eagles/800- plot/20-min survey), followed by Points 6, 8, and 9 (0.36, 0.36, and 0.44, respectively). Point 2 is outside of the Phase 1 boundary. Detailed descriptions of all golden eagle observations are available in Table 4 and flight paths and perch locations are provided in Figure 7.

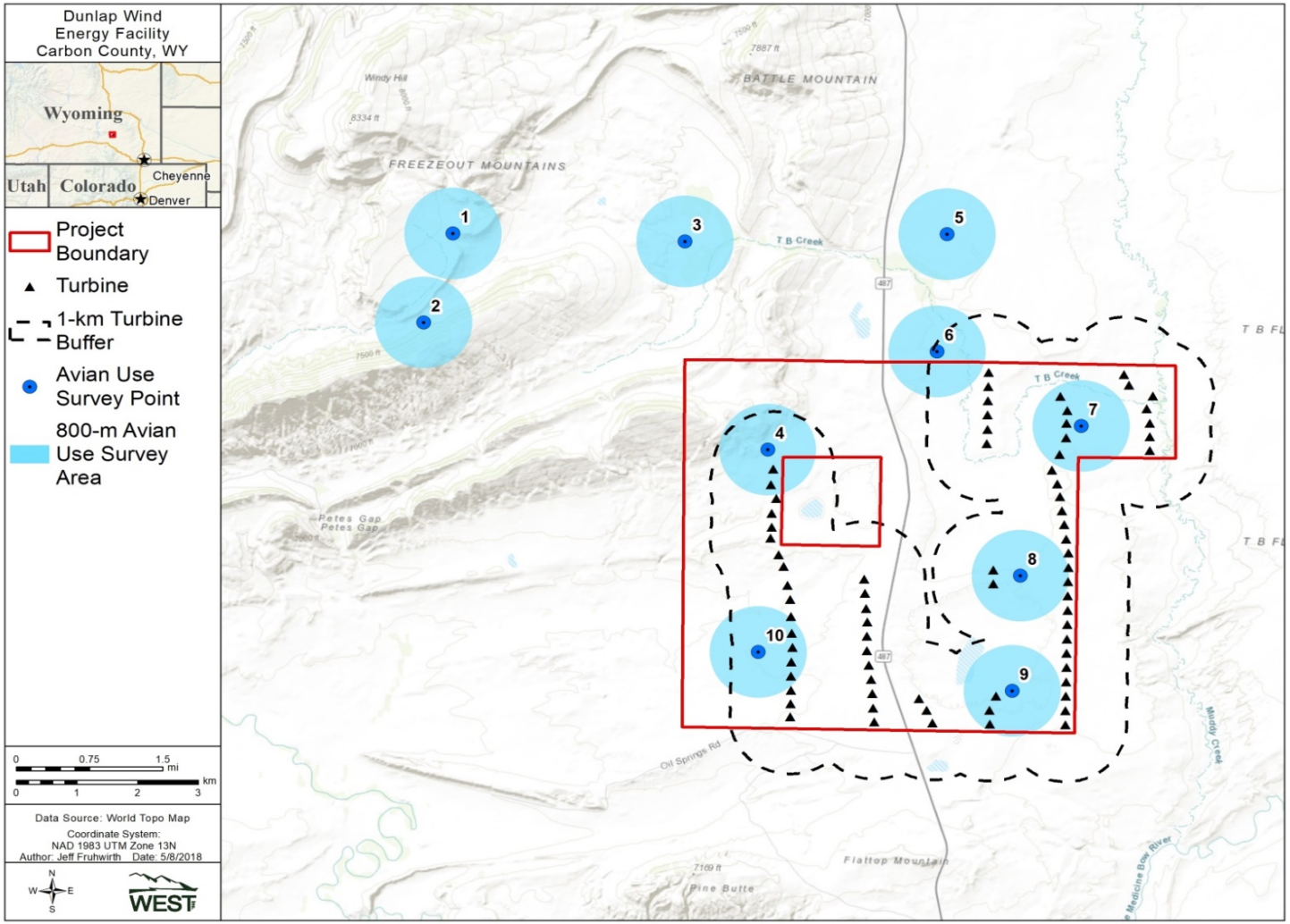

Figure 6. Fixed-point avian-use survey points at the Dunlap Project surveyed during Phase 1 and 2 evaluations. Figure includes a 1-km buffer from constructed turbines, the Project boundary (Phase 1 only), and turbine locations. These features are provided to illustrate the areas surveyed in comparisons to the final Project layout.

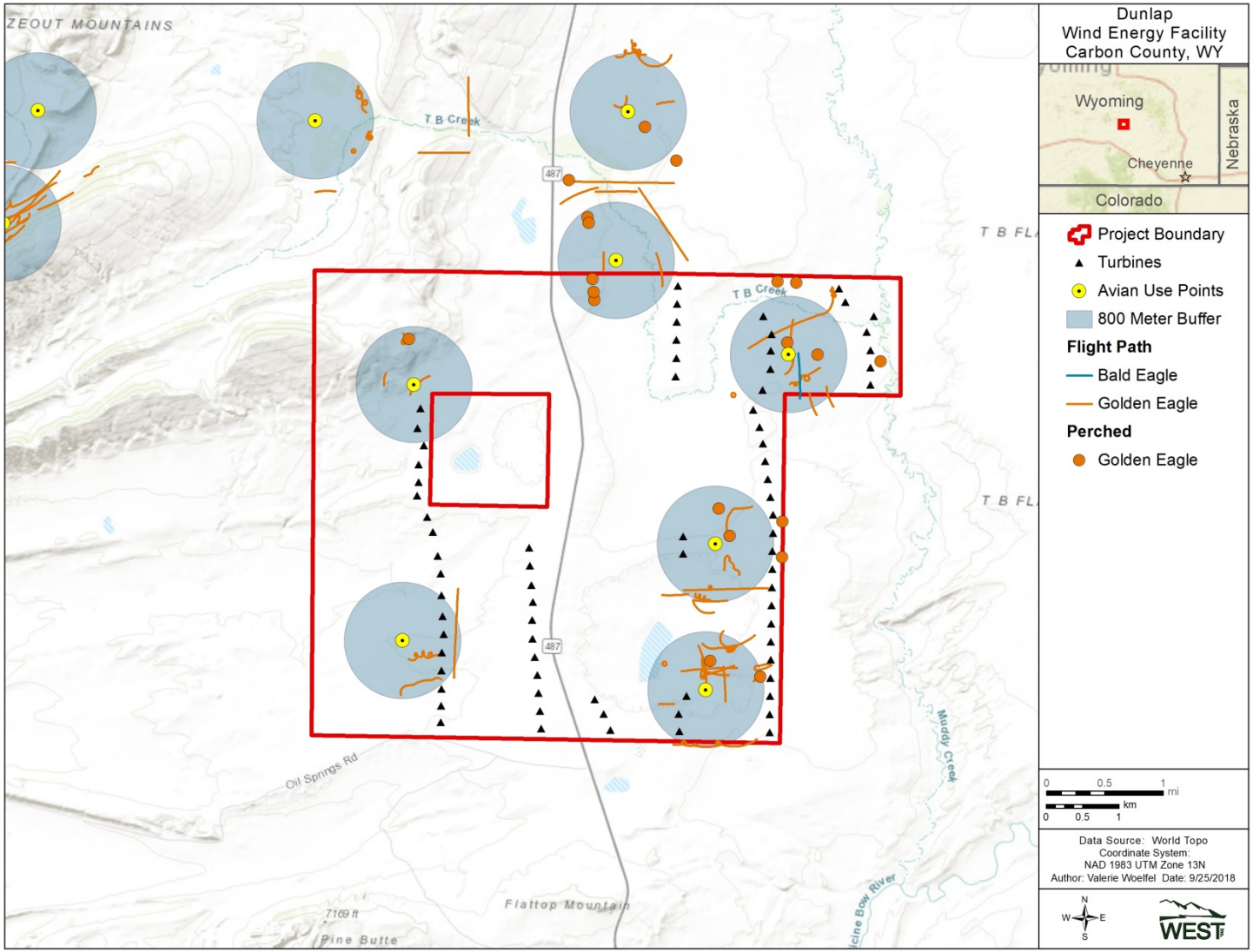

Figure 7. Bald and golden eagle flight paths and perch locations collected during the avian use surveys at the Dunlap Project. Only flight paths associated with survey points in the Project area were included in the CRM (Points 4, 6, 7, 8, 9, 10). Other flight paths/perch points are provided to illustrate the use area in comparisons to the final Project layout.

Table 4. Details of bald and golden eagle observations collected during the 2008/2009 avian use surveys at the Dunlap Phase 1 and 2 Project area, Carbon County, Wyoming. Note: Stations 1, 2, 3, and 5 are beyond the current Project boundary and as such were not included in the CRM discussed in Section 7.

Date	Station	# of Individuals	Age	First Activity*	Initial Flight Height (meters)	Initial Distance from Observer (meters)	Closest Distance from Observer (meters)
Bald Eagle							
4/18/2009	7	1	ADULT	FL	1	200	
5/3/2009	2	1	ADULT	GL	80	350	
Golden Eagle							
6/4/2008	3	1		SO	75	600	
6/4/2008	3	1		SO	75	700	
6/4/2008	8	3		OT		800	
6/30/2008	6	2		PE		600	
7/16/2008	8	1		FL	1	200	
7/16/2008	6	1		PE		450	
7/16/2008	1	1		SO	30	1000	
7/16/2008	3	1		GL	20	1000	
7/28/2008	8	1		SO	60	50	
7/28/2008	6	2		PE		700	
8/13/2008	5	1	MIXED	PE		175	
8/13/2008	2	5	MIXED	GL		400	300
8/13/2008	4	1		FL	20	1000	
8/13/2008	1	2		SO	20	1000	
8/13/2008	6	1		GL	60	1000	
8/13/2008	9	1		FL	5	1500	
8/27/2008	2	1	SUBADULT	GL	80	400	100
8/27/2008	2	2		SO	30	1000	800
9/3/2008	8	1		PE		900	
9/3/2008	1	1		PE		1000	
9/3/2008	2	1		FL	10	1000	800
9/3/2008	2	2		SO	20	1000	
9/3/2008	9	1		SO	20	3000	
9/7/2008	9	1		GL	125	0	
9/7/2008	2	1		GL	20	800	
9/7/2008	5	1		PE		900	
9/7/2008	5	1		SO	50	1000	
9/7/2008	7	2		PE		1000	
9/7/2008	8	1		SO	40	1000	
9/7/2008	9	1	SUBADULT	SO	20	1000	800

Table 4 (*continued*). Details of bald and golden eagle observations during the 2008/2009 eagle use surveys at the Dunlap Phase 1 and 2 Project area, Carbon County, Wyoming. Note: Stations 1, 2, 3, and 5 are beyond the current Project boundary.

Date	Station	# of Individuals	Age	First Activity*	Initial Flight Height (meters)	Initial Distance from Observer (meters)	Closest Distance from Observer (meters)
9/7/2008	9	2		SO	125	1000	
9/7/2008	1	7		FL		6000	2000
9/17/2008	7	1		GL	100	700	
9/17/2008	9	1	ADULT	FL	12	750	
9/17/2008	5	1		FL	10	1000	
9/17/2008	7	1		FL	12	1000	
9/24/2008	7	1		PE		100	
9/24/2008	6	1		PE		500	
9/24/2008	2	1		GL	20	500	
9/24/2008	6	1		PE		800	
9/24/2008	5	1		PE		900	
9/24/2008	6	2		PE		1000	
9/24/2008	7	1		SO	80	1000	
9/24/2008	9	1	ADULT	SO	12	1000	800
9/24/2008	9	1		SO	40	1000	
9/24/2008	9	1		SO		2000	
9/30/2008	10	1	ADULT	FL	10	300	
9/30/2008	6	2		PE		700	
9/30/2008	2	3		GL		800	100
9/30/2008	7	1		FL	3	1000	
9/30/2008	3	4		SO		1000	
9/30/2008	3	1		FL	10	1000	
9/30/2008	3	1		FL		1000	
9/30/2008	2	1		SO	60	1000	
9/30/2008	10	1		FL	15	1000	
9/30/2008	10	1		SO	150	1000	
9/30/2008	10	1		SO	75	1000	
9/30/2008	1	1		PE		2000	
10/7/2008	9	1		FL	2	700	
10/7/2008	8	1		HO	10	1000	
10/7/2008	7	1		PE		1000	
10/15/2008	7	1		PE		0	
10/15/2008	2	1		FL	90	400	150
10/15/2008	5	2	MIXED	FL		800	
10/15/2008	9	1		SO	50	1200	
10/15/2008	9	1		SO	30	2000	
10/21/2008	2	1		GL	10	350	
10/21/2008	9	1		FL	1	500	
10/21/2008	7	1		FL	1	850	

Table 4 (*continued*). Details of bald and golden eagle observations during the 2008/2009 eagle use surveys at the Dunlap Phase 1 and 2 Project area, Carbon County, Wyoming. Note: Stations 1, 2, 3, and 5 are beyond the current Project boundary.

Date	Station	# of Individuals	Age	First Activity*	Initial Flight Height (meters)	Initial Distance from Observer (meters)	Closest Distance from Observer (meters)
10/21/2008	8	1		FL	6	900	
10/30/2008	8	1		PE		250	
10/30/2008	4	1		PE		700	
11/10/2008	9	1		PE		300	
11/10/2008	6	1		PE		600	
11/10/2008	8	1		PE		900	
12/9/2008	4	1	ADULT	FL	10	400	400
12/9/2008	4	1	ADULT	FL	6	600	600
12/13/2008	8	1	ADULT	FL	3	200	
12/13/2008	7	1	JUVENILE	FL	5	400	400
12/13/2008	3	2		FL	100	700	
12/13/2008	5	1	ADULT	SO	200	800	800
12/13/2008	3	2		FL	75	800	800
12/13/2008	10	2	ADULT	FL	6	800	600
1/16/2009	9	1		PE		400	400
1/16/2009	9	1		FL		500	250
1/16/2009	9	1		FL	10	800	600
2/7/2009	7	1	ADULT	FL		300	50
2/24/2009	9	1		FL	8	400	300
3/3/2009	9	1	ADULT	FL	15	200	200
3/3/2009	8	1		FL	12	500	250
3/3/2009	9	2		FL	15	700	700
3/19/2009	5	1		FL	5	200	150
3/19/2009	5	1		FL	10	700	650
3/19/2009	4	1		SO	40	1500	
3/19/2009	2	1		FL	20	1500	
3/19/2009	4	1		SO	35	2000	
3/19/2009	6	2	ADULT	FL	15	2500	
3/19/2009	6	1		FL	30	2500	
3/19/2009	1	1		FL	15	2500	
3/19/2009	1	1		SO	100	2500	
3/19/2009	7	1		FL	15	3000	
3/19/2009	3	1		FL	2	3000	
3/19/2009	4	1		SO	75	5000	
3/24/2009	4	1		FL	10	125	50
3/24/2009	6	1		FL	1	900	
3/24/2009	4	1		FL	20	1000	
3/24/2009	7	1		GL	3	1500	
3/24/2009	4	1		SO	75	1500	
3/24/2009	10	1	ADULT	FL	1	2000	

Table 4 (*continued*). Details of bald and golden eagle observations during the 2008/2009 eagle use surveys at the Dunlap Phase 1 and 2 Project area, Carbon County, Wyoming. Note: Stations 1, 2, 3, and 5 are beyond the current Project boundary.

Date	Station	# of Individuals	Age	First Activity*	Initial Flight Height (meters)	Initial Distance from Observer (meters)	Closest Distance from Observer (meters)
3/24/2009	8	1		GL	5	2000	
3/29/2009	6	1		FL	2	500	
3/29/2009	8	1		PE		550	
3/29/2009	9	1		GL	5	1000	
3/29/2009	9	1		SO	5	1000	
3/29/2009	9	1		PE		1250	
4/11/2009	9	1		FL	10	300	
4/11/2009	7	1		FL	100	700	
4/11/2009	8	1		GL	75	800	600
4/11/2009	5	1		PE		1000	
4/11/2009	8	1		SO	60	2000	
4/18/2009	2	1		GL	80	100	0
4/18/2009	7	1		PE		400	
4/18/2009	9	1		HO	10	700	
4/18/2009	10	1	ADULT	GL	75	1000	750
4/21/2009	2	1	ADULT	GL	150	0	
4/21/2009	3	1		SO	125	700	
4/21/2009	7	1		SO	40	1000	
4/21/2009	8	1		FL	15	1000	800
4/21/2009	1	1		GL	5	1500	
4/26/2009	5	2		FL		400	
4/26/2009	6	1		FL	5	1000	
4/26/2009	2	2		GL	10	1000	
4/26/2009	9	1		HO	5	2500	
5/3/2009	8	1		PE		1250	
5/10/2009	8	1	SUBADULT	PE		80	
5/10/2009	3	1		SO	10	1000	
5/10/2009	7	1		PE		1250	
5/10/2009	7	1		FL	15	1250	
5/10/2009	6	1		FL	25	1500	800
5/18/2009	8	1		SO	125	0	
5/27/2009	6	1		FL	50	300	200
5/27/2009	5	1		SO	20	1500	
5/27/2009	1	1		GL	15	2000	
5/27/2009	3	1	ADULT	FL	5	2500	
5/27/2009	5	1		SO	125	3500	

*Activities include perched (PE), soaring (SO), gliding (GL), flapping (FL), hovering (HO), and other (OT).

5.1.2 *Eagle Nest Surveys*

5.1.2.1 Methods

Aerial nest surveys were completed in the spring of 2009 throughout the proposed Project area (Phase 1 and 2) and a surrounding one-mile buffer as well as within a one-mile buffer of the proposed transmission line. To supplement the fixed-wing aerial surveys, comprehensive ground surveys were completed by visually inspecting areas of suitable habitat (e.g., trees, cliffs, rocky outcrops and other potential nest structures). Universal Transverse Mercator (UTM) coordinates, as well as nesting substrate and current status (i.e., inactive, active, incubating, young in nest), were recorded for each nest located.

5.1.2.2 Results

One active golden eagle nest was found during the 2009 raptor nest surveys (Figure 8). The nest had an incubating adult. No follow up surveys were completed to determine nest success or productivity. No other eagle nests were identified during pre-construction surveys.

For additional information on eagles nest surveys and results for the Project please see section 9.4 Nest Surveys.

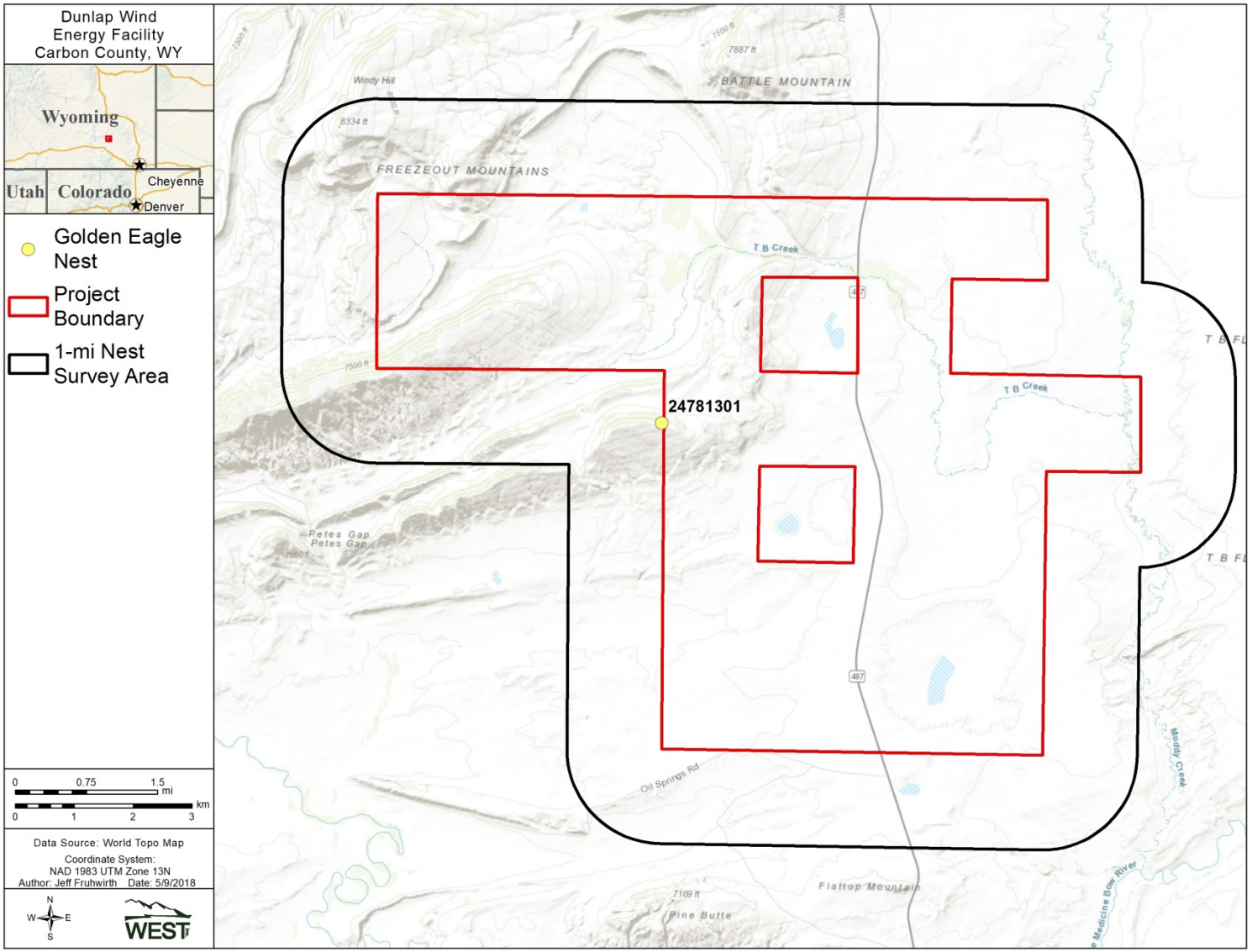

Figure 8. Location of eagle nest found in 2009 at the Dunlap Project and 1-mile buffer from the Phase 1 and Phase 2 boundaries, Carbon County, Wyoming. Nest was identified as active (incubating adult) in 2009.

5.1.3 *Prey Base Assessments*

5.1.3.1 Sage Grouse

Since greater sage-grouse provide a source of prey for eagles, the results of greater sage-grouse surveys are summarized in this section. Sage-grouse lek surveys were competed with an objective of locating leks in the Project area and a 4-mile (6.4-km) buffer of the proposed Project area. This area included the proposed Phase 1 and Phase 2 boundaries (Figure 8). The locations of known historic and existing greater-sage grouse leks in the Project and the 4-mile buffer were obtained from the WGFD. To search for undocumented or new leks, five surveys were conducted for greater sage-grouse in spring 2009, according to the present time WGFD protocols: four ground counts and one aerial survey. The aerial survey was conducted on April 24, 2009, from a fixed-wing aircraft and the four ground counts were conducted at the Project between April 21 and May 10.

Three historic WGFD leks were located within four miles of the survey area, one occupied and two unoccupied (Figure 8). However, no sage-grouse were observed on these three leks during any of the field surveys performed in 2009.

The Wyoming Executive Order (WGFD 2014) did not exist during the initial site assessment stage; however, the Project area is approximately six miles north of the nearest greater sage-grouse core population area (Figure 9). The core areas identify the most important sage grouse habitat in the state and are afforded additional protection under the Executive Order (WGFD 2014).

5.1.3.2 Big Game

Pronghorn may also be considered prey for golden eagles. Range maps for pronghorn were developed as part of the baseline assessments (Johnson et. al 2009). The WGFD data showed crucial winter range across most of the Project area. The far western portion of the Project boundary was not classified as pronghorn range. These data were used to support additional big game evaluations, but were not specifically used to assess eagle risk at the Project. During the pre-construction surveys 4,006 pronghorn and 1,748 elk were observed incidentally (Johnson et al. 2009).

5.1.3.3 Other Prey

Avian point count surveys did document waterfowl and waterbird use in the Project area. Waterfowl are known prey for bald eagles. Waterbird use was limited and did not compose species likely to be predated by eagles (e.g. American white pelicans [*Pelecanus erythrorhyncos*]). Waterfowl use did not appear to be associated with any water features located in the Project area, as most of the waterfowl use occurred in spring in the northeast Project area (Johnson et al. 2009).

No additional prey surveys were conducted prior to construction to specifically evaluate eagle use and associated risk at the Project. In a July 10, 2009 letter from the USFWS Wyoming Field Office, USFWS provided PacifiCorp with the recommendation that wind turbines not be located in or near

prairie dog towns; however, prairie dog surveys were not conducted prior to Project construction. Prairie dog surveys did occur after the Project was constructed (Section 9.0) and mapped active prairie dog colonies scattered across the Project area (Figure 17). Additionally, livestock activities have occurred at the Project during pre-construction and operational periods. These activities included seasonal cattle grazing.

5.2 Bald and Golden Eagles

Both bald and golden eagles are known to occur within the Project area; in particular, golden eagles are present year round and bald eagles are present less frequently. Discussion of habitat and observations about bald and golden eagles in the vicinity of the Project are provided below.

5.2.1 *Bald Eagle*

Three bald eagles were observed on the Project during the 2008-2009 pre-construction avian surveys: two were observed during fixed-point avian use surveys in spring and one was observed incidentally in August (Johnson et al. 2009). Bald eagle nesting habitat (e.g., trees in proximity to large waterbodies) is not present in the Project and foraging habitat is minimal. No communal bald eagle roosts or habitat for such roosts exist in the Project area.

5.2.2 *Golden Eagle*

Golden eagles occur in the Project area, and had the highest use of any raptor species during the pre-construction avian use surveys. One golden eagle nest was identified as active within one mile of the Project boundary during the pre-construction nest survey (Figure 8). The turbine layout was not finalized at the time of the survey; however, based on the final construction locations, the nest was just over one mile from the closest turbine. Suitable golden eagle foraging habitat is available in and surrounding the Project. The Project lies on the edge of the Shirley Basin, where colonial prey species (i.e., prairie dogs) are very abundant and wide spread. Additionally, lagomorphs have been observed in the Project area. No trees exist in the Project, but some artificial perch locations (i.e., power poles, fence posts, etc.) do occur. Other potential nesting habitat exists outside of the Project in the form of cliffs, trees, and man-made structures. No known communal roosts have been identified within the Project area.

5.3 Eagle Risk Categorization

Risk to eagles at the Project was identified based on pre-construction avian use data collection. The avian use survey documented eagle use, specifically golden eagles, in the Project area. Nest surveys documented a golden eagle nest one-mile from the Project. Additional data evaluation identified prey sources in the Project area and perch opportunities. Based on the site-specific surveys, minimization measures were established to reduce the risk to eagles.

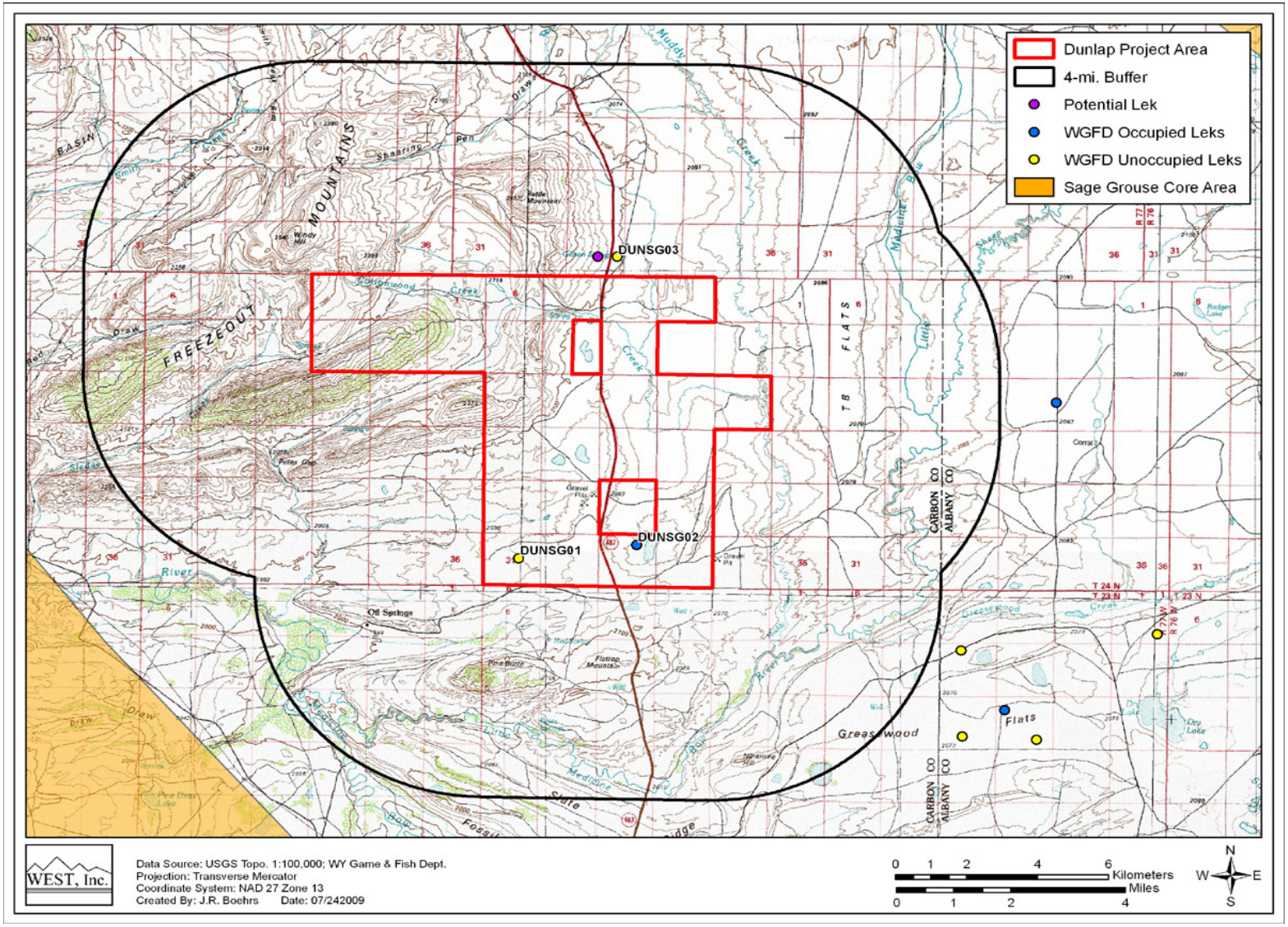

Figure 9. Greater sage-grouse core use habitats and location of greater sage-grouse leks in relation to the Dunlap Project Area (Phase 1 and 2), Carbon County, Wyoming.

6.0 Avoidance and Minimization of Risks in Project Siting (ECPG Stage 4)

In accordance with the Reg. 6 ECP Guidance, this section includes information on avoidance and minimization of risks during project siting and design. Information in this section also addresses recommendations under Stage 4 of the ECPG.

Throughout Project development, PacifiCorp evaluated and adopted conservation measures to avoid and minimize impacts to eagles. These conservation measures were and will be incorporated into the infrastructure layout and design, construction/clean-up, operations, and decommissioning/restoration plans for the Project. This section provides a summary of the conservation measures developed during site selection and Project design. Conservation measures that were implemented during construction, are being implemented during operations, and will be implemented during decommissioning/restoration are included in Section 8.0 below.

6.1 Site Selection and Project Design

- Project siting and design plans were shared and discussed with USFWS and WGFD in meetings on May 7, 2008 and June 12, 2009. These communications were documented in USFWS response letters dated May 15, 2008 and July 10, 2009 (Appendix C).
- Multiple turbine and associated infrastructure alignments were evaluated during the Project siting and design process. Part of the siting and design evaluation included removing turbines in an effort to avoid and minimize Project impacts to eagles. Turbines were also removed from initial layouts due to roadway setbacks, engineering input, and other siting considerations. While these modifications did not specifically target minimization of risk to eagles, the reduction of constructed turbines did result in a risk reduction.
    - An initial *maximum capacity turbine layout* was prepared for the Dunlap 1 and 2 projects that included 243 turbines (Figure 10). Of these, 142 of the turbines were initially sited in Phase 1. This initial layout did not consider wind resources, roadway setbacks, or environmental resources. The Project was ultimately scaled back to 74 turbines (Figure 5) based on a number of factors, including avoidance and minimization to eagles.
- After discussions with USFWS and WGFD, turbine locations were removed and PacifiCorp determined disturbance-free buffers be maintained for the known eagle nest.
    - Figure 11 demonstrates a preliminary Project design that did not include a disturbance-free buffer for an eagle nest. Figure 12 demonstrates the modified turbine layout design that removed 14 turbines from the preliminary Phase 1 Project design to create a disturbance-free eagle nest buffer. PacifiCorp established a one-mile nest buffer to minimize nest disturbance. USFWS acknowledged that PacifiCorp's buffers and turbine siting was in accordance with the general recommendations from USFWS to avoid disturbing raptor nests; however, USFWS also recommended additional evaluations to better understand

eagle movement throughout the site to further inform nest buffers beyond the standard (USFWS letter dated July 10, 2009; Appendix C). PacifiCorp did not conduct the additional pre-construction evaluations beyond what has been presented in this document.

- Turbine siting also evaluated greater sage-grouse habitat and lek locations that represent a concentrated eagle prey source, by buffering active leks and identifying and avoiding areas mapped as containing sagebrush communities.
    - No turbines were constructed in a 0.25-mile disturbance free buffer and a 2-mile buffer was identified as a controlled surface area (Figure 13). Because leks are attractive to eagles, establishing a buffer around leks was intended to reduce potential impacts to eagles in a known concentration area.
    - Twelve turbines identified as Phase 1 - Alternative (Figure 14) were removed from the final Project design (Figure 5). This turbine string was aligned through a moderate density sagebrush community and would likely have resulted in greater risk to eagles.
- In addition, the location of the transmission line was modified to concentrate impacts within an existing transmission line corridor. Figure 12 demonstrates the original transmission line alignment (solid blue line), while Figure 5 shows the final alignment. The transmission line alignment modification was supported by the USFWS in a letter dated July 10, 2009 (Appendix C).
- The Project incorporates state-of-the-art turbine technology, including unguyed, tubular towers and slow-rotating, upwind rotors.
- The Project implemented APLIC (2006) recommendations (e.g. a minimum of 150 centimeters [cm; 60 in] of horizontal separation between energized and/or grounded parts and 100 cm [40 in] of vertical separation and insulation or covering of exposed energized or grounded parts into overhead lines constructed for the Project to minimize electrocution risks to eagles).

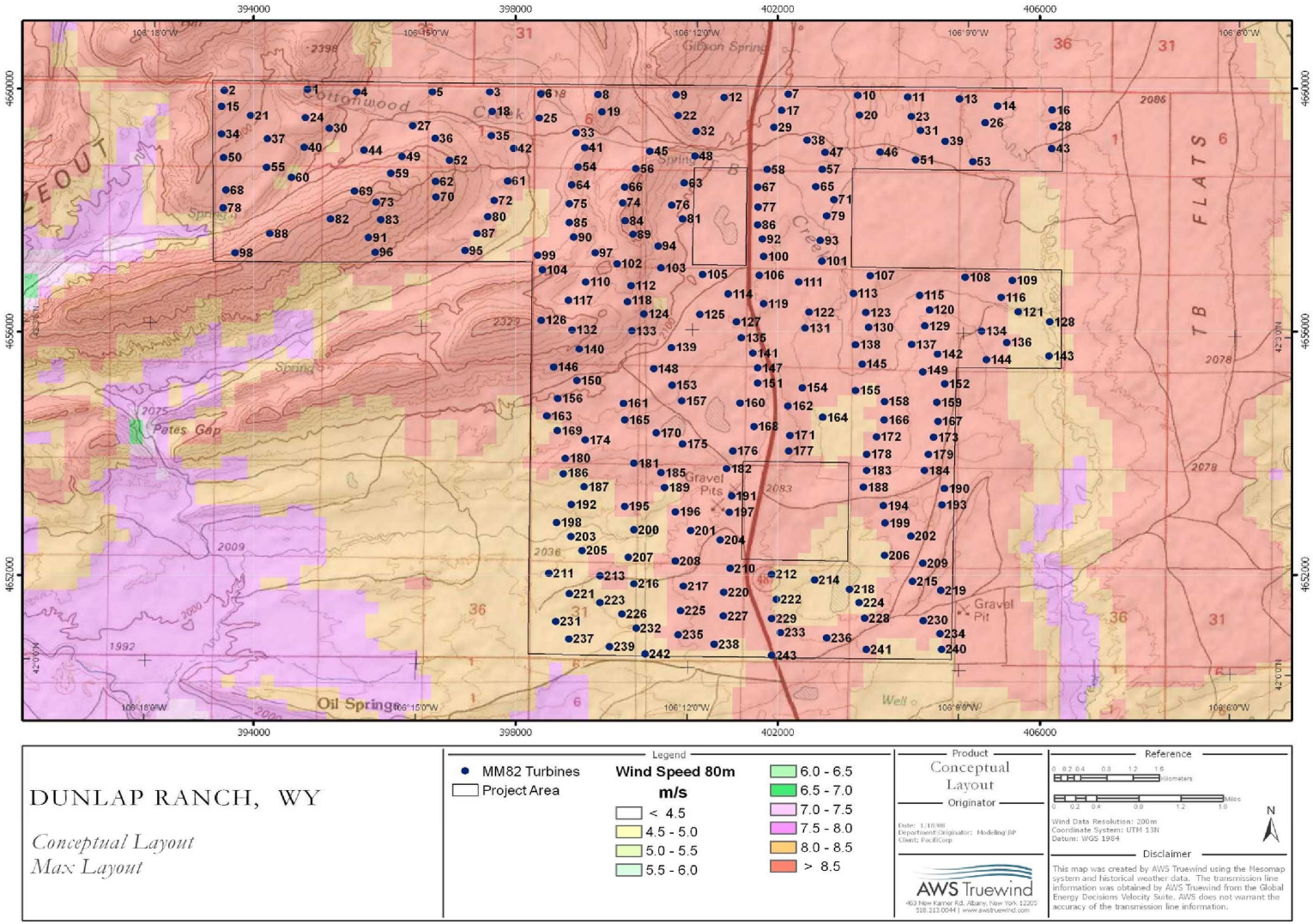

Figure 10. Maximum layout Project design for the Dunlap 1 and 2 Projects, Carbon County, Wyoming.

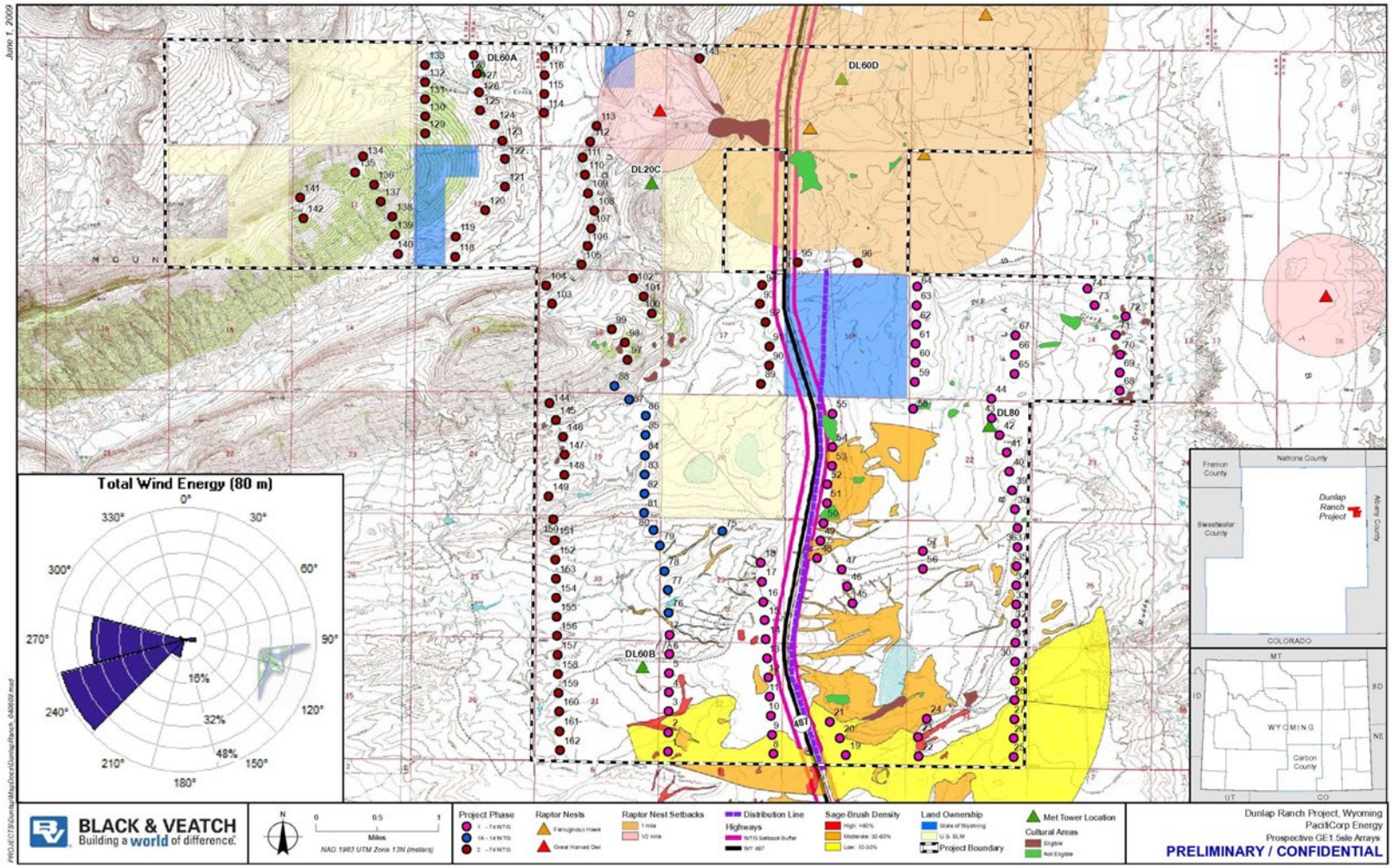

Figure 11. Preliminary Project design for the Dunlap 1 and 2 Projects, Carbon County, Wyoming.

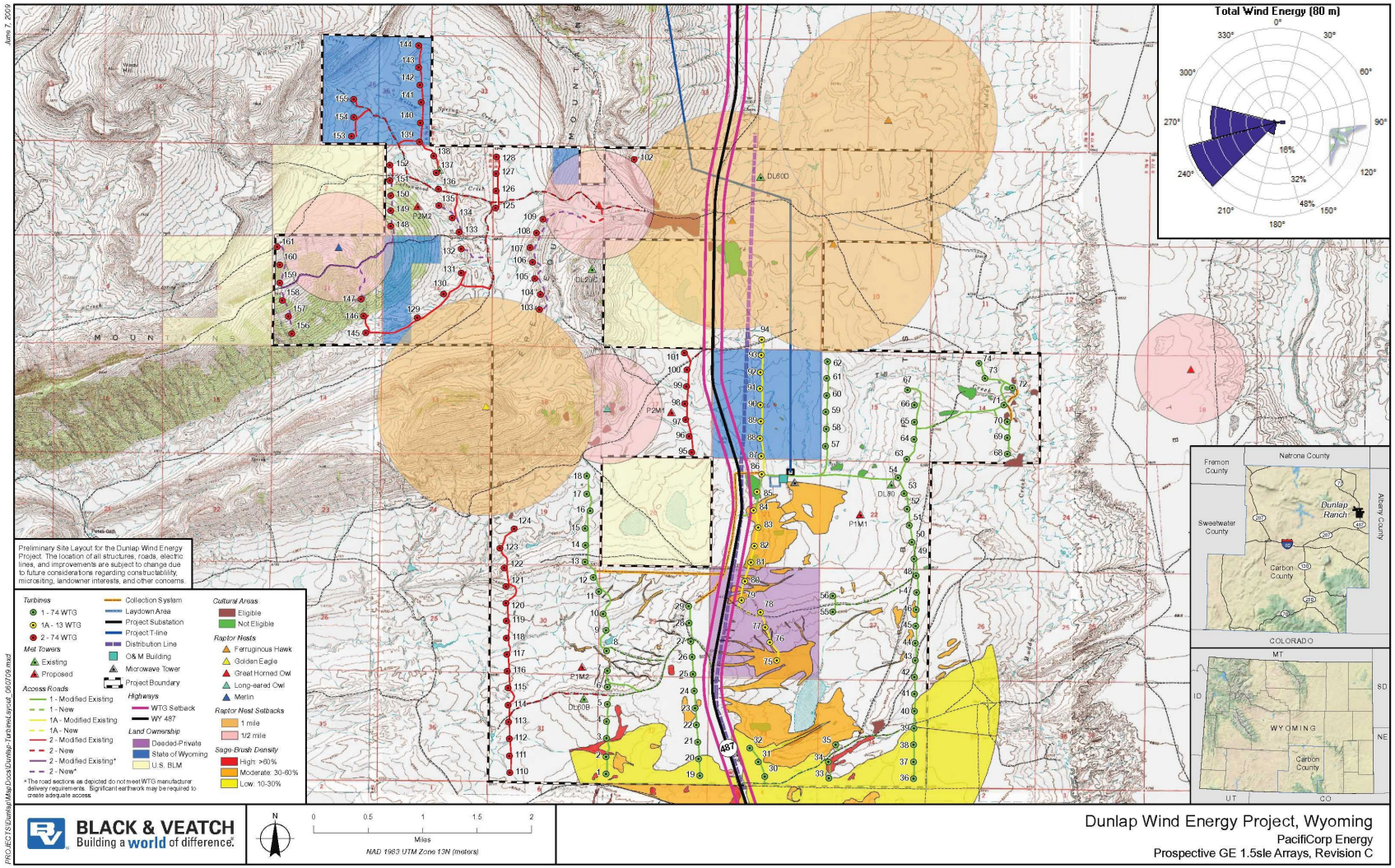

Figure 12. Modified Project design that implemented measures to avoid and minimize potential impacts to eagles at the Dunlap 1 and 2 Projects, Carbon County, Wyoming. Note the removal of 14 Phase 1 turbines within the eagle nest buffer.

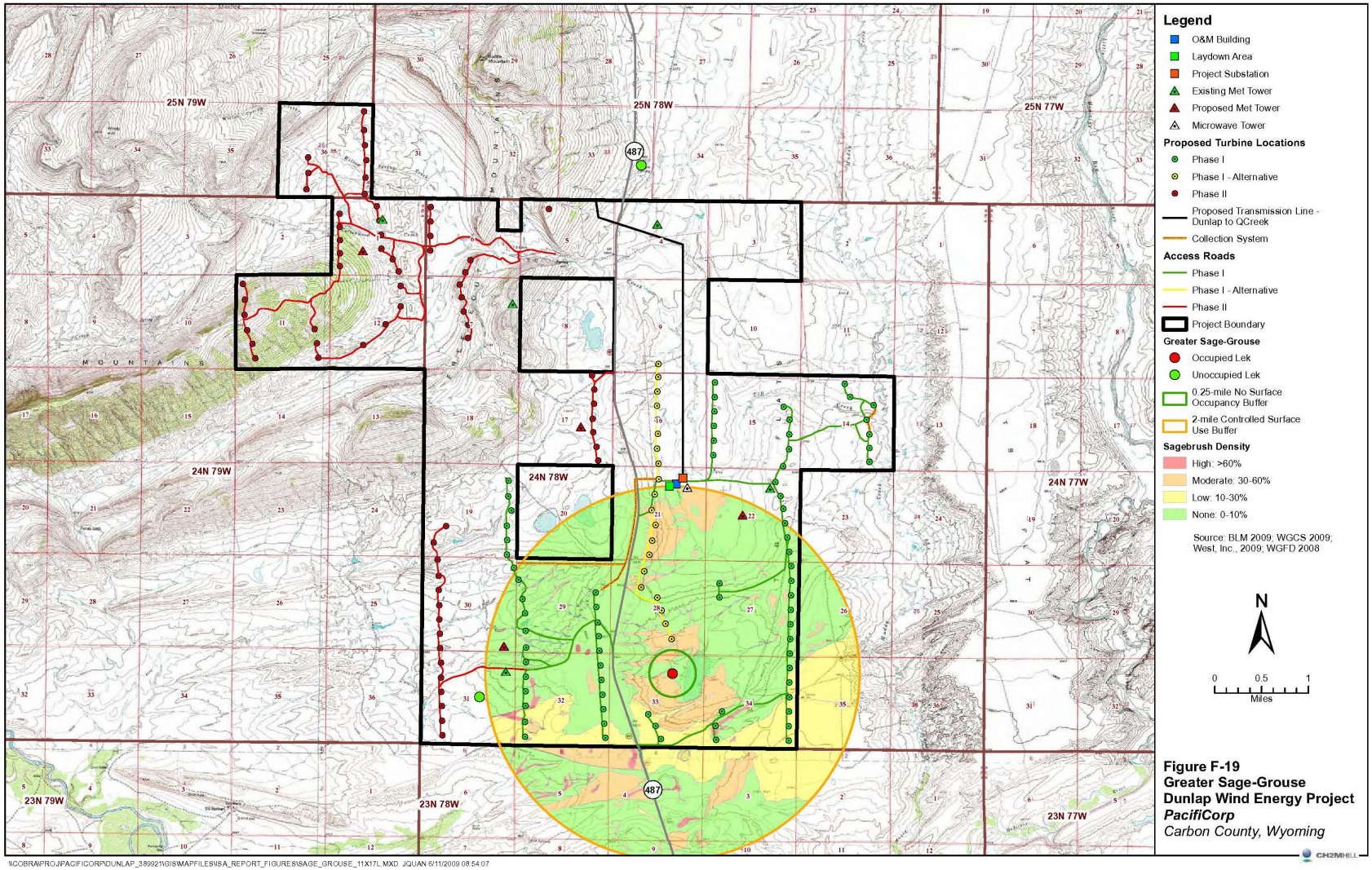

Figure 13. Project design for the Dunlap 1 and 2 Projects, Carbon County, Wyoming that shows the no surface occupancy sage-grouse lek buffer (0.25 miles), the controlled surface use or seasonal use restriction buffer (2 miles), and sagebrush density.

7.0 Predicting Eagle Fatalities (ECPG Stage 3)

This section includes a risk assessment for the Project based on the pre-construction eagle use data that was collected at the Project during avian use surveys. Information in this section addresses recommendations under Stage 3 of the ECPG. As stated above, the data used to inform the USFWS Collision Risk Model were not collected under the ECPG (USFWS 2013b) or Final Eagle Rule (USFWS 2016) data standards. Readers should be cognizant of the potential limitation of the results provided below. An updated risk assessment and associated fatality prediction that incorporates the post-construction mortality monitoring data from the Project is included in Section 9.0 , and therefore may be more representative of the Project's risk to eagles.

7.1 USFWS Mortality Modeling

Pre-construction eagle data for the Project that was collected during avian use surveys has been used to provide golden eagle and bald eagle mortality predictions under the current USFWS Collision Risk Model (USFWS 2013b). The 2016 USFWS eagle rule allows project proponents to use any credible, scientifically peer-reviewed model. In addition to the USFWS prior collision correction factor, this ECP uses the Bay et al. 2016 prior collision correction factor within the USFWS Collision Risk Model to allow comparisons between a range of potential eagle risk predictions. The results of the modeling efforts based on pre-construction data are provided to allow for calibration and updating of the modeled eagle mortality through the use of the post-construction and ongoing monitoring efforts (see Section 9.0 below). It is understood that the USFWS will independently determine the appropriate level of take for this Project.

The pre-construction avian-use data collection effort for the Project pre-dates the USFWS ECPG and 2016 eagle permit rule data standards and data inputs for this analysis vary from standard inputs in the following ways:

Table 5. Comparison between USFWS data standards and baseline surveys conducted for the Project.

USFWS Collision Risk Model Assumptions	Dunlap Wind Project Use Survey Methods
≥ 1-hr surveys	20-minute surveys
Number of eagle minutes recorded	Number of eagles observed recorded
Two years of eagle-use surveys	One year of all bird use surveys
Minimum 30% of project footprint surveyed	~23% of the area within 1-km of constructed turbines surveyed
All points sampled each month	Sample points surveyed weekly in spring/fall; every other week in summer/winter
Survey points randomly selected	Points established to provide coverages across the Project in representative habitats and topography

Acknowledging that the avian use survey data were not collected per standards in the ECPG and Final Eagle Rule, it was considered informative to run the fatality model with the eagle use data collected in 2008-2009 and then to compare that information to the analyses of fatality estimates

derived from the mortality monitoring data (see Section 9.0 below). To obtain an estimate of bald and golden eagle mortalities at the Project using the USFWS methodology, the following information was used for each eagle species: 1) the number of eagle observations within 800 m of observers and below 200 m AGL at points within a 1-km buffer of constructed turbines (see Figure 6, all eagle data from points 4, 6, 7, 8, 9, 10 were included in analysis) ; 2) estimated daylight hours of facility operation within a year; 3) the number of turbines and rotor radius of the turbines at the Project; and 4) the prior Bayesian collision correction factor as recommended by the USFWS (2013b) as well as an alternative collision correction factor as presented in Bay et al. 2016 that is based on pre- and post-construction golden eagle surveys conducted at 26 modern wind energy facilities. A total of 70.67 hours of pre-construction avian use surveys were completed at the Project. There were a total of 27 individual golden eagle observations recorded during the studies at or below 200 m within 800 m of observers at survey points within a 1-km buffer of Project turbines. Zero individual bald eagles were recorded during the studies at or below 200 m and within 800 m of observers at survey points within a 1-km buffer of Project turbines.

Exposure rate (λ), as defined by the USFWS (2013b), is the expected number of flight minutes below 200 m per daylight hour across the surveyed area (km^2). Avian use surveys at the Project were conducted prior to release of the ECPG and, as a result, eagle observations were not conducted on a per-minute basis and the total minutes eagles were observed in flight were not recorded. In this modeling approach, we assumed one minute of eagle flight time per eagle observation. Based on this, a total of 27 golden eagle flight minutes and zero bald eagle flight minutes were recorded within fixed-point plots that covered the sampled portion of the Project during 70.67 survey hours (Table 6). The exposure rate and subsequent collision prediction will increase if more than one minute per eagle observation is assumed or if all of the survey points are included in the analysis. Additionally, there is bias using eagle risk minutes resulting from general avian surveys methods versus large bird only methods to inform the CRM and as such, results should be interpreted with caution. PacifiCorp understands the USFWS – Region 6 may choose to apply a different approach to informing the model based on the methods and data collected.

A $Gamma(\alpha = 0.97, \beta = 2.76)$ prior distribution with mean (0.35) and standard deviation (0.357) has been recommended by the USFWS for the exposure prior. Posterior exposure distributions of eagle use at the Project were estimated as $Gamma$ distributions with the α parameters equal to the sum of the prior α and total flight minutes below 200 m, and the β parameters equal to the sum of the prior β and effort (hours of surveys x km^2 of area surveyed). This resulted in a posterior distribution for the golden eagle exposure rate at the Project of *Gamma* (27.97, 144.84) with mean 0.193 golden eagle flight minutes observed per hour of survey per km^2 (Table 6). The posterior distribution for the bald eagle exposure rate at the Project of *Gamma* (0.97, 144.84), with a mean 0.007 bald eagle flight minutes observed per hour of survey per km^2 (Table 6).

Table 6. Estimated exposure rate (λ) from golden eagle and bald eagle observations made during pre-construction avian use surveys at the Dunlap I Project, Carbon County, Wyoming.

Variable		Golden Eagle	Bald Eagle
1	Number of Surveys	213	213
2	Average Length of Surveys (hours)	0.33	0.33
3	Survey Hours	70.67	70.67
4	Survey Radius (meters)	800	800
5	Recorded Flight Minutes below 200 m at points	27	0
6	Eagle Flight Minutes (α : Line 5 + 0.97)	27.97	0.97
7	Effort (β ; survey hours x sq km of area surveyed+2.76)	144.844	144.844
8	Mean Exposure Rate (Line 6 / Line 7)	0.1931	0.0067

A facility-specific expansion factor is included to account for the hazardous area within the Project and this expansion factor is multiplied by the eagle exposure rate

$$\left(\frac{\textbf{eagle flight minutes}}{\textbf{hour} \cdot \textbf{km}^2}\right)$$

to estimate the potential annual eagle-wind turbine interactions (minutes of flight within the turbine hazardous area). The expansion factor also scales the exposure rate to daylight and/or operational daylight hours (τ) within a year across the total hazardous areas (δ_i) surrounding all proposed turbines (n_t; USFWS 2013b). For this modeling effort, an annual estimate of operational turbine hours during daylight was used. To calculate operational hours, Project specific turbine operational data were compiled from January 1, 2015 through April 14, 2017 and script was run to identify when turbine sensors were engaged (i.e., operational). These data were correlated with sunrise and sunset times for the latitude/longitude location associated with the Dunlap Operational and Maintenance building.

$$\varepsilon = \tau \sum_{i=1}^{n_t} \delta_i$$

The USFWS has defined the turbine hazardous area (δ_i) as the rotor-swept area around each turbine or proposed turbine location ($\mathbf{km}^2$; USFWS 2013b). Expansion factors (ε) were calculated using annual daylight hours and the originally proposed turbine scenarios (Table 7). The repowered turbine specifications were not evaluated for this exercise.

Table 7. Expansion factors (ε) for the turbine layout at the Dunlap I Project, Carbon County, Wyoming. Turbine hazardous area = pi * turbine radius expressed in km^2. Expansion factor = Line 9 x Line 11 x Line 12.

Variable		GE 1.5 MW Turbine
9	Operating Time During Annual Daylight Hours	3586.55
10	Rotor Radius (meters)	38.5
11	Turbine Hazardous Area	0.005
12	Number of Turbines	74
13	Overall Expansion Factor	1235.89

The collision correction factor (collision probability; C) was defined as the probability of an eagle colliding with a turbine given each minute of eagle flight in the turbine hazardous area. The prior distribution for collision probability was developed by the USFWS using the four previous golden eagle mortality studies (Foote Creek Rim, Wyoming; San Gorgonio, California; Tehachapi, California; and Altamont, California) reported in Whitfield (2009). A mean of the estimated golden eagle flight minutes within the turbine hazardous area to recorded golden eagle collision events at those facilities was used to determine a $\mathrm{Beta}(2.31, 396.69)$ prior distribution for collision probability with mean of 0.00579 eagle fatalities per minute of flight in the turbine hazardous area, respectively (Table 8). WEST has also applied the model using an alternative collision correction factor developed from pre- and post-construction studies at 26 modern facilities (Bay et al. 2016). The Bay et al. (2016) collision prior is $\mathrm{Beta}(9.28, 3{,}224.51)$ for collision probability with mean of 0.00287 eagle fatalities per minute of flight in the turbine hazardous area (Table 8). The modeling efforts presented in this section do not incorporate site specific information into the collision probability; however, the modeling efforts in section 9.0 include information from the post-construction mortality monitoring to inform the modeling efforts.

Table 8 Collision correction factor (*C*) calculated as Line 14/(Line 14 + Line 15).

Variable		USFWS GOEA	Bay et al. 2016 Prior GOEA	USFW BAEA	Bay et al 2016. Prior BAEA
14	Prior Mortalities	2.31	9.28	2.31	9.28
15	Prior exposure events not resulting in mortality	396.69	3224.51	369.69	3224.51
16	Prior mean collision correction factor	0.00579	0.00287	0.00579	0.00287

Bay et al. 2016
USFWS=US Fish and Wildlife Service; GOEA=golden eagles

The USFWS collision risk model assumes that higher site-specific eagle flight activity will correspond to higher annual eagle mortality, once the wind energy facility is operational. Under this assumption, predictions of annual eagle mortality (F) were modeled as the pre-construction measure of eagle exposure (λ) within areas of potential eagle-wind turbine interactions (ε) multiplied by a collision correction factor (C):

$$F = \varepsilon\lambda C$$

Credible intervals (i.e., Bayesian confidence intervals) were calculated using a simulation of 10,000 Monte Carlo draws from the posterior distribution of eagle exposure (λ) and the collision probability distribution $(C;$ Manly 1991). The product of each of these draws, with the exposure area corresponding to turbine type was used to estimate the distribution of possible mortality at the Project. The upper 80th percentile of this distribution has been recommended by the USWFS as a conservative estimate of take for a proposed wind energy Project (USFWS 2013b).

Predicted golden eagle mortalities per year using the USFWS Bayesian Collision prior are 1.38 golden eagles/year (point estimate) and 2.04 golden eagles/year (upper 80th credible interval; Table 9). The predicted number of golden eagle mortalities per year using the Bay et al. 2016 collision prior is 0.68 (upper 80th = 0.89; Table 9).

Predicted bald eagle mortalities per year using the USFWS Bayesian Collision prior are 0.48 bald eagles/year (point estimate) and 0.07 bald eagles/year (upper 80th credible interval; Table 9). The predicted number of bald eagle mortalities per year using the Bay et al. 2016 collision prior is 0.02 (upper 80th = 0.04; Table 9).

Table 9. Eagle fatalities per year (F).

	Golden Eagle		Bald Eagle	
Variable	**USFWS**	**Bay et al. 2016 Collision Prior**	**USFWS**	**Bay et al. 2016 Collision Prior**
Estimated annual eagle fatalities	1.3817	0.6849	0.0479	0.0238
Upper 80th Credible Interval	2.0365	0.8850	0.0733	0.0376

Bay et al 2016

7.2 Other Impacts

7.2.1 *Habitat Loss, Degradation, and Fragmentation*

Construction of wind energy facilities also impact eagles and their prey, through habitat loss, degradation, or fragmentation. The removal of habitat and conversion of interior habitat to edge habitat during construction of turbines and associated facilities likely results in certain species being displaced from at least portions of habitat within the Project footprint. Construction of the 74-turbine Project resulted in the removal of approximately 72.2 acres of habitat for the substation, interconnection substation, O&M building turbine, crane pads, new access roads, and transmission line access roads (Table 3). The primary habitat lost was sagebrush steppe dominated by a mix of grassland and shrub communities. Temporary land disturbances resulting from the construction of the turbines and associated infrastructure include appropriately 205 acres. Temporary impacts included a laydown area and batch plant, widened new and existing roads, and ground disturbance associated with the underground collector system and temporary MET towers (Table 3). Temporary land disturbances have been reclaimed and re-vegetated so that natural succession could occur.

In addition to the direct ground-level impacts associated with this Project, the construction of the Project created a hazardous area (zone of risk) to eagles the can result in collisions with turbine

(as assessed in Section 7.1 above) or other vertical structures, electrocutions associated with above ground line, or impacts associated with the increased presence of vehicles and other equipment. Our current understanding of these additional impacts associated with Project features makes quantification of these impacts difficult; however, the potential for these impacts are recognized in this ECP.

7.2.2 *Disturbance/Displacement*

In addition to removing and degrading habitat, Project wind turbines may displace eagles and their prey from an area due to creation of edge habitat, the introduction of vertical structures, and disturbances directly associated with turbine operation (e.g., noise and shadow flicker) (USFWS 2012, NRC 2007). Impacts are concentrated near turbine locations and along access roads, although available data indicate that avoidance of wind turbines by birds generally extends 245 to 2,625 ft from a turbine, depending on the environment and the bird species affected (Strickland 2004). Eagle specific information was not located for inclusion in this document. Literature is not currently available to define the magnitude of these impacts.

Although construction and operation of the wind energy facility likely resulted in displacement of some groups of birds and prey species, the Project was sited to minimize disturbance to native habitat, and undisturbed native habitats are abundant in the region. Therefore, it is unlikely that this Project alone would cause displacement of eagles or prey species that would result in any population level impacts to eagles.

7.3 Eagle Risk Factors

In addition to abundance, the two main risk factors identified in the ECPG are: (1) the interaction of topographic features, season, and wind currents that create conditions for high-risk flight behavior near turbines; and (2) behavior that distracts eagles and presumably makes them less vigilant (e.g., active foraging or inter- and intra-specific interactions such as territorial defense).

The ECPG also provides table of general risk factors that can be used to guide risk assessments for a Project. These factors are listed in Table 10 with additional site specific information regarding each factor and a qualitative risk assignment based on available information. It should be noted, this information is only provided to identify general factors at the Project that may result in more or less risk and is not used to specifically identify each risk factor and magnitude at the Project. Further risk evaluations based on post-construction monitoring data are provided in Section 9.0.

Table 10. Risk factors listed in the US Fish and Wildlife Service Eagle Conservation Plan Guidance and a discussion of these factors for the Dunlap Project, Carbon County, Wyoming.

Risk Factor	Scientific Evidence/Support	Citations	Project Situation	Qualitative Assessment
Eagle Density	Mixed findings; likely some relationship but other factors have overriding influence across a range of species	Barrios and Rodríguez (2004), de Lucas et al. (2007), Hunt (2002), Smallwood et al. (2009), Ferrer et al. (2011)	Raptor use estimated during pre-construction surveys was moderate relative to other studies; however, eagles made up about 55% of all raptors and were the most abundant large bird species.	Moderate to High
Eagle Age	Mixed findings. Higher number of fatalities among subadult and adult golden eagles in one area. Higher fatalities among adult white-tailed eagles in another	Hunt (2002), Nygård et al. (2010)	Data collected to date suggest more adult eagle use at the Project although subadults and juveniles were observed as well.	Moderate
Proximity to Nests	White-tailed eagle nesting areas close to turbines have been observed to have low nest success and be abandoned over time.	Nygård et al. (2010)	The nearest golden eagle nest was originally located approx. 1.04 miles from nearest turbine.	Moderate
Eagle Residency Status	Mixed findings. Higher risk to resident adults in Egyptian vultures (*Neophron percnopterus*). Higher number of mortalities among subadults and floating adults in golden eagles in one other study.	Barrios and Rodríguez (2004), Hunt (2002)	One golden eagle nest was identified pre-construction. Various golden and bald eagle activity was documented during pre-construction surveys.	Moderate

Table 10 (*continued*). Risk factors listed in the US Fish and Wildlife Service Eagle Conservation Plan Guidance and a discussion of these factors for the Dunlap Project, Carbon County, Wyoming.

Risk Factor	Scientific Evidence/Support	Citations	Project Situation	Qualitative Assessment
Season	Mixed findings. In some cases for some species, risk appears higher in seasons with greater propensity to use slope soaring (fewer thermals) or kiting flight (windy weather) while hunting.	Barrios and Rodríguez (2004), de Lucas et al. (2007), Hoover and Morrison (2005), Smallwood et al. (2009)	Eagle use was similar among seasons.	Unknown
Flight Style	Species most at risk perform more frequent flights that can be described as kiting, hovering, and diving for prey.	Smallwood et al. (2009)	Potential for these flight behaviors within the Project.	Moderate to High
Interaction with Other Birds	Higher risk when interactive behavior is occurring.	Smallwood et al. (2009)	Potential exists based on location of golden eagle and other raptor nests.	Unknown, needs further study to determine actual influence to risk
Active Hunting/Prey Availability	High risk when hunting close to turbines, across a range of species	Barrios and Rodríguez (2004), de Lucas et al. (2007), Hoover and Morrison (2005),Hunt (2002), Smallwood et al. (2009)	Presence of sage grouse, prairie-dogs, lagomorph species and other small mammals, variety of avian species, livestock grazing, and big-game.	High

Table 10 (*continued*). Risk factors listed in the US Fish and Wildlife Service Eagle Conservation Plan Guidance and a discussion of these factors for the Dunlap Project, Carbon County, Wyoming.

Risk Factor	Scientific Evidence/Support	Citations	Project Situation	Qualitative Assessment
Turbine Height	Mixed, contradictory findings across a range of species	Barclay et al. (2007), de Lucas et al. (2008)	34.5% of flying eagle observations were initially recorded within the RSH during pre-construction surveys	Moderate
Rotor Speed	Higher risk associated with higher blade-tip speed for golden eagles in one study, but this finding may not be generally applicable.	Chamberlain et al. (2006)	State of the art technology, low RPM's, more space between rotor sweeps, however tip speeds generally the same	Low or Unknown
Rotor-swept Area	Meta-analysis found no effect, but variation among studies clouds interpretation	Barclay et al. (2007)	34.5% flying eagle observations were initially recorded within the RSH during pre-construction surveys. However, larger rotors generally have more space and time between sweeps	Moderate
Topography	Several studies show higher risk of collisions with turbines on ridgelines and on slopes. Also a higher risk in saddles that present low-energy ridge crossing points.	Barrios and Rodríguez (2004), de Lucas et al. (2007), Hoover and Morrison (2005), Smallwood and Thelander (2004)	Based on the prevailing wind direction in relation to topography including slope, aspect, and elevation.	Low to Moderate
Wind Speed	Mixed findings, probably locality dependent.	Barrios and Rodríguez (2004), Hoover and Morrison (2005), Smallwood et al. (2009)	Based on the prevailing wind direction in relation to topography including slope, aspect, and elevation.	Low to Moderate

7.3.1 *Topography and Wind*

The Project area is relatively flat with limited topographic relief (Figure 3). The eastern half of the Project has a shallow basin in the southern portion of the Project. The western half of the Project was constructed on a soft windward slope (western aspect). The slope is gradual, not forming an obvious ridgeline that is often associated with higher use by eagles, but is the most notable feature

in the Project area. All turbines at the Project are located on an area of generally flat topography, with increased topography immediately to the west-northwest and south of the Project. The Freezeout Mountains abut the northwest boundary and the Pine Butte and Flattop Mountain are located slightly more than a mile south the Project. To the east of the Project lie the TB flats and Greasewood flats. The prominent wind direction at the Project is oriented in a westerly direction (wind blows out of the west). The orientation of the overall topography in the vicinity of the Project at a landscape-scale and the prominent wind direction in relation to the Project suggest that turbines sited on steep slopes with a west facing aspect may be more risky to eagles because these areas could support strong updrafts of wind. The Project area lacks steep slopes that may result in increased impacts.

Baseline surveys (Johnson et al. 2009) did not record higher use along the slope when compared with points in the eastern portion of the Project; however, the two survey points near the slope (point 4 and 10) were at the bottom of the feature. Although scientific support is limited, some research suggests turbines in saddles or canyons or on the upwind side of ridges may pose more risk to golden eagles (Barrios and Rodríguez 2004, de Lucas et al. 2008, Hoover and Morrison 2005, Smallwood and Thelander 2004). While some gaps and saddles and other areas that could provide orographic lift are located within the Project area, the Project does not contain significant topographic features (e.g., ridgelines) that would combine with prevailing winds to provide substantial orographic lift for eagles. The results of the landscape-scale assessment of topography and wind suggest that topography and wind conditions at the Project might be a low risk to eagles overall in relation to facility and individual turbine siting, with the greatest risk associated with turbine sited at the top of the western slope feature.

7.3.2 *Inter- and Intra-Specific Interactions and Foraging Behavior*

Inter specific interaction is the competition among different species; and intra-specific interaction is competition within the same species (e.g., ECPG; *see also* Eagle Risk Factors *above*). Assuming that intra- and inter-specific competition and territorial defense increases collision risk, these behaviors likely occur within the Project based on the location of known eagle and other raptor nests in the vicinity of the Project. While this potential risk factor is identified in the ECPG, studies that clearly quantify the magnitude of risk associated with this behavior are not currently available.

Eagles are known to forage within the Project and foraging behavior near prairie dog towns is believed to result in higher risk to eagles if turbines are present. Prairie dog towns are scattered throughout the Project area, but may be more risky in areas at the top of slopes or areas where turbines area sited between prey locations and perch or nest structures (see Section 9.5 for further discussion). Additionally, the Project area is designated winter range for pronghorn and migration routes occur in the Project region. Seasonal ranges, specifically winter ranges, are more likely to result in pronghorn mortality, and carcasses are known attractants to eagles. The increase in pronghorn may increase risk to eagle foraging in the area. As indicated in Section 8.0 below, PacifiCorp is implementing a carcass removal program that should also help to reduce risk to foraging eagles. Common perch structures are located along the highway in the form of transmission poles. Turbines located parallel and relatively close to the highway may result in

greater risk as eagles may fly through the turbines when traveling from perch sites or nest locations to forage.

7.4 Eagle Risk Site Categorization

The ECPG recommends that Project developers or operators use a standardized approach to categorize the likelihood that a project will meet the standards for issuance of a programmatic eagle take permit. Those categories are listed below.

- Category 1—High risk to eagles/potential to avoid or mitigate impacts is low.
- Category 2—High to moderate risk to eagles/opportunity to mitigate impacts.
- Category 3—Minimal risk to eagles.

The ECPG (USFWS 2013b) applies primarily to wind energy facilities that have not yet been constructed or are operational. Dunlap was constructed and operational prior to the publication of the ECPG; therefore, the USFWS has determined that risk categorization does not apply to Dunlap and it should not be assigned a risk category.

8.0 Additional Avoidance and Minimization of Risks, and ACP's (Stage 4)

In accordance with the Region 6 ECP Guidance, this section covers additional information on avoidance and minimization of risks to eagles during construction and operations at the Project (*see* Section 6.0 *above for avoidance and minimization during Siting and Design*). Information in this section also addresses recommendations under Stage 4 of the ECPG. The compensatory mitigation and adaptive management sections have been moved to section 9.0 based on the current state of the Project and decision making process.

8.1 Construction Phase Best Management Practices

The following avoidance and minimization measures were implemented to reduce impacts to eagles during the construction phase. These measures included both direct and indirect measure to reduce impacts to eagles and their prey. The measures listed below include all measures implemented to address the impacts discussed in Section 7 including habitat fragmentation, degradation, disturbance, and displacement. For detailed explanation of best management practices please see the project-specific BBCS or ISC permit application.

- The Project complied with all federal, state, and county environmental laws, orders, and regulations related to construction.
- During Project construction, travel was restricted to designated roads, and Project personnel were advised regarding speed limits (25 miles per hour [mph]) to minimize wildlife mortality due to vehicle collisions and to reduce disturbance and displacement.
- Where applicable, efforts were made to minimize impacts to vegetation and soils. These efforts help minimize degradation and fragmentation of habitat for eagles and their prey. A brief list of measures to support vegetation and soils includes:

  - Minimized damage to the land surface and property, to only areas necessary for the safe and efficient construction;
  - Used existing roads and minimized disturbed area where possible;
  - Soil and vegetation restoration for areas impacted by construction (filling ruts and scars);
  - Roads, portions of roads, crane paths, and staging areas not required for operation and maintenance were restored to the original contour. Reclaimed areas were contoured, graded, and seeded as needed to promote successful re-vegetation, provide for proper drainage, and prevent erosion;
  - Proper soil handling techniques (top soil removal, minimizing excavation, protecting exposed soils, minimizing work on wet soils) were implemented to help restore habitat and reduce potential fragmentation and degradation;
  - Equipment was inspected for potential noxious weed sources prior to entering the facility. This measure helped to reduce habitat degradation; and
  - All erosion reduction material (straw waddles) were certified weed free to minimize habitat degradations.
- Where applicable, efforts were made to minimize impacts to water resources and wetlands. These efforts supported reduced water impairment issues and degradation of habitat and resources that are used by eagles and their prey. A brief list is provided below:
  - Wind turbines and most ancillary facilities were built on uplands to avoid surface water features and designated floodplains;
  - Refueling and staging occurred at least 300 ft from the edge of a channel bank at all stream channels. Sediment control measures were utilized to minimize impacts to aquatic and riparian habitats;
  - Restoration near drainages included matching contours to allow natural flows; and
- During Project construction, riparian areas were avoided, where feasible. If avoidance was not feasible, activities within riparian areas were conducted in conformance with SWPPP requirements.
- Effective exhaust mufflers were installed and properly maintained on all construction equipment to minimize additional noise and potential disturbance to eagles and their prey.
- PacifiCorp required construction contractors to comply with federal limits on truck noise. Construction activities took place mostly during daylights hours. Nighttime construction work was minimized. These measures reduced potential disturbance and displacement to roosting eagles and their prey.
- Gates were installed on private roads to restrict public access to turbine locations. These restrictions reduce traffic on the Project which likely resulted in fewer opportunities for collision, less disturbance and displacement to eagles and prey, and generally reduced

sound, minimized air quality impairments, or other disturbances to the land that supports eagles.

- All applicable hazardous material laws and regulations existing or hereafter enacted or promulgated regarding regulated chemicals were complied with, and a Spill Prevention, Control, and Countermeasure Plan (SPCC) were implemented. The only hazardous chemicals anticipated to be on-site are the chemicals contained in batteries, diesel fuel, gasoline, coolant (ethylene glycol), and lubricants in machinery. These restrictions minimize the potential for direct eagle poisoning or poising to their prey.
- No burning or burying of waste materials occurred or will occur at the Project. Post construction waste materials were removed from the construction area. All contaminated soil and construction debris was disposed of in approved landfills in accordance with appropriate environmental regulations to minimize habitat degradation.

8.2 Operational Phase Best Management Practices

As discussed above (see Section 6.0), Project siting was developed in coordination with WGFD and USFWS to avoid or minimize impacts to eagles. The measures implemented during the operational phase included both direct and indirect measures to reduce impacts to eagles and their prey. The measures listed below include all measures implemented to address the impacts discussed in Section 7 including habitat fragmentation, degradation, disturbance, and displacement. Specific measures taken include:

8.2.1 *Site Management*

- To avoid attracting eagles and other raptors, the availability of carrion is reduced by removing carcasses discovered on-site during regular maintenance and monitoring activities. O&M personnel, or PacifiCorp contractors, will either pick up the carrion and dispose of it at an appropriate off-site facility or immediately call the WGFD to collect the wildlife carcass in an effort to remove potential eagle attractants from turbines areas. Appropriate owners are called to remove livestock carcasses. The removal notification occurs immediately with the target carcass removed as quickly as possible.
- The Project is located on private property. Hunting is not allowed near the Project turbines. A benefit of this practice is safety and a reduction in eagle attraction as gut piles and other carcass remnants are reduced. This also reduces potential lead poisoning incidents.
- Project personnel are advised regarding speed limits on roads (25 mph) to minimize wildlife mortality due to vehicle collisions and to minimize potential disturbance and displacement.
- Typical travel is restricted to designated roads; and no off-road travel is allowed except to perform operational activities such as turbine maintenance and repair and in emergencies. This measure reduces habitat degradation, disturbance, and displacement.
- PacifiCorp performs regular maintenance on Project components to ensure they are functioning properly and do not pose additional risk to eagles.

- Rodent control is performed utilizing non-poison bait traps to avoid release of the dead carcasses into the environment. The traps are self-contained and do not result in the release of toxins to the environment. PacifiCorp contracts with a rodent management company that performs monthly inspections and trap collection/replacement.
- Heavy equipment utilized for road maintenance and snow plowing is inspected for fluid leaks and noxious weeds by site supervisors prior to work commencement. These steps ensure potential hazardous materials will not directly or indirectly impact eagles and that vegetation in the project area remains intact.
- Large scale maintenance cranes typically utilize existing crane access pads, thus minimizing ground disturbance in the event a crane is utilized. Ground disturbing activities may include the occasional need to access underground cable or communications lines.

8.2.2 *Collision Risk*

- Wind turbines are unguyed, tubular towers and have slow-rotating, upwind rotors.
- Practices suggested by APLIC (2006) were used to ensure that overhead lines constructed for the Project, for ownership by PacifiCorp, are consistent with recommendations provided in APLIC guidance documents (e.g., a minimum of 150 cm (60 inches) of horizontal separation between energized and/or grounded parts and 100 cm (40 inches) of vertical separation, insulation or covering of exposed energized or grounded parts, and application of perch management techniques (APLIC 2006)).
- Collection and communication lines were buried to minimize and avoid collision and electrocution risks to eagles and other avian species. This included over 26 miles of buried lines.
- The two permanent MET towers erected at the Project have bird diverters installed on the guy wires to reduce the potential for avian collision.
- Turbine lighting has been minimized to that which is required by the Federal Aviation Administration (FAA) and red pulsating lights are being utilized, consistent with the 2012 Guidelines. Kerlinger et al. (2010) summarized several studies which showed that FAA lighting on wind turbines does not increase bird mortality.
- In accordance with the 2012 Guidelines (USFWS 2012), each turbine also has a low voltage, shielded light (white incandescent).

8.2.3 *General Operation and Continued Monitoring*

- PacifiCorp employees and on-site O&M contractors receive annual training in Wildlife Incident Reporting and Handling System (WIRHS) protocols to ensure they understand the procedures (Appendix E).
- PacifiCorp will continue to monitor for the presence of eagle mortalities at the Project in accordance with Chapter 9 of this ECP (or the Eagle Take Permit upon issuance) to verify the effectiveness of the avoidance, minimization, and mitigation strategies incorporated in

the project operation and management and to support future evaluations under adaptive management.

- Ongoing operational monitoring needs will be evaluated in coordination with the USFWS, based on the results of previous operational monitoring, and will be implemented if warranted.
- An adaptive management program will be implemented as described below.
- Annual nest surveys are performed to identify eagle nesting activity and success. These surveys allow PacifiCorp and agency representatives to understand current eagle use and use over time and to support discussions on adaptive management.
- Results of all monitoring activities through February of 2014, including mortality surveys and nest surveys, were recorded in formal annual reports since monitoring was initiated in May 2011 (Martinson et al. 2012, 2013, 2014). Results from monitoring surveys from 2014 – 2017 have been documented in annual Special Purpose Utility Permits (SPUT). Monitoring activities and eagle nest surveys are ongoing. The continued monitoring and evaluation of collected data has and will continue to support the need for potential adaptive management or additional study needs. These results also provide actual mortality data that can be used to determine the Project's impacts on eagles.
- PacifiCorp will meet or exceed current APLIC recommendations in the event that any utility poles or power lines are built or retrofitted at the Site for ownership by PacifiCorp.

8.2.4 *Decommissioning and Restoration*

- In the event that the Project is decommissioned, infrastructure will be removed, and the site will be graded and restored to as near its original condition as reasonably possible.
- Native habitat that was removed as a result of Project development will be allowed to re-establish through natural succession, thereby restoring habitat over time for eagle species.

8.2.5 *Conservation Measures for Bald and Golden Eagles and Other Raptors*

In addition to the above actions, PacifiCorp has and/or will implement the following monitoring efforts and conservation measures. These measures are designed to identify impacts and provide ongoing conservation and benefits to eagles and other raptors, with the goal of enhancing eagle populations, but also have the potential to benefit other avian species.

8.2.5.1 Carrion and Carcass Removal

PacifiCorp will continue to remove the potential source(s) of eagle attraction in the Project area (e.g., carrion, prey and/or prey habitat) in accordance with applicable state and federal law. PacifiCorp has carrion removal contracts in place with vendors at all Wyoming wind facilities to collect and remove observed carrion which could create an attraction for foraging eagles, raptors, and other scavengers. Depending upon the carcass(es) observed, PacifiCorp will contact applicable carcass owners to request permission before relocating or disposing of the carcass(es). Disposal of carcasses varies and may include onsite burial or transfer to a local landfill. If illegal activity is assumed, the WGFD is notified and disposal occurs are directed.

9.0 Calibration and Updating of the Fatality Prediction and Continued Risk Assessment (ECPG Stage 5) and Compensatory Mitigation (ECPG Stage 4)

9.1 Post-Construction Monitoring and Analysis Summary

PacifiCorp placed the Project in operation on October 1, 2010. Two post-construction monitoring periods have been conducted since the Project went operational including: 1) a standard three year post-construction monitoring study (2011 – 2014; Martinson et al. 2012, Martinson et al. 2013, Martinson et al. 2014), and 2) post-settlement monitoring reviewed by the settlement team (2014 – present [currently April 2020]).

The first period (March 2011 – February 2014) included a one year post-construction monitoring and reporting program to estimate and evaluate Project impacts, as required by the ISC permit. The monitoring study followed the protocol presented in the "Wildlife Monitoring Studies at Dunlap Wind Energy Facility" document (Appendix F), which outlined the protocols to monitor wildlife impacts. Post-construction avian monitoring efforts included standardized carcass searches, bias trials, and nest surveys. After the one year monitoring study, in coordination with the TAC, two additional years of monitoring were implemented. Summaries of the post-construction surveys along with comparisons to pre-construction risk assessments are included below. The full post-construction monitoring reports are included in Appendix F.

The second period (March 2014 – present) included multiple monitoring methodologies and is described in detail below (Section 9.3). Carcass searches occurred throughout the study period with bias trials varying based on the survey period. These methods were reviewed and adapted through coordination with the USFWS.

As part of the overall monitoring effort, avian mortalities discovered at the Project were handled under the WIRHS manual and will continue to be for the life of the Project (Appendix E). Eagle mortality reporting changed over time with initial reporting to USFWS – Ecological Services. Carcasses were retrieved by USFWS staff or PacifiCorp was authorized by USFWS to collect carcasses until retrieval. Under the current protocol, PacifiCorp reports all eagle mortalities to USFWS – Office of Law Enforcement and obtains permission to deliver carcasses to the repository. Future reporting will likely change with the issuance of an eagle take permit and subsequent stipulations will be followed based on the stated permit conditions.

9.1.1 *Standardized Avian Carcass Searches - March 11, 2011 to February 28, 2013*

Three years (March 11, 2011 – February 28, 2014) of post-construction monitoring was completed at the Project to assess avian mortalities discovered at the Project and raptor nesting activity. These surveys included monitoring for eagle mortalities and nest surveys that were focused on eagle species.

9.1.1.1 Methods

The methods for the carcass search studies were broken into four primary components: 1) standardized carcass surveys of selected turbines and MET towers; 2) searcher efficiency trials

to estimate the percentage of carcasses found by searchers; 3) carcass removal trials to estimate the length of time that a carcass remained in the field for possible detection; and 4) adjusted mortality estimates for bird species calculated using the results from searcher efficiency trials and carcass removal trials to estimate the total number of bird mortalities within the Project area.

Eagle mortalities found within search plots were included in the mortality estimate calculations, including mortalities found outside scheduled search times, under the assumption that the mortalities found incidentally on search plots would have been found during subsequent standardized searches. Mortalities found outside of the defined search plots were not included in the estimate as areas outside of the search plots were not part of the standardized monitoring. Searcher efficiency trials were conducted to estimate how detectable birds were (i.e, the percentage of carcasses that searchers found); however, these trials did not focus specifically on eagles, rather large birds in general. Twenty-six of the 74 turbines were selected for surveying using a systematic design with a random start (Figure 14). The 26 turbines were searched each year during the three year post-construction monitoring study. Search plots at turbines were 160 m (525 ft) x 160 m centered on the turbine. Standardized carcass surveys occurred at all 26 turbines once every 4-week (28-day) period throughout the year, with standardized surveys at half of these turbines (13 turbines) conducted once every week (seven days) during the spring (March 16 – May 15) and fall (August 1 – October 31) migration periods. A total of 38 large bird trial carcasses were placed for searcher efficiency trials in Year 1, 33 large birds were placed in Year 2, and 26 large birds were placed in Year 3. A total of 27 large bird trial carcasses were placed for Year 1 carcass removal trials; 28 large bird trial carcasses were placed in Year 2; and 27 large bird trial carcasses were placed Year 3. Carcasses used for large bird trials included hen mallards (*Anas platyrhynchos*).

For each study year, the average probability that a large bird carcass was available and detected was calculated using the bias trial results. Season was tested to determine if removal rates was affected by season. Then, due to the different search intervals for half of the searched turbines, a probability of persistence was calculated for migration season (weekly and monthly) searches and non-migration season (monthly) searches in all three study years based on the appropriate removal rate.

9.1.1.2 Results

Year 1 (March 11, 2011 – February 10, 2012)

A total of 541 turbine searches were completed and two eagle mortalities (one golden eagle and one bald eagle) were found. The golden eagle was an incidental detection on a non-search plot, while the bald eagle was detected during searches on a search plot. The detection rate for large birds in Year 1 was 82.4% across all seasons. Individual search efficiency rates were not calculated for each individual searcher, but efforts were made to evenly distribute trials across all searchers. The mean removal time for large birds was 16.7 days across all seasons. The average probability that a large bird carcass was available and detected was 76.0% for weekly surveys and approximately 42% for monthly searches.

Year 2 (March 1, 2012 – February 28, 2013)

A total of 504 turbine searches were completed and no bald or golden eagle mortalities were found. The detection rate for large birds in Year 2 was 90.6%. The mean removal time for large birds was 8.23 days across all seasons. The average probability that a large bird carcass was available and detected was 64.0% for weekly surveys and approximately 24.0% for monthly searches.

Year 3 (March 1, 2013 – February 28, 2014)

A total of 498 turbine searches were completed and one golden eagle mortality was found incidentally on a non-search plot. The detection rate for large birds in Year 3 was 96.0%. The mean removal time for large birds was 26.6 days during migration season and 10.4 days during non-migration season. The average probability that a large bird carcass was available and detected was 84.0% during weekly migration season surveys, 56.0% during monthly migration season surveys, and 31.0% during monthly non-migration season surveys.

9.1.1.3 Conclusions

A total of two golden eagle mortalities and one bald eagle mortality (including incidentals) were found during the carcass search studies, from March 11, 2011 to February 20, 2014 (Appendix F). Only the bald eagle mortality was found on a search plot. Golden and bald eagle mortalities detected during the three year post-construction monitoring are shown by location and date in Figure 15.

In addition to the eagles found during the study, one golden eagle mortality was found on November 4, 2010 at Turbine 6 after the Project had begun operation, but prior to the commencement of the post-construction mortality monitoring. An additional golden eagle mortality was found in April 2010 during Project construction (prior to operation and monitoring). These detections were not included in the fatality analyses.

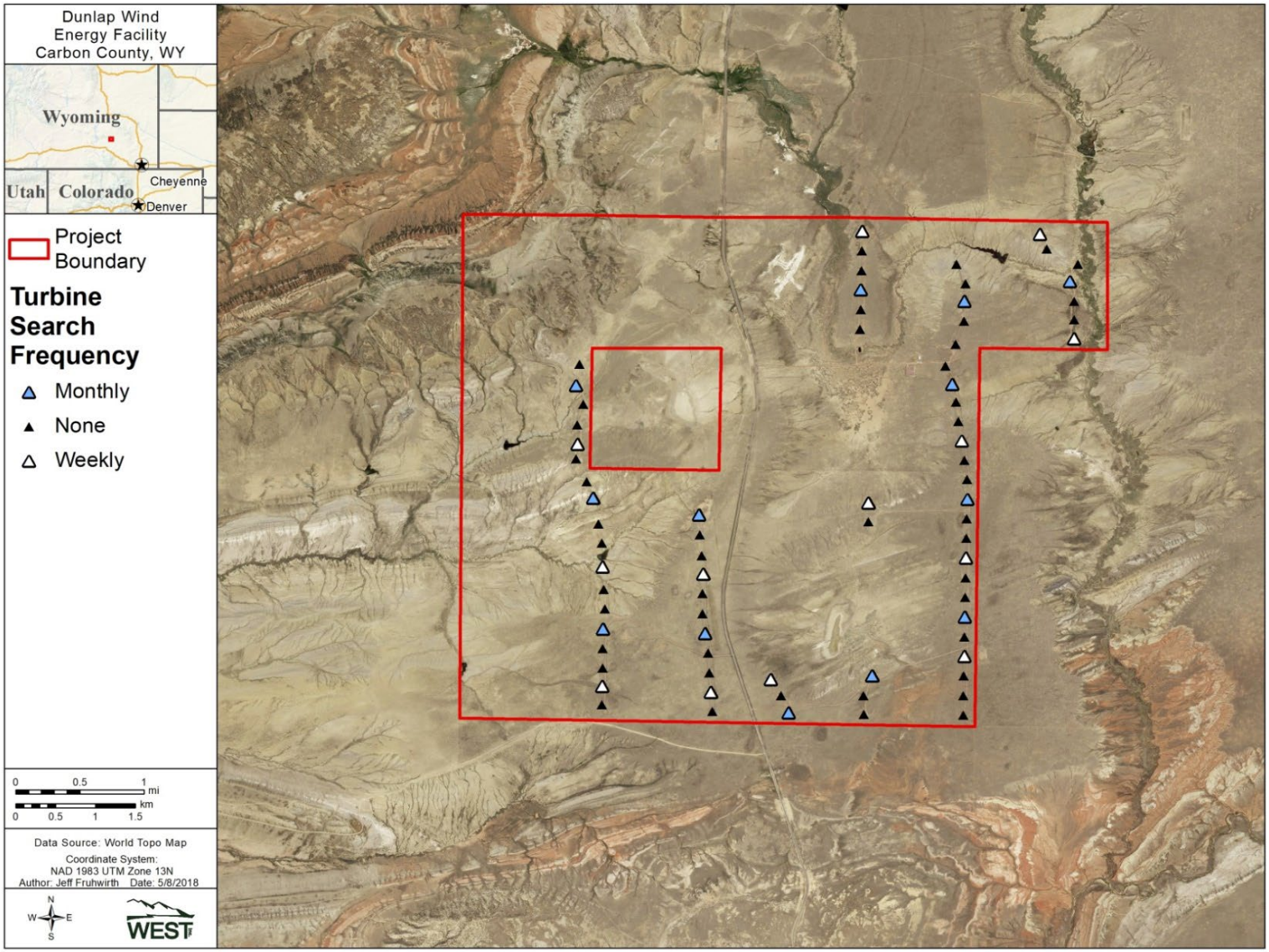

Figure 14. Location of carcass search plots at the Dunlap Wind Energy Facility, Carbon County, Wyoming (March 2011 – February 2014).

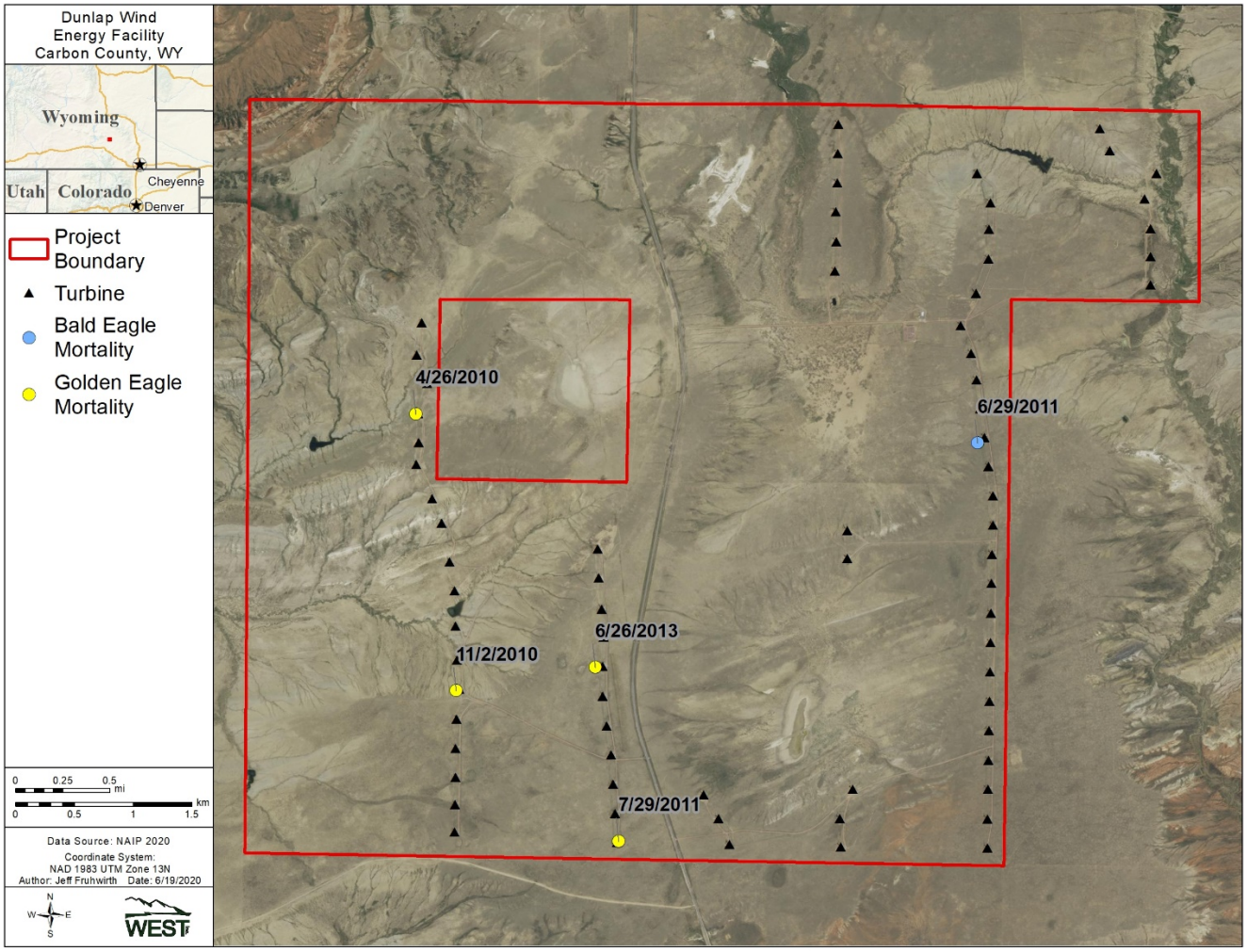

Figure 15. Location of eagle mortalities found at the Dunlap Wind Energy Facility, Carbon County, Wyoming, between March 11, 2011, and February 28, 2014 (three year post-construction monitoring period). The golden eagle mortality found on April 26, 2010 was discovered during construction before turbine 16 was erected. The golden eagle mortality found on November 2, 2010 was discovered during Project operation, but prior to the monitoring study. As such, these two mortalities have not been included in any fatality analyses.

9.2 Ongoing Monitoring

Ongoing mortality monitoring was initiated in March 2014 after the three year study was completed and continues in the present [currently April 2020]. PacifiCorp collaborated with the USFWS on mortality monitoring methods from March 2014 through the present [currently April 2020]. Only data through April 2018 are presented in this document.

PacifiCorp has implemented a number of monitoring methods after the completion of the 3-yr post-construction monitoring study and will continue to evaluate the need to conduct and/or modify monitoring efforts. In all cases, PacifiCorp has and will utilize qualified individuals to perform carcass searches at selected turbines.

From the period of March 2014 – December 2015, PacifiCorp contracted qualified biologists to search turbines two times a month (approximately every two weeks) at 20 m transects. Starting in January 2016, the search interval was reduced to one search round per month. Discussions and letter correspondence with USFWS representatives determined modifying the search methods was appropriate. No changes were made to transect search width or turbines to be searched. The once a month search interval has been conducted from January 2016 – present [currently April 2020]. For comparison to the three years of standardized monitoring (previously conducted from March 2011 through February 2014), PacifiCorp monitored the 26 turbines originally selected for standardized monitoring (*see* Section 9.1 above). PacifiCorp, in discussions with the USFWS, believed this monitoring method was sufficient to detect golden and bald eagles. The USFWS did recommend bias trials continue to be conducted to verify the methods remain appropriate.

Square plots (160 m [525 ft] on a side) were searched at each of the selected turbines. Since emphasis was placed on detecting eagle mortalities, transects were spaced approximately 20 m (33 ft to 50 ft) apart. In addition, since the possibility exists for eagle mortalities to occur in all areas of the Project, surveyors also inspected all non-searched turbines in the Project; this inspection included conducting a rapid visual inspection from the turbine pad as well as examination on foot of any areas hidden from view of the turbine pad. The rapid method varied by turbine and was based on the surveyor's discretion. The surveyor evaluated the visibility across the landscape and glassed the area around the turbine out to the edge of the plot (approximately 80 m). In most cases, the surveyor did not leave the pad. If areas were unseen (e.g., back of slope), the surveyor would investigate the non-visible areas on foot. Searches were not performed when weather conditions made turbines inaccessible or unsafe to access in a standard road vehicle. Any detection located at a rapid turbine search was classified as an incidental detection and was not included in the fatality estimates.

Searcher efficiency trials of similar size and coloration to golden eagles were used to calculate detection rates. The trials were real feather skins (Turkey Skinz) wrapped around a foam decoy (Figure 15). Initially trials were placed on search and non-search turbines to evaluate the probability of detection; however, starting in 2017 a decision was made to only target searched turbines. Trials placed on non-search turbines were not used to inform fatality estimates. The goal

of the trials was to evaluate the effectiveness of the monitoring for detecting eagles during the monitoring period at searched turbines. Incidental detection of trials was not an objective of the monitoring study, but was tracked as detections were reported. Trials were conducted throughout each search year, with approximately 100 trials conducted to date. No additional carcass persistence trials (beyond those conducted during the 2011 – 2014 studies) have been completed for the Project to date.

Data collected during the search efforts (i.e., eagle discoveries) have been compared against previous annual values. The eagle mortality discoveries have remained consistent throughout the continued monitoring period (2014 – 2018), with one golden eagle found in 2014 (8/15/14), one golden eagle found in 2015 (10/23/15), one golden eagle found in 2016 (10/13/2016), no golden eagles detected in 2017, and one golden eagle found to date in 2018 (3/14/2018). Searcher efficiency trial rates have been approximately 87% for searched turbines and 79% for non-searched turbines during the study period. The non-searched turbine detection rates were based on a limited number of trials (n = 24).

PacifiCorp will continue to monitor the search efforts and discuss potential protocol modifications with the USFWS. The results of continuing detection trials may inform changes to the protocols used for the ongoing monitoring program. Additionally, year-round for the life of the project, PacifiCorp contractors and staff will report, using the WIRHS protocols, any eagle mortalities found.

Figure 16. Photo of a representative Turkey Skinz decoy used for searcher efficiency trials at Dunlap from March 2014 – present.

9.3 Nest Surveys

9.3.1 *Methods*

The methods implemented to survey raptor nests have been modified throughout the Project's duration. Modifications have been made to increase nest survey proficiency and follow protocols and naming conventions recommended by the USFWS.

The Project as well as a surrounding 2-mile buffer was searched for active and non-active raptor nests during the three years of post-construction monitoring (Summer 2011, Spring 2012, and Spring 2013; Appendix G). The objective of the raptor nest surveys was to determine the occupancy of eagle nests in and near the study area to compare to pre-construction data on nesting eagles obtained during the 2009 baseline study. Similar to searches in 2009, ground based searches were conducted in 2011. One round of nest surveys was completed in July 2011. Nest surveys specifically targeted previously identified nests; however, efforts were made to locate additional nests in suitable habitat (e.g., rocky out crops/cliffs, trees, etc.). The property southeast of the Project was not accessible for ground checks during any survey year due to private landownership. Aerial and ground-based nest surveys were completed in 2012 and 2013 to determine occupancy and nest success. In 2012, a 2-mile buffer was surveyed including one early season ground check and one aerial flight in April. Follow up checks were not required at eagle nests, as no activity was observed in April. In 2013, a 2.5-mile buffer was surveyed including one early season ground check and one aerial flight in May. Follow up checks were not required at eagle nests, as no activity was observed in May.

Survey methods for 2014, 2015, 2016, and 2017 were designed to identify potentially occupied eagle nests and track eagle nest activities throughout the nesting season, with a goal of determining nest productivity (i.e., number of chicks) and success (i.e. did chicks fledge). This included the identification of unoccupied eagle nests. In 2015, a formal raptor nest survey protocol was developed in conjunction with the USFWS. The methods detailed in this plan were agreed upon by PacifiCorp and USFWS. The text of the plan is provided below.

PacifiCorp will conduct annual eagle nest surveys within 2.5 miles of the Project (subject to weather conditions, safety, and landowner access to nests). The primary objectives of the raptor nest surveys are to: 1) identify all eagle and ferruginous hawk nests present in the defined survey area that were identified in previous years; 2) locate potentially new eagle and ferruginous hawk nests during the current nesting season; 3) monitor the occupied eagle and ferruginous hawk nests status throughout the nesting season (January 1 – August 31); and 4) determine the productivity and nest success for all occupied nests.

Modifications to this protocol may be warranted over time as new information becomes available.

Occupancy determinations will follow the guidance as outlined in the USFWS Eagle Conservation Plan document:

"Occupied nest – a nest used for breeding in the current year by a pair. Presence of an adult, eggs, or young, freshly molted feathers or plucked down, or current years' mutes (whitewash) suggest site occupancy. In years when food resources are scarce, it is not uncommon for a pair of eagles to occupy a nest yet never lay eggs; such nests are considered occupied."

Nest survey schedules may be modified based on weather and logistic issues. Ground checks will only be completed at nests where property access has been granted and these will be clearly identified. Aerial surveys will check all known (historic) and potentially new nests during each nesting season. Ground surveys will only check known nests or nests determined to be occupied during the current year's surveys. These methods will apply to eagle and ferruginous hawk nests. Nests that are determined to not be occupied in the current year will not be checked during subsequent checks. However, even for these nests at least two nest checks will still be made prior to April 1 of each nesting season. If a nest is determined, through the nest checks, to not be occupied as of April 1, then there will be no further monitoring of this nest during the current nesting season. Similarly, if a nest is determined to be occupied early in the season (e.g. March), but an incubating adult is not documented prior to April 1, this nest will not be included in the check for chicks or fledge success.

Survey Methods

The eagle nest surveys will follow the guidelines provided below:

January 1 – mid-February: Informal ground checks will be completed to verify potential occupation at known nest locations. A nest will be considered potentially occupied if it meets the definition provided above. These checks will be completed in coordination with other site activities.

Mid-February – late-March: The first round of aerial surveys will be conducted from a helicopter. The goal of this survey will be to document all eagle nests (potentially new and historic) and determine if the nests are occupied. One qualified WEST biologist and the helicopter pilot will fly the survey area (2.5-mile turbine buffer). Known nest data will include previous WEST survey data and BLM nest data. Features within the survey area where nests are likely to occur (e.g., rocky outcrops, trees, man-made structures) will be investigated for potential new nests.

Late-March – April: Ground checks will be completed at all occupied eagle nests (based on the results of the previous surveys). The goal of this survey will be to identify occupied eagle nests with incubating adults. The timing of surveys will be triggered by the presence of an incubating adult at a highly visible nest (e.g., eagle nest visible from public road). It is assumed one check will be completed at each occupied nest.

May: The second round of aerial surveys will be conducted from a helicopter. The goal of this survey will be to identify chicks at eagle nests that had incubating adults (based on previous surveys). This survey will be conducted at least 60-days after the first aerial survey. Only eagle nests where an incubating adult was observed (unless property access did not allow a March-April check) will be checked.

June – August: Ground checks will be completed at eagle and ferruginous hawk nests that have continued to be occupied and eggs or chicks were observed or assumed to be present) during previous surveys. The goal of this survey will be to identify eagle fledge success. It is assumed one check will be completed at each nest where chicks were present. Timing of surveys will be triggered by the fledge success confirmation at a highly visible nest (e.g. eagle or ferruginous hawk nest visible from a public road).

9.3.2 *Results*

As discussed in Section 5.1, in 2009, one active golden eagle nest (24781301) was located outside the Project boundary, but within the one-mile buffer surrounding the Project (Figure 8, Table 12). In 2011, no golden eagle nests were identified. The nest located in 2009 was not located in 2011 (or during the remainder of the nest surveys). No evidence of the nest was observed in the tree or on the ground below the tree during the ground check. In 2012, two golden eagle nests were located and one was classified as an occupied unsuccessful nest (24792501) and one was classified as unoccupied (23780101). The occupied nest had tending adults early in the season, but no further nesting activity was observed. No evidence of occupation was observed at the unoccupied nest. In 2013, two occupied unsuccessful golden eagle nests (24792501 and 23780101) were identified during survey efforts. Both nests had adult eagles near the nest, fresh greenery, and mutes observed during early season checks, but did not have incubating adults or chicks observed later in the nesting season.

In 2014, two occupied – active golden eagle nests (24792501 and 23780101) were identified during the first round of aerial nest surveys. A golden eagle was observed on each nest, in an incubating posture. As of May 2 (date of the second aerial survey) chicks were not present; however, an adult was still observed incubating at both nest sites. Land access was not granted to the golden eagle nest (23780101) southeast of the Project area; therefore, follow up surveys were not conducted and success could not be determined. The golden eagle nest (24792501) west of the Project was monitored on foot on June 19, 2014. No adults were present at or near the nest site and no chicks were observed. Based on these observations, the nest was believed to be unsuccessful.

In 2015, three golden eagle nests (23780101, 24792501, and 24780401) were located and monitored. No evidence of occupancy was observed at two nests (23780101 and 24792501) and these were determined to be unoccupied. A new golden eagle nest (24780401) was occupied and successfully fledged one young in 2015 (Figure 17; Table 12). This nest was historically an occupied and successful ferruginous hawk nest.

In 2016 and 2017, two golden eagle nests (23780101 and 24792501) were located and designated as unoccupied. No evidence of nesting was observed. The successful golden eagle nest in 2015 (24780401), reverted back to a ferruginous hawk nest in 2016 and 2017.

9.3.3 *Conclusions*

Only one successful nest was identified during the 2011 – 2017 nest surveys (Table 12). This occurred in 2015 at a nest that has been occupied by a ferruginous hawk in all other years. Beyond the nest located in 2009, two golden eagle nests were identified from 2011 – 2017. These nests have not been occupied since 2014. Survey methods varied among the survey years; therefore, results may not be directly comparable between years. Readers are encouraged to review the annual raptor nest memos for detailed descriptions on methods and results (Appendix F).

Annual eagle nest monitoring is planned until a permit is obtained. At that time, nest surveys will meet the permit requirements. Results from the monitoring efforts will be evaluated on an annual basis to determine if any additional measures are warranted. The annual results will be shared with USFWS.

Table 12. Eagle nest survey summary for the Dunlap Wind Energy Facility from 2009 through 2017.

NEST ID	2009		2011		2012		2013	
	Occupied (Y/N)	***Successful (Y/N)***	***Occupied (Y/N)***	***Successful (Y/N)***	***Occupied (Y/N)***	***Successful (Y/N)***	***Occupied (Y/N)***	***Successful (Y/N)***
24781301	Y	Unknown	Not Located	-	Not Located	-	Not Located	-
23780101	NS	-	NS	-	N	N	Y	N
24792501	NS	-	NS	-	Y	N	Y	N
24780401	NA	-	NA	-	NA	-	NA	-
NEST ID	**2014**		**2015**		**2016**		**2017**	
	Occupied (Y/N)	***Successful (Y/N)***	***Occupied (Y/N)***	***Successful (Y/N)***	***Occupied (Y/N)***	***Successful (Y/N)***	***Occupied (Y/N)***	***Successful (Y/N)***
24781301	Not Located	-	Not Located	-	Not Located	-	Not Located	-
23780101	Y	Unknown	N	-	N	-	N	-
24792501	Y	N	N	-	N	-	N	-
24780401	NA	-	Y	Y	NA	-	NA	-

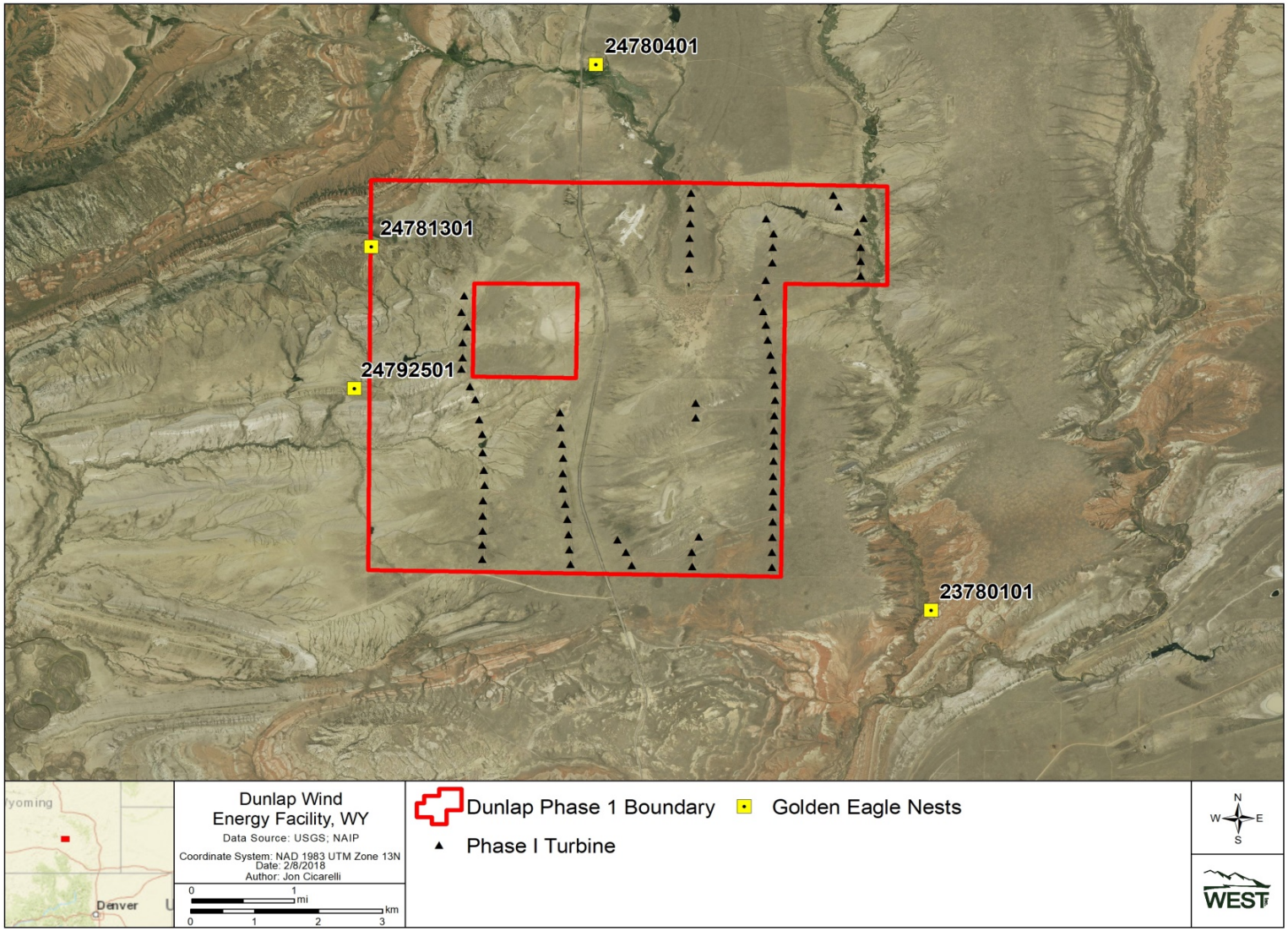

Figure 17. Dunlap Wind Energy Facility eagle nest locations from 2009 through 2017, Carbon County, Wyoming.

9.3.4 *Inter-Nest Distance*

Based on the eagle nest surveys conducted for the Project and surrounding 1-mile buffer in 2009, 2-mile buffer in 2011, 2012, and 2013, and 2.5-mile buffer in 2014, 2015, 2016, and 2017 there have been four golden eagle nests located within 2.5 miles of Project turbines. Only two nests have been occupied in any one year within the defined survey areas (2013 and 2014; Table 12).

The approach used in the ECPG for approximating eagle territories and evaluating the distance for monitoring potential disturbance/displacement impacts calls for measuring nearest neighbor distances from occupied nests in a single nesting year (USFWS 2013b). Using the two occupied golden eagle nests located in the vicinity of the Project in 2013 and 2014, the mean inter-nest distance is 9.74 miles and ½ the mean inter-nest distance or approximate territory radius is 4.87 miles (Figure 18). The two occupied golden eagle nests used for this calculation have not been occupied since 2014, and the nest that successfully fledged a young in 2015 was historically a ferruginous hawk nest, and returned to a ferruginous hawk nest in the 2016 and 2017 nesting seasons. The occupied golden eagle nest located during pre-construction surveys (Johnson et al. 2009), has not been identified during subsequent surveys. No other eagle nests have been located in the survey area. The mean inter-nest distance information for the Project should be interpreted with caution since the survey area has only extended out 2.5 miles from Project turbines, not the 10-mile buffer recommended in the ECPG (USFWS 2013).

9.4 Post-construction Risk Evaluations

In an effort to better understand potential risk to eagles at the Project, PacifiCorp coordinated efforts with WEST to map prairie dog populations at Dunlap and reviewed potential perch structures in the Project. This information was compared against eagle mortality locations.

The survey area was defined as a 1-mile buffer from Project turbines (PacifiCorp property only). Over 3,000 acres of concentrated white-tailed prairie dog (*Cynomy leucurus*) colonies (greater than 10 burrows per acre) were mapped during the survey at Dunlap. Less concentrated populations were present throughout the remainder of the site.

These concentration areas were compared with eagle mortality locations (Figure 19). Based on this comparison, prairie dog concentration areas were located near many of the golden eagle mortality discovery locations. The prairie dog concentration areas and mortalities were located in the west and southwest portions of the Project area. Extensive prairie dog populations were also mapped in the northeast Project area; however, only one golden eagle mortality has been discovered in this section of the Project.

Potential prairie dog control options were evaluated to minimize future risk to eagles; however, concerns were raised due to risk of harming eagles and potential impacts to other endangered species, specifically the black footed ferret.

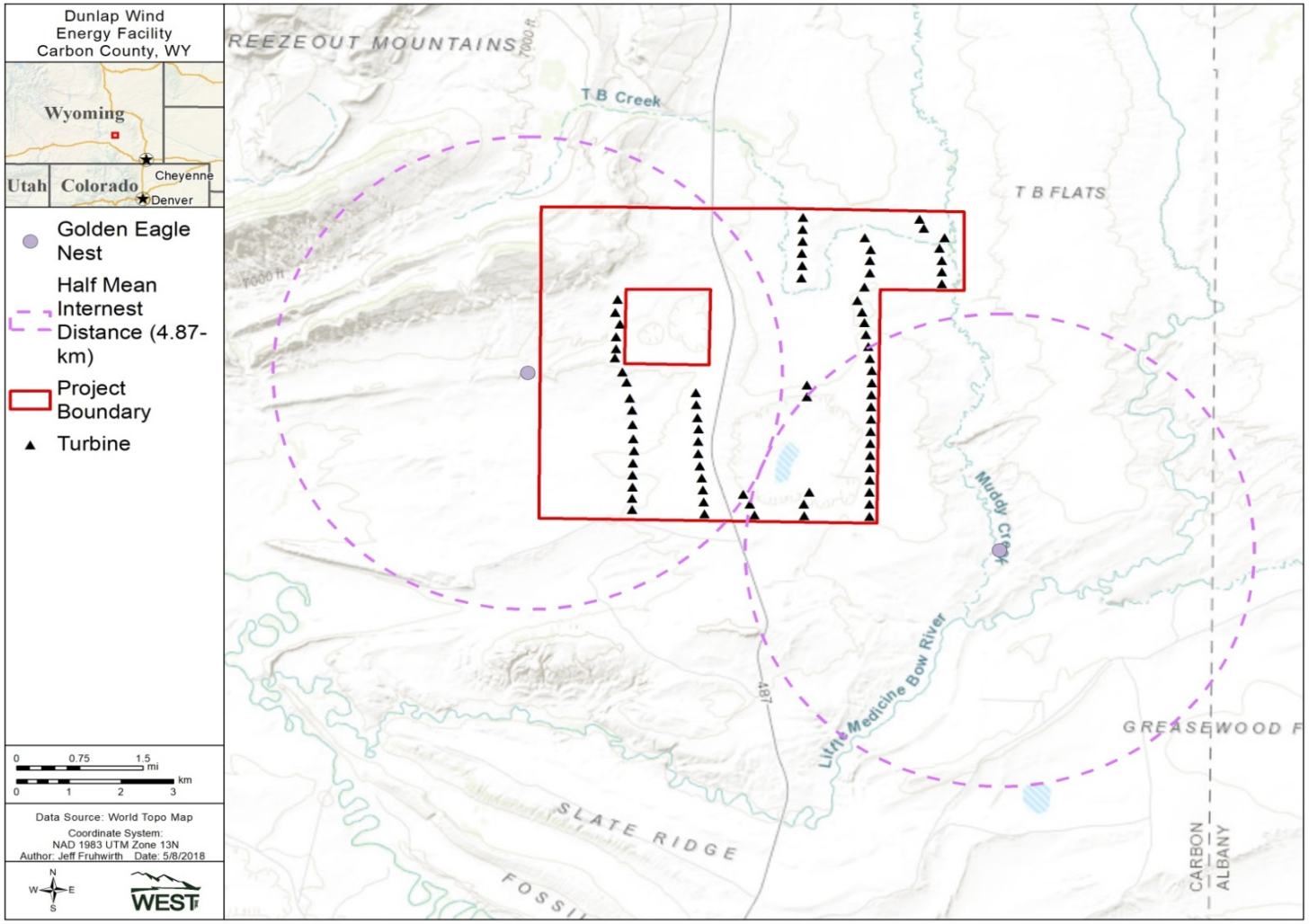

Figure 18. Approximate golden eagle territories occupied in 2013 and 2014 based on golden eagle nest surveys in the vicinity of the Dunlap Wind Energy Facility, Carbon County, Wyoming. A buffer distance of 4.87 miles was used based on half the mean inter-nest distance between the two occupied golden eagle nests identified in 2013 and 2014.

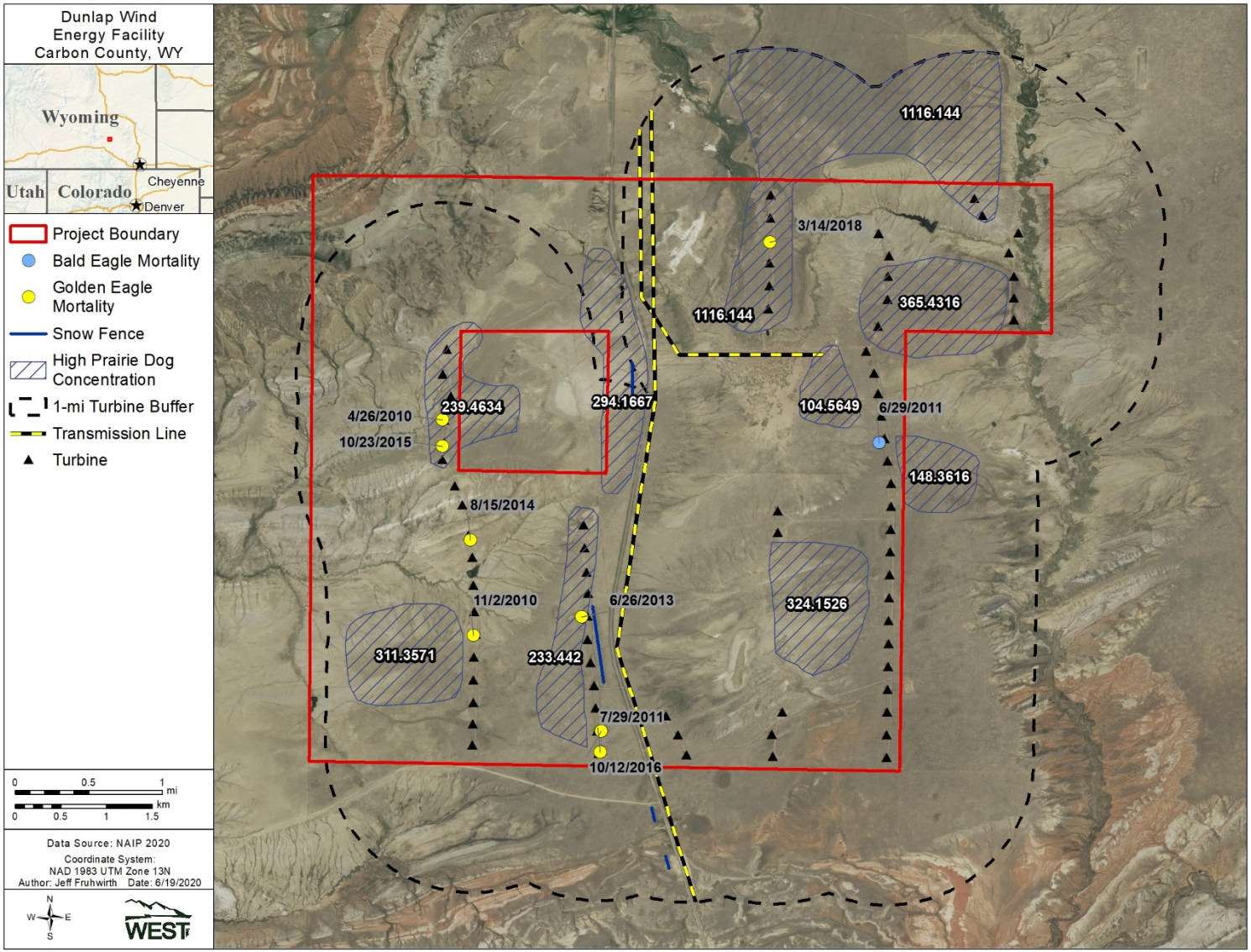

Figure 19. Dunlap Wind Energy Facility prairie dog populations, eagle perch opportunites, and eagle mortalities. Note: The April 2010 detection occurred prior to construction of turbines.

9.5 Eagle Mortality Discoveries to Date

To date, a total of eight eagle mortalities have been discovered at the Project during project operation through April 2018 (Figure 20; Table 13). One eagle mortality was found prior to the start of the mortality monitoring study, but after the Project began operations. This eagle was found in November 2010 at D6 by PacifiCorp personnel. This detection was not included in fatality estimates as it was located outside of the study period. An additional golden eagle was found during construction (April 2010; prior to operation) near the future turbine D15 location, and as such, this discovery has not been included in any fatality predictions or analyses. Two golden eagle mortalities were found during the initial 3-yr post-construction monitoring studies (Figure 9), both of which were incidental finds. The first golden eagle was found in July 2011 near turbine D19, and the second was found in June 2013 near turbine D25. Both detections occurred at non-searched turbines and were not included in fatality estimates. A bald eagle was found in June 2011 near turbine D50 at a searched turbine and during a scheduled search.

Four golden eagle discoveries have occurred during the ongoing monitoring surveys. One golden eagle was found in August 2014 near turbine D10. This detection was located during a rapid check at a non-searched turbine and as such was classified as an incidental detection. One golden eagle was found in October 2015 near turbine D14 during a transect search at a searched turbine. One golden eagle was found in October 2016 near D21 by PacifiCorp personnel. The detection was an incidental find at a non-searched turbine. One golden eagle was found in March 2018 near turbine D60 by PacifiCorp personnel. The detection was an incidental find at a non-searched turbine.

Table 13. Eagle mortality summary for the Dunlap Project; Carbon County, Wyoming (April 2010 – April 2018).

Date	Species	Mortality or Injury	Incidental or Scheduled Search
4/26/2010*	golden eagle	Mortality	Incidental
11/2/2010*	golden eagle	Mortality	Incidental**
6/29/2011	bald eagle	Mortality	Scheduled Search
7/29/2011	golden eagle	Mortality	Incidental**
6/26/2013	golden eagle	Mortality	Incidental
8/15/2014	golden eagle	Mortality	Incidental***
10/23/2015	golden eagle	Mortality	Scheduled Search
10/12/2016	golden eagle	Mortality	Incidental**
3/14/2018	golden eagle	Mortality	Incidental**

*Mortalities found prior to the start of mortality monitoring study
**Designates mortality found by operations personnel
***Found during a non-standard survey (rapid check)

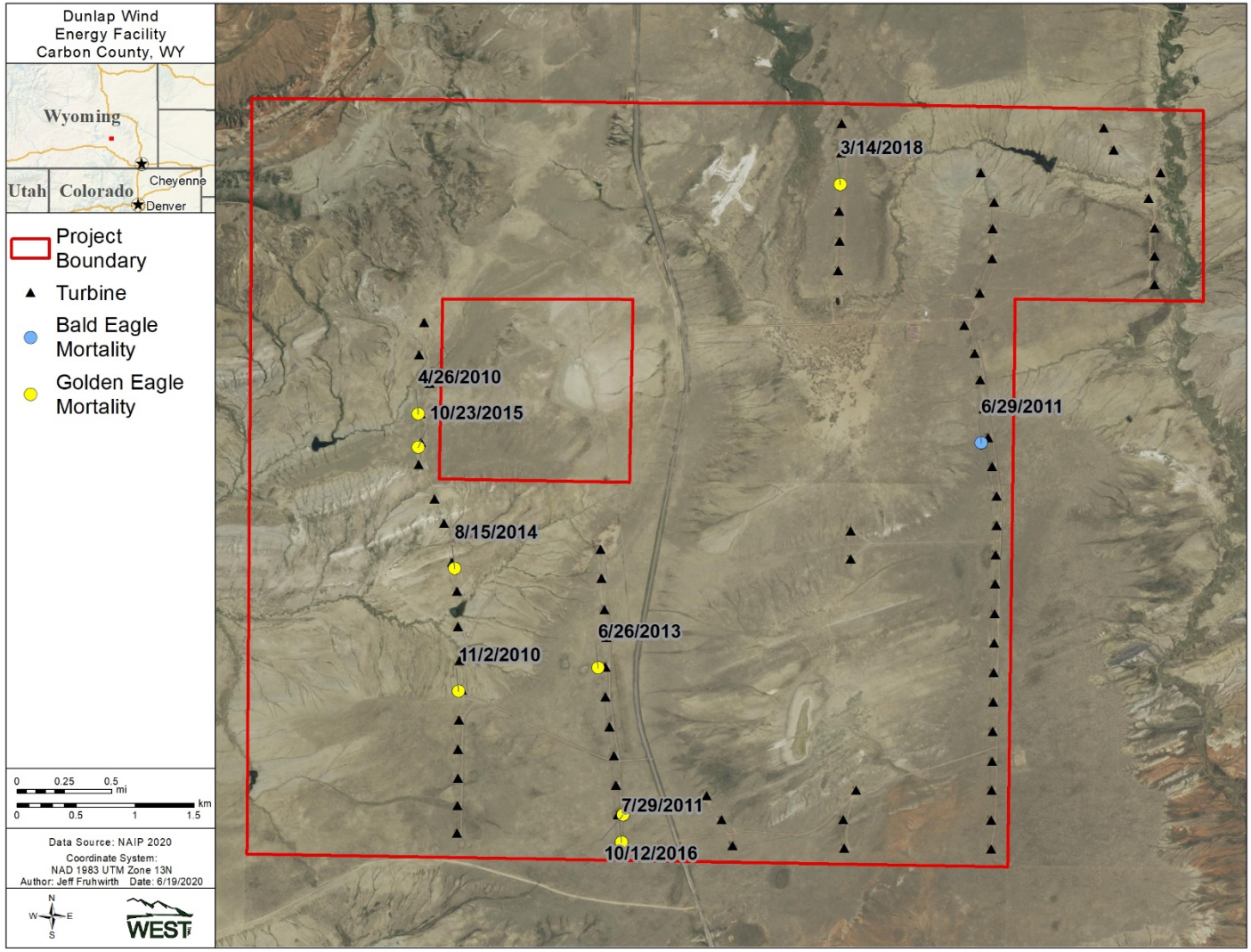

Figure 20. Location of eagle mortalities found to date at the Dunlap Wind Energy Facility, Carbon County, Wyoming (April 2010 through April 2018). The golden eagle mortality found on April 26, 2010 occurred during construction before turbine 16 was erected. The golden eagle mortality found on November 2, 2010 occurred during project operation, but prior to the monitoring study. As such, these two mortalities have not been included in any fatality analyses.

9.5.1 *Mortality Modeling – Informed (Post-construction)*

Pre-construction eagle data collected during avian use surveys for the Project were used to predict golden and bald eagle mortalities (see Section 7.3.1). The ECP Guidance recommends post-construction monitoring data are used to inform take predictions for an operational wind facility. As part of this ECP, additional take prediction modeling has also been completed that includes only post-construction mortality monitoring data. Due to the concerns raised by the USFWS related to the pre-construction eagle use data collected during avian use surveys and the fact that these data were collected before the Final Eagle Rule (USFWS 2016) data standards of the were available, the mortality predictions presented in this section of the ECP are based solely on the results of the post-construction mortality monitoring and Evidence of Absence (EoA) analysis. The EoA analysis was not used in conjunction with the USFWS Collision Risk Model (and associated pre-construction data) to predict eagle take.

The EoA framework utilizes a statistical hierarchical model to estimate the actual number of fatalities from the number found and probability of discovery. The EoA estimator assumes the number of fatalities found during searches follows a binomial distribution,

$$X \sim \text{binomial}(M,g)$$

where X is the count of fatalities found during standardized carcass searches, M is the (unknown) number of eagle fatalities, and g is the site-wide probability that a carcass is available to be found and detected by searchers. The site-wide probability that a carcass is available to be found and detected by searchers is based on the following Dunlap specific data (see Sections 9.1 – 9.3 above and Appendix F for additional details):

- Searcher efficiency expressed as the proportion of placed carcasses found by searchers during searcher efficiency trials. The searcher efficiency trials only include the Turkey Skinz trials that occurred during the ongoing monitoring period; large birds trials (mallards) conducted during the first three years of mortality monitoring were not used.
- Non-removal rates expressed as the estimated average probability a carcass was expected to remain in the study area and be available for detection by the searchers during removal trials. The persistence trials only occurred during the first three years of mortality monitoring and used mallards. No carcass persistence trials have been conducted during the ongoing monitoring periods; therefore, the non-removal rate from the three years of post-construction monitoring were used to inform subsequent years.
- Search area adjustment based on the relative carcass density within search areas and outside of search areas. The Hull and Muir distribution model was used to correct for potential search area bias.

- Search area correction also adjusted the estimate based on the number of turbines searched (26) relative to the total number of turbines at the Project (74).

The statistical hierarchy of models inherent in EoA assumes the total number of eagle fatalities (M) follows a Poisson distribution,

$$M \sim Poisson(\lambda),$$

where λ is the rate that eagle fatalities occur at the Project. A further step in the model hierarchy assumes λ is a Jeffreys prior, and g follows a beta distribution,

$$g \sim beta(\alpha,\beta).$$

The parameter of interest, λ, is estimated using Bayesian methods. Under these methods, the posterior distribution for λ is estimated using a direct calculation. The reported prediction is the mean of the posterior for λ, while 80th credible interval for λ is the upper 80% quantile from the posterior.

Post-construction fatality monitoring studies were conducted for nearly seven years, March 2010 - December 31, 2017, at the Project (Section 9.2 and 9.3). During the study, one bald eagle and six golden eagles mortalities were found. Of these, the one bald eagle detection in 2011 and one golden eagle detection in 2015 were found during scheduled searches of the 160 m x 160 m search area and located inside these search plots. EoA 50% credible interval and 80% credible interval are provided for each study year and the combined seven year period (Table 14) as well as the annual average for a single year (Table 15). Additionally, the adjustment factor (g-value) is also provided in both tables. As described in Section 9.2 and 9.3 above, data from two monitoring periods were used in this analysis. Results should be interpreted with caution as these data may not be directly comparable.

Individual year's take predictions for bald and golden eagles show a lot of variability with bald eagles ranging from one to 17 fatalities (50% credible interval) and golden eagles ranging from one to nine fatalities (50% credible interval). The annual average for bald and golden eagles was 1.8 fatalities per year at the 50% credible interval and 3.5 fatalities per year at the 80% credible interval (Table 15).

Comparisons between the USFWS Collision Risk Model (CRM) assessment (Section 7.0) and the EoA assessment show similar predicted take for golden eagles. The CRM predicted an annual average take at 1.38 golden eagles and an 80th percentile at 2.04 golden eagles, while the EoA predicted annual take at 1.8 golden eagles and 3.5 golden eagles, respectively. The bald eagle predictions showed greater disparity with the CRM predicting well under one bald eagle per year, while the EoA predicted 1.8 and 3.5 bald eagles per year at the average and 80th credible interval.

The take predictions provided in this chapter were developed using the model/process outlined above and may vary from the methodology and take predictions developed by USFWS. However, it is understood the USFWS will ultimately decide the number of eagle takes to evaluate in the NEPA process and include in associated permit conditions.

Table 14 Evidence of absence results for estimated yearly take based on data gathered during the seven years of post-construction mortality monitoring conducted from March 2011 – December 2017, at the Dunlap Wind Energy Project, Carbon County, Wyoming.

Study Year	Eagle Mortalities Included in the Estimate	g-value	Average Annual Take (λ)	Annual take (λ) - 80th credible bound
Bald eagles				
Year 1	1	0.069	17	33
Year 2	0	0.045	4	17
Year 3	0	0.089	2	8
Year 4	0	0.124	1	6
Year 5	0	0.129	1	5
Year 6	0	0.102	2	7
Year 7	0	0.115	1	6
Golden eagles				
Year 1	0	0.069	3	11
Year 2	0	0.045	4	17
Year 3	0	0.089	2	8
Year 4	0	0.124	1	6
Year 5	1	0.129	9	17
Year 6	0	0.102	2	7
Year 7	0	0.115	1	6

λ = lambda, annual take

Table 15. Evidence of Absence results for estimated annual take based on data gathered during the seven years of post-construction mortality monitoring conducted from March 2011 – December 2017, at the Dunlap Wind Energy Project, Carbon County, Wyoming.

Species	g-value	Average Annual Take (λ)	Annual take (λ) - 80th credible bound
bald eagles	0.096	1.8	3.5
golden eagles	0.096	1.8	3.5

λ = lambda, annual take

9.5.1.1 Local Area Population and Cumulative Impacts

USFWS Region 6 will complete the local area population (LAP) analysis for the Project using their cumulative effects tool and proprietary data on known eagle mortality within the LAP area for each eagle species. This is not an analysis that Project proponents are expected to complete.

The USFWS analysis will provide a cumulative impacts assessment for both golden and bald eagles at the LAP scale within the 109 mile and 86 mile species-specific buffers. This review will consider eagle mortality records from other existing wind energy facilities as well as all other sources of known mortality such as electrocution, collisions, shootings, poisonings, etc. This information, and the accompanying analysis, will be fully presented in the Environmental Assessment (EA) that USFWS will complete for the Project. The information about known eagle

mortality will be used by USFWS Region 6 in the decision making process about whether or not to issue an programmatic eagle take permit for the Project and the level of take for golden and bald eagles that could potentially be authorized.

9.6 Compensatory Mitigation

With the implementation of the AMMs described above, some unavoidable eagle mortalities may still occur. Additional compensatory mitigation will be necessary to ensure that the standard of no net loss to the population is achieved whenever golden eagles are taken. PacifiCorp will prepare a Project-specific power pole retrofit plan using a template provided by USFWS, Mountain Prairie Region Office.

Based on recommendations under the ECPG, utility pole retrofits are currently the preferred mitigation approach accepted by USFWS as compensatory mitigation. The requirements for *bird-safe* utility poles are well known and are being implemented by PacifiCorp and other utilities. The reduction of electrocutions will benefit eagle productivity directly by reducing this source of mortality.

PacifiCorp will retrofit, to meet or exceed current APLIC guidance (APLIC 2006), enough electric utility poles to provide full compensatory mitigation for all golden eagle take that would be authorized by USFWS under a EITP; if this permit is issued for the Project. The number of utility pole retrofits per eagle mortality discovery will be based on a resource equivalency analysis (REA) conducted by USFWS (USFWS 2013a). All power pole retrofits will be monitored in accordance with the protocols established in the Rocky Mountain Power APP. If additional monitoring is necessary it will be developed in accordance with permit requirements.

9.7 Adaptive Management

The ECPG recommends that a project developer or operator collect information to determine potential conservation measures that can be employed to avoid and/or minimize the predicted risks at a given site (Stage 4). PacifiCorp will continue to evaluate impacts to determine if additional ongoing operational monitoring beyond the WIRHS system is warranted. The adaptive management plan includes ongoing and future strategies (i.e., mitigation and conservation measures) to avoid and minimize impacts to avian resources.

9.8 Adaptive Management Plan

PacifiCorp has developed this ECP including the following adaptive management plan based on the Project specifics and data available to monitor for impacts and avoid, minimize and mitigate impacts to eagles and other avian species.

PacifiCorp's adaptive management plan (1) evaluates the mortality rates reported based on post-construction monitoring; (2) evaluates triggers to monitor the potential effects of various avoidance, minimization, and mitigation measures that may be implemented; and (3) reviews and

implements, as appropriate, recommendations from the USFWS related to resource avoidance, minimization, and mitigation measures designed to reduce Project impacts on eagles.

Actions described below include an investigation of the probable causes of discovered eagle mortalities that could trigger the need for adaptive management (e.g., weather events or other considerations correlating with mortality discoveries). This ECP provides a framework for assessing if the adaptive management triggers as defined below have been reached.

A summary table of the avoidance and minimization measures for golden eagles is provided below. Table 16 outlines a step-wise approach to mitigation, thresholds, and the implementation of conservation measures. This table will be updated once additional discussions with the USFWS have occurred and/or after the USFWS has conducted their take analysis to support potential permit issuance.

Table 16. Summary of Adaptive Management Plan using a step-wise approach.

Step	Conservation	Threshold or Trigger
I	Assess eagle fatality to determine and/or understand potential cause. Evaluate fatality with previous take to determine if common factors are evident. Initiate consultation with USFWS to review appropriate measures to minimize likelihood of future take. Evaluate take levels relative to permitted value.	One golden or bald eagle taken
II	Evaluate the need to conduct additional studies to inform take occurrences. Identify actions that can be taken to avoid or minimize future take. This may include operation BMP, habitat management, ACP, or other activities deemed appropriate. Consult with USFWS to determine potential course of action.	To be determined based on authorized take levels. Take is within the authorized limit. Trigger will be determined based on a rate of take that could exceed the authorized take over a 5 year period if take continues at the rate identified.
III	PacifiCorp will consult with the USFWS to review and discuss information known about previous takes, in an attempt to identify factors which might be targeted. PacifiCorp's overall mitigation program for the subsequent 5-year permit period would be re-evaluated, based on actual results as compared with permitted levels of take, and this stepwise approach will start over with Step I. Examples of measures that may be implemented include: • Employ onsite biological monitor(s) during daylight hours at locations and/or times of suspected risk, to further refine the understanding of risk factors. • Implement habitat management or modification plan to minimize attraction to the Project, limit perching within the Project, and generally minimize risky behaviors	To be determined based on authorized take levels. Take is within the authorized limit. An additional take would meet the authorized amount under the permit.

Table 16. Summary of Adaptive Management Plan using a step-wise approach.

Step	Conservation	Threshold or Trigger
	• Implement a limited curtailment program specific to the area(s) and/or period(s) of highest collision risk. • Develop and evaluate detection and deterrent system for eagles approaching area(s) of risk. • Other measures agreed upon in consultation with USFWS	

9.8.1 *Mitigation for Bald and Golden Eagles*

Upon discovery of a bald or golden eagle mortality at the Project, the following actions will be taken:

- PacifiCorp will tarp the mortality and fill out the appropriate WIRHS reporting form.
- PacifiCorp will notify the designated USFWS office consistent with permit requirements.
- PacifiCorp will, if requested by USFWS, meet and confer with the USFWS to help determine the circumstances under which the mortality was discovered.
- PacifiCorp will work with the USFWS to evaluate available mortality discovery data and, as appropriate, implement additional monitoring measures, or implement measures to help reduce potential risks to eagles.

10.0 Permits and Reporting

10.1 USFWS Eagle Incidental Take Permit

If PacifiCorp obtains an eagle incidental take permit, they will follow all stipulations required by the permit. It is assumed that a Project-specific monitoring plan will be developed and required by the permit. PacifiCorp is committed to meeting the permit stipulations. Incidental reporting will continue as described in the PacifiCorp WIRHS. Additionally, for the life of the Project quarterly checks at all turbines will be completed.

10.2 USFWS Special Purpose Utility Permit (SPUT)

PacifiCorp applied for and received a Special Purpose Utility Permit (SPUT) renewal from the USFWS on April 03, 2020 (MB00466B-0). This permit is valid through March 31, 2023. The SPUT authorizes PacifiCorp to collect, transport, and temporarily possess migratory birds found dead or injured at the Project. Sub-permittees and employees directly reporting to the sub-permittees are also authorized under the permit. The permit does not allow eagles and federally listed threatened and endangered species to be collected. PacifiCorp will apply for a permit renewal as necessary throughout the duration of the Project. Under the conditions of this SPUT, PacifiCorp will report to USFWS all birds found dead or injured at the Project.

10.3 Wyoming State Permits

PacifiCorp has applied for and received a Chapter 10 (No. 1545) and Chapter 33 (No. 696) Permit from the Wyoming Game and Fish Department (WGFD). Permits have been authorized for the present calendar year and will be updated as warranted for the life of the Project. The Chapter 10 permit authorizes PacifiCorp to import, possess, confine, transport, sell and/or dispose of live wildlife. The Chapter 33 permit is a scientific resource, education/display or special purposes permit that allows PacifiCorp to possess and remove bird and mammals on and within one mile of the Project area. As a stipulation of the permit, PacifiCorp will provide annual reports to the WGFD. PacifiCorp will renew permits as necessary to complete the Project activities.

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Appendix A. PacifiCorp's RESPECT Corporate Policy

Environmental RESPECT

MIDAMERICAN ENERGY HOLDINGS COMPANY

MidAmerican Energy Holdings Company Policy of Environmental RESPECT

MidAmerican Energy Holdings Company believes responsible environmental management is good business; it benefits our customers and improves the quality of the environment in which we live. This policy establishes the environmental RESPECT principles that guide our corporate commitment to the environment.

Responsibility

All levels of management are responsible for integrating environmental management programs into business processes in order to measure and improve environmental performance. All employees are responsible and accountable for understanding and incorporating environmental compliance requirements into their daily work activities with the obligation to bring issues and concerns forward for resolution.

Efficiency

We will responsibly use natural resources and pursue increased efficiencies that reduce waste and emissions at their source. We will develop sustainable operations and implement environmental projects designed to leave a clean, healthy environment for our children and future generations.

Stewardship

We will respect our natural resources and take care in balancing the needs of customers with our obligation to future generations. We will seek opportunities to preserve, restore, protect and improve our natural surroundings.

Performance

We will set challenging goals and assess our ability to continually improve our environmental performance. Through the strategic management of our assets, we will improve the environment and contribute to our business success.

Evaluation

We will perform audits to evaluate our environmental compliance and use the results to improve our operations and their impact on the environment.

Communication

We will foster open dialogue and informed decision making through communication of environmental information with management, employees and the public. We will work with governments and others in creating responsible environmental laws and regulations reflective of sound public policy.

Training

We will provide the training necessary for our employees to perform their environmental responsibilities. We will encourage and provide opportunities for employees to learn more about the environment and foster an atmosphere of creating cost effective solutions that go beyond compliance.

MidAmerican ENERGY. CALENERGY CE Electric UK

PACIFICORP Kern River GAS TRANSMISSION COMPANY Northern Natural Gas HomeServices of America inc. A Berkshire Hathaway Affiliate

Appendix B. Dunlap Technical Advisory Committee Meeting Notes

Dunlap Ranch Post Construction TAC Meeting

May 13, 2011

Participants:

Trish Sweanor	USFWS
Greg Johnson	WEST
Luke Martinson	WEST
Travis Brown	PAC
Craig Lucke	PAC
Ken Clark	PAC
Will Schultz	WGFD
Scott Gamo	WGFD
Jeff Beck	UW
Katie Taylor	UW

Meeting Minutes:

- The meeting started with introductions of participants
- **Big Game**
- Two studies are being completed at Dunlap Ranch (elk/pronghorn)
- 30 elk and 35 pronghorn were captured for collaring (scheduled to fall off May 2012)
- Walcott (30 pronghorn) used as reference site
- Monitoring for mortalities has been completed from the air
    - Dunlap pronghorn – 16 mortalities (2 capture stress related)
    - Walcott pronghorn – 8 mortalities (3 capture stress related)
    - Dunlap elk – 5 mortalities (2 hunter kills)
- Collars retrieved have shown Dunlap pronghorn moving out of the study area; summer north of Dunlap, lots of movement west to Seminole Reservoir, winter pronghorn wide spread
- Collars retrieved have shown Walcott pronghorn contained within winter range; some movement east/southeast; none north of Interstate 80.
- Collars retrieved for Dunlap elk show presence in study area
- Overall: Continue to collect/analyze data; consider placing collars on more pronghorn; look at weather and mortalities

- **Avian/Bat Fatality Study**
- Brief overview provided by WEST
    - 26 turbines/4 met towers searched monthly
    - 13 turbines/4 met towers searched weekly during spring/fall migration
    - Search efficiency and removal trials planned and ongoing
- Oct. 1, 2010 operations started
- Golden eagle carcass found November 4, 2010

- Mortality monitoring started on March 15, 2011 delay in establishing monitoring program reported due to funding not being in place earlier
- Prior to site operation a golden eagle (turbine 12) and horned lark (turbine 6) were located
    - PAC to follow-up on golden eagle mortality
- Golden eagle nest active 2009, but dilapidated in 2011
- Ferruginous hawk nest platform (no nesting material present) located by PAC not on previous nest maps
    - Need more info on platform, PAC is in contact with Keith
- USFWS requested
    - clear up nest location disparity among maps
    - nest search protocol
    - create as-built map with nest location/activity/species
        - check all nests
    - BLM data (4-mile buffer) for golden eagle nests
    - Potential for change in protocol if fatalities occur

- General discussion on Seven Mile Hill (SMH) and Glenrock/Rolling Hills (GRRH)
- 3 Active golden eagle nests at GRRH
- 1 Active golden eagle nest at SMH
- Sites need to be checked again for nest activity (tending, chick presence, etc.)
- Final GRRH and SMH golden eagle monitoring plan reports being completed by WEST

Appendix C. Agency Communication

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Ecological Services
5353 Yellowstone Road, Suite 308A
Cheyenne, Wyoming 82009

In Reply Refer To:
ES-61411/22/WY08FA0106

MAY 15 2008

Cindy Crane, Vice President
Strategy and Division Services
PacifiCorp Energy
825 NE Multnomah, 20th Floor
Portland, Oregon 97232

Dear Ms. Crane:

This letter is intended to follow up on our May 7, 2008, discussions concerning PacifiCorp Energy's proposed wind energy projects in Wyoming and specifically the Dunlap Ranch wind energy project near Medicine Bow, Wyoming. The U.S. Fish and Wildlife Service (Service) greatly appreciates the efforts you have made to coordinate with our office as well as with the Wyoming Game and Fish Department (WGFD). Pursuant to our meeting, we are providing you with the following information to assist you during early project planning and help ensure compliance with the Endangered Species Act (Act) of 1973, as amended (16 U.S.C 1531 *et seq.*), Migratory Bird Treaty Act (MBTA), 16 U.S.C. 703 and the Bald and Golden Eagle Protection Act (BGEPA), 16 U.S.C. 668.

Black-footed ferrets (*Mustela nigripes*) on the Dunlap Ranch property are part of the Shirley Basin/Medicine Bow Management Area population designated as experimental non-essential under the Act. Although such black-footed ferrets are listed and protected under the Act, additional management flexibility is provided under the provisions of the final rule (56 FR 41473) and special regulations promulgated for this population on August 21, 1991 (50 CFR 17.84(g)).

The WGFD has done an exceptional job at managing the reintroduction of the experimental population in the Shirley Basin/Medicine Bow Management Area and we rely on their expertise and on-the-ground experience to inform our decisions and recommendations concerning this population. Through close coordination with the WGFD, we believe that the development of the Dunlap Ranch wind energy project can be completed in a way that is compatible with the conservation of the black-footed ferret. However, in our discussions, PacifiCorp requested that we clarify how the provisions of section 7 and section 9 of the Act would apply to the experimental non-essential population of black-footed ferrets.

Consultation with the Service under section 7 of the Act only applies if there is a Federal nexus to the project (*e.g.*, a Federal permit, authorization, or funding will be obtained for the proposed

project). When there is a Federal nexus, the section 7 consultation requirement for a nonessential experimental population is to treat the population as though it were a species proposed to be listed (16 USC 1539 (j)(2)(C)(i)). Section 7(a)(4) of the Act requires Federal agencies to confer with us on any action that is likely to jeopardize the continued existence of any species proposed to be listed (16 USC 1536(a)(4)). Federal agencies may also confer with us on any action that may affect a species proposed to be listed. The Service can then assist the action agency in determining effects to species through an informal conference process. In accordance with section 10(j)(2)(B) of the Act, prior to establishing this population, we determined that this population was not essential to the continued existence of the species. Therefore, should it be required, we believe that the development of the Dunlap Ranch wind energy project can meet the objectives of the conference requirements under section 7 of the Act.

In addition to consultation or conferencing under section 7, Federal agencies have obligations under the provisions of section 7(a)(1), to utilize their authorities in furtherance of the purposes of the Act by carrying out programs for the conservation of endangered and threatened species (16 USC 1536(a)(1)). Agencies have discretion is selecting programs to conserve listed species, and we encourage Federal agencies to consider ways to further the conservation of the experimental non-essential population such as the black-footed ferrets located in the Shirley Basin/Medicine Bow Management Area.

The special rule for the experimental non-essential population of black-footed ferrets (50 CFR 17.84(g)) establishes the actions that are prohibited by section 9 of the Act ((16 USC 1539(j)(2)(C) and 1538(a)(1)(G)). The prohibition on taking black-footed ferrets from the experimental non-essential population (50 CFR 17.84(g)(2)), includes several exceptions, one of which is for take that "is incidental to and not the purpose of, the carrying out of an otherwise lawful activity and if such ferret injury or mortality was unavoidable, unintentional, and did not result from negligent conduct. Such conduct is not considered intentional or ``knowing take" for the purposes of this regulation, and the Service will not take legal action for such conduct . . ." (50 CFR 17.84(g)(5). We believe that this prohibition exception provides a means to address concerns about the potential for take incidental to the development of the wind energy project. Furthermore, we believe that through the continued close coordination with the WGFD, you will be able to minimize the potential for negative impacts to black-footed ferrets.

As stated in the preamble to the special rule, "It is the intent of the Service and the Department to work out reasonable, cooperative solutions to all situations where there is a conflict between human uses of and ferret recovery in the SB/MB Management Area" (56 FR 41487, Response to Issue 20). We stand fully behind that statement and look forward to working with you in coordination with the WGFD to resolve any potential conflicts with the experimental non-essential black-footed ferret population in the Shirley basin/Medicine Bow Management Area.

Based on our discussions, we understand that PacifiCorp will be preparing information describing how you will be working to ensure that wind energy projects in Wyoming address a variety of conservation concerns, including the black-footed ferret. To assist your efforts, we are providing some general information concerning recommendations for wind energy developments as well as information on other species of concern.

General Wind Energy Development Recommendations

The Service supports development of wind power as an alternative energy source. However, if not appropriately designed and sited, turbines and wind farms may negatively impact wildlife and their habitats. On July 10, 2003, the Service released *Interim Guidance on Avoiding and Minimizing Impacts to Wildlife from Wind Turbines* (http://www.fws.gov/ r9dhcbfa/wind.pdf). These voluntary guidelines are intended to assist project proponents avoid and minimize impacts from wind turbines to wildlife and their habitats. They are based on the best information available and were developed by a team of Federal, State, university, and wind energy industry biologists.

The guidelines contain a site evaluation process, called the Potential Impact Index (PII), with checklists for pre-development evaluations of potential wind energy sites. The PII represents a "first cut" analysis of the suitability of a proposed site. It does so by estimating use of the site by selected wildlife species and using those estimates as indicators of potential impacts. Emphasis of the PII is on initial site evaluation and is intended to provide more objectivity than simple reconnaissance surveys. There are two steps to follow:

1. Identify and evaluate reference sites, preferably within the general geographic area of the proposed facility. Reference sites are high-quality wildlife areas where wind development would result in the maximum negative impact on wildlife (i.e., sites selected to have the highest possible rank using the protocol). Reference sites are used to determine the comparative risks of developing other potential sites.

2. Evaluate potential development sites to determine risk to wildlife and rank sites against each other using the highest-ranking reference site as a standard. Although high-ranking sites are generally less desirable for wind energy development, a high rank does not necessarily preclude development of a site, nor does a low rank automatically eliminate the need to conduct predevelopment assessments of wildlife resources or post-development assessments of impacts.

The guidelines help to develop an objective comparison of the potential impacts to wildlife and their habitats between sites, and, in cases where only one site is being considered, can be used as a risk assessment tool. The evaluation area for a potential development site should include the "footprint" encompassing all of the turbines and associated structures including transmission lines planned for that proposed facility, and the adjacent wildlife habitats which may be affected by the proximity of the structures.

Pre-development evaluations should be conducted by a team that includes Federal and/or State agency wildlife professionals. Teams may also include academic and industry wildlife professionals as available. The pre-development evaluation may also identify additional studies needed prior to and after development. Post-construction monitoring is recommended at all developed sites to help improve the guidelines and to further reduce the potential effects of future wind development projects.

Migratory Birds
Migratory birds are protected under the MBTA and eagles are provided additional protection under the BGEPA. The MBTA prohibits the taking of any migratory birds, their parts, nests, or eggs except as permitted by regulations and does not require intent to be proven. Section 703 of the MBTA states, "Unless and except as permitted by regulations ... it shall be unlawful at any time, by any means or in any manner, to ... take, capture, kill, attempt to take, capture, or kill, or possess ... any migratory bird, any part, nest, or eggs of any such bird..." The BGEPA, prohibits knowingly taking, or taking with wanton disregard for the consequences of an activity, any bald or golden eagles or their body parts, nests, or eggs, which includes collection, molestation, disturbance, or killing.

Please note that it is important to avoid disturbance of nesting birds in a proposed project area to avoid violations of the MBTA and/or BGEPA. Therefore, if nesting migratory birds are present on, or near a project area, timing is a significant consideration and needs to be addressed in project planning. Please contact our office for assistance if you have any questions or concerns regarding active nests. Removal, destruction or causing abandonment of a nest could constitute violation of the MBTA and/or BGEPA. Under certain circumstances permits for nest manipulation, including removal or relocation may be issued, however, work that could lead to the take of a migratory bird including an eagle, their young, eggs, or nests should be coordinated with our office before any actions are taken.

While it is not possible under the MBTA to absolve individuals, companies, or agencies from liability if they follow recommended guidelines, the Service's Office of Law Enforcement and the Department of Justice have used enforcement and prosecutorial discretion in the past regarding individuals, companies, or agencies who have made good faith efforts to avoid the take of migratory birds.

Protective measures to help reduce possible impacts to migratory birds and other raptors should be installed. For example, 7 CFR § 1724.52 allows for deviations from construction standards for raptor protection, provided that structures are designed and constructed in accordance with *Suggested Practices for Raptor Protection on Power Lines: The State of the Art in 1996* published by the Edison Electric Institute/Raptor Research Foundation. The regulation requires that such structures be in accordance with the National Electrical Safety Code and applicable State and local regulations.

For new distribution lines associated with the wind power project we recommend (1) burying distribution lines where feasible, (2) constructing raptor-safe structures with increased conductor spacing adequate for bald eagles (i.e., minimum of 60 inches), (3) installing raptor-safe equipment, e.g., insulating the bushing conductor terminations and using covered jumper conductors, (4) employing arrestor and cutout covers, and (5) avoiding high avian use areas such as wetlands, prairie dog towns, and grouse leks.

Other Species of Concern
Greater Sage-grouse: The Service is currently conducting a review to determine if the greater sage-grouse grouse (*Centrocercus urophasianus*) warrants listing under the Act. Greater sage-

grouse are dependent on sagebrush habitats year-round. Habitat loss and degradation, as well as loss of population connectivity have been identified as important factors contributing to the decline of sage-grouse populations range-wide. Therefore, any activities that result in loss or degradation of sagebrush habitats that are important to this species should be closely evaluated for their impacts to sage-grouse. If important breeding habitat (leks, nesting or brood rearing habitat) is present in the project area, the Service recommends no project-related disturbance March 1 through June 30, annually. Minimization of disturbance during lek activity, nesting, and brood rearing is critical to sage- grouse persistence within these areas. If important winter habitats are present, we recommend no project-related disturbance November 15 through March 14.

Mountain Plover: Although the Service has withdrawn the proposal to list the mountain plover (*Charadrius montanus*) and we will no longer be reviewing project impacts to this species under the Act, we continue to encourage conservation of this species as it remains protected under the MBTA. Measures to protect mountain plover from further decline include (1) avoidance of suitable habitat during the plover nesting season (April 10 through July 10), (2) prohibition of ground disturbing activities in prairie dog towns, and (3) prohibition of any permanent above ground structures that provide perches for avian predators or deter plovers from using preferred habitat. Suitable habitat for nesting mountain plovers includes grasslands, mixed grassland areas and short-grass prairie, shrub-steppe, plains, alkali flats, agricultural lands, cultivated lands, sod farms, and prairie dog towns. We strongly encourage the development of protective measures with an assurance of implementation if mountain plovers are found within the project area.

White-tailed Prairie Dog: The white-tailed prairie dog has been petitioned for listing under the Act. White-tailed prairie dogs occupy mid to high grass meadows, shrub-grass, and desert grasslands 5,500 to 9,800 feet in elevation. White-tailed prairie dog populations are threatened by plague, resource development projects, recreational shooting, urban sprawl, habitat fragmentation and conversion of grasslands. Eradication programs have significantly impacted some populations of white-tailed prairie dogs. Project planning measures that protect and retain prairie dog towns for their value to the prairie ecosystem will aid in the conservation of this species and the myriad of species that rely on them.

The Service appreciates Pacificorp's efforts to conserve listed species, migratory birds and their habitats. If you have any questions or concerns regarding this letter, please contact Kathleen Erwin at the letterhead address or call (307) 367-5304.

Sincerely,

Scott Hicks

for Brian T. Kelly
Field Supervisor
Wyoming Field Office

cc: BLM, Wyoming State Office, Cheyenne, WY (J. Carroll)
BLM, Rawlins Field Office, Rawlins, WY (P. Madigan)
Pacificorp, Project Manager, Salt Lake City, UT (P. Johnson)
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United States Department of the Interior

FISH AND WILDLIFE SERVICE

Ecological Services
5353 Yellowstone Road, Suite 308
Cheyenne, Wyoming 82009

JUL 1 0 2009

In Reply Refer To:
ES-61411/W.99 /WY09FA0166

Mr. Chad Tepley
PacifiCorp Energy
1407 W. North Temple Suite 210
Salt Lake City, Utah 84116

Dear Mr. Tepley:

Thank you for meeting with our office on June 12, 2009, regarding PacifiCorp's Dunlap Wind Energy Project (Project) proposed for development north of the town of Medicine Bow in Carbon County, Wyoming. Seventy-four, 1.5-MW wind turbines are proposed for construction during Phase I of the project. Anticipated construction of roads for Phase I will begin in fall 2009, transmission line construction will begin fall 2009 and continue through winter 2010, and turbine construction will begin spring 2010. An additional 66 turbine sites have been identified for a potential Phase II development.

Our office has previously provided recommendations to PacifiCorp related to the development of the Project (letter WY08FA0106, May 15, 2008). A June 12, 2009, meeting was convened to discuss options to minimize potential impacts of project development on raptors in the project area. Meeting participants included you and Ken Clark from PacifiCorp; Dave Phillips from PacifiCorp's consultant, CH2MHill; and Trish Sweanor, Clark McCreedy, and Scott Covington from the U.S. Fish and Wildlife Service's (Service) Ecological Services' Wyoming Field Office.

All proposed turbine locations in Phase I of the Project are sited in accordance with the buffers that our office generally recommends to avoid disturbing active raptor nest sites. The Service recognizes PacifiCorp's efforts to develop a project layout that does not negatively impact these important nest sites. However, we also note that decisions regarding siting of turbines, related infrastructure, or timing of activities, are best informed with thorough data related to site characterization (e.g., topography, vegetation), location of resources such as prey, and behavioral patterns of raptors in the project area (e.g., foraging, soaring, roosting). It is important to recognize that establishing a generic buffer absent site specific information on bird use may not be sufficient to reduce the incidence of avian collisions (for example, if turbines are placed outside a generic buffer, but inadvertently still within areas of normal daily or migratory movements).

For the development of facilities that have an increased potential to cause direct raptor mortality (i.e., wind turbines, guyed towers, transmission lines), more comprehensive planning is needed to ensure compliance with the Migratory Bird Treaty Act, 16 U.S.C. 703 and the Bald and

Golden Eagle Protection Act, 16 U.S.C. 668. Determining what buffer size and shape is most likely to adequately protect migratory birds will depend upon having a thorough understanding of the normal movement patterns of birds in and around the project site (for example, the movements between daily roosting, feeding, or nesting sites as well as migration routes). Turbine alignments that separate birds from their daily roosting, feeding, or nesting sites or that are located in high bird use areas could significantly increase the risk of collision.

The transmission line proposed for development transects two ferruginous hawk nest buffers. At the June 12th meeting, PacifiCorp discussed the option of altering the proposed location of this transmission line to the right-of way along State Highway 487. The Service supports this option that will place the transmission line outside of one ferruginous hawk nest buffer and will locate the transmission line in an already disturbed area near the second nest. The segment of this transmission line that occurs within one-mile of the second ferruginous hawk nest should be constructed outside of the active nesting season of February 15 through August 1. Additionally, PacifiCorp noted during the meeting, that transmission lines will be designed and constructed in accordance with *Suggested Practices for Raptor Protection on Power Lines - The State of the Art in 2006* published by the Edison Electric Institute/Raptor Research Foundation.

During the June 12th meeting, the Service requested a copy of the baseline report of wildlife surveys that were conducted for Dunlap Wind Energy Project area. We look forward to receiving this report as soon as it becomes available. As you are aware, the Service provides general guidance for baseline wildlife studies for wind energy development (enclosure).

In anticipation of Phase II development of this project area, the Service looks forward to continuation of baseline studies in that part of the project area. We recommend that project developers to collect pre-construction raptor nest data that are current up to the year development occurs. Raptors in the project area may be affected by different phases of project development. For example, a golden eagle nest in T 24N, R 79W, Section 13 in the project area is situated away from most turbine development in Phase I, but it is in the middle of an arc of turbines proposed for development in Phase II. The proposed turbine sites are located northwest of the golden eagle nest and continue clockwise due south of the nest. PacifiCorp has provided this nest a one-mile buffer from turbine development, and this buffer is beneficial to restrict disturbance to the nest site. To effectively minimize potential wind turbine collision morality to eagles using this nest, it is helpful to evaluate how eagles at this nest are expected to utilize the project area. Data points of eagle locations and flight paths collected during baseline studies and overlayed on maps of important micro-habitats important to birds (such as water sources, habitat edges, isolated tree or rock outcrops, and rodent colonies or other prey base) can greatly aid in developing effective guidance for turbine layout that will help minimize the likelihood of eagle and other raptor collisions with wind turbines.

Designs of post-construction surveys should be addressed now, during the pre-construction phase, while allowing for some flexibility in design and scope pending baseline survey results and final project design and layout. In addition to fixed survey plots in the project area, the Service advises that fixed point survey plots be established outside of the project impact area, but within the same habitat types, and surveyed during both pre- and post-construction phases. These plots will serve as control plots for post-construction monitoring. We recommend three

years of post-construction monitoring, involving continuation of pre-construction fixed point counts to document avian behavior, habitat use, and flight paths overlayed on maps of important avian-use micro-habitats. Raptor nest success should continue to be evaluated. Additionally, avian mortality counts should be conducted during all seasons, and bat mortality counts, from April to November, using survey protocols designed to address site-specific characteristics such as terrain and vegetation type, species population levels, size of the development, and the level of impact the development is expected to have on birds and bats in the area.

We appreciate PacifiCorp's efforts to communicate with our office regarding project developments that have the potential to impact Service's trust resources. The Service looks forward to continuing involvement in assessing how negative impacts to avian and bat populations in the area may be minimized. Thank you for your efforts to ensure the conservation of wildlife resources in Wyoming. If you have any questions regarding this letter, please contact Trish Sweanor at (307) 772-2374, extension 239.

Sincerely,

Scott Hicks

for Brian T. Kelly
Field Supervisor
Wyoming Field Office

Enclosure (1)

cc: CH2MHILL, Project Manager, Laramie, WY (D. Phillips)
PacifiCorp Energy, Wind Development Manager, Casper, WY (K. Clark)
WGFD, Non-Game Coordinator, Lander, WY (B. Oakleaf)
WGFD, Statewide Habitat Protection Coordinator, Cheyenne, WY (M. Flanderka)

Appendix D. Pre-Construction Technical Report

FINAL REPORT

Wildlife Baseline Studies for the Dunlap Ranch Wind Resource Area Carbon County, Wyoming

June 4, 2008 – May 27, 2009

Prepared for:

CH2MHill

9193 South Jamaica Street
Englewood, Colorado 80112

Prepared by:

Greg Johnson, Kimberly Bay, and Jamey Eddy

Western **E**co**S**ystems **T**echnology**,** Inc.

2003 Central Avenue
Cheyenne, Wyoming

July 2, 2009

EXECUTIVE SUMMARY

PacifiCorp Energy (PacifiCorp) has proposed a wind-energy facility at the Dunlap Ranch Wind Resource Area located in Carbon County, Wyoming, north of the town of Medicine Bow. Western EcoSystems Technology, Inc. conducted surveys, under contract to CH2MHill, to monitor wildlife resources in the Dunlap Ranch Wind Resource Area to estimate the impacts of project construction and operations on wildlife. The following document contains results for fixed-point bird use surveys, raptor nest surveys, greater sage-grouse lek surveys, bat acoustic surveys, and incidental wildlife observations.

The principal objectives of the study were to (1) provide site specific bird and bat resource and use data that would be useful in evaluating potential impacts from the proposed wind-energy facility, and (2) provide information that could be used in project planning and design of the facility to minimize impacts to birds and bats.

The Dunlap Ranch Wind Resource Area encompasses 18,633 acres (29.1 square miles; 75.4 square kilometers) in Carbon County, Wyoming, and lies approximately seven miles (11 kilometers) north of the town of Medicine Bow. Land ownership in the Dunlap Ranch Wind Resource Area includes private fee lands and leased State of Wyoming lands. Elevations range from 6,560–8,300 feet (2,000–2,530 meters) above sea level. Most (74.2%) of the proposed wind resource area is scrub-shrub habitat, covering 13,829 acres (21.6 square miles; square kilometers). Grassland habitat covers 23.0% of the resource area, while small portions of emergent wetlands, developed areas, and evergreen forest are also present. The remaining land cover types, barren habitat, deciduous forest, and woody wetlands, comprise less than 0.5% of the total. The project area is located approximately six miles (9.6 km) from greater sage-grouse core use areas, and includes areas of crucial winter range for elk and pronghorn.

The objective of the fixed-point bird use surveys was to estimate the seasonal, spatial, and temporal use of the study area by birds, particularly raptors. Fixed-point surveys were conducted from June 4, 2008, through May 27, 2009 at ten points established throughout the Dunlap Ranch Wind Resource Area. A total of 340 20-minute fixed-point surveys were completed and 83 bird species were identified. A total of 330 individual raptors were recorded within the wind resource area, representing 11 species.

Waterbirds were only observed in spring (0.04 birds/plot/20-minute survey), while waterfowl use was highest during the spring (0.59 birds/plot/20-minute survey), primarily due to several groups of lesser scaup, redhead, northern pintail, and mallard. Shorebirds had the highest use in spring (0.37 birds/plot/20-minute survey), compared to other times of the year. Raptor use was highest during the summer (0.81 birds/plot/20-minute survey) and lowest during the winter (0.33). The most common raptors observed in the Dunlap Ranch Wind Resource Area were golden eagle and ferruginous hawk. Vultures were recorded only during the fall (0.03 birds/plot/20-minute survey), while large corvids had highest use during the fall (0.65 birds/plot/20-minute survey), followed by summer (0.33), spring (0.20), and winter (0.08). Passerine use ranged from 0.13 birds/plot/20-minute survey in winter to 2.82 in spring; however, passerines were only recorded within a 100 meter viewshed and therefore passerine use is not directly comparable to the other bird types, which were recorded out to 800 m.

During the study, 141 single or groups of large birds totaling 167 individuals were observed flying during fixed-point bird use surveys. For all large bird species combined, 77.2% of birds were observed flying below the likely zone of risk, 19.8% were observed within the zone of risk, and 3.0% were observed flying above the zone of risk for typical turbines that could be used in the Dunlap Ranch Wind Resource Area. Large bird types most commonly observed flying within the zone of risk were vultures (66.7%) and raptors (27.9%). A total of 321 passerines and other small birds in 146 groups were recorded flying in the proposed wind resource area, with 98.4% below the zone of risk, 1.2% within the zone of risk, and 0.3% observed above the zone of risk.

For large bird species with at least 20 separate groups of flying birds, all species were observed within the zone of risk less than 35% of the time. Based on the use (measure of abundance) of the Dunlap Ranch Wind Resource Area by each species and the flight characteristics observed for that species, the golden eagle had the highest probability of turbine exposure, with an exposure index of 0.06. All other large bird species had exposure indices of 0.02 or less. For passerines and other small birds, only two species had measurable exposure indexes, Brewer's blackbird and horned lark, each with an exposure index of less than 0.01.

Levels of bird use varied within the Dunlap Ranch Wind Resource Area by point. For all large bird species combined, use was highest at point seven, with 2.14 birds/20-minute survey. The higher mean use at point seven was due mostly to use by waterfowl at this point (1.28 birds/20-minute survey). Use at the other points ranged from 0.74 to 1.89 birds/20-minute survey for large bird species. Raptor use was highest at points two and five (0.93 and 0.94 birds/20-minute survey, respectively), comprised primarily of eagle use (point two; 0.66 birds/20-minute survey) and buteo use (point five; 0.47). Passerine use, restricted to within 100 meters, was highest at point seven, with 3.30 birds/20-minute survey, and ranged from 1.03 to 3.31 at the other points. Flight paths for waterbirds, waterfowl, shorebirds, raptor subtypes, and vultures were digitized and mapped. With the exception of an apparent golden eagle flight corridor on the northwest portion of a large ridge in the western portion of the project area, where several golden eagle flight paths parallel to the rim were noted at avian use survey point #2, no obvious flyways or concentration areas were observed for any species.

The objective of the raptor nest mapping was to record raptor nests within 1 mile (1.6 km) of the proposed project. One fixed-wing aerial flight was conducted to locate raptor nests in the study area. In addition, ground based surveys were conducted in conjunction with fixed-point bird use surveys in March, April, and May 2009. Seven active raptor nests and one inactive raptor nest were located in or within one mile of the Dunlap Ranch Wind Resource Area, resulting in an active nest density of 0.12 nests/square mile within the wind resource area and one-mile buffer.

The objective of greater sage-grouse lek surveys was to locate leks within 2 miles (3.2 km) of the Dunlap Ranch Wind Resource Area and count males at active leks, if any. The Wyoming Game and Fish Department has previously mapped three greater-sage grouse leks on or within four miles (6.4 kilometers) of the Dunlap Ranch Wind Resource Area, two of which are considered unoccupied. No greater sage-grouse were observed at any of these three lek sites during spring 2009 surveys. Seven males were observed strutting at one location approximate.y 0.5 miles (0.8 kilometers) north of the project area on April 21, 2009; however, they were not observed during

any of the other ground surveys or the aerial survey. No new or previously undocumented leks were detected in 2009.

The objective of incidental wildlife observations was to provide a record of wildlife observed outside of the standardized surveys. Twenty-two bird species, five mammal species, and one amphibian were observed incidentally within the Dunlap Ranch Wind Resource Area. Five bird species were recorded only during incidental observations at the Dunlap Ranch Wind Resource Area and were not observed during fixed-point bird use surveys. Big game species observed incidentally included 4,006 pronghorn in 200 groups, 1,748 elk in 21 groups, and 29 mule deer in eight groups. Other species observed incidentally included coyote, badger, and boreal toad.

Acoustic surveys for bats were conducted from July 16 to October 14, 2008. The objective of the acoustic bat surveys was to estimate the seasonal and spatial use of the study area by bats during the primary fall migration period. Bat acoustic surveys were conducted using two Anabat™ SD-1 ultrasonic bat detectors at three stations. A total of 275 bat passes were recorded during 173 detector nights. Averaging bat passes per detector-night across locations, a mean of 1.67 bat passes per detector-night was detected.

Just over half (60.4%) of the calls were low frequency (<35 kHz; e.g., big brown bat, hoary bat, silver-haired bat), and the remaining calls were high frequency (>35 kHz; e.g., *Myotis* bat species). Species identification was only possible for the hoary bat and eastern red bat, which made up 7.6% and 1.5% of all passes, respectively. Activity levels for bat passes were highest in July and August, with most passes detected on August 21. Activity levels for hoary bats were highest in August, suggesting this species migrates through the study area at that time of year. Only four eastern red bat passes were identified, all occurring at station DL2, suggesting this species is relatively rare in the study area.

The mean number of bat passes per detector per night was compared to existing data at five wind-energy facilities where both bat activity and mortality levels have been measured. The level of bat activity documented at the Dunlap Ranch Wind Resource Area was slightly lower than that at facilities in Minnesota and an existing facility in Carbon County, Wyoming, where reported bat mortalities are low. Bat activity levels at the Dunlap Ranch Wind Resource Area were much lower than at facilities in the eastern US, where reported bat mortality is highest. Assuming that a relationship between bat activity and bat mortality exists, relatively low levels of bat mortality can be expected to occur in the study area; most fatalities will likely occur during August.

Based on fixed-point bird use data collected for the Dunlap Ranch Wind Resource Area, mean annual raptor use was 0.52 raptors/plot/20-minute survey. The annual rate was low to moderate relative to raptor use at other wind-energy facilities that implemented similar protocols to the present study and had data for three or four different seasons. Similar studies were conducted at 36 other wind-energy facilities. Mean raptor use in the Dunlap Ranch Wind Resource Area was low to moderate compared to these other wind resource areas, ranking nineteenth.

A regression analysis of raptor use and raptor collision mortality for 13 new-generation wind-energy facilities where similar methods were used to obtain raptor use estimates showed a

significant (R^2 = 69.9%) correlation between raptor use and raptor collision mortality. Using this regression to predict raptor collision mortality the Dunlap Ranch Wind Resource Area yields an estimated fatality rate of 0.06 fatalities/megawatt/year, or six raptors per year for each 100-megawatts of wind-energy development. Based on species composition of the most common raptor fatalities at other western wind-energy facilities and species composition of raptors observed at the Dunlap Ranch Wind Resource Area during the surveys, the majority of the fatalities of diurnal raptors will likely consist of golden eagles, ferruginous hawks, and American kestrels. Based on the seasonal use estimates, it is expected that risk to raptors would be unequal across seasons, with the lowest risk in the winter, and highest risk during the summer.

No obvious concentration areas were observed. With the exception of an apparent golden eagle flight corridor on the northwest portion of a large ridge in the western portion of the project area, where several golden eagle flight paths parallel to the rim were noted at avian use survey point #2, no strong association with topographic features within the study area was noted for raptors or other large birds. Although some differences in bird use were detected among survey points, the differences are not large enough to suggest that any portions of the Dunlap Ranch Wind Resource Area should be avoided when siting turbines. The data collected during this study also suggest that the Dunlap Ranch Wind Resource Area is not within a major migratory pathway for raptors. In addition, the study area does not appear to provide important stopover habitat for migrant passerines based on fixed-point bird use surveys. Construction and operation of the wind-energy facility may displace some types of birds. However, similar habitats are abundant in the region and it is unlikely displacement would result in significant impacts.

No federally listed threatened or endangered species were observed within the Dunlap Ranch Wind Resource Area. Some species considered sensitive by the Wyoming Game and Fish Department were observed within the Dunlap Ranch Wind Resource Area. During all surveys and incidental observations, 16 sensitive bird species were observed, including 81 sightings of ferruginous hawks, five of Swainson's hawks, and three of bald eagles, in addition to sightings of several species of waterbirds, waterfowl, shorebirds, and passerines. This is a tally that in some cases represents repeated observations of the same individuals. Some potential exists for turbine collision mortality or for wind turbines to displace these species. Research concerning displacement impacts of wind-energy facilities are limited, but some show the potential for small scale displacement of 180 meters (591 feet) or less, while impacts to densities of birds at larger scales has not been shown.

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Figure 22. Regression analysis comparing raptor use estimates versus estimated raptor mortality. 89

INTRODUCTION

PacifiCorp Energy (PacifiCorp) has proposed a wind-energy facility in Carbon County, Wyoming, north of the town of Medicine Bow (Figures 1 and 2). CH2MHill contracted Western EcoSystems Technology, Inc. (WEST) to conduct surveys and monitor wildlife resources in the Dunlap Ranch Wind Resource Area (DRWRA) to estimate the impacts of wind-energy facility construction and operations on wildlife.

The principal objectives of the study were to (1) provide site specific bird and bat resource and use data that would be useful in evaluating potential impacts from the proposed wind-energy facility, and (2) provide information that could be used in project planning and design of the facility to minimize impacts to birds and bats. The protocols for the baseline studies are similar to those used at other wind-energy facilities across the nation, and follow the guidance of the National Wind Coordinating Collaborative (NWCC; Anderson et al. 1999). The protocols have been developed based on WEST's experience studying wildlife at proposed wind-energy facilities throughout the US, and were designed to help predict potential impacts to bird (particularly raptors) and bat species.

Baseline surveys, conducted from June 4, 2008 through May 27, 2009 at the DRWRA, included fixed-point bird use surveys, raptor nest surveys, greater sage-grouse (*Centrocercus urophasianus*) lek surveys, bat acoustic surveys, and incidental wildlife observations. In addition to site-specific data, this report presents existing information and results of studies conducted at other wind-energy facilities. The ability to estimate potential bird mortality at the proposed DRWRA is greatly enhanced by operational monitoring data collected at existing wind-energy facilities. For several wind-energy facilities, standardized data on fixed-point surveys were collected in association with standardized post-construction (operational) monitoring, allowing comparisons of bird use with bird mortality. Where possible, comparisons with regional and local studies were made.

In addition to presenting results of field surveys, we obtained relevant published information on wildlife use of the DRWRA, including maps of big game crucial winter ranges and greater sage-grouse core use areas.

STUDY AREA

The DRWRA encompasses 18,633 acres (29.1 square miles [mi^2]; 75.4 square kilometers [km^2]) in Carbon County, Wyoming, and lies approximately seven miles (11 km) north of the town of Medicine Bow (Figure 1). The DRWRA is situated near the southern end of the Shirley Basin. State Highway 487 bisects the study area, and the western end of the study area abuts the Freezeout Mountains (Figure 2). Land ownership in the Dunlap Ranch Wind Resource Area includes private fee and leased State of Wyoming lands. The DRWRA contains a major ridge at the western end, but most of the remainder of the area is flat to gently rolling. Elevations range from 6,560–8,300 feet (ft; 2,000–2,530 meters [m]) above sea level. Climate is classified as a semiarid, cold desert, and mean annual precipitation averages 12 inches (in; 30.48 centimeters [cm]).

Most (74.2%) of the proposed wind resource area is scrub-shrub habitat, dominated primarily by big sagebrush (*Artemisia tridentata*) and covering 13,829.40 acres (21.61 mi^2; 55.97 km^2; Table 1; Figure 3). Grassland habitat covers 23.0% of the resource area (4,285.42 acres; 6.70 mi^2; 17.34 km^2), while small portions of emergent wetlands (1.1%), developed areas (0.8%), and evergreen forest (0.7%) are also present. The remaining land cover types, barren habitat, deciduous forest, and woody wetlands, comprise less than 0.5% of the total (Table 1). Areas of mountain mahogany (*Cercocarpus montanus*) and scattered limber pine (*Pinus flexilus*) also occur on the ridges at the western end of the DRWRA.

Using publicly available data from the WGFD, the following assessments can be made. The DRWRA is not within an area mapped as a greater sage-grouse core use area (Figure 4). The nearest core use area is located over six miles west of the project area. The extreme western end of the project area is located within elk crucial winter range (Figure 5). All but the extreme western end of the project area is also located within designated pronghorn antelope crucial winter range (Figure 6). The project area is located within winter/yearlong and yearlong range for mule deer but no mule deer crucial winter range is on the project site (Figure 7).

METHODS

The study at the DRWRA consisted of the following research components: 1) fixed-point bird use surveys; 2) raptor nest surveys; 3) greater sage-grouse lek surveys; 4) bat acoustic surveys; and 5) incidental wildlife observations.

Fixed-Point Bird Use Surveys

The objective of the fixed-point bird use surveys was to estimate the seasonal, spatial, and temporal use of the DRWRA by birds, particularly raptors, defined here as kites, accipiters, buteos, harriers, eagles, falcons, and owls. Fixed-point surveys (variable circular plots) were conducted using methods described by Reynolds et al. (1980). The points were selected to survey representative habitats and topography of the DRWRA, while also providing relatively even coverage. All birds observed during each 20-minute (min) fixed-point survey were recorded.

Bird Use Survey Plots

Ten points were selected to achieve relatively even coverage of the study area and survey representative habitats and topography within the DRWRA (Figure 8). Each survey plot was an 800-m (2,625-ft) radius circle centered on the point.

Bird Survey Methods

All species of birds observed during fixed-point surveys were recorded. Observations of large birds beyond the 800-m radius were recorded, but were not included in the statistical analyses; for small birds, observations beyond the 100-m (328-ft) radius were excluded. A unique observation number was assigned to each observation.

The date, start and end time of the survey period, and weather information such as temperature, wind speed, wind direction, and cloud cover were recorded for each survey. Species or best possible identification, number of individuals, sex and age class (if possible), distance from plot center when first observed, closest distance, altitude above ground, activity (behavior), and habitat(s) were recorded for each observation. The behavior of each bird observed, and the vegetation type in which, or over which the bird occurred were recorded based on the point of first observation. Approximate flight height and flight direction at first observation were recorded to the nearest 5-m (16-ft) interval. Other information recorded about the observation included whether or not the observation was auditory only and the 10-min interval of the 20-min survey in which it was first observed.

Locations of raptors, other large birds, and species of concern seen during fixed-point bird use surveys were recorded on field maps by observation number. Flight paths and perched locations were digitized using ArcGIS 9.3. Any comments were recorded in the comments section of the data sheet. Any unusual wildlife observations were recorded on the incidental datasheets.

Observation Schedule

Sampling intensity was designed to document bird use and behavior by habitat and season within the DRWRA. Fixed-point surveys were conducted from June 4, 2008, through May 27, 2009. Surveys were conducted approximately once a week during the spring (March 16 to May 31) and fall (September 1 to November 15), and once every two weeks during the summer (June 1 to August 31) and winter (November 16 to March 15). Surveys were conducted during daylight hours and survey periods were varied to approximately cover all daylight hours during a season. To the extent practical, each point was surveyed about the same number of times; however, the schedule varied in response to adverse weather conditions (e.g., fog and/or rain), which caused delays and/or missed surveys.

Raptor Nest Surveys

The objective of the raptor nest surveys was to locate and record raptor nests within 1 mile (1.6 km) of the project area and proposed transmission line. One fixed-wing aerial survey of the DRWRA and 1-mile (1.6-km) buffer was conducted on May 4, 2009. The proposed transmission line route and 1-mile buffer on either side of it were also flown to check for active raptor nests. To supplement the aerial surveys, comprehensive ground surveys were completed by visually inspecting areas of suitable habitat (trees, rock outcrops, etc) in March, April, and May 2009. Universal Transverse Mercator (UTM) or Global Positioning System (GPS) coordinates, as well as nesting substrate and current status (inactive, active, incubating, young in nest), were recorded for each nest located.

Greater Sage-Grouse Lek Surveys

The greater sage-grouse has been petitioned for listing as federally threatened or endangered. A listing decision is expected in February 2010. The Wyoming Game and Fish Department (WGFD) recently completed a map showing greater sage-grouse “Core Population Areas” within the state of Wyoming, and the Governor issued an Executive Order mandating that new development within Core Population Areas should be authorized or conducted only when it can

be demonstrated that the activity will not cause declines in greater sage-grouse populations. The DRWRA is not within a greater sage-grouse Core Population Area.

The objective of greater sage-grouse lek surveys was to locate leks in the DRWRA and a 2-mile (3.2-km) buffer of the wind-energy facility. The locations of known historic and existing greater-sage grouse leks in the DRWRA and the 2-mile buffer were obtained from the WGFD. To search for undocumented or new leks in the study area, one aerial survey and four ground-based searches were conducted. The aerial survey was conducted on April 24, 2009 from a fixed-wing aircraft flying parallel transects designed to provide full coverage of the DRWRA and the area encompassed by the 2-mile buffer around the DRWRA. All mapped historic and existing leks were flown to check for occupancy. The survey was conducted from one-half hour (hr) before sunrise to two hrs after sunrise. Aerial flight transects were oriented north-south and were separated by approximately 0.6 miles (1.0 km). Transects were flown at a height of 300 to 450 ft (91 to 137 m) above ground level (AGL) at an approximate speed of 100 miles per hr (161 km per hr). GPS coordinates and the approximate numbers of birds observed on the lek were recorded for all leks located.

The four ground-based greater sage-grouse lek surveys were conducted at the DRWRA between April 21 and May 10. Public roads and accessible private roads within two miles of the boundary of the proposed DRWRA were driven from 30 min prior to sunrise until two hrs after sunrise. Observers stopped for a minimum of five min every half-mile (0.8 km) to listen and look for displaying greater sage-grouse.

The objective of the ground count surveys was to count the number of greater sage-grouse using the lek using WGFD methodology. Each known active or historic lek location in the survey area was visited three times. Ground surveys of each lek location were spaced a minimum of seven days apart. Counts were conducted for a 15-30 min period between one-half hour before and two hours after sunrise when the lek was active. Data collected including the maximum number of birds counted by sex (males, females, unknown), date, time period of observation, and weather information (temperature, wind speed and direction, cloud cover, precipitation). To the extent possible, surveys were conducted on relatively calm mornings.

Bat Acoustic Surveys

The objective of the bat use surveys was to estimate the seasonal and spatial use of the DRWRA by bats. Bats were surveyed using Anabat™ (Anabat) SD-1 ultrasonic bat detectors (Titley Electronics Pty Ltd., NSW, Australia). Bat detectors are a recommended method to index and compare habitat use by bats. The use of bat detectors for calculating an index to bat impacts has been used at several wind-energy facilities (Kunz et al. 2007a), and is a primary and economically feasible bat risk assessment tool (Arnett 2007). Bat activity was surveyed using two detectors from July 16 to October 14, 2008, a period corresponding to likely fall bat migration at this study area. Detectors were initially placed at two fixed locations. Due to issues with vandalism at the original location, the detector at station DL1 was moved to location DL3 on August 27 (Figure 9).

Anabat detectors record bat echolocation calls with a broadband microphone. The echolocation sounds are then translated into frequencies audible to humans by dividing the frequencies by a predetermined ratio. A division ratio of 16 was used for the study. Bat echolocation detectors also detect other ultrasonic sounds made by insects, raindrops hitting vegetation, and other sources. A sensitivity level of six was used to reduce interference from these other sources of ultrasonic noise. Calls were recorded to a Compact Flash memory card with large storage capacity. The Anabat detectors were placed inside plastic weather-tight containers with a hole cut in the side of the container for the microphone to extend through. Microphones were encased in PVC tubing with drain holes that curved skyward at 45 degrees outside the container to minimize the potential for water damage due to rain. Containers were raised approximately one m (3.3 ft) off the ground to minimize echo interference and lift the unit above vegetation. All units were programmed to turn on each night approximately one half-hr before sunset and to turn off approximately one half-hr after sunrise.

Incidental Wildlife Observations

The objective of incidental wildlife observations was to provide a record of wildlife seen outside of the standardized surveys. All raptors, unusual or unique birds, sensitive species, mammals, reptiles, and amphibians were recorded in a similar fashion to standardized surveys. The observation number, date, time, species, number of individuals, sex/age class, distance from observer, activity, height above ground (for bird species), habitat, and, in the case of sensitive species, the location was recorded by UTM or GPS coordinates. It is important to note that incidental sightings are recorded ancillary to other survey objectives without systematic sampling methodology. Recording of incidental observations indicates presence of a species on site, but cannot be used in risk assessment. Multiple counts of the same individual may have occurred.

Statistical Analysis

Quality Assurance and Quality Control

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

Data Compilation and Storage

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

Fixed-Point Bird Use Surveys

Bird Diversity and Species Richness

Bird diversity was illustrated by the total number of unique species observed. Species lists, with the number of observations and the number of groups, were generated by season, including all observations of birds detected regardless of their distance from the observer. Species richness was calculated as the mean number of species observed per plot per survey (i.e., number of species/plot/20-min survey). Species diversity and richness were compared between seasons for fixed-point bird use surveys.

Bird Use, Composition, and Frequency of Occurrence

For the standardized fixed-point bird use estimates, only observations of large birds detected within the 800-m radius plot were used, while observations of small birds were limited to 100-m. Estimates of mean bird use (i.e., number of birds/plot/20-min survey) were used to compare differences between bird types, seasons, and other wind-energy facilities.

The frequency of occurrence was calculated as the percent of surveys in which a particular species or bird type was observed. Percent composition was calculated as the proportion of the overall mean use for a particular species or bird type. Frequency of occurrence and percent composition provide relative estimates of species exposure to the proposed wind-energy facility. For example, a species may have high use estimates for the area based on just a few observations of large groups; however, the frequency of occurrence will indicate that the species occurs during very few of the surveys and therefore, the species may be less likely affected by the wind-energy facility.

Bird Flight Height and Behavior

To calculate potential risk to bird species, the first flight height recorded was used to estimate the percentages of birds flying within the likely zone or risk (ZOR) for collision with turbine blades of 35 m to 130 m (114 – 427 ft) AGL, which is the blade height of typical turbines that could be used at the DRWRA.

Bird Exposure Index

A relative index of collision exposure (*R*) was calculated for bird species observed during the fixed-point bird use surveys using the following formula:

$$R = A*P_f*P_t$$

Where *A* equals mean relative use for species *i* (large bird observations within 800 m of the observer or 100 m for small birds) averaged across all surveys, P_f equals the proportion of all observations of species *i* where activity was recorded as flying (an index to the approximate percentage of time species *i* spends flying during the daylight period), and P_t equals the proportion of all initial flight height observations of species *i* within the likely ZOR.

Spatial Use

Data were analyzed by comparing use among plots. Mapped flight paths were qualitatively compared to study area features such as topographic features. The objective of mapping observed bird locations and flight paths was to look for areas of concentrated use by raptors and other

large birds and/or consistent flight patterns within the DRWRA. This information can be useful in turbine layout design or adjustments of individual turbines for micro-siting.

Bat Acoustic Surveys

The units of activity were number of bat passes (Hayes 1997). A pass was defined as a continuous series of two or more call notes produced by an individual bat with no pauses between call notes of more than one second (White and Gehrt 2001; Gannon et al. 2003). In this report, the terms bat pass and bat call are used interchangeably. The number of bat passes was determined by downloading the data files to a computer and tallying the number of echolocation passes recorded. Total number of passes was corrected for effort by dividing by the number of detector nights. Bat calls were classified as either high-frequency calls (≥ 35 kHz) that are generally given by small bats (e.g., *Myotis* spp.) or low-frequency calls (< 35 kHz) that are generally given by larger bats (e.g., silver-haired bat [*Lasionycteris noctivagans*], big brown bat [*Eptesicus fuscus*], hoary bat [*Lasiurus cinereus*]). Data determined to be noise (produced by a source other than a bat) or call notes that did not meet the pre-specified criteria to be termed a pass were removed from the analysis. To establish which species may have produced the high- and low-frequency calls recorded, a list of species expected to occur in the study area was compiled from range maps (Table 2; Harvey et al. 1999; BCI website).

The total number of bat passes per detector night was used as an index of bat use in the DRWRA. Bat pass data represented levels of bat activity rather than the numbers of individuals present because individuals could not be differentiated by their calls. To predict potential for bat mortality (i.e., low, moderate, high), the mean number of bat passes per detector night (averaged across monitoring stations) was compared to existing data from wind-energy facilities where both bat activity and mortality levels have been measured.

Within high- and low-frequency categories, an attempt was made to identify calls made by hoary bats and eastern red bats (*Lasiurus borealis*), two species that comprise most of the fatalities at many wind energy facilities. Calls that had a distinct U-shape and that exhibited variability in the minimum frequency across the call sequence were identified as belonging to the *Lasiurus* genus (C. Corben, pers comm.). Hoary and eastern red bats were distinguished based on minimum frequency; hoary bats typically produce calls with minimum frequencies between 18 and 24 kHz, whereas eastern red bats typically emit calls with minimum frequencies between 30 and 43 kHz (J. Szewczak, pers comm.).

RESULTS

Surveys were conducted at the DRWRA from June 4, 2008 through May 27, 2009. Eighty-eight bird species, five mammal species, and one amphibian species were identified during fixed-point surveys completed at the DRWRA or were observed incidentally. Results of the fixed-point bird use, raptor nest, greater sage-grouse lek, and bat acoustic surveys, and incidental observations are discussed in the sections below.

Fixed-Point Bird Use Surveys

A total of 340 20-minute fixed-point surveys were conducted at the DRWRA (Table 3). Two different viewsheds were used when calculating the different statistics; species richness, use, percent composition, percent frequency, and exposure index; an 800-m plot for large birds and a 100-m plot for small birds.

Bird Diversity and Species Richness

Eighty-three unique species were observed over the course of all fixed-point bird use surveys. The mean number of birds observed per survey was 0.65 large bird species/800-m plot/20-min survey and 0.65 small bird species/100-m plot/20-min survey (Table 3). More unique species were observed during the spring (62 species), followed by summer (45), fall (37), and winter (four; Table 3). The mean number of species per survey for large birds was higher in the spring (1.05 species/survey), summer (0.90), and fall (0.62) compared to the winter (0.23 Table 3). For small birds, the mean number of species per survey held to the same general pattern, with use being higher in the spring (1.06 species/survey), summer (1.15), and fall (0.56) compared to the winter (0.05 Table 3).

A total of 2,031 individual bird observations within 1,061 separate groups were recorded during the fixed-point bird use surveys (Table 4). Cumulatively, regardless of bird size, two species (2.4% of all observed species) composed 45.0% of the observations: horned lark (*Eremophila alpestris*; 735 observations) and golden eagle (*Aquila chrysaetos*; 179). All other species comprised less than 5% of the observations individually. The most abundant large bird species were golden eagle (179 individuals in 145 groups), ferruginous hawk (*Buteo regalis*; 78 individuals in 69 groups), and Canada goose (*Branta canadensis*; 73 individuals in four groups). A total of 330 individual raptors were recorded within the DRWRA, representing 11 species (Table 4).

Bird Use, Composition, and Frequency of Occurrence by Season

Mean bird use, percent composition, and frequency of occurrence by season were calculated for each bird type, raptor subtype, and species (Tables 5a and 5b). The highest overall large bird use occurred in the spring (1.71 birds/plot/20-min survey), followed by summer (1.50), fall (1.37), and winter (0.40; Table 5a). For small birds, use was also highest in the spring (2.82), followed by the summer (2.29), fall (2.25), and winter (0.13; Table 5b).

<u>Waterbirds</u>

Waterbirds were only observed in spring (0.04 birds/plot/20-min survey; Table 5a). Use by waterbirds in spring was due to one group of two American white pelicans (*Pelecanus erythrorhyncos*) and one group of two California gulls (*Larus californicus*). There were also two groups of American white pelicans, totaling 24 individuals, observed at the DRWRA during the fall of 2008, one group of three great blue herons (*Ardea herodias*) observed during the summer of 2008, and one common loon (*Gavia immer*) and one additional group of American white pelican, totaling eight individuals, observed during the spring of 2009; however, these groups were observed outside of the pre-determined 800-m radius plot, and are therefore not included in further calculations. Waterbirds comprised 2.1% of the overall large bird use in spring and were only observed during 1.8% of the spring surveys (Table 5a).

Waterfowl

Waterfowl had the highest use in spring (0.59 birds/plot/20-min survey), compared to other times of the year (summer 0.03, and 0 for fall and winter; Table 5a). Higher waterfowl use in spring was largely due to one group of lesser scaup (*Aythya affinis*), followed by one group of redheads (*Aythya americana*), and several smaller groups of mallards (*Anas platyrhynchos*) and northern pintail (*Anas acuta*; Table 4). Canada geese were observed in four groups totaling 73 individuals, but these groups were observed outside the plot and are not included in this analysis. Waterfowl made up 34.6% of the overall spring use by large birds, but only 2.1% of the summer use (Table 5a). Waterfowl were seldom observed in the spring (7.3%) and summer (1.6%), and were absent during the fall and winter surveys.

Shorebirds

Shorebirds had the highest use in spring (0.37 birds/plot/20-min survey), compared to other times of the year (summer 0.28, fall 0.22, and winter 0; Table 5a). Shorebirds comprised 21.6% of the overall large bird use in the spring compared to 18.7% in the summer and 15.9% in the fall. Shorebirds were observed during 21.4% of the surveys in the spring, 16.2% in the summer, and 2.7% in the fall. Mountain plover (*Charadrius montanus*) was the most common shorebird observed, followed by killdeer (*Charadrius vociferous*; Table 4).

Raptors

Raptor use was highest in the summer (0.81 birds/plot/20-min survey), followed by spring (0.51), fall (0.47) and winter (0.33; Table 5a). Higher use in the summer was primarily due to use of the area by golden eagles (0.31 birds/plot/20-min survey) and ferruginous hawks (0.29). Golden eagle also had the highest use of any raptor in the spring (0.21 birds/plot/20-min survey), fall (0.25), and winter (0.33). Raptors comprised 81.0% of the overall large bird use during the winter, compared to 54.3% in the summer, 34.4% in the fall, and 29.9% in the spring. Raptors were observed during 42.1% of summer, 35.1% of spring, 32.7% of fall and 17.8% of winter surveys (Table 5a).

Upland Gamebirds

No upland gamebirds (e.g., greater sage-grouse) were recorded during fixed-point bird use surveys of the DRWRA (Table 5a).

Vultures

Vultures were recorded only during the fall (0.03 birds/plot/20-min survey; Table 5a). Turkey vulture (*Cathartes aura*) was the only vulture species recorded (Table 4). Vultures comprised 2.0% of the overall large bird use during the fall and were observed during 2.7% of fall surveys (Table 5a).

Large Corvids

Large corvids, defined as common raven (*Corvus corax*), American crow (*Corvus brachyrhynchos*), and black-billed magpie (*Pica pica*) had highest use during the fall (0.65 birds/plot/20-min survey), followed by summer (0.33), spring (0.20), and winter (0.08; Table 5a). Large corvids comprised 47.0% of the overall large bird use during the fall, compared to 22.0% in the summer, 19.0% in the winter, and 11.8% in the spring. Large corvids were

observed during 15.2% of surveys in the spring, 14.4% in the summer, and 12.7% in fall, compared to only 5.6% of the surveys in the winter (Table 5a).

Passerines

A 100-m viewshed was used for small birds; therefore use values are not directly comparable to large bird types, which were recorded out to 800 m. Use by passerines was highest in spring (2.82 birds/plot/20-min survey), compared to summer (2.29), fall (2.25), and winter (0.13; Table 5b). Horned lark had the highest use by any one species in all four seasons, ranging from 0.13 birds/plot/20-min survey in the winter to 2.18 in the spring. Horned lark was the only small bird species to be observed in winter. Passerines were observed during 81.6% of surveys in the spring and 69.8% in the summer, compared to 39.1% of fall surveys and only 5.4% of the surveys in winter (Table 5b).

Bird Flight Height and Behavior

Flight height characteristics were estimated for both bird types and bird species (Tables 6 and 7). For large bird species, 141 single birds or groups totaling 167 individuals were observed flying within the 800-m plot (Table 6). Overall, 19.8% of large birds observed flying were recorded within the ZOR for collision with turbine blades of 35 to 135 m AGL, 77.2% were below the ZOR, and 3.0% were flying above the ZOR (Table 6). More than half (67.6%) of flying raptors were observed below the ZOR, 27.9% were within the ZOR, and only 4.5% were above the ZOR. Vultures had the highest percentage of flying birds within the ZOR (66.7%), while raptors had the second highest percentage of birds within the ZOR, primarily due to 34.5% of eagle observations and 30.3% of buteo observations recorded at this height range. No other large bird types were observed flying within the ZOR. All flying waterbirds, waterfowl, shorebirds, large corvids, and doves/pigeons were observed below the ZOR (Table 6). Raptors were the only large bird type to be observed flying above the ZOR. The majority of passerines within the 100-m plot were observed flying below the estimated ZOR (98.4%), while 1.2% were recorded within the ZOR and 0.3% were observed above the ZOR (Table 6). Other birds were always observed flying below the ZOR.

Of all large birds, two species had at least 20 groups observed flying (golden eagle and ferruginous hawk). Neither of these species were observed flying within the likely ZOR during more than 35% of the observations (Table 7a). Of all small bird species, two had at least 20 groups observed flying, and both species (horned lark and McCown's longspur [*Calcarius mccownii*]) were recorded flying within the ZOR less than 1.0% of the time (Table 7b).

Bird Exposure Index

A relative exposure index was calculated for each bird species (Tables 7a and 7b). This index is only based on initial flight height observations and relative abundance (defined as the use estimate) and does not account for other possible collision risk factors such as foraging or courtship behavior. Golden eagle had the highest exposure index for large birds with a value of 0.06. Ferruginous hawk ranked second with an exposure index of 0.02. All other raptors and large birds had an exposure index of 0.01 or less (Table 7a).

Based on observations within 100 m, only two passerine species had a measurable exposure index. Brewer's blackbird (*Euphagus cyanocephalus*) and horned lark each had an index of less than 0.01 (Table 7b). All other small bird species had exposure indices of zero.

Spatial Use

For all large bird species combined, use was highest at point seven (2.14 birds/20-min survey). Bird use at other points ranged from 0.74 to 1.89 birds/20-min survey (Figure 10). The higher mean use estimate for point seven was largely due to relatively higher waterfowl use at this point (1.28 birds/20-min survey). Waterfowl use was only recorded at two other points, point three (0.09 birds/20-min survey) and point nine (0.50). Waterbirds were only observed at points six and seven, each with 0.06 birds/20-min survey. Shorebird use was highest at point eight, with 0.69 birds/20-min survey, and ranged from zero to 0.40 at the other points. Raptor use was highest at points two and five (0.93 and 0.94 birds/20-min survey, respectively), and ranged from 0.11 to 0.69 at other points. The higher mean use estimate for raptors at point two was largely due to relatively higher eagle use at this point (0.66 birds/20-min survey), while the use at point five was largely due to buteos at this point (0.47). Vultures were only observed at points five, seven, and nine, each with a use of 0.03 birds/20 min survey at these points. Use by large corvids ranged from 1.54 birds/20-min survey at point one to zero at point seven. Passerine use was highest at point seven (3.30 birds/20-min survey), and ranged from 1.03 to 3.31 at other points.

Flight paths for waterbirds, waterfowl, shorebirds, raptor subtypes, and vultures were digitized and mapped (Figures 11a-f). With the exception of an apparent golden eagle flight corridor on the northwest portion of a large ridge in the western portion of the project area, where several golden eagle flight paths parallel to the rim were noted at avian use survey point #2 (see Figure 11e), no obvious flyways or concentration areas were observed for any species.

Raptor Nest Surveys

Two active ferruginous hawk nests, one active merlin (*Falco columbarius*) nest, one active great-horned owl (*Bubo virginianus*) nest, and one active long-eared owl (*Asio otus*) nest were located within the DRWRA. One ferruginous hawk nest and one golden eagle nest were found outside the DRWRA, but within the 1-mile buffer of the project area, resulting in an active raptor nest density of 0.12 nests/mi^2 (Table 8 and Figure 12). One inactive raptor nest was also found within the DRWRA. No active raptor nests were located outside the 1-mile project area buffer along the proposed transmission line route.

Greater Sage-Grouse Lek Surveys

The WGFD has mapped three greater-sage grouse leks on or within four miles (6.4 km) of the DRWRA. Two of these are considered historical leks whereas one is considered occupied (Figure 13). No greater sage-grouse were observed at any of these three lek sites during the spring 2009 surveys. Seven males were observed strutting at one location north of the project area on April 21, 2009; however, they were not observed during any of the other ground surveys or the aerial survey. Visual inspection of this site for droppings, feathers, tracks, or other signs of high use indicating a lek was not completed due to private land access limitations. Chapter 12 of the WGFD's Wildlife Techniques Manual (Christiansen 2007) states that additional

confirmation is necessary to verify that a site where males are seen strutting is actually a lek, and that strutting activity should be documented at a site on at least two mornings before it is designated as a lek. Our data suggest that this is not an established lek, but that the site may warrant further evaluation.

Incidental Wildlife Observations

Twenty-two bird species were observed incidentally, totaling 47 birds within 26 separate groups during the study (Table 9). Five mammal species and one amphibian were also observed incidentally at the DRWRA. It is important to note that incidental sightings are recorded ancillary to other survey objectives without systematic sampling methodology. Recording of incidental observations indicates presence of a species on site, but cannot be used in risk assessment. Multiple counts of the same individual may have occurred.

Bird Observations
The most frequent bird species recorded as an incidental wildlife observation was yellow-rumped warbler (*Dendroica coronata;* six individuals). Six species, Wilson's snipe (*Gallinago delicate*; two observations), broad-tailed hummingbird (*Selasphorus platycercus*; one), Bullock's oriole (*Icterus bullockii*; one), cedar waxwing (*Bombycilla cedrorum*; one), cinnamon teal (*Anas cyaneus*; one), and red-breasted nuthatch (*Sitta canadensis*; one) were only observed incidentally at the DRWRA.
Mammal Observations

Big game observed incidentally included 4,006 pronghorn antelope (*Antilocapra americana*) in 200 groups, 1,748 elk (*Cervus elaphus*) in 21 groups, and 29 mule deer (*Odocoileus hemionus*) in eight groups (Table 9). Ten coyotes (*Canis latrans*) and four badgers (*Taxidea taxus*) were also observed incidentally at the DRWRA.

Amphibian Observations
One species of amphibian, boreal toad (*Bufo boreas*), was observed incidentally. One group of two individuals was observed (Table 9).

Bat Acoustic Surveys

Bat activity was monitored at three sampling locations on a total of 91 nights during the period July 16 to October 14, 2008. Station DL2 was monitored continuously during the study period. Station DL1 was monitored from July 16 through August 27, and was moved to location DL3 on August 27 and monitored from that location until the end of the study period on October 14, 2008. Anabat units were operable for 94.8% of the sampling period (Figure 14), recording 275 bat passes on 173 detector-nights (Table 10). Levels of wind and insect noise were high on some nights (Figure 15), and may have interfered with bat detection. Averaging bat passes per detector-night across locations, a mean of 1.67 bat passes per detector-night were detected (Table 10).

Spatial Variation
Bat activity was relatively low among all three stations (Figures 9 and 16). Activity was highest at station DL1, which recorded 2.27 bat passes per detector night (Table 10). Bat activity at stations DL2 and DL3 was similar, with 1.58 and 1.14 bat passes per detector night, respectively. Patterns of nightly activity were similar among stations (Figure 17), although stations DL1 and DL3 were not sampled concurrently. Only the detector at station DL2 was active during August 21, the night that the most bat passes were recorded.

Temporal Variation
Bat activity was relatively low-to-moderate from July 16 to August 31, with a single night of high activity (11 bat passes) recorded on August 21 at station DL2 (Figure 15). During September and October, activity continued to be relatively low-to-moderate, but bats were only detected on slightly more than half (54.5%) of the 44 nights.

Species Composition
Overall, passes by low-frequency bats (LF; 60.4%) outnumbered passes by high-frequency bats (HF; 39.6%). The proportion of HF and LF bat passes was similar among Anabat stations DL2 and DL3, where LF passes outnumbered HF passes. However, HF passes outnumbered LF passes at station DL1 (Figure 16). HF passes generally outnumbered LF passes during July, while LF passes were usually more numerous throughout the rest of the study period (Figure 18).

Species identification for specific passes was possible for the hoary bat and eastern red bat; therefore, passes by these species could be separated from passes by other bats. Hoary bats comprised 7.6% of total passes detected within the study area (Table 10). Hoary bat activity was highest at station DL1 (Figure 19). Patterns of hoary bat activity were congruent with the overall temporal trend (Figure 20), with most passes recorded on August 12. Eastern red bats comprised just 1.5% of all bat passes (four passes; Table 10), and were only detected at station DL2 on a few nights in July, August, and September (Figures 19 and 20). Given the high intraspecific variability of Lasiurine calls, and the number of call files that were too fragmented for proper identification, it is likely that more hoary and eastern red bat calls were present than were positively identified.

DISCUSSION AND IMPACT ASSESSMENT

Bird Impacts

Direct Effects
The most probable direct impact to birds from wind-energy facilities is direct mortality or injury due to collisions with turbines or guy wires of meteorological (met) towers. Collisions may occur with resident birds foraging and flying within the DRWRA or with migrant birds seasonally moving through the DRWRA. Project construction could affect birds through loss of habitat, or potential fatalities from construction equipment. Impacts from the decommissioning of the facility are anticipated to be similar to construction in terms of noise, disturbance, and equipment. Potential mortality from construction equipment is expected to be very low. Equipment used in wind-energy facility construction generally moves at slow rates or is

stationary for long periods (e.g., cranes). The risk of direct mortality to birds from construction is most likely potential destruction of a nest for ground- and shrub-nesting species during initial site clearing.

Substantial data on bird mortality at wind-energy facilities are available from studies in California and throughout the West and Midwest. Of 841 bird fatalities reported from California studies (more than 70% from the Altamont Pass facility in California), about 39% were diurnal raptors, about 19% were passerines (excluding house sparrows [*Passer domesticus*] and European starlings [*Sturnus vulgaris*]), and about 12% were owls. Non-protected birds including house sparrows, European starlings, and rock pigeons (*Columba livia*) comprised about 15% of the fatalities. Other bird types generally made up less than 10% of the fatalities (Erickson et al. 2002b). During 12 fatality monitoring studies conducted outside of California, diurnal raptor fatalities comprised about 2% of the wind-energy facility-related fatalities and raptor mortality averaged 0.03/turbine/year. Passerines (excluding house sparrows and European starlings) were the most common collision victims, comprising about 82% of the 225 fatalities documented. For all bird species combined, estimates of the number of bird fatalities per turbine per year from individual studies ranged from zero at the Searsburg wind-energy facility in Vermont (Kerlinger 1997) and the Algona facility in Iowa (Demastes and Trainer 2000), to 7.7 at the Buffalo Mountain facility in Tennessee (Nicholson 2003). Using mortality data from a 10-year period from wind-energy facilities throughout the entire United States, the average number of bird collision fatalities is 3.1 per megawatt (MW) per year, or 2.3 per turbine per year (NWCC 2004).

Raptor Use and Exposure Risk

The annual mean raptor use at the DRWRA (0.52 raptors/plot/20-min survey) was compared with other wind-energy facilities that implemented similar protocols and had data for three or four seasons. Similar studies were conducted at 36 other wind-energy facilities. The annual mean raptor use at these wind-energy facilities ranged from 0.09 to 2.34 raptors/plot/20-min survey (Figure 21). Based on the results from these wind-energy facilities, a ranking of seasonal raptor mean use was developed as: low (0 – 0.5 raptors/plot/20-min survey); low to moderate (0.5 – 1.0); moderate (1.0 – 2.0); high (2.0 – 3.0); and very high (> 3.0). Under this ranking, mean raptor use (number of raptors divided by the number of 800-m plots and the total number of surveys) at the DRWRA is considered to be low to moderate, ranking nineteenth when compared to the 36 other wind-energy facilities (Figure 21).

Although high numbers of raptor fatalities have been documented at some wind-energy facilities (e.g. Altamont Pass), a review of studies at wind-energy facilities across the United States reported that only 3.2% of casualties were raptors (Erickson et al. 2001a). Indeed, although raptors occur in most areas with the potential for wind-energy development, individual species appear to differ from one another in their susceptibility to collision (NRC 2007). Results from Altamont Pass in California suggest that mortality for some species is not necessarily related to abundance (Orloff and Flannery 1992). American kestrels (*Falco sparverius*), red-tailed hawks (*Buteo jamaicensis*), and golden eagles were killed more often than predicted based on abundance. Thus far, only three northern harrier (*Circus cyaneus*) fatalities at existing wind-energy facilities have been reported in publicly available documents, despite the fact they are commonly observed during point counts at these facilities (Erickson et al. 2001a; Whitfield and Madders 2006). Because northern harriers often forage close to the ground, risk of collision with turbine blades is considered low for this species. In addition, reports from the High Winds wind-

energy facility in California document high American kestrel mortality. Relative use by American kestrels at the High Winds facility is almost six times the use of American kestrels at the Altamont Pass facility (Kerlinger 2005). It is likely that many factors, in addition to abundance, are important in predicting raptor mortality.

An exposure index analysis may also provide insight into what species have a higher likelihood of turbine casualties. The index considers relative probability of exposure based on abundance, proportion of daily activity spent flying, and proportion of flight height of each species within the ZOR for turbines likely to be used at the wind-energy facility. For the DRWRA, the raptor species with the highest exposure index was the golden eagle, which was ranked highest of all large bird species (Table 6a). The higher exposure index for golden eagle (0.06) was due to flight height data showing that 34.0% of flying observations were within the ZOR. Although the golden eagle had the highest exposure index relative to other bird species, the absolute value of 0.06 is quite low. The exposure index analysis is based on observations of birds during the daylight period and does not take into consideration flight behavior (e.g., during foraging or courtship) or abundance of nocturnal migrants. It also does not take into consideration habitat selection, the ability to detect and avoid turbines, and other factors that may vary among species and influence likelihood for turbine collision. For these reasons, the actual risk for some species may be lower or higher than indicated by this index.

A regression analysis of raptor use and mortality for 13 new-generation wind-energy facilities, where similar methods were used to estimate raptor use and mortality, found that there was a significant correlation between use and mortality (R^2 = 69.9%; Figure 22). Using this regression to predict raptor collision mortality at the DRWRA, based on an adjusted mean raptor use of 0.52 raptors/20-min survey, yields an estimated fatality rate of 0.06 fatalities/MW/year, or six raptor fatalities per year for each 100-MW of wind-energy development. A 90% prediction interval around this estimate is zero to 0.32 fatalities/MW/year. Because there is more uncertainty associated with predicting for a single value at a point, rather then estimating a confidence interval around a point, prediction intervals are typically wider than confidence intervals (Devore and Peck 2001).

Based on species composition of the most common raptor fatalities at other western wind-energy facilities and species composition of raptors observed at the Dunlap Ranch Wind Resource Area during the surveys, the majority of the fatalities of diurnal raptors will likely consist of golden eagles, ferruginous hawks, and American kestrels. Based on the seasonal use estimates, it is expected that risk to raptors would be unequal across seasons, with the lowest risk in the winter, and highest risk during the summer.

Active raptor nest density within the DRWRA and 1- mile buffer was 0.12 nests/mi^2 (Table 8). This is low in comparison to ten other wind resource areas evaluated in the western US, where active raptor nest density ranged from 0.03 to 0.30 nests/mi^2 (0.01 to 0.12 nests/km^2) and averaged 0.15 nests/mi^2 (0.06 nests/km^2). Since few raptor species targeted during nest surveys have been observed as fatalities at newer wind-energy facilities, correlations are very low between the number of collision fatalities and raptor nest density within one mile of project facilities. Raptors nesting closest to turbines likely have higher probabilities of being impacted from collision with turbines, but data on nests very close to turbines (e.g., within a half-mile) are

currently inadequate to determine the level of these impacts. The existing wind-energy facility with the highest reported nest density is the Foote Creek Rim facility in Wyoming. Most of the nests within two miles of the wind-energy facility are red-tailed hawks (Johnson et al. 2000a), but no red-tailed hawk fatalities have been documented at this facility (Young et al. 2003c).

Non-Raptor Use and Exposure Risk

Most bird species in the US are protected by the Migratory Bird Treaty Act (MBTA 1918). Passerines (primarily perching birds) have been the most abundant bird fatality at wind-energy facilities outside California (Erickson et al. 2001a, 2002b), often comprising more than 80% of the bird fatalities. Both migrant and resident passerine fatalities have been observed. Given that passerines made up a large proportion of the birds observed during the baseline study, passerines would be expected to make up the largest proportion of fatalities at the DRWRA. Exposure indices based on observations within 100 m indicate that Brewer's blackbird and horned lark are the most likely passerine species to be exposed to collision from wind turbines at the DRWRA. No other passerine species was at risk based on abundance and flight behavior (Table 7b). Most non-raptors had relatively low exposure indices due to the majority of individuals flying below the likely zone of risk. Due to the low exposure risks at DRWRA, it is unlikely that non-raptor populations will be adversely affected by direct mortality from the operation of the wind-energy facility.

Wind-energy facilities with year-round use by water dependent species have shown the highest mortality, although the levels of waterfowl/waterbird/shorebird mortality appear insignificant compared to the use of the facilities by these groups. Of 1,033 bird carcasses collected at US wind-energy facilities, waterbirds comprised about 2%, waterfowl comprised about 3%, and shorebirds comprised less than 1% (Erickson et al. 2002b). At the Klondike wind-energy facility in Oregon, only two Canada goose fatalities were documented (Johnson et al. 2003a) even though 43 groups totaling 4,845 individual Canada geese were observed during pre-construction surveys (Johnson et al. 2002a). The Top of Iowa wind-energy facility is located in cropland between three Wildlife Management Areas (WMAs) with historically high bird use, including migrant and resident waterfowl. During studies of that facility, approximately one million goose-use days and 120,000 duck-use days were recorded in the WMAs during the fall and early winter, and no waterfowl fatalities were documented during concurrent and standardized wind-energy facility fatality studies (Jain 2005). Similar findings were observed at the Buffalo Ridge wind-energy facility in southwestern Minnesota, which is located in an area with relatively high waterfowl/waterbird use and some shorebird use. Snow geese (*Chen caerulescens*), Canada geese and mallards were the most common waterfowl observed. Three of the 55 fatalities observed during the fatality monitoring studies were waterfowl, including two mallards and one blue-winged teal (*Anas discors*). Two American coots (*Fulica americana*), one grebe, and one shorebird fatality were also found (Johnson et al. 2002b). Based on available evidence, waterfowl do not seem especially vulnerable to turbine collisions and significant impacts are not likely.

Sensitive Species Use and Exposure Risk

No federally listed threatened or endangered species were observed in the DRWRA during fixed-point bird use surveys (Table 4) or incidentally (Table 9). All sensitive bird species recorded incidentally were also recorded during fixed-point bird use surveys. Sixteen bird species

considered sensitive, or of Native Species Status (NSS), by the WGFD were observed within the DRWRA. Wyoming sensitive species of most concern are those classified as NSS1 or NSS2. The only NSS1 bird species observed was common loon. Only two individuals were observed, both flying over the DRWRA (Table 11). The only NSS2 bird species observed was bald eagle (three observations). Due to very low use of the DRWRA by these two species, it is unlikely that collision mortality would occur. Of those species classified as NSS3 or NSS4, the most frequently observed species were McCown's longspur (89 observations), ferruginous hawk (81 observations), mountain plover (63 observations), and American white pelican (34 observations). This is a tally that in some cases represents repeated observations of the same individuals. The ferruginous hawk was one of the most common raptors recorded at the DRWRA and some collision mortality may occur over the life of the wind-energy facility. However, overall raptor collision mortality is expected to be relatively low based on our analysis, and significant population level impacts would not be expected. Mountain plover, McCown's longspur, and American white pelican were never observed flying within the turbine ZOR. Therefore, significant risk of collision mortality is not expected for these species. Mountain plovers were common at the Foote Creek Rim wind-energy facility in Wyoming, yet no fatalities were found during several years of post-construction monitoring (Young et al. 2005a). Use of the DRWRA by the other sensitive species recorded was relatively low and no significant direct impacts are likely to occur.

Indirect Effects

The presence of wind turbines may alter the landscape so that wildlife use patterns are affected, displacing wildlife away from the wind-energy facilities and suitable habitat. Some studies from wind-energy facilities in Europe consider displacement effects to have a greater impact on birds than collision mortality (Gill et al. 1996). The greatest concern with displacement impacts for wind-energy facilities in the US has been where these facilities have been constructed in grassland or other native habitats (Leddy et al. 1999; Mabey and Paul 2007). Although Crockford (1992) suggests that disturbance appears to impact feeding, resting, and migrating birds, rather than breeding birds, results from several studies in the US suggest that breeding birds may also be displaced by wind-facility operations.

Raptor Displacement

In addition to possible direct effects on raptors within the DRWRA (discussed above), indirect effects caused by disturbance-type impacts, such as construction activity near an active nest or primary foraging area, also have a potential impact on raptor species. Active raptor nest density within the DRWRA and 1-mile buffer was 0.12 nests/mi^2, which is low compared to most other regional wind-energy facilities, thereby minimizing the potential impact on nesting raptors. Birds displaced from wind-energy facilities might move to areas with fewer disturbances, but with lower quality habitat, with an overall effect of reducing breeding success. Most studies on raptor displacement at wind-energy facilities, however, indicate effects to be negligible (Howell and Noone 1992; Johnson et al. 2000b, 2003b; Madders and Whitfield 2006). Notable exceptions to this include a study in Scotland that described territorial golden eagles avoiding the entire wind-energy facility area, except when intercepting non-territorial birds (Walker et al. 2005). A study at the Buffalo Ridge wind-energy facility in Minnesota found evidence of northern harriers avoiding turbines on both a small scale (< 100 m [328 ft] from turbines) and a larger scale in the

year following construction (Johnson et al. 2000b). Two years following construction, however, no large-scale displacement of northern harriers was detected.

The only published report of avoidance of wind turbines by nesting raptors occurred at Buffalo Ridge, Minnesota, where raptor nest density on 101 mi^2 (261.6 km^2) of land surrounding a wind-energy facility was 5.94 nests/39 mi^2 (5.94 nests/101.0 km^2) yet no nests were present in the 12 mi^2 (31.1 km^2) facility itself, even though habitat was similar (Usgaard et al. 1997). However, this analysis assumes that raptor nests are uniformly distributed across the landscape, an unlikely event, and even though no nests were found, only two nests would be expected for an area 12 mi^2 in size if the nests were distributed uniformly. At a wind-energy facility in eastern Washington, based on extensive monitoring using helicopter flights and ground observations, raptors still nested in the study area at approximately the same levels after construction, and several nests were located within a half-mile of turbines (Erickson et al. 2004). At the Foote Creek Rim Wind-Energy Facility in southern Wyoming, one pair of red-tailed hawks nested within 0.3 miles (0.5 km) of the turbine strings, and seven red-tailed hawk nests, one great horned owl nest, and one golden eagle nest located within one mile of the wind-energy facility successfully fledged young (Johnson et al. 2000a). The golden eagle pair successfully nested a half-mile from the facility for three different years after it became operational. A Swainson's hawk (*Buteo swainsoni*) also nested within 0.25 mile (0.4 km) of a turbine string at the Klondike I wind-energy facility in Oregon after the facility was operational (Johnson et al. 2003b). These observations suggest that there will be limited nesting displacement of raptors at the DRWRA, although the creation of a buffer surrounding known nests when siting turbines may reduce any potential impact.

Displacement of Non-Raptor Bird Species

Studies concerning displacement of non-raptor species have concentrated on grassland passerines and waterfowl/waterbirds (Winkelman 1990; Larsen and Madsen 2000; Mabey and Paul 2007). Wind-energy facility construction appears to cause small-scale local displacement of grassland passerines and is likely due to the birds avoiding turbine noise and maintenance activities. Construction also reduces habitat effectiveness because of the presence of access roads and large gravel pads surrounding turbines (Leddy 1996; Johnson et al. 2000b). Leddy et al. (1999) surveyed bird densities in Conservation Reserve Program (CRP) grasslands at the Buffalo Ridge wind-energy facility in Minnesota, and found mean densities of ten grassland bird species were four times higher at areas located 180 m (591 ft) from turbines than they were at grasslands nearer turbines. Johnson et al. (2000b) found reduced use of habitat by seven of 22 grassland-breeding birds following construction of the Buffalo Ridge wind energy facility in Minnesota. Results from the Stateline wind-energy facility in Oregon and Washington (Erickson et al. 2004), and the Combine Hills wind-energy facility in Oregon (Young et al. 2005b), suggest a relatively small impact of the wind-energy facilities on grassland nesting passerines. Transect surveys conducted prior to and after construction of the wind-energy facilities found that grassland passerine use was significantly reduced within approximately 50 m (164 ft) of turbine strings, but areas further away from turbine strings did not have reduced bird use.

Shaffer and Johnson (2008) examined displacement of grassland birds in the northern Great Plains. Intensive transect surveys were conducted within grid cells that contained turbines as well as reference areas. The study focused on five species at two study sites, one in South Dakota and one in North Dakota. Based on this analysis, killdeer, western meadowlark (*Sturna neglecta*),

and chestnut-collared longspur (*Calcarius ornatus*) did not show any avoidance of wind turbines. However, grasshopper sparrow (*Ammodramus savannarum*) and clay-colored sparrow (*Spizella pallida*) showed avoidance out to 200 m (656 ft).
Displacement effects of wind-energy facilities on waterfowl and shorebirds appear to be mixed. Studies from the Netherlands and Denmark suggest that densities of these types of species near turbines were lower compared to densities in similar habitats away from turbines (Winkelman 1990; Pedersen and Poulsen 1991). However, a study from a facility in England found no effect of wind turbines on populations of cormorant (*Phalacrcorax xarbo*), purple sandpipers (*Calidris maritima*), eiders (*Somateria mollissima*), or gulls, although the cormorants were temporarily displaced during construction (Lawrence et al. 2007). At the Buffalo Ridge wind-energy facility in Minnesota, the abundance of several bird types, including shorebirds and waterfowl, was found to be significantly lower at survey plots with turbines than at reference plots without turbines (Johnson et al. 2000b). The report concluded that the area of reduced use was limited primarily to those areas within 100 m of the turbines. Disturbance tends to be greatest for migrating birds while feeding and resting (Crockford 1992; NRC 2007). The majority of waterfowl/waterbird use at the DRWRA included nine groups of mallards, four groups of Canada geese, four groups of American white pelican, two groups of redheads, and two groups of unidentified waterfowl comprising a total of 200 individuals (69.7% of waterfowl/waterbird observations).

Results of a long-term mountain plover monitoring study at Foote Creek Rim suggest that construction of the wind-energy facility resulted in some displacement of mountain plovers. The mountain plover population was reduced during construction but has slowly increased since, although not to the same level as it was prior to construction. It is not known if this was due to presence of the wind-energy facility or to regional declines in mountain plover populations. Some mountain plovers have apparently become habituated to the turbines, as several mountain plover nests have been located within 75 m (246 ft) of turbines, and many of the nests were successful (Young et al. 2005a).

A study conducted in England to assess displacement of wintering farmland birds by wind turbines located in an agricultural landscape found that only common (ring-necked) pheasants (*Phasianus colchicus*) apparently avoided turbines. The other species/bird groups examined, including granivores, red-legged partridge (*Alectoris rufa*), Eurasian skylark (*Alauda arvensis*) and corvids, showed no displacement from wind turbines. In fact, Eurasian skylarks and corvids showed increased use of areas close to turbines, possibly due to increased food resources associated with disturbed areas (Devereux et al. 2008). Due to the presence of similar habitats surrounding the DRWRA, it is unlikely that any displacement impacts would cause significant declines in breeding birds.

Much debate has occurred recently regarding the potential impacts of wind-energy projects on prairie grouse, including greater sage-grouse. Under a set of voluntary guidelines, the US Fish and Wildlife Service (USFWS) has taken a precautionary approach and recommends wind turbines be placed at least five miles (eight km) from known prairie grouse lek locations (USFWS 2003). The USFWS argues that because prairie grouse evolved in habitats with little vertical structure, placement of tall man-made structures, such as wind turbines, in occupied prairie grouse habitat may result in a decrease in habitat suitability (USFWS 2004). While the

potential exists for wind turbines to displace prairie grouse from occupied habitat, well-designed studies examining the potential impacts of wind turbines on prairie grouse are currently lacking. Ongoing telemetry research being conducted by Kansas State University to examine response of greater prairie-chickens to wind energy development in Kansas and a similar study being conducted by WEST (Johnson et al. 2009a) on greater sage-grouse in Wyoming will help to address this lack of knowledge.

Other than these two ongoing telemetry studies, we are aware of only two publicly-available studies that examined response of prairie grouse species to wind energy development. The Nebraska Game and Parks Commission (NGPC 2008) monitored both greater prairie-chicken (*Tympanuchus cupido*) and sharp-tailed grouse leks (*Tympanuchus phasianellus*) following construction of the 36-turbine Ainsworth wind-energy facility in Brown County, Nebraska. Surveys for leks were conducted three years post-construction (2006-2008) within a 1- to 2-mile radius of the facility, an area that covered approximately 25 square miles (65 km^2). Six sharp-tailed grouse and seven greater prairie-chicken leks were recorded during the study, and all 13 leks were present each of the three study years. The total number of greater prairie-chickens and sharp-tailed grouse combined counted on the leks was 136 in 2006, 135 in 2007, and 134 in 2008, indicating no significant decrease in populations within the study area. No pre-construction data were available on prairie grouse leks near the site; however, densities of lekking grouse on the study area at Ainsworth were within the range of expected grouse densities in similar habitats in Brown County and the adjacent Rock County. The 13 leks ranged from approximately 0.30 to 1.59 miles (0.48 to 2.56 km) from the nearest turbine, with an average distance of 0.66 miles (1.06 km).

At a three-turbine wind energy facility in Minnesota, researchers documented six active greater prairie-chicken leks within two miles of the three turbines, with the nearest lek located within one km (0.6 miles) of the nearest turbine. One hen with a brood was also documented immediately adjacent to a turbine (Society of Tympanuchus Cipido Pinnatus and Toepfer 2003).

Although the data collected during these two studies indicate that prairie grouse may continue to use habitats near wind-energy facilities, research conducted on greater sage-grouse response to oil and gas development has found population declines due to oil and gas development may not occur until four or five years post-construction (Holloran 2005). Therefore, long-term data may be required to adequately assess impacts of wind-energy development on prairie grouse species. Due to the apparent low density of greater sage-grouse in the DRWRA, and because it is not in a greater sage-grouse core use area, it is unlikely that construction and operation of a wind energy facility in this area will significantly impact greater sage-grouse populations.

Bat Impacts

Assessing the potential impacts of wind energy development to bats at the DRWRA is complicated by the current lack of understanding of why bats die at wind turbines (Kunz et al. 2007b; Baerwald et al. 2008), combined with the inherent difficulties of monitoring elusive, night-flying animals (O'Shea et al. 2003). To date, monitoring studies of wind-energy facilities suggest that: a) migratory tree-roosting species (eastern red, hoary, and silver-haired bats) comprise almost 75% of reported bats killed; b) the majority of fatalities occur during the post-

breeding or fall migration season (roughly August and September); and c) the highest reported fatalities occur at facilities located along forested ridge tops in the eastern US (Gruver 2002; Johnson et al. 2003a; Kunz et al. 2007b; Arnett et al. 2008), although recent studies in agricultural regions of Iowa and Alberta, Canada, also report relatively high numbers of fatalities (Jain 2005; Baerwald 2006).

Some studies of wind-energy facilities have recorded both Anabat detections per night and bat mortality (Table 12). The number of bat calls per night as determined from bat detectors shows a rough correlation with bat mortality, but may be misleading because effort, timing of sampling, species recorded, and detector settings (equipment and locations) varies among studies (Kunz et al. 2007b). Thus, the best available estimate of mortality levels at a proposed wind-energy facility involves evaluation of the on-site bat acoustic data in terms of activity levels, seasonal variation, species composition, and habitat and topographic features of the study area.

Activity

Bat activity within the DRWRA (mean of 1.67 bat passes per detector-night) was much lower than activity recorded at wind-energy facilities in West Virginia, Iowa, and Tennessee, where bat mortality rates were highest (Table 12), and was slightly lower when compared to facilities in Minnesota and an existing wind-energy facility in Carbon County, Wyoming, where bat mortality was lower. Thus, based on the presumed relationship between pre-construction bat activity and post-construction fatalities, bat mortality rates at the DRWRA can be expected to be much lower than the rates observed in the eastern US, and likely more consistent with the estimates in the Midwest and western US.

Spatial Variation

The proposed wind-energy facility is not located near any large, known bat colonies or other features that are likely to attract large numbers of bats. In addition, the DRWRA does not contain topographic features that may funnel migrating bats, and is lacking large tracts of forest cover, unlike high-mortality sites in the eastern US. However, the relatively large numbers of bat fatalities recently reported in northern Iowa (Jain 2005) and southwestern Alberta (Baerwald 2006) indicate that an open landscape is no guarantee of low mortality. Based on the lack of forested areas and wetlands to attract local, breeding bat populations, the majority of bat mortalities can be expected to be individuals migrating through the area.

Bat activity was uniformly low among all three stations, which were located in rangeland/grassland habitat on flat to hilly terrain. Station DL1 recorded the most activity; an abandoned building nearby may have attracted bats as a night roost. Two ponds were located near station DL3, but did not appear to attract bats to the area.

Temporal Variation

Bat activity at the DRWRA was highest during July and August, with the highest activity recorded on August 21 (11 passes). August activity likely represents movement of migrating bats through the area, which may explain the greater number of low-frequency bats at this time. Activity by hoary bats peaked on August 12, and none were recorded after August 30, suggesting migration of this species through the area at this time. Eastern red bats were only recorded on four occasions at station DL2 in July, August, and September, so temporal trends are not

discernable for this species. Based on range maps, abundance of eastern red bats in this portion of Wyoming is expected to be very low.

Fatality studies of bats at wind-energy facilities in the US have shown a peak in mortality in August and September and generally lower mortality earlier in the summer (Johnson 2005; Arnett et al. 2008). While the survey effort varies among the different studies, the studies that combine Anabat surveys and fatality surveys show a general association between the timing of increased bat call rates and timing of mortality, with both call rates and mortality peaking during the fall (Kunz et al. 2007b). Based on the available data, it is expected that bat mortality at the DRWRA will be highest in August.

Species Composition

Of the 11 species of bat likely to occur in the study area, five are known fatalities at wind-energy facilities (Table 2). Acoustic bat surveys were unable to determine bat species present in the study area (except for hoary and eastern red bats), but they were able to distinguish high-frequency from low-frequency species.

Most (60.4%) of passes were by low-frequency bats, suggesting higher relative abundance of species such as big brown, silver-haired, hoary and fringed (*Myotis thysanodes*) bats. High-frequency species were most abundant from July to mid-August, whereas low-frequency species were more common during the rest of the study period. This change in species composition probably reflects movement of resident high-frequency species out of the area, and passage of low-frequency species through the area during fall migration. Station DL1 recorded more high-frequency bat passes, while stations DL2 and DL3 recorded more low-frequency bat passes, suggesting spatial differences in species composition. However, stations DL1 and DL3 were located very near each other (Figure 9). Differences in species composition between stations may be an artifact of moving the detector at station DL1 to DL3 at the time that species composition was changing across the study area in mid-August. Many of the low-frequency species likely to be present at the DRWRA (e.g., hoary, silver-haired, and big brown bat) tend to forage at higher altitudes than most high-frequency species due to their wing morphology and echolocation call structure (Norberg and Rayner 1987).

Hoary bats made up 7.6% of all low-frequency passes, and were most active in late August, suggesting fall migration through the area at that time. Four passes by eastern red bats were identified, all at station DL2 and on different nights in July, August, and September, suggesting this species is relatively rare in the study area.

CONCLUSIONS

Based on data collected during this study, raptor and all bird use of the DRWRA is generally similar to most wind resource areas evaluated throughout the western and midwestern US using similar methods. Based on the results of the studies to date, bird mortality at the DRWRA would likely be similar or lower than that documented at other wind-energy facilities located in the western and Midwestern US, where bird collision mortality has been relatively low.

Currently, few published studies are available from the Western US (West) that compare bird use to bird mortality rates. Based on research conducted at wind-energy facilities throughout the US, raptor use at the DRWRA is generally lower than use levels recorded at other wind-energy facilities. Raptor fatality rates are expected to be within the range of fatality rates observed at other facilities where raptor use levels are lower. To date, no relationships have been observed between overall use by other bird types, and fatality rates of those bird types at wind-energy facilities. However, the flight characteristics and foraging habits of some species may result in increased exposure for these species at the DRWRA. The surveys conducted for this proposed wind resource area also do not address the impacts of the proposed facility to nocturnal migrants, such as passerines. To date, overall fatality rates for birds (including nocturnal migrants) at wind-energy facilities have been relatively low and consistent in the West. As more research is conducted at facilities in the West, more information regarding the potential direct impacts of wind-energy facilities to bird species will be obtained.

The proposed wind-energy facility is comprised of native habitats such as scrub-shrub and grasslands (Table 1, Figure 3). Several species considered to be sensitive were observed breeding within these habitats at the DRWRA, and some potential exists for wind turbines to displace breeding birds. Research concerning displacement impacts to passerines, waterfowl, and waterbirds associated with wind-energy facilities is limited, but some studies show the potential for small scale (200 m [656 ft] or less) displacement, while impacts to densities of birds at larger scales have not been shown.

Overall bat activity at the DRWRA (1.67 bat passes/detector-night) was somewhat lower than the mean of 2.2 bat passes/detector-night recorded at the Foote Creek Rim wind-energy facility, located approximately 25 miles (40.23 km) south of the DRWRA. Actual bat mortality at the Foote Creek Rim facility was estimated at 1.34 bat fatalities/MW/year (Young et al. 2001), which is relatively low compared to most other operational wind-energy facilities (Johnson 2005; Arnett et al. 2008). Therefore, similar rates of bat mortality could be expected at the DRWRA. Bat activity at the DRWRA was somewhat higher than that recorded at the PacifiCorp Glenrock/Rolling Hills WRA in Converse County (0.29 bat passes/detector night; Johnson et al. 2008a); however, it was lower than that recorded at the PacifiCorp Seven Mile Hill WRA, located approximately eight miles (12.9 km) southwest of the DRWRA (2.9 bat passes/detector-night; Johnson et al. 2008b), the PacifiCorp High Plains WRA, located on the Carbon/Albany County line approximately 18 miles (28.8 km) south of the DRWRA (3.76 bat passes/detector night; Johnson et al. 2009b), and the Horizon Wind Energy Simpson Ridge WRA, located approximately 12 miles (19.2 km) southwest of the DRWRA (1.79 bat passes/detector night; Johnson et al. 2009c).

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Table 1. The land cover types, coverage, and composition within the Dunlap Ranch Wind Resource Area.

Habitat	Acres	% Composition
Developed, Open Space	146.10	0.8
Barren	38.16	0.2
Deciduous Forest	1.03	<0.1
Evergreen Forest	132.30	0.7
Scrub-Shrub	13,829.40	74.2
Grassland	4,285.42	23.0
Woody Wetlands	5.66	<0.1
Emergent Wetlands	195.19	1.1
Total	**18,633.26**	**100**

Data from the National Landcover Database (USGS NLCD 2001).

Table 2. Bat species determined from range-maps (Harvey et al. 1999; BCI website) as likely to occur within the Dunlap Ranch Wind Resource Area, sorted by call frequency.

Common Name	Scientific Name
High-frequency (> 35 kHz)	
western small-footed bat	*Myotis ciliolabrum*
little brown bat†	*Myotis lucifugus*
long-legged bat	*Myotis volans*
western small-footed bat	*Myotis ciliolabrum*
eastern red bat*†	*Lasiurus borealis*
Low-frequency (< 35 kHz)	
Townsend's big-eared bat	*Corynorhinus townsendii*
big brown bat†	*Eptesicus fuscus*
silver-haired bat*†	*Lasionycteris noctivagans*
hoary bat*†	*Lasiurus cinereus*
western long-eared bat	*Myotis evotis*
fringed bat	*Myotis thysanodes*

*long-distance migrant; †species known to have been killed at wind-energy facilities

Table 3. Summary of species richness (species/plot[a]/20-min survey), and sample size by season and overall during the fixed-point bird use surveys at the Dunlap Ranch Wind Resource Area, June 4, 2008 - May 27, 2009.

Season	Number of Visits	# Surveys Conducted	# Unique Species	Species Richness	
				Large Birds	Small Birds
Summer	7	69	45	0.90	1.15
Fall	11	110	37	0.62	0.56
Winter	7	58	4	0.23	0.05
Spring	11	103	62	1.05	1.06
Overall	**36**	**340**	**83**	**0.65**	**0.65**

[a] 800-m radius for large birds and 100-m radius for small birds

Table 4. Total number of individuals and groups for each bird type and species[a], by season and overall, during the fixed-point bird use surveys at the Dunlap Ranch Wind Resource Area[a] , June 4, 2008 - May 27, 2009.

		Summer		Fall		Winter		Spring		Total	
Species/Type	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Waterbirds		**1**	**3**	**2**	**24**	**0**	**0**	**4**	**13**	**7**	**40**
American white pelican	*Pelecanus erythrorhyncos*	0	0	2	24	0	0	2	10	4	34
California gull	*Larus californicus*	0	0	0	0	0	0	1	2	1	2
common loon	*Gavia immer*	0	0	0	0	0	0	1	1	1	1
great blue heron	*Ardea herodias*	1	3	0	0	0	0	0	0	1	3
Waterfowl		**4**	**18**	**2**	**18**	**0**	**0**	**40**	**211**	**46**	**247**
American wigeon	*Anas americana*	0	0	0	0	0	0	4	8	4	8
Canada goose	*Branta canadensis*	1	10	1	11	0	0	2	52	4	73
common merganser	*Mergus merganser*	0	0	0	0	0	0	3	5	3	5
gadwall	*Anas strepera*	0	0	0	0	0	0	4	9	4	9
green-winged teal	*Anas crecca*	0	0	0	0	0	0	1	1	1	1
lesser scaup	*Aythya affinis*	0	0	0	0	0	0	1	18	1	18
mallard	*Anas platyrhynchos*	1	2	0	0	0	0	8	19	9	21
northern pintail	*Anas acuta*	0	0	0	0	0	0	10	19	10	19
northern shoveler	*Anas clypeata*	0	0	0	0	0	0	2	7	2	7
redhead	*Aythya americana*	0	0	0	0	0	0	2	27	2	27
ruddy duck	*Oxyura jamaicensis*	0	0	0	0	0	0	1	2	1	2
unidentified duck		1	3	1	7	0	0	1	2	3	12
unidentified waterfowl		1	3	0	0	0	0	1	42	2	45
Shorebirds		**16**	**19**	**4**	**24**	**0**	**0**	**35**	**54**	**55**	**97**
American avocet	*Recurvirostra americana*	0	0	0	0	0	0	6	19	6	19
killdeer	*Charadrius vociferus*	1	1	0	0	0	0	8	9	9	10
long-billed curlew	*Numenius americanus*	0	0	0	0	0	0	2	2	2	2
mountain plover	*Charadrius montanus*	13	15	4	24	0	0	16	19	33	58
upland sandpiper	*Bartramia longicauda*	1	2	0	0	0	0	0	0	1	2
willet	*Catoptrophorus semipalmatus*	1	1	0	0	0	0	1	1	2	2
Wilson's phalarope	*Phalaropus tricolor*	0	0	0	0	0	0	2	4	2	4

Table 4. Total number of individuals and groups for each bird type and species[a], by season and overall, during the fixed-point bird use surveys at the Dunlap Ranch Wind Resource Area[a] , June 4, 2008 - May 27, 2009.

		Summer		Fall		Winter		Spring		Total	
Species/Type	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Raptors		**54**	**72**	**97**	**117**	**16**	**20**	**112**	**121**	**279**	**330**
Accipiters		*0*	*0*	*1*	*1*	*0*	*0*	*3*	*3*	*4*	*4*
Cooper's hawk	*Accipiter cooperii*	0	0	1	1	0	0	2	2	3	3
sharp-shinned hawk	*Accipter striatus*	0	0	0	0	0	0	1	1	1	1
Buteos		*25*	*30*	*30*	*33*	*0*	*0*	*33*	*38*	*88*	*101*
ferruginous hawk	*Buteo regalis*	20	25	29	32	0	0	20	21	69	78
red-tailed hawk	*Buteo jamaicensis*	2	2	1	1	0	0	9	13	12	16
Swainson's hawk	*Buteo swainsoni*	1	1	0	0	0	0	4	4	5	5
unidentified buteo		2	2	0	0	0	0	0	0	2	2
Northern Harrier		*0*	*0*	*2*	*2*	*0*	*0*	*7*	*7*	*9*	*9*
northern harrier	*Circus cyaneus*	0	0	2	2	0	0	7	7	9	9
Eagles		*18*	*28*	*57*	*74*	*16*	*20*	*56*	*59*	*147*	*181*
bald eagle	*Haliaeetus leucocephalus*	0	0	0	0	0	0	2	2	2	2
golden eagle	*Aquila chrysaetos*	18	28	57	74	16	20	54	57	145	179
Falcons		*11*	*14*	*7*	*7*	*0*	*0*	*12*	*13*	*30*	*34*
American kestrel	*Falco sparverius*	8	11	5	5	0	0	10	11	23	27
prairie falcon	*Falco mexicanus*	3	3	2	2	0	0	2	2	7	7
Other Raptors		*0*	*0*	*0*	*0*	*0*	*0*	*1*	*1*	*1*	*1*
osprey	*Pandion haliaetus*	0	0	0	0	0	0	1	1	1	1
Vultures		**0**	**0**	**4**	**5**	**0**	**0**	**1**	**1**	**5**	**6**
turkey vulture	*Cathartes aura*	0	0	4	5	0	0	1	1	5	6
Doves/Pigeons		**3**	**3**	**1**	**1**	**0**	**0**	**0**	**0**	**4**	**4**
mourning dove	*Zenaida macroura*	3	3	1	1	0	0	0	0	4	4
Passerines		**234**	**334**	**135**	**380**	**7**	**14**	**272**	**559**	**648**	**1,287**
American crow	*Corvus brachyrhynchos*	0	0	2	41	0	0	7	9	9	50
American goldfinch	*Carduelis tristis*	0	0	1	1	0	0	0	0	1	1
American pipit	*Anthus rubescens*	0	0	0	0	0	0	1	1	1	1
American robin	*Turdus migratorius*	0	0	0	0	0	0	3	3	3	3

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		Summer		Fall		Winter		Spring		Total	
Species/Type	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
bank swallow	*Riparia riparia*	0	0	0	0	0	0	1	1	1	1
barn swallow	*Hirundo rustica*	0	0	1	1	0	0	1	1	2	2
black-billed magpie	*Pica pica*	0	0	10	15	1	1	5	5	16	21
blue-gray gnatcatcher	*Polioptila caerulea*	2	2	0	0	0	0	2	2	4	4
Brewer's blackbird	*Euphagus cyanocephalus*	6	8	1	1	0	0	5	10	12	19
Brewer's sparrow	*Spizella breweri*	8	9	1	4	0	0	8	12	17	25
chipping sparrow	*Spizella passerina*	1	1	0	0	0	0	0	0	1	1
Clark's nutcracker	*Nucifraga columbiana*	2	4	0	0	0	0	0	0	2	4
cliff swallow	*Petrochelidon pyrrhonota*	3	12	0	0	0	0	3	4	6	16
common raven	*Corvus corax*	14	27	13	26	2	3	17	23	46	79
common yellowthroat	*Geothlypis trichas*	0	0	1	3	0	0	0	0	1	3
dark-eyed junco	*Junco hyemalis*	1	1	1	1	0	0	0	0	2	2
dusky flycatcher	*Empidonax oberholseri*	1	1	0	0	0	0	1	1	2	2
European starling	*Sturnus vulgaris*	0	0	0	0	0	0	1	2	1	2
green-tailed towhee	*Pipilo chlorurus*	6	6	0	0	0	0	5	8	11	14
horned lark	*Eremophila alpestris*	91	136	66	222	4	10	132	367	293	735
house wren	*Troglodytes aedon*	3	3	0	0	0	0	1	1	4	4
Lapland longspur	*Calcarius lapponicus*	0	0	1	1	0	0	0	0	1	1
lark bunting	*Calamospiza melanocorys*	3	9	0	0	0	0	0	0	3	9
lark sparrow	*Chondestes grammacus*	1	5	0	0	0	0	0	0	1	5
loggerhead shrike	*Lanius ludovicianus*	4	7	2	2	0	0	5	5	11	14
McCown's longspur	*Calcarius mccownii*	44	50	4	4	0	0	20	35	68	89
mountain bluebird	*Sialia currucoides*	4	5	4	18	0	0	5	8	13	31
mountain chickadee	*Poecile gambeli*	1	1	0	0	0	0	0	0	1	1
northern rough-winged swallow	*Stelgidopteryx serripennis*	0	0	0	0	0	0	1	1	1	1
pine siskin	*Carduelis pinus*	1	1	4	4	0	0	1	1	6	6
red-winged blackbird	*Agelaius phoeniceus*	1	1	0	0	0	0	2	3	3	4

Table 4. Total number of individuals and groups for each bird type and species[a], by season and overall, during the fixed-point bird use surveys at the Dunlap Ranch Wind Resource Area[a] , June 4, 2008 - May 27, 2009.

		Summer		Fall		Winter		Spring		Total	
Species/Type	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
rock wren	*Salpinctes obsoletus*	5	5	5	6	0	0	4	4	14	15
ruby-crowned kinglet	*Regulus calendula*	0	0	0	0	0	0	1	1	1	1
sage thrasher	*Oreoscoptes montanus*	4	4	1	1	0	0	4	4	9	9
savannah sparrow	*Passerculus sandwichensis*	0	0	1	1	0	0	0	0	1	1
Say's phoebe	*Sayornis saya*	0	0	0	0	0	0	1	1	1	1
Sprague's pipit	*Anthus spragueii*	0	0	2	3	0	0	0	0	2	3
Townsend's solitaire	*Myadestes townsendi*	0	0	2	2	0	0	0	0	2	2
tree swallow	*Tachycineta bicolor*	1	1	1	8	0	0	0	0	2	9
unidentified sparrow		1	4	0	0	0	0	0	0	1	4
vesper sparrow	*Pooecetes gramineus*	8	9	7	8	0	0	10	13	25	30
violet-green swallow	*Tachycineta thalassina*	1	1	0	0	0	0	0	0	1	1
western meadowlark	*Sturnella neglecta*	13	17	4	7	0	0	25	33	42	57
yellow-rumped warbler	*Dendroica coronata*	4	4	0	0	0	0	0	0	4	4
Other Birds		**7**	**9**	**4**	**4**	**0**	**0**	**6**	**7**	**17**	**20**
common nighthawk	*Chordeiles minor*	1	1	0	0	0	0	0	0	1	1
hairy woodpecker	*Picoides villosus*	2	4	0	0	0	0	0	0	2	4
northern flicker	*Colaptes auratus*	3	3	4	4	0	0	5	6	12	13
red-headed woodpecker	*Melanerpes erythrocephalus*	1	1	0	0	0	0	0	0	1	1
white-throated swift	*Aeronautes saxatalis*	0	0	0	0	0	0	1	1	1	1
Overall		**319**	**458**	**249**	**573**	**23**	**34**	**470**	**966**	**1,061**	**2,031**

[a] All birds observed, regardless of distance from observer

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Table 5a. Mean bird use (number of birds/plot/20-min survey), percent of total composition (%), and frequency of occurrence (%) for each large bird type and species by season during the fixed-point bird use surveys at the Dunlap Ranch Wind Resource Area, June 4, 2008 - May 27, 2009.

	Use				% Composition				% Frequency			
Species/Type	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**
Waterbirds	**0**	**0**	**0**	**0.04**	**0**	**0**	**0**	**2.1**	**0**	**0**	**0**	**1.8**
American white pelican	0	0	0	0.02	0	0	0	1.1	0	0	0	0.9
California gull	0	0	0	0.02	0	0	0	1.1	0	0	0	0.9
Waterfowl	**0.03**	**0**	**0**	**0.59**	**2.1**	**0**	**0**	**34.6**	**1.6**	**0**	**0**	**7.3**
American wigeon	0	0	0	0.02	0	0	0	1.1	0	0	0	0.9
common merganser	0	0	0	0.02	0	0	0	1.1	0	0	0	0.9
green-winged teal	0	0	0	0.01	0	0	0	0.5	0	0	0	0.9
lesser scaup	0	0	0	0.16	0	0	0	9.6	0	0	0	0.9
mallard	0.03	0	0	0.09	2.1	0	0	5.3	1.6	0	0	4.5
northern pintail	0	0	0	0.11	0	0	0	6.4	0	0	0	5.5
northern shoveler	0	0	0	0.05	0	0	0	3.2	0	0	0	0.9
redhead	0	0	0	0.13	0	0	0	7.5	0	0	0	0.9
Shorebirds	**0.28**	**0.22**	**0**	**0.37**	**18.7**	**15.9**	**0**	**21.6**	**16.2**	**2.7**	**0**	**21.4**
American avocet	0	0	0	0.07	0	0	0	4.3	0	0	0	3.6
killdeer	0.01	0	0	0.08	1.0	0	0	4.5	1.4	0	0	6.8
long-billed curlew	0	0	0	0.02	0	0	0	1.1	0	0	0	1.8
mountain plover	0.22	0.22	0	0.17	14.8	15.9	0	10.1	16.2	2.7	0	12.7
upland sandpiper	0.03	0	0	0	1.9	0	0	0	1.4	0	0	0
willet	0.02	0	0	0.01	1.1	0	0	0.5	1.6	0	0	0.9
Wilson's phalarope	0	0	0	0.02	0	0	0	1.1	0	0	0	0.9
Raptors	**0.81**	**0.47**	**0.33**	**0.51**	**54.3**	**34.4**	**81.0**	**29.9**	**42.1**	**32.7**	**17.8**	**35.1**
Accipiters	*0*	*0*	*0*	*0.02*	*0*	*0*	*0*	*1.2*	*0*	*0*	*0*	*2.0*
Cooper's hawk	0	0	0	0.02	0	0	0	1.2	0	0	0	2.0
Buteos	*0.32*	*0.15*	*0*	*0.15*	*21.4*	*10.6*	*0*	*8.7*	*20.3*	*13.6*	*0*	*12.9*
ferruginous hawk	0.29	0.14	0	0.08	19.5	9.9	0	4.4	18.9	12.7	0	6.6
red-tailed hawk	0.01	0.01	0	0.07	1.0	0.7	0	3.8	1.4	0.9	0	5.4
Swainson's hawk	0.01	0	0	0.01	1.0	0	0	0.5	1.4	0	0	0.9

Table 5a. Mean bird use (number of birds/plot/20-min survey), percent of total composition (%), and frequency of occurrence (%) for each large bird type and species by season during the fixed-point bird use surveys at the Dunlap Ranch Wind Resource Area, June 4, 2008 - May 27, 2009.

	Use				% Composition				% Frequency			
Species/Type	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**
Northern Harrier	*0*	*0.02*	*0*	*0.02*	*0*	*1.3*	*0*	*1.2*	*0*	*1.8*	*0*	*2.0*
northern harrier	0	0.02	0	0.02	0	1.3	0	1.2	0	1.8	0	2.0
Eagles	*0.31*	*0.25*	*0.33*	*0.22*	*20.5*	*18.5*	*81.0*	*13.1*	*14.6*	*20.0*	*17.8*	*19.7*
bald eagle	0	0	0	0.02	0	0	0	1.1	0	0	0	1.8
golden eagle	0.31	0.25	0.33	0.21	20.5	18.5	81.0	12.1	14.6	20.0	17.8	18.8
Falcons	*0.19*	*0.05*	*0*	*0.10*	*12.4*	*4.0*	*0*	*5.6*	*12.9*	*5.5*	*0*	*7.5*
American kestrel	0.16	0.04	0	0.10	10.5	2.6	0	5.6	10.0	3.6	0	7.5
prairie falcon	0.03	0.02	0	0	1.9	1.3	0	0	2.9	1.8	0	0
Vultures	**0**	**0.03**	**0**	**0**	**0**	**2.0**	**0**	**0**	**0**	**2.7**	**0**	**0**
turkey vulture	0	0.03	0	0	0	2.0	0	0	0	2.7	0	0
Large Corvids	**0.33**	**0.65**	**0.08**	**0.20**	**22.0**	**47.0**	**19.0**	**11.8**	**14.4**	**12.7**	**5.6**	**15.2**
American crow	0	0.37	0	0.08	0	27.2	0	4.9	0	1.8	0	5.2
black-billed magpie	0	0.13	0.02	0.05	0	9.3	4.4	2.9	0	6.4	1.8	5.0
common raven	0.33	0.15	0.06	0.07	22.0	10.6	14.6	4.0	14.4	6.4	3.8	5.8
Doves/Pigeons	**0.04**	**0.01**	**0**	**0**	**2.9**	**0.7**	**0**	**0**	**4.3**	**0.9**	**0**	**0**
mourning dove	0.04	0.01	0	0	2.9	0.7	0	0	4.3	0.9	0	0
Overall	**1.50**	**1.37**	**0.40**	**1.71**	**100**	**100**	**100**	**100**				

Table 5b. Mean use (number of birds/100-m plot/20-min survey), percent of total composition (%), and frequency of occurrence (%) for each small bird type and species by season during the fixed-point bird use surveys at the Dunlap Ranch Wind Resource Area, June 4, 2008 - May 27, 2009.

	Use				% Composition				% Frequency			
Species/Type	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**
Passerines	**2.26**	**2.25**	**0.13**	**2.82**	**98.8**	**99.6**	**100**	**100**	**69.8**	**39.1**	**5.4**	**81.6**
American pipit	0	0	0	0.01	0	0	0	0.3	0	0	0	0.9
American robin	0	0	0	0.01	0	0	0	0.3	0	0	0	0.9
bank swallow	0	0	0	0.01	0	0	0	0.3	0	0	0	0.9
barn swallow	0	0.01	0	0.01	0	0.4	0	0.3	0	0.9	0	0.9
blue-gray gnatcatcher	0.01	0	0	0.02	0.6	0	0	0.6	1.4	0	0	1.8
Brewer's blackbird	0.07	0.01	0	0.08	3.1	0.4	0	2.9	4.3	0.9	0	2.7
Brewer's sparrow	0.04	0.04	0	0.08	1.9	1.6	0	2.9	2.9	0.9	0	4.5
chipping sparrow	0.01	0	0	0	0.6	0	0	0	1.4	0	0	0
cliff swallow	0.13	0	0	0.01	5.6	0	0	0.3	2.9	0	0	0.9
common yellowthroat	0	0.03	0	0	0	1.2	0	0	0	0.9	0	0
dark-eyed junco	0	0.01	0	0	0	0.4	0	0	0	0.9	0	0
dusky flycatcher	0.01	0	0	0	0.6	0	0	0	1.4	0	0	0
European starling	0	0	0	0.02	0	0	0	0.8	0	0	0	1.1
green-tailed towhee	0.01	0	0	0	0.6	0	0	0	1.4	0	0	0
horned lark	0.99	1.85	0.13	2.18	43.3	81.9	100	77.3	49.7	30.0	5.4	61.8
house wren	0.03	0	0	0	1.2	0	0	0	1.4	0	0	0
lark bunting	0.11	0	0	0	5.0	0	0	0	1.4	0	0	0
lark sparrow	0.07	0	0	0	3.1	0	0	0	1.4	0	0	0
loggerhead shrike	0.07	0.01	0	0.02	3.1	0.4	0	0.6	2.9	0.9	0	1.8
McCown's longspur	0.41	0.04	0	0.19	17.8	1.6	0	6.9	20.3	3.6	0	10.2
mountain bluebird	0.07	0.04	0	0.04	3.3	1.6	0	1.5	4.4	2.7	0	4.1
northern rough-winged swallow	0	0	0	0.01	0	0	0	0.3	0	0	0	0.9
pine siskin	0	0.02	0	0	0	0.8	0	0	0	1.8	0	0
ruby-crowned kinglet	0	0	0	0.01	0	0	0	0.3	0	0	0	0.9
rock wren	0	0.02	0	0.01	0	0.8	0	0.3	0	1.8	0	0.9

Table 5b. Mean use (number of birds/100-m plot/20-min survey), percent of total composition (%), and frequency of occurrence (%) for each small bird type and species by season during the fixed-point bird use surveys at the Dunlap Ranch Wind Resource Area, June 4, 2008 - May 27, 2009.

	Use				% Composition				% Frequency			
Species/Type	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**
Say's phoebe	0	0	0	0.01	0	0	0	0.3	0	0	0	0.9
sage thrasher	0.01	0.01	0	0.01	0.6	0.4	0	0.3	1.4	0.9	0	0.9
savannah sparrow	0	0.01	0	0	0	0.4	0	0	0	0.9	0	0
Sprague's pipit	0	0.03	0	0	0	1.2	0	0	0	1.8	0	0
tree swallow	0.01	0.07	0	0	0.6	3.2	0	0	1.4	0.9	0	0
unidentified sparrow	0.06	0	0	0	2.5	0	0	0	1.4	0	0	0
vesper sparrow	0.01	0.05	0	0.06	0.6	2.4	0	2.3	1.4	3.6	0	5.5
violet-green swallow	0.01	0	0	0	0.6	0	0	0	1.4	0	0	0
western meadowlark	0.03	0.02	0	0.03	1.2	0.8	0	1.0	2.9	1.8	0	3.0
yellow-rumped warbler	0.06	0	0	0	2.6	0	0	0	4.4	0	0	0
Other Birds	**0.03**	**0.01**	**0**	**0**	**1.2**	**0.4**	**0**	**0**	**2.9**	**0.9**	**0**	**0**
hairy woodpecker	0.01	0	0	0	0.6	0	0	0	1.4	0	0	0
northern flicker	0.01	0.01	0	0	0.6	0.4	0	0	1.4	0.9	0	0
Overall	**2.29**	**2.25**	**0.13**	**2.82**	**100**	**100**	**100**	**100**				

Table 6. Flight height characteristics by bird type during fixed-point bird use surveys at the Dunlap Ranch Wind Resource Area, June 4, 2008 - May 27, 2009. Large bird observations were limited to within 800-m and small birds were limited to within 100-m.

Bird Type	# Groups Flying	# Obs Flying	Mean Flight Height (ft)	% Obs Flying	% within Flight Height Categories 0-114 ft	114-427 ft	> 427 ft
Waterbirds	2	4	17.50	100	100	0	0
Waterfowl	1	1	1.00	1.5	100	0	0
Shorebirds	8	15	6.88	18.1	100	0	0
Raptors	100	111	33.72	61.7	67.6	27.9	4.5
Accipiters	*2*	*2*	*102.50*	*100*	*50.0*	*0*	*50.0*
Buteos	*30*	*33*	*25.47*	*62.3*	*63.6*	*30.3*	*6.1*
Northern Harrier	*4*	*4*	*3.50*	*100*	*100*	*0*	*0*
Eagles	*50*	*55*	*43.32*	*59.8*	*61.8*	*34.5*	*3.6*
Falcons	*14*	*17*	*15.93*	*58.6*	*88.2*	*11.8*	*0*
Vultures	3	3	40.00	100	33.3	66.7	0
Large Corvids	25	31	7.44	26.3	100	0	0
Doves/Pigeons	2	2	1.00	50.0	100	0	0
Large Birds Overall	**141**	**167**	**26.74**	**36.4**	**77.2**	**19.8**	**3.0**
Passerines	143	318	7.76	44.9	98.4	1.3	0.3
Other Birds	3	3	5.67	100	100	0	0
Small Birds Overall	**146**	**321**	**7.71**	**45.1**	**98.4**	**1.2**	**0.3**

ZOR: The likely "zone of risk" for potential collision with a turbine blade, or 114-427 ft (35-130 m) above ground level (AGL).

Table 7a. Relative exposure index and flight characteristics by large bird species during the fixed-point bird use surveys at the Dunlap Ranch Wind Resource Area, June 4, 2008 - May 27, 2009.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within ZOR based on initial obs	Exposure Index	% Within ZOR at anytime
golden eagle	48	0.28	58.9	34.0	0.06	50.9
ferruginous hawk	22	0.12	55.8	25.0	0.02	29.2
red-tailed hawk	7	0.02	100	50.0	0.01	50.0
American kestrel	14	0.07	68.0	11.8	0.01	11.8
turkey vulture	3	0.01	100	66.7	<0.01	66.7
bald eagle	2	<0.01	100	50.0	<0.01	50.0
common raven	16	0.15	42.9	0	0	0
mountain plover	6	0.14	20.7	0	0	0
American crow	3	0.10	6.1	0	0	0
black-billed magpie	6	0.04	35.0	0	0	0
lesser scaup	0	0.03	0	0	0	0
mallard	1	0.03	8.3	0	0	0
redhead	0	0.03	0	0	0	0
northern pintail	0	0.02	0	0	0	0
killdeer	1	0.02	11.1	0	0	0
American avocet	0	0.02	0	0	0	0
mourning dove	2	0.01	50.0	0	0	0
northern shoveler	0	0.01	0	0	0	0
prairie falcon	0	0.01	0	0	0	0
northern harrier	4	0.01	100	0	0	0
upland sandpiper	1	0.01	100	0	0	100
willet	0	0.01	0	0	0	0
Swainson's hawk	1	0.01	50.0	0	0	0
Cooper's hawk	2	<0.01	100	0	0	0
American white pelican	1	<0.01	100	0	0	0
American wigeon	0	<0.01	0	0	0	0
California gull	1	<0.01	100	0	0	0

Table 7a. Relative exposure index and flight characteristics by large bird species during the fixed-point bird use surveys at the Dunlap Ranch Wind Resource Area, June 4, 2008 - May 27, 2009.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within ZOR based on initial obs	Exposure Index	% Within ZOR at anytime
common merganser	0	<0.01	0	0	0	0
long-billed curlew	0	<0.01	0	0	0	0
Wilson's phalarope	0	<0.01	0	0	0	0
green-winged teal	0	<0.01	0	0	0	0

ZOR: The likely "zone of risk" for potential collision with a turbine blade, or 114-427 ft (35-130 m) above ground level (AGL).

Table 7b. Relative exposure index and flight characteristics for small birds during the fixed-point bird use surveys at the Dunlap Ranch Wind Resource Area, June 4, 2008 - May 27, 2009.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within ZOR based on initial obs	Exposure Index	% Within ZOR at anytime
Brewer's blackbird	6	0.04	53.3	25.0	<0.01	25.0
horned lark	88	1.13	45.5	0.9	<0.01	2.2
McCown's longspur	24	0.15	64.2	0	0	0
Brewer's sparrow	1	0.04	12.5	0	0	0
mountain bluebird	1	0.04	7.7	0	0	0
cliff swallow	2	0.03	20.0	0	0	0
lark bunting	2	0.03	100	0	0	0
vesper sparrow	3	0.03	28.6	0	0	0
loggerhead shrike	1	0.02	12.5	0	0	0
tree swallow	2	0.02	100	0	0	11.1
lark sparrow	0	0.02	0	0	0	0
western meadowlark	0	0.02	0	0	0	0
yellow-rumped warbler	0	0.01	0	0	0	0
unidentified sparrow	1	0.01	100	0	0	0
blue-gray gnatcatcher	0	0.01	0	0	0	0
sage thrasher	0	0.01	0	0	0	0
house wren	0	0.01	0	0	0	0
rock wren	0	0.01	0	0	0	0
common yellowthroat	0	0.01	0	0	0	0
Sprague's pipit	2	0.01	100	0	0	0
northern flicker	2	0.01	100	0	0	0
European starling	1	<0.01	100	0	0	0
barn swallow	2	<0.01	100	0	0	0
pine siskin	2	<0.01	100	0	0	0
chipping sparrow	0	<0.01	0	0	0	0
dusky flycatcher	0	<0.01	0	0	0	0
green-tailed towhee	0	<0.01	0	0	0	0

Table 7b. Relative exposure index and flight characteristics for small birds during the fixed-point bird use surveys at the Dunlap Ranch Wind Resource Area, June 4, 2008 - May 27, 2009.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within ZOR based on initial obs	Exposure Index	% Within ZOR at anytime
hairy woodpecker	1	<0.01	100	0	0	0
violet-green swallow	0	<0.01	0	0	0	0
American pipit	1	<0.01	100	0	0	0
American robin	0	<0.01	0	0	0	0
bank swallow	1	<0.01	100	0	0	0
northern rough-winged swallow	0	<0.01	0	0	0	0
ruby-crowned kinglet	0	<0.01	0	0	0	0
Say's phoebe	1	<0.01	100	0	0	0
dark-eyed junco	1	<0.01	100	0	0	0
savannah sparrow	1	<0.01	100	0	0	0

ZOR: The likely “zone of risk” for potential collision with a turbine blade, or 114-427 ft (35-130 m) above ground level (AGL).

Table 8. Nesting raptor species and nest density for the Dunlap Ranch Wind Resource Area and the study area, based on raptor nest surveys.

Species	Scientific Name	Number of nests on or within 1-mi buffer of DRWRA	Nest Density within 1-mi buffer of DRWRA (#nests/mi^2)
ferruginous hawk	*Buteo regalis*	3	0.05
great-horned owl	*Bubo virginianus*	1	0.02
golden eagle	*Aquila chrysaetos*	1	0.02
long-eared owl	*Asio otus*	1	0.02
merlin	*Falco columbarius*	1	0.02
Total		**7**	**0.12**

Table 9. Incidental wildlife observed while conducting all surveys at the Dunlap Ranch Wind Resource Area, June 4, 2008 - May 27, 2009.

Species	Scientific Name	#grps	# obs
yellow-rumped warbler	*Dendroica coronata*	1	6
mountain plover	*Charadrius montanus*	2	5
golden eagle	*Aquila chrysaetos*	3	4
American kestrel	*Falco sparverius*	1	4
ferruginous hawk	*Buteo regalis*	2	3
violet-green swallow	*Tachycineta thalassina*	1	3
American robin	*Turdus migratorius*	1	2
American wigeon	*Anas americana*	1	2
blue-gray gnatcatcher	*Polioptila caerulea*	1	2
mallard	*Anas platyrhynchos*	1	2
white-throated swift	*Aeronautes saxatalis*	1	2
Wilson's snipe	*Gallinago delicata*	1	2
bald eagle	*Haliaeetus leucocephalus*	1	1
broad-tailed hummingbird	*Selasphorus platycercus*	1	1
Bullock's oriole	*Icterus bullockii*	1	1
cedar waxwing	*Bombycilla cedrorum*	1	1
cinnamon teal	*Anas cyanoptera*	1	1
common loon	*Gavia immer*	1	1
northern harrier	*Circus cyaneus*	1	1
red-breasted nuthatch	*Sitta canadensis*	1	1
sharp-shinned hawk	*Accipter striatus*	1	1
Townsend's solitaire	*Myadestes townsendi*	1	1
Bird Subtotal	**22 species**	**26**	**47**
pronghorn	*Antilocapra americana*	200	4,006
elk	*Cervus elephus*	21	1,748
mule deer	*Odocoileus hemionus*	8	29
coyote	*Canis latrans*	9	10
badger	*Taxidea taxus*	4	4
Mammal Subtotal	**5 species**	**242**	**5,797**
boreal toad	*Bufo boreas*	1	2
Amphibian Subtotal	**1 species**	**1**	**2**

Table 10. Results of acoustic bat surveys conducted at the Dunlap Ranch Wind Resource Area, July 16, 2008 - October 14, 2008.

Anabat Location	# of HF Bat Passes	# of LF Bat Passes	# of Hoary Bat Passes*	# of Eastern Red Bat Passes**	Total Bat Passes	Detector-Nights	Bat Passes/ Night
DL1	53	22	12	0	75	33	2.27
DL2	46	98	4	4	144	91	1.58
DL3	10	46	5	0	56	49	1.14
Total	**109**	**166**	**21**	**4**	**275**	**173**	**1.67**

*Passes by hoary bats included in low-frequency (LF) numbers.
** Passes by eastern red bats included in high-frequency (HF) and low-frequency (LF) numbers.

Table 11. Summary of sensitive species observed at the Dunlap Ranch Wind Resource Area during fixed-point bird use surveys (FP) and as incidental wildlife observations (IWO), June 4, 2008 – May 27, 2009.

			FP		IWO		Total	
Species	**Scientific Name**	**Status**	**# of grps**	**# of obs**	**# of grps**	**# of obs**	**# of grps**	**# of obs**
McCown's longspur	*Calcarius mccownii*	NSS4	68	89	0	0	68	89
ferruginous hawk	*Buteo regalis*	NSS3	69	78	2	3	71	81
mountain plover	*Charadrius montanus*	NSS4	33	58	2	5	35	63
American white pelican	*Pelcanus erythrorhyncos*	NSS3	4	34	0	0	4	34
redhead	*Aythya americana*	NSS3	2	27	0	0	2	27
Brewer's sparrow	*Spizella breweri*	NSS4	17	25	0	0	17	25
northern pintail	*Anas acuta*	NSS3	10	19	0	0	10	19
lesser scaup	*Aythya affinis*	NSS3	1	18	0	0	1	18
sage thrasher	*Oreoscoptes montanus*	NSS4	9	9	0	0	9	9
lark bunting	*Calamospiza melanocorys*	NSS4	3	9	0	0	3	9
Swainson's hawk	*Buteo swainsoni*	NSS4	5	5	0	0	5	5
bald eagle	*Haliaeetus leucocephalus*	NSS2	2	2	1	1	3	3
great blue heron	*Ardea herodias*	NSS4	1	3	0	0	1	3
common loon	*Gavia immer*	NSS1	1	1	1	1	2	2
long-billed curlew	*Numenius americanus*	NSS3	2	2	0	0	2	2
upland sandpiper	*Bartramia longicauda*	NSS4	1	2	0	0	1	2
Bird Subtotal	**16 species**		**228**	**381**	**6**	**10**	**234**	**391**
boreal toad	*Bufo boreas*	**NSS1**			1	2	1	2

NSS1 - Populations greatly restricted or declining, extirpation possible OR ongoing significant loss of habitat.

NSS2 - Populations declining, extirpation possible; habitat restricted or vulnerable but no recent or ongoing significant loss; species likely sensitive to human disturbance OR populations declining or restricted in numbers or distribution, extirpation not imminent; ongoing significant loss of habitat.

NSS3 - Populations greatly restricted or declining, extirpation possible; habitat not restricted, vulnerable but no loss; species not sensitive to human disturbance OR populations declining or restricted in numbers or distribution, extirpation not imminent; habitat restricted or vulnerable but no recent or ongoing significant loss; species likely sensitive to human disturbance OR species widely distributed; population status or trends unknown but suspected to be stable; on-going significant loss of habitat.

NSS4 - Populations greatly restricted or declining, extirpation possible; habitat stable and not restricted OR populations declining or restricted in numbers or distribution, extirpation not imminent; habitat not restricted, vulnerable but no loss; species not sensitive to human disturbance OR species widely distributed, population status or trends unknown but suspected to be stable; habitat restricted or vulnerable but no recent or on-going significant loss; species likely sensitive to human disturbance OR populations stable or increasing and not restricted in numbers or distribution; on-going significant loss of habitat.

NSS Definitions from WGFD (2005) and Wyoming's Natural Diversity Database (WYNDD 2009).

Table 12. Wind-energy facilities in the US with both pre-construction Anabat sampling data and post-construction mortality data for bat species (adapted from Kunz et al. 2007b).

Wind-Energy Facility	Activity (#/detector night)	Mortality (bats/turbine/year)	Reference
Dunlap Ranch, WY	1.7		This study
Foote Creek Rim, WY	2.2	1.3	Gruver 2002
Buffalo Ridge, MN	2.1	2.2	Johnson et al. 2004
Buffalo Mountain, TN	23.7	20.8	Fiedler 2004
Top of Iowa, IA	34.9	10.2	Jain 2005
Mountaineer, WV	38.3	38	Arnett et al. 2005

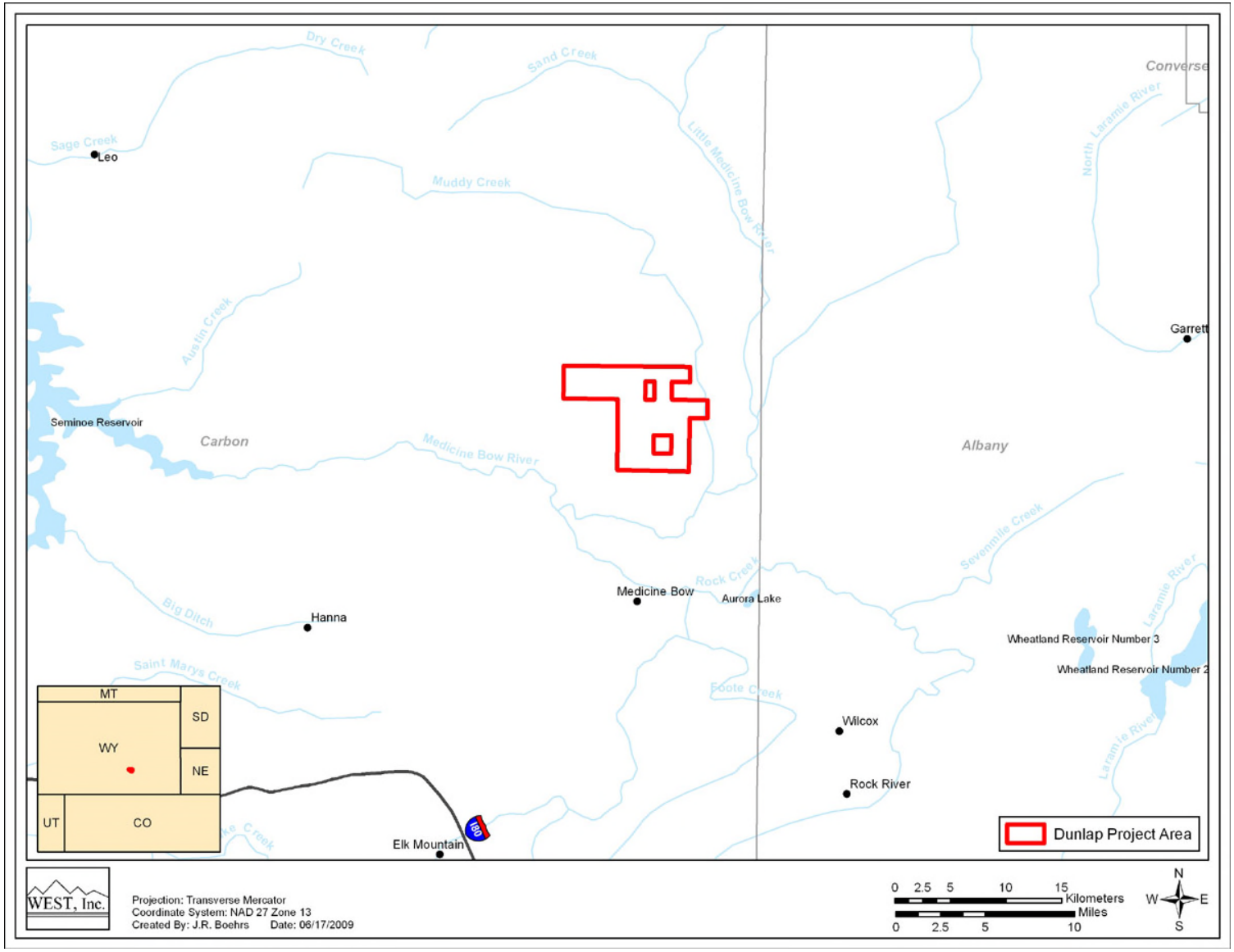


Figure 1. Location of the Dunlap Ranch Wind Resource Area.

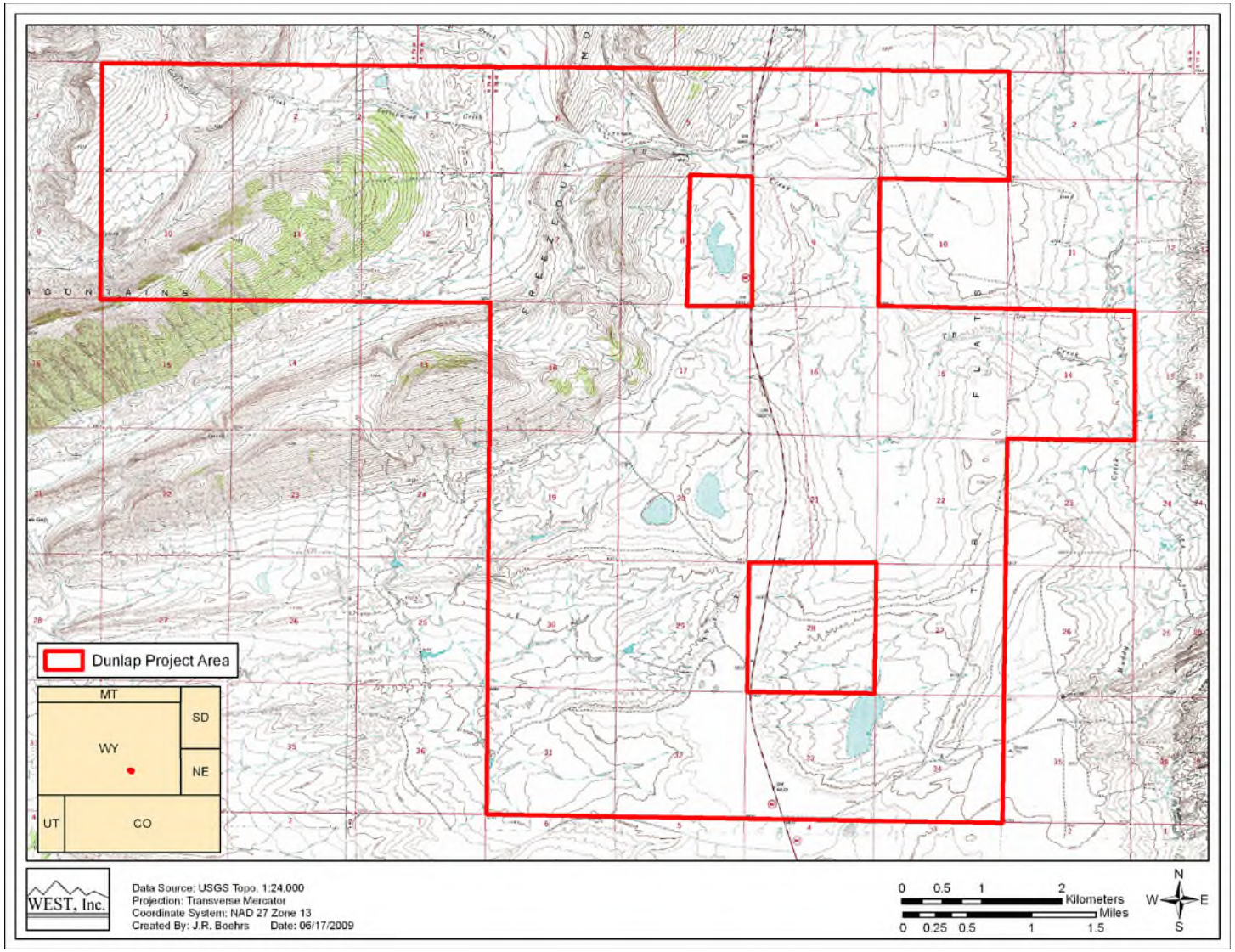


Figure 2. Elevation and topography of the Dunlap Ranch Wind Resource Area.

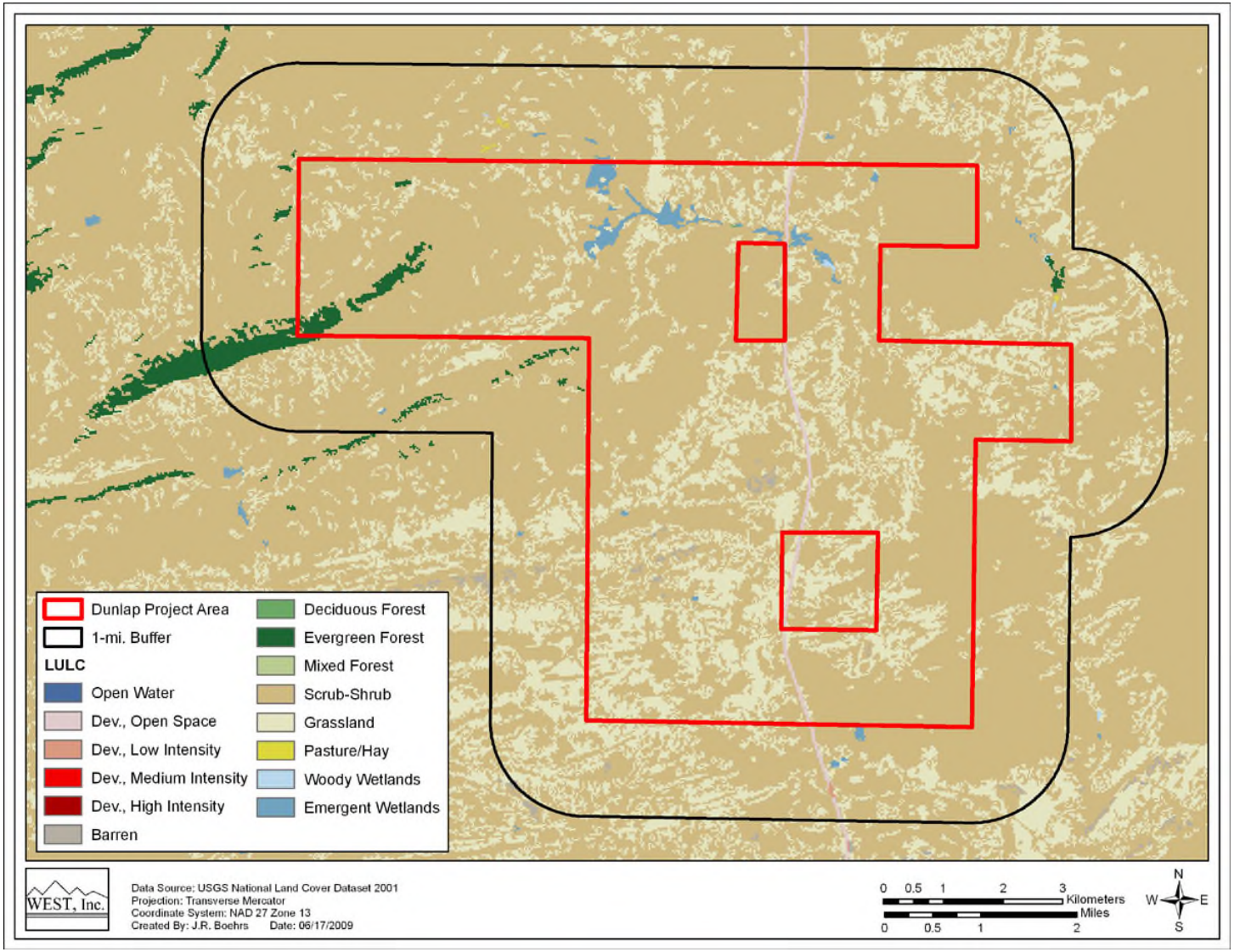


Figure 3. The land cover types and coverage within the Dunlap Ranch Wind Resource Area (USGS NLCD 2001).

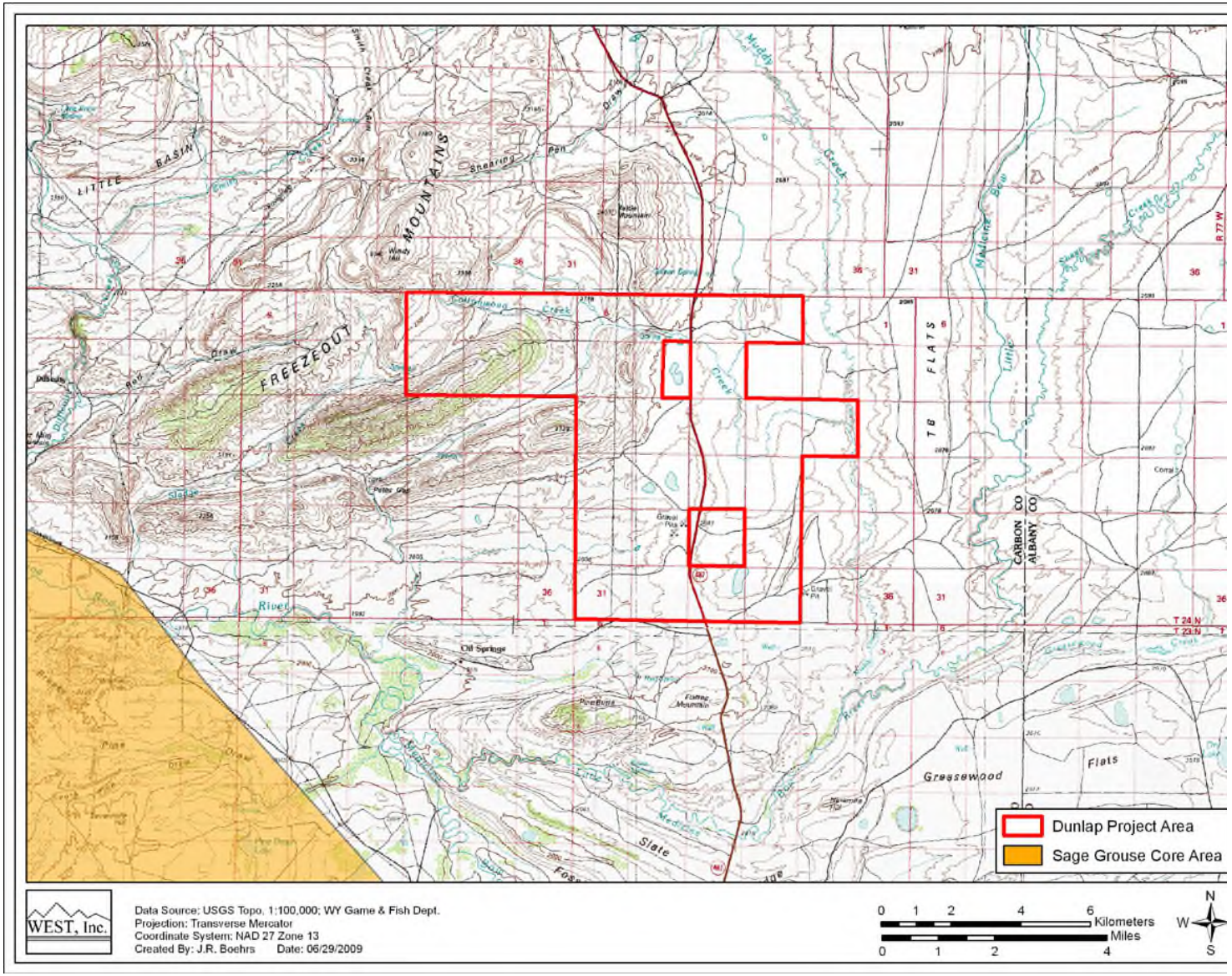


Figure 4. Greater sage-grouse core use habitats in relation to the Dunlap Ranch Wind Resource Area.

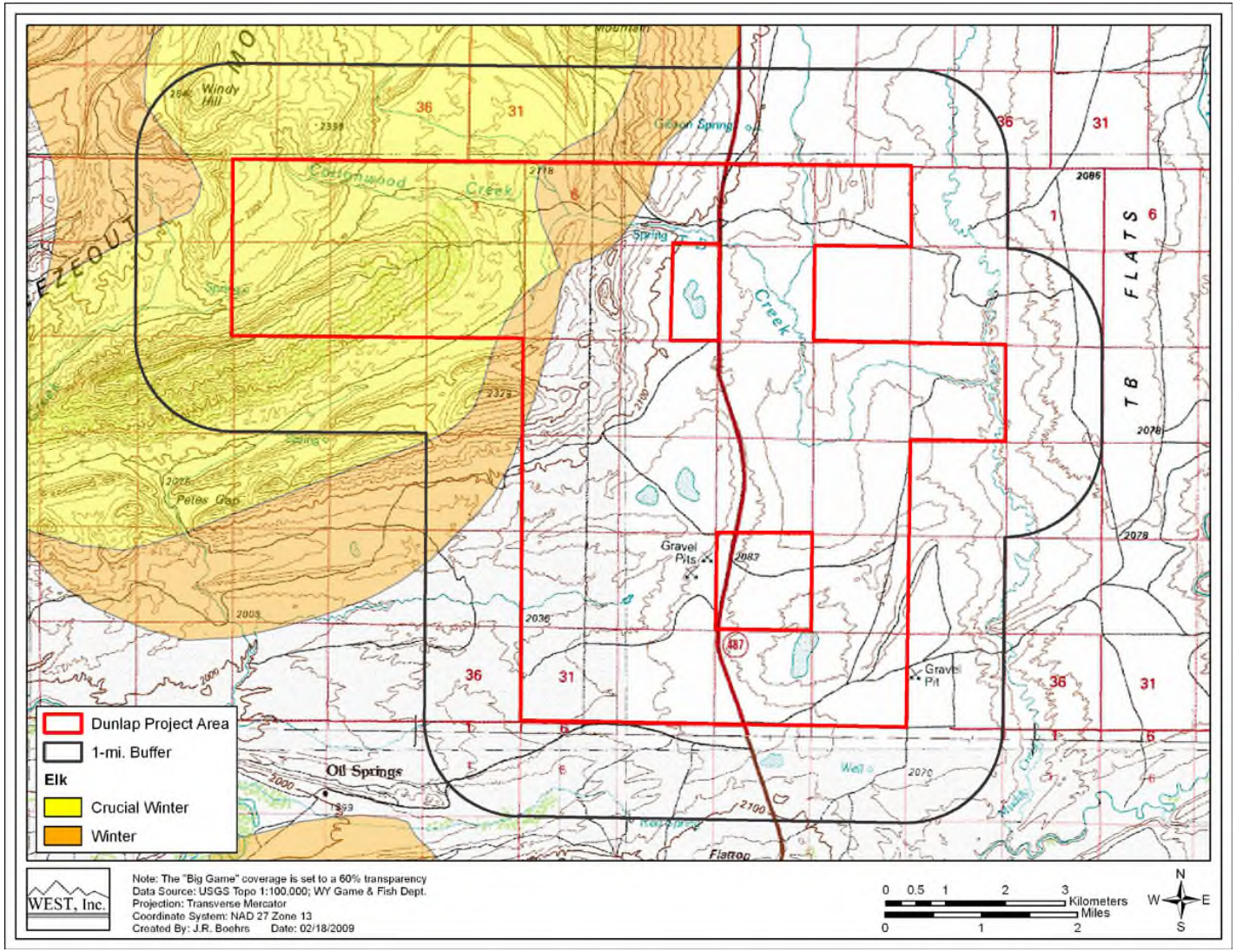


Figure 5. Location of designated elk ranges in the Dunlap Ranch Wind Resource Area.

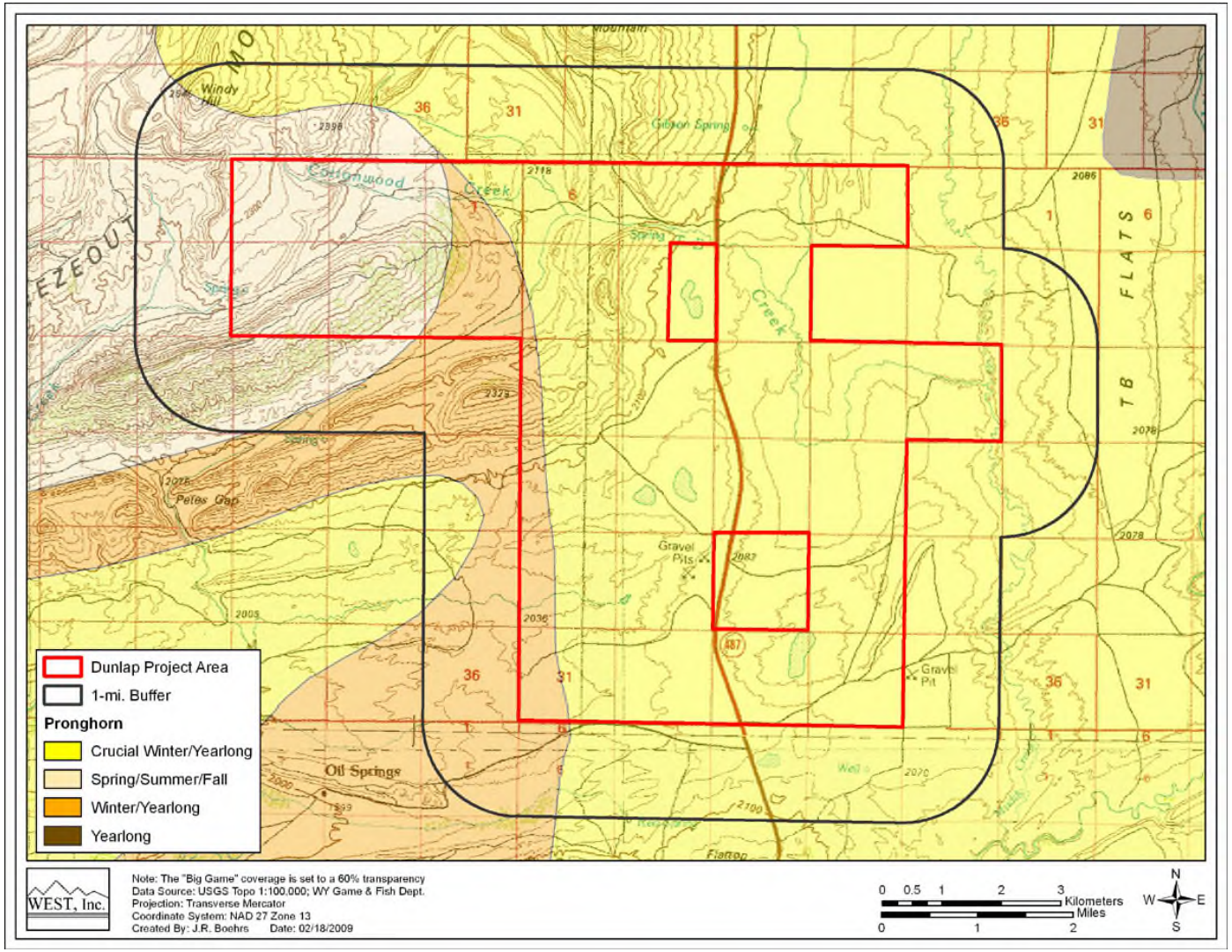


Figure 6. Location of designated pronghorn antelope ranges at the Dunlap Ranch Wind Resource Area.

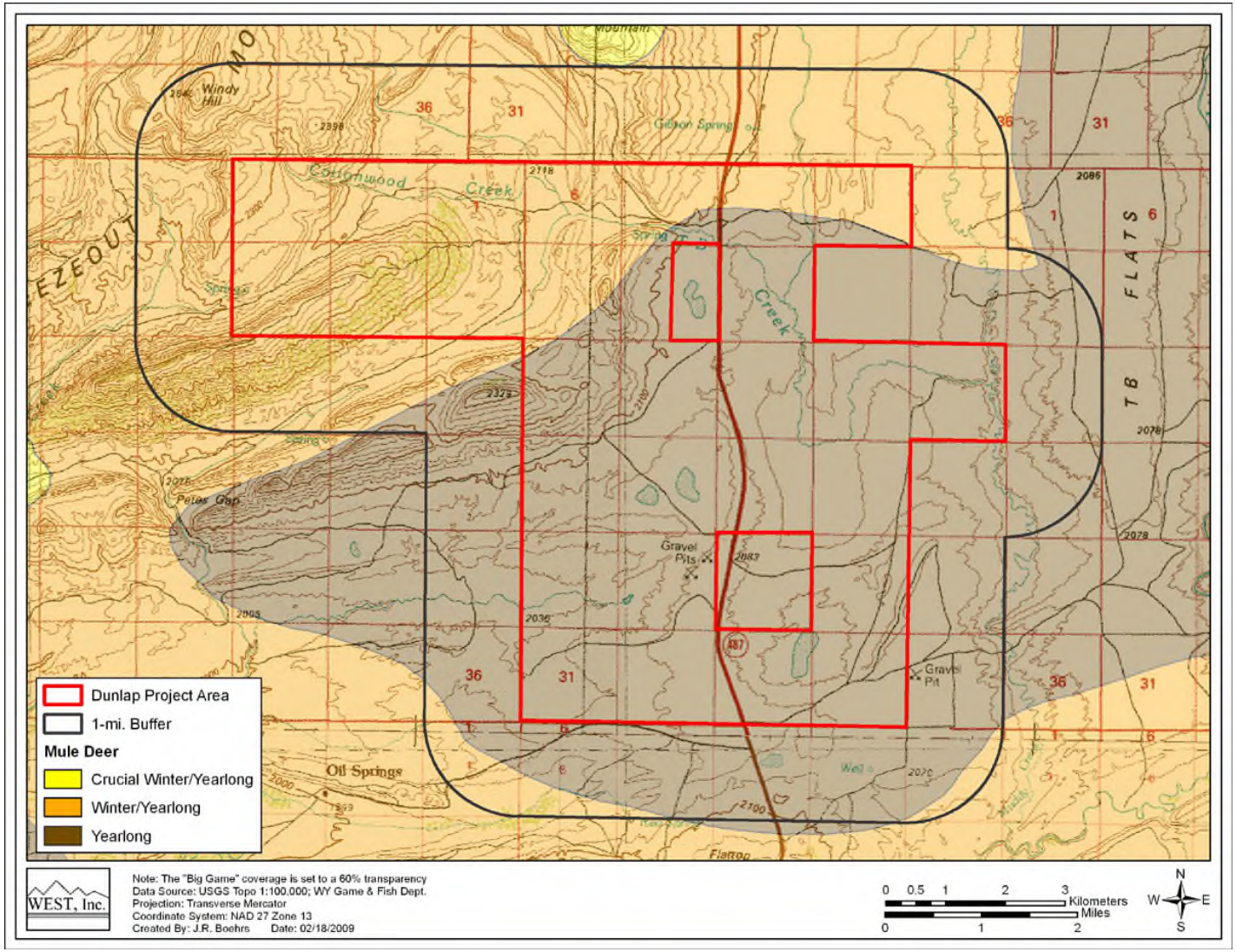


Figure 7. Location of designated mule deer ranges at the Dunlap Ranch Wind Resource Area.

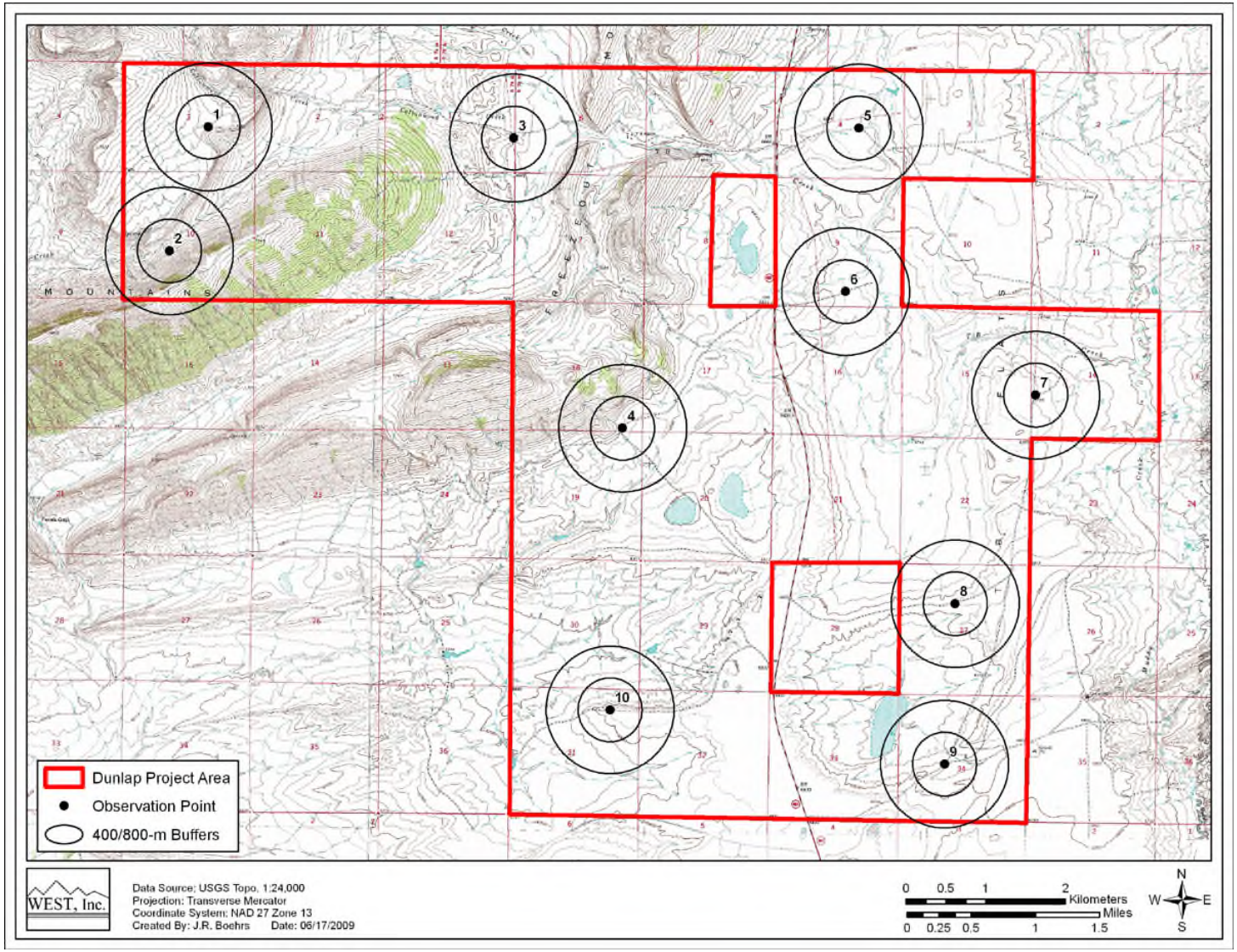


Figure 8. Fixed-point bird use survey points at the Dunlap Ranch Wind Resource Area.

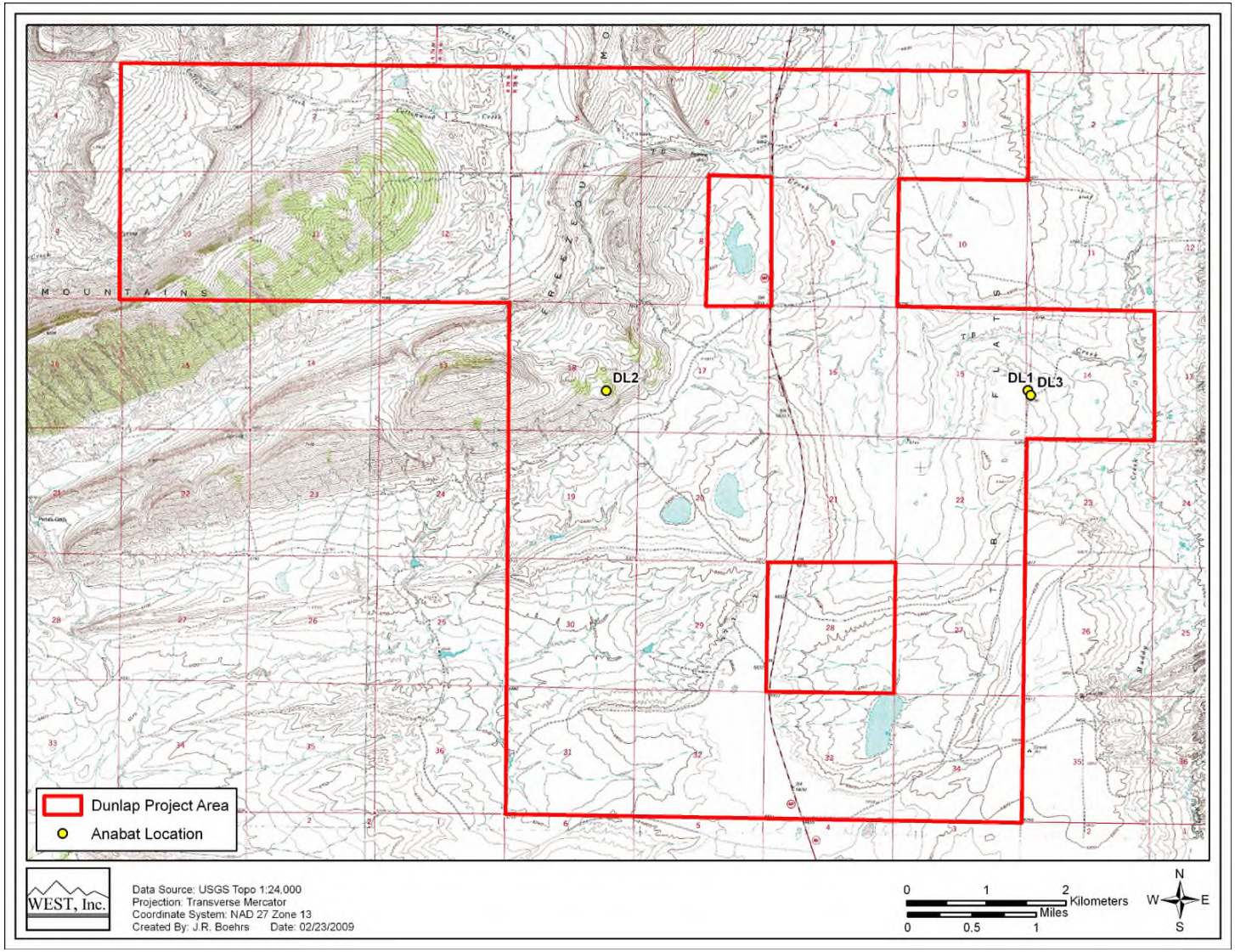


Figure 9. Anabat sampling locations at the Dunlap Ranch Wind Resource Area. Due to vandalism, the detector at station DL1 was moved to location DL3 on August 27, 2008.

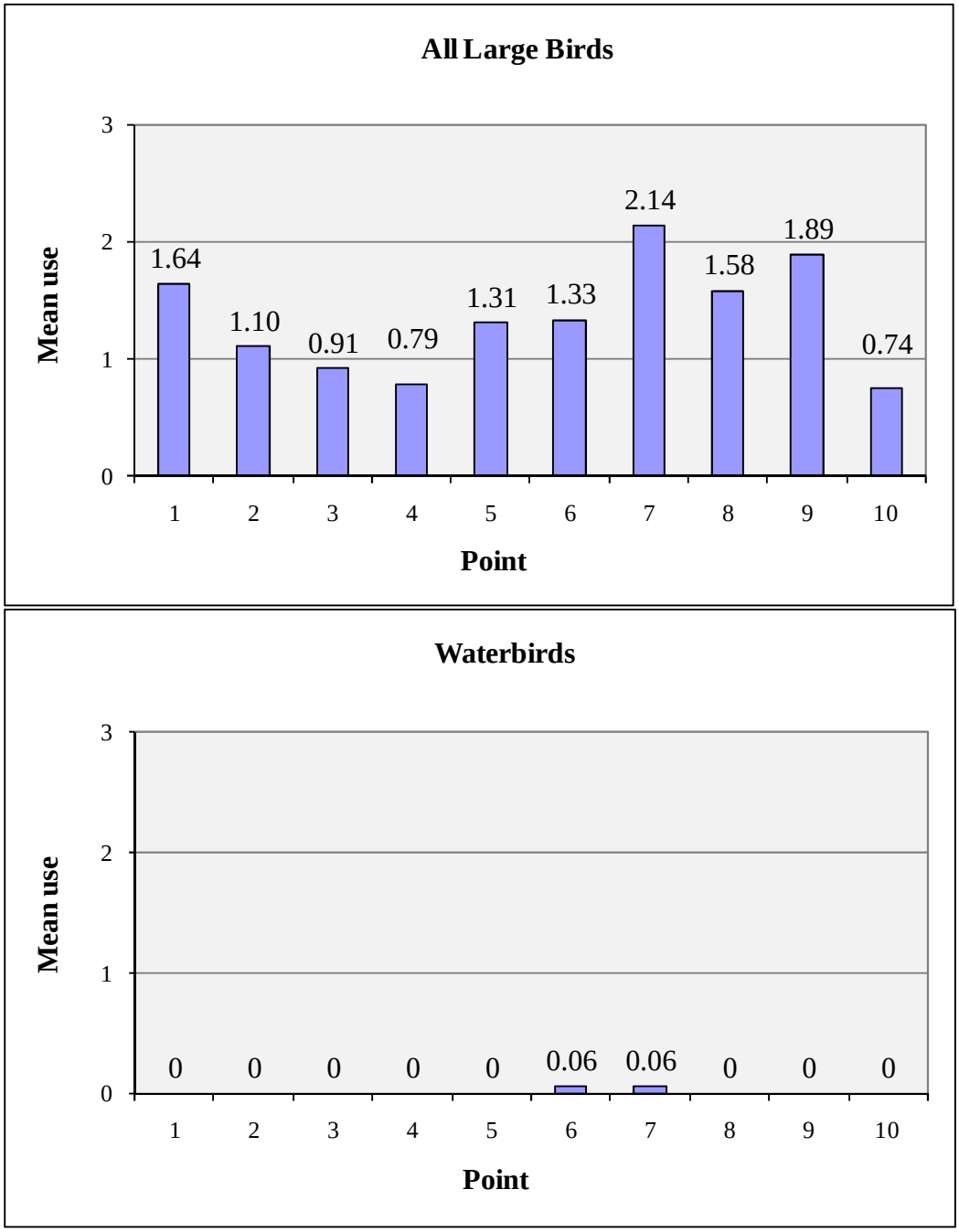
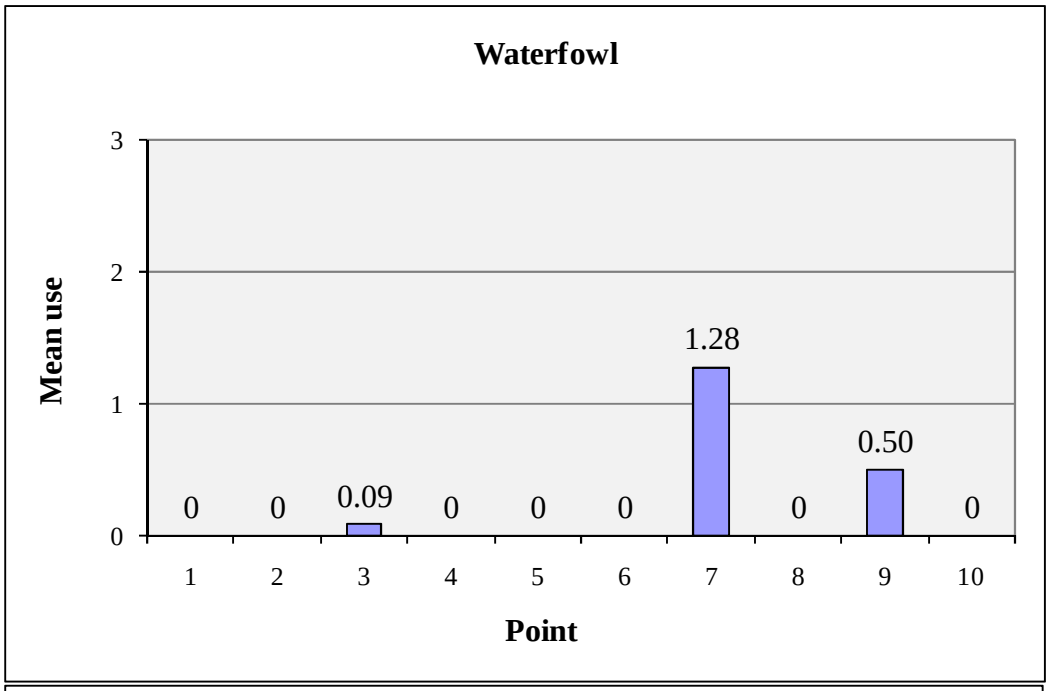


Figure 10. Mean use (number of birds/20-min survey) at each fixed-point bird use survey point for all birds, major bird types, and raptor subtypes at the Dunlap Ranch Wind Resource Area.



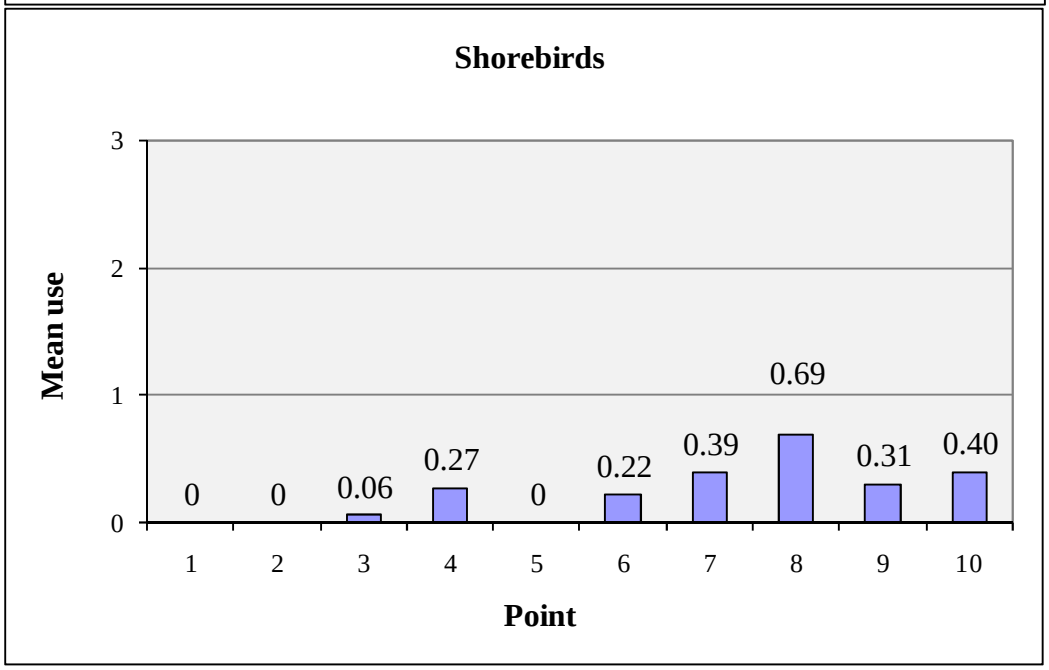
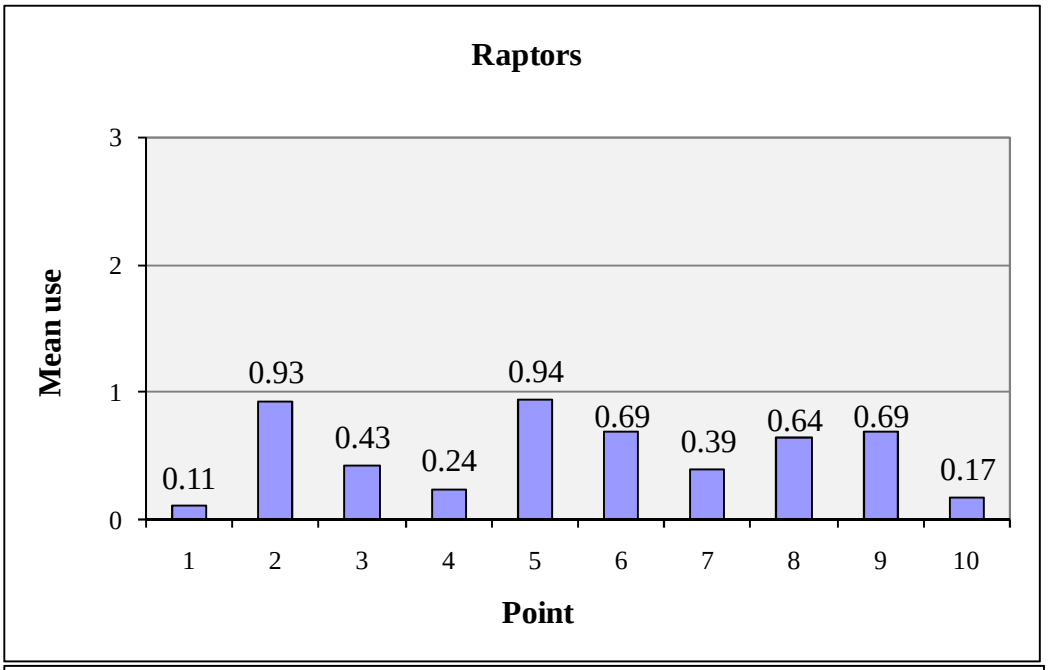
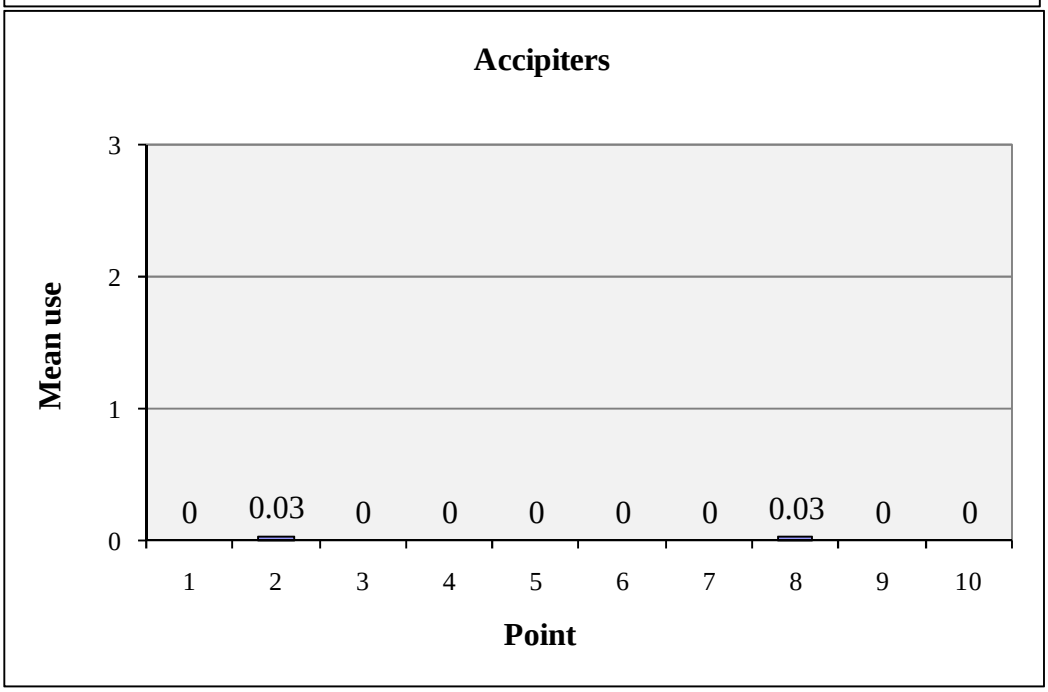


Figure 10 (*continued*). Mean use (number of birds/20-min survey) at each fixed-point bird use survey point for all birds, major bird types, and raptor subtypes at the Dunlap Ranch Wind Resource Area.





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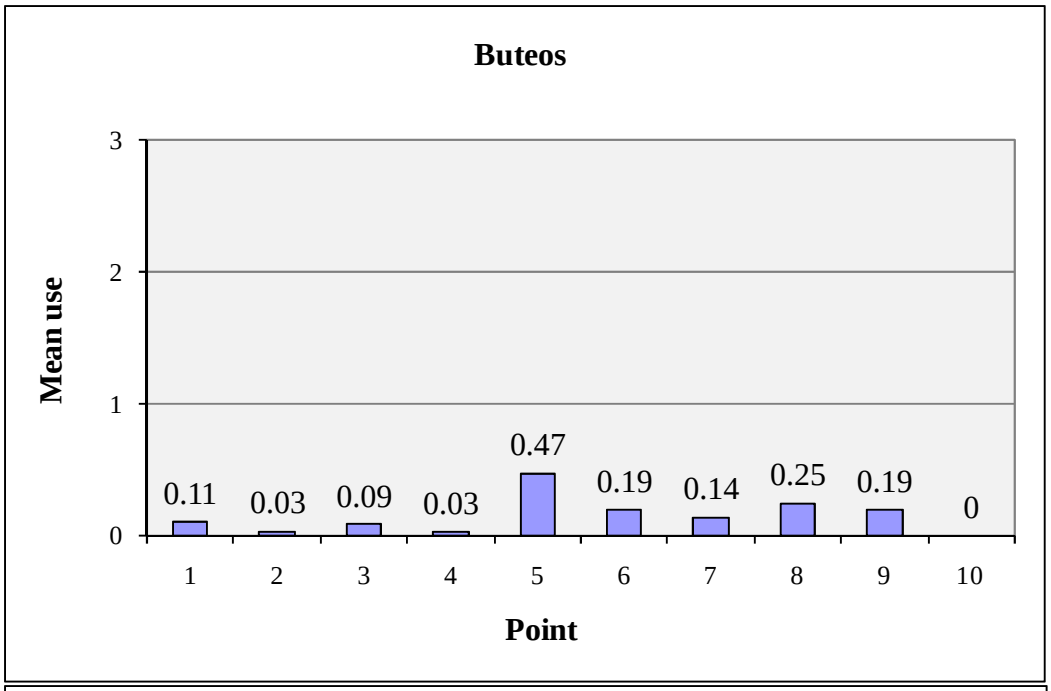


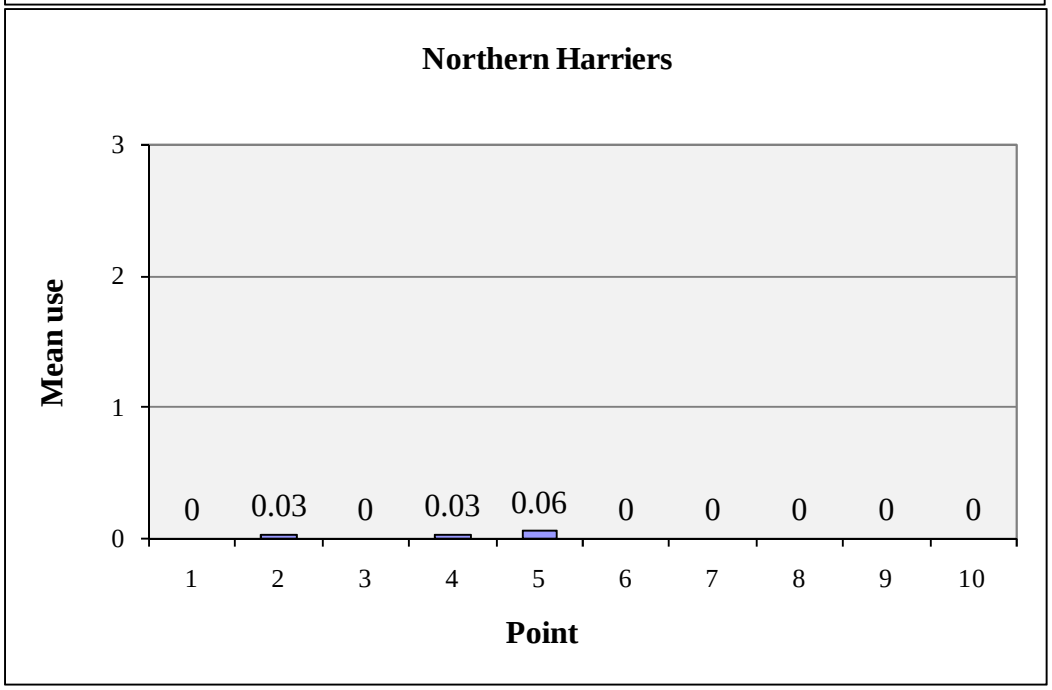
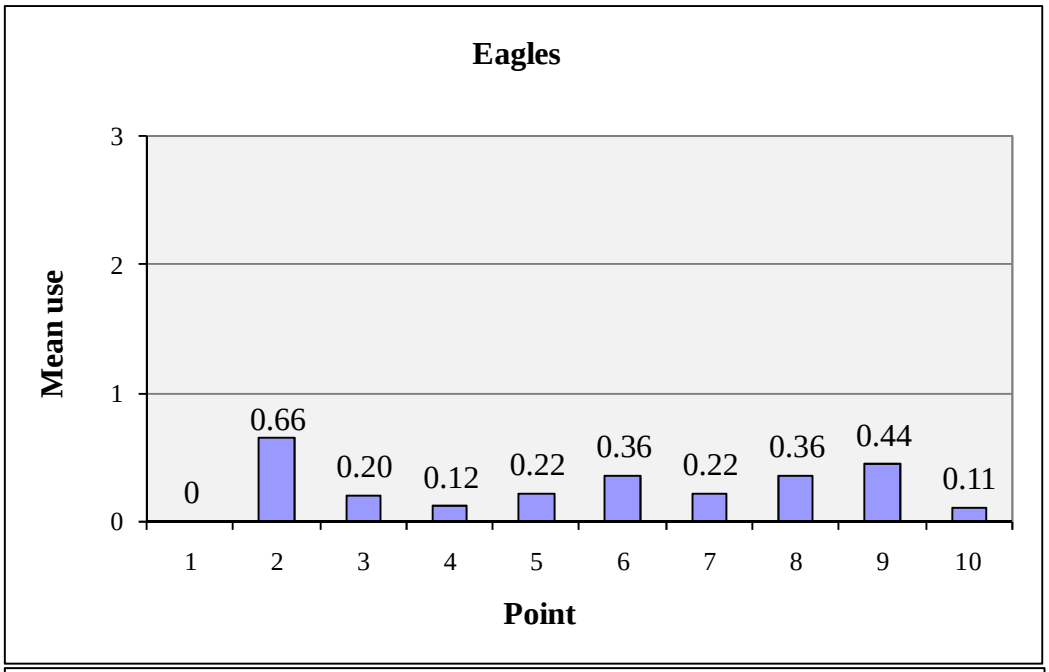


Figure 10 (*continued*). Mean use (number of birds/20-min survey) at each fixed-point bird use survey point for all birds, major bird types, and raptor subtypes at the Dunlap Ranch Wind Resource Area.



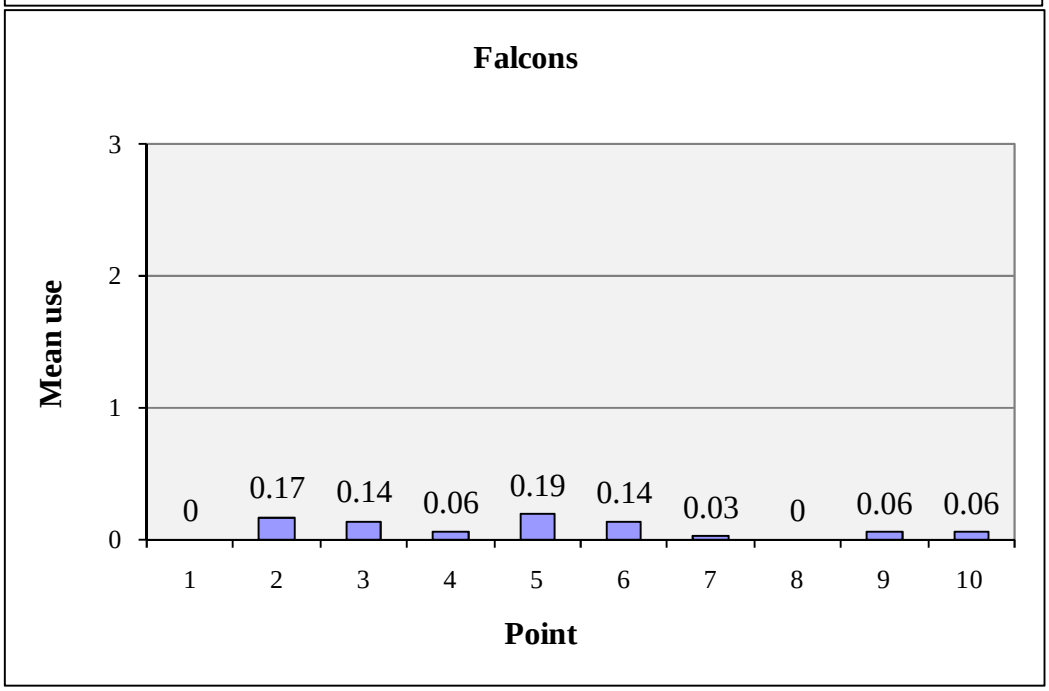
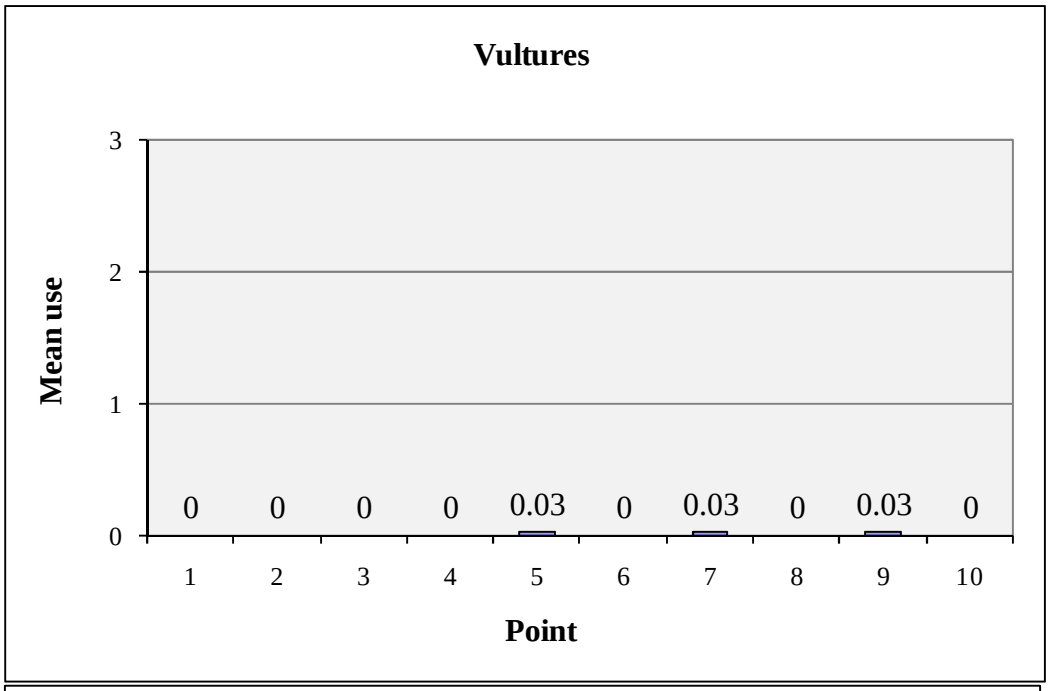


Figure 10 (*continued*). Mean use (number of birds/20-min survey) at each fixed-point bird use survey point for all birds, major bird types, and raptor subtypes at the Dunlap Ranch Wind Resource Area.



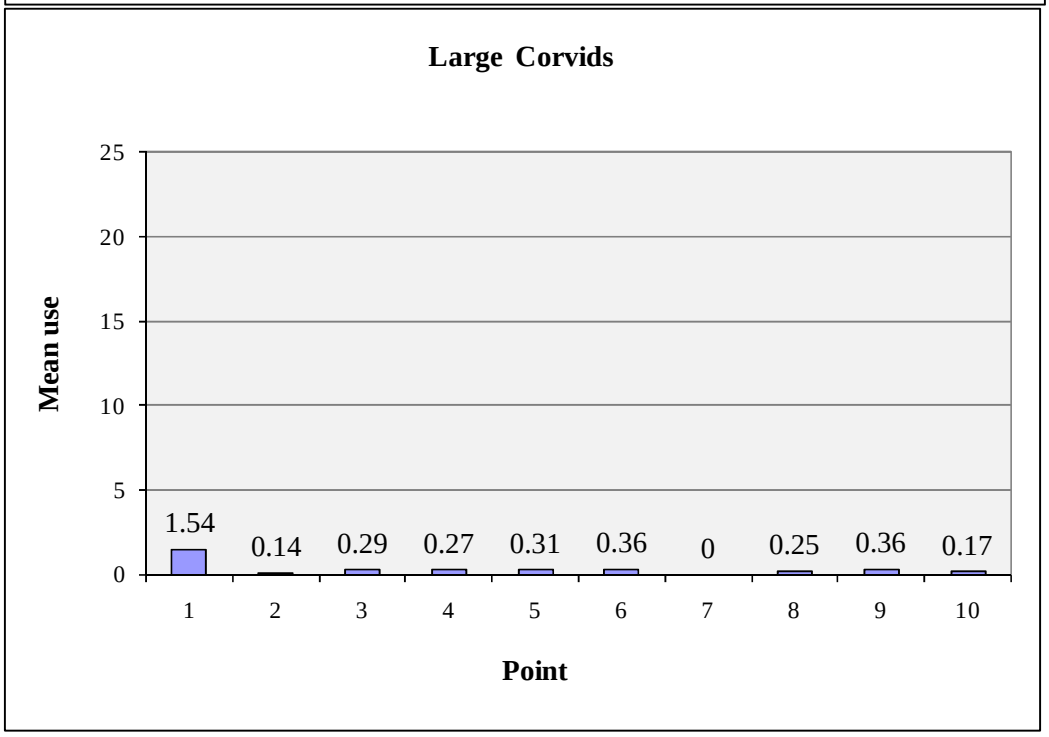


Figure 10 (*continued*). Mean use (number of birds/20-min survey) at each fixed-point bird use survey point for all birds, major bird types, and raptor subtypes at the Dunlap Ranch Wind Resource Area.

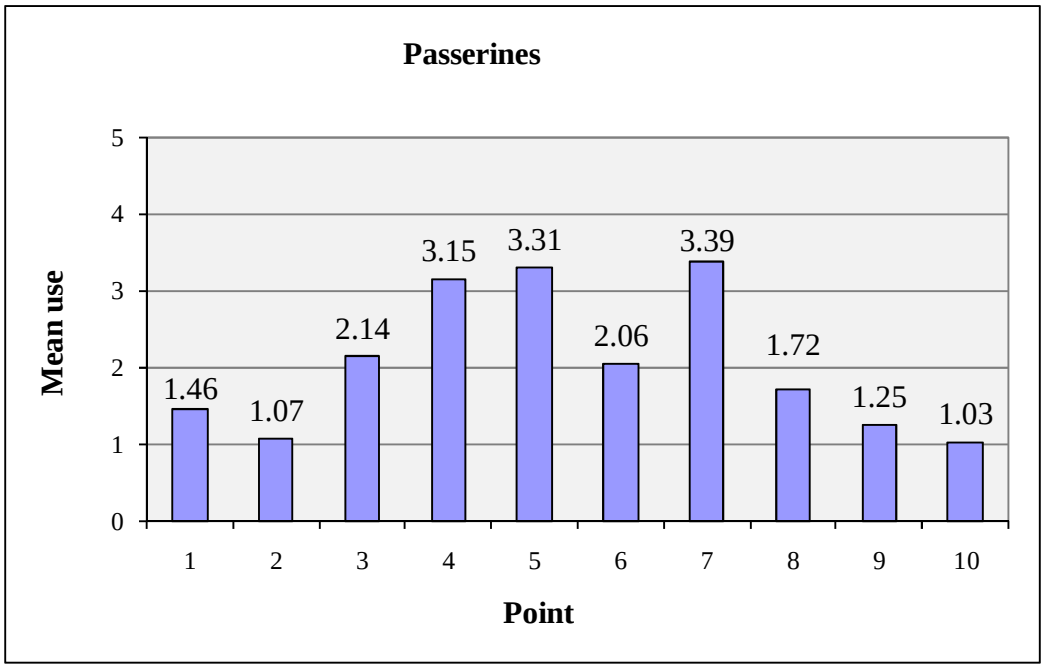


Figure 10 (*continued*). Mean use (number of birds/20-min survey) at each fixed-point bird use survey point for all birds, major bird types, and raptor subtypes at the Dunlap Ranch Wind Resource Area. Passerine observations were focused within 100-m viewsheds.

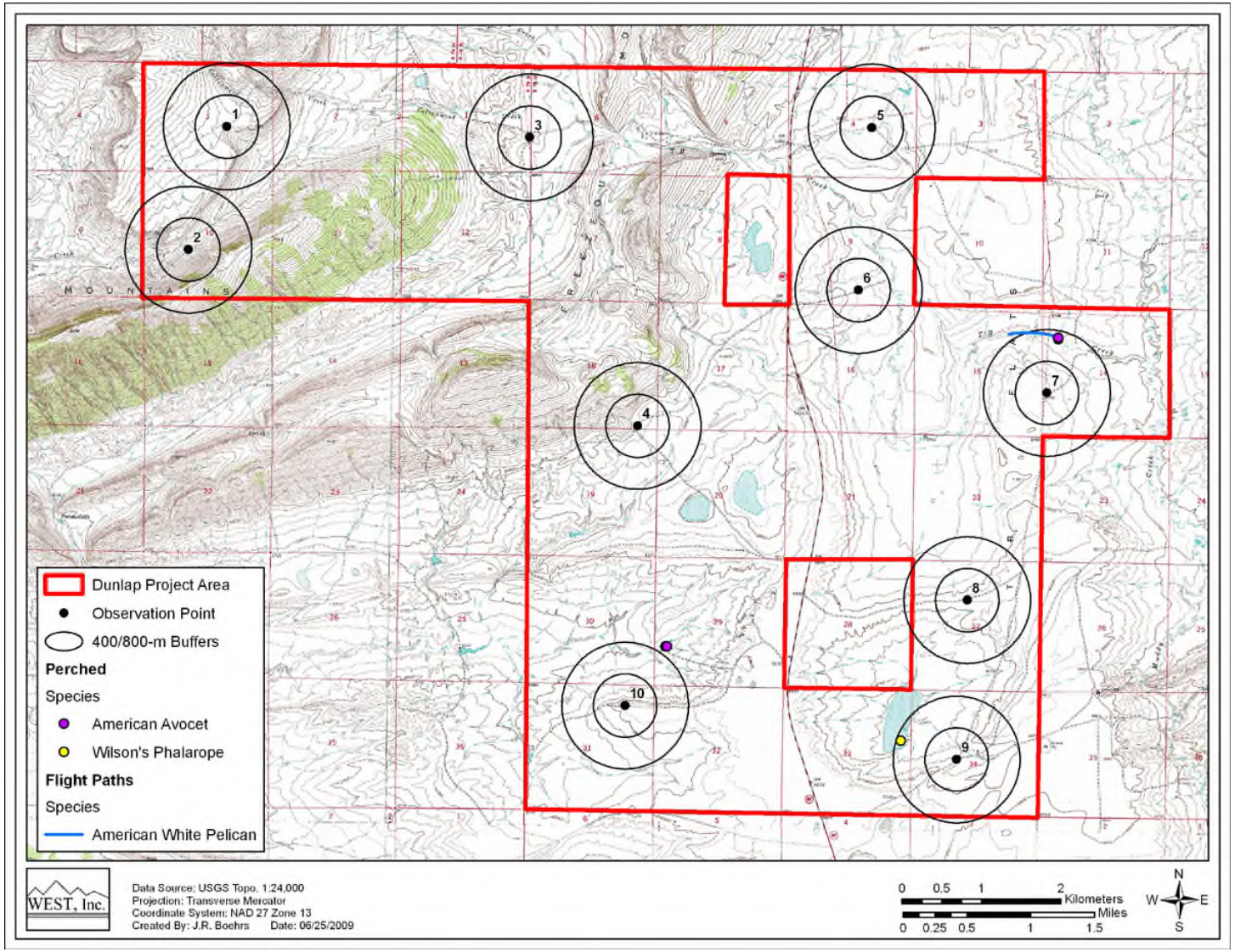


Figure 11a. Flight paths of waterbirds and shorebirds at the Dunlap Ranch Wind Resource Area.

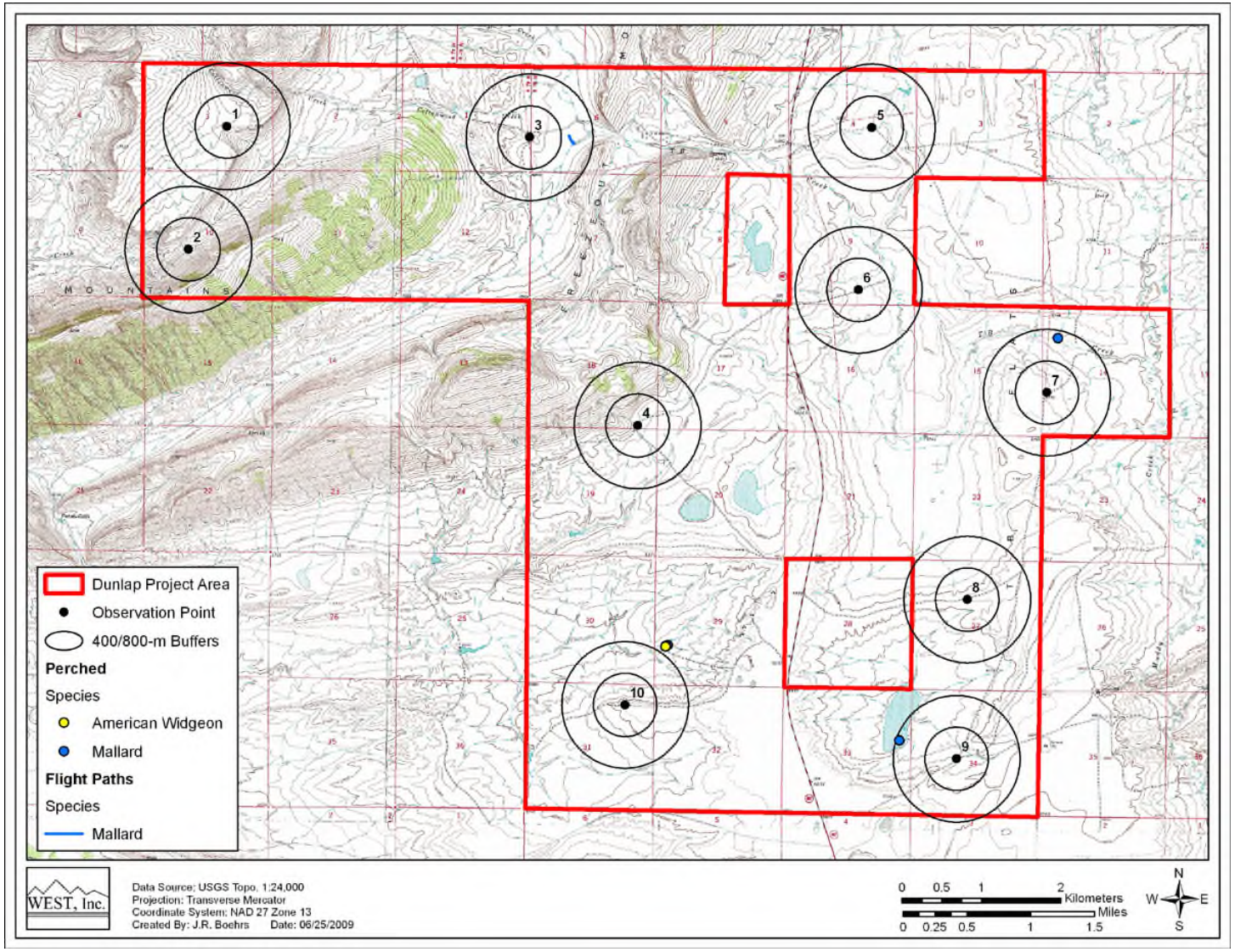


Figure 11b. Flight paths of waterfowl at the Dunlap Ranch Wind Resource Area.

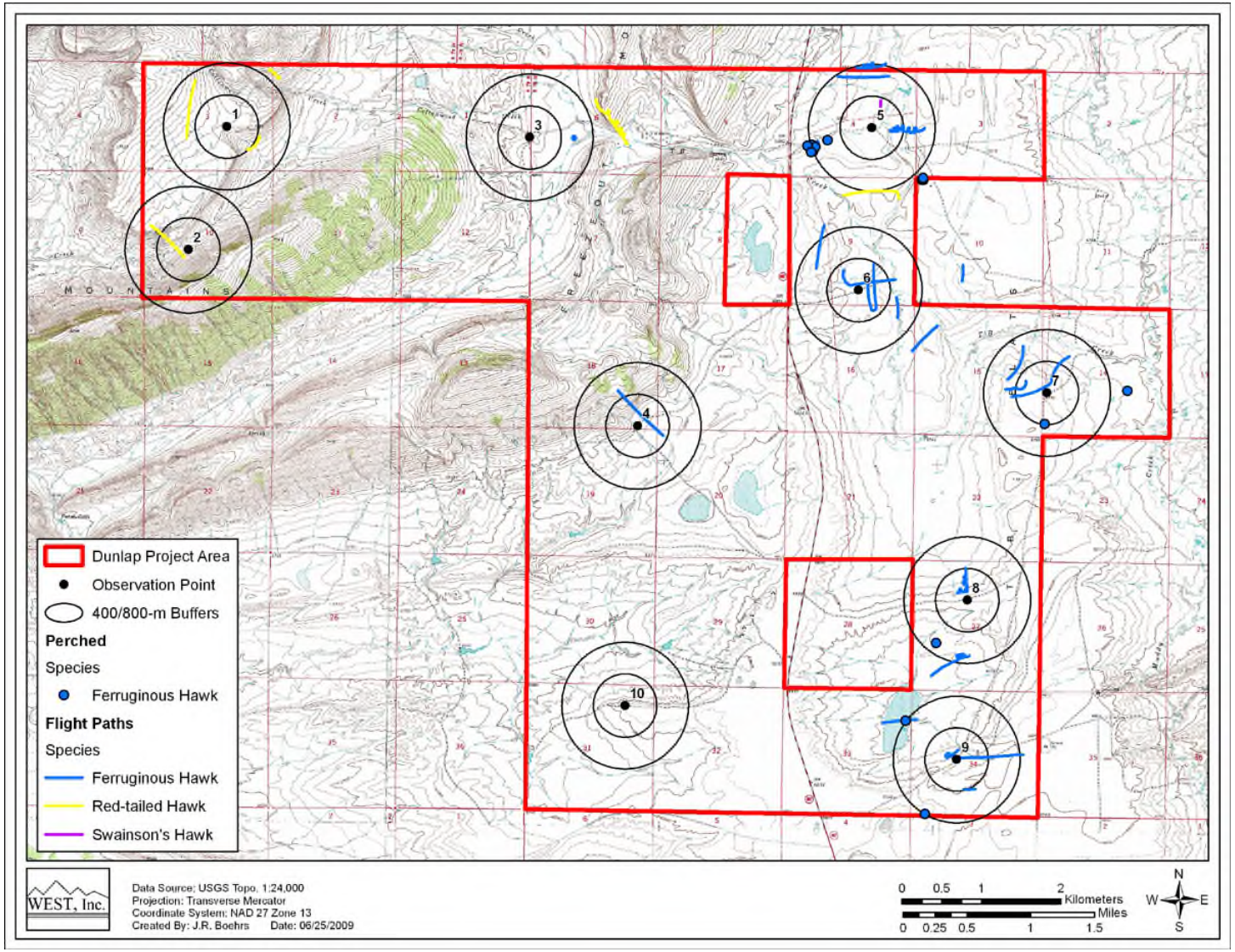


Figure 11c. Flight paths of buteos at the Dunlap Ranch Wind Resource Area.

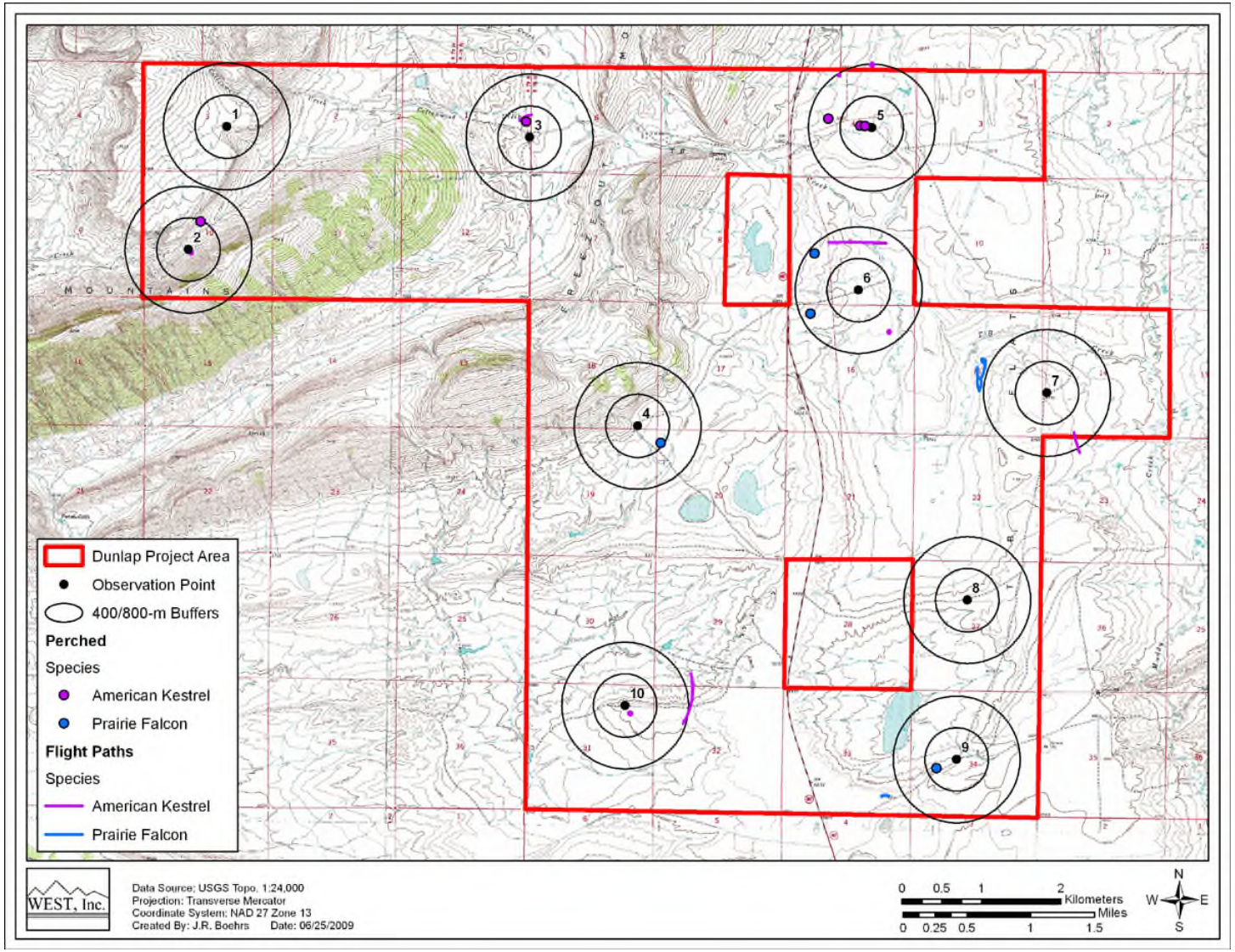


Figure 11d. Flight paths of falcons at the Dunlap Ranch Wind Resource Area.

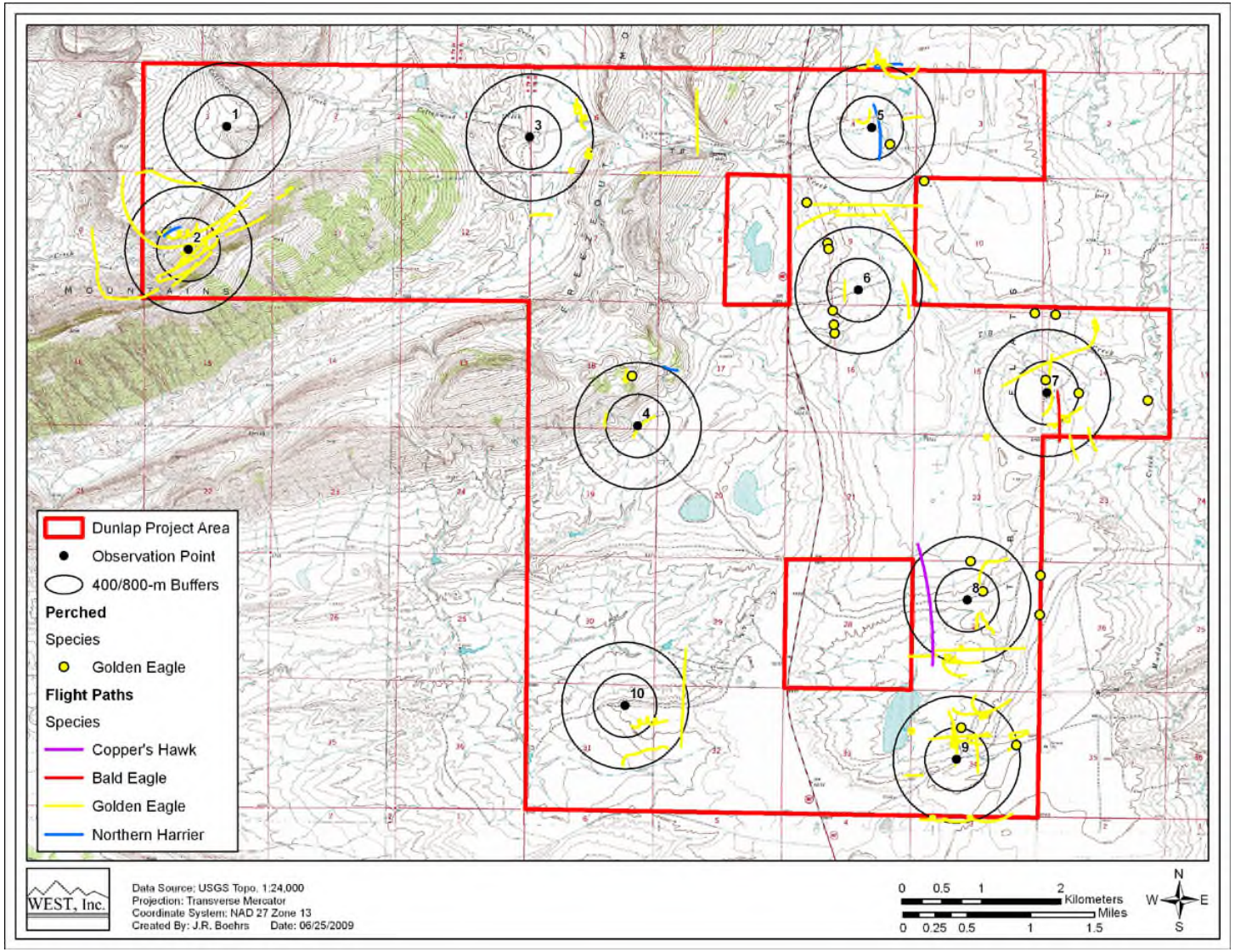


Figure 11e. Flight paths of accipiters, eagles, and northern harriers at the Dunlap Ranch Wind Resource Area.

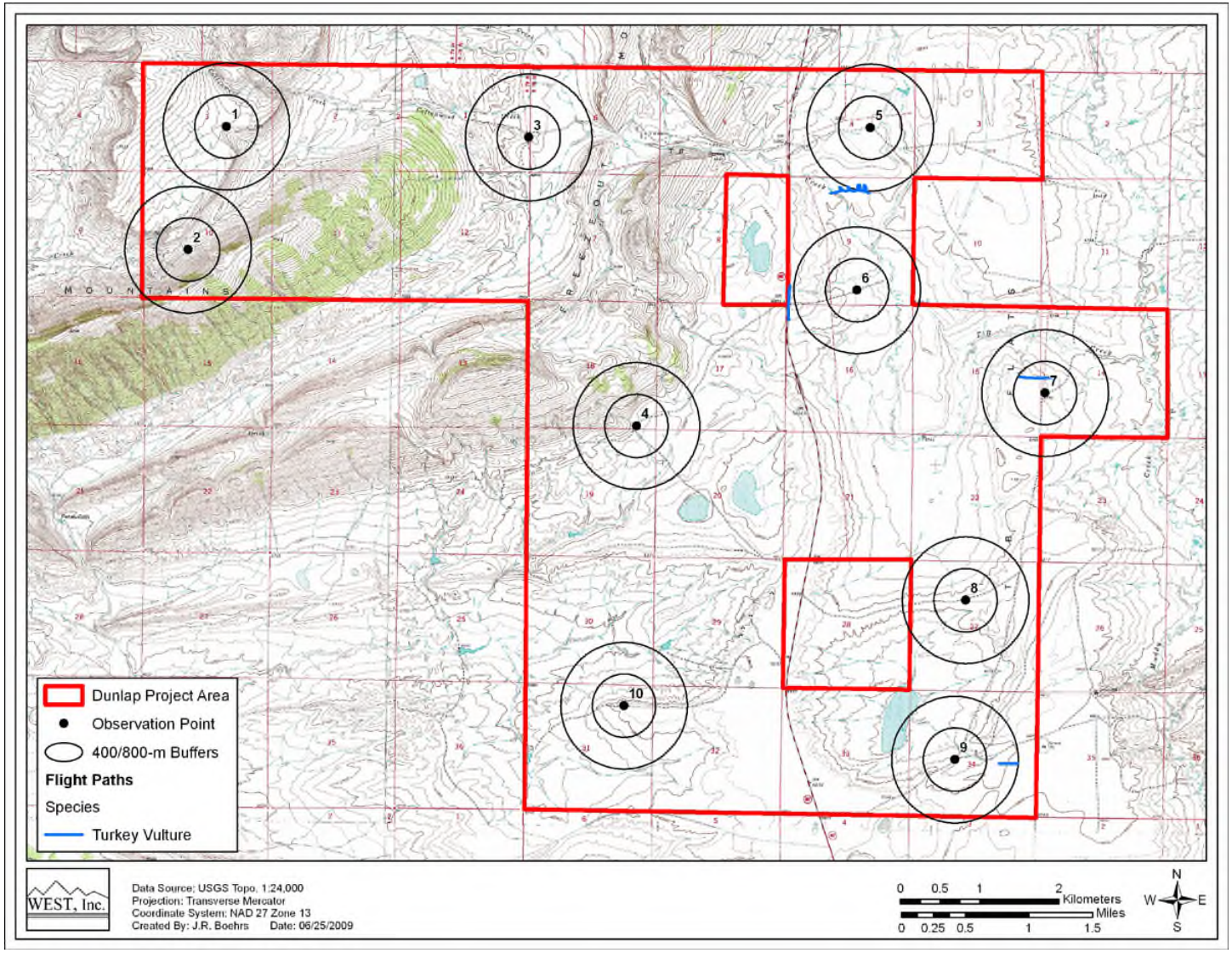


Figure 11f. Flight paths of vultures at the Dunlap Ranch Wind Resource Area.

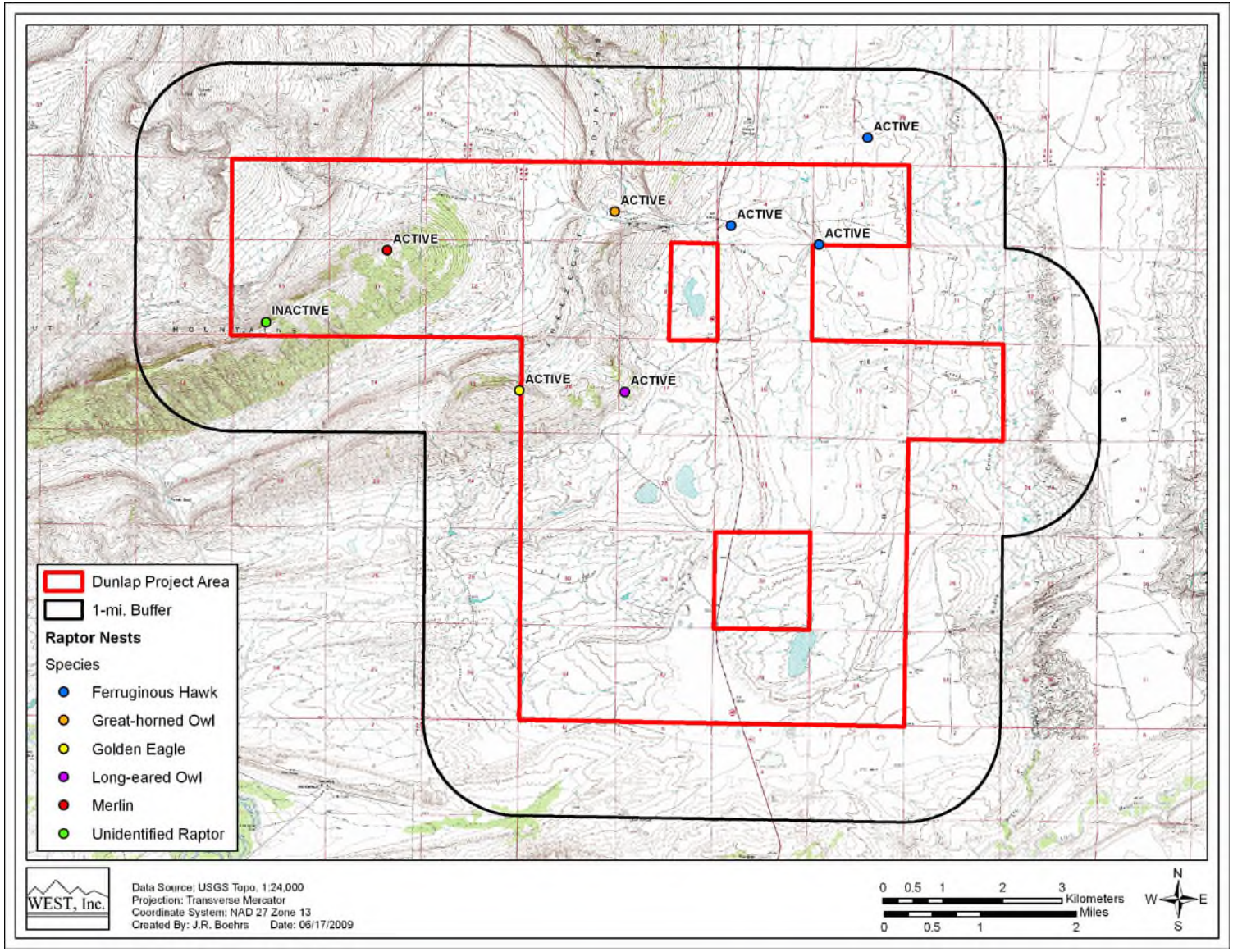


Figure 12. Location of raptor nests at the Dunlap Ranch Wind Resource Area.

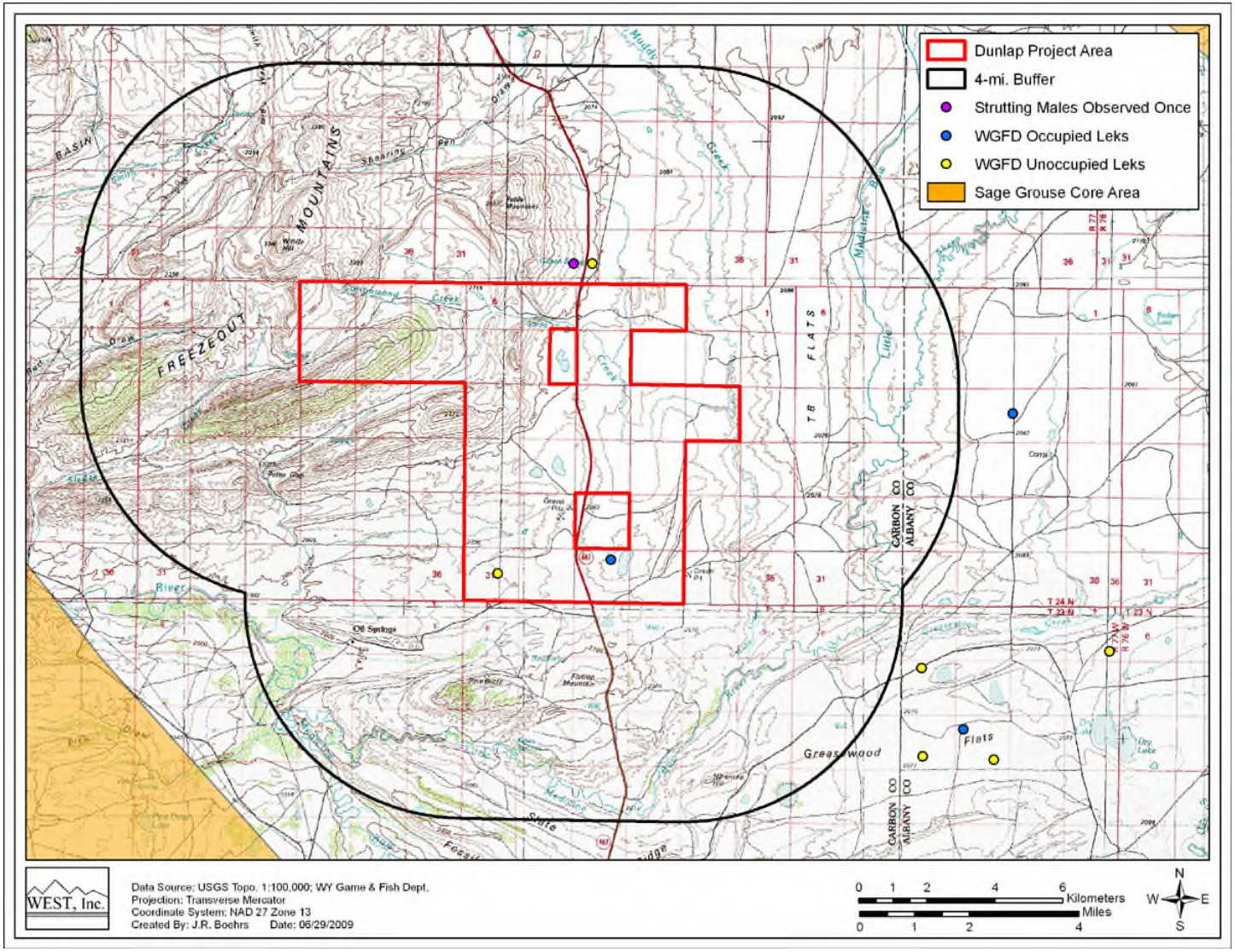


Figure 13. Location of greater sage-grouse leks at the Dunlap Ranch Wind Resource Area. Strutting males were only observed once at one location in the spring of 2009.

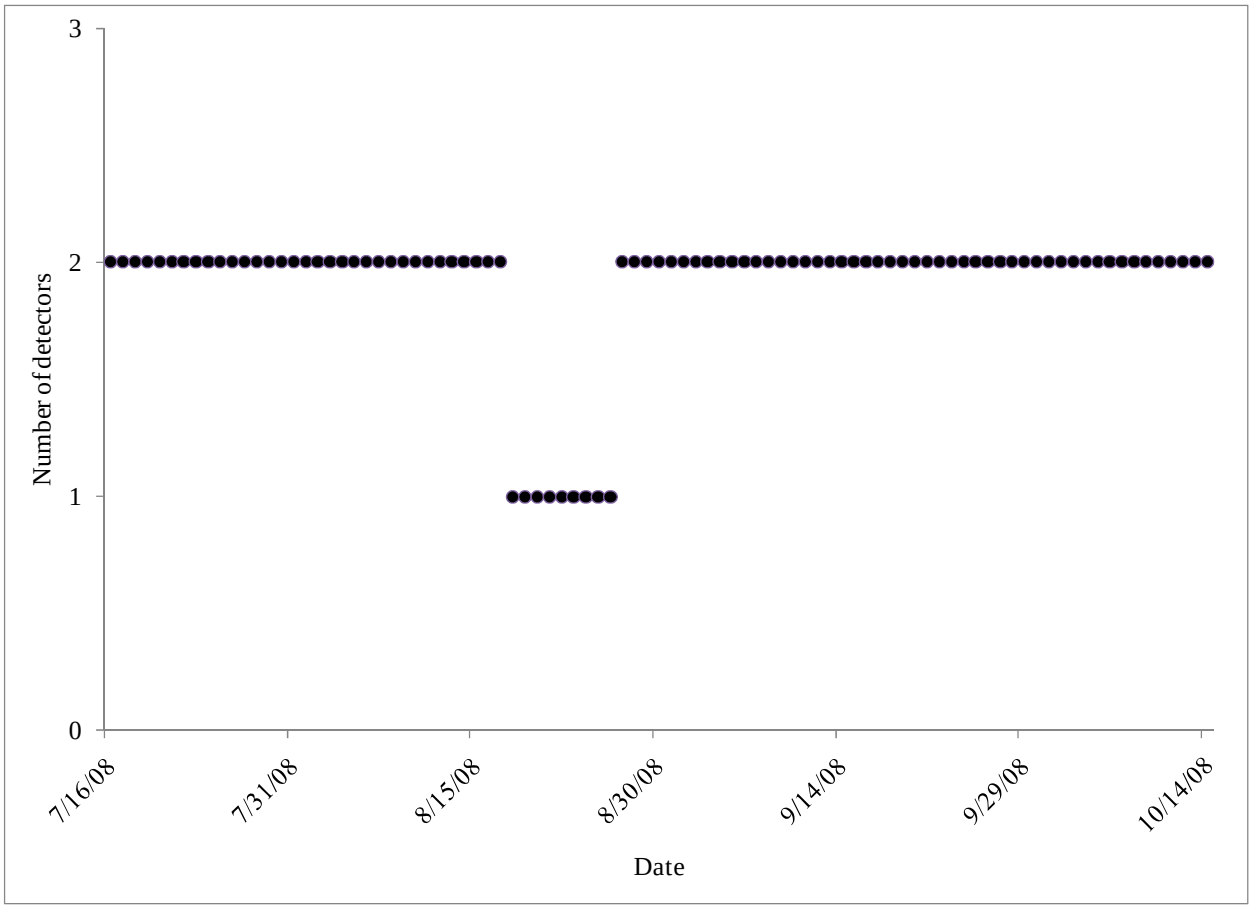


Figure 14. Number of Anabat detectors (n = 2) at the Dunlap Ranch Wind Resource Area operating during each night of the study period July 16 – October 14, 2006, 2008.

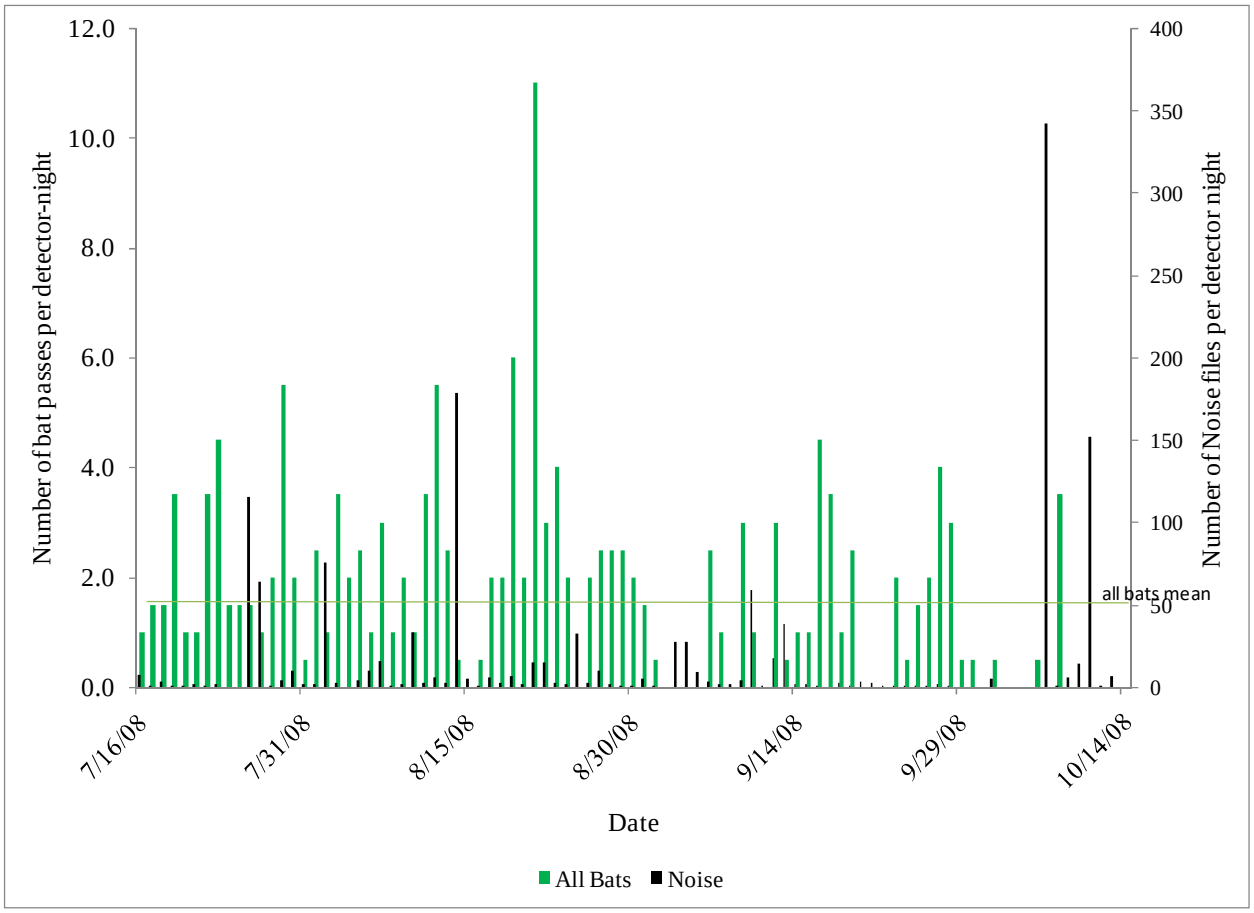


Figure 15. Number of bat passes and noise files detected per detector-night at the Dunlap Ranch Wind Resource Area for the study period July 16 – October 14, 2008, presented nightly. Noise files are indicated on the second axis.

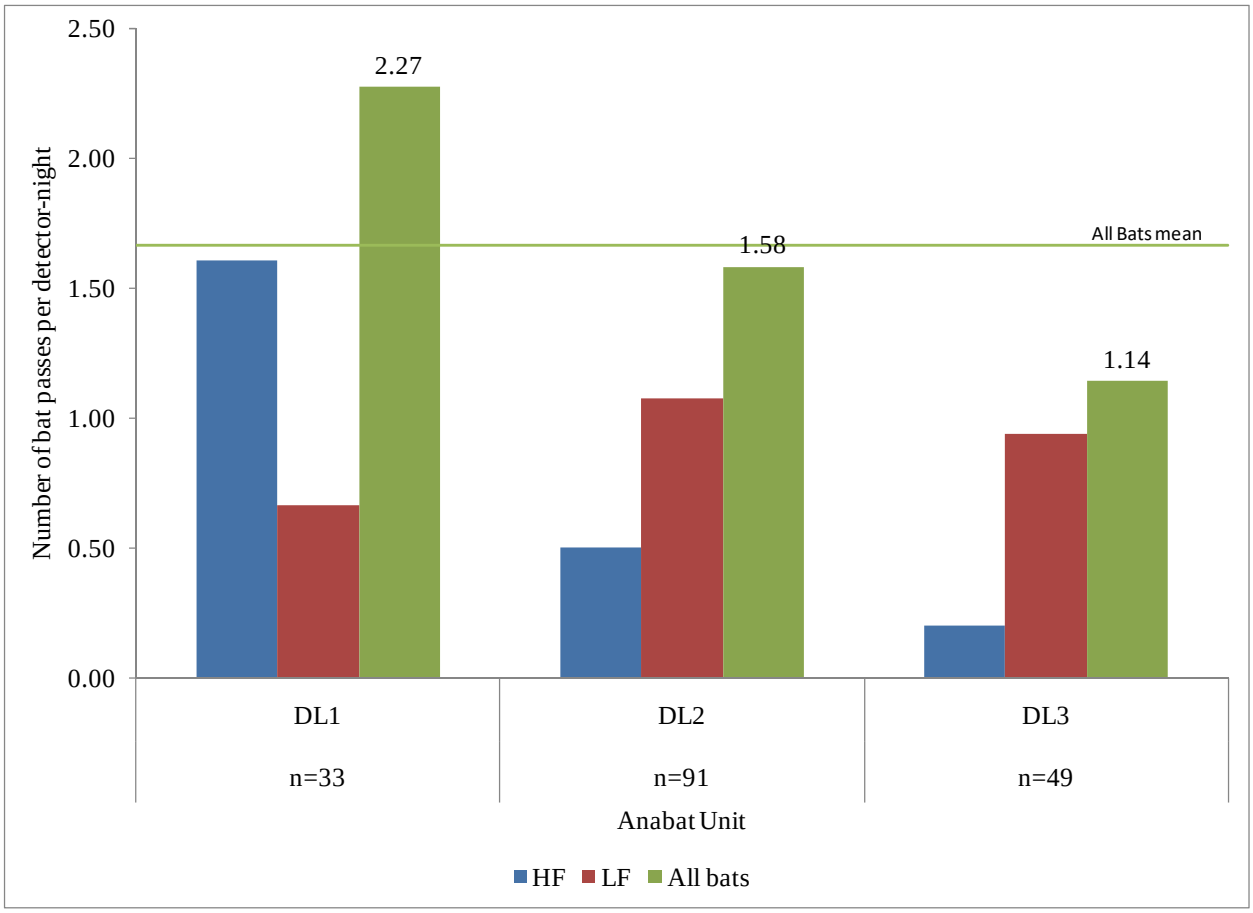


Figure 16. Number of bat passes per detector-night by Anabat location at the Dunlap Ranch Wind Resource Area for the study period July 16 – October 14, 2008. Detector DL1 was moved to location DL3 on August 27 due to vandalism.

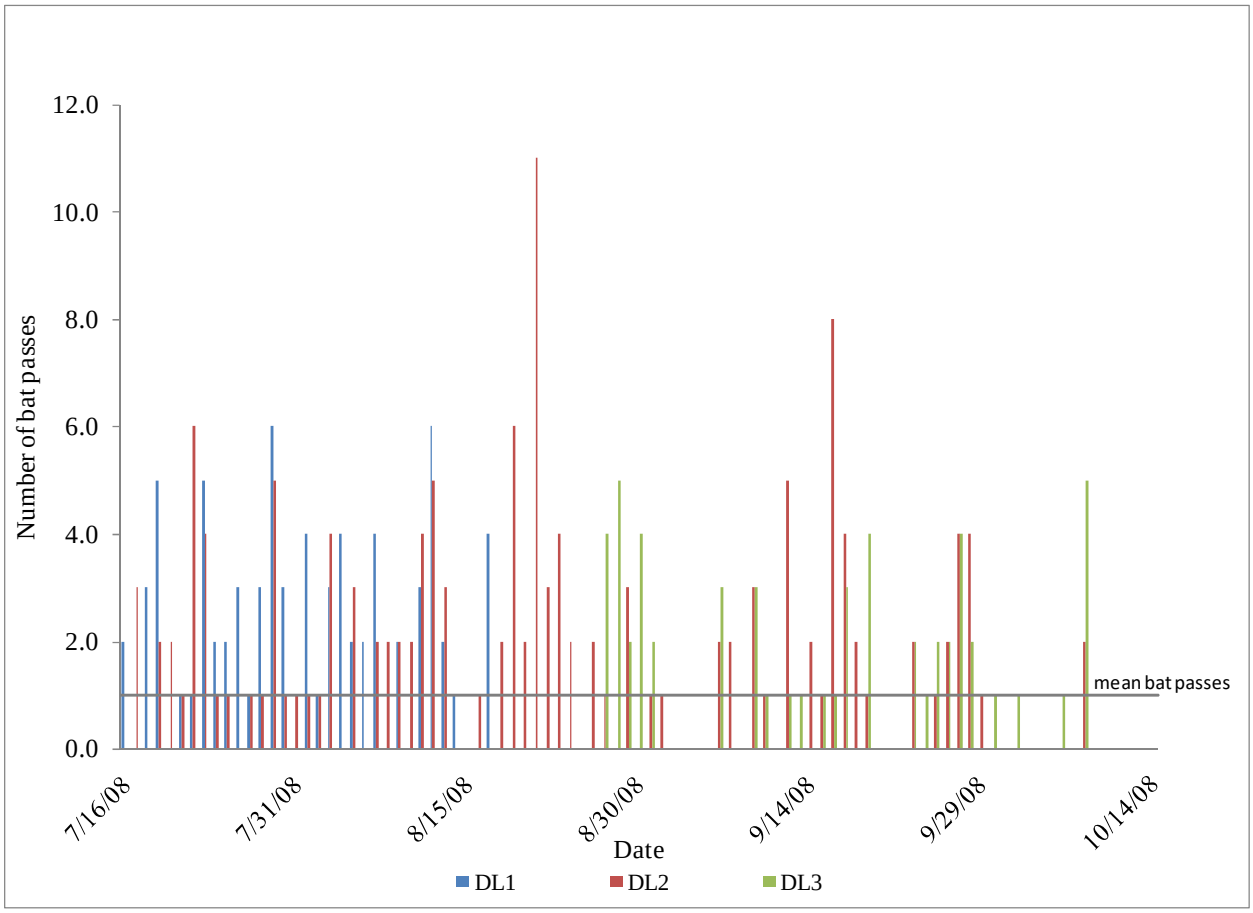


Figure 17. Number of nightly bat passes, grouped by Anabat location at the Dunlap Ranch Wind Resource Area for the for the study period July 16 – October 14, 2008.

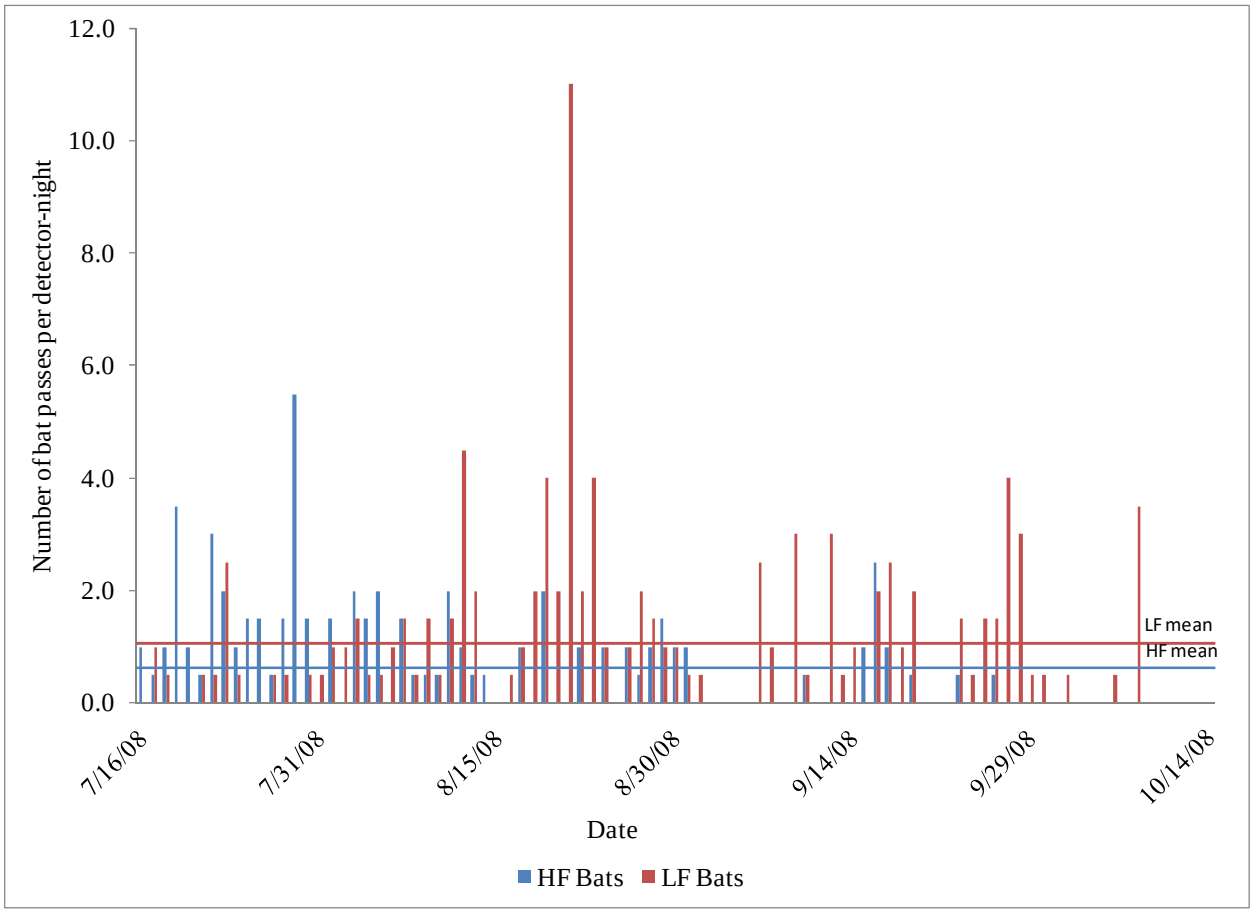


Figure 18. Nightly activity by high-frequency (HF) and low-frequency (LF) bats at the Dunlap Ranch Wind Resource Area for the study period July 16 – October 14, 2008.

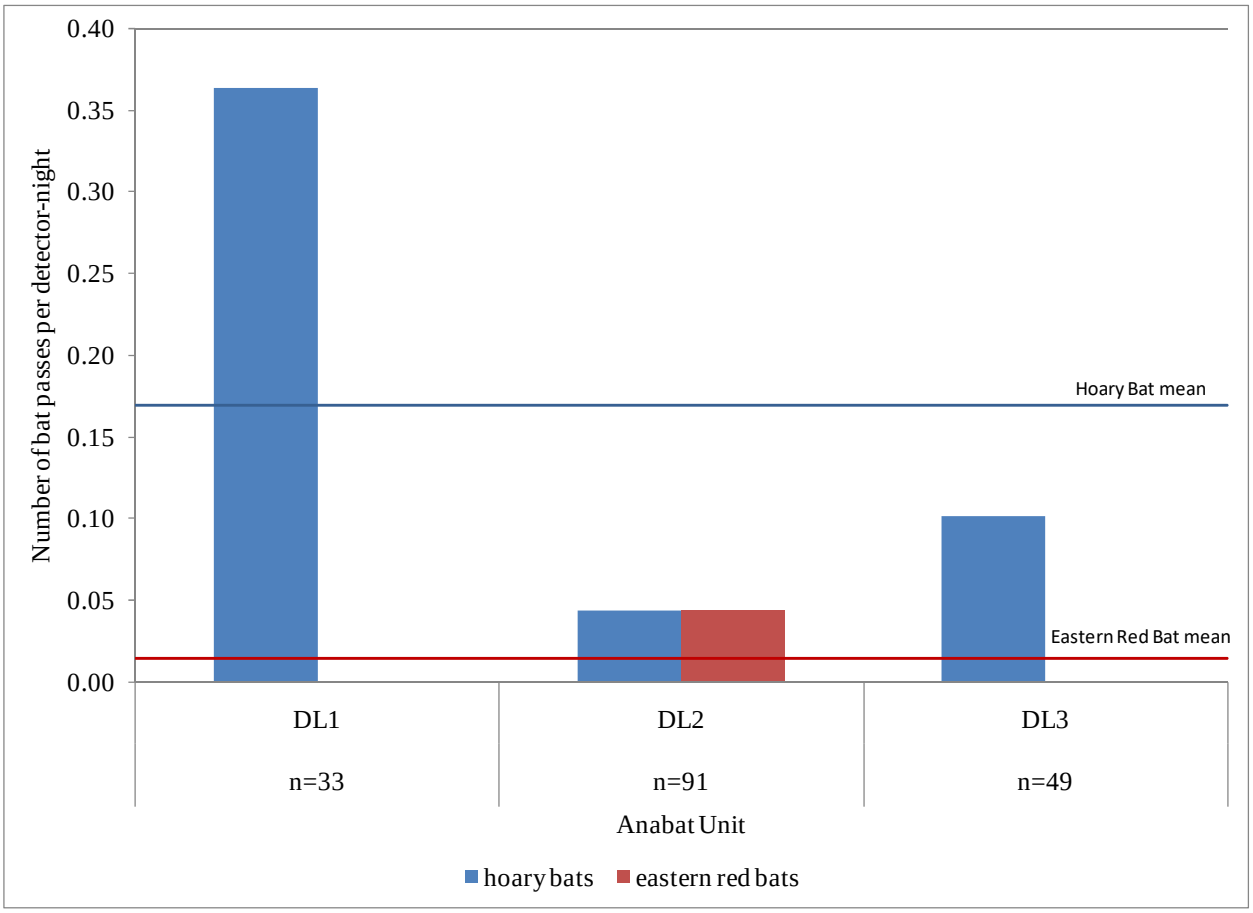


Figure 19. Number of passes per detector–night by hoary bats, by Anabat station at the Dunlap Ranch Wind Resource Area, for the study period July 16 – October 14, 2008.

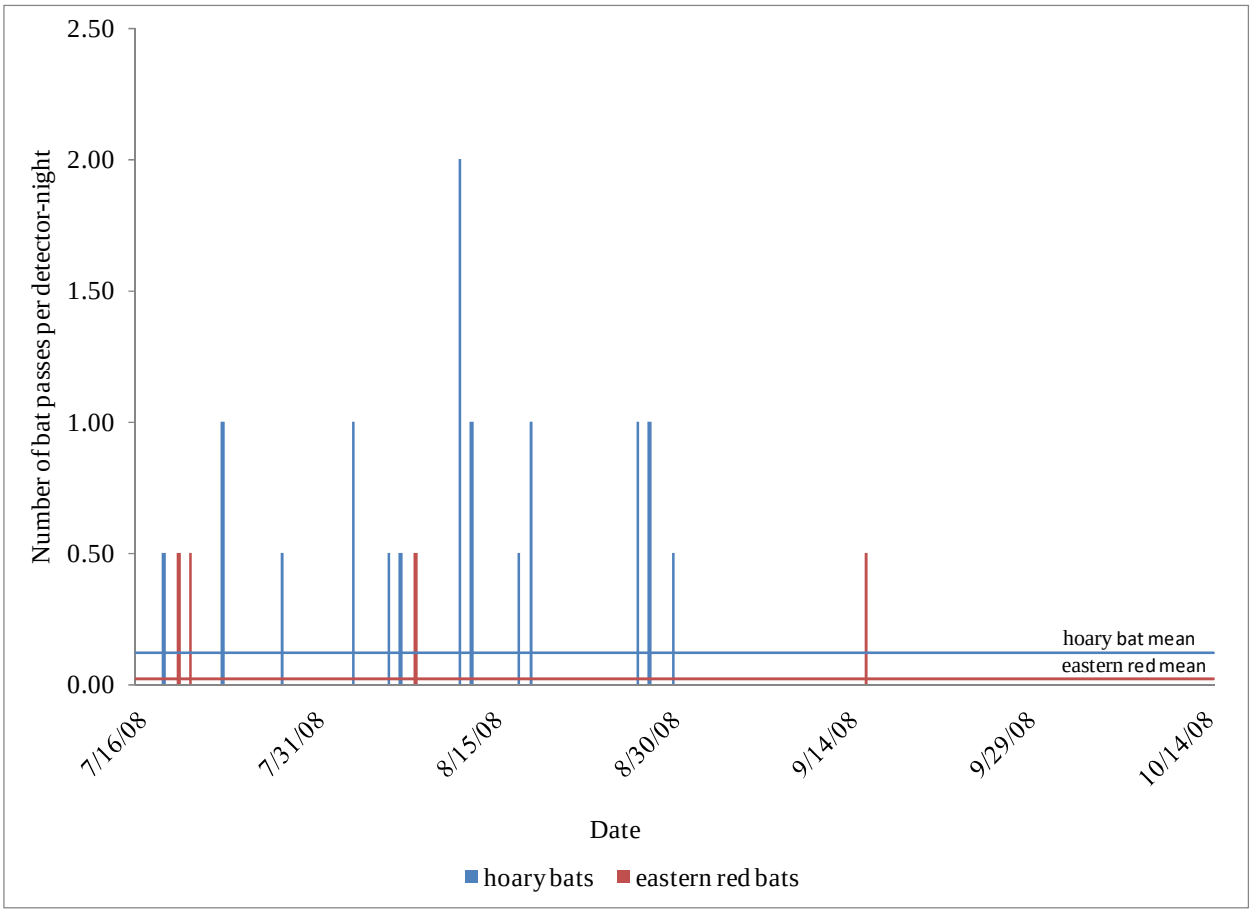


Figure 20. Number of passes per detector–night by hoary bats at the Dunlap Ranch Wind Resource Area, presented nightly for the study period July 16 – October 14, 2008.

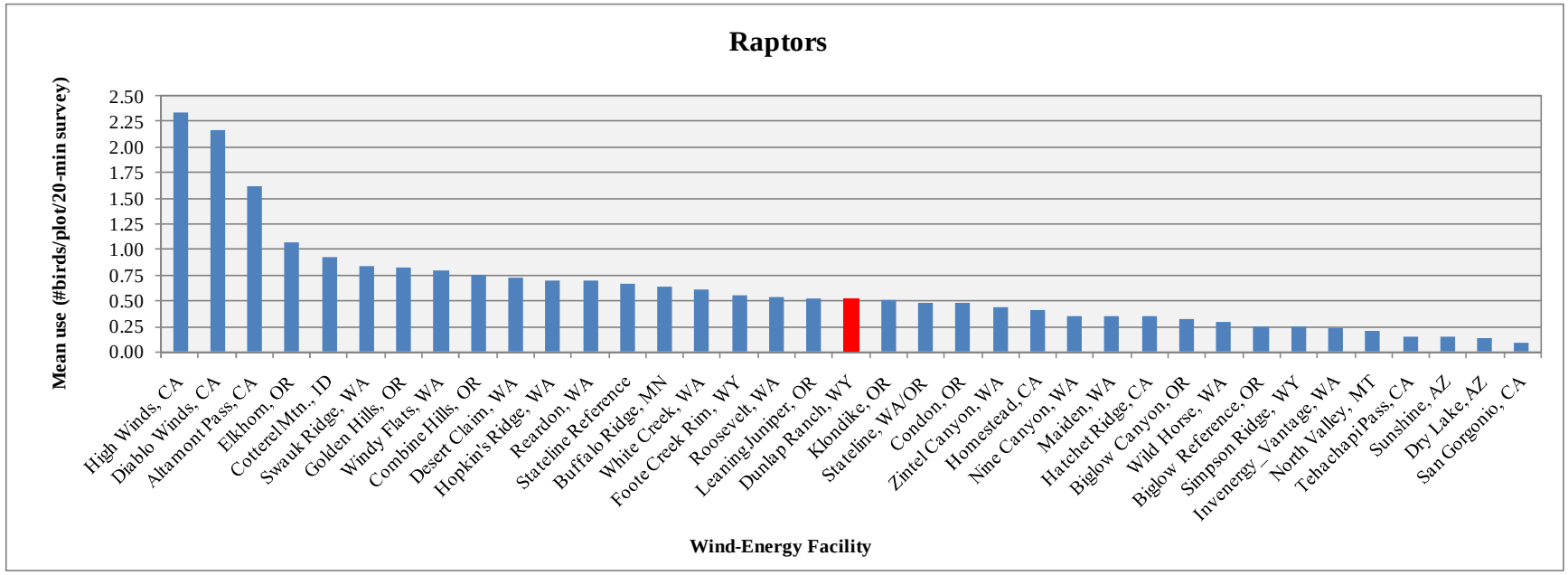
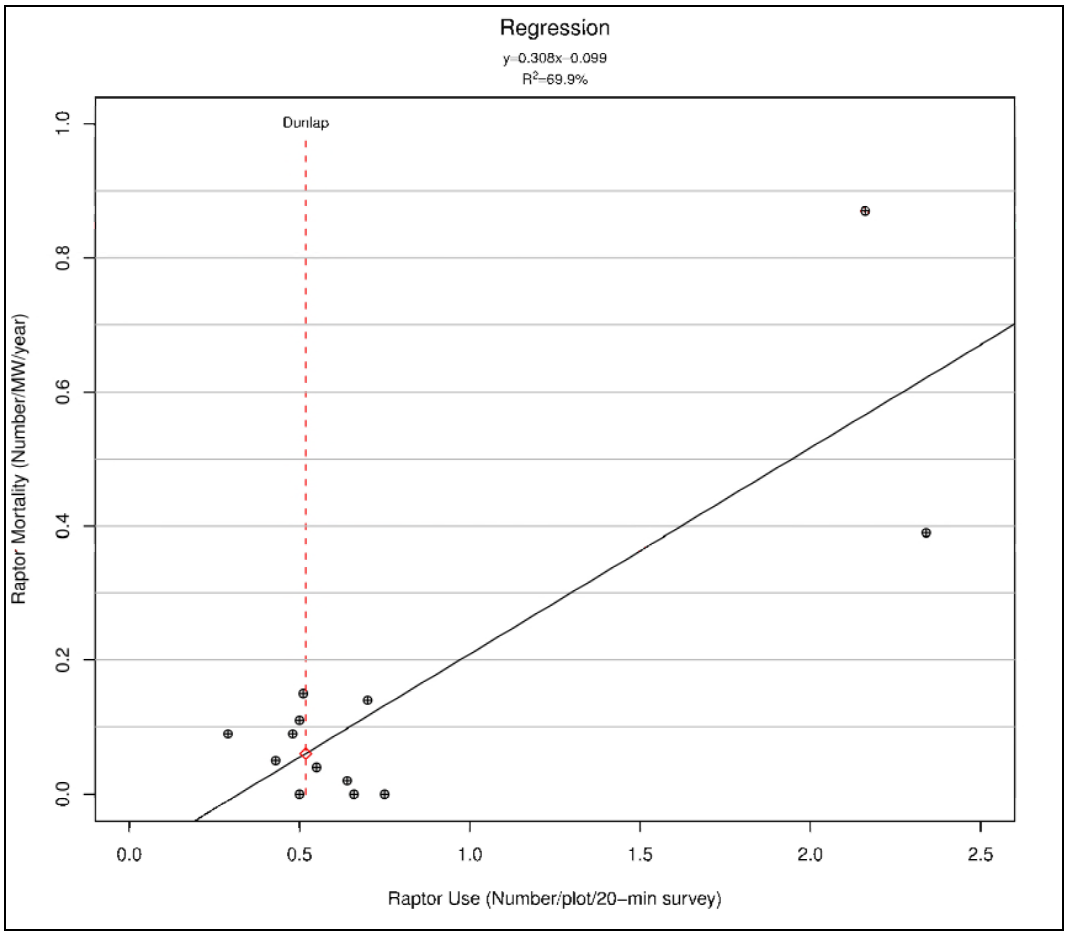


Figure 21. Comparison of annual raptor use between the Dunlap Ranch Wind Resource Area and other US wind-energy facilities.

Data from the following sources:

Dunlap Ranch, WY	This study.				
High Winds, CA	Kerlinger et al. 2005	Stateline Reference	URS et al. 2001	Maiden, WA	Erickson et al. 2002b
Diablo Winds, CA	WEST 2006a	Buffalo Ridge, MN	Erickson et al. 2002b	Hatchet Ridge, CA	Young et al. 2007b
Altamont Pass, CA	Erickson et al. 2002b	White Creek, WA	NWC and WEST 2005a	Biglow Canyon, OR	WEST 2005c
Elkhorn, OR	WEST 2005a	Foote Creek Rim, WY	Erickson et al. 2002b	Wild Horse, WA	Erickson et al. 2003a
Cotterel Mtn., ID	Cooper et al. 2004	Roosevelt, WA	NWC and WEST 2004	Biglow Reference, OR	WEST 2005c
Swauk Ridge, WA	Erickson et al. 2003b	Leaning Juniper, OR	NWC and WEST 2005b	Simpson Ridge, WY	Johnson et al. 2000b
Golden Hills, OR	Jeffrey et al. 2008	Klondike, OR	Johnson et al. 2002a	Invenergy_Vantage, WA	WEST 2007
Windy Flats, WA	Johnson et al. 2007	Stateline, WA/OR	Erickson et al. 2002b	North Valley, MT	WEST 2006b
Combine Hills, OR	Young et al. 2003d	Condon, OR	Erickson et al. 2002b	Tehachapi Pass, CA	Erickson et al. 2002b
Desert Claim, WA	Young et al. 2003b	Zintel Canyon, WA	Erickson et al. 2002a	Sunshine, AZ	WEST and the CPRS 2006
Hopkin's Ridge, WA	Young et al. 2003a	Homestead, CA	WEST et al. 2007	Dry Lake, AZ	Young et al. 2007c
Reardon, WA	WEST 2005b	Nine Canyon, WA	Erickson et al. 2001b	San Gorgonio, CA	Erickson et al. 2002b



Overall Raptor Use 0.52
Predicted Fatality Rate 0.06 fatalities/MW/year
90.0% Prediction Interval (0, 0.32 fatalities/MW/year)

Figure 22. Regression analysis comparing raptor use estimates versus estimated raptor mortality.

Data from the following sources:

Study and Location	Raptor Use (birds/plot/20-min survey)	Source	Raptor Mortality (fatalities/MW/yr)	Source
Buffalo Ridge, MN	0.64	Johnson et al. 2000b	0.02	Johnson et al. 2000b
Combine Hills, OR	0.75	Young et al. 2003d	0.00	Young et al. 2005b
Diablo Winds, CA	2.161	WEST 2006a	0.87	WEST 2006a
Foote Creek Rim, WY	0.55	Erickson et al. 2002b	0.04	Erickson et al. 2002b
High Winds, CA	2.34	Kerlinger et al. 2005	0.39	Kerlinger et al. 2006
Hopkins Ridge	0.70	Young et al. 2003a	0.14	Young et al. 2007a
Klondike II, OR	0.50	Johnson 2004	0.11	NWC and WEST 2007
Klondike, OR	0.50	Johnson et al. 2002a	0.00	Johnson et al. 2003b
Stateline, WA/OR	0.48	Erickson et al. 2002b	0.09	Erickson et al. 2002b
Vansycle, OR	0.66	WCIA and WEST 1997	0.00	Erickson et al. 2002b
Wild Horse, WA	0.29	Erickson et al. 2003a	0.09	Erickson et al. 2008
Zintel, WA	0.43	Erickson et al. 2002a	0.05	Erickson et al. 2002b
Bighorn, WA	0.51	Johnson and Erickson 2004	0.15	Kronner et al. 2008

Appendix E. Wildlife Incident Report and Handling System

PacifiCorp - Wyoming Wind Energy Facilities

Wildlife Incident
Reporting and Handling System (WIRHS)

PACIFICORP ENERGY
A DIVISION OF PACIFICORP

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Attachment A: Wildlife Incident Reporting Form
Attachment B: Project Personnel Listing and Contact Information
Attachment C: Freezer Tag
Attachment D: Wildlife Incident Reporting Log

BACKGROUND AND INTRODUCTION

The US Fish and Wildlife Service (USFWS) requests that mortality discoveries of birds protected under the Bald and Golden Eagle Protection Act, the Endangered Species Act, and the Migratory Bird Treaty Act be reported. PacifiCorp intends to report all avian mortality discoveries found in the Wind Project over the entire life of the project as part of the project operations and monitoring efforts. The purpose of this Wildlife Incident Reporting and Handling System (WIRHS) manual is to standardize and describe the actions taken by wind project personnel in response to wildlife incidents found in the wind project. The manual is intended to be working directions for personnel encountering a wildlife incident to fulfill the obligations of PacifiCorp in reporting bird incidents.

PACIFICORP POLICY

Employees or subcontractors of PacifiCorp, have a responsibility to comply with all environmental laws and regulations. Most birds that occur in the Wind Projects are protected by the federal Migratory Bird Treaty Act and eagles are further protected by the Bald and Golden Eagle Protection Act.

MIGRATORY BIRD TREATY ACT

The Migratory Bird Treaty Act of 1918 (MBTA) is the cornerstone of migratory bird conservation and protection in the United States. The MBTA offers protection of 836 species of migratory birds, including waterfowl, shorebirds, seabirds, wading birds, raptors, and passerines. Generally speaking, the MBTA protects all birds in the U.S. except gallinaceous (upland game) birds, rock doves (pigeons), European starlings, and house (English) sparrows.

BALD AND GOLDEN EAGLE PROTECTION ACT

In June 1940, Congress signed into law the Bald and Golden Eagle Protection Act (BGEPA). This law afforded additional protection to the bald and golden eagle. Penalties for violations of the BGEPA are up to $250,000 and/or 2 years imprisonment for a felony (violations are defined as a felony), with fines doubled for organizations.

ENDANGERED SPECIES ACT

In 1973 the Endangered Species Act (ESA) was passed to protect endangered and threatened species and to provide a means to conserve their ecosystems. Under the ESA, Federal agencies are directed to utilize their authorities to conserve listed species, as well as "Candidate" species that may be listed in the near future, and make sure that federal agencies' actions do not jeopardize the continued existence of these species. As with the MBTA and the BGEPA, the ESA as amended prohibits the taking of species listed under the act as threatened or endangered.

PacifiCorp's WIRHS will be active for the life of the wind project. The WIRHS is designed to provide a means of recording and collecting avian and bat mortality discoveries found in the wind project to minimize and avoid attracting scavenging wildlife. It is the responsibility of PacifiCorp employees and subcontractors to report all avian and wildlife incidents to appropriate personnel or your immediate supervisor.

WILDLIFE INCIDENT REPORTING

The following procedures are to be followed when wind project personnel or others observe an avian or bat mortality discovery or injury while on site. These procedures are intended to be in place for the life of the Wind Project and are independent to any monitoring studies. Implementation of this WIRHS will be part of the PacifiCorp staff training program.

WHEN TO USE THE WIRHS - WHAT CONSTITUTES A REPORTABLE INCIDENT?

For the purposes of this reporting system, *incident* is a general term that refers to any bird or bat, or evidence thereof, that is found either dead or injured within the wind project. Note that an incident may include an injured animal and does not necessarily indicate death as in a carcass or mortality discovery.

An intact carcass, carcass parts, bones, or scattered feathers or an injured bird or bat are all considered reportable incidents. Report all such discoveries even if you are uncertain if the carcass or parts are associated with a wind project structure.

A *mortality discovery* is any find where a carcass, carcass parts, bones, or feather spots are observed. An *injury* or injured animal is any bird or bat with an apparent injury, or that exhibits signs of distress to the point where it can not move under normal means or does not display normal escape or defense behavior.

Prior to assuming a bird or bat is injured, it should be observed to determine if it can not or does not display normal behaviors. For example, raptors will occasionally walk on the ground, especially if they have captured a prey item. Raptors also "mantle" or hold their wings out and down covering a prey item. These types of behaviors may make the wings appear broken or the animal injured. Identification of specific behaviors typical to bird life cycles and distress behaviors will be part of the wind facility staff training program, otherwise a biologist with expertise will be notified as to uncertain bird behavior.

Note: Any incident involving a threatened or endangered species or a bald or golden eagle must be reported to USFWS within 48 hours of identification. See project personnel listing for contact information.

MATERIALS NEEDED TO RECOVER/REPORT AN INCIDENT

The supplies needed for this WIRHS will be contained in a "run-kit" storage device (e.g., Rubbermaid storage container, backpack, or airlines luggage) available on site at the Operations and Maintenance Office. The run-kit includes the following items:

A copy of this WIRHS
Wildlife Incident Report Forms
1 - large, portable, tool boxes or storage boxes (lockable; **i.e.** http://www.walmart.com/catalog/product.do?product_id=2476189&findingMethod=rr)
1 - 5 pack of Sharpies, multicolor
1 - 5 pack of pens
1 - 5 pack of mechanical pencils
2 - packs of 3" X 5" index cards
2 - boxes of 1 gallon & quart size zip lock freezer bags (16 gallon & 16 quart)
1 - packages of 12" zip ties (Wal-Mart or Home Depot/Lowe's 30ct minimum)
1 - boxes of garbage bags (13 gallon)
1 - boxes of disposable gloves (30 pair count or more per box/bag) (**i.e.** http://www.walmart.com/catalog/product.do?product_id=10715978)
1 - "inexpensive" digital cameras (minimum 3.0 mega pixels) (**i.e.** http://www.walmart.com/catalog/product.do?product_id=9134433)
1 - salad or BBQ tongs (forceps if available) (**i.e.** http://www.walmart.com/catalog/product.do?product_id=10097014)
1 - packages of red "survey marking flags" (20 pack or larger) (Home Depot or Lowe's carry these)
2 - pairs of inexpensive leather gloves (16 large and 16 medium) (Wal-Mart or Home Depot/Lowe's)
1 - large canine transporters/carriers (**i.e.** http://www.walmart.com/catalog/product.do?product_id=10893743)
1 - dark blankets or large throws (**i.e.** http://www.walmart.com/catalog/product.do?product_id=10371352)
1 - medium hand towels
2 - small collapsible cardboard boxes (large enough for small bird or bat)
1 - small padlocks that will fit in tool box lock opening (**i.e.** http://www.walmart.com/catalog/product.do?product_id=8251841)

INCIDENT RECOVERY AND REPORTING PROCEDURES:

If an animal is found or if you determine a bird/bat is injured, the following procedures should be followed:

1. If the incident discovered is an injured bird, initially move to a distance far enough away that it is not visibly disturbed or uneasy due to your presence. Follow the procedures for reporting and care of injured wildlife found below.

   If the incident discovered is a mortality discovery or injured bat the following procedures apply.

2. Initially, leave the subject animal in place. A flag may be used to mark it's location for easy finding while specific data is being recorded. If it is a mortality discovery, leave the subject animal in place until all the data is recorded. It is recommended that any flagging be marked with the date, time and initials of the recorder.

3. Prepare a Wildlife Incident Report Form. The form and instructions for filling out the form are provided below.

4. Prepare a 3x5 card label that includes the exact date and time of the find and the observer's initials that are recorded on the Wildlife Incident Report Form. Use a Sharpie to record information on the label and write in large letters. This label is critical to correlating the carcass and photographs back to the data forms in the future and will be bagged and stored with the carcass.

5. Photograph the incident as it was found in the field. Take at least two pictures: a close up shot of the animal as it lays in the field and a broader view of the animal (marked by a flag) with the road, turbines, or other local features in the view. For the close up picture lay the 3x5 card label marked with the date, time and initials of the recorder facing up next to the carcass so that it appears in the picture.

6. Following completion of the report form and photographs, the mortality discovery should be collected. In the case of a scavenged mortality or feather spot it is important to collect all parts so that it is not encountered and counted again at a later date. The mortality discovery or parts should be bagged in a Ziploc freezer bag (or other such adequate sample bag such as Whirlpaks) or garbage bag in the case of large birds. The 3x5 card label should be included in a second Ziploc bag with the bag holding the actual animal (double bagged). It is advisable to use plastic disposable gloves to collect casualties for hygiene and potential disease considerations.

   Injured bats (that can not fly) are also to be collected. Due to disease considerations and safety, injured bats should be collected with long forceps using disposable gloves. Confine the injured bat in a shoebox with a lid, punched air holds, and a soft cloth. The Operations project manager, project biologist, or monitoring study Field Coordinator (see list of contacts) should be notified immediately and will be responsible for euthanizing injured bats.

7. Report the find to the authorized representative or PacifiCorp staff within 24 hours. As soon as possible after the mortality discovery is collected it should be stored in the site freezer and an entry completed in the freezer log book. Follow the instructions on the freezer log book for logging fatalities into the freezer. Include the card label double bagged with the mortality discovery in the freezer.

   Any incident involving a State or Federally listed threatened or endangered species or a bald or golden eagle must be reported to the USFWS and/or state wildlife agencies within 48 hours of identification. These finds will be reported to the agency verbally or via email by the authorized representative or PacifiCorp staff. See project personnel listing for contact information.

WILDLIFE INCIDENT REPORT FORM INSTRUCTIONS

SECTION 1 – DISCOVERY DATA

Date and Time: Record the date and time when the incident was found and the report is completed.

Name(s): Record the name(s) of the person(s) who made the discovery and filled out the report form.

SECTION 2 – LOCATION INFORMATION

Structure: Record the nearest turbine or met tower number. If no wind project facility is nearby indicate that the incident was found on site and the approximate location.

Distance from Structure: Record the approximate distance to the structure from where the incident was found. Pacing is a good means of estimating distance.

Direction from Structure: Record the general direction such as N (north), NE (northeast), E (east) etc. from the structure to where the incident was found. If the direction is unknown indicate in the Location Remarks (below) if the incident was on the road side or non-road side from the turbine.

Location Remarks: Include in this section any other information about the incident location that might be helpful such as found on the road, found on the turbine pad, found directly under guy wires, power lines overhead, etc.

SECTION 3 – WEATHER INFORMATION

Identify the weather condition present at the time of the incident

SECTION 4 – SPECIES IDENTIFICATION

Species: If known, record the species. If unknown, record "unidentified" or "unknown".
Mortality/Injury: Circle the appropriate choice.

Disposition of the Incident: Incidents located by wind project personnel are to be collected. The disposition of the find in most cases will be that it is stored in the site freezer. In cases of injured birds (see procedure below) the disposition may be the wildlife rehabilitator or if an eagle or threatened or endangered species is found, the incident will be turned over to the USFWS.

Condition: Circle appropriate description. *Complete* is an intact carcass or carcass that appears complete with no obvious signs of scavenging. *Dismembered* is a carcass with appendages missing or amputated from body. *Feathers* indicates an incident where only feathers were found, a feather spot.

Field Notes and Physical Condition: This section is for recording any field notes or observations specific to the incident. For example, describe observations about the incident at

the time it was found. Some good observations to include are whether the carcass appears fresh or is old and desiccated, whether it was infested with insects, whether maggots were present, the condition of the eyes – dried and sunken versus moist and round, whether all appendages were present or if one or more were missing (e.g., missing right wing). Notes recorded in this section are helpful in estimating the time since death.

Estimated Time Since Death: Indicate the approximate number of days since the time of death based on your best judgment. Very fresh carcasses which may be only a few hours old will generally have no insect infestations and eyes may be round and wet appearing. Insect infestations can occur relatively quickly, especially in warm weather, and even carcasses less than 24 hours old may have flies or beetles on them. The presence of fly larvae (maggots) would indicate a carcass is a few days (generally >24 hours) to a week old. A dried carcass with all the flesh removed is likely to be greater than 14 days and if bones are visible it could be over 30 days old. In cold weather, carcasses will appear fresh for longer time periods and may not experience insect scavenging.

Field Marks used: Include in this section any notes or information such as identification marks that helped you determine the species of the bird or bat. If the species was unknown but you have an educated guess, or you know the bird was a raptor for example but don't know the species, include it here.

Photos: Indicate whether photos were taken and if so how many.

SECTION 5 – ADDITIONAL COMMENTS

Document any additional information in this section. (e.g. behavior observed if injured; details of carcass – missing body parts, injuries, number of feathers in feather spot; indications of cause of death; field marks for identification, characteristics of where found - hidden or exposed)

SECTION 6 – CHAIN OF CUSTODY

Disposition of Carcass: Record the method of disposition of the carcass, date, time and the initials of the person performing the disposition. If the carcass is release to the USFWS, document the person's name, date and time, including the PacifiCorp representative that approved the disposition.

SECTION 7 – AGENCY RECORD OF CONVERSATION

Name of Field Personnel/Manager Notified: Record the name, date and time that the O&M Project Manager, project biologist, or the monitoring study Field Coordinator was notified about the find. Record the name, date, and time of all governmental agency notifications.

INJURED WILDLIFE – PROCEDURES FOR REPORTING AND CARE

The following procedures apply to injured birds:

Fill out a Wildlife Incident Report Form as for a mortality discovery, but first, the primary objective is to provide immediate care for the injured animal. If safely possible and authorized to do so, capture the injured bird by placing a dark cloth or towel over the animal. By removing its ability to see, birds generally calm down and are more easily handled. Place the bird in a box that has a towel or other material for the animal to hide under or grasp on to.

While capturing the animal, assess the injury so you'll know what to report to the authorized representative, PacifiCorp staff, and/or the wildlife rehabilitator. As soon as possible after capture, contact the authorized representative or PacifiCorp staff about the find and for further instruction (see contact list).

Minimize additional stress to the animal by keeping it cool if it is a hot day or keeping it slightly warm if it is a cool day. Placing the box in a darkened room with closed doors may be helpful in minimizing stress while the appropriate arrangements are made for care.

If the injured bird is a Federally or State listed species, an authorized representative or PacifiCorp staff will notify the appropriate U.S. Fish and Wildlife and/or state wildlife representatives (see contact list). If the injured animal is found after normal weekday office hours, leave a message (if possible) and report it again the next available working day.

If you can't reach the authorized representative or PacifiCorp staff, phone the nearest rehabilitation center and request further instruction (see contact list). The rehabilitation center is required to report any injured raptor to the WDFW and USFWS within 48 hours. If the injured bird is an eagle or has been gun shot, it should also be reported to federal and state law enforcement offices. Describe the injury to the rehabilitation center and they will determine if it should go directly to a veterinary clinic.

Deliver the animal to the specified location. If applicable, request that the veterinary clinic make arrangements to deliver the bird to the designated rehabilitation center following treatment. PacifiCorp will pay for all veterinary bills.

Attachment A: Wildlife Incident Reporting Form

SECTION 1: LOCATION INFORMATION

Confidential Business Information

Date: _____ Time: _____ Observer: _____ ID No.: _____

Found during (choose one): _____Scheduled Carcass Search _____Incidental Find

Project Location:_____

SECTION 2: LOCATION INFORMATION (if known)

Location: _____Nearest Turbine #_____ _____Other – describe:

_____Weather Station #_____

Distance and Bearing to nearest turbine or weather tower as *measured from carcass to structure*:

Azimuth (degrees): _____ Distance (meters): _____

GPS Unit: _____ State Plane Coordinates: Northing_____ Easting_____

Landform (all applicable): _____Flat/Rolling _____Steep slope _____Hilltop _____Depression

Habitat or Community Type(s) present at carcass location:

_____Standing Crops _____CRP/Pasture _____Plowed/Fallow

_____Forest _____Scrubland _____Other – describe:_____

Location Notes:_____

SECTION 3: WEATHER INFORMATION

Weather History

___Clear ___Calm ___Fog ___Cloudy ___Light Rain ___Storm ___Snow ___Blizzard

___Gusty Winds ___Sustained High Winds ___Violent Storm

Weather Notes:_____

SECTION 4: SPECIES INFORMATION (if known)

Species: _____ Photo No.: _____

Sex (circle): _____Male _____Female _____Unknown

Age (circle): _____Adult _____Juvenile _____Unknown

Disposition of carcass (project office freezer, other): _____

Estimated time since death or injury: _____

Condition: ___Injured ___Intact ___Scavenged ___Dismembered ___Feather Spot

___Other – describe: _____

Bird banded or tagged – describe thoroughly:_____

Species Notes:_____

SECTION 5: ADDITIONAL COMMENTS:

Confidential Business Information

_____

_____

_____

_____

_____

SECTION 6: CHAIN OF CUSTODY

Disposition of carcass: _____ Date:_____ Time: _____ Initials:___

Disposition of carcass: _____ Date:_____ Time: _____ Initials:___

Disposition of carcass: _____ Date:_____ Time: _____ Initials:___

Disposition of carcass: _____ Date:_____ Time: _____ Initials:___

If Release to USFWS:

USFWS Person's Name: _____ Date:_____ Time: _____

PacifiCorp Representative: _____ Signature: _____

SECTION 7: AGENCY RECORD OF CONVERSATION

Contact Name: _____ Agency: _____

Contact Phone Number:_____ Date:_____ Time: _____

PacifiCorp Representative: _____

Discussion Topics and Comments:_____

_____

_____

GLENROCK & ROLLING HILLS (WYOMING)

PacifiCorp
Laine Anderson, PacifiCorp
Cell: (801) 386-3861
laine.anderson@pacificorp.com
or
Travis Brown, PacifiCorp
Office (801)220-2737
travis.brown@pacificorp.com

State:
Wyoming Game and Fish Deparment
3030 Energy Lane
Casper, WY 82604
Carol Havlik: (307) 233-6413
Gary Boyd: (307) 436-9617
Martin Grenier (Bats): (307) 332-7723

County (Converse):
Converse County Sheriff Dept.
Office of Sheriff Clint Becker
(307) 358-4700

Agencies
U.S. Fish and Wildlife Service
Curtis A. Graves, Special Agent
9297 S. Wadsworth Blvd.
Littleton, CO 80128
Phone: (303) 562-4279

Wildlife Rehabilitation Center

Frank and Lois Layton
6520 W. Riverside Terrace
Casper, WY 82601
(307) 472-7009

Wildlife Rehabilitation Center
Laramie Raptor Refuge
28 Corthell Road
Laramie, WY 82070
(307) 721-9841

SEVEN MILE HILL (WYOMING)

PacifiCorp
Robert Booth, PacifiCorp
Cell: (307) 251-3908
Robert.Booth2@pacificorp.com
or
Travis Brown, PacifiCorp
Office (801)220-2737
travis.brown@pacificorp.com

State:
Wyoming Game and Fish Department
528 S. Adams
Laramie , WY 82070
Carol Havlik: (307) 233-6413
Ryan Kenneda: (307) 348-7311
Martin Grenier (Bats): (307) 332-7723

Wildlife Rehabilitation Center

Laramie Raptor Refuge
28 Corthell Road
Laramie, WY 82070
(307) 721-9841

County (Carbon):

Emergency Mgmt. Services
Harold Newborough
(307) 328-2750

Agencies
U.S. Fish and Wildlife Service
Curtis A. Graves, Special Agent
9297 S. Wadsworth Blvd.
Littleton, CO 80128
Phone: (303) 562-4279

HIGH PLAINS AND MCFADDEN RIDGE (WYOMING)

PacifiCorp
Aron Anderson, PacifiCorp
Cell: (307) 379-4131
Aron.Anderson@pacificorp.com
or
Travis Brown, PacifiCorp
Office (801)220-2737
travis.brown@pacificorp.com

State:
Wyoming Game and Fish Department
528 S. Adams
Laramie , WY 82070
Carol Havlik: (307) 233-6413
Roger Bredehoft: (307) 745-4401
Martin Grenier (Bats): (307) 332-7723

Wildlife Rehabilitation Center

Laramie Raptor Refuge
28 Corthell Road
Laramie, WY 82070
(307) 721-9841

County (Carbon):

Emergency Mgmt. Services
Harold Newborough
(307) 328-2750

Agencies
U.S. Fish and Wildlife Service
Curtis A. Graves, Special Agent
9297 S. Wadsworth Blvd.
Littleton, CO 80128
Phone: (303) 562-4279

Foote Creek I (WYOMING)

PacifiCorp
Aron Anderson, PacifiCorp
Cell: (307) 379-4131
Aron.Anderson@pacificorp.com
or
Travis Brown, PacifiCorp
Office (801)220-2737
travis.brown@pacificorp.com

State:
Wyoming Game and Fish Department
528 S. Adams
Laramie , WY 82070
Carol Havlik: (307) 233-6413
Roger Bredehoft: (307) 745-4401
Martin Grenier (Bats): (307) 332-7723

County (Carbon):

Emergency Mgmt. Services
Harold Newborough
(307) 328-2750

Agencies
U.S. Fish and Wildlife Service
Curtis A. Graves, Special Agent
9297 S. Wadsworth Blvd.
Littleton, CO 80128
Phone: (303) 562-4279

Wildlife Rehabilitation Center

Laramie Raptor Refuge
28 Corthell Road
Laramie, WY 82070
(307) 721-9841

Attachment B: Project Personnel Listing and Contact Information

DUNLAP I (WYOMING)

PacifiCorp
Robert Booth, PacifiCorp
Cell: (307) 251-3908
Robert.Booth2@pacificorp.com

or

Travis Brown, PacifiCorp
Office (801)220-2737
travis.brown@pacificorp.com

State:
Wyoming Game and Fish Department
528 S. Adams
Laramie , WY 82070
Carol Havlik: (307) 233-6413
Kelly Todd: (307) 379-2337
Martin Grenier (Bats): (307) 332-7723

Wildlife Rehabilitation Center

Laramie Raptor Refuge
28 Corthell Road
Laramie, WY 82070
(307) 721-9841

County (Carbon):

Emergency Mgmt. Services
Harold Newborough
(307) 328-2750

Agencies
U.S. Fish and Wildlife Service
Curtis A. Graves, Special Agent
9297 S. Wadsworth Blvd.
Littleton, CO 80128
Phone: (303) 562-4279

Attachment C: Freezer Tag

Facility:_____ Sample Log #:_____
(from log book)
Date:_____ Time:_____

Collector's Name/Employee # or Company's name:_____

Circle one: Bird / Bat Species:_____

Facility:_____ Sample Log #:_____
(from log book)
Date:_____ Time:_____

Collector's Name/Employee # or Company's name:_____

Circle one: Bird / Bat Species:_____

Facility:_____ Sample Log #:_____
(from log book)
Date:_____ Time:_____

Collector's Name/Employee # or Company's name:_____

Circle one: Bird / Bat Species:_____

Facility:_____ Sample Log #:_____
(from log book)
Date:_____ Time:_____

Collector's Name/Employee # or Company's name:_____

Circle one: Bird / Bat Species:_____

Attachment D: SAMPLE Wildlife Incident Reporting Facility Log

_____ WIND FACILITY

ID	Date of Find	Time of Find	Turbine I.D.	Bird or Bat Species	CS or INCID	O&M or BIOL	Collector's Initials	Carcass in Freezer (Y/N)	Disposition
13-001									
13-002									
13-003									
13-004									
13-005									
13-006									
13-007									
13-008									
13-009									
13-010									
13-011									
13-012									
13-013									
13-014									
13-015									
13-016									
13-017									
13-018									
13-019									
13-020									

NOTE: CS = scheduled carcass search, INCID = incidental find.

Appendix F. Post-Construction Monitoring Reports

Wildlife Monitoring Studies
Dunlap Wind Energy Facility
Carbon County, Wyoming

Prepared for:

PacifiCorp Energy

Prepared by:

Western EcoSystems Technology Inc.
2003 Central Avenue
Cheyenne, Wyoming 82001

January 18, 2011

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INTRODUCTION AND BACKGROUND

PacifiCorp Energy (PacifiCorp) has recently completed development a wind energy project in Wyoming. The Dunlap project is located in Carbon County, Wyoming, and consists of 74 GE 1.5-megawatt (MW) wind turbine generators with 80-meter (m) tubular towers with a total nameplate capacity of 111 MW.

This protocol outlines the methods to monitor wildlife impacts and the measures to meet compliance requirements during operations of the Project. Monitoring of the Project includes estimating avian and bat collision mortality.

The proposal is divided into three sections. This section provides the technical proposal for implementing the required monitoring for the Project. Attachment A is the business proposal, which provides a statement of qualifications, resumes for key staff, company financials, references, and the safety questionnaire. Attachment B provides the price schedule for conducting the studies.

Scope

The scope of the Wildlife Monitoring Studies includes:

- Avian and Bat Fatality Monitoring –The monitoring study will estimate the annual number of avian and bat fatalities attributable to wind turbine collisions from Project operations each year of operation (up to three years). This information will be used to determine whether projected impact levels for the Project are within acceptable ranges and are consistent with reported data from other wind projects in the region. The proposed monitoring study conforms to industry standard in the western U.S. and provides the WGFD with good baseline data on avian and bat fatality rates at wind energy facilities in Wyoming.

- Technical Advisory Committee (TAC) – The TAC will review the monitoring protocol, assess study results, and prepare recommendations for PacifiCorp at the completion of the Year 1 monitoring studies (and each subsequent year). It is composed of representatives from the Wyoming Game and Fish Department, U.S. Fish and Wildlife Service, and perhaps other state/federal agencies.

AVIAN AND BAT FATALITY STUDY

The primary objective of the fatality monitoring study is to estimate avian and bat mortality at the Project and determine whether the estimated mortality is lower, similar, or higher than the average mortality observed at other regional projects. The monitoring study will begin in early 2011. The study will be conducted for 1 year followed by a TAC review of findings and recommendations on additional monitoring. For budgeting purposes, however, we have assumed mortality monitoring will occur for three years.

Definitions and Field Methods

All casualties located within areas surveyed, regardless of species, will be recorded and a cause of death determined, if possible, based on field inspection of the carcass. Total number of avian and bat carcasses will be estimated by adjusting for search frequency, removal bias (length of stay in the field), and searcher efficiency bias (percent found). For carcasses where the cause of death is not apparent, the assumption that the fatality is a wind turbine or met tower collision casualty will be made for the analysis. This approach may lead to an overestimate of the true number of wind farm-related fatalities. Most wind farm monitoring studies have used this conservative approach because of the relative high costs associated with obtaining accurate estimates of natural or reference mortality (Johnson et al. 2000). A second low-range estimate will be calculated by eliminating fatalities where cause of death is not considered trauma due to collision.

Seasons

Seasons will be based roughly on the calendar seasons. For analysis purposes and to help with categorizing impacts (e.g., migratory birds) a spring and fall migration period and summer breeding season are also defined.

The following dates will be used for defining seasons in the study:

Season	Dates
Spring	March 16 – June 15
Spring Migration	March 16 – May 15
Summer	June 16 - September 15
Breeding Season	May 15 – August 15
Fall	September 15 – December 15
Fall Migration	August 1 - October 31
Winter	December 16 - March 15

These dates are used for analysis purposes only and may not cover all potential migrants or breeding residents in the Project area.

Search Plot and Sample Size

The project has 74 turbines and six meteorological (met) towers. One-third (26) of the turbines and all six met towers will be sampled during the study. The 26 turbines and six met towers will be searched year-round every 28 days, and half of the turbines (13) and all six met towers will be searched every 7 days during the spring and fall migration periods. The first search will be conducted to clear all plots of any casualties prior to the start of the study. Turbines will be selected for sampling using a systematic design with a random start. In this fashion, the search effort is spread throughout the entire Project.

Turbine search plots will be 160 m on a side (80 m from the turbine) and centered on the turbine. The survey plot of the met towers will be 120 m on a side (60 m from the tower), also roughly equivalent to the height of the tower.

Standardized searches of 26 selected turbines and all met towers will be conducted once every 4-week (28-day) period. During the spring and fall migration periods, 13 of the 26 turbines and all six met towers will be selected for searching, and the search effort will be increased to once a week at these 13 turbines and met towers. A total of 13 monthly (28-day) searches will be completed for all 26 turbines and six met towers, while an additional 15 searches (6 – spring; 9 – fall) will be conducted for the 13 turbines and all met towers selected for weekly (7-day) searches during the migration seasons.

Standardized Carcass Searches

The objective of the standardized carcasses searches is to search the wind Project systematically for avian and bat casualties that are attributable to collision with project facilities. Personnel trained in proper search techniques will conduct the carcass searches. A searcher will walk at a rate of approximately 45 to 60 m a minute along each transect. Transects will be spaced 6 to 10 m apart, and searchers will scan the area on both side sides to approximately 3 to 5 m for casualties as they walk each transect. Search area and speed may be adjusted after evaluation of the first searcher efficiency trial.

The condition of each carcass found will be recorded using the following categories:

- Intact - a carcass that is completely intact, is not badly decomposed, and shows no sign of being fed upon by a predator or scavenger.
- Scavenged - an entire carcass that shows signs of being fed upon by a predator or scavenger, or a portion(s) of a carcass in one location (e.g., wings, skeletal remains, portion of a carcass, etc.), or a carcass that has been heavily infested by insects.
- Feather Spot - 10 or more feathers at one location indicating predation or scavenging.

In addition to carcasses, all injured bats and birds observed in search plots will be recorded and treated as a fatality. All carcasses found will be labeled with a unique number and bagged and frozen for future reference and possible necropsy. A copy of the data sheet for each carcass will be maintained, bagged, and frozen with the carcass at all times. For all casualties found, data recorded will include species, sex and age when possible, date and time collected, global positioning system (GPS) location, condition (intact, scavenged, feather spot), and any comments that may indicate cause of death. All casualties located will be photographed as found and plotted on a detailed map of the study area showing the location of the wind turbines and associated facilities such as overhead power lines and met towers.

Casualties found outside the formal search area by carcass searchers will be treated following the above protocol as closely as possible. Casualties found in non-search areas (e.g., near a turbine not included in the search area) will be coded as incidental discoveries and will be documented in a similar fashion as those found during standard searches.

Any injured native birds found during standard searches will be carefully captured by the observer and transported to the nearest wildlife rehabilitation center or veterinary clinic before close of business that day. Appropriate wildlife salvage/collection permits will be obtained from the Wyoming Game and Fish Department (WGFD) and the U.S. Fish and Wildlife Service

(USFWS). Dissemination of data (e.g., to the USFWS Special Agent and other agency representatives) is discussed in the Disposition of Data section below.

Searcher Efficiency Trials

The objective of the searcher efficiency trials is to estimate the percentage of casualties that are found by searchers. Searcher efficiency trials will be conducted in the same areas carcass searches occur. Trials will be conducted by season. Searcher efficiency will be estimated by major habitat type (e.g., cultivated agriculture, grassland), size of carcass, and season. Estimates of searcher efficiency will be used to adjust the total number of carcasses found for those missed by searchers, correcting for detection bias.

Searcher efficiency trials will begin when carcass search studies begin. Personnel conducting carcass searches will not know when trials are conducted or the location of the detection carcasses. During each season and within each major habitat type, approximately eight carcasses of birds of two different size classes will be placed in the search area during the search period, for a total of approximately 64 searcher efficiency trial carcasses for the entire year. Carcasses will consist of non-native/non-protected or commercially available species such as house sparrows, European starlings, rock pigeons, bobwhite quail, and hen mallards or hen pheasants. Other salvaged birds may be used if they are collected under a valid salvage permit. A minimum of two dates will be used each season for a minimum total of eight trial dates. An attempt will be made to use several small brown birds (house sparrows) during the late summer and fall seasons to simulate bat carcasses. Legally obtained bat carcasses will also be used, if available.

All carcasses will be placed at random locations within areas being searched prior to the carcass search on the same day. Carcasses will be placed in a variety of postures to simulate a range of conditions. For example, birds will be: 1) placed in an exposed posture (tossed randomly to one side), 2) hidden to simulate a crippled bird, and 3) partially hidden.

Each trial carcass will be discreetly marked so that it can be identified as a study carcass after it is found. The number and location of the detection carcasses found during the carcass search will be recorded. The number of carcasses available for detection during each trial will be determined immediately after the trial by the person responsible for distributing the carcasses.

Carcass Removal Trials

The objective of carcass removal trials is to estimate the likelihood a carcass is removed by scavengers as a function of the day since the trial carcasses are placed in the field. Carcass removal includes removal by predation or scavenging. Carcass removal studies will be conducted during each season near the carcass search plots (e.g., near a turbine that is not included in the standard search plots). Estimates of carcass removal will be used to adjust the total number of carcasses found for those removed from the study area, correcting for removal bias.

Carcass removal trials will begin when carcass search studies begin. During each season and within two major habitat types, approximately eight carcasses of birds of two different size classes (same as searcher efficiency birds) will be placed in the study plots, for a total of approximately 64 removal trial carcasses for the entire year. Legally obtained fresh carcasses that have never been frozen such as waterfowl from game farms or raptors obtained from rehabilitation centers or

agencies will be used if available. Carcasses will be placed on a minimum of three dates during each season for a minimum total of 12 trial initiation dates, spreading the trials throughout the year to incorporate the effects of varying weather, climatic conditions, and scavenger densities. Legally obtained fresh bat carcasses will also be used, if available.

Removal trial birds will not be placed in the standardized search plots to minimize the chance of confusing a trial bird with a true casualty. Turbines not included in the standardized searches will be randomly selected for inclusion in the removal trials and trial carcasses will be randomly located in a similar-sized plot as used to search turbines. Trial carcasses will be placed in a variety of postures to simulate a range of conditions. For example, birds will be: 1) placed in an exposed posture (tossed randomly to one side), 2) hidden to simulate a crippled bird (e.g., placed beneath a shrub or bunch grass), and 3) partially hidden.

Personnel conducting carcass searches will monitor the trial birds over a 40-day period according to the following schedule as closely as possible. Carcasses will be checked every day for the first 4 days, and then on day 7, day 10, day 14, day 20, day 30, and day 40. This schedule may vary depending on weather and coordination with the other survey work. Experimental carcasses will be marked discreetly (for example with dark electrical tape around one or both legs) for recognition by searchers and other personnel. Experimental carcasses will be left at the location until the end of the carcass removal trial. At the end of the 40-day period any evidence of the carcasses that remains will be removed.

Statistical Methods for Fatality Estimates

Estimates of facility-related fatalities are based on:

(1) Observed number of carcasses found during standardized searches during the monitoring year for which the cause of death is either unknown or is probably facility-related.
(2) Non-removal rates expressed as the estimated average probability a carcass is expected to remain in the study area and be available for detection by the searchers during removal trials.
(3) Searcher efficiency expressed as the proportion of planted carcasses found by searchers during searcher efficiency trials.

Fatality estimates will be provided for six categories: 1) all birds, 2) small birds, 3) large birds, 4) raptors, 5) likely nocturnal migrants, and 6) bats. The number of avian and bat fatalities attributable to operation of the facility based on the number of avian and bat fatalities found at the facility site whose death appears related to facility operation will be reported. All carcasses located within areas surveyed, regardless of species, will be recorded and, if possible, a cause of death determined based on a cursory field necropsy. Total number of avian and bat carcasses will be estimated by adjusting for removal and searcher efficiency bias. If the cause of death is not apparent, a worst-case estimate will be made by attributing the mortality to facility operation.

Definition of Variables

The following variables are used in the equations below:

c_i the number of carcasses detected at plot i for the study period of interest (e.g., 1

monitoring year) for which the cause of death is either unknown or is attributed to the facility

n the number of search plots

k the number of turbines searched (including the turbines centered within each search plot)

$\bar{c}$ the average number of carcasses observed per turbine per monitoring year

s the number of carcasses used in removal trials

s_c the number of carcasses in removal trials that remain in the study area after 30 days

se standard error (square of the sample variance of the mean)

t_i the time (in days) a carcass remains in the study area before it is removed, as determined by the removal trials

$\bar{t}$ the average time (in days) a carcass remains in the study area before it is removed, as determined by the removal trials

d the total number of carcasses placed in searcher efficiency trials

p the estimated proportion of detectable carcasses found by searchers, as determined by the searcher efficiency trials

I the average interval between standardized carcass searches, in days

A proportion of the search area of a turbine actually searched

$\hat{\pi}$ the estimated probability that a carcass is both available to be found during a search and is found, as determined by the removal trials and the searcher efficiency trials

m the estimated annual average number of fatalities per turbine per year, adjusted for removal and searcher efficiency bias

Observed Number of Carcasses

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

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

Estimation of Carcass Non-Removal Rates

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

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

Estimation of Searcher Efficiency Rates

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

Estimation of Facility-Related Fatality Rates

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

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

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

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

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

This formula has been independently verified by Shoenfeld (2004). The final reported estimates of *m* and associated standard errors and 90 percent confidence intervals will be calculated using bootstrapping (Manly 1997).

Bootstrapping is a computer simulation technique that is useful for calculating point estimates, variances, and confidence intervals for complicated test statistics. For each bootstrap sample, $\bar{c}$, $\bar{t}$, p, $\hat{\pi}$, and m are calculated. A total of 5,000 bootstrap samples will be used. The reported estimates are the mathematical means of the 5,000 bootstrap estimates. The standard deviation of the bootstrap estimates is the estimated standard error. The lower 5th and upper 95th percentiles of the 5,000 bootstrap estimates are estimates of the lower limit and upper limit of 90 percent confidence intervals.

QualityAssurance/Quality Control (QA/QC)

QA/QC measures will be implemented at all stages of the study, including field data collection, data entry, data analysis, and report preparation. At the end of each survey day, each observer will be responsible for inspecting his or her data forms for completeness, accuracy, and legibility. Periodically, the study team leader will review data forms to insure completeness and legibility; any problems detected will be corrected. Any changes made to the data forms will be initialed and dated by the person making the change. Data will be entered into a relational database (e.g., Microsoft ACCESS) and checked thoroughly for data entry errors. Any errors will be corrected by referencing the raw data forms and/or consulting with the observer(s) who collected the data. Any irregular codes detected, or any data suspected as questionable, will be discussed with the observer and study team leader. Any changes made to the raw data will be documented for future reference.

Wildlife Reporting and Handling System

WEST is familiar with and will continue to implement the PacifiCorp *Wildlife Incident Reporting and Handling System*. WEST will prepare a training manual for the WIRHS protocol and train all appropriate personnel in use of the WIRHS.

TECHNICAL ADVISORY COMMITTEE

The proposed monitoring plan is designed as a dynamic process that uses an accumulation of data to detect impacts and to direct further study. A technical advisory committee (TAC) will be formed to review the wildlife post-construction monitoring studies for the Project. The TAC membership may include the Wyoming Game and Fish Department (WGFD), U.S. Fish and Wildlife Service (USFWS), Industrial Siting/state government, landowners, local/county governments, Non-governmental organizations (NGOs), and PacifiCorp.

The TAC will act as an advisory group on the wildlife post-construction monitoring studies. The TAC will review the technical procedures of the monitoring studies, assess the scientific findings, and recommend various practices or measures, as necessary, to PacifiCorp. The TAC's responsibilities include the following:

- Reviewing and commenting on the post-construction (Operations Phase) avian and bat fatality monitoring study.
- Providing input to PacifiCorp on monitoring and mitigation, based on the post-construction monitoring results and final fatality estimates.

The TAC will use a collaborative process to reach understanding and consensus on reviews and recommendations. The TAC does not replace regulatory authority or responsibility of the various agencies or groups. WEST will assist PacifiCorp with planning and arrangements for meetings and with briefing and reporting to TAC members.

WEST will submit progress reports to the TAC every six months. In addition, an annual report of findings will be prepared at the end of the first year of monitoring and will be distributed to the members of the TAC at least 2 weeks prior to the annual meeting. The TAC will meet after the first monitoring report is submitted to discuss the results. The need for further study (beyond 2010) or changes to the current protocol will be based on reasonable criteria proposed by the TAC. A final report on study results will be submitted to the TAC as appropriate for review and subsequent discussion on mitigation recommendations.

Draft meeting minutes will be completed within 2 weeks of each meeting. Minutes will be forwarded to TAC members for review and comment. Minutes will be approved and finalized at the subsequent meeting. Depending on the group's preferences, meetings may be in person or by conference call. Monitoring findings (summarized per season or semi-annually) and other pertinent information (unusual findings or events) will be transmitted via hard copy, e-mail, or phone call, as necessary.

DISPOSITION OF DATA AND REPORTING STANDARDS

This monitoring study will provide information on fatalities and total mortality associated with development of the Project. The data will be used to evaluate the overall impacts of the Project on wildlife. The final disposition of data from the study will be with PacifiCorp, the Project owner, and will include the data forms and electronic data files. During the study, the raw data forms will be housed with the contractor conducting the study, and individual carcasses collected

during the study will be housed in a freezer. Individual carcasses will be maintained until after the final analysis and report are prepared in case questions about identity or cause of death should arise. The final disposition of individual casualties will be based on direction from the appropriate salvage permits (WGFD and USFWS), the legal status of individual casualties, and direction of the USFWS Law Enforcement Agent in Charge. It is anticipated that bird carcasses will be donated to a local museum or disposed of by burying except for raptors and any threatened or endangered species found. Bat carcass will also be donated to a local museum or disposed of by burying unless their condition is intact and fresh in which case they may be saved for future searcher efficiency and carcass removal trials.

Interim progress reports will be prepared every 6 months to provide an update about the Project and results to date. A first year annual report will include data pertaining to avian and bat fatalities discovered during the study, as well as other information relevant to monitoring the Projects. The USFWS will be notified (email and phone) within 24 hours if any eagles or federally threatened or endangered species are discovered. All reports will be distributed to TAC representatives for review and comment.

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Post-Construction Monitoring Studies – First Annual Report
Dunlap Wind Energy Facility
Carbon County, Wyoming

Draft Final Report
March 11, 2011 – February 10, 2012

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NATURAL RESOURCES ◆ SCIENTIFIC SOLUTIONS

EXECUTIVE SUMMARY

PacifiCorp Energy (PacifiCorp) owns and operates the Dunlap I Wind Energy Facility (DWEF). The facility has a capacity of 111 megawatts (MW) and is located in Carbon County, north of Medicine Bow, Wyoming. The 74 GE 1.5-MW turbines at the DWEF have a rotor diameter of 77 meters (m; 252 feet [ft]) and the wind turbines are situated on 80-m (262-ft) tall steel tubular towers secured to concrete foundations. Four meteorological (met) towers are also present within the DWEF.

In 2011, Western EcoSystems Technology, Inc. (WEST) began bird and bat monitoring at the DWEF. Monitoring included estimating the total number of bird and bat collision fatalities at wind turbines and met towers based on the number of fatalities found, adjusted for searcher efficiency, scavenger removal bias, and the proportion of the turbines searched. Raptor nest surveys at the DWEF were also completed in 2011.

The primary objective of the fatality monitoring was to estimate the level of bird and bat mortality attributable to collisions with wind turbines and met towers for the entire DWEF on an annual basis. The monitoring study began after the wind energy facility became fully operational and was conducted for one full year, from March 15, 2011, through February 10, 2012. Monitoring initiated on March 15, 2011, was intended to detect any casualties present at the site for the prior four-week period. Twenty-six of the 74 turbines were randomly selected for surveying and square plots were established around the 26 turbines. Four met towers were also searched, but two towers were later removed during the first study year as they were temporary structures. Search plots at turbines were 160 m (525 ft) on a side, while search plots at met towers were 120 m (394 ft) on a side. Standardized carcass surveys occurred at all 26 turbines and met towers once every four weeks throughout the year, with standardized surveys at half of these turbines (13 turbines) and all four met towers conducted once every week during the spring (March 16–May 15) and fall (August 1–October 31) migration periods.

A total of 648 combined turbine and met tower searches were conducted during the first monitoring year, and 20 birds were found during this period, including 18 found during standardized searches of the study plots and two found as incidental fatalities. Of the 20 bird fatalities found during the study, 13 were passerines, with the most common species being horned lark and McCown's longspur; three of the fatalities were raptors (including one prairie falcon, one golden eagle, and one bald eagle) and two were western grebes. Other avian fatalities included one vesper sparrow, two lark buntings, a rock wren, a rufous hummingbird, an unidentified warbler, and an unidentified duck. Seven of the 21 bird fatalities, including three McCown's longspurs and single individuals of western grebe, horned lark, vesper sparrow, and rock wren, were found at met towers while the other fatalities were all found at wind turbines. None of the bird fatalities found are federally listed species. Bald and golden eagles are protected under the Bald and Golden Eagle Protection Act and all of the other birds found are protected under the Migratory Bird Treaty Act.

Thirty-one bat fatalities were found during the first year of monitoring, including 30 found during standardized searches of the study plots and one found as an incidental fatality. Of the 31 bat fatalities, 22 were hoary bats, six were silver-haired bats, one was an unidentified mouse-eared bat, and two were too decomposed for positive identification. No bat fatalities involved federally listed species and all bat casualties were found at turbines.

During searcher efficiency trials, searchers detected 82.4% of the large birds, 55.6% of the small birds, and 45.5% of the bats. Based on scavenger trial data, the mean removal time was 16.7 days for large birds, 12.6 days for small birds, and 3.3 days for bats. Given the estimated searcher efficiency and scavenger removal rates, the average probability that a large bird would remain in a search plot and be found during a scheduled search was 76.0% for turbines searched weekly and anywhere from 40.0% to 42.0% for turbines searched every four weeks, depending on season. For small birds, these probabilities were 57.0% for turbines searched weekly and 23.0% – 24.0% for turbines searched every four weeks. For bats, these percentages were 20.0% for turbines searched weekly and 5.0% – 6.0% for turbines searched every four weeks.

The adjusted fatality estimate for small birds at wind turbines was 1.02 fatalities/turbine/year (0.68 fatalities/MW/year, which resulted in a total mortality estimate of approximately 75 small birds for the entire facility per year. The estimated small bird fatality rate at met towers was 2.63 fatalities/met tower/year, which is approximately 2.5 times higher than the small bird fatality rate at the project wind turbines. The adjusted fatality estimate for all large birds (raptors, waterbirds, waterfowl) at wind turbines was 0.28 fatalities/turbine/year (0.19 fatalities/MW/year), which resulted in a total mortality estimate of 21 large birds for the entire facility per year. The estimated large bird fatality rate at met towers was 0.56 fatalities/met tower/year, which is twice the fatality rate at the project wind turbines. The adjusted fatality estimate for raptors at wind turbines was 0.18 fatalities/turbine/year (0.12 fatalities/MW/year), which resulted in a total mortality estimate of 13 raptors for the entire facility. No raptor fatalities were found at met towers. The adjusted fatality estimate for all birds combined at wind turbines was 1.30 fatalities/turbine/year (0.87 fatalities/MW/year), which resulted in a total mortality estimate of 97 birds for all 74 turbines combined. When the total estimate of 97 bird fatalities at wind turbines was combined with the estimated 13 bird fatalities at met towers, the total estimate is roughly 110 bird fatalities per year for the entire facility. The total avian fatality rate at met towers (3.18 fatalities/met tower/year) was approximately 2.5 times higher than the avian fatality rate per turbine (1.30 fatalities/turbine/year).

The adjusted fatality estimate for bats at wind turbines was 8.87 fatalities/turbine/year (5.91 fatalities/MW/year), which resulted in a total mortality estimate of 656 bats for the entire facility per year. No bats were found at met towers and therefore it was assumed that no bat mortality occurred at met towers during the first study year.

The raptor fatality estimate at the DWEF (0.12 raptors/MW/year) was moderate compared to estimated raptor fatality rates at other regional wind energy facilities with comparable and publicly-available fatality data. Compared to 36 other studies at wind energy facilities in western

North America with publically-available raptor mortality data, the DWEF raptor fatality estimate ranked 11th highest. Based on raptor use data collected during the baseline study for the DWEF, the predicted raptor mortality rate was 0.06 fatalities/MW/year. The actual mortality rate during the first year was higher than the predicted rate, but was within the 90% prediction interval, which was 0 – 0.32 fatalities/MW/year. Overall bird fatality estimates are available for 39 comparable and publicly-available studies at wind energy facilities across western North America. Compared to these other studies at regional wind energy facilities, the estimated bird fatality rate at turbines within the DWEF (0.87 fatalities/MW/year) is relatively very low, ranking 35th of the 39 publicly-available studies with similar avian fatality data.

The estimated bat fatality rate at the DWEF of 5.91 bats/MW/year was relatively high compared to other regional wind energy facilities in western North America, ranking third of 38 western studies at facilities with publically-available bat fatality data. Compared to some wind energy facilities in other parts of the country, however, bat fatality rates at the DWEF are relatively low. For example, documented bat fatality rates have been 39.7 fatalities/MW/year at a facility in Tennessee, 31.69 fatalities/MW/year at a facility in West Virginia, and 30.61 fatalities/MW/year at a facility in Wisconsin. The bat fatality estimate for the DWEF was likely strongly influenced by relatively short scavenger removal times for bat carcasses, which lasted an average of 3.3 days before being removed, compared to 12.6 days for small birds. The mean scavenger removal time for bats was determined with 14 fresh bat carcasses found during the study, compared to 23 small and 27 large birds used to determine mean removal time for birds. The relatively small sample size for bats may have artificially inflated mean removal times and resulted in a higher estimate of the total bat fatality rate. Data collected during the additional two years of monitoring planned for the site will provide more information on bat fatality rates at the site. With the exception of one *Myotis* bat and excluding two badly decomposed bats that could not be identified, all of the other bat fatalities found at the DWEF were either hoary or silver-haired bats. This species composition is similar to that of other wind energy facilities across western North America where the majority of casualties are either hoary or silver-haired bats. Based on the timing of fatalities, and, again, similar to other wind energy facilities, it is likely that the majority of bat fatalities within the DWEF were fall migrants.

The objective of the raptor nest surveys was to determine the presence of active raptor nests in and near the DWEF study area to compare to preconstruction data on nesting raptors obtained during the 2009 baseline study. The entire DWEF, as well as a 2-mile (3.2-kilometers [km]) buffer around the study area, was searched for active and non-active raptor nests. The one active golden eagle nest within one mile (1.6 km) of the project area in 2009 was not active in 2011. Use of the project vicinity by other nesting raptors was lower in 2011 than it was in 2009. It is not known if the reduction in use of the project area by nesting raptors was due to natural variation, loss of nesting birds due to collision mortality, or displacement by wind energy facilities or human activity in the wind energy facility.

The objective of incidental wildlife observations was to provide a record of wildlife observed within the DWEF while conducting monitoring activities. Although no pre-construction data are available for most species at the DWEF, there is little information for many species on how they

are affected by wind energy development. Therefore, even post-construction observational data on wildlife use near wind turbines provides meaningful information. A total of 185 incidental observations, including nine bird species, were recorded. Six raptor species were observed incidentally, including 109 golden eagles, 39 ferruginous hawks, seven American kestrels, five prairie falcons, three bald eagles, and three northern harriers. Two mammal species also were recorded, including two observations of coyotes and one of badger. Due to comparatively large numbers and consistent sightings, incidental observations of pronghorn antelope were not documented for each sighting. Pronghorn antelope were observed throughout the DWEF during nearly every survey event.

To date, post-construction monitoring data are only available for one wind energy facility in Wyoming, the Foote Creek Rim project located in Carbon County. In addition, there are relatively very few comparable and publicly-available studies available from the surrounding states. Results of this monitoring will further contribute to the understanding of effects of wind energy developments on wildlife in Wyoming and the Rocky Mountain West. As more wind power projects are built in the region, and additional information becomes available, a clearer picture of the potential impacts will likely emerge.

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REPORT REFERENCE

Martinson, L. G.D. Johnson, M. Sonnenberg, and K. Bay. 2012. Post-Construction Monitoring Studies – First Annual Report: Dunlap Wind Energy Facility, Carbon County, Wyoming. Draft Final Report: March 11, 2011 – February 10, 2012. Prepared for PacifiCorp Energy, Salt Lake City, Utah. Prepared by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming.

INTRODUCTION

PacifiCorp Energy (PacifiCorp) owns and operates the Dunlap Wind Energy Facility (DWEF) (Phase I). The facility has a capacity of 111 megawatts (MW) from 74 turbines and is located in Carbon County, north of Medicine Bow, Wyoming. During the early stages of facility development, the Wyoming Game and Fish Department (WGFD) and the US Fish and Wildlife Service (USFWS) expressed an interest in ensuring that potential post-construction impacts to wildlife be monitored. PacifiCorp Energy contracted Western EcoSystems Technology, Inc. (WEST) to develop a 3-year post-construction monitoring study at the DWEF to assess the level of impacts from operation of the wind energy facility to wildlife.

A Technical Advisory Committee (TAC), composed of PacifiCorp, the WGFD, and the USFWS, was created to review the monitoring protocol, assess the study results, and prepare recommendations for PacifiCorp at the completion of the first year of monitoring. This report provides the results of that first year monitoring, which covered the period March 11, 2011, through February 10, 2012.

The purpose of the avian and bat fatality monitoring was to estimate the annual number of avian and bat fatalities attributable to wind turbine and meteorological (met tower) collisions from operations throughout the first year of operation at the DWEF. The monitoring study conforms to industry standards in the western United States.

The monitoring study for the DWEF consists of the following components:

1) Standardized carcass surveys of selected turbines and met towers within a square plot centered on the turbine or met tower;
2) Searcher efficiency trials to estimate the percentage of carcasses found by searchers;
3) Carcass removal trials to estimate the length of time that a carcass remained in the field for possible detection; and
4) Adjusted fatality estimates based on the results of searcher efficiency trials and carcass removal trials.

Additional studies at the DWEF included raptor nest surveys, which were completed in 2011. Incidental wildlife observations are also reported in this document.

STUDY AREA

Dunlap (Phase I) is located approximately 10 miles (16.1 kilometers [km]) north of the town of Medicine Bow, Wyoming. Topography of the DWEF is primarily flat, with minimal topographic relief (Figure 1). Elevations range from approximately 6,750 to 7,200 feet (ft; 2,057 to 2,195 meters [m]). The land cover onsite is a mix of grasslands and sagebrush (*Artemisia* spp.) communities. The site encompasses approximately 10,340 acres (16.16 square miles [mi^2]) of land.

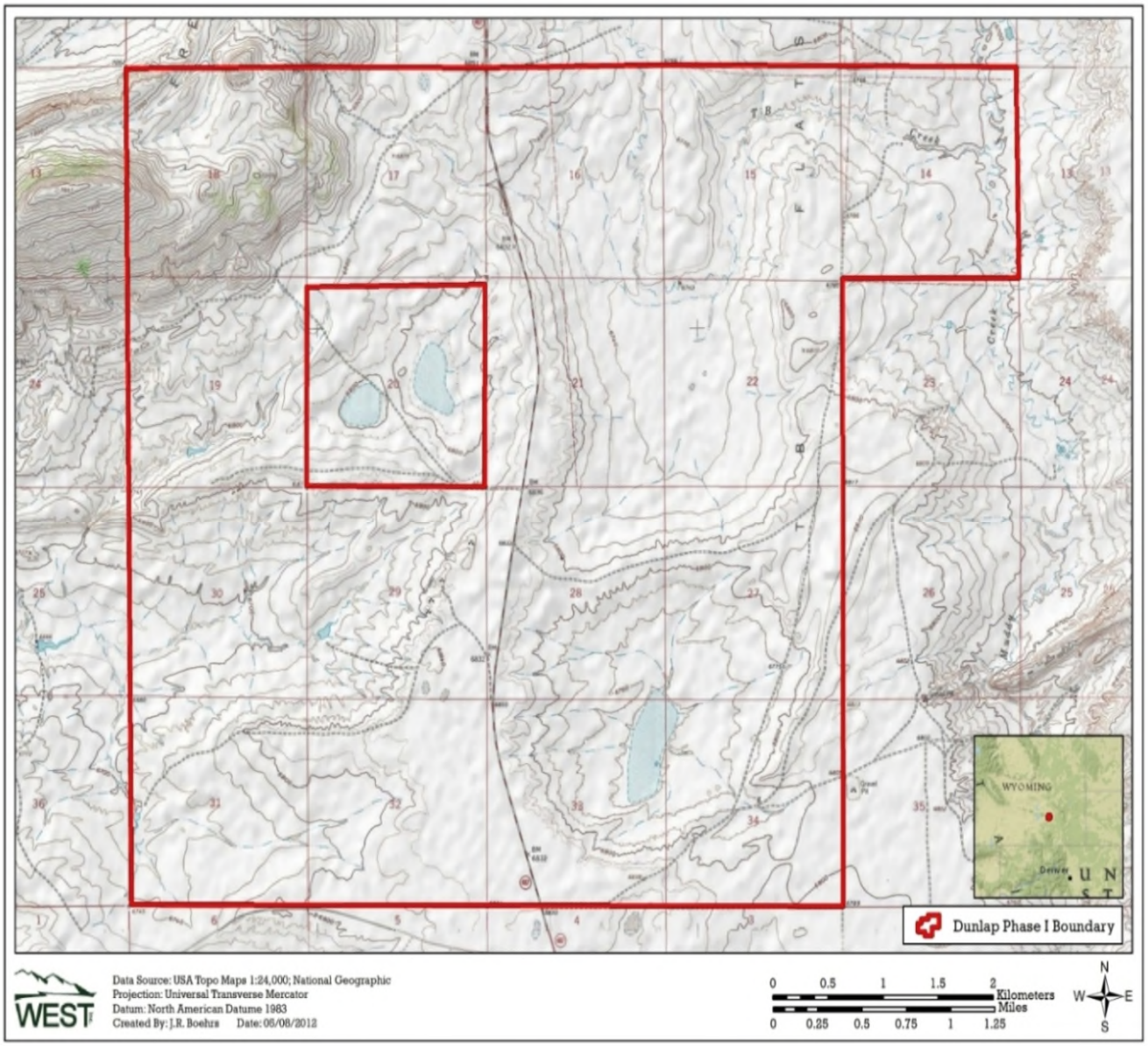

Figure 1. Location of the Dunlap Wind Energy Facility.

The DWEF has 74 GE 1.5-MW turbines with a rotor diameter of 77 m (252 ft). The turbines are situated on 80-m (262-ft) tall steel tubular towers secured to concrete foundations. Four met towers are also present within the DWEF (Figure 2).

METHODS

Casualty Surveys

The primary objective of the monitoring was to estimate the level of bird and bat mortality attributable to collisions with wind turbines and met towers for the entire DWEF on an annual basis. The monitoring study began after the wind energy facility became fully operational and was conducted for one full year (March 11, 2011, through March 10, 2012). Monitoring beyond the first year is currently ongoing.

The methods for the fatality study were broken into four primary components: 1) standardized carcass surveys of selected turbines and met towers; 2) searcher efficiency trials to estimate the percentage of carcasses found by searchers; 3) carcass removal trials to estimate the length of time that a carcass remained in the field for possible detection; and 4) adjusted fatality estimates for bird and bat species, calculated using the results from searcher efficiency trials and carcass removal trials to estimate the total number of bird and bat fatalities within the DWEF.

There were three scenarios under which casualties were found in the DWEF: 1) during the standardized surveys for the study; 2) while observers were onsite, but not conducting a standardized search (i.e., an incidental find); and 3) by facility personnel or others onsite for other purposes, such as turbine maintenance. Casualties found by study observers, regardless of timing (i.e., during a standardized survey or not), were recorded by the methods described below. All casualties found within a search plot, even if outside of the standard survey period, were included in the dataset under the broad assumption that these casualties would have been found during standardized surveys. Casualties found by DWEF site personnel were collected and recorded following PacifiCorp's procedures.

All bird and bat casualties located within the search areas, regardless of species, were recorded and a cause of death determined, if possible, based on field inspection of the carcass. The total number of bird and bat carcasses was estimated by adjusting for search frequency, removal bias (length of stay in the field), searcher efficiency bias (percent of carcasses found) and proportion of the turbines sampled. For carcasses where the cause of death was not apparent, the assumption that the fatality was a wind turbine or met tower collision casualty was made for the analysis. While this approach likely leads to an overestimate of the true number of facility-related fatalities, most studies of wind energy facilities have used this conservative approach because of the relative high costs associated with obtaining accurate estimates of natural or reference mortality (see Johnson et al. 2000a).

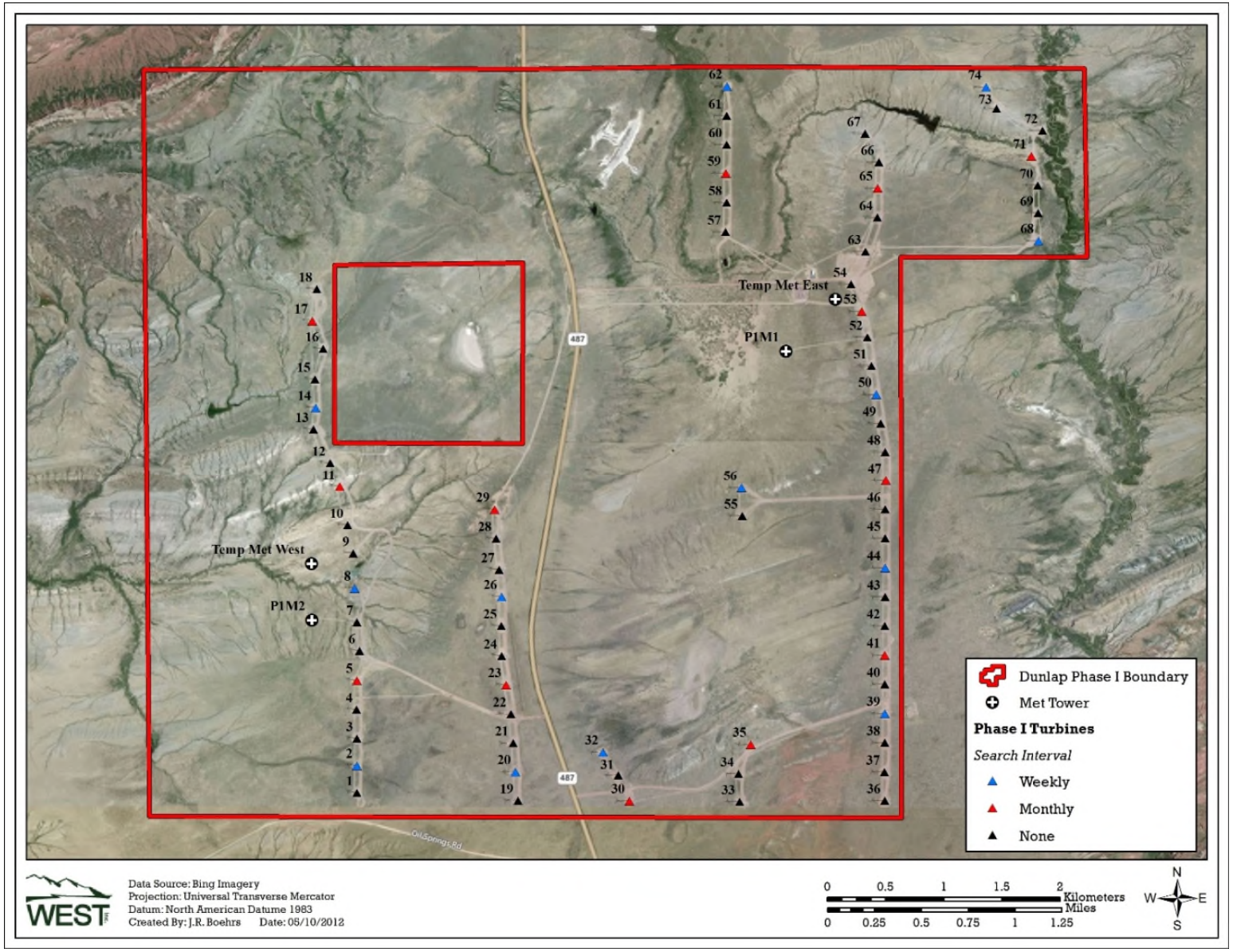

Figure 2. Location of carcass search plots at the Dunlap Wind Energy Facility.

Field Methods

Twenty-six of the 74 turbines were selected for surveying using a systematic design with a random start (Figure 2). Square plots were established around the 26 turbines and all four met towers and systematically searched for carcasses. Search plots at turbines were 160 m (525 ft) on a side and centered on the turbine (with each side at 80 m from the turbine), while search plots at met towers were 120 m (394 ft) on a side and centered on the met tower (with each side at 60 m [197 ft] from the tower). Studies at other facilities with large turbines, such as the Klondike wind energy facility in Oregon (Johnson et al. 2003b), the Combine Hills facility, also in Oregon (Young et al. 2005b), and the Crescent Ridge facility in Illinois (Kerlinger et al. 2007), indicate most of the fatalities are found within the area that is roughly equivalent to the height of the turbine tower.

Standardized carcass surveys occurred at all 26 turbines and met towers once every 4-week (28-day) period throughout the year, with standardized surveys at half of these turbines (13 turbines) and all four met towers conducted once every week (seven days) during the spring (March 16–May 15) and fall (August 1–October 31) migration periods. The four met towers consisted of two permanent and two temporary towers. The two temporary met towers were disassembled at the end of October 2011 and therefore met tower searches were limited to the two permanent towers after that date.

Standardized Carcass Surveys

The objective of the standardized carcasses surveys was to systematically search wind turbines and met towers for bird and bat casualties that were attributable to collision with project facilities. Study personnel were trained in proper search techniques prior to conducting the carcass surveys. An observer walked at a rate of approximately 45 to 60 m/minute (148 to 197 ft/min) along each transect. Transects were spaced 6.0 to 10.0 m (19.7 to 32.8 ft) apart, and observers scanned the areas on both sides to approximately 3.0 to 5.0 m (9.8 to 16.4 ft) for casualties as they walked each transect. To facilitate conducting the searches, a global positioning system (GPS) coordinate was obtained for each turbine or met tower being searched, and a shape file was created to show the boundary of the 160 x 160-m turbine plot or 120 x 120-m met tower plot. To help maintain appropriate transect spacing, the observer used a GPS unit with the downloaded shape files while searching each plot so that the observer could see exactly where they were within the plot. The “tracks” option (feature showing intact route alignment) of the GPS unit was also used to help searchers ensure the entire plot was searched appropriately.

The condition of each carcass found was recorded using the following categories:

- Intact - a carcass that was completely intact, was not badly decomposed, and showed no signs of being fed upon by a predator or scavenger.
- Scavenged - an entire carcass, which showed signs of being fed upon by a predator or scavenger, or a portion(s) of a carcass in one location (e.g., wings, skeletal remains, portion of a carcass, etc.), or a carcass that was heavily infested by insects.

- Feather Spot - 10 or more feathers or two or more primaries at one location, indicating a bird fatality had been there.

All casualties were photographed as found. All carcasses were then labeled with a unique number, bagged, and frozen for future reference and possible necropsy. A copy of the data sheet for each carcass was maintained with the bagged and frozen carcass at all times (i.e., freezer log). For all casualties found, data recorded included species, sex and age (when possible), date and time collected, GPS location, condition (intact, scavenged, feather spot), and any comments that indicated possible cause of death.

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

Searcher Efficiency Trials

The objective of the searcher efficiency trials was to estimate the percentage of casualties found by observers. Searcher efficiency trials were conducted throughout the year. Searcher efficiency trials were conducted in the same areas as standardized carcass surveys and searcher efficiency was estimated by the type of carcass (bird or bat), size of carcass (birds only), and season. Estimates of searcher efficiency were used to adjust the total number of carcasses found for those missed by observers, correcting for detection bias.

Observers conducting carcass surveys did not know when searcher efficiency trials were being conducted or the location of the trial carcasses. A total of 72 carcasses (38 large birds, 23 small birds and 11 bats) were placed on nine separate dates. Carcasses used for searcher efficiency trials were non-native/non-protected or commercially available species, including adult *Coturnix* quail and adult female mallards (*Anas platyrhynchos*), and bat carcasses found during previous search events. Trial carcasses were placed within study plots using a randomly generated distance and direction from the turbine.

All searcher efficiency trial carcasses were placed within the search area prior to that day's scheduled standardized carcass survey. Each trial carcass was discreetly marked (e.g., dark tape or thread placed on the leg of the trial carcass) so that it could be identified as a study carcass after it was found.

The number and location of the searcher efficiency trial carcasses found during the carcass surveys were recorded. The number of carcasses available for detection during each trial was determined immediately after the trial by the person responsible for distributing the trial carcasses.

Carcass Removal Trials

The objective of carcass removal trials was to estimate the average length of time a carcass remained in the study area and was potentially detectable. Carcass removal included removal by predation or scavenging. Removal trial carcasses were not placed in the standardized search plots in order to minimize the chance of confusing a trial bird or bat with a turbine casualty. Turbines not included in the standardized carcass surveys were randomly selected for inclusion in the removal trials. Trial carcasses were randomly placed at selected turbines within a plot of similar size to the actual search plots. Estimates of carcass removal were used to adjust the total number of carcasses found for those removed from the study area, correcting for removal bias.

Carcass removal trials were spread throughout the year to incorporate the effects of varying weather, climatic conditions, and scavenger densities. A total of 27 large birds, 23 small birds, and 14 bat carcasses were placed in the DWEF across eight dates throughout the duration of the monitoring period. Carcass composition was similar to that used for searcher efficiency trials.

Observers conducting carcass searches monitored the trial birds and bats over a 40-day period, checking the condition and presence of the carcasses every day for the first four days of the trial, and then on day 7, 10, 14, 20, 30, and 40. This schedule varied somewhat depending on weather and coordination with the other survey work. Removal trial carcasses were marked discreetly (e.g., tape or ribbon around leg) for recognition by observers and other personnel, and left at the location until the end of the carcass removal trial. At the end of the 40-day period, any remaining evidence of the carcass was removed.

Statistical Analysis

Quality Assurance and Quality Control

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

Data Compilation and Storage

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

Fatality Estimates

Estimates of facility-related fatalities were based on:

1. Observed number of carcasses found during standardized searches during the monitoring period, for which the cause of death was either unknown or was probably facility-related;
2. Non-removal rates, expressed as the estimated average probability a carcass was expected to remain in the study area and was available for detection by the searchers during removal trials; and
3. Searcher efficiency, expressed as the proportion of trial carcasses found by searchers during searcher efficiency trials.

The number of bird and bat fatalities attributable to operation of the wind energy facility, based on the number of bird and bat fatalities found at the facility whose death appeared related to facility operation, was reported. All carcasses located within areas surveyed, regardless of species, were recorded and, if possible, a cause of death was determined based on a cursory field necropsy. The total number of bird and bat fatalities was estimated by adjusting the number of carcasses found for removal and searcher efficiency bias. Fatality estimates were provided for five categories: 1) all birds, 2) small birds, 3) large birds, 4) raptors, and 5) bats. Only bird or bat fatalities found within the 26 turbine plots selected for fatality searches were used to estimate bird and bat fatality rates, including fatalities found incidentally at these plots outside of the scheduled surveys; incidental fatalities found at other turbine plots were recorded but were not used in the estimates.

Definition of Variables

The following variables are used in the equations below:

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

n the number of search plots

k the number of turbines searched (including the turbines centered within each search plot)

$\bar{c}$ the average number of carcasses observed per turbine per monitoring year

s the number of carcasses used in removal trials

s_c the number of carcasses in removal trials that remained in the study area after 30 days

se standard error (square of the sample variance of the mean)

t_i the time (in days) a carcass remained in the study area before it was removed, as determined by the removal trials

$\bar{t}$ the average time (in days) a carcass remained in the study area before it was removed, as determined by the removal trials

d the total number of carcasses placed in searcher efficiency trials

p the estimated proportion of detectable carcasses found by searchers, as determined by the searcher efficiency trials

I the average interval between standardized carcass searches, in days

A proportion of the search area of a turbine actually searched

$\hat{\pi}$ the estimated probability that a carcass was both available to be found during a search and was found, as determined by the removal trials and the searcher efficiency trials

m the estimated annual average number of fatalities per turbine per year, adjusted for removal and searcher efficiency bias

Observed Number of Carcasses

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

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

Estimation of Carcass Non-Removal Rates

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

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

Estimation of Searcher Efficiency Rates

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

Estimation of Facility-Related Fatality Rates

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

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

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

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

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

This formula has been independently verified by Shoenfeld (2004). The final reported estimates of *m* and associated standard errors and 90% confidence intervals are calculated using bootstrapping (Manly 1997). Bootstrapping is a computer simulation technique that is useful for calculating point estimates, variances, and confidence intervals for complicated test statistics.

For each bootstrap sample, $\bar{c}$, $\bar{t}$, p, $\hat{\pi}$, and *m* were calculated. A total of 5,000 bootstrap samples were used. The reported estimates are the mathematical means of the 5,000 bootstrap estimates. The standard deviation of the bootstrap estimates is the estimated standard error. The lower 5th and upper 95th percentiles of the 5,000 bootstrap estimates are estimates of the lower limit and upper limit of 90 % confidence intervals.

Raptor Nest Surveys

The entire DWEF, as well as a 2-mile (3.2-km) buffer around the study area, was searched for active and non-active raptor nests. The objective of the raptor nest surveys was to determine the presence of active raptor nests in and near the study area to compare to preconstruction data on nesting raptors obtained during the 2009 baseline study (Johnson et al. 2009). The entire study area and the 2-mile buffer were systematically searched by foot and by vehicle for active and non-active raptor nests. Trees, cliffs, rock outcrops, and other potential nest structures, such as wind mills and utility poles, were searched. Universal Transverse Mercator (UTM) coordinates, as well as nesting substrate and current status (inactive, active, incubating, young in nest) were recorded for each nest located. All nests identified during previous studies in 2009 were revisited in 2011. However, the 2009 survey only encompassed an area within a 1-mile (1.6-km) buffer of the proposed facility, while the 2011 survey encompassed an area within a 2-mile buffer. Raptor nest surveys were conducted during the week of July 4, 2011.

Incidental Wildlife Observations

The objective of incidental wildlife observations was to provide a record of wildlife observed within the DWEF while conducting monitoring activities. Although no pre-construction data are available for most species at the DWEF, there is little information for many species on how they were affected by wind energy development (Gamo 2010). Therefore, even post-construction observational data on wildlife use near wind turbines provide meaningful information. All raptors, unusual or unique birds, sensitive species, mammals, reptiles, and amphibians were recorded.

Data recorded included date, time, species, number of individuals, sex/age class, distance from observer, activity, height above ground (for bird species), and habitat. The location of sensitive species was recorded using GPS coordinates.

RESULTS

Standardized Carcass Surveys

Birds

Twenty-six wind turbines and two to four met towers were searched at the DWEF during the period March 11, 2011, to February 10, 2012, for a total of 541 turbine and 107 met tower searches combined.

Twenty bird fatalities were found during this period (Table 1), including 18 found during standardized searches of the study plots and two found as incidental fatalities (Table 1, Appendix A). Of the 20 bird fatalities found during the study, 13 were passerines, with the most common species being horned lark (*Eremophila alpestris*; five carcasses) and McCown's longspur (*Rhynchophanes mccownii*; three). Three fatalities were raptors, including one prairie falcon (*Falco mexicanus*), one golden eagle (*Aquila chrysaetos*), and one bald eagle (*Haliaeetus leucocephalus*). Two fatalities were western grebes (*Aechmophorus occidentalis*). The other avian fatalities included one vesper sparrow (*Pooecetes gramineus*), two lark buntings (*Calamospiza melanocorys*), a rock wren (*Salpinctes obsoletus*) a rufous hummingbird (*Selasphorus rufus*), an unidentified warbler, and an unidentified duck. Seven of the 20 bird fatalities, including all three McCown's longspurs and single individuals of western grebe, horned lark, vesper sparrow, and rock wren, were found at met towers while the other fatalities were all found at wind turbines. No fatalities were found incidentally on search plots, while a western grebe and the golden eagle were found incidentally at other turbine plots.

Table 1. Total number of bird and bat casualties and the composition of casualties discovered at the Dunlap Wind Energy Facility from March 31, 2011 – February 10, 2012.

	Fatalities during Scheduled Searches		Incidental Fatalities at Search Plots*		Other Incidentals		Total	
Species	**Total**	**% Comp.**	**Total**	**% Comp.**	**Total**	**% Comp.**	**Total**	**% Comp.**
Birds								
horned lark	5	27.78	0	0	0	0	5	25.0
McCown's longspur	3	16.67	0	0	0	0	3	15.0
lark bunting	2	11.11	0	0	0	0	2	10.0
bald eagle	1	5.56	0	0	0	0	1	5.0
prairie falcon	1	5.56	0	0	0	0	1	5.0
rock wren	1	5.56	0	0	0	0	1	5.0
rufous hummingbird	1	5.56	0	0	0	0	1	5.0
unidentified warbler	1	5.56	0	0	0	0	1	5.0
unidentified waterfowl	1	5.56	0	0	0	0	1	5.0
vesper sparrow	1	5.56	0	0	0	0	1	5.0
western grebe	1	5.56	0	0	1	50.0	2	10.0
golden eagle	0	0	0	0	1	50.0	1	5.0
Overall Birds	**18**	**100**	**0**	**0**	**2**	**100**	**20**	**100**
Bats								
hoary bat	22	73.33	0	0	0	0	22	70.97
silver-haired bat	6	20.00	0	0	0	0	6	19.35
unidentified bat	1	3.33	0	0	1	100	2	6.45
unidentified myotis	1	3.33	0	0	0	0	1	3.23
Overall Bats	**30**	**100**	**0**	**0**	**1**	**100**	**31**	**100**

*Fatalities found incidentally on turbine search plots were included in analyses.

None of the bird fatalities found were federally-listed species. Bald and golden eagles are protected under the Bald and Golden Eagle Protection Act (BGEPA 1940) and all of the other bird species found as fatalities are protected under the Migratory Bird Treaty Act (MBTA 1918). For the two eagle fatalities, the USFWS was notified within 24 hours of their discovery. The eagle carcasses were covered with a tarp and left as found in the field until collected by USFWS representatives, or until personnel were given other directives by the agency.

Of the turbines searched during fatality surveys, one turbine had three bird fatalities, one turbine had two fatalities, six turbines had one fatality, and the remaining 18 turbines did not have any avian fatalities (Figures 3 and 4). No turbine had more than one raptor found during standard searches. Three of the met towers each had two fatalities while one met tower had one fatality (Figures 3 and 4).

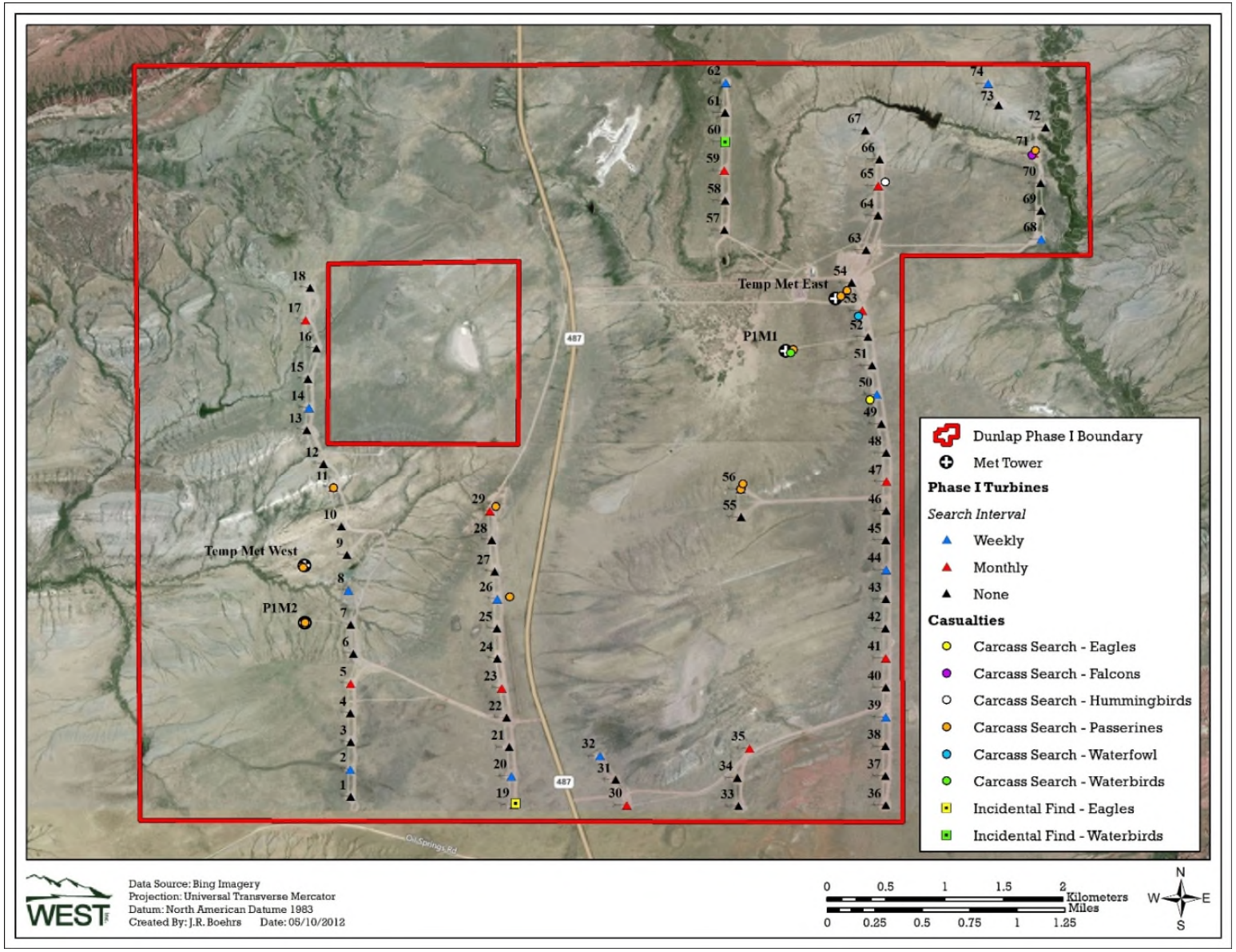

Figure 3. Location of bird casualties found at the Dunlap Wind Energy Facility.

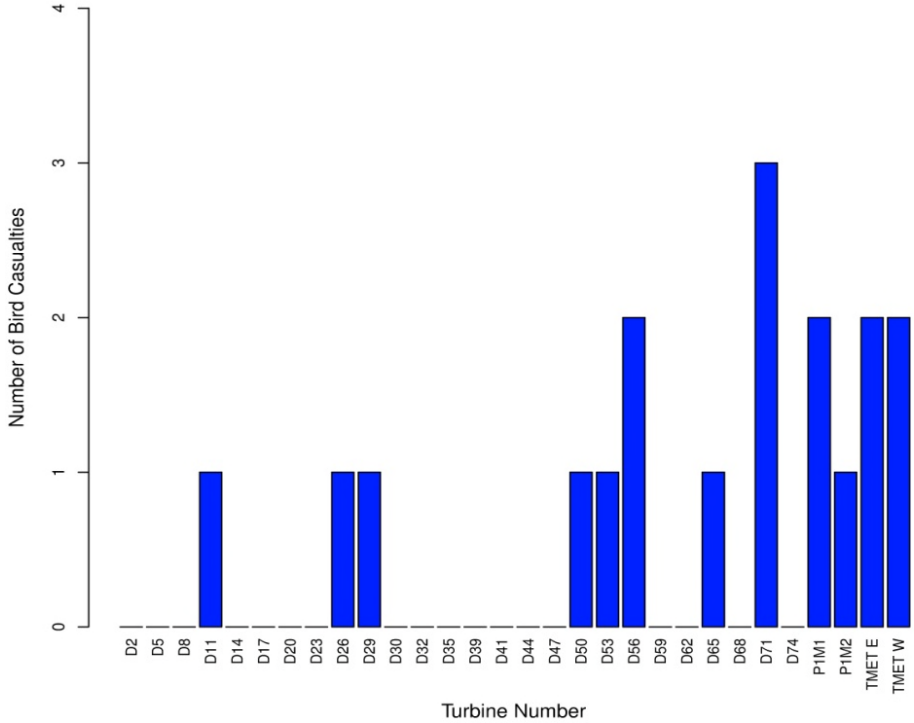

Figure 4. Number of bird fatalities by turbine and meteorological (met) tower at the Dunlap Wind Energy Facility.

Most (53.9%) bird fatalities were found <30 m (98 ft) from the nearest turbine, 23.1% were found between 30 and 60 m (98 to 197 ft) from the nearest turbine, and 23.1% were found >60 m from the nearest turbine (Table 2; Figure 5). Most of the bird fatalities (42.9%) found at met towers were located from 20 to 30 m (66 to 98 ft) away from the tower (Table 3; Figure 6). Bird fatalities at turbines were detected during the period March through September, with the highest fatality rate occurring in late June (Figure 7). Bird fatalities at met towers occurred from June through September, with a peak fatality rate in early August (Figure 8).

Table 2. Distribution of distances of bird and bat casualties from turbines at the Dunlap Wind Energy Facility.

Distance to Turbine (m)	% Bird Casualties	% Bat Casualties
0 to 10	23.1	16.1
10 to 20	15.4	19.4
20 to 30	15.4	19.4
30 to 40	7.7	22.6
40 to 50	0	12.9
50 to 60	15.4	0
60 to 70	7.7	6.5
70 to 80	7.7	3.2
>80	7.7	0

Table 3. Distribution of distances of bird and bat casualties from meteorological (met) towers at the Dunlap Wind Energy Facility.

Distance to Turbine (m)	% Bird Casualties	% Bat Casualties
0 to 10	14.3	0
10 to 20	0	0
20 to 30	42.9	0
30 to 40	0	0
40 to 50	14.3	0
50 to 60	14.3	0
60 to 70	0	0
70 to 80	0	0
>80	14.3	0

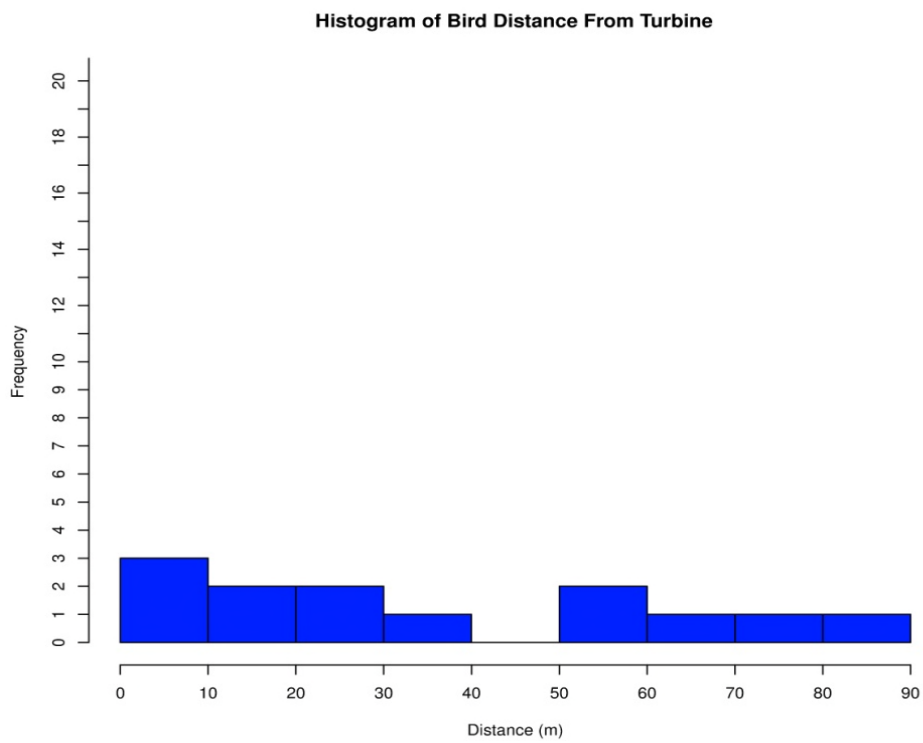

Figure 5. Distance of bird fatalities from the turbines at the Dunlap Wind Energy Facility.

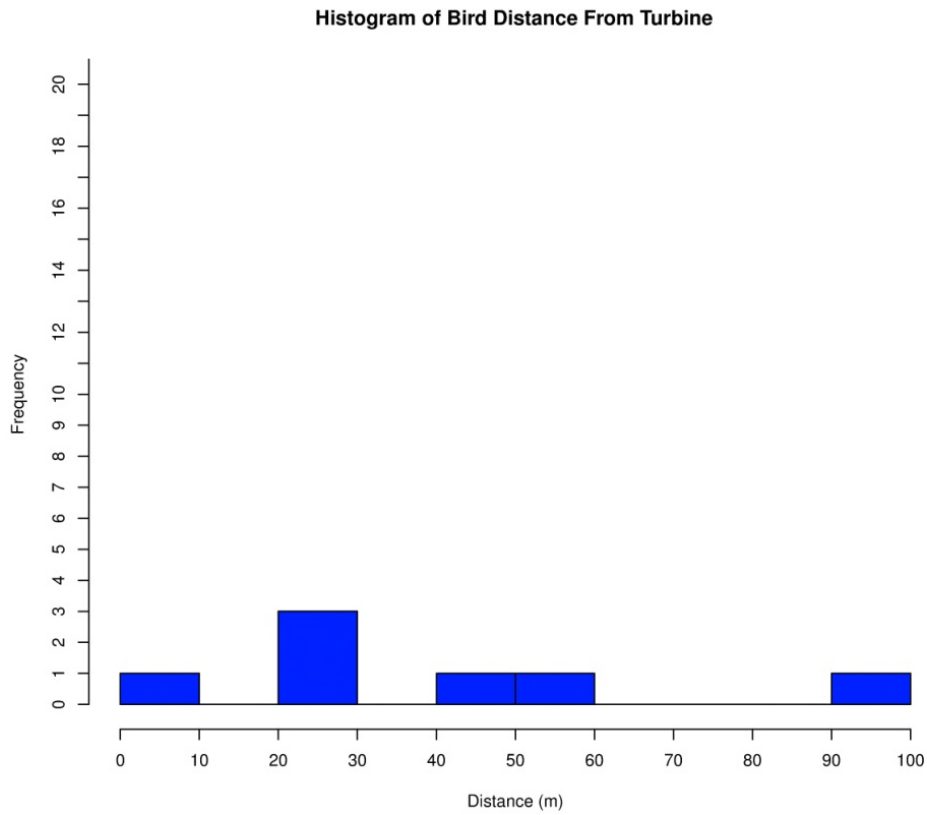

Figure 6. Distance of bird fatalities from the meteorological (met) towers at the Dunlap Wind Energy Facility.

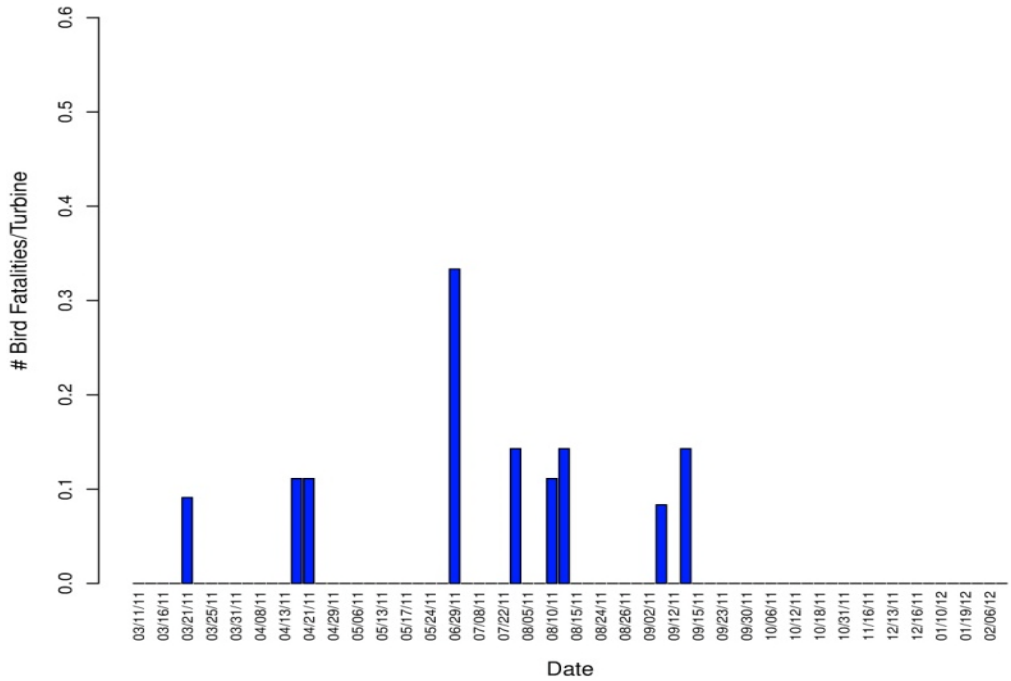

Figure 7. Timing of bird fatalities at the turbines for the Dunlap Wind Energy Facility.

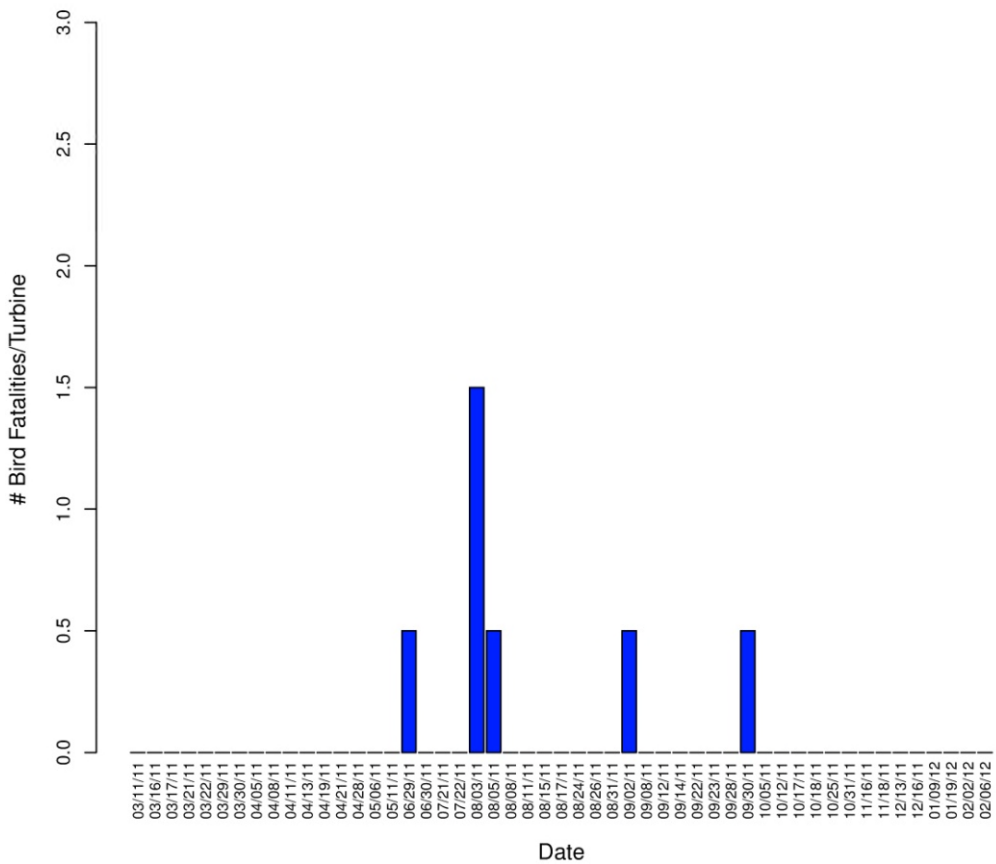

Figure 8. Timing of bird fatalities at the meteorological (met) towers for the Dunlap Wind Energy Facility.

Bats

Thirty-one bat fatalities were found during the first year of monitoring (Table 1), including 30 found during standardized searches of the study plots and one found as an incidental fatality (Table 1, Appendix A). Of the 31 bat fatalities, 22 fatalities were of were hoary bats (*Lasiurus cinereus*), six were silver-haired bats (*Lasionycteris noctivagans*), one was an unidentified mouse-eared bat (*Myotis* spp.), and two bats were too decomposed for positive identification (Appendix A). None of the bat fatalities involved federally-listed species. All bat casualties were found at turbines.

Two turbines each had six bat fatalities, one turbine had four fatalities, three turbines had two fatalities, eight turbines had one bat fatality, and the remaining 12 turbines did not have any bat fatalities (Figures 9 and 10). Most (90.3%) bat fatalities were found <50 m (164 ft) from the nearest turbine, while 9.7% were found between 60 and 80 m (197 to 262 ft) from the nearest turbine (Table 2; Figure 11). Four of the bat fatalities occurred during the period June 15 – July 21, while the remaining 27 fatalities occurred in the months of August and September (Figure 12; Appendix A).

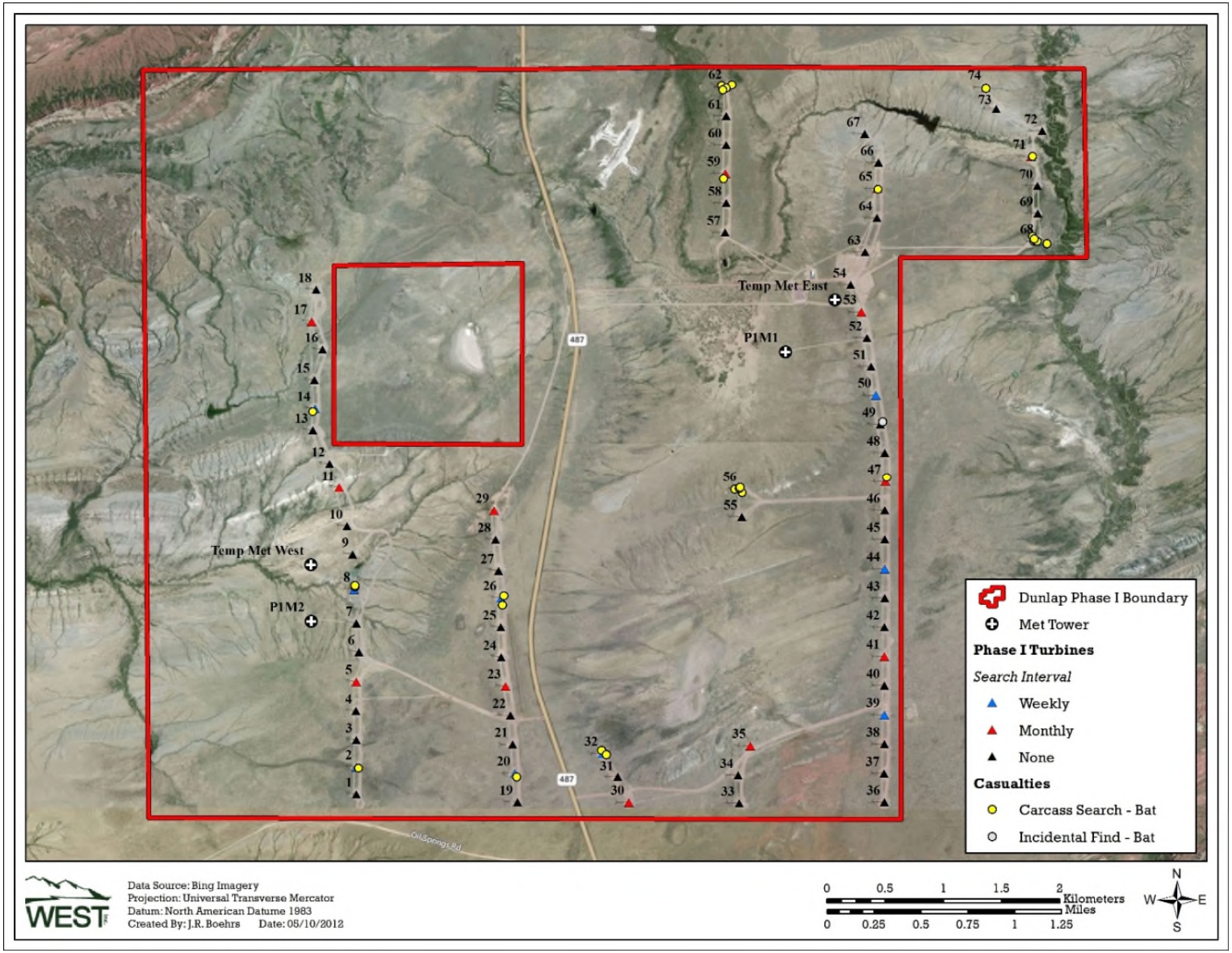

Figure 9. Location of bat casualties found at the Dunlap Wind Energy Facility.

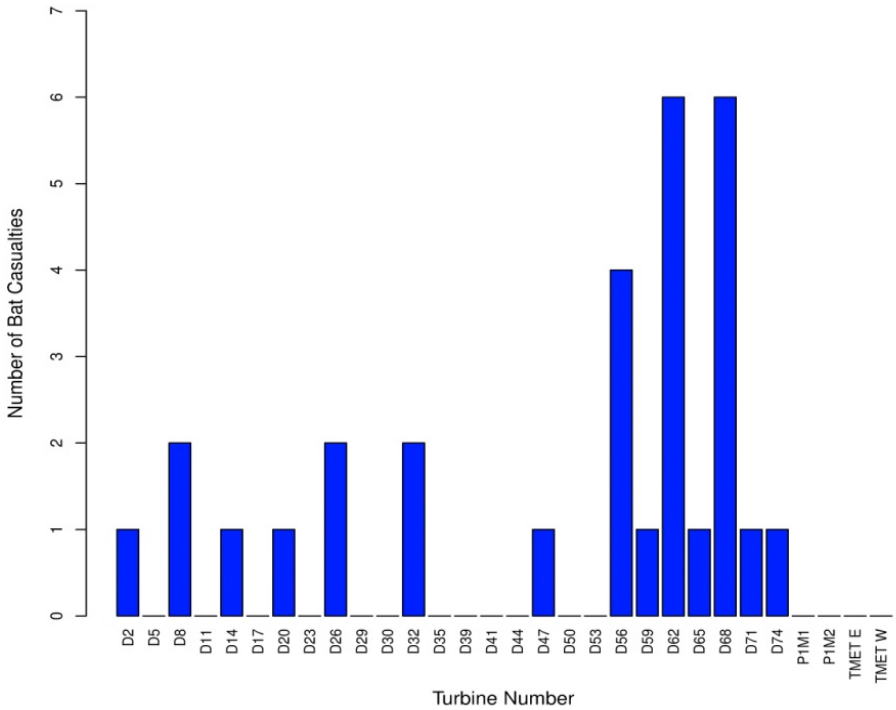

Figure 10. Number of bat fatalities by turbine and meteorological (met) tower at the Dunlap Wind Energy Facility.

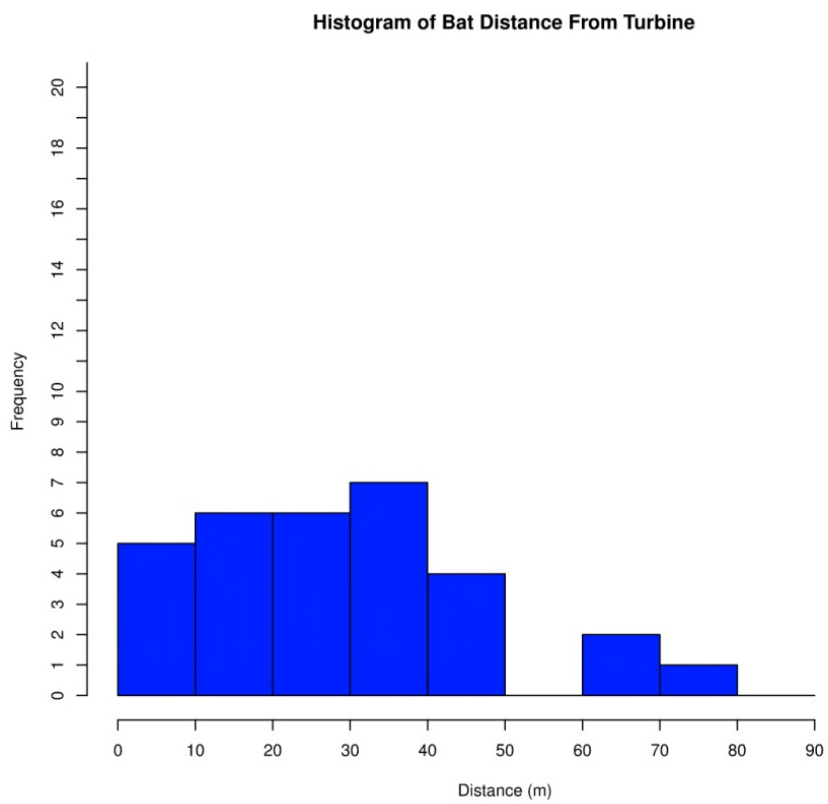

Figure 11. Distance of bat fatalities from the turbines at the Dunlap Wind Energy Facility.

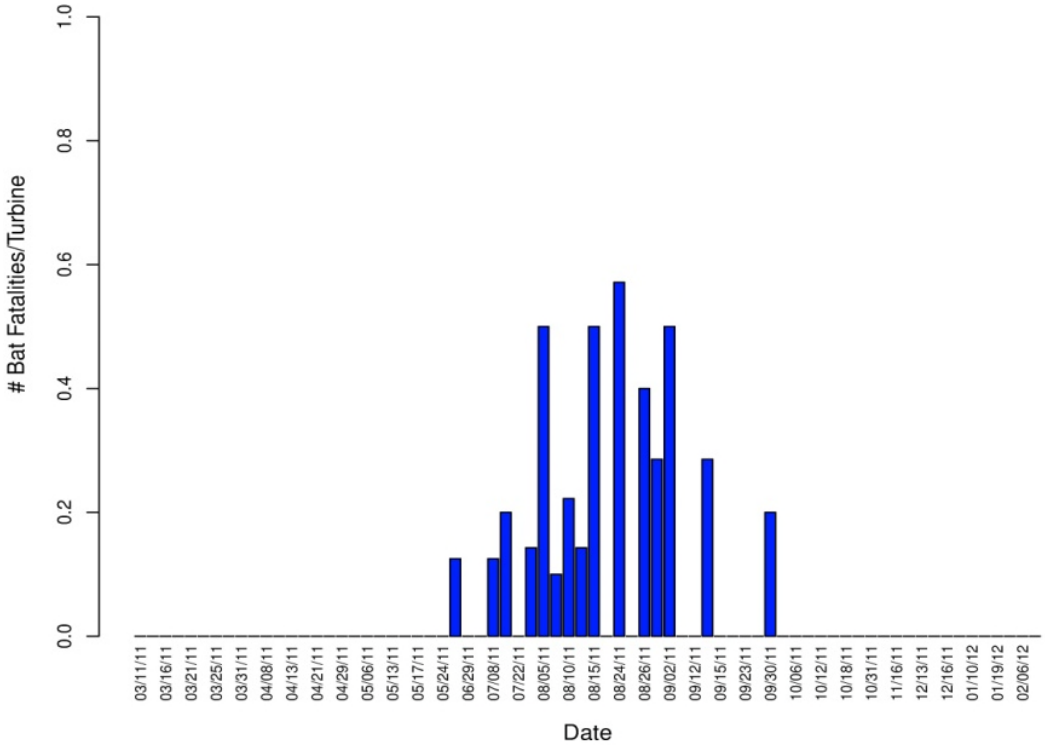

Figure 12. Timing of bat fatalities at the turbines for the Dunlap Wind Energy Facility.

Bias Trials

During searcher efficiency trials, searchers detected 82.4% of the large birds, 55.6% of the small birds, and 45.5% of the bats (Table 4). Based on scavenger trial data, the mean removal time was 16.7 days for large birds, 12.6 days for small birds, and 3.3 days for bats (Figure 13).

Table 4. Searcher efficiency results at the Dunlap Wind Energy Facility as a function of season and carcass size.

Size	Date	# Placed	# Available	# Found	% Found
Small Birds	4/28/2011	5	4	4	100
	5/24/2011	4	4	1	25.0
	10/19/2011	2	1	1	100
	12/14/2011	4	4	2	50.0
	1/10/2012	4	4	1	25.0
	2/10/2012	1	1	1	100
Small Bird Total		**20**	**18**	**10**	**55.6**
Large Birds	3/21/2011	7	7	5	71.4
	4/28/2011	4	4	3	75.0
	5/24/2011	4	4	3	75.0
	10/19/2011	3	3	2	66.7
	12/14/2011	4	4	3	75.0
	1/10/2012	5	5	5	100
	2/10/2012	7	7	7	100
Large Bird Total		**34**	**34**	**28**	**82.4**

Table 4. Searcher efficiency results at the Dunlap Wind Energy Facility as a function of season and carcass size.

Size	Date	# Placed	# Available	# Found	% Found
Bats	9/2/2011	8	8	3	37.5
	10/19/2011	3	3	2	66.7
Bat Total		**11**	**11**	**5**	**45.5**

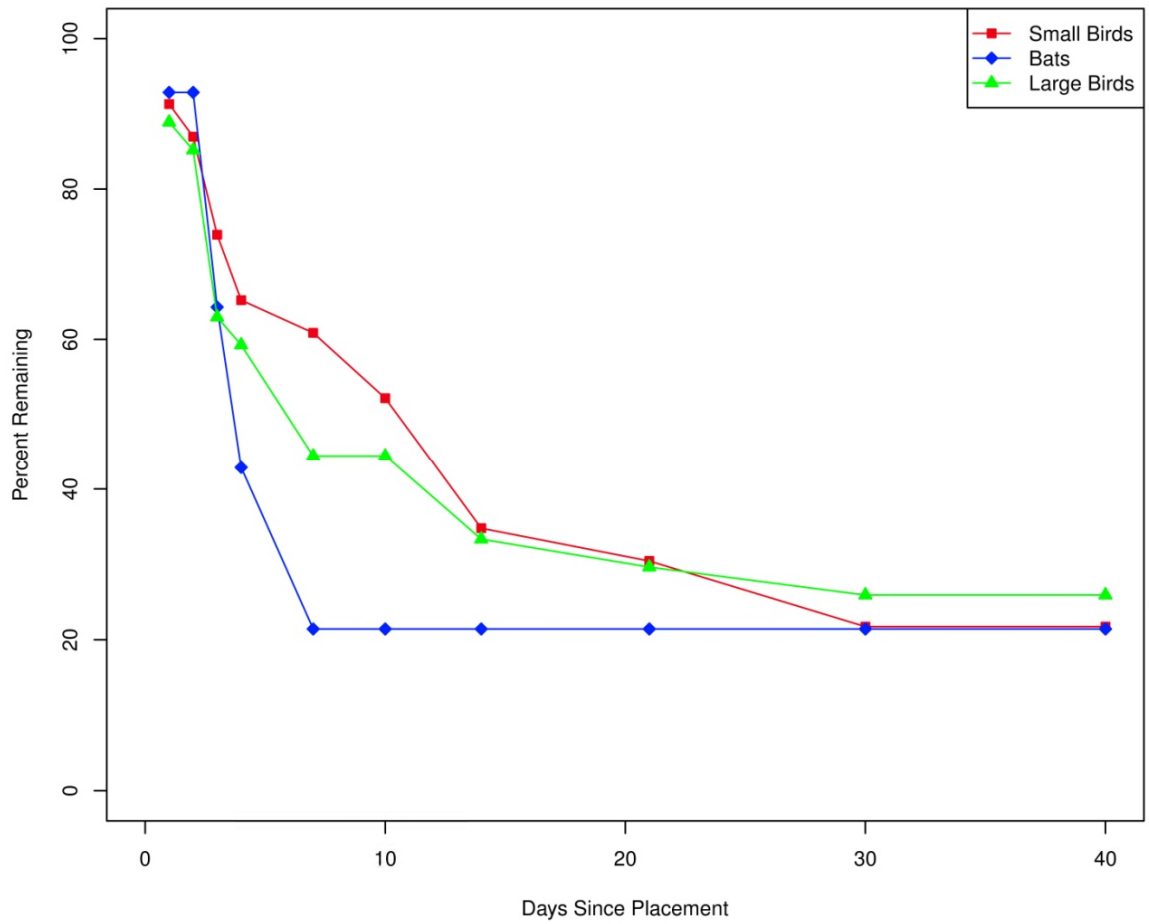

Figure 13. Carcass removal rates at the Dunlap Wind Energy Facility.

Given the estimated searcher efficiency and scavenger removal rates, the average probability that a large bird would remain in a search plot and be found during a scheduled search was 76.0% for turbines searched weekly and anywhere from 40.0% to 42.0% for turbines searched every four weeks, depending on season (Appendix B). For small birds, these probabilities were 57.0% for turbines searched weekly and 23.0% – 24.0% for turbines searched every four weeks. For bats, these percentages were 20.0% for turbines searched weekly and 5.0% – 6.0% for turbines searched every four weeks (Appendix C).

Adjusted Fatality Estimates

Small Birds

The adjusted fatality estimate for small birds at wind turbines was 1.02 fatalities/turbine/year (0.68 fatalities/MW/year; Table 5), which resulted in a total mortality estimate of approximately 75 small birds for the entire facility per year. The estimated small bird fatality rate at met towers was 2.63 fatalities/met tower/year (Table 6), which is approximately 2.5 times higher than the small bird fatality rate at the project wind turbines.

Large Birds

The adjusted fatality estimate for all large birds (e.g., raptors, waterbirds, and waterfowl) at wind turbines was 0.28 fatalities/turbine/year (0.19 fatalities/MW/year; Table 5), which resulted in a total mortality estimate of approximately 21 large birds for the entire facility per year. The estimated large bird fatality rate at met towers was 0.56 fatalities/met tower/year (Table 6), which is approximately twice the fatality rate at the project wind turbines.

Raptors

The adjusted fatality estimate for raptors at wind turbines was 0.18 fatalities/turbine/year (0.12 fatalities/MW/year; Table 5), which resulted in a total mortality estimate of approximately 13 raptors for the entire facility per year. No raptor fatalities were found at the met towers.

All Birds

The adjusted fatality estimate for all birds combined at wind turbines was 1.30 fatalities/turbine/year (0.87 fatalities/MW/year; Table 5), which resulted in a total mortality estimate of approximately 97 birds per year for all 74 turbines combined. When the total estimate of 97 bird fatalities at wind turbines was combined with the approximately 13 bird fatalities estimated at met towers (3.18 birds/met tower/year; Table 6), the fatality estimate was roughly 110 bird fatalities per year for the entire facility.

Bats

The adjusted fatality estimate for bats at wind turbines was 8.87 fatalities/turbine/year (5.91 fatalities/MW/year; Table 5), which resulted in a total mortality estimate of about 656 bats for the entire facility per year. No bats were found at met towers and therefore it was assumed that no bat mortality occurred at met towers during the first study year.

Table 5. Adjusted bird and bat fatality estimates for wind turbines at the Dunlap Wind Energy Facility from March 31, 2011 – February 10, 2012.

	Corrected Fatality Estimate
# fatalities/turbine/year	
Small Birds	1.02
Large Birds	0.28
Raptors	0.18
All Birds	1.30
Bats	8.87
# fatalities/MW/year	
Small Birds	0.68
Large Birds	0.19
Raptors	0.12
All Birds	0.87
Bats	5.91

For more details concerning correction factors and confidence intervals for both bird and bat fatality estimates, refer to Appendices B and C.

Table 6. Adjusted bird and bat fatality estimates for meteorological (met) towers at the Dunlap Wind Energy Facility from March 31, 2011 – February 10, 2012.

	Corrected Fatality Estimate
# fatalities/met tower/year	
Small Birds	2.63
Large Birds	0.56
Raptors	0
All Birds	3.18
Bats	0

For more details concerning correction factors and confidence intervals for both bird and bat fatality estimates, refer to Appendices B and C.

Raptor Nest Surveys

In 2009, one golden eagle nest, three active ferruginous hawk (*Buteo regalis*) nests, one active merlin (*Falco columbarius*) nest, one active great-horned owl (*Bubo virginianus*) nest, and one active long-eared owl (*Asio otus*) nest were located within the survey area (Johnson et al. 2009). The 2009 raptor nest survey area included a 1-mile buffer around the original proposed Dunlap Wind Resource Area, which covered a different area then the 2011 survey area, which included a 2-mile buffer from existing turbine locations. Therefore, some of the nests identified in 2009 were outside the 2011 nest survey area and were not visited in 2011.

During the 2011 raptor nest survey, one active merlin, and one active great-horned owl nest were recorded. Three ferruginous hawk nests and one long-eared owl nest were also located; however, there was no indication of nesting activity at these nests at the time of the survey. Based on the date of the raptor nest survey (July 2011), nest activity may have occurred at an earlier date and may have been missed. The golden eagle nest identified during the 2009 survey was not present in 2011.

Incidental Wildlife Observations

Incidental wildlife observations were recorded during all onsite events. A total of 185 incidental observations of nine bird and two mammal species were recorded (Table 7). Six raptor species were observed incidentally, including 109 golden eagles, 39 ferruginous hawks, seven American kestrels (*Falco sparverius*), five prairie falcons, three bald eagles, and three northern harriers (*Circus cyaneus*). Mammals observed included two observations of coyotes (*Canis latrans*) and one of badger (*Taxidea taxus*; Table 7). Due to comparatively large numbers and consistent sightings, incidental observations of pronghorn antelope (*Antilocapra americana*) were not documented for each sighting. Pronghorn antelope were observed throughout the DWEF during nearly every survey event.

Table 7. Incidental wildlife observed while conducting all surveys at the Dunlap Wind Energy Facility from March 31, 2011 – February 10, 2012.

Species	Scientific Name	# grps	# obs
golden eagle	*Aquila chrysaetos*	98	109
ferruginous hawk	*Buteo regalis*	35	39
American kestrel	*Falco sparverius*	5	7
prairie falcon	*Falco mexicanus*	5	5
mountain plover	*Charadrius montanus*	4	13
bald eagle	*Haliaeetus leucocephalus*	3	3
northern harrier	*Circus cyaneus*	3	3
greater sage grouse	*Centrocercus urophasianus*	2	2
northern shrike	*Lanius excubitor*	1	1
Bird Subtotal	**9 species**	**156**	**182**
coyote	*Canis latrans*	2	2
badger	*Taxidea taxus*	1	1
Mammal Subtotal	**2 species**	**3**	**3**

DISCUSSION

Bird Fatalities at Dunlap

The raptor fatality estimate at the DWEF (0.12 raptors/MW/year; Table 5) was moderate compared to estimated raptor fatality rates at other regional wind energy facilities with similarly collected data (Figure 14). Compared to 36 other comparable studies at wind energy facilities in western North America with publicly-available raptor mortality data, the raptor fatality estimate at the DWEF ranked 11th highest. Based on raptor use data collected during the baseline study for the Dunlap Wind Resource Area, the predicted raptor mortality rate was 0.06 fatalities/MW/year (Johnson et al. 2009). The actual mortality rate at the DWEF during the first year of fatality monitoring was higher than the predicted rate, but was within the 90% prediction interval, which ranged from zero to 0.32 fatalities/MW/year (Johnson et al. 2009).

Overall bird fatality estimates are available for 39 comparable studies at wind energy facilities across western North America (Figure 15). Compared to these other regional wind energy facilities in western North America, the estimated bird fatality rate at turbines within the DWEF (0.87 fatalities/MW/year) was relatively very low, ranking 35th of the 39 studies with similarly-collected avian fatality data (Figure 16). The total avian fatality rate at met towers (3.18

fatalities/met tower/year) was approximately 2.5 times higher than the avian fatality rate per turbine (1.30 fatalities/turbine/year; Tables 5 and 6).

Bat Fatalities at Dunlap

The estimated bat fatality rate at the DWEF of 5.91 bats/MW/year was relatively high compared to other regional wind energy facilities in western North America, ranking third of 38 studies at facilities with comparable and publicly-available bat fatality data (Figure 17). Compared to some wind energy facilities in other parts of the country, however, bat fatality rates at the DWEF are relatively low. For example, documented bat fatality rates have been 39.7 fatalities/MW/year in Tennessee (Fiedler et al. 2007), 31.69 fatalities/MW/year in West Virginia (Kerns and Kerlinger 2004), and 30.61 fatalities/MW/year in Wisconsin (BHE Environmental 2010).

The bat fatality estimate for the DWEF was likely strongly influenced by relatively short scavenger removal times for bat carcasses; bat carcasses lasted an average of 3.3 days before being removed, compared to 12.6 days for small bird carcasses. The mean scavenger removal time for bats was determined with 14 fresh bat carcasses found during the study, compared to 23 small and 27 large birds used to determine mean removal time for birds. The relatively small sample size for bats may have artificially inflated mean removal times and resulted in a higher estimate of the total bat fatality rate. Data collected during the additional two years of monitoring planned for the site will provide more information on bat fatality rates at the site.

With the exception of one *Myotis* bat and excluding two badly decomposed bats that could not be identified, all of the bat fatalities found at the DWEF were either hoary or silver-haired bats. This species composition is similar to that of other wind energy facilities across western North America where the majority of casualties are either hoary or silver-haired bats (Johnson and Stephens 2010). Based on the timing of fatalities, and, again, similar to other wind energy facilities (Johnson 2005, Arnett et al. 2008), it is likely that the majority of bat fatalities within the DWEF were fall migrants.

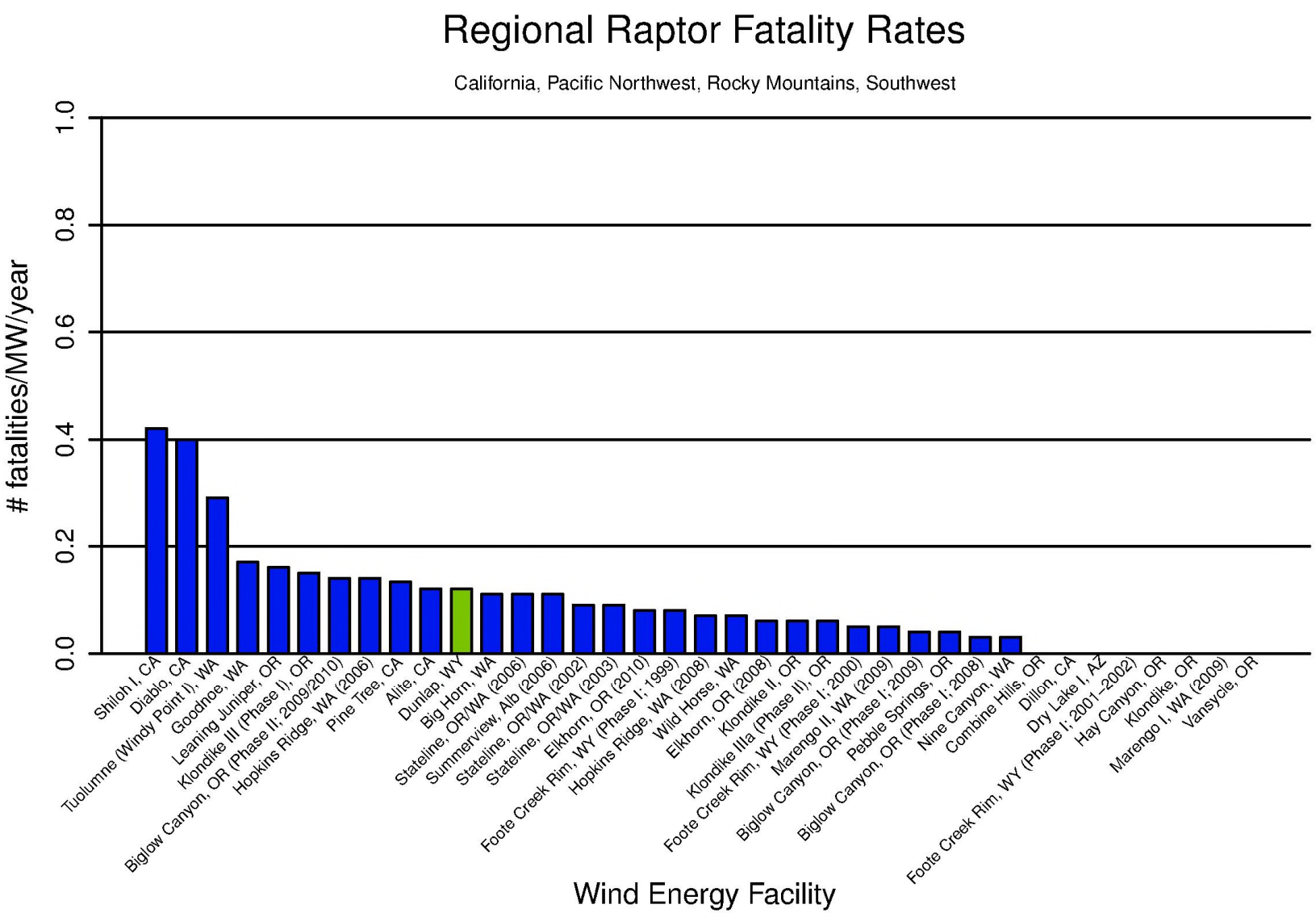

Figure 14. Fatality rates for raptors (number of raptors per megawatt per year) from comparable and publicly-available studies at wind energy facilities in western North America. The estimated fatality rate for the Dunlap Wind Energy Facility is highlighted in green.

Figure 14 (*continued*). Fatality rates for raptors (number of raptors per megawatt per year) from comparable and publicly-available studies at wind energy facilities in western North America.

Data from the following sources:

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

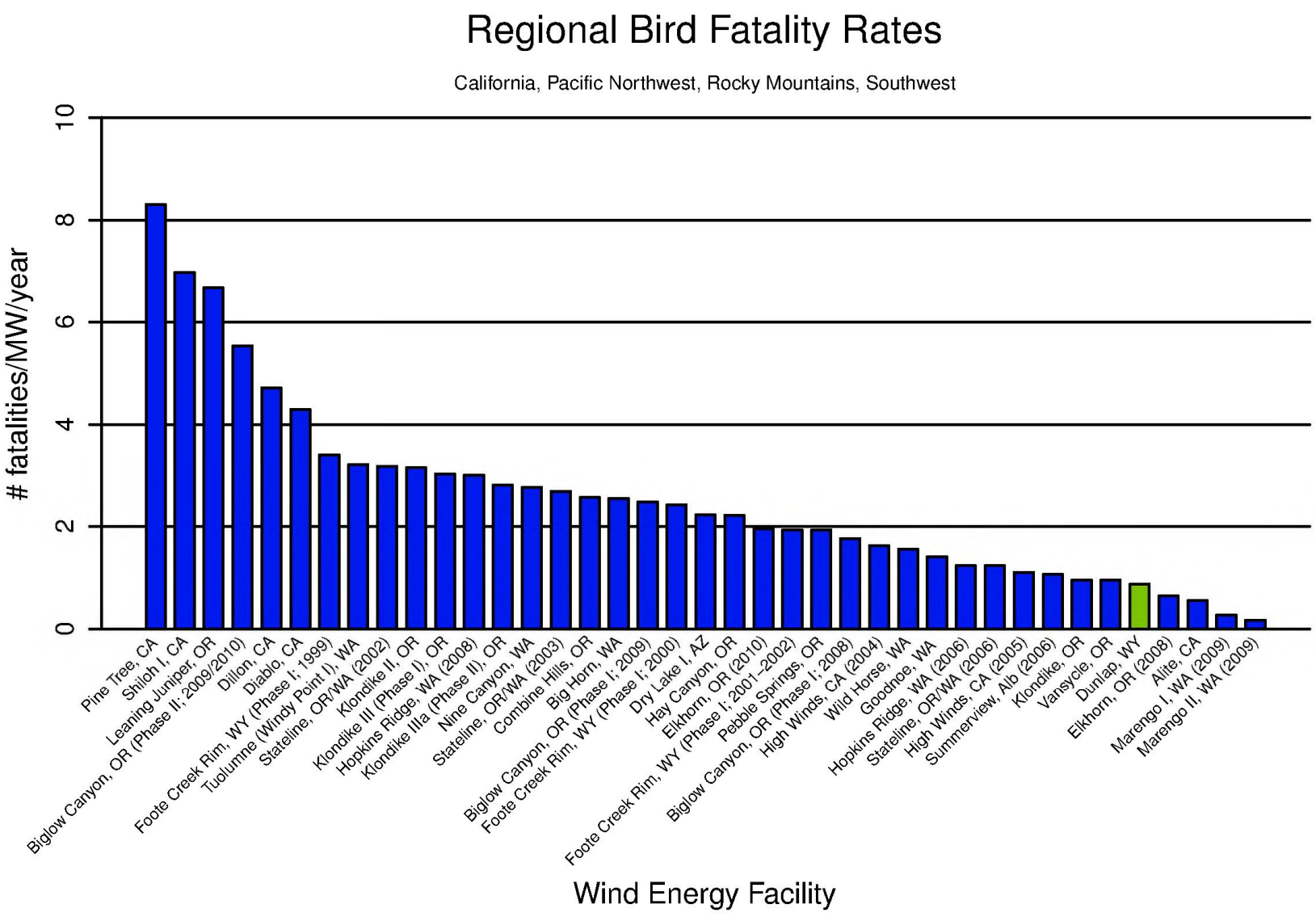

Figure 15. Fatality rates for all birds (number of birds per megawatt per year) from comparable and publicly-available studies at wind energy facilities in western North America. The estimated fatality rate for the Dunlap Wind Energy Facility is highlighted in green.

Figure 15 (*continued*). Fatality rates for all birds (number of birds per megawatt per year) from comparable and publicly-available studies at wind energy facilities in western North America.

Data from the following sources:

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

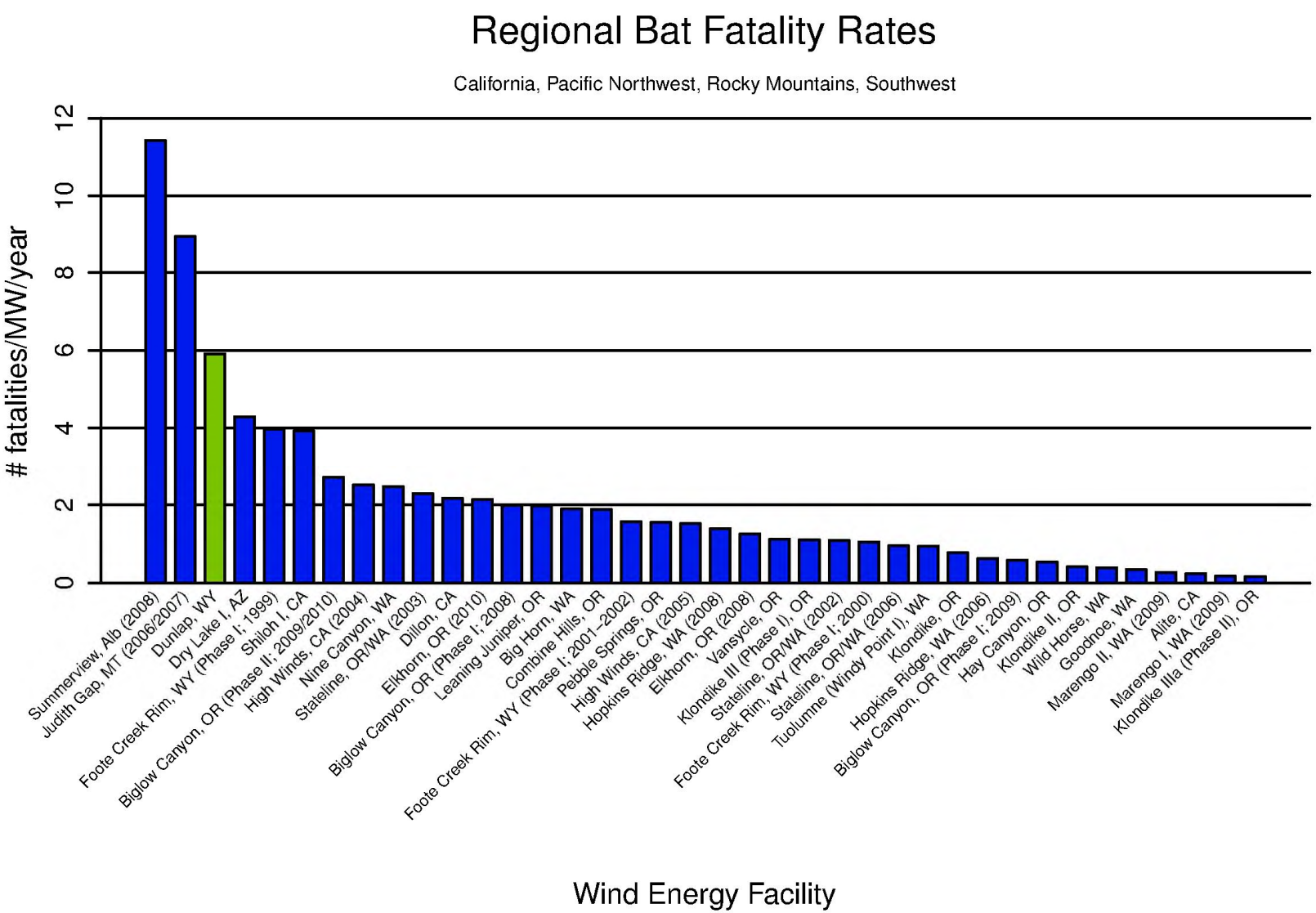

Figure 16. Fatality rates for bats (number of bats per megawatt per year) from comparable and publicly-available studies at wind energy facilities in western North America. The estimated fatality rate for the Dunlap Wind Energy Facility is highlighted in green

Figure 16 (*continued*). Fatality rates for bats (number of bats per megawatt per year) from comparable and publicly-available studies at wind energy facilities in western North America.

Data from the following sources:

Wind Energy Facility	Reference	Wind Energy Facility	Reference	Wind Energy Facility	Reference
Dunlap, WY	This study				
Summerview, Alb (2008)	Baerwald 2008	Big Horn, WA	Kronner et al. 2008	Klondike, OR	Johnson et al. 2003a
Judith Gap, MT	TRC 2008	Combine Hills, OR	Young et al. 2006	Hopkins Ridge, WA (06)	Young et al. 2007
Dry Lake I, AZ	Thompson et al. 2011	Foote Creek Rim, WY (Phase I; 01-02)	Young et al. 2003a, 2003b	Biglow Canyon, OR (Phase I; 09)	Enk et al. 2010
Foote Creek Rim, WY (Phase I; 99)	Young et al. 2003a	Pebble Springs, OR	Gritski and Kronner 2010b	Hay Canyon, OR	Gritski and Kronner 2010a
Shiloh I, CA	Kerlinger et al. 2010	High Winds, CA (05)	Kerlinger et al. 2006	Klondike II, OR	NWC and WEST 2007
Biglow Canyon, OR (Phase II; 09/10)	Enk et al. 2011a	Hopkins Ridge, WA (08)	Young et al. 2009	Wild Horse, WA	Erickson et al. 2008
High Winds, CA (04)	Kerlinger et al. 2006	Elkhorn, OR (08)	Jeffrey et a. 2009b	Goodnoe, WA	URS Corporation 2010a
Nine Canyon, WA	Erickson et al. 2003	Vansycle, OR	Erickson et al. 2000a	Marengo II, WA (09)	URS Corporation 2010c
Stateline, OR/WA (03)	Erickson et al. 2004	Klondike III (Phase I), OR	Gritski et al. 2010	Alite, CA	Chatfield et al. 2010
Dillon, CA	Chatfield et al. 2009	Stateline, OR/WA (02)	Erickson et al. 2004	Marengo I, WA (09)	URS Corporation 2010b
Elkhorn, OR (10)	Enk et al. 2011b	Foote Creek Rim, WY (Phase I; 00)	Young et al. 2003a, 2003b	Klondike IIIa (Phase II), OR	Gritski et al. 2011
Biglow Canyon, OR (Phase I; 08)	Jeffrey et al. 2009a	Stateline, OR/WA (06)	Erickson et al. 2007		
Leaning Juniper, OR	Kronner et al. 2007	Tuolumne (Windy Point I), WA	Enz and Bay 2010		

Raptor Nest Data

The one active golden eagle nest within one mile of the project area in 2009 was not active in 2011. Use of the project vicinity by other nesting raptors was lower in 2011 than it was in 2009. It is not known if the reduction in use of the project area by nesting raptors was due to natural variation, loss of nesting birds due to collision mortality, or displacement by wind energy facilities or human activity in the wind energy facility.

CONCLUSIONS

Based on data collected during the monitoring period, collision mortality of raptors was moderate compared to most other wind energy facilities evaluated in western North America using similar methods. Mortality of all bird species combined at the DWEF was very low compared to national as well as other regional fatality estimates. Bat fatalities were moderate to relatively high compared to other projects across North America and regionally.

To date, post-construction monitoring data are only available for one wind energy facility in Wyoming, the Foote Creek Rim project located in Carbon County (Johnson et al. 2000b; Young et al. 2003a, 2005a). In addition, there are relatively very few studies with publicly-available data from the surrounding states. Results of this monitoring further contribute to the understanding of effects of wind energy developments on wildlife in Wyoming and the Rocky Mountain West. As more wind power projects are built in the region, and additional monitoring results become available, a clearer picture of the potential impacts will likely emerge.

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Appendix A. Bird and bat fatalities found during fatality monitoring at the Dunlap Wind Energy Facility.

Date	Common Name	Location	Distance from Turbine (m)	Type of Find	Search Type	Condition
3/21/2011	prairie falcon	D71	16	carcass search	monthly	feather spot
4/19/2011	horned lark	D56	5	carcass search	weekly	intact
4/21/2011	horned lark	D29	57	carcass search	monthly	intact
4/26/2011	western grebe	D63	2	incidental find	na	intact
6/15/2011	silver-haired bat	D47	36	carcass search	monthly	intact
6/29/2011	lark bunting	D71	25	carcass search	monthly	feather spot
6/29/2011	western grebe	P1M1	44	carcass search	weekly	scavenged
6/29/2011	bald eagle	D50	75	carcass search	weekly	scavenged
6/29/2011	lark bunting	D71	25	carcass search	monthly	feather spot
7/8/2011	hoary bat	D56	13	carcass search	weekly	intact
7/21/2011	hoary bat	D65	11	carcass search	monthly	Intact
7/21/2011	unidentified myotis	D68	5	carcass search	weekly	intact
7/29/2011	golden eagle	D19	18	incidental find	na	dismembered
8/3/2011	McCown's longspur	TMET E	10	carcass search	weekly	feather spot
8/3/2011	McCown's longspur	P1M1	60	carcass search	weekly	feather spot
8/3/2011	hoary bat	D68	37	carcass search	weekly	intact
8/3/2011	horned lark	D56	39	carcass search	weekly	intact
8/3/2011	McCown's longspur	TMET E	100	carcass search	weekly	intact
8/5/2011	hoary bat	D62	42	carcass search	weekly	scavenged
8/5/2011	unidentified bat	D8	25	carcass search	weekly	scavenged
8/5/2011	hoary bat	D8	35	carcass search	weekly	intact
8/5/2011	horned lark	TMET W	24	carcass search	weekly	intact
8/8/2011	hoary bat	D56	32	carcass search	weekly	intact
8/10/2011	hoary bat	D68	41	carcass search	weekly	intact
8/10/2011	rufous hummingbird	D65	62	carcass search	monthly	intact
8/10/2011	hoary bat	D59	42	carcass search	monthly	intact
8/11/2011	hoary bat	D2	19	carcass search	weekly	scavenged
8/11/2011	horned lark	D11	1	carcass search	monthly	intact
8/15/2011	hoary bat	D56	0	carcass search	weekly	scavenged
8/15/2011	hoary bat	D62	14	carcass search	weekly	intact
8/15/2011	hoary bat	D62	14	carcass search	weekly	scavenged
8/15/2011	hoary bat	D62	41	carcass search	weekly	scavenged
8/24/2011	hoary bat	D32	28	carcass search	weekly	intact
8/24/2011	silver-haired bat	D56	18	carcass search	weekly	intact
8/24/2011	hoary bat	D74	4	carcass search	weekly	intact
8/24/2011	hoary bat	D68	65	carcass search	weekly	dismembered

Appendix A. Bird and bat fatalities found during fatality monitoring at the Dunlap Wind Energy Facility.

Date	Common Name	Location	Distance from Turbine (m)	Type of Find	Search Type	Condition
8/24/2011	unidentified bat	D49	29	incidental find	na	scavenged
8/26/2011	hoary bat	D26	28	carcass search	weekly	intact
8/26/2011	hoary bat	D14	27	carcass search	weekly	intact
8/31/2011	hoary bat	D68	71	carcass search	weekly	intact
8/31/2011	hoary bat	D32	32	carcass search	weekly	intact
9/2/2011	silver-haired bat	D62	8	carcass search	weekly	intact
9/2/2011	hoary bat	D62	35	carcass search	weekly	intact
9/2/2011	vesper sparrow	TMET W	22	carcass search	weekly	intact
9/2/2011	silver-haired bat	D20	32	carcass search	weekly	intact
9/8/2011	unidentified warbler	D26	85	carcass search	weekly	intact
9/14/2011	hoary bat	D71	6	carcass search	monthly	intact
9/14/2011	unidentified waterfowl	D53	58	carcass search	monthly	scavenged
9/14/2011	silver-haired bat	D68	24	carcass search	weekly	intact
9/30/2011	silver-haired bat	D26	61	carcass search	weekly	intact
9/30/2011	rock wren	P1M2	22	carcass search	weekly	intact

Appendix A. Bird and Bat Fatalities Found During Fatality Monitoring at the Dunlap Wind Energy Facility

Appendix B. Fatality Estimates for Birds at the Dunlap Wind Energy Facility for Monitoring Conducted from March 31, 2011 – February 10, 2012

Appendix B1. Fatality estimates for birds at wind turbines at the Dunlap Wind Energy Facility for monitoring conducted from March 31, 2011 – February 10, 2012.

	Migration				Non-Migration	
	Weekly		Monthly		Monthly	
Parameter	**Mean**	**CI**	**Mean**	**CI**	**Mean**	**CI**
Search Area Adjustment						
A (small birds)	1.00	-	1.00	-	1.00	-
A (large birds)	1.00	-	1.00	-	1.00	-
Observer Detection						
A (small birds)	0.56	(0.33-0.76)	0.56	(0.33-0.76)	0.56	(0.33-0.76)
A (large birds)	0.82	(0.71-0.91)	0.82	(0.71-0.91)	0.82	(0.71-0.91)
Observed Fatality Rates (fatalities/turbine/year)						
Small birds	0.23	(0.00-0.54)	0.23	0.06-0.43	0.08	(0.00-0.21)
Large birds	0.00	-	0.15	(0.00-0.33)	0.04	(0.00-0.11)
Raptors	0.00	-	0.08	(0.00-0.21)	0.04	(0.00-0.11)
All birds	0.23	(0.00-0.54)	0.38	0.14-0.65	0.12	(0.00-0.23)
Average Probability of Carcass Availability and Detected-						
Small birds	0.57	(0.35-0.72)	0.23	(0.11-0.37)	0.24	(0.12-0.40)
Large birds	0.76	(0.62-0.85)	0.40	(0.25-0.55)	0.42	(0.26-0.58)
Adjusted Fatality Estimates (fatalities/turbine/year)-						
Small birds	0.40	(0.00-1.05)	1.01	(0.17-2.84)	0.32	(0.00-0.99)
Large birds	0.00	-	0.38	(0.00-0.95)	0.09	(0.00-0.28)
Raptors	0.00	-	0.19	(0.00-0.62)	0.09	(0.00-0.28)
All birds	0.40	(0.00-1.05)	1.39	(0.47-3.25)	0.41	(0.00-1.12)

Overall Adjusted Fatality Estimates (fatalities/turbine/year)

	Migration		Non-Migration	
	Mean	**CI**	**Mean**	**CI**
Small birds	**0.70**	**(0.21-1.73)**	**0.32**	**(0.00-0.99)**
Large birds	**0.19**	**(0.00-0.47)**	**0.09**	**(0.00-0.28)**
Raptors	**0.09**	**(0.00-0.31)**	**0.09**	**(0.00-0.28)**
All birds	**0.89**	**(0.38-1.96)**	**0.41**	**(0.00-1.12)**

Appendix B2. Fatality estimates at meteorological (met) towers for birds at the Dunlap Wind Energy Facility for monitoring conducted from March 31, 2011 – February 10, 2012.

	Migration		Non-Migration	
	Weekly		Monthly	
Parameter	**Mean**	**CI**	**Mean**	**CI**
Search Area Adjustment				
A (small birds)	1.00	-	1.00	-
A (large birds)	1.00	-	1.00	-
Observer Detection				
A (small birds)	0.56	(0.33-0.76)	0.56	(0.33-0.76)
A (large birds)	0.82	(0.71-0.91)	0.82	(0.71-0.91)
Observed Fatality Rates (fatalities/met tower/year)				
Small birds	1.50	(1.00-1.75)	0.00	-
Large birds	0.00	-	0.25	(0.00-0.50)
Raptors	0.00	-	0.00	-
All birds	1.50	(1.00-1.75)	0.25	(0.00-0.50)
Average Probability of Carcass Availability and Detected-				
Small birds	0.57	(0.35-0.72)	0.26	(0.13-0.41)
Large birds	0.76	(0.63-0.85)	0.45	(0.28-0.60)
Adjusted Fatality Estimates (fatalities/met tower/year)-				
Small birds	2.63	(1.70-4.19)	0.00	-
Large birds	0.00	-	0.56	(0.00-1.30)
Raptors	0.00	-	0.00	-
All birds	2.63	(1.70-4.19)	0.56	(0.00-1.30)

Overall Adjusted Fatality Estimates (fatalities/met tower/year)	**Mean**	**CI**
Small birds	**2.63**	**(1.70-4.19)**
Large birds	**0.56**	**(0.00-1.30)**
Raptors	**0.00**	**-**
All birds	**3.18**	**(1.93-4.94)**

Appendix C. Fatality Estimates for Bats at the Dunlap Wind Energy Facility for Monitoring Conducted from March 31, 2011 – February 10, 2012

Appendix C1. Fatality estimates for bats at wind turbines at the Dunlap Wind Energy Facility for studies conducted from March 31, 2011 – February 10, 2012.

	Migration				Non-Migration	
	Weekly		Monthly		Monthly	
Parameter	**Mean**	**CI**	**Mean**	**CI**	**Mean**	**CI**
Search Area Adjustment						
A (bats)	1.00	-	1.00	-	1.00	-
Observer Detection						
A (bats)	0.46	(0.18-0.73)	0.46	(0.18-0.73)	0.46	(0.18-0.73)
Observed Fatality Rates (fatalities/turbine/year)						
Bats	1.85	(1.00-2.73)	0.15	(0.00-0.33)	0.15	(0.04-0.25)
Average Probability of Carcass Availability and Detected-						
Bats	0.20	(0.09-0.33)	0.05	(0.02-0.09)	0.06	(0.02-0.09)
Adjusted Fatality Estimates (fatalities/turbine/year)-						
Bats	9.21	(4.32-22.64)	2.96	(0.00-8.99)	2.78	(0.75-7.89)

Overall Adjusted Fatality Estimates (fatalities/turbine/year)

	Migration		Non-Migration	
	Mean	**CI**	**Mean**	**CI**
Bats	**6.09**	**(2.92-14.58)**	**2.78**	**(0.75-7.89)**

Post-Construction Monitoring Studies – Second Annual Report
Dunlap Wind Energy Facility
Carbon County, Wyoming

Draft Report
March 1, 2012 – February 28, 2013

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May 31, 2013

EXECUTIVE SUMMARY

PacifiCorp Energy (PacifiCorp) owns and operates the Dunlap I Wind Energy Facility (DWEF). The facility has a capacity of 111 megawatts (MW) and is located in Carbon County, north of Medicine Bow, Wyoming. The 74 GE 1.5-MW turbines at the DWEF have a rotor diameter of 77 meters (m; 252 feet [ft]) and the wind turbines are situated on 80-m (262-ft) tall steel tubular towers secured to concrete foundations. Two meteorological (met) towers are also present within the DWEF.

In 2011, Western EcoSystems Technology, Inc. (WEST) began bird and bat monitoring at the DWEF. Year-2 monitoring was initiated in March 2012 and continued through February 2013. Monitoring included estimating the total number of bird and bat collision fatalities at wind turbines and met towers based on the number of fatalities found, adjusted for searcher efficiency, scavenger removal bias, and the proportion of the turbines searched. Raptor nest surveys at the DWEF were also completed in 2012.

The primary objective of the fatality monitoring was to estimate the level of bird and bat mortality attributable to collisions with wind turbines and met towers for the entire DWEF on an annual basis. The second year annual monitoring was conducted from March 1, 2012, through February 28, 2013. Twenty-six of the 74 turbines were randomly selected for surveying and square plots were established around the 26 turbines. Two met towers were also searched. Search plots at turbines were 160 m (525 ft) on a side, while search plots at met towers were 120 m (394 ft) on a side. Standardized carcass surveys occurred at all 26 turbines and met towers once every four weeks throughout the year, with standardized surveys at half of these turbines (13 turbines) and two met towers conducted once every week during the spring (March 16–May 15) and fall (August 1–October 31) migration periods.

A total of 558 combined turbine and met tower searches were conducted during the second monitoring year, and 25 birds were found during this period, including 22 found during standardized searches of the study plots and three found as incidental carcasses. Of the 25 bird carcasses found during the study, 20 were passerines, one was a raptor (ferruginous hawk), and one was a mallard. The most common species located was horned lark (four carcasses). Incidental avian discoveries included one vesper sparrow, one burrowing owl, and one western grebe. Six of the 25 bird carcasses, including a Brewer's sparrow, yellow-headed blackbird, horned lark, yellow warbler, and two unidentified sparrows, were found at met towers while all other carcasses were all found at project turbines. None of the bird fatalities found are federally listed species. All of the birds found are protected under the Migratory Bird Treaty Act, excluding European starling (*Sturnus vulgaris*), which is a non-native introduced species.

Eleven bat carcasses were found during the second year of monitoring. All were located during scheduled turbine searches. Of the 11 bat discoveries, four were hoary bats, three were silver-haired bats, one was an eastern red bat, and three were unidentified. No bat fatalities involved federally listed species.

During searcher efficiency trials, searchers detected 90.6% of the large birds, 47.6% of the small birds, and 62.5% of the bats. Based on scavenger trial data, the mean removal time was 8.23 days for large birds, 4.25 days for small birds and bats. Due a limited number of bat carcasses available, small bird and bat rates were combined. Given the estimated searcher efficiency and scavenger removal rates, the average probability that a large bird would remain in a search plot and be found during a scheduled search was 64.0% for turbines searched weekly and anywhere from 23.0% to 25.0% for turbines searched every four weeks, depending on season. For small birds and bats, these probabilities were 28.0% for turbines searched weekly and 7.0% – 8.0% for turbines searched every four weeks.

The adjusted fatality estimate for small birds at wind turbines was 3.62 fatalities/turbine/year (2.41 fatalities/MW/year, which resulted in a total mortality estimate of approximately 268 small birds for the entire facility per year. The estimated small bird fatality rate at met towers was 16.24 fatalities/met tower/year, which is approximately 4.5 times higher than the small bird fatality rate at the project wind turbines. The adjusted fatality estimate for all large birds (raptors, waterbirds, waterfowl) at wind turbines was 0.32 fatalities/turbine/year (0.21 fatalities/MW/year), which resulted in a total mortality estimate of approximately 24 large birds for the entire facility per year. Because no large birds were found at met towers, no estimate is provided (assumed zero). The adjusted fatality estimate for raptors at wind turbines was 0.15 fatalities/turbine/year (0.10 fatalities/MW/year), which resulted in a total mortality estimate of approximately 11 raptors for the entire facility per year. No raptor fatalities were found at met towers. The adjusted fatality estimate for all birds combined at wind turbines was 3.94 fatalities/turbine/year (2.63 fatalities/MW/year), which resulted in a total mortality estimate of approximately 292 birds for all 74 turbines combined. When the total estimate of 292 bird fatalities at wind turbines was combined with the estimated 32 bird fatalities at met towers, the total estimate is roughly 324 bird fatalities per year for the entire facility. The estimates may be affected by the low bias trial rates. The average removal rate for small birds (and bats) was less than five days, while the searcher efficiency rate for small birds was less than 50%.

The adjusted fatality estimate for bats at wind turbines was 2.24 fatalities/turbine/year (1.49 fatalities/MW/year), which resulted in a total mortality estimate of approximately 166 bats for the entire facility per year. No bats were found at met towers and therefore it was assumed that no bat mortality occurred at met towers during the second year of monitoring.

The raptor fatality estimate at the DWEF (0.10 raptors/MW/year) was moderate compared to estimated raptor fatality rates at other regional wind energy facilities with comparable and publicly-available fatality data. Compared to 39 other studies at wind energy facilities in western North America with publically-available raptor mortality data, the DWEF raptor fatality estimate ranked 21st highest. Based on raptor use data collected during the baseline study for the DWEF, the predicted raptor mortality rate was 0.06 fatalities/MW/year. The actual mortality rate during the second year was higher than the predicted rate, but was within the 90% prediction interval, which was zero – 0.32 fatalities/MW/year. Overall bird fatality estimates are available for 49 comparable and publicly-available studies at wind energy facilities across western North

America. Compared to these other studies at regional wind energy facilities, the estimated bird fatality rate at turbines within the DWEF (2.63 fatalities/MW/year) is relatively moderate, ranking 20th of the 50 publicly-available studies (including this study) with similar avian fatality data.

The estimated bat fatality rate at the DWEF of 1.49 bats/MW/year was moderate compared to other regional wind energy facilities in western North America, ranking 25th of 52 studies at facilities with publically-available bat fatality data. The bat fatality estimate for the DWEF was likely influenced by relatively short scavenger removal times for bat carcasses (and small birds), which lasted an average of 4.25 days before being removed. This value was higher than Year-1, where removal rates for bats only were 3.3. days, but was much lower than the 12.6-day average removal rate for small birds. Due to the limited number of bat carcasses available for use in Year-2, small bird and bat bias trial numbers were combined. With the exception of one eastern red bat, all of the other bat fatalities found at the DWEF were either hoary or silver-haired bats. Three unidentified bats carcasses (wings or partial) were also located. This species composition is similar to that of other wind energy facilities across western North America where the majority of casualties are either hoary or silver-haired bats. Based on the timing of fatalities, and, again, similar to other wind energy facilities, it is likely that the majority of bat fatalities within the DWEF were fall migrants.

The objective of the raptor nest surveys was to determine the presence of occupied and successful raptor nests in and near the DWEF study area. The entire DWEF, as well as a 2-mile (3.2-kilometer [km]) buffer around the project turbines, was surveyed. One golden eagle nest was occupied, but unsuccessful; four ferruginous hawk nests were occupied and successful; and one prairie falcon nest was occupied and successful.

The objective of incidental wildlife observations was to provide a record of wildlife observed within the DWEF while conducting monitoring activities. Although no pre-construction data are available for most species at the DWEF, there is little information for many species on how they are affected by wind energy development. Therefore, even post-construction observational data on wildlife use near wind turbines provides meaningful information. A total of 82 incidental observations, representing 12 bird species, were recorded. Six raptor species were observed incidentally, including 37 golden eagles, 10 ferruginous hawks, four American kestrels, four prairie falcons, two red-tailed hawks, and one northern harrier. Two mammal species also were recorded, including two observations of muskrats and one badger. Due to comparatively large numbers and consistent sightings, incidental observations of pronghorn antelope were not documented for each sighting. Pronghorn antelope were observed throughout the DWEF during nearly every survey event.

To date, post-construction monitoring data are only available for one wind energy facility in Wyoming, the Foote Creek Rim project located in Carbon County. In addition, there are relatively very few comparable and publicly-available studies available from the surrounding states. Results of this monitoring will further contribute to the understanding of effects of wind energy developments on wildlife in Wyoming and the Rocky Mountain region. As more wind

power projects are built in the region, and additional information becomes available, a clearer picture of the potential impacts will likely emerge.

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REPORT REFERENCE

Martinson, L., G.D. Johnson, S. Howlin, and K. Bay. 2013. Post-Construction Monitoring Studies – Second Annual Report: Dunlap Wind Energy Facility, Carbon County, Wyoming. Draft Report: March 1, 2012 – February 28, 2013. Prepared for PacifiCorp Energy, Salt Lake City, Utah. Prepared by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming.

INTRODUCTION

PacifiCorp Energy (PacifiCorp) owns and operates the Dunlap Wind Energy Facility (DWEF) (Phase I). The facility has a capacity of 111 megawatts (MW) from 74 turbines and is located in Carbon County, north of Medicine Bow, Wyoming. During the early stages of facility development, the Wyoming Game and Fish Department (WGFD) and the US Fish and Wildlife Service (USFWS) expressed an interest in ensuring that potential post-construction impacts to wildlife be monitored. PacifiCorp Energy contracted Western EcoSystems Technology, Inc. (WEST) to develop a 3-year post-construction monitoring study at the DWEF to assess the level of impacts from operation of the wind energy facility to wildlife.

A Technical Advisory Committee (TAC), composed of PacifiCorp, the WGFD, and the USFWS, was created to review the monitoring protocol, assess the study results, and prepare recommendations for PacifiCorp. This report provides the results of the second year monitoring, which covered the period March 1, 2012, through February 28, 2013.

The purpose of the avian and bat fatality monitoring was to estimate the annual number of avian and bat fatalities attributable to wind turbine and meteorological (met tower) collisions from operations throughout the second year of operation at the DWEF. The monitoring study conforms to industry standards in the western United States.

The monitoring study for the DWEF consists of the following components:

1) Standardized carcass surveys of selected turbines and met towers within a square plot centered on the turbine or met tower;
2) Searcher efficiency trials to estimate the percentage of carcasses found by searchers;
3) Carcass removal trials to estimate the length of time that a carcass remained in the field for possible detection; and
4) Adjusted fatality estimates based on the results of searcher efficiency trials and carcass removal trials.

Additional studies at the DWEF included raptor nest surveys, which were completed in 2012. Incidental wildlife observations are also reported in this document.

STUDY AREA

Dunlap (Phase I) is located approximately 10 miles (16.1 kilometers [km]) north of the town of Medicine Bow, Wyoming. Topography of the DWEF is primarily flat, with minimal topographic relief (Figure 1). Elevations range from approximately 6,750 to 7,200 feet (ft; 2,057 to 2,195 meters [m]). The land cover onsite is a mix of grasslands and sagebrush (*Artemisia* spp.) communities. The site encompasses approximately 10,340 acres (16.16 square miles [mi^2]) of land.

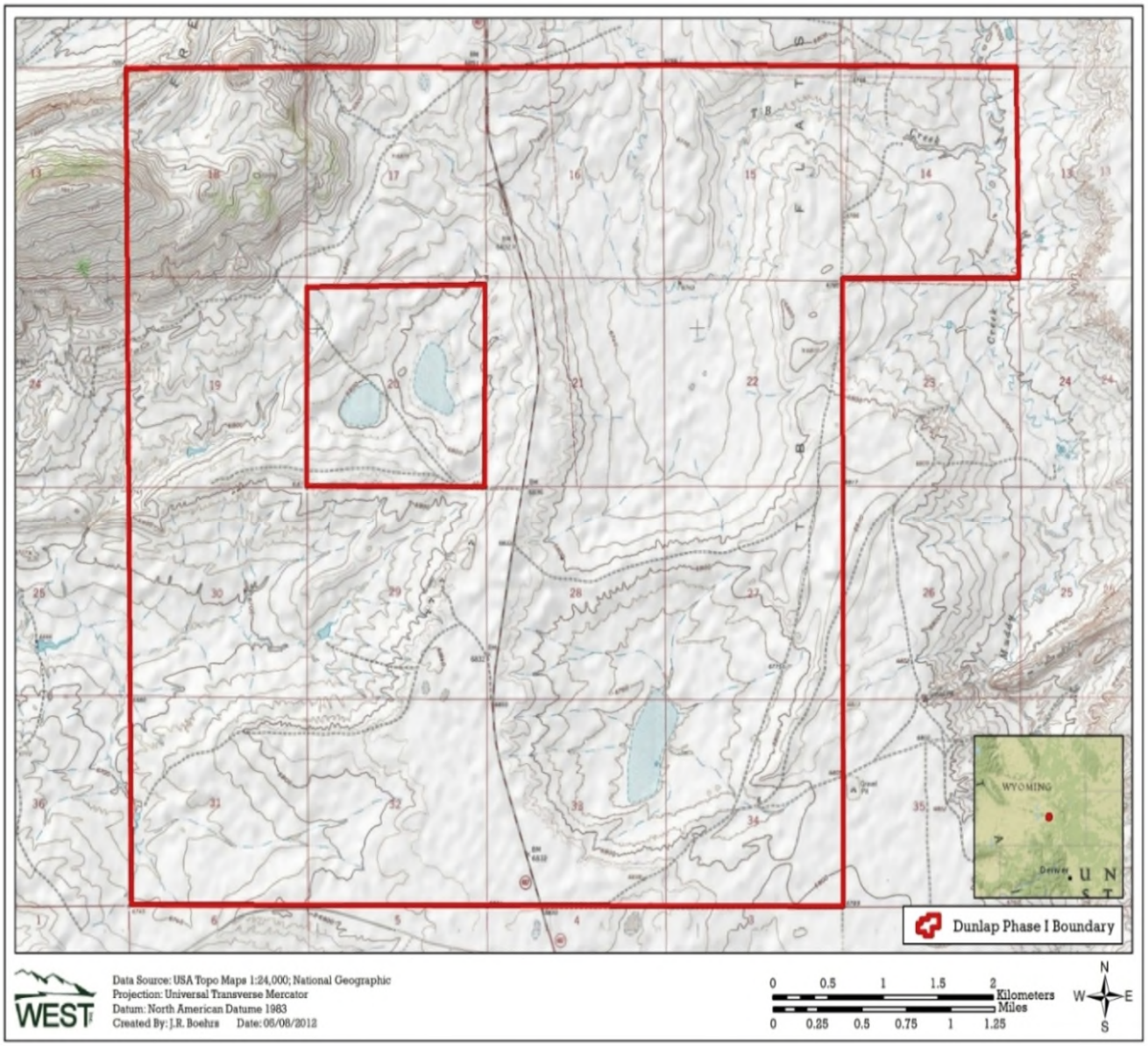

Figure 1. Location of the Dunlap Wind Energy Facility.

The DWEF has 74 GE 1.5-MW turbines with a rotor diameter of 77 m (252 ft). The turbines are situated on 80-m (262-ft) tall steel tubular towers secured to concrete foundations. Two meteorological (met) towers are also present within the DWEF (Figure 2).

METHODS

Casualty Surveys

The primary objective of the monitoring was to estimate the level of bird and bat mortality attributable to collisions with wind turbines and met towers for the entire DWEF on an annual basis. The Year-1 monitoring study began in March 2011 and was conducted for one full year. Year-2 monitoring was conducted from March 1, 2012, through February 28, 2013. Monitoring beyond the second year is currently ongoing.

The methods for the fatality study were broken into four primary components: 1) standardized carcass surveys of selected turbines and met towers; 2) searcher efficiency trials to estimate the percentage of carcasses found by searchers; 3) carcass removal trials to estimate the length of time that a carcass remained in the field for possible detection; and 4) adjusted fatality estimates for bird and bat species, calculated using the results from searcher efficiency trials and carcass removal trials to estimate the total number of bird and bat fatalities within the DWEF.

There were three scenarios under which casualties were found in the DWEF: 1) during the standardized surveys for the study; 2) while observers were onsite, but not conducting a standardized search (i.e., an incidental find); and 3) by facility personnel or others onsite for other purposes, such as turbine maintenance. Casualties found by study observers, regardless of timing (i.e., during a standardized survey or not), were recorded by the methods described below. All casualties found within a search plot, even if outside of the standard survey period, were included in the dataset under the broad assumption that these casualties would have been found during standardized surveys. Casualties found by DWEF site personnel were collected and recorded following PacifiCorp's procedures.

All bird and bat casualties located within the search areas, regardless of species, were recorded and a cause of death determined, if possible, based on field inspection of the carcass. The total number of bird and bat carcasses was estimated by adjusting for search frequency, removal bias (length of stay in the field), searcher efficiency bias (percent of carcasses found) and proportion of the turbines sampled. For carcasses where the cause of death was not apparent, the assumption that the fatality was a wind turbine or met tower collision casualty was made for the analysis. While this approach likely leads to an overestimate of the true number of facility-related fatalities, most studies of wind energy facilities have used this conservative approach because of the relative high costs associated with obtaining accurate estimates of natural or reference mortality (see Johnson et al. 2000a).

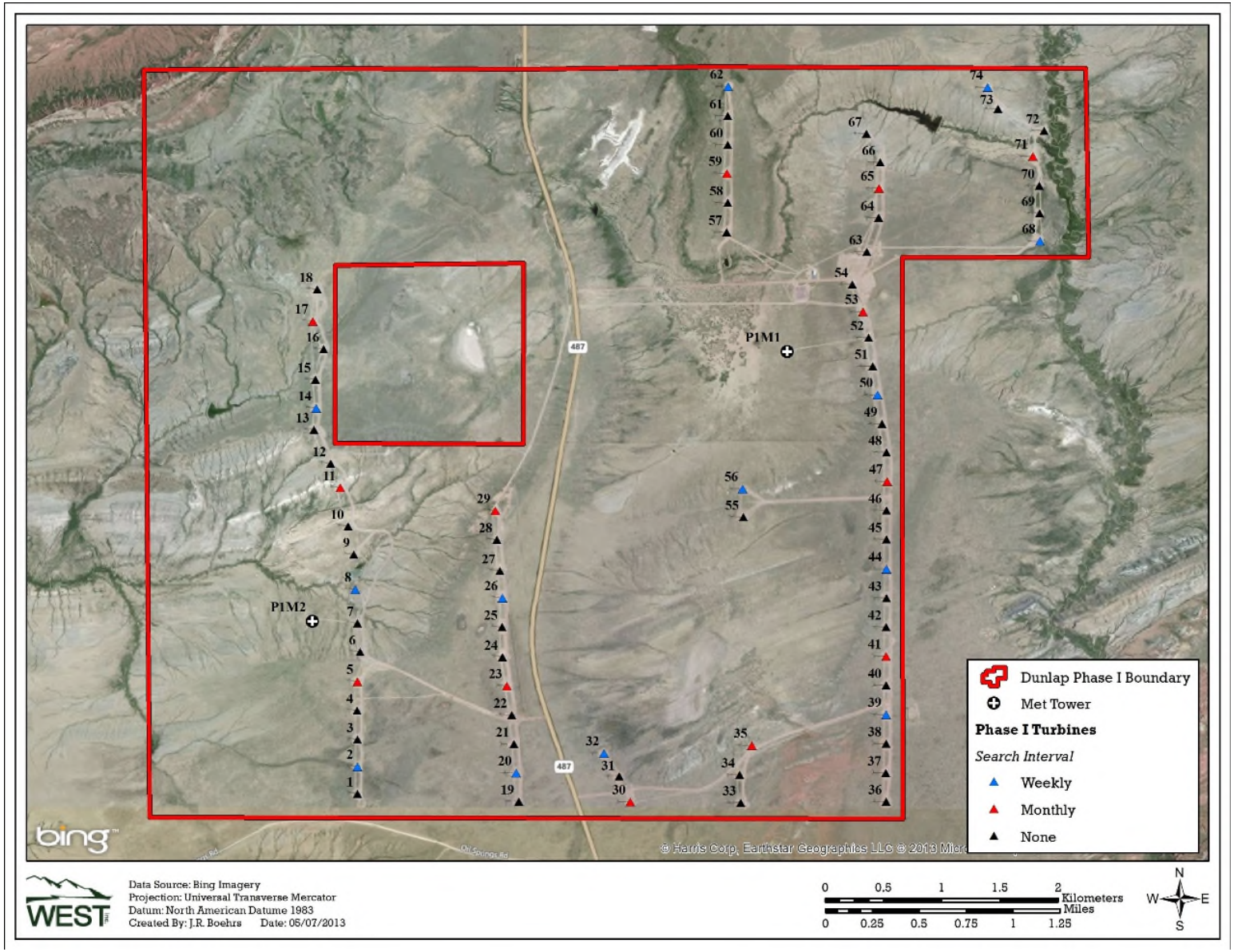

Figure 2. Location of carcass search plots at the Dunlap Wind Energy Facility.

Field Methods

Twenty-six of the 74 turbines were selected for surveying using a systematic design with a random start (Figure 2). Square plots were established around the 26 turbines and two met towers and systematically searched for carcasses. Search plots at turbines were 160 m (525 ft) on a side and centered on the turbine (with each side at 80 m from the turbine), while search plots at met towers were 120 m (394 ft) on a side and centered on the met tower (with each side at 60 m [197 ft] from the tower). Studies at other facilities with large turbines, such as the Klondike wind energy facility in Oregon (Johnson et al. 2003b), the Combine Hills facility, also in Oregon (Young et al. 2006), and the Crescent Ridge facility in Illinois (Kerlinger et al. 2007), indicate most of the fatalities are found within the area that is roughly equivalent to the height of the turbine tower.

Standardized carcass surveys occurred at all 26 turbines and met towers once every 4-week (28-day) period throughout the year, with standardized surveys at half of these turbines (13 turbines) and two met towers conducted once every week (seven days) during the spring (March 16–May 15) and fall (August 1–October 31) migration periods. The two met towers are permanent towers.

Standardized Carcass Surveys

The objective of the standardized carcasses surveys was to systematically search wind turbines and met towers for bird and bat casualties that were attributable to collision with project facilities. Study personnel were trained in proper search techniques prior to conducting the carcass surveys. An observer walked at a rate of approximately 45 to 60 m/minute (148 to 197 ft/min) along each transect. Transects were spaced 6.0 to 10.0 m (19.7 to 32.8 ft) apart, and observers scanned the areas on both sides to approximately 3.0 to 5.0 m (9.8 to 16.4 ft) for casualties as they walked each transect. To facilitate conducting the searches, a global positioning system (GPS) coordinates were obtained for each turbine or met tower being searched, and a shape file was created to show the boundary of the 160 x 160-m turbine plot or 120 x 120-m met tower plot. To help maintain appropriate transect spacing, the observer used a GPS unit with the downloaded shape files while searching each plot so that the observer could see exactly where they were within the plot. The “tracks” option (feature showing intact route alignment) of the GPS unit was also used to help searchers ensure the entire plot was searched appropriately.

The condition of each carcass found was recorded using the following categories:

- Intact - a carcass that was completely intact, was not badly decomposed, and showed no signs of being fed upon by a predator or scavenger.
- Scavenged - an entire carcass, which showed signs of being fed upon by a predator or scavenger, or a portion(s) of a carcass in one location (e.g., wings, skeletal remains, portion of a carcass, etc.), or a carcass that was heavily infested by insects.

- Feather Spot - 10 or more feathers or two or more primaries at one location, indicating a bird fatality had been there.

All casualties were photographed as found. All carcasses were then labeled with a unique number, bagged, and frozen for future reference and possible necropsy. A copy of the data sheet for each carcass was maintained with the bagged and frozen carcass at all times (i.e., freezer log). For all casualties found, data recorded included species, sex and age (when possible), date and time collected, GPS location, condition (intact, scavenged, feather spot), and any comments that indicated possible cause of death.

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

Searcher Efficiency Trials

The objective of the searcher efficiency trials was to estimate the percentage of casualties found by observers. Searcher efficiency trials were conducted throughout the year. Searcher efficiency trials were conducted in the same areas as standardized carcass surveys and searcher efficiency was estimated by the type of carcass (bird or bat), size of carcass (birds only), and season. Estimates of searcher efficiency were used to adjust the total number of carcasses found for those missed by observers, correcting for detection bias.

Observers conducting carcass surveys did not know the location of the trial carcasses. A total of 67 carcasses (33 large birds, 23 small birds and 11 bats) were placed on eight separate dates. Carcasses used for searcher efficiency trials were non-native/non-protected or commercially available species, including adult *Coturnix* quail, adult female mallards (*Anas platyrhynchos*), house sparrows (*Passer domesticus*), rock doves (*Columba livia*), and bat carcasses found during previous search events. Trial carcasses were placed within study plots using a randomly generated distance and direction from the turbine.

All searcher efficiency trial carcasses were placed within the search area prior to that day's scheduled standardized carcass survey. Each trial carcass was discreetly marked (e.g., dark tape or thread placed on the leg of the trial carcass) so that it could be identified as a study carcass after it was found.

The number and location of the searcher efficiency trial carcasses found during the carcass surveys were recorded. The number of carcasses available for detection during each trial was determined immediately after the trial.

Carcass Removal Trials

The objective of carcass removal trials was to estimate the average length of time a carcass remained in the study area and was potentially detectable. Carcass removal included removal by predation or scavenging. Removal trial carcasses were not placed in the standardized search plots in order to minimize the chance of confusing a trial bird or bat with a turbine casualty. Turbines not included in the standardized carcass surveys were randomly selected for inclusion in the removal trials. Trial carcasses were randomly placed at selected turbines within a plot of similar size to the actual search plots. Estimates of carcass removal were used to adjust the total number of carcasses found for those removed from the study area, correcting for removal bias.

Carcass removal trials were spread throughout the year to incorporate the effects of varying weather, climatic conditions, and scavenger densities. A total of 28 large birds, 24 small birds, and eight bat carcasses were placed in the DWEF across seven dates throughout the duration of the Year-2 monitoring period. Carcass composition was similar to that used for searcher efficiency trials.

Observers conducting carcass searches monitored the trial birds and bats over a 40-day period, checking the condition and presence of the carcasses every day for the first four days of the trial, and then on day seven, 10, 14, 20, 30, and 40. This schedule varied somewhat depending on weather and coordination with the other survey work. Removal trial carcasses were marked discreetly (e.g., tape or ribbon around leg) for recognition by observers and other personnel, and left at the location until the end of the carcass removal trial. At the end of the 40-day period, any remaining evidence of the carcass was removed.

Statistical Analysis

Quality Assurance and Quality Control

Quality assurance and quality control (QA/QC) measures were implemented at all stages of the study, including in the field, during data entry and analysis, and during report writing. Following field surveys, observers were responsible for inspecting data forms for intactness, accuracy, and legibility. A weekly summary of data collected on electronic tablets was sent and reviewed by field personnel. A sample of records from an electronic database was compared to the raw data forms and any errors detected were corrected. Irregular codes or data suspected as questionable were discussed with the observer or project manager. Errors, omissions, or problems identified in later stages of analysis were traced back to the raw data forms, and appropriate changes in all steps were made.

Data Compilation and Storage

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

Fatality Estimates

Estimates of facility-related fatalities were based on:

1. Observed number of carcasses found during standardized searches during the monitoring period, for which the cause of death was either unknown or was probably facility-related;
2. Non-removal rates, expressed as the estimated average probability a carcass was expected to remain in the study area and was available for detection by the searchers during removal trials; and
3. Searcher efficiency, expressed as the proportion of trial carcasses found by searchers during searcher efficiency trials.

The number of bird and bat fatalities attributable to operation of the wind energy facility, based on the number of bird and bat fatalities found at the facility whose death appeared related to facility operation, was reported. All carcasses located within areas surveyed, regardless of species, were recorded and, if possible, a cause of death was determined based on a cursory field necropsy. The total number of bird and bat fatalities was estimated by adjusting the number of carcasses found for removal and searcher efficiency bias. Fatality estimates were provided for five categories: 1) all birds, 2) small birds, 3) large birds, 4) raptors, and 5) bats. Only bird or bat fatalities found within the 26 turbine plots selected for fatality searches were used to estimate bird and bat fatality rates, including fatalities found incidentally at these plots outside of the scheduled surveys; incidental fatalities found at other turbine plots were recorded but were not used in the estimates.

Definition of Variables

The following variables are used in the equations below:

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

n the number of search plots

k the number of turbines searched (including the turbines centered within each search plot)

$\bar{c}$ the average number of carcasses observed per turbine per monitoring year

s the number of carcasses used in removal trials

s_c the number of carcasses in removal trials that remained in the study area after 40 days

se standard error (square of the sample variance of the mean)

t_i the time (in days) a carcass remained in the study area before it was removed, as determined by the removal trials

$\bar{t}$ the average time (in days) a carcass remained in the study area before it was removed, as determined by the removal trials

d the total number of carcasses placed in searcher efficiency trials

p the estimated proportion of detectable carcasses found by searchers, as determined by the searcher efficiency trials

I the average interval between standardized carcass searches, in days

A proportion of the search area of a turbine actually searched

$\hat{\pi}$ the estimated probability that a carcass was both available to be found during a search and was found, as determined by the removal trials and the searcher efficiency trials

m the estimated annual average number of fatalities per turbine per year, adjusted for removal and searcher efficiency bias

Observed Number of Carcasses

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

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

Estimation of Carcass Non-Removal Rates

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

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

Estimation of Searcher Efficiency Rates

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

Estimation of Facility-Related Fatality Rates

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

$$m = \frac{\bar{c}}{\hat{\pi}} \tag{3}$$

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

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

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

This formula has been independently verified by Shoenfeld (2004). The final reported estimates of *m* and associated standard errors and 90% confidence intervals are calculated using bootstrapping (Manly 1997). Bootstrapping is a computer simulation technique that is useful for calculating point estimates, variances, and confidence intervals for complicated test statistics.

For each bootstrap sample, $\bar{c}$, $\bar{t}$, p, $\hat{\pi}$, and *m* were calculated. A total of 5,000 bootstrap samples were used. The reported estimates are the mathematical means of the 5,000 bootstrap estimates. The standard deviation of the bootstrap estimates is the estimated standard error. The lower 5th and upper 95th percentiles of the 5,000 bootstrap estimates are estimates of the lower limit and upper limit of 90 % confidence intervals.

Raptor Nest Surveys

The entire DWEF, as well as a 2-mile (3.2-km) buffer around the project turbines, was surveyed for raptor nests. The objective of the raptor nest surveys was to determine which nests were occupied during the 2012 nesting season and if possible determine nesting success. The 2012 nest data will be compared to preconstruction data on nesting raptors obtained during the 2009 baseline study (Johnson et al. 2009). Known golden eagle (*Aquila chrysaetos*) nests were visited early in the nesting season (late-March/early-April) to determine occupancy. The occupancy checks were completed on foot. The entire study area and the 2-mile buffer were systematically searched by helicopter in April 2012. Trees, cliffs, rock outcrops, and other potential nest structures, such as wind mills and utility poles, were searched. Historic nest databases (received from the Bureau of Land Management [BLM]) were utilized during aerial surveys. The helicopter flew north/south transects across the project area. Universal Transverse Mercator (UTM) coordinates, as well as nesting substrate and current status (inactive, active, incubating, young in nest) were recorded for each nest located. Follow-up checks were completed throughout the nesting season to monitoring nest success and identify chicks/fledglings.

Incidental Wildlife Observations

The objective of incidental wildlife observations was to provide a record of wildlife observed within the DWEF while conducting monitoring activities. Although no pre-construction data are available for most species at the DWEF, there is little information for many species on how they

were affected by wind energy development (Gamo 2010). Therefore, even post-construction observational data on wildlife use near wind turbines provide meaningful information. All raptors, unusual or unique birds, sensitive species, mammals, reptiles, and amphibians were recorded. Data recorded included date, time, species, number of individuals, sex/age class, distance from observer, activity, height above ground (for bird species), and habitat. The location of sensitive species was recorded using GPS coordinates.

RESULTS

Standardized Carcass Surveys

Birds

Twenty-six wind turbines and two met towers were searched at the DWEF during the period March 1, 2012, to February 28, 2013, for a total of 558 turbine and met tower searches.

Twenty-five bird carcasses were found during this period (Table 1), including 22 found during standardized searches of the study plots and three found as incidental discoveries (Table 1, Appendix A). The 22 bird carcasses found during scheduled searches included 20 passerines, with the most common species being horned lark (*Eremophila alpestris*; four carcasses), one raptor (ferruginous hawk [*Buteo regalis*]), and one mallard. The mallard may have been a trial bird; however, this could not be confirmed so it was included in the fatality estimate. The birds carcasses found incidentally included a vesper sparrow (*Pooecetes gramineus*), western grebe (*Aechmophorus occidentalis*), and burrowing owl (*Athene cunicularia*). Six of the 25 bird carcasses, including a Brewer's sparrow (*Spizella breweri*), yellow-headed blackbird (*Xanthocephalus xanthocephalus*), horned lark, yellow warbler (*Setophaga petechia*), and two unidentified sparrows, were found at met towers while all other carcasses were found at project turbines.

Table 1. Total number of bird and bat casualties and the composition of casualties discovered at the Dunlap Wind Energy Facility from March 1, 2012 – February 28, 2013.

	Fatalities during Scheduled Searches		Incidental Fatalities at Search Plots*		Other Incidentals		Total	
Species	**Total**	**% Comp.**	**Total**	**% Comp.**	**Total**	**% Comp.**	**Total**	**% Comp.**
Birds								
horned lark	4	18.2	0	0	0	0	4	16
unidentified bird (small)	3	13.6	0	0	0	0	3	12
Brewer's sparrow	2	9.1	0	0	0	0	2	8
lark bunting	2	9.1	0	0	0	0	2	8
unidentified sparrow	2	9.1	0	0	0	0	2	8
European starling	1	4.5	0	0	0	0	1	4
ferruginous hawk	1	4.5	0	0	0	0	1	4
indigo bunting	1	4.5	0	0	0	0	1	4
mallard	1	4.5	0	0	0	0	1	4
Townsend's warbler	1	4.5	0	0	0	0	1	4
unidentified passerine	1	4.5	0	0	0	0	1	4
white-throated swift	1	4.5	0	0	0	0	1	4
yellow-headed blackbird	1	4.5	0	0	0	0	1	4
yellow warbler	1	4.5	0	0	0	0	1	4
burrowing owl	0	0	0	0	1	33.3	1	4
vesper sparrow	0	0	0	0	1	33.3	1	4
western grebe	0	0	0	0	1	33.3	1	4
Overall Birds	**22**	**100**	**0**	**0**	**3**	**100**	**25**	**100**
Bats								
hoary bat	4	36.4	0	0	0	0	4	36.4
silver-haired bat	3	27.3	0	0	0	0	3	27.3
unidentified bat	3	27.3	0	0	0	0	3	27.3
eastern red bat	1	9.1	0	0	0	0	1	9.1
Overall Bats	**11**	**100**	**0**	**0**	**0**	**0**	**11**	**100**

*Fatalities found incidentally on turbine search plots were included in analyses.

None of the bird fatalities found are federally-listed species; however, all of the bird species found are protected under the Migratory Bird Treaty Act (MBTA 1918), excluding European starling (*Sturnus vulgaris*), which is a non-native introduced species.

Of the turbines searched during fatality surveys, one turbine (D74) had three bird discoveries, three turbines (D20, D29, and D32) had two discoveries, seven turbines (D2, D14, D35, D39, D50, D62, and D68) had one discovery, and the remaining turbines did not have any avian discoveries (Figures 3 and 4). Met P1M2 had five discoveries, while met P1M1 had one (Figures 3 and 4). Not including incidental discoveries or discoveries at met towers, 62.5% of the carcasses were located at end turbines.

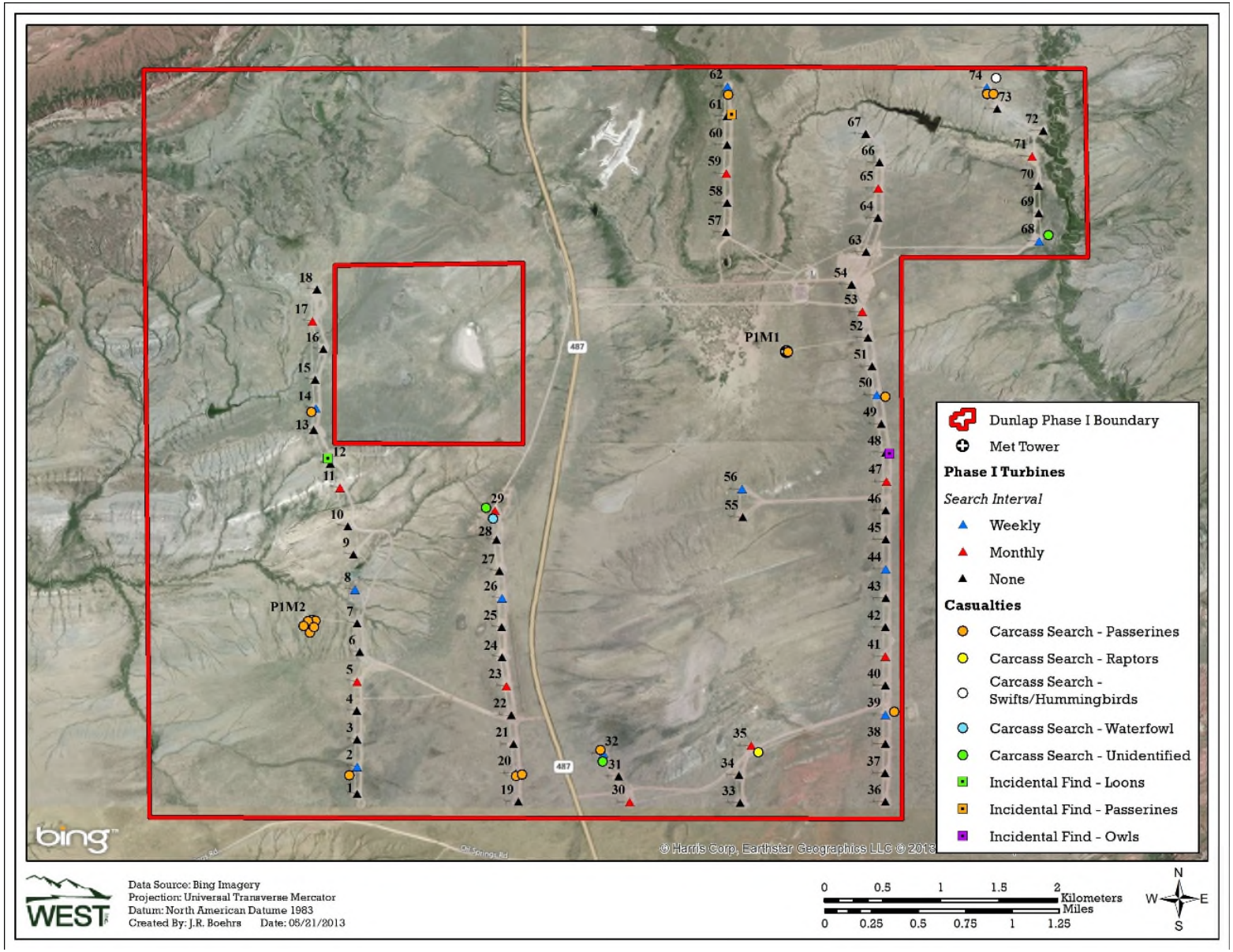

Figure 3. Location of bird casualties found at the Dunlap Wind Energy Facility.

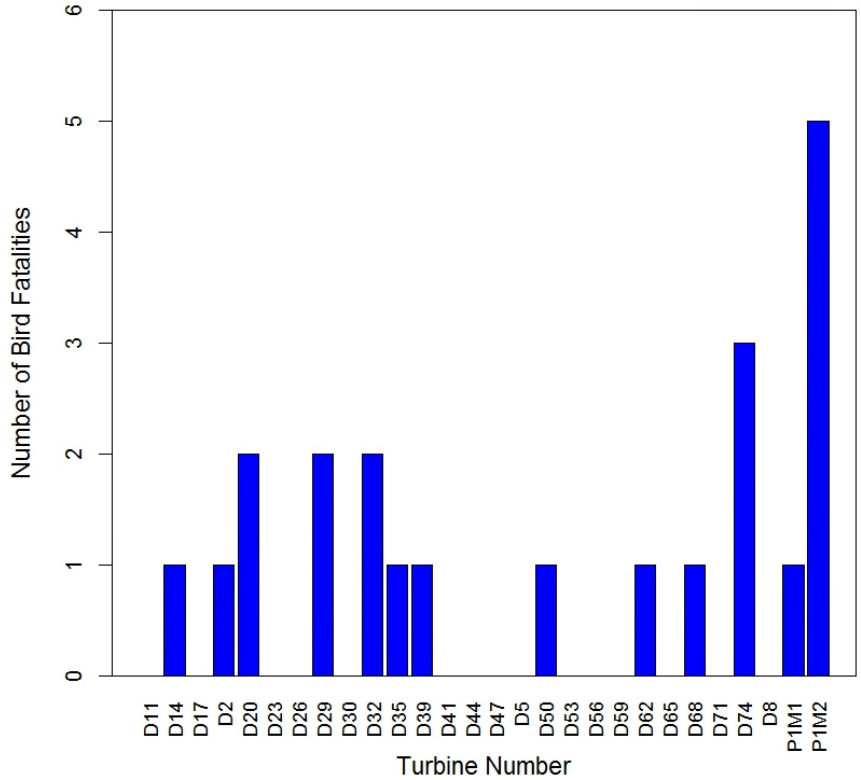

Figure 4. Number of bird fatalities by turbine and meteorological (met) tower at the Dunlap Wind Energy Facility.

Most (81.3%) bird carcasses were found greater than 50 m (164 ft) from the nearest turbine, while 18.9% were found between 20 and 50 m (66 to 164 ft) from the nearest turbine (Table 2; Figure 5). Most of the bird carcasses (50.0%) found at met towers were located from 30 to 40 m (98 to 131 ft) away from the tower, while the remainder were located less than 30 m (Table 3; Figure 6). Bird carcasses at turbines were detected during the period April through November (Figure 7). No clear indication of peak risk was noted based on the discovery timing. Bird carcasses at met towers occurred from June through September (Figure 8).

Table 2. Distribution of distances of bird and bat casualties from turbines at the Dunlap Wind Energy Facility.

Distance to Turbine (m)	% Bird Casualties	% Bat Casualties
0 to 10	0	0.0
10 to 20	0	9.1
20 to 30	6.3	27.3
30 to 40	6.3	18.2
40 to 50	6.3	27.3
50 to 60	12.5	9.1
60 to 70	18.8	9.1
70 to 80	25	0.0
> 80	25	0.0

Table 3. Distribution of distances of bird and bat casualties from meteorological (met) towers at the Dunlap Wind Energy Facility.

Distance to Turbine (m)	% Bird Casualties	% Bat Casualties
0 to 10	16.7	0
10 to 20	16.7	0
20 to 30	16.7	0
30 to 40	50	0
40 to 50	0	0
50 to 60	0	0
>60	0	0

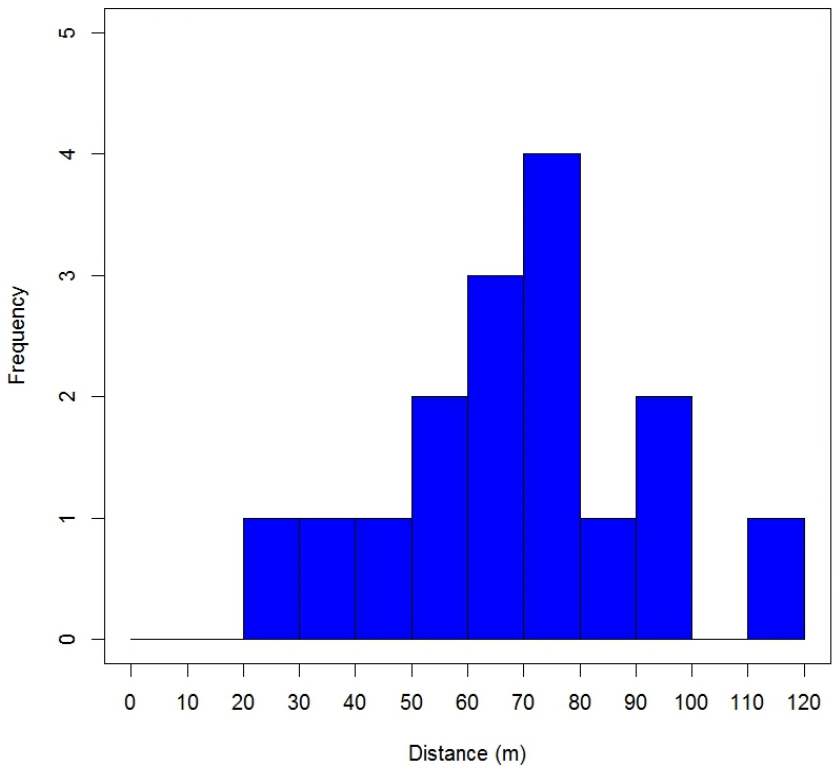

Figure 5. Distance of bird fatalities from the turbines at the Dunlap Wind Energy Facility.

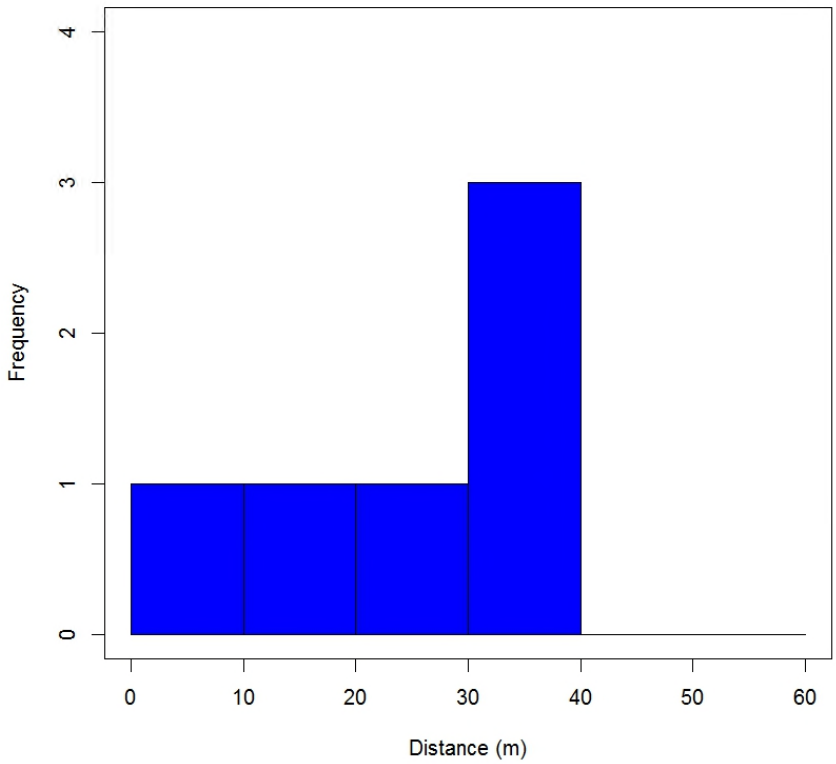

Figure 6. Distance of bird fatalities from the meteorological (met) towers at the Dunlap Wind Energy Facility.

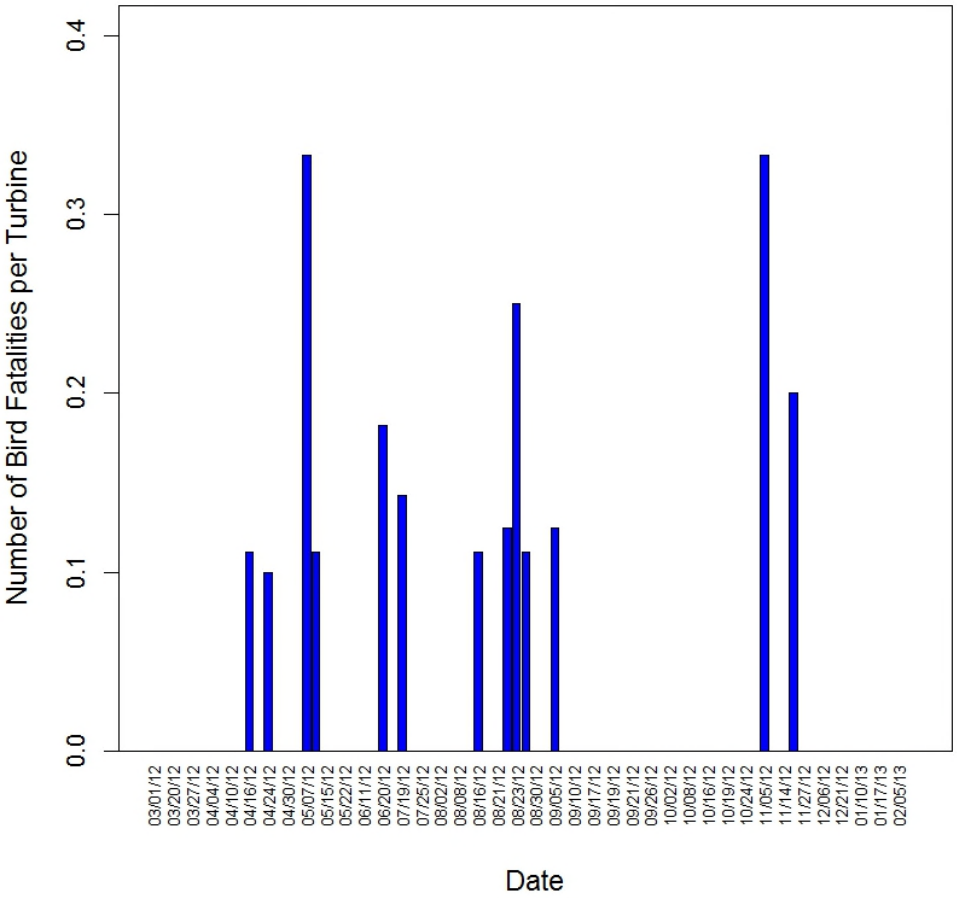

Figure 7. Timing of bird fatalities at the turbines for the Dunlap Wind Energy Facility.

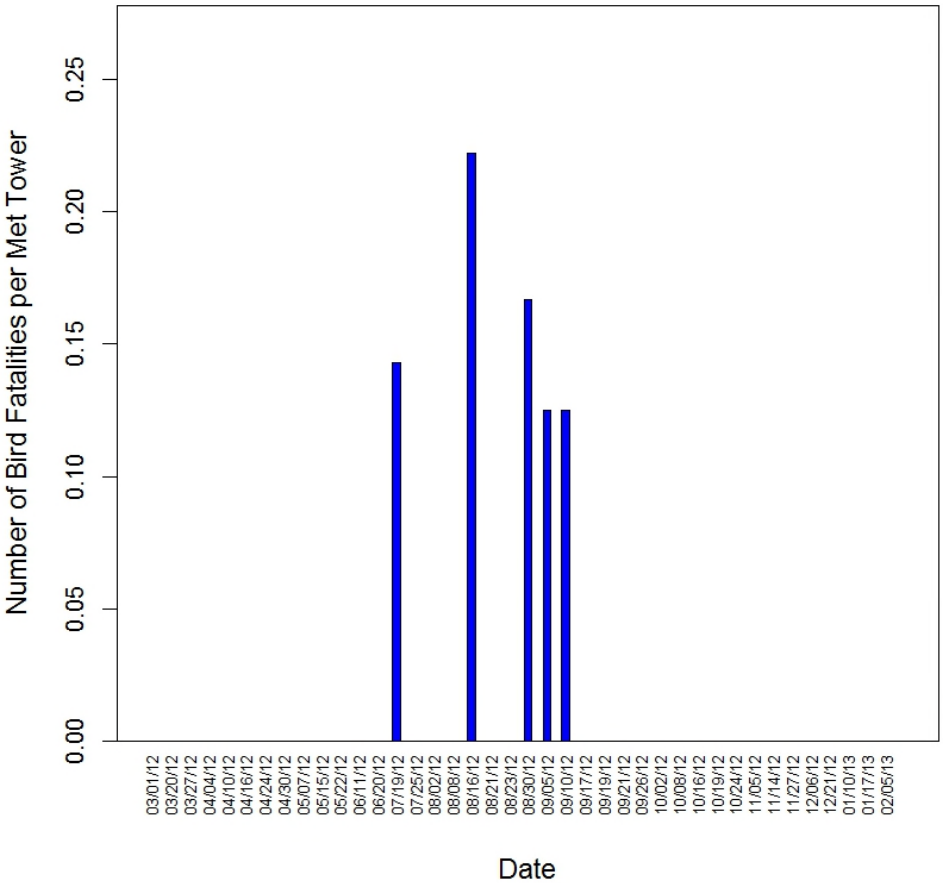

Figure 8. Timing of bird fatalities at the meteorological (met) towers for the Dunlap Wind Energy Facility.

Bats

Eleven bat carcasses were found during the second year of monitoring (Table 1), all found during standard searches (Table 1, Appendix A). Of the 11 bat discoveries, four were hoary bats (*Lasiurus cinereus*), three were silver-haired bats (*Lasionycteris noctivagans*), one was an eastern red bat (*Lasiurus borealis*), and three bats were too decomposed (or partial) for and positive identification (Appendix A). None of the bat fatalities involved federally-listed species. All bat casualties were found at turbines.

One turbine (D62) had three discoveries, one turbine (D50) had two, six turbines (D2, D8, D35, D39, D56, and D71) had one discovery, and the remaining turbines had none (Figure 9 and 10). Most (81.8%) bat fatalities were found less than 50 m from the nearest turbine, while 18.2% were found between 60 and 80 m (197 to 262 ft) from the nearest turbine (Table 2; Figure 11). Ten of the bat discoveries occurred in the months of August and September, while one occurred in October (Figure 12; Appendix A).

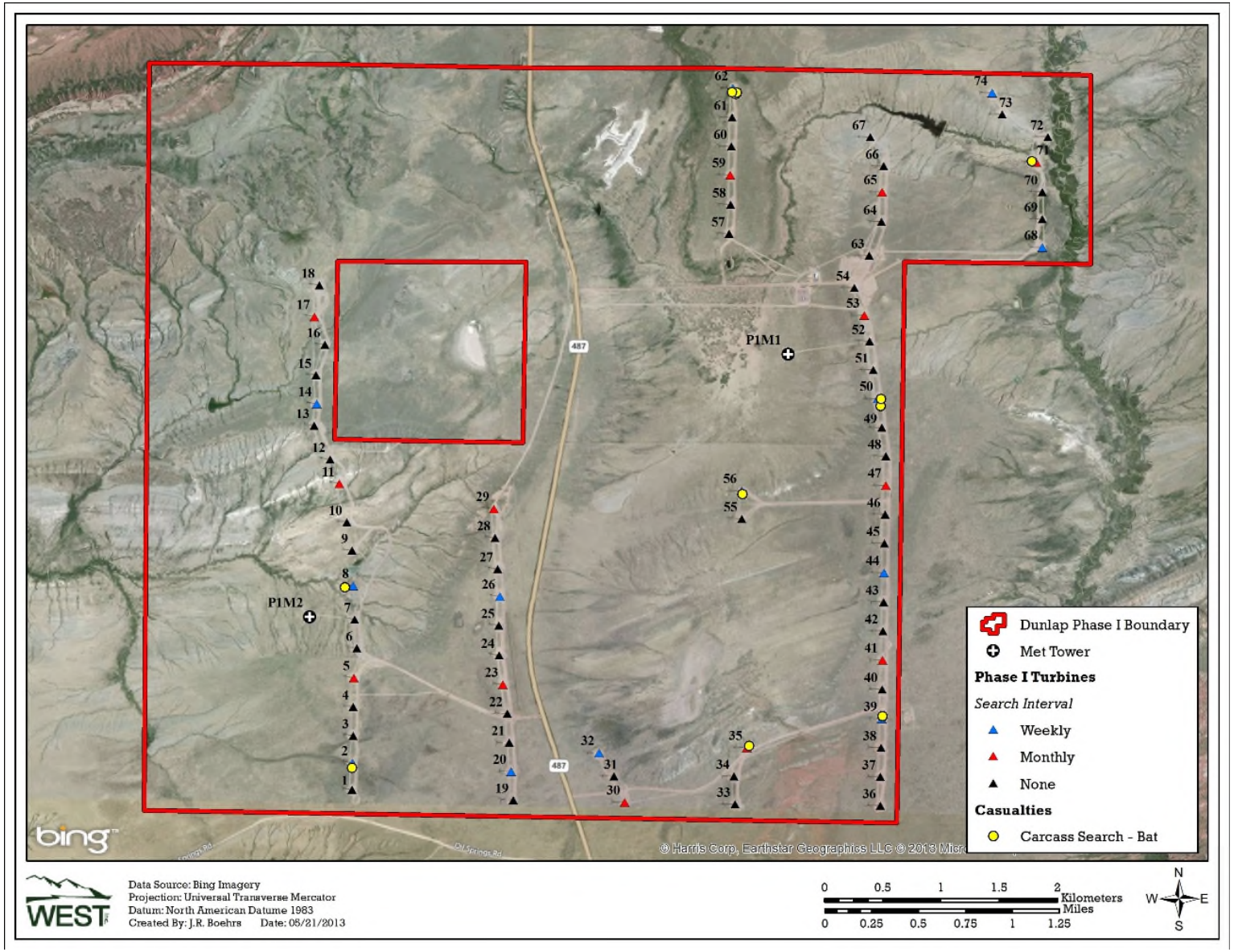

Figure 9. Location of bat casualties found at the Dunlap Wind Energy Facility.

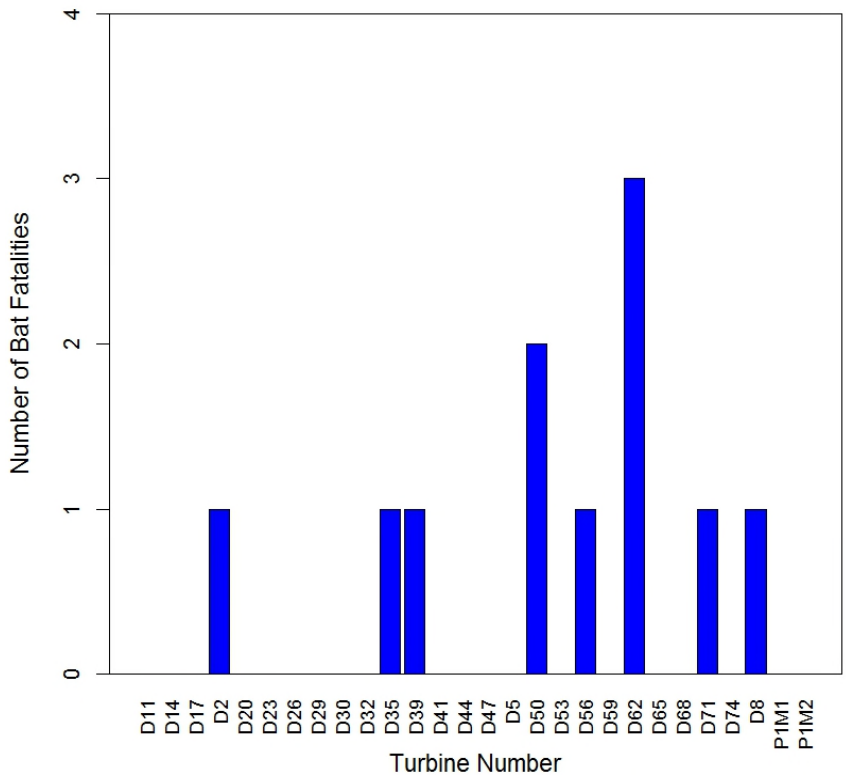

Figure 10. Number of bat fatalities by turbine and meteorological (met) tower at the Dunlap Wind Energy Facility.

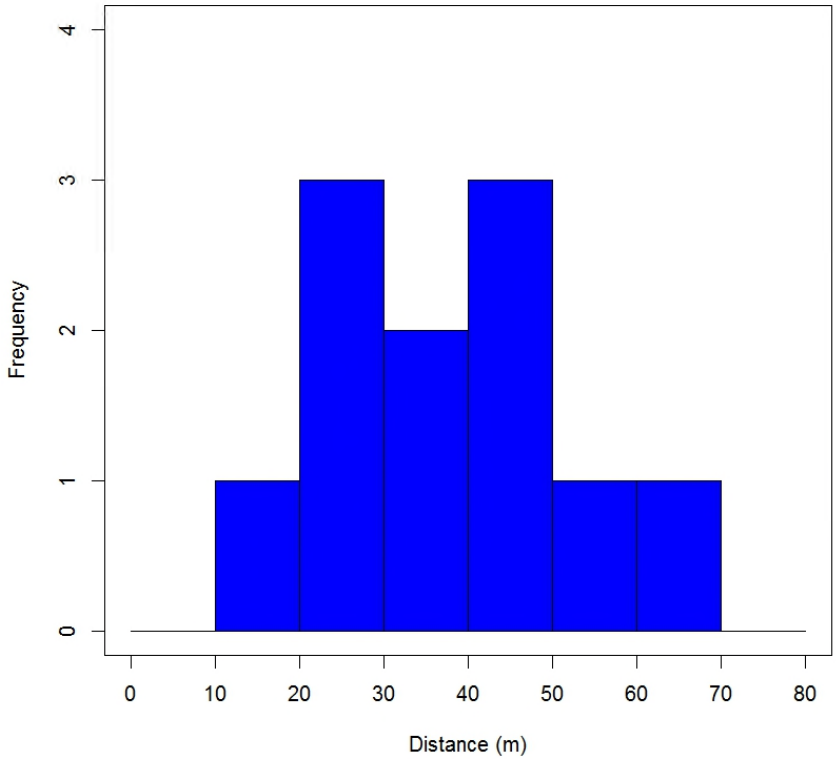

Figure 11. Distance of bat fatalities from the turbines at the Dunlap Wind Energy Facility.

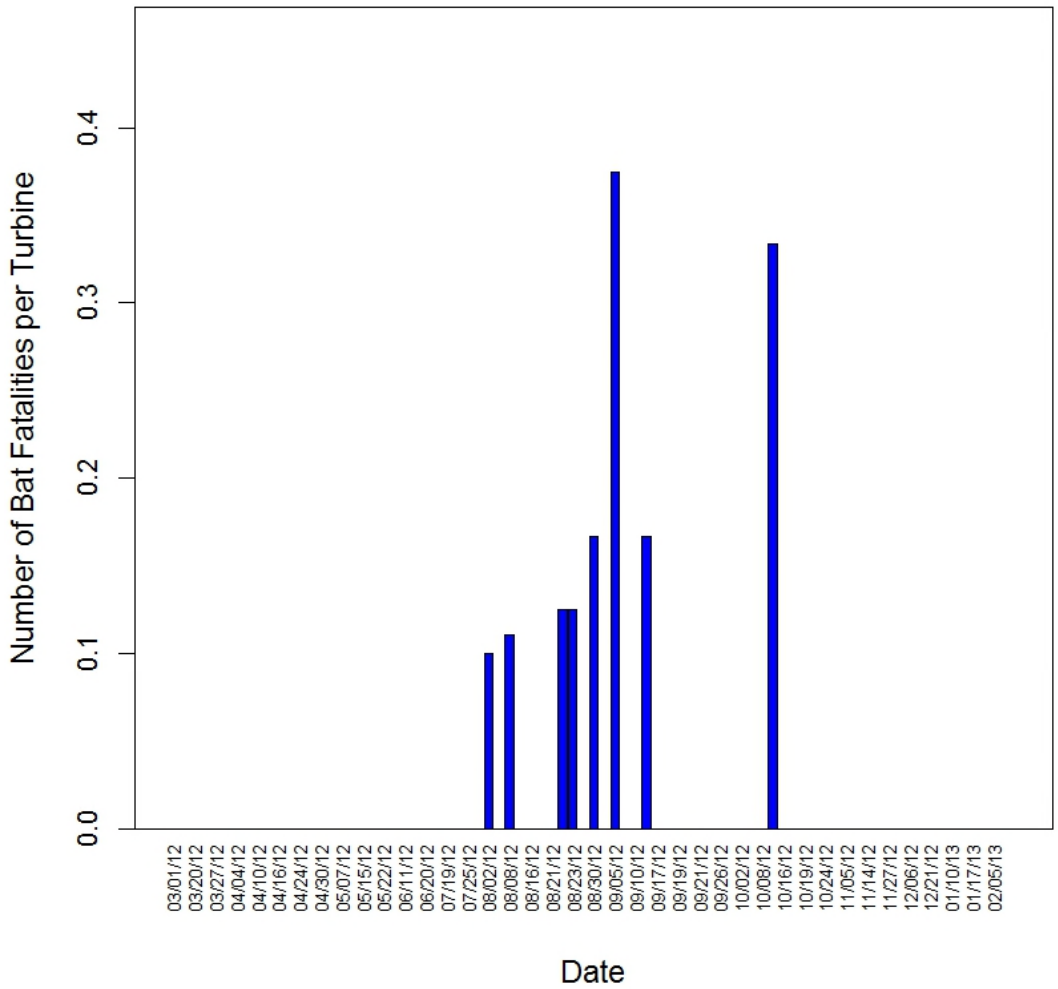

Figure 12. Timing of bat fatalities at the turbines for the Dunlap Wind Energy Facility.

Bias Trials

During searcher efficiency trials, searchers detected 90.6% of the large birds, 47.6% of the small birds, and 62.5% of the bats (Table 4). Based on scavenger trial data, the mean removal time was 8.23 days for large birds, 4.25 days for small birds and bats (Figure 13). Due to the small sample size of trial bats, they were combined with small birds.

Table 4. Searcher efficiency results at the Dunlap Wind Energy Facility as a function of carcass size.

Size	Date	# Placed	# Available	# Found	% Found
Small Birds	4/10/2012	3	3	2	66.7
	5/8/2012	2	2	0	0.0
	6/20/2012	3	3	3	100.0
	7/19/2012	3	3	0	0.0
	8/29/2012	2	2	0	0.0
	10/16/2012	2	2	1	50.0
	11/14/2012	6	4	2	50.0
	1/16/2013	2	2	2	100.0
Small Bird Total		**23**	**21**	**10**	**47.6**
Large Birds	4/10/2012	4	4	4	100.0
	5/8/2012	4	3	2	66.7
	6/20/2012	3	3	3	100.0
	8/29/2012	3	3	3	100.0
	10/16/2012	3	3	3	100.0
	11/14/2012	10	10	8	80.0
	1/16/2013	6	6	6	100.0
Large Bird Total		**33**	**32**	**29**	**90.6**
Bats	5/8/2012	2	1	1	100.0
	6/20/2012	2	1	1	100.0
	7/19/2012	5	4	2	50.0
	8/29/2012	2	2	1	50.0
Bat Total		**11**	**8**	**5**	**62.5**

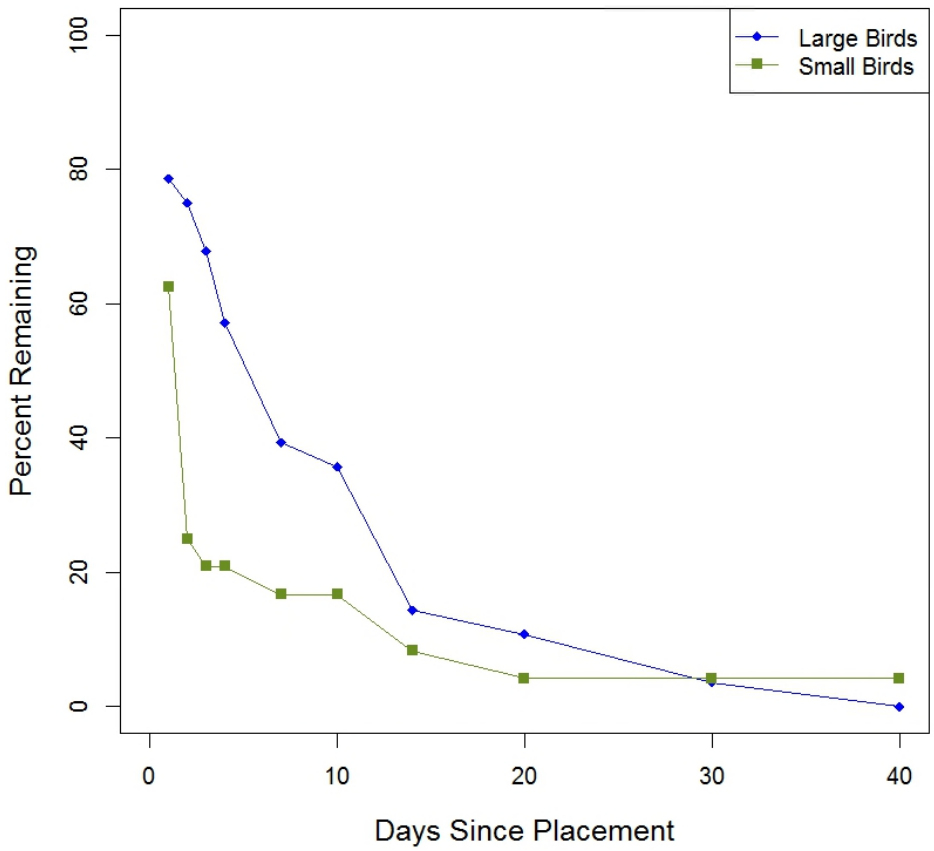

Figure 13. Carcass removal rates at the Dunlap Wind Energy Facility.

Given the estimated searcher efficiency and scavenger removal rates, the average probability that a large bird would remain in a search plot and be found during a scheduled search was 64.0% for turbines searched weekly and anywhere from 23.0% to 25.0% for turbines searched every four weeks, depending on season (Appendix B). For small birds and bats, these probabilities were 28.0% for turbines searched weekly and 7.0% – 8.0% for turbines searched every four weeks. (Appendix B and C).

Adjusted Fatality Estimates

Small Birds

The adjusted fatality estimate for small birds at wind turbines was 3.62 fatalities/turbine/year (2.41 fatalities/MW/year; Table 5), which resulted in a total mortality estimate of approximately 268 small birds for the entire facility per year. The estimated small bird fatality rate at met towers was 16.24 fatalities/met tower/year (Table 6), which is approximately 4.5 times higher than the small bird fatality rate at the project wind turbines.

Large Birds

The adjusted fatality estimate for all large birds (e.g., raptors, waterbirds, and waterfowl) at wind turbines was 0.32 fatalities/turbine/year (0.21 fatalities/MW/year; Table 5), which resulted in a total mortality estimate of approximately 24 large birds for the entire facility per year. No large birds were located at met towers, therefore an estimate is not provided.

Raptors

The adjusted fatality estimate for raptors at wind turbines was 0.15 fatalities/turbine/year (0.10 fatalities/MW/year; Table 5), which resulted in a total mortality estimate of approximately 11 raptors for the entire facility per year. No raptor fatalities were found at the met towers.

All Birds

The adjusted fatality estimate for all birds combined at wind turbines was 3.94 fatalities/turbine/year (2.63 fatalities/MW/year; Table 5), which resulted in a total mortality estimate of approximately 292 birds per year for all 74 turbines combined.

Bats

The adjusted fatality estimate for bats at wind turbines was 2.24 fatalities/turbine/year (1.49 fatalities/MW/year; Table 5), which resulted in a total mortality estimate of about 166 bats for the entire facility per year. No bats were found at met towers.

Table 5. Adjusted bird and bat fatality estimates for wind turbines at the Dunlap Wind Energy Facility from March 1, 2012 – February 28, 2013.

	Corrected Fatality Estimate
# fatalities/turbine/year	
Small Birds	3.62
Large Birds	0.32
Raptors	0.15
All Birds	3.94
Bats	2.24
# fatalities/MW/year	
Small Birds	2.41
Large Birds	0.21
Raptors	0.10
All Birds	2.63
Bats	1.49

For more details concerning correction factors and confidence intervals for both bird and bat fatality estimates, refer to Appendices B and C.

Table 6. Adjusted bird and bat fatality estimates for meteorological (met) towers at the Dunlap Wind Energy Facility from March 1, 2012 – February 28, 2013.

	Corrected Fatality Estimate
# fatalities/met tower/year	
Small Birds	16.24
Large Birds	0
Raptors	0
All Birds	16.24
Bats	0

For more details concerning correction factors and confidence intervals for both bird and bat fatality estimates, refer to Appendices B and C.

Raptor Nest Surveys

In 2009, one golden eagle nest, three active ferruginous hawk (*Buteo regalis*) nests, one active merlin (*Falco columbarius*) nest, one active great horned owl (*Bubo virginianus*) nest, and one active long-eared owl (*Asio otus*) nest were located within the survey area (Johnson et al. 2009). The 2009 raptor nest survey area included a 1-mile (1.6-km) buffer around the proposed Phase I and Phase II Dunlap Wind Resource Area, which covered a different area then the 2012 survey area, which included a 2-mile buffer from existing turbine locations. Therefore, some of the nests identified in 2009 were outside the 2012 nest survey area and were not visited in 2012.

During the 2012 raptor nest survey, one golden eagle nest was occupied and inactive, four ferruginous hawk nests were occupied and active, and one prairie falcon (*Falco mexicanus*) nest was occupied and active (Figure 14). The ferruginous hawk nests (including two artificial nest platforms) each produced between one and three chicks. Five eggs were observed in the prairie falcon nest.

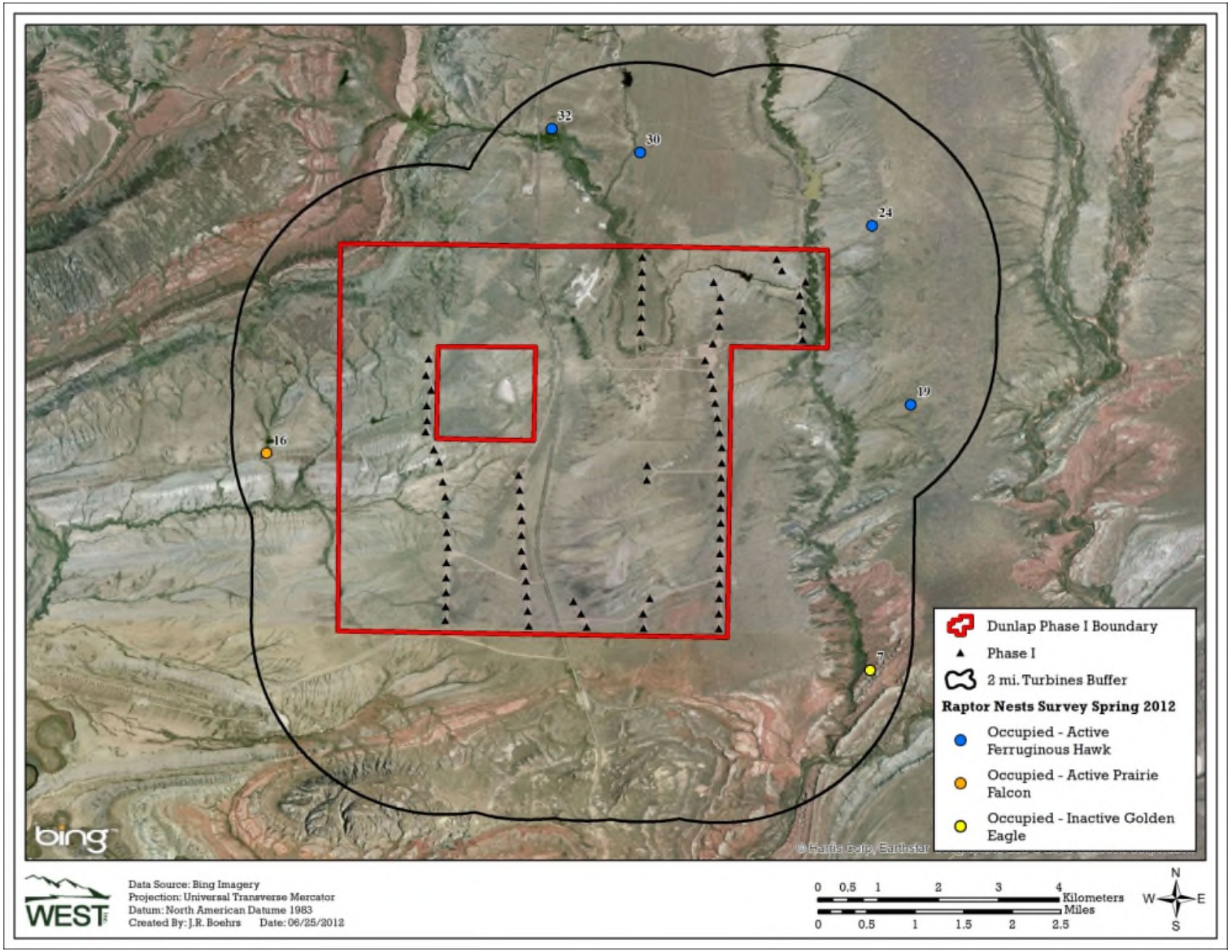

Figure 14. 2012 raptor nest survey results at the Dunlap Wind Energy Facility.

Incidental Wildlife Observations

Incidental wildlife observations were recorded during all onsite events. A total of 82 incidental observations of 12 bird and two mammal species were recorded (Table 7). Six raptor species were observed incidentally, including 37 golden eagles, 10 ferruginous hawks, four American kestrels (*Falco sparverius*), four prairie falcons, two red-tailed hawks (*Buteo jamaicensis*), and one northern harrier (*Circus cyaneus*). Mammals observed included two observations of muskrats (*Ondatra zibethicus*) and one of badger (*Taxidea taxus*; Table 7). Due to comparatively large numbers and consistent sightings, incidental observations of pronghorn antelope (*Antilocapra americana*) were not documented for each sighting. Pronghorn antelope were observed throughout the DWEF during nearly every survey event.

Table 7. Incidental wildlife observed while conducting all surveys at the Dunlap Wind Energy Facility from March 1, 2012 – February 28, 2013.

Species	Scientific Name	# grps	# obs
golden eagle	*Aquila chrysaetos*	24	37
northern pintail	*Anas acuta*	1	10
ferruginous hawk	*Buteo regalis*	9	10
mountain plover	*Charadrius montanus*	6	7
prairie falcon	*Falco mexicanus*	3	4
American kestrel	*Falco sparverius*	4	4
American avocet	*Recurvirostra americana*	3	3
American wigeon	*Anas americana*	1	2
red-tailed hawk	*Buteo jamaicensis*	2	2
greater sage grouse	*Centrocercus urophasianus*	1	1
northern harrier	*Circus cyaneus*	1	1
American pipit	*Anthus rubescens*	1	1
Bird Subtotal	**9 species**	**56**	**82**
muskrat	*Ondatra zibethicus*	1	2
badger	*Taxidea taxus*	1	1
Mammal Subtotal	**2 species**	**2**	**3**
rattlesnake	*Crotalus spp.*	1	1
Reptile Subtotal	**1 species**	**1**	**1**

DISCUSSION

Bird Fatalities at Dunlap

The raptor fatality estimate at the DWEF (0.10 raptors/MW/year; Table 5) was moderate compared to estimated raptor fatality rates at other regional wind energy facilities with similarly collected data (Figure 15; Appendix D). Compared to 39 studies at wind energy facilities in western North America with publically-available raptor mortality data, the DWEF raptor fatality estimate ranked 21st highest. Based on raptor use data collected during the baseline study for the Dunlap Wind Resource Area, the predicted raptor mortality rate was 0.06 fatalities/MW/year (Johnson et al. 2009). The actual mortality rate at the DWEF during the second year of monitoring was higher than the predicted rate, but was within the 90% prediction interval, which ranged from zero to 0.32 fatalities/MW/year (Johnson et al. 2009). The Year-2 estimate is down

slightly from the Year-1 estimate. The first year of monitoring resulted in a 0.13 raptor/MW/year estimate (Martinson et al. 2012). The Year-2 estimate is based on a single raptor carcass (and bias trials).

Overall bird fatality estimates are available for 49 comparable studies at wind energy facilities across western North America (Figure 16; Appendix D). Compared to these other regional wind energy facilities in western North America, the estimated bird fatality rate at turbines within the DWEF (2.63 fatalities/MW/year) was moderate, ranking 20th of the 50 studies with similarly-collected avian fatality data (Figure 16). The total avian fatality rate at met towers (16.24 fatalities/met tower/year) was approximately 4.5 times higher than the avian fatality rate per turbine (3.62 fatalities/turbine/year; Tables 5 and 6). Year-2 estimates were significantly higher that Year-1 results. Year-1 provided a small bird estimate of 0.68 fatalities/MW/year.

The higher fatality estimate for small birds was partially driven by bias trial rates. Year-2 carcasses removal trials for small birds (and bats) had an average removal time of 4.25 days, compared to a 12.6 day removal average during Year-1. Biologist did note scavengers (coyotes [*Canis latrans*], common ravens [*Corvus corax*], and raptors) present in the area while laying trials. It is not known if scavengers are keying on trials; however, efforts will be made in Year-3 to lay trial when scavengers are not present. Searcher efficiency rates did not show dramatic changes (Year-2 47.6% vs. Year-1 55.6%), but were lower in Year-2 when compared with Year-1 rates.

Bat Fatalities at Dunlap

The estimated bat fatality rate at the DWEF of 1.49 bats/MW/year was moderate compared to other regional wind energy facilities in western North America, ranking 25th of 52 studies at facilities with comparable and publicly-available bat fatality data (Figure 17). Compared to some wind energy facilities in other parts of the country, however, bat fatality rates at the DWEF are relatively low (Appendix D). For example, documented bat fatality rates have been 39.7 fatalities/MW/year in Tennessee (Fiedler et al. 2007), 31.69 fatalities/MW/year in West Virginia (Kerns and Kerlinger 2004), and 30.61 fatalities/MW/year in Wisconsin (BHE Environmental 2010). Bat fatality estimates in Year-2 were considerably lower than Year-1 (5.91 fatalities/MW/year).

The bat fatality estimate for the DWEF was likely strongly influenced by relatively short scavenger removal times for bat carcasses; bat carcasses lasted an average of 4.25 days before being removed. Due to the limited number of available bat carcasses, trial rates were combined with small birds. Data collected during the final years of monitoring will provide more information on bat fatality rates at the site.

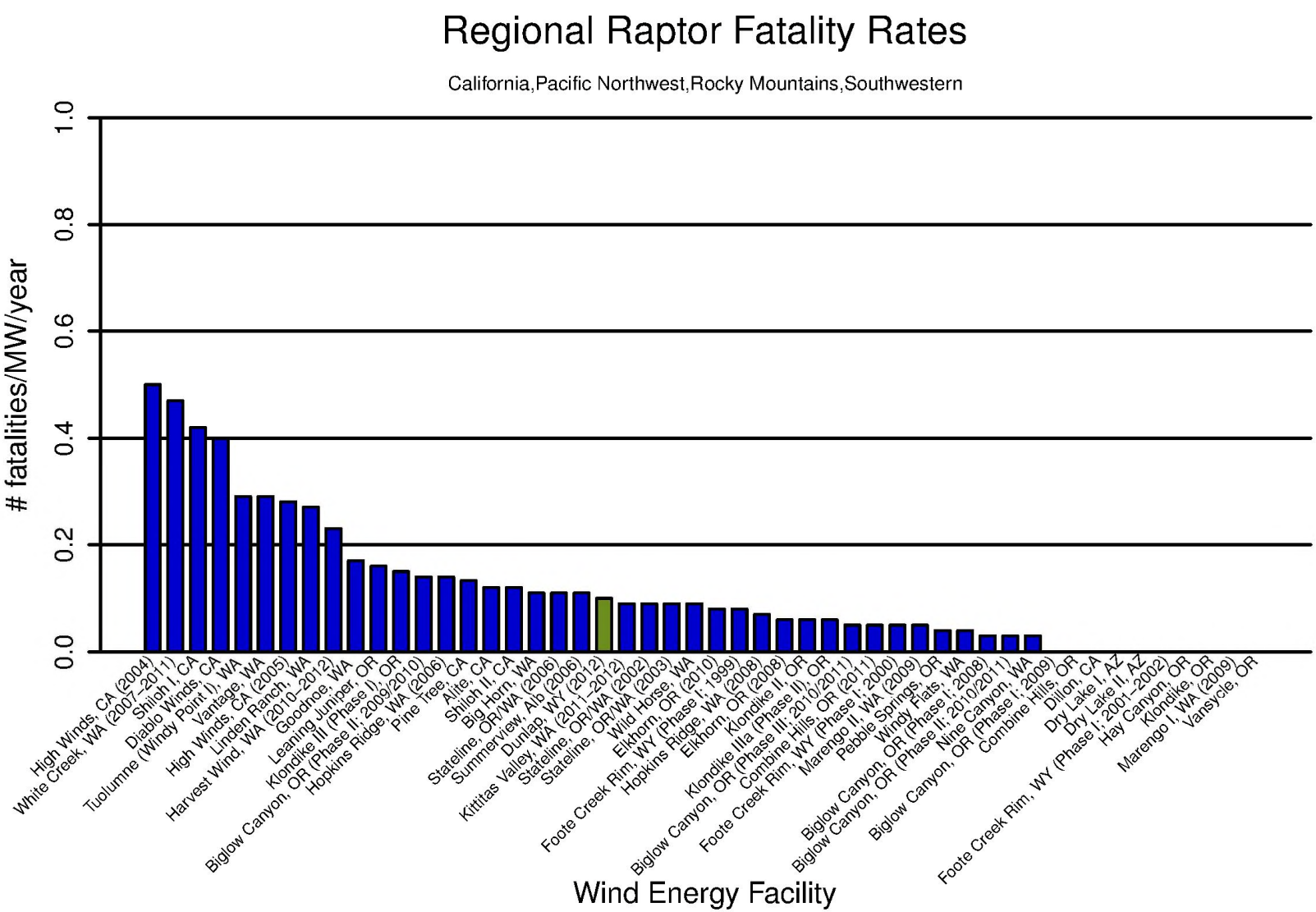

Figure 15. Fatality rates for raptors (number of raptors per megawatt per year) from comparable and publicly-available studies at wind energy facilities in western North America. The estimated fatality rate for the Dunlap Wind Energy Facility is highlighted in green.

Figure 15 (*continued*). Fatality rates for raptors (number of raptors per megawatt per year) from comparable and publicly-available studies at wind energy facilities in western North America.

Data from the following sources:

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

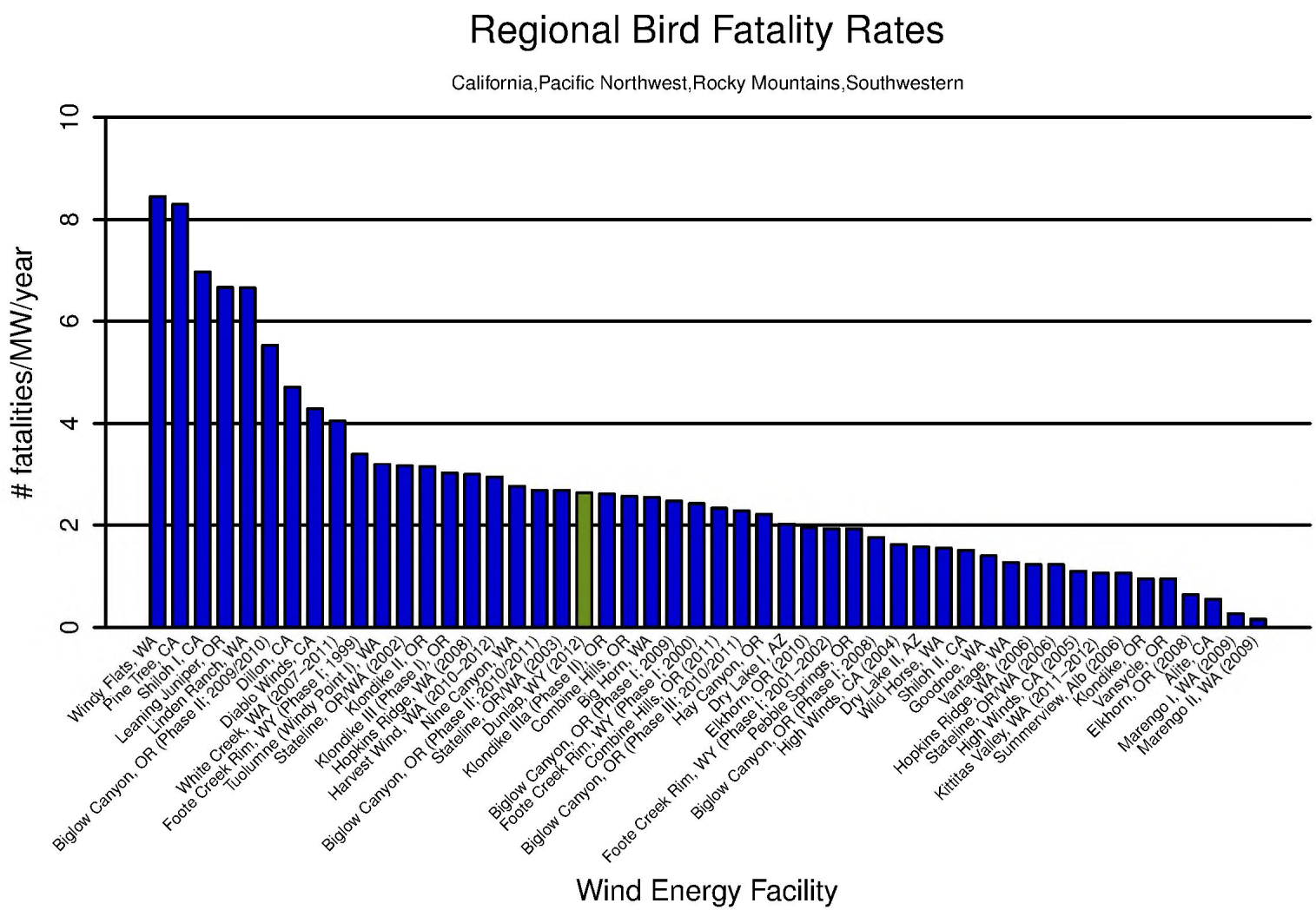

Figure 16. Fatality rates for all birds (number of birds per megawatt per year) from comparable and publicly-available studies at wind energy facilities in western North America. The estimated fatality rate for the Dunlap Wind Energy Facility is highlighted in green.

Figure 16 (*continued*). Fatality rates for all birds (number of birds per megawatt per year) from comparable and publicly-available studies at wind energy facilities in western North America.

Data from the following sources:

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

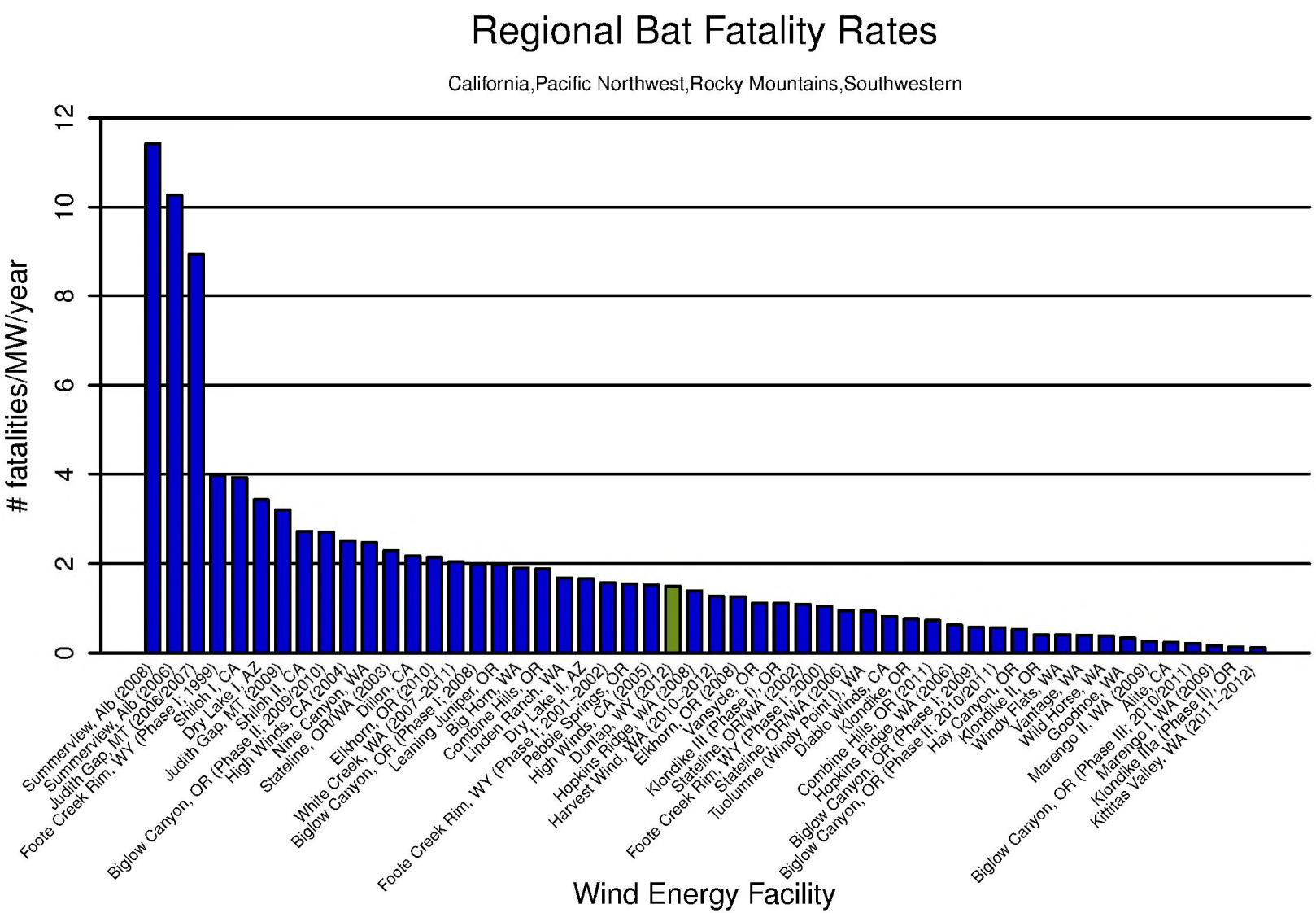

Figure 17. Fatality rates for bats (number of bats per megawatt per year) from comparable and publicly-available studies at wind energy facilities in western North America. The estimated fatality rate for the Dunlap Wind Energy Facility is highlighted in green

Figure 17 (*continued*). Fatality rates for bats (number of bats per megawatt per year) from comparable and publicly-available studies at wind energy facilities in western North America.

Data from the following sources:

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

With the exception of one eastern red bat and excluding three unidentified bats, all of the bat fatalities found at the DWEF were either hoary or silver-haired bats. This species composition is similar to that of other wind energy facilities across western North America where the majority of casualties are either hoary or silver-haired bats (Johnson and Stephens 2011). Based on the timing of fatalities, and, again, similar to other wind energy facilities (Johnson 2005, Arnett et al. 2008), it is likely that the majority of bat fatalities within the DWEF were fall migrants.

Raptor Nest Data

One occupied (inactive) golden eagle nest was present in the survey area (2-mile buffer from project turbines) in 2012. This nest was not within the 2009 survey area. Four ferruginous hawk nests were occupied (active) in 2012. Two of the ferruginous hawks were within the 2009 survey limits and active in 2009. The remaining two were not within the 2009 survey area. One prairie falcon nest was occupied (active) in 2012. This nest was within the 2009 survey limits, but not present in 2009. Nest occupation and success continues to vary from year to year.

CONCLUSIONS

Based on data collected during the monitoring period, collision mortality of raptors was moderate compared to most other wind energy facilities evaluated in western North America using similar methods. Mortality of all bird species combined at the DWEF was moderate compared to national as well as other regional fatality estimates. Bat fatalities were moderate compared to other projects across North America and regionally.

To date, post-construction monitoring data are only available for one wind energy facility in Wyoming, the Foote Creek Rim project located in Carbon County (Johnson et al. 2000b; Young et al. 2003b, 2003d, 2005). In addition, there are relatively very few studies with publicly-available data from the surrounding states. Results of this monitoring further contribute to the understanding of effects of wind energy developments on wildlife in Wyoming and the Rocky Mountain West. As more wind power projects are built in the region, and additional monitoring results become available, a clearer picture of the potential impacts will likely emerge.

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Appendix A. Bird and Bat Carcasses Found During Fatality Monitoring at the Dunlap Wind Energy Facility

Appendix A. Bird and bat carcasses found during fatality monitoring at the Dunlap Wind Energy Facility.

Date	Common Name	Location	Distance from Turbine (m)	Type of Find	Search Type	Condition
4/10/2012	western grebe	D12	42	incidental find		dismembered
4/16/2012	unidentified passerine	D2	100	carcass search	weekly	feather spot
4/24/2012	ferruginous hawk	D35	81	carcass search	monthly	dismembered
4/27/2012	vesper sparrow	D61	38	incidental find		dismembered
5/7/2012	horned lark	D20	52	carcass search	weekly	scavenged
5/7/2012	horned lark	D20	28	carcass search	weekly	feather spot
5/8/2012	horned lark	D39	79	carcass search	weekly	intact
6/20/2012	White-throated swift	D74	114	carcass search	weekly	dismembered
6/20/2012	lark bunting	D74	63	carcass search	weekly	dismembered
7/19/2012	mallard	D29	63	carcass search	weekly	dismembered
7/19/2012	Brewer's sparrow	P1M2	7	carcass search	weekly	intact
8/2/2012	burrowing owl	INC	25	incidental find		scavenged
8/2/2012	hoary bat	D39	15	carcass search	weekly	intact
8/8/2012	hoary bat	D8	68	carcass search	weekly	scavenged
8/16/2012	lark bunting	D14	50	carcass search	weekly	intact
8/16/2012	yellow-headed blackbird	P1M2	25	carcass search	weekly	intact
8/16/2012	horned lark	P1M1	15	carcass search	weekly	feather spot
8/22/2012	hoary bat	D71	37	carcass search	monthly	dismemberd
8/22/2012	unidentified bird (small)	D68	95	carcass search	weekly	feather spot
8/23/2012	hoary bat	D35	24	carcass search	monthly	intact
8/23/2012	indigo bunting	D32	34	carcass search	weekly	intact
8/23/2012	unidentified bird (small)	D32	71	carcass search	weekly	feather spot
8/29/2012	Brewer's sparrow	D62	69	carcass search	weekly	intact
8/30/2012	unidentified sparrow	P1M2	34	carcass search	weekly	scavenged
8/30/2012	unidentified bat	D2	45	carcass search	weekly	scavenged
9/5/2012	yellow warbler	P1M2	34	carcass search	weekly	intact
9/5/2012	eastern red bat	D62	42	carcass search	weekly	intact
9/5/2012	silver-haired bat	D62	31	carcass search	weekly	intact
9/5/2012	Townsend's warbler	D50	74	carcass search	weekly	intact
9/5/2012	unidentified bat	D50	44	carcass search	weekly	dismemberd
9/10/2012	unidentified sparrow	P1M2	40	carcass search	weekly	intact
9/11/2012	unidentified bat	D62	56	carcass search	weekly	dismemberd
10/9/2012	silver-haired bat	D56	25	carcass search	weekly	intact
10/9/2012	silver-haired bat	D50	28	carcass search	weekly	intact
11/5/2012	European starling	D74	53	carcass search	weekly	feather spot
11/26/2012	unidentified bird	D29	80	carcass search	monthly	feather spot

Appendix B. Fatality Estimates for Birds at the Dunlap Wind Energy Facility for Monitoring Conducted from March 1, 2012 – February 28, 2013

Appendix B1. Fatality estimates for birds at wind turbines at the Dunlap Wind Energy Facility for monitoring conducted from March 1, 2012 – February 28, 2013.

	Migration				Non-Migration	
	Weekly		Monthly		Monthly	
Parameter	**Mean**	**CI**	**Mean**	**CI**	**Mean**	**CI**
Search Area Adjustment						
A (small birds)	1.00	-	1.00	-	1.00	-
A (large birds)	1.00	-	1.00	-	1.00	-
Observer Detection						
A (small birds)	0.52	(0.34-0.66)	0.52	(0.33-0.66)	0.52	(0.33-0.66)
A (large birds)	0.91	(0.81-0.97)	0.91	(0.81-0.97)	0.91	(0.81-0.97)
Observed Fatality Rates (fatalities/turbine/year)						
Small birds	0.77	(0.62-0.92)	0.00	-	0.15	(0.08-0.23)
Large birds	0.00	-	0.08	(0.08-0.08)	0.04	(0.04-0.04)
Raptors	0.00	-	0.08	(0.08-0.08)	0.00	-
All birds	0.77	(0.62-0.92)	0.08	(0.08-0.08)	0.19	(0.12-0.27)
Average Probability of Carcass Availability and Detected-						
Small birds	0.28	(0.14-0.43)	0.08	(0.03-0.14)	0.07	(0.03-0.12)
Large birds	0.64	(0.53-0.71)	0.25	(0.18-0.33)	0.23	(0.16-0.30)
Adjusted Fatality Estimates (fatalities/turbine/year)-						
Small birds	2.75	(1.71-5.53)	0.00	-	2.25	(0.84-5.52)
Large birds	0.00	-	0.30	(0.23-0.43)	0.17	(0.13-0.24)
Raptors	0.00	-	0.30	(0.23-0.43)	0.00	-
All birds	2.75	(1.71-5.53)	0.30	(0.23-0.43)	2.41	(1.01-5.70)

Overall Adjusted Fatality Estimates (fatalities/turbine/year)

	Migration		Non-Migration	
	Mean	**CI**	**Mean**	**CI**
Small birds	**1.38**	**(0.86-2.76)**	**2.25**	**(0.84-5.52)**
Large birds	**0.15**	**(0.12-0.21)**	**0.17**	**(0.13-0.24)**
Raptors	**0.15**	**(0.12-0.21)**	**0.00**	**(0.00-0.00)**
All birds	**1.53**	**(1.01-2.91)**	**2.41**	**(1.01-5.70)**

Appendix B2. Fatality estimates at meteorological (met) towers for birds at the Dunlap Wind Energy Facility for monitoring conducted from March 1, 2012 – February 28, 2013.

	Migration		Non-Migration	
	Weekly		Monthly	
Parameter	**Mean**	**CI**	**Mean**	**CI**
Search Area Adjustment				
A (small birds)	1.00	-	1.00	-
A (large birds)	1.00	-	1.00	-
Observer Detection				
A (small birds)	0.52	(0.34-0.66)	0.52	(0.33-0.66)
A (large birds)	0.91	(0.81-0.97)	0.91	(0.81-0.97)
Observed Fatality Rates (fatalities/met tower/year)				
Small birds	2.50	(1.00-4.00)	0.50	(0.50-0.50)
Large birds	0.00	-	0.00	-
Raptors	0.00	-	0.00	-
All birds	2.50	(1.00-4.00)	0.50	(0.50-0.50)
Average Probability of Carcass Availability and Detected-				
Small birds	0.28	(0.14-0.42)	0.07	(0.03-0.12)
Large birds	0.64	(0.53-0.71)	0.23	(0.16-0.30)
Adjusted Fatality Estimates (fatalities/met tower/year)-				
Small birds	8.94	(2.90-21.28)	7.30	(4.16-15.86)
Large birds	0.00	-	0.00	-
Raptors	0.00	-	0.00	-
All birds	8.94	(2.90-21.28)	7.30	(4.16-15.86)

Overall Adjusted Fatality Estimates (fatalities/met tower/year)	**Mean**	**CI**
Small birds	**16.24**	**(9.40-31.97)**
Large birds	**0.00**	**-**
Raptors	**0.00**	**-**
All birds	**16.24**	**(9.40-31.97)**

Appendix C. Fatality Estimates for Bats at the Dunlap Wind Energy Facility for Monitoring Conducted from March 1, 2012 – February 28, 2013

Appendix C1. Fatality estimates for bats at wind turbines at the Dunlap Wind Energy Facility for studies conducted from March 1, 2012 – February 28, 2013.

	Migration				Non-Migration	
	Weekly		Monthly		Monthly	
Parameter	**Mean**	**CI**	**Mean**	**CI**	**Mean**	**CI**
Search Area Adjustment						
A (bats)	1.00	-	1.00	-	1.00	-
Observer Detection						
A (bats)	0.52	(0.34-0.66)	0.52	(0.38-0.66)	0.52	(0.38-0.66)
Observed Fatality Rates (fatalities/turbine/year)						
Bats	0.69	(0.46-0.92)	0.15	(0.15-0.15)	0.00	-
Average Probability of Carcass Availability and Detected-						
Bats	0.28	(0.14-0.43)	0.08	(0.03-0.14)	0.07	(0.03-0.12)
Adjusted Fatality Estimates (fatalities/turbine/year)-						
Bats	2.48	(4.32-22.64)	2.00	(1.13-4.40)	0.00	-

Overall Adjusted Fatality Estimates (fatalities/turbine/year)

	Migration		Non-Migration	
	Mean	**CI**	**Mean**	**CI**
Bats	**2.24**	**(1.57-4.15)**	**0.00**	**-**

Appendix D. North American Fatality Tables

Appendix D1. Wind energy facilities in North America with comparable and publicly-available fatality data for all bird species, by geographic region.

Wind Energy Facility	Fatality Estimate[A]	No. of Turbines	Total MW
Dunlap, WY (Year 1)	**0.87**	**74**	**111**
Dunlap, WY (Year 2)	**2.63**	**74**	**111**
Rocky Mountains			
Foote Creek Rim, WY (Phase I; 1999)	3.4	69	41.4
Foote Creek Rim, WY (Phase I; 2000)	2.42	69	41.4
Foote Creek Rim, WY (Phase I; 2001-2002)	1.93	69	41.4
Summerview, Alb (2006)	1.06	39	70.2
Foote Creek Rim, WY (Phase I; 1999)	3.4	69	41.4
Foote Creek Rim, WY (Phase I; 2000)	2.42	69	41.4
Foote Creek Rim, WY (Phase I; 2001-2002)	1.93	69	41.4
Summerview, Alb (2006)	1.06	39	70.2
Pacific Northwest			
Windy Flats, WA	8.45	114	262.2
Leaning Juniper, OR	6.66	67	100.5
Linden Ranch, WA	6.65	25	50
Biglow Canyon, OR (Phase II; 2009/2010)	5.53	65	150
White Creek, WA (2007-2011)	4.05	89	204.7
Tuolumne (Windy Point I), WA	3.2	62	136.6
Stateline, OR/WA (2002)	3.17	454	299
Klondike II, OR	3.14	50	75
Klondike III (Phase I), OR	3.02	125	223.6
Hopkins Ridge, WA (2008)	2.99	87	156.6
Harvest Wind, WA (2010-2012)	2.94	43	98.9
Nine Canyon, WA	2.76	37	48.1
Biglow Canyon, OR (Phase II; 2010/2011)	2.68	65	150
Stateline, OR/WA (2003)	2.68	454	299
Klondike IIIa (Phase II), OR	2.61	51	76.5
Combine Hills, OR	2.56	41	41
Big Horn, WA	2.54	133	199.5
Biglow Canyon, OR (Phase I; 2009)	2.47	76	125.4
Combine Hills, OR (2011)	2.33	104	104
Biglow Canyon, OR (Phase III; 2010/2011)	2.28	76	174.8
Hay Canyon, OR	2.21	48	100.8
Elkhorn, OR (2010)	1.95	61	101
Pebble Springs, OR	1.93	47	98.7
Biglow Canyon, OR (Phase I; 2008)	1.76	76	125.4
Wild Horse, WA	1.55	127	229
Goodnoe, WA	1.4	47	94
Vantage, WA	1.27	60	90
Hopkins Ridge, WA (2006)	1.23	83	150
Stateline, OR/WA (2006)	1.23	454	299
Kittitas Valley, WA (2011-2012)	1.06	48	100.8
Klondike, OR	0.95	16	24
Vansycle, OR	0.95	38	24.9
Elkhorn, OR (2008)	0.64	61	101
Marengo I, WA (2009)	0.27	78	140.4
Marengo II, WA (2009)	0.16	39	70.2

Appendix D1. Wind energy facilities in North America with comparable and publicly-available fatality data for all bird species, by geographic region.

Wind Energy Facility	Fatality Estimate[A]	No. of Turbines	Total MW
Southwest			
Dry Lake I, AZ	2.02	30	63
Dry Lake II, AZ	1.57	31	65
California			
Pine Tree, CA	8.3	90	135
Shiloh I, CA	6.96	100	150
Dillon, CA	4.71	45	45
Diablo Winds, CA	4.29	31	20.46
High Winds, CA (2004)	1.62	90	162
Shiloh II, CA	1.51	75	150
High Winds, CA (2005)	1.1	90	162
Midwest			
Wessington Springs, SD (2009)	8.25	34	51
Blue Sky Green Field, WI	7.17	88	145
Cedar Ridge, WI (2009)	6.55	41	67.6
Buffalo Ridge, MN (Phase III; 1999)	5.93	138	103.5
Moraine II, MN	5.59	33	49.5
Barton I & II, IA	5.5	80	160
Buffalo Ridge I, SD (2010)	5.06	24	50.4
Buffalo Ridge, MN (Phase I; 1996)	4.14	73	25
Winnebago, IA	3.88	10	20
Rugby, ND	3.82	71	149
Cedar Ridge, WI (2010)	3.72	41	68
Elm Creek II, MN	3.64	62	148.8
Buffalo Ridge, MN (Phase II; 1999)	3.57	143	107.25
Buffalo Ridge, MN (Phase I; 1998)	3.14	73	25
Ripley, Ont (2008)	3.09	38	76
Buffalo Ridge, MN (Phase I; 1997)	2.51	73	25
Buffalo Ridge, MN (Phase II; 1998)	2.47	143	107.25
Buffalo Ridge II, SD (2011)	1.99	105	210
Kewaunee County, WI	1.95	31	20.46
NPPD Ainsworth, NE	1.63	36	20.5
Prairie Winds ND1 (Minot), ND 2011	1.56	80	115.5
Elm Creek, MN	1.55	67	100
Prairie Winds ND1 (Minot), ND	1.48	80	115.5
Buffalo Ridge, MN (Phase I; 1999)	1.43	73	25
Prairie Winds (SD1), SD	1.41	108	162
Wessington Springs, SD (2010)	0.89	34	51
Top of Iowa, IA (2004)	0.81	89	80
Grand Ridge I, IL	0.48	66	99
Top of Iowa, IA (2003)	0.42	89	80
Pioneer Prairie I, IA (Phase II)	0.27	62	102.3

Appendix D1. Wind energy facilities in North America with comparable and publicly-available fatality data for all bird species, by geographic region.

Wind Energy Facility	Fatality Estimate[A]	No. of Turbines	Total MW
Northeast			
Criterion, MD (2011)	6.4	28	70
Mount Storm, WV (2011)	4.24	132	264
Mount Storm, WV (2009)	3.85	132	264
Maple Ridge, NY (2007)	3.44	195	321.75
Lempster, NH (2009)	3.38	12	24
Casselman, PA (2009)	2.88	23	34.5
Mountaineer, WV (2003)	2.69	44	66
Stetson Mountain I, ME (2009)	2.68	38	57
Noble Ellenburg, NY (2009)	2.66	54	80
Lempster, NH (2010)	2.64	12	24
Mount Storm, WV (2010)	2.6	132	264
Noble Bliss, NY (2009)	2.28	67	100
Maple Ridge, NY (2008)	2.07	195	321.75
Noble Altona, NY	1.84	65	97.5
Mars Hill, ME (2008)	1.76	28	42
High Sheldon, NY (2010)	1.76	75	112.5
Noble Wethersfield, NY	1.7	84	126
Mars Hill, ME (2007)	1.67	28	42
Noble Chateaugay, NY	1.66	71	106.5
Noble Clinton, NY (2008)	1.59	67	100
High Sheldon, NY (2011)	1.57	75	112.5
Casselman, PA (2008)	1.51	23	34.5
Munnsville, NY (2008)	1.48	23	34.5
Stetson Mountain II, ME (2010)	1.42	17	25.5
Cohocton/Dutch Hill, NY (2009)	1.39	50	125
Cohocton/Dutch Hills, NY (2010)	1.32	50	125
Noble Bliss, NY (2008)	1.3	67	100
Stetson Mountain I, ME (2011)	1.18	38	57
Noble Clinton, NY (2009)	1.11	67	100
Locust Ridge, PA (Phase II; 2009)	0.84	51	102
Noble Ellenburg, NY (2008)	0.83	54	80
Locust Ridge, PA (Phase II; 2010)	0.76	51	102
Southeast			
Buffalo Mountain, TN (2000-2003)	11.02	3	1.98
Buffalo Mountain, TN (2005)	1.1	18	28.98
Southern Plains			
Buffalo Gap I, TX	1.32	67	134
Barton Chapel, TX	1.15	60	120
Buffalo Gap II, TX	0.15	155	233

A=number of bird fatalities/MW/year

Appendix D1 (*continued*). Wind energy facilities in North America with comparable and publicly-available fatality data for all bird species.

Data from the following sources:

Wind Energy Facility	Fatality Estimate	Wind Energy Facility	Fatality Estimate
Dunlap, WY (Year 1)	Martinson et al. 2012		
Dunlap, WY (Year 2)	This study		
Alite, CA	Chatfield et al. 2010	Klondike IIIa (Phase II), OR	Gritski et al. 2011
Barton I & II, IA	Derby et al. 2011a	Leaning Juniper, OR	Gritski et al. 2008
Barton Chapel, TX	WEST 2011	Lempster, NH (09)	Tidhar et al. 2010
Big Horn, WA	Kronner et al. 2008	Lempster, NH (10)	Tidhar et al. 2011
Biglow Canyon, OR (Phase I; 08)	Jeffrey et al. 2009a	Linden Ranch, WA	Enz and Bay 2011
Biglow Canyon, OR (Phase I; 09)	Enk et al. 2010	Locust Ridge, PA (Phase II; 09)	Arnett et al. 2011
Biglow Canyon, OR (Phase II; 09-10)	Enk et al. 2011a	Locust Ridge, PA (Phase II; 10)	Arnett et al. 2011
Biglow Canyon, OR (Phase II; 10-11)	Enk et al. 2012b	Maple Ridge, NY (07)	Jain et al. 2009a
Biglow Canyon, OR (Phase iII; 10-11)	Enk et al. 2012a	Maple Ridge, NY (08)	Jain et al. 2009d
Blue Sky Green Field, WI	Gruver et al. 2009	Marengo I, WA (09)	URS Corporation 2010b
Buffalo Gap I, TX	Tierney 2007	Marengo II, WA (09)	URS Corporation 2010c
Buffalo Gap II, TX	Tierney 2009	Mars Hill, ME (07)	Stantec 2008
Buffalo Mountain, TN (00-03)	Nicholson et al. 2005	Mars Hill, ME (08)	Stantec 2009a
Buffalo Mountain, TN (05)	Fiedler et al. 2007	Moraine II, MN	Derby et al. 2010d
Buffalo Ridge, MN (Phase I; 96)	Johnson et al. 2000a	Mount Storm, WV (09)	Young et al. 2009a, 2010b
Buffalo Ridge, MN (Phase I; 97)	Johnson et al. 2000a	Mount Storm, WV (10)	Young et al. 2010a, 2011b
Buffalo Ridge, MN (Phase I; 98)	Johnson et al. 2000a	Mount Storm, WV (11)	Young et al. 2011a, 2012b
Buffalo Ridge, MN (Phase I; 99)	Johnson et al. 2000a	Mountaineer, WV	Kerns and Kerlinger 2004
Buffalo Ridge, MN (Phase II; 98)	Johnson et al. 2000a	Munnsville, NY (08)	Stantec 2009b
Buffalo Ridge, MN (Phase II; 99)	Johnson et al. 2000a	Nine Canyon, WA	Erickson et al. 2003b
Buffalo Ridge, MN (Phase III; 99)	Johnson et al. 2000a	Noble Altona, NY	Jain et al. 2011b
Buffalo Ridge I, SD (10)	Derby et al. 2010b	Noble Bliss, NY (08)	Jain et al. 2009e
Buffalo Ridge II, SD (11)	Derby et al. 2012a	Noble Bliss, NY (09)	Jain et al. 2010a
Casselman, PA (08)	Arnett et al. 2009a	Noble Chateaugay, NY	Jain et al. 2011c
Casselman, PA (09)	Arnett et al. 2010	Noble Clinton, NY (08)	Jain et al. 2009c
Cedar Ridge, WI (09)	BHE Environmental 2010	Noble Clinton, NY (09)	Jain et al. 2010b
Cedar Ridge, WI (10)	BHE Environmental 2011	Noble Ellenburg, NY (08)	Jain et al. 2009b
Cohocton/Dutch Hill, NY (09)	Stantec 2010	Noble Ellenburg, NY (09)	Jain et al. 2010c
Cohocton/Dutch Hill, NY (10)	Stantec 2011	Noble Wethersfield, NY	Jain et al. 2011a
Combine Hills, OR	Young et al. 2006	NPPD Ainsworth, NE	Derby et al. 2007
Combine Hills, OR (11)	Enz et al. 2012	Pebble Springs, OR	Gritski and Kronner 2010b
Criterion, MD (11)	Young et al. 2012a	Pine Tree, CA	BioResource Consultants 2010
Diablo Winds, CA	WEST 2006, 2008	Pioneer Prairie I, IA (Phase II)	Chodachek et al. 2012
Dillon, CA	Chatfield et al. 2009	PrairieWinds ND1, ND	Derby et al. 2011c
Dry Lake I, AZ	Thompson et al. 2011	PrairieWinds ND1, ND (11)	Derby et al. 2012c
Dry Lake II, AZ	Thompson and Bay 2012	PrairieWinds SD1, SD	Derby et al. 2012d
Elkhorn, OR (08)	Jeffrey et al. 2009b	Ripley, Ont (08)	Jacques Whitford 2009
Elkhorn, OR (10)	Enk et al. 2011b	Rugby, ND	Derby et al. 2011b
Elm Creek, MN	Derby et al. 2010c	Shiloh I, CA	Kerlinger et al. 2010a
Elm Creek II, MN	Derby et al. 2012b	Shiloh II, CA	Kerlinger et al. 2010b
Foote Creek Rim, WY (Phase I; 99)	Young et al. 2003b	Stateline, OR/WA (02)	Erickson et al. 2004
Foote Creek Rim, WY (Phase I; 00)	Young et al. 2003b	Stateline, OR/WA (03)	Erickson et al. 2004
Foote Creek Rim, WY (Ph. I; 01-02)	Young et al. 2003b	Stateline, OR/WA (06)	Erickson et al. 2007
Goodnoe, WA	URS Corporation 2010a	Stetson Mountain I, ME (09)	Stantec 2009c
Grand Ridge, IL	Derby et al. 2010g	Stetson Mountain I, ME (11)	Normandeau Associates 2011
Harvest Wind, WA (10-12)	Downes and Gritski 2012a	Stetson Mountain II, ME (10)	Normandeau Associates 2010
Hay Canyon, OR	Gritski and Kronner 2010a	Summerview, Alb (06)	Brown and Hamilton 2006b
High Sheldon, NY (10)	Tidhar et al. 2012a	Top of Iowa, IA (03)	Jain 2005
High Sheldon, NY (11)	Tidhar et al. 2012b	Top of Iowa, IA (04)	Jain 2005
High Winds, CA (04)	Kerlinger et al. 2006	Tuolumne (Windy Point I), WA	Enz and Bay 2010
High Winds, CA (05)	Kerlinger et al. 2006	Vansycle, OR	Erickson et al. 2000b
Hopkins Ridge, WA (06)	Young et al. 2007	Vantage, WA	Ventus 2012
Hopkins Ridge, WA (08)	Young et al. 2009c	Wessington Springs, SD (09)	Derby et al. 2010f
Kewaunee County, WI	Howe et al. 2002	Wessington Springs, SD (10)	Derby et al. 2011d
Kittitas Valley, WA (11-12)	Stantec Consulting Services 2012	White Creek, WA (07-11)	Downes and Gritski 2012b
Klondike, OR	Johnson et al. 2003b	Wild Horse, WA	Erickson et al. 2008
Klondike II, OR	NWC and WEST 2007	Windy Flats, WA	Enz et al. 2011
Klondike III (Phase I), OR	Gritski et al. 2010	Winnebago, IA	Derby et al. 2010e

Appendix D2. Wind energy facilities in North America with comparable and publicly-available use and fatality data for raptors, by geographic region.

Wind Energy Facility	Use Estimate[A]	Raptor Fatality Estimate[B]	No. of Turbines	Total MW
Dunlap, WY (Year 1)	**0.06**	**0.10**	**74**	**111**
Dunlap, WY (Year 2)	**0.06**	**0.13**	**74**	**111**
Rocky Mountains				
Summerview, Alb (2006)	NA	0.11	39	70.2
Foote Creek Rim, WY (Phase I; 1999)	0.554	0.08	69	41.4
Foote Creek Rim, WY (Phase I; 2000)	0.554	0.05	69	41.4
Foote Creek Rim, WY (Phase I; 2001-2002)	0.554	0	69	41.4
Pacific Northwest				
White Creek, WA (2007-2011)	NA	0.47	89	204.7
Vantage, WA	NA	0.29	60	90
Tuolumne (Windy Point I), WA	0.77	0.29	62	136.6
Linden Ranch, WA	NA	0.27	25	50
Harvest Wind, WA (2010-2012)	NA	0.23	43	98.9
Goodnoe, WA	NA	0.17	47	94
Leaning Juniper, OR	0.522	0.16	67	100.5
Klondike III (Phase I), OR	NA	0.15	125	223.6
Hopkins Ridge, WA (2006)	0.698	0.14	83	150
Biglow Canyon, OR (Phase II; 2009/2010)	0.318	0.14	65	150
Big Horn, WA	0.511	0.11	133	199.5
Stateline, OR/WA (2006)	0.478	0.11	454	299
Kittitas Valley, WA (2011-2012)	NA	0.09	48	100.8
Wild Horse, WA	0.291	0.09	127	229
Stateline, OR/WA (2002)	0.478	0.09	454	299
Stateline, OR/WA (2003)	0.478	0.09	454	299
Elkhorn, OR (2010)	1.07	0.08	61	101
Hopkins Ridge, WA (2008)	0.698	0.07	87	156.6
Klondike II, OR	0.504	0.06	50	75
Klondike IIIa (Phase II), OR	NA	0.06	51	76.5
Elkhorn, OR (2008)	1.07	0.06	61	101
Marengo II, WA (2009)	NA	0.05	39	70.2
Combine Hills, OR (2011)	0.746	0.05	104	104
Biglow Canyon, OR (Phase III; 2010/2011)	0.318	0.05	76	174.8
Pebble Springs, OR	NA	0.04	47	98.7
Windy Flats, WA	NA	0.04	114	262.2
Nine Canyon, WA	0.35	0.03	37	48.1
Biglow Canyon, OR (Phase I; 2008)	0.318	0.03	76	125.4
Biglow Canyon, OR (Phase II; 2010/2011)	0.318	0.03	65	150
Klondike, OR	0.504	0	16	24
Vansycle, OR	0.66	0	38	24.9
Combine Hills, OR	0.746	0	41	41
Hay Canyon, OR	NA	0	48	100.8
Biglow Canyon, OR (Phase I; 2009)	0.318	0	76	125.4
Marengo I, WA (2009)	NA	0	78	140.4
Southwest				
Dry Lake I, AZ	0.13	0	30	63
Dry Lake II, AZ	NA	0	31	65

Appendix D2. Wind energy facilities in North America with comparable and publicly-available use and fatality data for raptors, by geographic region.

Wind Energy Facility	Use Estimate[A]	Raptor Fatality Estimate[B]	No. of Turbines	Total MW
	California			
High Winds, CA (2004)	2.337	0.5	90	162
Shiloh I, CA	NA	0.42	100	150
Diablo Winds, CA	2.161	0.4	31	20.46
High Winds, CA (2005)	2.337	0.28	90	162
Pine Tree, CA	NA	0.133	90	135
Alite, CA	NA	0.12	8	24
Shiloh II, CA	NA	0.12	75	150
Dillon, CA	NA	0	45	45
	Midwest			
Buffalo Ridge, MN (Phase I; 1996)	NA	0.47	73	25
Moraine II, MN	NA	0.37	33	49.5
Winnebago, IA	NA	0.27	10	20
Buffalo Ridge I, SD (2010)	NA	0.2	24	50.4
Cedar Ridge, WI (2009)	NA	0.18	41	67.6
Top of Iowa, IA (2004)	NA	0.17	89	80
Cedar Ridge, WI (2010)	NA	0.13	41	68
Ripley, Ont (2008)	NA	0.1	38	76
Wessington Springs, SD (2010)	0.232	0.07	34	51
NPPD Ainsworth, NE	NA	0.06	36	20.5
Wessington Springs, SD (2009)	0.232	0.06	34	51
Rugby, ND	NA	0.06	71	149
Prairie Winds ND1 (Minot), ND	NA	0.05	80	115.5
Prairie Winds ND1 (Minot), ND 2011	NA	0.05	80	115.5
Kewaunee County, WI	NA	0	31	20.46
Buffalo Ridge, MN (Phase I; 1997)	NA	0	73	25
Buffalo Ridge, MN (Phase I; 1998)	NA	0	73	25
Buffalo Ridge, MN (Phase I; 1999)	NA	0	73	25
Top of Iowa, IA (2003)	NA	0	89	80
Grand Ridge I, IL	0.195	0	66	99
Elm Creek, MN	NA	0	67	100
Pioneer Prairie I, IA (Phase II)	NA	0	62	102.3
Buffalo Ridge, MN (Phase III; 1999)	NA	0	138	103.5
Buffalo Ridge, MN (Phase II; 1998)	NA	0	143	107.25
Buffalo Ridge, MN (Phase II; 1999)	NA	0	143	107.25
Blue Sky Green Field, WI	NA	0	88	145
Elm Creek II, MN	NA	0	62	148.8
Barton I & II, IA	NA	0	80	160
Prairie Winds (SD1), SD	NA	0	108	162
Buffalo Ridge II, SD (2011)	NA	0	105	210

Appendix D2. Wind energy facilities in North America with comparable and publicly-available use and fatality data for raptors, by geographic region.

Wind Energy Facility	Use Estimate[A]	Raptor Fatality Estimate[B]	No. of Turbines	Total MW
	Northeast			
Munnsville, NY (2008)	NA	0.59	23	34.5
Noble Ellenburg, NY (2009)	NA	0.25	54	80
Maple Ridge, NY (2007)	NA	0.25	195	321.75
Noble Clinton, NY (2009)	NA	0.16	67	100
Noble Wethersfield, NY	NA	0.13	84	126
Noble Bliss, NY (2009)	NA	0.12	67	100
Noble Ellenburg, NY (2008)	NA	0.11	54	80
Noble Bliss, NY (2008)	NA	0.1	67	100
Noble Clinton, NY (2008)	NA	0.1	67	100
Mount Storm, WV (2010)	NA	0.1	132	264
Noble Chateaugay, NY	NA	0.08	71	106.5
Cohocton/Dutch Hills, NY (2010)	NA	0.08	50	125
Mountaineer, WV (2003)	NA	0.07	44	66
High Sheldon, NY (2010)	NA	0.06	75	112.5
Mount Storm, WV (2011)	NA	0.03	132	264
Maple Ridge, NY (2008)	NA	0.03	195	321.75
Criterion, MD (2011)	NA	0.02	28	70
Lempster, NH (2009)	NA	0	12	24
Lempster, NH (2010)	NA	0	12	24
Stetson Mountain II, ME (2010)	NA	0	17	25.5
Casselman, PA (2008)	NA	0	23	34.5
Casselman, PA (2009)	NA	0	23	34.5
Mars Hill, ME (2007)	NA	0	28	42
Mars Hill, ME (2008)	NA	0	28	42
Stetson Mountain I, ME (2009)	NA	0	38	57
Stetson Mountain I, ME (2011)	NA	0	38	57
Noble Altona, NY	NA	0	65	97.5
Locust Ridge, PA (Phase II; 2009)	NA	0	51	102
Locust Ridge, PA (Phase II; 2010)	NA	0	51	102
High Sheldon, NY (2011)	NA	0	75	112.5
Cohocton/Dutch Hill, NY (2009)	NA	0	50	125
Mount Storm, WV (2009)	NA	0	132	264
	Southeast			
Buffalo Mountain, TN (2000-2003)	NA	0	3	1.98
Buffalo Mountain, TN (2005)	NA	0	18	28.98
	Southern Plains			
Barton Chapel, TX	NA	0.25	60	120
Buffalo Gap I, TX	NA	0.1	67	134
Buffalo Gap II, TX	NA	0	155	233

A=number of raptors/plot/20min survey
B=number of fatalities/MW/year

Appendix D2 (*continued*). Wind energy facilities in North America with comparable and publicly-available use and fatality data for raptors.

Data from the following sources:

Wind Energy Facility	Use Estimate	Fatality Estimate	Wind Energy Facility	Use Estimate	Fatality Estimate
Dunlap, WY (Year 1)	Johnson et al. 2009	Martinson et al. 2012			
Dunlap, WY (Year 2)	Johnson et al. 2009	This study			
Alite, CA		Chatfield et al. 2010	Klondike IIIa (Phase II), OR		Gritski et al. 2011
Barton I & II, IA		Derby et al. 2011a	Leaning Juniper, OR	Kronner et al. 2005	Gritski et al. 2008
Barton Chapel, TX		WEST 2011	Lempster, NH (09)		Tidhar et al. 2010
Big Horn, WA	Johnson and Erickson 2004	Kronner et al. 2008	Lempster, NH (10)		Tidhar et al. 2011
Biglow Canyon, OR (Ph. I; 08)	WEST 2007	Jeffrey et al. 2009a	Linden Ranch, WA		Enz and Bay 2011
Biglow Canyon, OR (Ph. I; 09)	WEST 2007	Enk et al. 2010	Locust Ridge, PA (Phase II; 09)		Arnett et al. 2011
Biglow Canyon, OR (Ph. II; 09/10)	WEST 2007	Enk et al. 2011a	Locust Ridge, PA (Phase II; 10)		Arnett et al. 2011
Biglow Canyon, OR (Ph. II; 10-11)	WEST 2007	Enk et al. 2012b	Maple Ridge, NY (07)		Jain et al. 2009a
Biglow Canyon, OR (Ph. III; 10-11)	WEST 2007	Enk et al. 2012a	Maple Ridge, NY (08)		Jain et al. 2009d
Blue Sky Green Field, WI		Gruver et al. 2009	Marengo I, WA (09)		URS Corporation 2010b
Buffalo Gap I, TX		Tierney 2007	Marengo II, WA (09)		URS Corporation 2010c
Buffalo Gap II, TX		Tierney 2009	Mars Hill, ME (07)		Stantec 2008
Buffalo Mountain, TN (00-03)		Nicholson et al. 2005	Mars Hill, ME (08)		Stantec 2009a
Buffalo Mountain, TN (05)		Fiedler et al. 2007	Moraine II, MN		Derby et al. 2010d
Buffalo Ridge, MN (Ph. I; 96)		Johnson et al. 2000a	Mount Storm, WV (09)		Young et al. 2009a, 2010b
Buffalo Ridge, MN (Ph. I; 97)		Johnson et al. 2000a	Mount Storm, WV (10)		Young et al. 2010a, 2011b
Buffalo Ridge, MN (Ph. I; 98)		Johnson et al. 2000a	Mount Storm, WV (11)		Young et al. 2011a, 2012b
Buffalo Ridge, MN (Ph. I; 99)		Johnson et al. 2000a	Mountaineer, WV (03)		Kerns and Kerlinger 2004
Buffalo Ridge, MN (Ph. II; 98)		Johnson et al. 2000a	Munnsville, NY (08)		Stantec 2009b
Buffalo Ridge, MN (Ph. II; 99)		Johnson et al. 2000a	Nine Canyon, WA	Erickson et al. 2001	Erickson et al. 2003b
Buffalo Ridge, MN (Ph. III; 99)		Johnson et al. 2000a	Noble Altona, NY		Jain et al. 2011b
Buffalo Ridge I, SD (10)		Derby et al. 2010b	Noble Bliss, NY (08)		Jain et al. 2009e
Buffalo Ridge II, SD (11)		Derby et al. 2012a	Noble Bliss, NY (09)		Jain et al. 2010a
Casselman, PA (08)		Arnett et al. 2009a	Noble Chateaugay, NY		Jain et al. 2011c
Casselman, PA (09)		Arnett et al. 2010	Noble Clinton, NY (08)		Jain et al. 2009c
Cedar Ridge, WI (09)		BHE Environmental 2010	Noble Clinton, NY (09)		Jain et al. 2010b
Cedar Ridge, WI (10)		BHE Environmental 2011	Noble Ellenburg, NY (08)		Jain et al. 2009b
Cohocton/Dutch Hill, NY (09)		Stantec 2010	Noble Ellenburg, NY (09)		Jain et al. 2010c
Cohocton/Dutch Hill, NY (10)		Stantec 2011	Noble Wethersfield, NY		Jain et al. 2011a
Combine Hills, OR	Young et al. 2003c	Young et al. 2006	NPPD Ainsworth, NE		Derby et al. 2007
Combine Hills, OR (11)	Young et al. 2003c	Enz et al. 2012	Pebble Springs, OR		Gritski and Kronner 2010b
Criterion, MD (11)		Young et al. 2012a	Pine Tree, CA		BioResource Consultants 2010
Diablo Winds, CA	WEST 2006, 2008	WEST 2006, 2008	Pioneer Prairie I, IA (Ph. II)		Chodachek et al. 2012
Dillon, CA		Chatfield et al. 2009	PrairieWinds ND1, ND		Derby et al. 2011c
Dry Lake I, AZ	Thompson et al. 2011	Thompson et al. 2011	PrairieWinds ND1, ND (11)		Derby et al. 2012c
Dry Lake II, AZ		Thompson and Bay 2012	PrairieWinds SD1, SD		Derby et al. 2012d
Elkhorn, OR (08)	WEST 2005	Jeffrey et al. 2009b	Ripley, Ont (08)		Jacques Whitford 2009
Elkhorn, OR (10)	WEST 2005	Enk et al. 2011b	Rugby, ND		Derby et al. 2011b
Elm Creek, MN		Derby et al. 2010c	Shiloh I, CA		Kerlinger et al. 2010a
Elm Creek II, MN		Derby et al. 2012b	Shiloh II, CA		Kerlinger et al. 2010b
Foote Creek Rim, WY (Ph. I; 99)	Johnson et al. 2000b	Young et al. 2003b	Stateline, OR/WA (02)	Erickson et al. 2003a	Erickson et al. 2004
Foote Creek Rim, WY (Ph. I; 00)	Johnson et al. 2000b	Young et al. 2003b	Stateline, OR/WA (03)	Erickson et al. 2003a	Erickson et al. 2004

Appendix D2 (*continued*). Wind energy facilities in North America with comparable and publicly-available use and fatality data for raptors.

Data from the following sources:

Wind Energy Facility	Use Estimate	Fatality Estimate	Wind Energy Facility	Use Estimate	Fatality Estimate
Foote Creek Rim, WY (Ph. I; 01-02)	Johnson et al. 2000b	Young et al. 2003b	Stateline, OR/WA (06)	Erickson et al. 2003a	Erickson et al. 2007
Goodnoe, WA		URS Corporation 2010a	Stetson Mountain I, ME (09)		Stantec 2009c
Grand Ridge, IL	Derby et al. 2009	Derby et al. 2010g	Stetson Mountain I, ME (11)		Normandeau Associates 2011
Harvest Wind, WA (10-12)		Downes and Gritski 2012a	Stetson Mountain II, ME (10)		Normandeau Associates 2010
Hay Canyon, OR		Gritski and Kronner 2010a	Summerview, Alb (06)		Brown and Hamilton 2006b
High Sheldon, NY (10)		Tidhar et al. 2012a	Top of Iowa, IA (03)		Jain 2005
High Sheldon, NY (11)		Tidhar et al. 2012b	Top of Iowa, IA (04)		Jain 2005
High Winds, CA (04)	Kerlinger et al. 2005	Kerlinger et al. 2006	Tuolumne (Windy Point I), WA	Johnson et al. 2006	Enz and Bay 2010
High Winds, CA (05)	Kerlinger et al. 2005	Kerlinger et al. 2006	Vansycle, OR	WCIA & WEST 1997	Erickson et al. 2000b
Hopkins Ridge, WA (06)	Young et al. 2003a	Young et al. 2007	Vantage, OR		Ventus 2012
Hopkins Ridge, WA (08)	Young et al. 2003a	Young et al. 2009c	Wessington Springs, SD (09)	Derby et al. 2008	Derby et al. 2010f
Kewaunee County, WI		Howe et al. 2002	Wessington Springs, SD (10)	Derby et al. 2008	Derby et al. 2011d
Kittitas Valley, WA		Stantec Consulting Services 2012	White Creek, WA (07-11)		Downes and Gritski 2012b
Klondike, OR	Johnson et al. 2002	Johnson et al. 2003b	Wild Horse, WA	Erickson et al. 2003c	Erickson et al. 2008
Klondike II, OR	Johnson et al. 2002	NWC and WEST 2007	Windy Flats, WA		Enz et al. 2011
Klondike III (Phase I), OR		Gritski et al. 2010	Winnebago, IA		Derby et al. 2010e

Appendix D3. Wind energy facilities in North America with comparable and publicly-available activity and fatality data for bats, by geographic region.

Wind Energy Facility	Bat Activity Estimate[A]	Bat Activity Dates	Fatality Estimate[B]	No. of Turbines	Total MW
Dunlap, WY (Year 1)	**1.67**	**07/16/08-10/14/08**	**5.91**	**74**	**111**
Dunlap, WY (Year 2)	**1.67**	**07/16/08-10/14/08**	**1.49**	**74**	**111**
		Rocky Mountains			
Summerview, Alb (2008)	7.65[C]	07/15/06-07-09/30/06-07	11.42	39	70.2
Summerview, Alb (2006)	NA	NA	10.27	39	70.2
Judith Gap, MT (2006/2007)	NA	NA	8.93	90	135
Foote Creek Rim, WY (Phase I; 1999)	NA	NA	3.97	69	41.4
Judith Gap, MT (2009)	NA	NA	3.2	90	135
Foote Creek Rim, WY (Phase I; 2001-2002)	2.2[C,D]	6/15/01-9/1/01	1.57	69	41.4
Foote Creek Rim, WY (Phase I; 2000)	2.2[C,D]	6/15/00-9/1/00	1.05	69	41.4
		Pacific Northwest			
Biglow Canyon, OR (Phase II; 2009/2010)	NA	NA	2.71	65	150
Nine Canyon, WA	NA	NA	2.47	37	48.1
Stateline, OR/WA (2003)	NA	NA	2.29	454	299
Elkhorn, OR (2010)	NA	NA	2.14	61	101
White Creek, WA (2007-2011)	NA	NA	2.04	89	204.7
Biglow Canyon, OR (Phase I; 2008)	NA	NA	1.99	76	125.4
Leaning Juniper, OR	NA	NA	1.98	67	100.5
Big Horn, WA	NA	NA	1.9	133	199.5
Combine Hills, OR	NA	NA	1.88	41	41
Linden Ranch, WA	NA	NA	1.68	25	50
Pebble Springs, OR	NA	NA	1.55	47	98.7
Hopkins Ridge, WA (2008)	NA	NA	1.39	87	156.6
Harvest Wind, WA (2010-2012)	NA	NA	1.27	43	98.9
Elkhorn, OR (2008)	NA	NA	1.26	61	101
Vansycle, OR	NA	NA	1.12	38	24.9
Klondike III (Phase I), OR	NA	NA	1.11	125	223.6
Stateline, OR/WA (2002)	NA	NA	1.09	454	299
Stateline, OR/WA (2006)	NA	NA	0.95	454	299
Tuolumne (Windy Point I), WA	NA	NA	0.94	62	136.6
Klondike, OR	NA	NA	0.77	16	24
Combine Hills, OR (2011)	NA	NA	0.73	104	104
Hopkins Ridge, WA (2006)	NA	NA	0.63	83	150
Biglow Canyon, OR (Phase I; 2009)	NA	NA	0.58	76	125.4
Biglow Canyon, OR (Phase II; 2010/2011)	NA	NA	0.57	65	150
Hay Canyon, OR	NA	NA	0.53	48	100.8
Klondike II, OR	NA	NA	0.41	50	75
Windy Flats, WA	NA	NA	0.41	114	262.2
Vantage, WA	NA	NA	0.4	60	90
Wild Horse, WA	NA	NA	0.39	127	229
Goodnoe, WA	NA	NA	0.34	47	94
Marengo II, WA (2009)	NA	NA	0.27	39	70.2
Biglow Canyon, OR (Phase III; 2010/2011)	NA	NA	0.22	76	174.8
Marengo I, WA (2009)	NA	NA	0.17	78	140.4
Klondike IIIa (Phase II), OR	NA	NA	0.14	51	76.5
Kittitas Valley, WA (2011-2012)	NA	NA	0.12	48	100.8

Appendix D3. Wind energy facilities in North America with comparable and publicly-available activity and fatality data for bats, by geographic region.

Wind Energy Facility	Bat Activity Estimate[A]	Bat Activity Dates	Fatality Estimate[B]	No. of Turbines	Total MW
	Southwest				
Dry Lake I, AZ	8.8	4/29/10-11/10/10	3.43	30	63
Dry Lake II, AZ	11.5	5/11/11-10/26/11	1.66	31	65
	California				
Shiloh I, CA	NA	NA	3.92	100	150
Shiloh II, CA	NA	NA	2.72	75	150
High Winds, CA (2004)	NA	NA	2.51	90	162
Dillon, CA	NA	NA	2.17	45	45
High Winds, CA (2005)	NA	NA	1.52	90	162
Diablo Winds, CA	NA	NA	0.82	31	20.46
Alite, CA	NA	NA	0.24	8	24

Appendix D3. Wind energy facilities in North America with comparable and publicly-available activity and fatality data for bats, by geographic region.

Wind Energy Facility	Bat Activity Estimate[A]	Bat Activity Dates	Fatality Estimate[B]	No. of Turbines	Total MW
	Midwest				
Cedar Ridge, WI (2009)	9.97[C,D,E,F]	7/16/07-9/30/07	30.61	41	67.6
Blue Sky Green Field, WI	7.7[E]	7/24/07-10/29/07	24.57	88	145
Cedar Ridge, WI (2010)	9.97[C,D,E,F]	7/16/07-9/30/07	24.12	41	68
Fowler I, II, III, IN (2011)	NA	NA	20.19	355	600
Fowler I, II, III, IN (2010)	NA	NA	18.96	355	600
Forward Energy Center, WI	6.97	8/5/08-11/08/08	18.17	86	129
Harrow, Ont (2010)	NA	NA	11.13	24 (four 6-turb facilities)	39.6
Top of Iowa, IA (2004)	35.7	5/26/04-9/24/04	10.27	89	80
Pioneer Prairie I, IA (Phase II)	NA	NA	10.06	62	102.3
Crystal Lake II, IA	NA	NA	7.42	80	200
Top of Iowa, IA (2003)	NA	NA	7.16	89	80
Kewaunee County, WI	NA	NA	6.45	31	20.46
Ripley, Ont (2008)	NA	NA	4.67	38	76
Winnebago, IA	NA	NA	4.54	10	20
Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)	2.2[C]	6/15/01-9/15/01	4.35	143	107.25
Buffalo Ridge, MN (Phase III; 2001/Lake Benton II)	2.2[C]	6/15/01-9/15/01	3.71	138	103.5
Crescent Ridge, IL	NA	NA	3.27	33	49.5
Elm Creek II, MN	NA	NA	2.81	62	148.8
Buffalo Ridge II, SD (2011)	NA	NA	2.81	105	210
Buffalo Ridge, MN (Phase III; 1999)	NA	NA	2.72	138	103.5
Buffalo Ridge, MN (Phase II; 1999)	NA	NA	2.59	143	107.25
Moraine II, MN	NA	NA	2.42	33	49.5
Buffalo Ridge, MN (Phase II; 1998)	NA	NA	2.16	143	107.25
Prairie Winds ND1 (Minot), ND	NA	NA	2.13	80	115.5
Grand Ridge I, IL	NA	NA	2.1	66	99
Barton I & II, IA	NA	NA	1.85	80	160
Buffalo Ridge, MN (Phase III; 2002/Lake Benton II)	1.9[C]	6/15/02-9/15/02	1.81	138	103.5
Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)	1.9[C]	6/15/02-9/15/02	1.64	143	107.25
Rugby, ND	NA	NA	1.6	71	149
Elm Creek, MN	NA	NA	1.49	67	100
Wessington Springs, SD (2009)	NA	NA	1.48	34	51
Prairie Winds ND1 (Minot), ND 2011	NA	NA	1.39	80	115.5
Prairie Winds (SD1), SD	NA	NA	1.23	108	162
NPPD Ainsworth, NE	NA	NA	1.16	36	20.5
Buffalo Ridge, MN (Phase I; 1999)	NA	NA	0.74	73	25
Wessington Springs, SD (2010)	NA	NA	0.41	34	51
Buffalo Ridge I, SD (2010)	NA	NA	0.16	24	50.4

Appendix D3. Wind energy facilities in North America with comparable and publicly-available activity and fatality data for bats, by geographic region.

Wind Energy Facility	Bat Activity Estimate[A]	Bat Activity Dates	Fatality Estimate[B]	No. of Turbines	Total MW
	Northeast				
Mountaineer, WV (2003)	NA	NA	31.69	44	66
Mount Storm, WV (2009)	30.09	7/15/09-10/7/09	17.53	132	264
Noble Wethersfield, NY	NA	NA	16.3	84	126
Criterion, MD (2011)	NA	NA	15.61	28	70
Mount Storm, WV (2010)	36.67[G]	4/18/10-10/15/10	15.18	132	264
Locust Ridge, PA (Phase II; 2010)	NA	NA	14.38	51	102
Locust Ridge, PA (Phase II; 2009)	NA	NA	14.11	51	102
Casselman, PA (2008)	NA	NA	12.61	23	34.5
Maple Ridge, NY (2006)	NA	NA	11.21	120	198
Cohocton/Dutch Hills, NY (2010)	NA	NA	10.32	50	125
Wolfe Island, Ont (July-December 2010)	NA	NA	9.5	86	197.8
Maple Ridge, NY (2007)	NA	NA	9.42	195	321.75
Cohocton/Dutch Hill, NY (2009)	NA	NA	8.62	50	125
Casselman, PA (2009)	NA	NA	8.6	23	34.5
Noble Bliss, NY (2008)	NA	NA	7.8	67	100
Mount Storm, WV (2011)	NA	NA	7.43	132	264
Mount Storm, WV (Fall 2008)	35.2	7/20/08-10/12/08	6.62	82	164
Wolfe Island, Ont (July-December 2009)	NA	NA	6.42	86	197.8
Maple Ridge, NY (2008)	NA	NA	4.96	195	321.75
Noble Clinton, NY (2009)	1.9[F]	8/1/09-09/31/09	4.5	67	100
Casselman Curtailment, PA (2008)	NA	NA	4.4	23	35.4
Noble Altona, NY	NA	NA	4.34	65	97.5
Noble Ellenburg, NY (2009)	16.1[F]	8/16/09-09/15/09	3.91	54	80
Noble Bliss, NY (2009)	NA	NA	3.85	67	100
Lempster, NH (2010)	NA	NA	3.57	12	24
Noble Ellenburg, NY (2008)	NA	NA	3.46	54	80
Noble Clinton, NY (2008)	2.1[F]	8/8/08-09/31/08	3.14	67	100
Lempster, NH (2009)	NA	NA	3.11	12	24
Mars Hill, ME (2007)	NA	NA	2.91	28	42
Wolfe Island, Ont (July-December 2011)	NA	NA	2.49	86	197.8
Noble Chateaugay, NY	NA	NA	2.44	71	106.5
High Sheldon, NY (2010)	NA	NA	2.33	75	112.5
Munnsville, NY (2008)	NA	NA	1.93	23	34.5
High Sheldon, NY (2011)	NA	NA	1.78	75	112.5
Stetson Mountain II, ME (2010)	NA	NA	1.65	17	25.5
Stetson Mountain I, ME (2009)	28.5; 0.3[G]	7/10/09-10/15/09	1.4	38	57
Mars Hill, ME (2008)	NA	NA	0.45	28	42
Stetson Mountain I, ME (2011)	NA	NA	0.28	38	57
Kibby, ME (2011)	NA	NA	0.12	44	132
	Southeast				
Buffalo Mountain, TN (2005)	NA	NA	39.7	18	28.98
Buffalo Mountain, TN (2000-2003)	23.7[D]	NA	31.54	3	1.98

Appendix D3. Wind energy facilities in North America with comparable and publicly-available activity and fatality data for bats, by geographic region.

Wind Energy Facility	Bat Activity Estimate[A]	Bat Activity Dates	Fatality Estimate[B]	No. of Turbines	Total MW
	Southern Plains				
Barton Chapel, TX	NA	NA	3.06	60	120
Buffalo Gap II, TX	NA	NA	0.14	155	233
Buffalo Gap I, TX	NA	NA	0.1	67	134

A = Bat passes per detector-night
B = Number of fatalities per megawatt per year
C = Activity rate was averaged across phases and/or years
D = Activity rate calculated by WEST from data presented in referenced report
E= Activity rate based on pre-construction monitoring; data for all other activity and fatality rates were collected concurrently
F = Activity rate based on data collected at various heights all other activity rates are from ground-based units only
G = Activity rate based on data collected from ground-based units excluding reference stations during the spring, summer and fall seasons
H = The overall activity rate of 28.5 is from reference stations located along forest edges which may be attractive to bats; the activity rate of 0.3 is from one unit placed on a nacelle

Appendix D3 (*continued*). Wind energy facilities in North America with comparable and publicly-available activity and fatality data for bats.

Project, Location	Activity Reference	Fatality Reference	Project, Location	Activity Reference	Fatality Reference
Dunlap, WY (Year 1)	Johnson et al. 2009	Martinson et al. 2012			
Dunlap, WY (Year 2)	Johnson et al. 2009	This study			
Alite, CA		Chatfield et al. 2010	Klondike, OR		Johnson et al. 2003a
Barton I&II, IA		Derby et al. 2011a	Klondike II, OR		NWC and WEST 2007
Barton Chapel, TX		WEST 2011	Klondike III (Phase I), OR		Gritski et al. 2010
Big Horn, WA		Kronner et al. 2008	Klondike IIIa (Phase II), OR		Gritski et al. 2011
Biglow Canyon, OR (Ph. I; 08)		Jeffrey et al. 2009a	Leaning Juniper, OR		Gritski et al. 2008
Biglow Canyon, OR (Ph. I; 09)		Enk et al. 2010	Lempster, NH (09)		Tidhar et al. 2010
Biglow Canyon, OR (Ph. II; 09/10)		Enk et al. 2011a	Lempster, NH (10)		Tidhar et al. 2011
Biglow Canyon, OR (Ph. II; 10/11)		Enk et al. 2012b	Linden Ranch, WA		Enz and Bay 2011
Biglow Canyon, OR (Ph. III; 10/11)		Enk et al. 2012a	Locust Ridge, PA (Phase II; 09)		Arnett et al. 2011
Blue Sky Green Field, WI	Gruver 2008	Gruver et al. 2009	Locust Ridge, PA (Phase II; 10)		Arnett et al. 2011
Buffalo Gap I, TX		Tierney 2007	Maple Ridge, NY (06)		Jain et al. 2007
Buffalo Gap II, TX		Tierney 2009	Maple Ridge, NY (07)		Jain et al. 2009a
Buffalo Mountain, TN (00-03)	Fiedler 2004	Nicholson et al. 2005	Maple Ridge, NY (08)		Jain et al. 2009d
Buffalo Mountain, TN (05)		Fiedler et al. 2007	Marengo I, WA (09)		URS Corporation 2010b
Buffalo Ridge, MN (Ph. I; 99)		Johnson et al. 2000a	Marengo II, WA (09)		URS Corporation 2010c
Buffalo Ridge, MN (Ph. II; 98)		Johnson et al. 2000a	Mars Hill, ME (07)		Stantec 2008
Buffalo Ridge, MN (Ph. II; 99)		Johnson et al. 2000a	Mars Hill, ME (08)		Stantec 2009a
Buffalo Ridge, MN (Ph. II; 01/Lake Benton I)	Johnson et al. 2004	Johnson et al. 2004	Moraine II, MN		Derby et al. 2010d
Buffalo Ridge, MN (Ph. II; 02/Lake Benton I)	Johnson et al. 2004	Johnson et al. 2004	Mount Storm, WV (Fall 08)	Young et al. 2009b	Young et al. 2009b
Buffalo Ridge, MN (Ph. III; 99)		Johnson et al. 2000a	Mount Storm, WV (09)	Young et al. 2009a, 2010b	Young et al. 2009a, 2010b
Buffalo Ridge, MN (Ph. III; 01/Lake Benton II)	Johnson et al. 2004	Johnson et al. 2004	Mount Storm, WV (10)	Young et al. 2010a, 2011b	Young et al. 2010a, 2011b
Buffalo Ridge, MN (Ph. III; 02/Lake Benton II)	Johnson et al. 2004	Johnson et al. 2004	Mount Storm, WV (11)		Young et al. 2011a, 2012b
Buffalo Ridge I, SD (10)		Derby et al. 2010b	Mountaineer, WV (03)		Kerns and Kerlinger 2004
Buffalo Ridge II, SD		Derby et al. 2012a	Munnsville, NY (08)		Stantec 2009b
Casselman, PA (08)		Arnett et al. 2009a	Nine Canyon, WA		Erickson et al. 2003b
Casselman, PA (09)		Arnett et al. 2010	Noble Altona, NY		Jain et al. 2011b
Casselman Curtailment, PA (08)		Arnett et al. 2009b	Noble Bliss, NY (08)		Jain et al.2009e
Cedar Ridge, WI (09)	BHE Environmental 2008	BHE Environmental 2010	Noble Bliss, NY (09)		Jain et al. 2010a
Cedar Ridge, WI (10)	BHE Environmental 2008	BHE Environmental 2011	Noble Chateaugay, NY		Jain et al. 2011c
Cohocton/Dutch Hill, NY (09)		Stantec 2010	Noble Clinton, NY (08)	Reynolds 2010a	Jain et al. 2009c
Cohocton/Dutch Hill, NY (10)		Stantec 2011	Noble Clinton, NY (09)	Reynolds 2010a	Jain et al. 2010b
Combine Hills, OR		Young et al. 2006	Noble Ellenburg, NY (08)		Jain et al. 2009b
Combine Hills, OR (11)		Enz et al. 2012	Noble Ellenburg, NY (09)	Reynolds 2010b	Jain et al. 2010c
Crescent Ridge, IL		Kerlinger et al. 2007	Noble Wethersfield, NY		Jain et al. 2011a
Criterion, MD (11)		Young et al. 2012a	NPPD Ainsworth, NE		Derby et al. 2007
Crystal Lake II, IA		Derby et al. 2010a	Pebble Springs, OR		Gritski and Kronner 2010b
Diablo Winds, CA		WEST 2006, 2008	Pioneer Prairie, IA (Ph. II)		Chodachek et al. 2012
Dillon, CA		Chatfield et al. 2009	PrairieWinds ND1 (Minot), ND		Derby et al. 2011c
Dry Lake I, AZ	Thompson et al. 2011	Thompson et al. 2011	PrairieWinds ND1 (Minot), ND (11)		Derby et al. 2012c
Dry Lake II, AZ	Thompson and Bay 2012	Thompson and Bay 2012	PrairieWinds SD1, SD		Derby et al. 2012d
Elkhorn, OR (08)		Jeffrey et a. 2009b	Ripley, Ont (08)		Jacques Whitford 2009
Elkhorn, OR (10)		Enk et al. 2011b	Rugby, ND		Derby et al. 2011b
Elm Creek, MN		Derby et al. 2010c	Shiloh I, CA		Kerlinger et al. 2010a
Elm Creek II, MN		Derby et al. 2012b	Shiloh II, CA		Kerlinger et al. 2010b
Foote Creek Rim, WY (Ph. I; 99)		Young et al. 2003b	Stateline, OR/WA (02)		Erickson et al. 2004
Foote Creek Rim, WY (Ph. I; 00)	Gruver 2002	Young et al. 2003b, 2003d	Stateline, OR/WA (03)		Erickson et al. 2004
Foote Creek Rim, WY (Ph. I; 01-02)	Gruver 2002	Young et al. 2003b, 2003d	Stateline, OR/WA (06)		Erickson et al. 2007
Forward Energy Center, WI	Watt and Drake 2011	Grodsky and Drake 2011	Stetson Mountain, ME (09)	Stantec 2009c	Stantec 2009c

Appendix D3 (*continued*). Wind energy facilities in North America with comparable and publicly-available activity and fatality data for bats.

Project, Location	Activity Reference	Fatality Reference	Project, Location	Activity Reference	Fatality Reference
Fowler I, II, III, IN (10)		Good et al. 2011	Stetson Mountain I, ME (11)		Normandeau Associates 2011
Fowler I, II, III, IN (11)		Good et al. 2012	Stetson Mountain II, ME (10)		Normandeau Associates 2010
Goodnoe, WA		URS Corporation 2010a	Summerview, Alb (06)		Brown and Hamilton 2006b
Grand Ridge, IL		Derby et al. 2010g	Summerview, Alb (08)	Baerwald 2008	Baerwald 2008
Harvest Wind, WA (10-12)		Downes and Gritski 2012a	Top of Iowa, IA (03)		Jain 2005
Harrow, Ont. (10)		NRSI 2011	Top of Iowa, IA (04)	Jain 2005	Jain 2005
Hay Canyon, OR		Gritski and Kronner 2010a	Tuolumne (Windy Point I), WA		Enz and Bay 2010
High Sheldon, NY (10)		Tidhar et al. 2012a	Vansycle, OR		Erickson et al. 2000a
High Sheldon, NY (11)		Tidhar et al. 2012b	Vantage, WA		Ventus 2012
High Winds, CA (04)		Kerlinger et al. 2006	Wessington Springs, SD (09)		Derby et al. 2010f
High Winds, CA (05)		Kerlinger et al. 2006	Wessington Springs, SD (10)		Derby et al. 2011d
Hopkins Ridge, WA (06)		Young et al. 2007	White Creek, WA (07-11)		Downes and Gritski 2012b
Hopkins Ridge, WA (08)		Young et al. 2009c	Wild Horse, WA		Erickson et al. 2008
Judith Gap, MT (06-07)		TRC 2008	Windy Flats, WA		Enz et al. 2011
Judith Gap, MT (09)		Poulton and Erickson 2010	Winnebago, IA		Derby et al. 2010e
Kewaunee County, WI		Howe et al. 2002	Wolfe Island, Ont (Jul-Dec 09)		Stantec Ltd. 2010b
Kibby, ME (11)		Stantec 2012	Wolfe Island, Ont (Jul-Dec 10)		Stantec Ltd. 2011b
Kittitas Valley, WA (11-12)		Stantec Consulting Services 2012	Wolfe Island, Ont (Jul-Dec 11)		Stantec Ltd. 2012

Appendix D4. Fatality estimates for North American wind-energy facilities.

Project	Bird Fatalities (birds/MW/ year)	Raptor Fatalities (raptors/MW/ year)	Bat Fatalities (bats/MW/ year)	Predominant Habitat Type	Citation
Alite, CA	0.55	0.12	0.24	Shrub/scrub & grassland	Chatfield et al. 2010
Barton I & II, IA	5.5	0	1.85	Agriculture	Derby et al. 2011a
Barton Chapel, TX	1.15	0.25	3.06	Agriculture/forest	WEST 2011
Big Horn, WA	2.54	0.11	1.9	Agriculture/grassland	Kronner et al. 2008
Biglow Canyon, OR (Phase I; 2008)	1.76	0.03	1.99	Agriculture/grassland	Jeffrey et al. 2009a
Biglow Canyon, OR (Phase I; 2009)	2.47	0	0.58	Agriculture/grassland	Enk et al. 2010
Biglow Canyon, OR (Phase II; 2009/2010)	5.53	0.14	2.71	Agriculture	Enk et al. 2011a
Biglow Canyon, OR (Phase II; 2010/2011)	2.68	0.03	0.57	Grassland/shrub-steppe, agriculture	Enk et al. 2012b
Biglow Canyon, OR (Phase III; 2010/2011)	2.28	0.05	0.22	Grassland/shrub-steppe, agriculture	Enk et al. 2012a
Blue Sky Green Field, WI	7.17	0	24.57	Agriculture	Gruver et al. 2009
Buffalo Gap I, TX	1.32	0.1	0.1	Grassland	Tierney 2007
Buffalo Gap II, TX	0.15	0	0.14	Forest	Tierney 2009
Buffalo Mountain, TN (2000-2003)	11.02	0	31.54	Forest	Nicholson et al. 2005
Buffalo Mountain, TN (2005)	1.1	0	39.7	Forest	Fiedler et al. 2007
Buffalo Ridge, MN (Phase I; 1996)	4.14	0.47	NA	Agriculture	Johnson et al. 2000a
Buffalo Ridge, MN (Phase I; 1997)	2.51	0	NA	Agriculture	Johnson et al. 2000a
Buffalo Ridge, MN (Phase I; 1998)	3.14	0	NA	Agriculture	Johnson et al. 2000a
Buffalo Ridge, MN (Phase I; 1999)	1.43	0	0.74	Agriculture	Johnson et al. 2000a
Buffalo Ridge, MN (Phase II; 1998)	2.47	0	2.16	Agriculture	Johnson et al. 2000a
Buffalo Ridge, MN (Phase II; 1999)	3.57	0	2.59	Agriculture	Johnson et al. 2000a

Appendix D4. Fatality estimates for North American wind-energy facilities.

Project	Bird Fatalities (birds/MW/ year)	Raptor Fatalities (raptors/MW/ year)	Bat Fatalities (bats/MW/ year)	Predominant Habitat Type	Citation
Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)	NA	NA	4.35	Agriculture	Johnson et al. 2004
Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)	NA	NA	1.64	Agriculture	Johnson et al. 2004
Buffalo Ridge, MN (Phase III; 1999)	5.93	0	2.72	Agriculture	Johnson et al. 2000a
Buffalo Ridge, MN (Phase III; 2001/Lake Benton II)	NA	NA	3.71	Agriculture	Johnson et al. 2004
Buffalo Ridge, MN (Phase III; 2002/Lake Benton II)	NA	NA	1.81	Agriculture	Johnson et al. 2004
Buffalo Ridge I, SD (2010)	5.06	0.2	0.16	Agriculture/grassland	Derby et al. 2010b
Buffalo Ridge II, SD (2011)	1.99	0	2.81	Agriculture, grassland	Derby et al. 2012a
Casselman Curtailment, PA (2008)	NA	NA	4.4	Forest	Arnett et al. 2009b
Casselman, PA (2008)	1.51	0	12.61	Forest	Arnett et al. 2009a
Casselman, PA (2009)	2.88	0	8.6	Forest, pasture, grassland	Arnett et al. 2010
Cedar Ridge, WI (2009)	6.55	0.18	30.61	Agriculture	BHE Environmental 2010
Cedar Ridge, WI (2010)	3.72	0.13	24.12	Agriculture	BHE Environmental 2011
Cohocton/Dutch Hill, NY (2009)	1.39	0	8.62	Agriculture/forest	Stantec 2010
Cohocton/Dutch Hills, NY (2010)	1.32	0.08	10.32	Agriculture, forest	Stantec 2011
Combine Hills, OR	2.56	0	1.88	Agriculture/grassland	Young et al. 2006
Combine Hills, OR (2011)	2.33	0.05	0.73	Grassland/shrub-steppe, agriculture	Enz et al. 2012
Crescent Ridge, IL	NA	NA	3.27	Agriculture	Kerlinger et al. 2007
Criterion, MD (2011)	6.4	0.02	15.61	Forest, agriculture	Young et al. 2012a
Crystal Lake II, IA	NA	NA	7.42	Agriculture	Derby et al. 2010a
Diablo Winds, CA	4.29	0.4	0.82	NA	WEST 2006, 2008
Dillon, CA	4.71	0	2.17	Desert	Chatfield et al. 2009
Dry Lake I, AZ	2.02	0	3.43	Desert grassland/forested	Thompson et al. 2011

Appendix D4. Fatality estimates for North American wind-energy facilities.

Project	Bird Fatalities (birds/MW/ year)	Raptor Fatalities (raptors/MW/ year)	Bat Fatalities (bats/MW/ year)	Predominant Habitat Type	Citation
Dry Lake II, AZ	1.57	0	1.66	Desert grassland/forested	Thompson and Bay 2012
Elkhorn, OR (2008)	0.64	0.06	1.26	Shrub/scrub & agriculture	Jeffrey et al. 2009b
Elkhorn, OR (2010)	1.95	0.08	2.14	Shrub/scrub & agriculture	Enk et al. 2011b
Elm Creek, MN	1.55	0	1.49	Agriculture	Derby et al. 2010c
Elm Creek II, MN	3.64	0	2.81	Agriculture, grassland	Derby et al. 2012b
Foote Creek Rim, WY (Phase I; 1999)	3.4	0.08	3.97	Grassland	Young et al. 2003b
Foote Creek Rim, WY (Phase I; 2000)	2.42	0.05	1.05	Grassland	Young et al. 2003b
Foote Creek Rim, WY (Phase I; 2001-2002)	1.93	0	1.57	Grassland	Young et al. 2003b
Forward Energy Center, WI	NA	NA	18.17	Agriculture	Grodsky and Drake 2011
Fowler I, II, III, IN (2010)	NA	NA	18.96	Agriculture	Good et al. 2011
Fowler I, II, III, IN (2011)	NA	NA	20.19	Agriculture	Good et al. 2012
Goodnoe, WA	1.4	0.17	0.34	Grassland and shrub-steppe	URS Corporation 2010a
Grand Ridge I, IL	0.48	0	2.1	Agriculture	Derby et al. 2010g
Harrow, Ont (2010)	NA	NA	11.13	Agriculture	Natural Resource Solutions Inc. (NRSI) 2011
Harvest Wind, WA (2010-2012)	2.94	0.23	1.27	Grassland/shrub-steppe	Downes and Gritski 2012a
Hay Canyon, OR	2.21	0	0.53	Agriculture	Gritski and Kronner 2010a
High Sheldon, NY (2010)	1.76	0.06	2.33	Agriculture	Tidhar et al. 2012a
High Sheldon, NY (2011)	1.57	0	1.78	Agriculture	Tidhar et al. 2012b
High Winds, CA (2004)	1.62	0.5	2.51	Agriculture/grassland	Kerlinger et al. 2006
High Winds, CA (2005)	1.1	0.28	1.52	Agriculture/grassland	Kerlinger et al. 2006
Hopkins Ridge, WA (2006)	1.23	0.14	0.63	Agriculture/grassland	Young et al. 2007
Hopkins Ridge, WA (2008)	2.99	0.07	1.39	Agriculture/grassland	Young et al. 2009c
Judith Gap, MT (2006/2007)	NA	NA	8.93	Agriculture/grassland	TRC 2008
Judith Gap, MT (2009)	NA	NA	3.2	Agriculture/grassland	Poulton and Erickson 2010
Kewaunee County, WI	1.95	0	6.45	Agriculture	Howe et al. 2002

Appendix D4. Fatality estimates for North American wind-energy facilities.

Project	Bird Fatalities (birds/MW/ year)	Raptor Fatalities (raptors/MW/ year)	Bat Fatalities (bats/MW/ year)	Predominant Habitat Type	Citation
Kibby, ME (2011)	NA	NA	0.12	Forest; commercial forest	Stantec 2012
Kittitas Valley, WA (2011-2012)	1.06	0.09	0.12	Sagebrush-steppe, grassland	Stantec Consulting Services 2012
Klondike, OR	0.95	0	0.77	Agriculture/grassland	Johnson et al. 2003a
Klondike II, OR	3.14	0.06	0.41	Agriculture/grassland	NWC and WEST 2007
Klondike III (Phase I), OR	3.02	0.15	1.11	Agriculture/grassland	Gritski et al. 2010
Klondike IIIa (Phase II), OR	2.61	0.06	0.14	Grassland/shrub-steppe and agriculture	Gritski et al. 2011
Leaning Juniper, OR	6.66	0.16	1.98	Agriculture	Gritski et al. 2008
Lempster, NH (2009)	3.38	0	3.11	Grasslands/forest/rocky embankments	Tidhar et al. 2010
Lempster, NH (2010)	2.64	0	3.57	Grasslands/forest/rocky embankments	Tidhar et al. 2011
Linden Ranch, WA	6.65	0.27	1.68	Grassland/shrub-steppe, agriculture	Enz and Bay 2011
Locust Ridge, PA (Phase II; 2009)	0.84	0	14.11	Grassland	Arnett et al. 2011
Locust Ridge, PA (Phase II; 2010)	0.76	0	14.38	Grassland	Arnett et al. 2011
Maple Ridge, NY (2006)	NA	NA	11.21	Agriculture/forested	Jain et al. 2007
Maple Ridge, NY (2007)	3.44	0.25	9.42	Agriculture/forested	Jain et al. 2009a
Maple Ridge, NY (2008)	2.07	0.03	4.96	Agriculture/forested	Jain et al. 2009d
Marengo I, WA (2009)	0.27	0	0.17	Agriculture	URS Corporation 2010b
Marengo II, WA (2009)	0.16	0.05	0.27	Agriculture	URS Corporation 2010c
Mars Hill, ME (2007)	1.67	0	2.91	Forest	Stantec 2008
Mars Hill, ME (2008)	1.76	0	0.45	Forest	Stantec 2009a
Moraine II, MN	5.59	0.37	2.42	Agriculture/grassland	Derby et al. 2010d
Mount Storm, WV (Fall 2008)	NA	NA	6.62	Forest	Young et al. 2009b
Mount Storm, WV (2009)	3.85	0	17.53	Forest	Young et al. 2009a, 2010b
Mount Storm, WV (2010)	2.6	0.1	15.18	Forest	Young et al. 2010a, 2011b
Mount Storm, WV (2011)	4.24	0.03	7.43	Forest	Young et al. 2011a, 2012b
Mountaineer, WV (2003)	2.69	0.07	31.69	Forest	Kerns and Kerlinger 2004

Appendix D4. Fatality estimates for North American wind-energy facilities.

Project	Bird Fatalities (birds/MW/ year)	Raptor Fatalities (raptors/MW/ year)	Bat Fatalities (bats/MW/ year)	Predominant Habitat Type	Citation
Munnsville, NY (2008)	1.48	0.59	1.93	Agriculture/forest	Stantec 2009b
Nine Canyon, WA	2.76	0.03	2.47	Agriculture/grassland	Erickson et al. 2003b
Noble Altona, NY	1.84	0	4.34	Forest	Jain et al. 2011b
Noble Bliss, NY (2008)	1.3	0.1	7.8	Agriculture/forest	Jain et al.2009e
Noble Bliss, NY (2009)	2.28	0.12	3.85	Agriculture/forest	Jain et al. 2010a
Noble Chateaugay, NY	1.66	0.08	2.44	Agriculture	Jain et al. 2011c
Noble Clinton, NY (2008)	1.59	0.1	3.14	Agriculture/forest	Jain et al. 2009c
Noble Clinton, NY (2009)	1.11	0.16	4.5	Agriculture/forest	Jain et al. 2010b
Noble Ellenburg, NY (2008)	0.83	0.11	3.46	Agriculture/forest	Jain et al. 2009b
Noble Ellenburg, NY (2009)	2.66	0.25	3.91	Agriculture/forest	Jain et al. 2010c
Noble Wethersfield, NY	1.7	0.13	16.3	Agriculture	Jain et al. 2011a
NPPD Ainsworth, NE	1.63	0.06	1.16	Agriculture/grassland	Derby et al. 2007
Pebble Springs, OR	1.93	0.04	1.55	Grassland	Gritski and Kronner 2010b
Pine Tree, CA	8.3	0.133	NA	Grassland	BioResource Consultants 2010
Pioneer Prairie I, IA (Phase II)	0.27	0	10.06	Agriculture, grassland	Chodachek et al. 2012
Prairie Winds ND1 (Minot), ND	1.48	0.05	2.13	Agriculture	Derby et al. 2011c
Prairie Winds ND1 (Minot), ND 2011	1.56	0.05	1.39	Agriculture, grassland	Derby et al. 2012c
Prairie Winds (SD1), SD	1.41	0	1.23	Grassland	Derby et al. 2012d
Ripley, Ont (2008)	3.09	0.1	4.67	Agriculture	Jacques Whitford 2009
Rugby, ND	3.82	0.06	1.6	Agriculture	Derby et al. 2011b
Shiloh I, CA	6.96	0.42	3.92	Agriculture/grassland	Kerlinger et al. 2010a
Shiloh II, CA	1.51	0.12	2.72	Agriculture	Kerlinger et al. 2010b
Stateline, OR/WA (2002)	3.17	0.09	1.09	Agriculture/grassland	Erickson et al. 2004
Stateline, OR/WA (2003)	2.68	0.09	2.29	Agriculture/grassland	Erickson et al. 2004
Stateline, OR/WA (2006)	1.23	0.11	0.95	Agriculture/grassland	Erickson et al. 2007
Stetson Mountain I, ME (2009)	2.68	0	1.4	Forest	Stantec 2009c
Stetson Mountain I, ME (2011)	1.18	0	0.28	Forested	Normandeau Associates 2011
Stetson Mountain II, ME (2010)	1.42	0	1.65	Forested	Normandeau Associates 2010
Summerview, Alb (2006)	1.06	0.11	10.27	Agriculture	Brown and Hamilton 2006b

Appendix D4. Fatality estimates for North American wind-energy facilities.

Project	Bird Fatalities (birds/MW/ year)	Raptor Fatalities (raptors/MW/ year)	Bat Fatalities (bats/MW/ year)	Predominant Habitat Type	Citation
Summerview, Alb (2008)	NA	NA	11.42	Agriculture/grassland	Baerwald 2008
Top of Iowa, IA (2003)	0.42	0	7.16	Agriculture	Jain 2005
Top of Iowa, IA (2004)	0.81	0.17	10.27	Agriculture	Jain 2005
Tuolumne (Windy Point I), WA	3.2	0.29	0.94	Grassland/shrub-steppe, agriculture and forest	Enz and Bay 2010
Vansycle, OR	0.95	0	1.12	Agriculture/grassland	Erickson et al. 2000a
Vantage, WA	1.27	0.29	0.4	Shrub-steppe, grassland	Ventus Environmental Solutions 2012
Wessington Springs, SD (2009)	8.25	0.06	1.48	Grassland	Derby et al. 2010f
Wessington Springs, SD (2010)	0.89	0.07	0.41	Grassland	Derby et al. 2011d
White Creek, WA (2007-2011)	4.05	0.47	2.04	Grassland/shrub-steppe, agriculture	Downes and Gritski 2012b
Wild Horse, WA	1.55	0.09	0.39	Grassland	Erickson et al. 2008
Windy Flats, WA	8.45	0.04	0.41	Grassland/shrub-steppe, agriculture	Enz et al. 2011
Winnebago, IA	3.88	0.27	4.54	Agriculture/grassland	Derby et al. 2010e
Wolfe Island, Ont (July-December 2009)	NA	NA	6.42	Grassland	Stantec Ltd. 2010b
Wolfe Island, Ont (July-December 2010)	NA	NA	9.5	Grassland	Stantec Ltd. 2011b
Wolfe Island, Ont (July-December 2011)	NA	NA	2.49	Grassland	Stantec Ltd. 2012

Appendix D5. Summary of all publicly-available post-construction monitoring studies, with project characteristics and select study methodologies.

Project Name	Total # of turbines	Total MW	Tower size (m)	Number turbines searched	Plot Size	Length of Study	Survey frequency
Alite, CA	8	24	80	8	200 m x 200 m	1 year	Weekly (spring, fall), bi-monthly (summer, winter)
Barton I & II, IA	80	160	100	35 (9 turbines were dropped in June 2010 due to landowner issues) 26 turbines were searched for the remainder of the study	200 m x 200 m	1 year	Weekly (spring, fall; migratory turbines), monthly (summer, winter; non-migratory turbines)
Barton Chapel, TX	60	120	78	30	200 m x 200 m	1 year	10 turbines weekly, 20 monthly
Big Horn, WA	133	199.5	80	133	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Biglow Canyon, OR (Phase I; 2008)	76	125.4	80	50	110 m x 110 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Biglow Canyon, OR (Phase I; 2009)	76	125.4	80	50	110 m x 110 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Biglow Canyon, OR (Phase II; 2009/2010)	65	150	80	50	250 m x 250 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Biglow Canyon, OR (Phase II; 2010/2011)	65	150	NA	50	252 m x 252 m	1 year	Bi-weekly(spring, fall), monthly (summer, winter)
Biglow Canyon, OR (Phase III; 2010/2011)	76	174.8	NA	50	252 m x 252 m	1 year	Bi-weekly(spring, fall), monthly (summer, winter)
Blue Sky Green Field, WI	88	145	80	30	160 m x 160 m	Fall, spring	Daily(10 turbines), weekly (20 turbines)
Buena Vista, CA	38	38	45-55	38	75-m radius	1 year	Monthly to bi-monthly starting in September 2008
Buffalo Gap I, TX	67	134	NA	21	215 m x 215 m	10 months	Every 3 weeks

Appendix D5. Summary of all publicly-available post-construction monitoring studies, with project characteristics and select study methodologies.

Project Name	Total # of turbines	Total MW	Tower size (m)	Number turbines searched	Plot Size	Length of Study	Survey frequency
Buffalo Gap II, TX	155	233	80	36	215 m x 215 m	14 months	Every 21 days
Buffalo Mountain, TN (2000-2003)	3	1.98	65	3	50-m radius	3 years	Bi-weekly, weekly, bi-monthly
Buffalo Mountain, TN (2005)	18	28.98	V47 = 65; V80 = 78	18	50-m radius	1 year	Bi-weekly, weekly, bi-monthly, and 2 to 5 day intervals
Buffalo Ridge, MN (1994/1995)	73	25	37	1994:10 plots (3 turbines/plot), 20 addition plots in Sept & Oct 1994, 1995: 30 turbines search every other week (Jan-Mar), 60 searched weekly (Apr, July, Aug) 73 searched weekly (May-June and Sept-Oct), 30 searched weekly (Nov-Dec)	100 x 100m	20 months	Varies. See number turbines searched or page 44 of report
Buffalo Ridge, MN (Phase I; 1996)	73	25	36	21	126 m x 126 m	1 year	Bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase I; 1997)	73	25	36	21	126 m x 126 m	1 year	Bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase I; 1998)	73	25	36	21	126 m x 126 m	1 year	Bi-monthly (spring, summer, and fall)

Appendix D5. Summary of all publicly-available post-construction monitoring studies, with project characteristics and select study methodologies.

Project Name	Total # of turbines	Total MW	Tower size (m)	Number turbines searched	Plot Size	Length of Study	Survey frequency
Buffalo Ridge, MN (Phase I; 1999)	73	25	36	21	126 m x 126 m	1 year	Bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase II; 1998)	143	107.25	50	40	126 m x 126 m	1 year	Bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase II; 1999)	143	107.25	50	40	126 m x 126 m	1 year	Bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)	143	107.25	50	83	60 m x 60 m	Summer, fall	Bi-monthly
Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)	143	107.25	50	103	60 m x 60 m	Summer, fall	Bi-monthly
Buffalo Ridge, MN (Phase III; 1999)	138	103.5	50	30	126 m x 126 m	1 year	Bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase III; 2001/Lake Benton II)	138	103.5	50	83	60 m x 60 m	Summer, fall	Bi-monthly
Buffalo Ridge, MN (Phase III; 2002/Lake Benton II)	138	103.5	50	103	60 m x 60 m	Summer, fall	Bi-monthly
Buffalo Ridge I, SD (2010)	24	50.4	79	24	200 m x 200 m	1 year	Weekly (migratory), monthly (non-migratory)
Buffalo Ridge II, SD (2011)	105	210	78	65 (60 road and pad, 5 turbine plots)	100 x 100m	1 year	Weekly (spring, summer, fall), monthly (winter)
Casselman, PA (2008)	23	34.5	80	10	126 m x 120 m	7 months	Daily
Casselman, PA (2009)	23	34.5	80	10	126 m x 120 m	7.5 months	Daily searches
Casselman Curtailment, PA (2008)	23	35.4	80	12 experimental; 10 control	126 m x 120 m	2.5 months	Daily
Castle River, Alb (2001)	60	39.6	50	60	50-m radius	2 years	Weekly, bi-weekly
Castle River, Alb (2002)	60	39.6	50	60	50-m radius	2 years	Weekly, bi-weekly
Cedar Ridge, WI (2009)	41	67.6	80	20	160 m x 160 m	Spring, summer, fall	Daily, every 4 days; late fall searched every 3 days

Appendix D5. Summary of all publicly-available post-construction monitoring studies, with project characteristics and select study methodologies.

Project Name	Total # of turbines	Total MW	Tower size (m)	Number turbines searched	Plot Size	Length of Study	Survey frequency
Cedar Ridge, WI (2010)	41	68	80	20	160 m x 160 m	1 year	Five turbines were surveyed daily, 15 turbines surveyed every 4 days in rotating groups each day. All 20 surveyed every three days during late fall
Cohocton/Dutch Hill, NY (2009)	50	125	80	17	130 m x 130 m	Spring, summer, fall	Daily (5 turbines), weekly (12 turbines)
Cohocton/Dutch Hills, NY (2010)	50	125	80	17	120 m x 120 m	Spring, summer, fall	Daily, weekly
Combine Hills, OR	41	41	53	41	90-m radius	1 year	Monthly
Combine Hills, OR (2011)	104	104	53	52 (plus 1 MET tower)	180 m x 180 m	1 year	Bi-weekly(spring, fall), monthly (summer, winter)
Condon, OR	84	NA	NA	NA	NA	NA	NA
Crescent Ridge, IL	33	49.5	80	33	70-m radius	1 year	Weekly (fall, spring)
Criterion, MD (2011)	28	70	80	28	40-50m radius	7.3 months	Daily
Crystal Lake II, IA	80	200	80	16 turbines through week 6, and then 15 for duration of study	100 m x 100 m	Spring, summer, fall	3 times per week for 26 weeks
Diablo Winds, CA	31	20.46	50 and 55	31	75 m x 75 m	2 years	Monthly
Dillon, CA	45	45	69	15	200 m x 200 m	1 year	Weekly, bi-monthly in winter
Dry Lake I, AZ	30	63	78	15	160 m x 160 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Dry Lake II, AZ	31	65	78	31: 5 (full plot), 26 (road & pad)	160 m x 160 m	1 year	Twice weekly (spring, summer, fall), weekly (winter)

Appendix D5. Summary of all publicly-available post-construction monitoring studies, with project characteristics and select study methodologies.

Project Name	Total # of turbines	Total MW	Tower size (m)	Number turbines searched	Plot Size	Length of Study	Survey frequency
Elkhorn, OR (2008)	61	101	80	61	220 m x 220 m	1 year	Monthly
Elkhorn, OR (2010)	61	101	80	31	220 m x 220 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Elm Creek, MN	67	100	80	29	200 m x 200 m	1 year	Weekly, monthly
Elm Creek II, MN	62	148.8	80	30	200 x 200m (2 random migration search areas 100 x 100m)	1 year	20 searched every 28 days, 10 turbines every 7 days during migration)
Erie Shores, Ont	66	99	80	66	40-m radius	2 years	Weekly, bi-monthly, 2-3 times weekly (migration)
Foote Creek Rim, WY (Phase I; 1999)	69	41.4	40	69	126 m x 126 m	1 year	Monthly
Foote Creek Rim, WY (Phase I; 2000)	69	41.4	40	69	126 m x 126 m	1 year	Monthly
Foote Creek Rim, WY (Phase I; 2001-2002)	69	41.4	40	69	126 m x 126 m	1 year	Monthly
Forward Energy Center, WI	86	129	80	29	160 m x 160 m	2 years	11 turbines daily, 9 every 3 days, 9 every 5 days
Fowler I, II, III, IN (2010)	355	600	Vestas = 80, Clipper = 80, GE = 80	36 turbines, 100 road and pads	80 m x 80 m for turbines ; 40-m radius for roads and pads	Spring, fall	Daily, weekly
Fowler I, II, III, IN (2011)	355	600	Vestas = 80, Clipper = 80, GE = 80	177 road and pads (spring), 9 turbines & 168 roads and pads (fall)	turbines (80 m circular plot), roads and pads (out to 80 m)	Spring, fall	Daily, weekly

Appendix D5. Summary of all publicly-available post-construction monitoring studies, with project characteristics and select study methodologies.

Project Name	Total # of turbines	Total MW	Tower size (m)	Number turbines searched	Plot Size	Length of Study	Survey frequency
Goodnoe, WA	47	94	80	24	180 m x 180 m	1 year	14 days during migration periods, 28 days during non-migration periods
Grand Ridge I, IL	66	99	80	30	160 m x 160 m	1 year	Weekly, monthly
Harrow, Ont (2010)	24 (four 6-turb facilities)	39.6	NA	12 in July, 24 Aug-Oct	50-m radius from turbine base	4 months	Twice-weekly
Harvest Wind, WA (2010-2012)	43	98.9	80	32	180 m x 180 m & 240 m x 240 m	2 years	Twice a week, weekly and monthly
Hay Canyon, OR	48	100.8	79	20	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
High Sheldon, NY (2010)	75	112.5	80	25	115 m x 115 m	7 months	Daily (8 turbines), weekly (17 turbines)
High Sheldon, NY (2011)	75	112.5	80	25	115 m x 115 m	7 months	Daily (8 turbines), weekly (17 turbines)
High Winds, CA (2004)	90	162	60	90	75-m radius	1 year	Bi-monthly
High Winds, CA (2005)	90	162	60	90	75-m radius	1 year	Bi-monthly
Hopkins Ridge, WA (2006)	83	150	67	41	180 m x 180 m	1 year	Monthly, weekly (subset of 22 turbines spring and fall migration)
Hopkins Ridge, WA (2008)	87	156.6	67	41-43	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Jersey Atlantic, NJ	5	7.5	80	5	130 m x 120 m	9 months	Weekly
Judith Gap, MT (2006/2007)	90	135	80	20	190 m x 190 m	7 months	Monthly
Judith Gap, MT (2009)	90	135	80	30	100 m x 100 m	5 months	Bi-monthly

Appendix D5. Summary of all publicly-available post-construction monitoring studies, with project characteristics and select study methodologies.

Project Name	Total # of turbines	Total MW	Tower size (m)	Number turbines searched	Plot Size	Length of Study	Survey frequency
Kewaunee County, WI	31	20.46	65	31	60 m x 60 m	2 years	Bi-weekly (spring, summer), daily (spring, fall migration), weekly (fall, winter)
Kibby, ME (2011)	44	132	124	22 turbines	75-m diameter circular plots	22 weeks	Avg 5-day
Kittitas Valley, WA (2011-2012)	48	100.8	80	48	100 m x 102 m	1 year	Bi weekly from Aug 15 - Oct 31 and March 16 - May 15; every 4 weeks from Nov 1 - March 15 and May 16 - Aug 14
Klondike, OR	16	24	80	16	140 m x 140 m	1 year	Monthly
Klondike II, OR	50	75	80	25	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (summer, winter)
Klondike III (Phase I), OR	125	223.6	GE = 80; Siemens= 80, Mitsubishi = 80	46	240 m x 240 m (1.5MW) 252 m x 252 m (2.3MW)	2 year	Bi-monthly (spring, fall migration), monthly (summer, winter)
Klondike IIIa (Phase II), OR	51	76.5	GE = 80	34	240 m x 240 m	2 years	Bi-monthly (spring, fall), monthly (summer, winter)
Leaning Juniper, OR	67	100.5	80	17	240 m x 240 m	2 years	Bi-monthly (spring, fall), monthly (winter, summer)
Lempster, NH (2009)	12	24	78	4	120 m x 130 m	6 months	Daily
Lempster, NH (2010)	12	24	78	12	120 m x 130 m	6 months	Weekly
Linden Ranch, WA	25	50	80	25	110 m x 110 m	1 year	Bi-weekly(spring, fall), monthly (summer, winter)

Appendix D5. Summary of all publicly-available post-construction monitoring studies, with project characteristics and select study methodologies.

Project Name	Total # of turbines	Total MW	Tower size (m)	Number turbines searched	Plot Size	Length of Study	Survey frequency
Locust Ridge, PA (Phase II; 2009)	51	102	80	15	120m x 126m	6.5 months	Daily
Locust Ridge, PA (Phase II; 2010)	51	102	80	15	120m x 126m	6.5 months	Daily
Madison, NY	7	11.55	67	7	60-m radius	1 year	Weekly (spring, fall), monthly (summer)
Maple Ridge, NY (2006)	120	198	80	50	130 m x 120 m	5 months	Daily (10 turbines), every 3 days (10 turbines), weekly (30 turbines)
Maple Ridge, NY (2007)	195	321.75	80	64	130 m x 120 m	7 months	Weekly
Maple Ridge, NY (2008)	195	321.75	80	64	130 m x 120 m	7 months	Weekly
Marengo I, WA (2009)	78	140.4	67	39	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Marengo II, WA (2009)	39	70.2	67	20	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Mars Hill, ME (2007)	28	42	80.5	28	76-m diameter, extended plot 238-m diameter	Spring, summer, fall	Daily (2 random turbines), weekly (all turbines): extended plot searched once per season
Mars Hill, ME (2008)	28	42	80.5	28	76-m diameter, extended plot 238-m diameter	Spring, summer, fall	Weekly: extended plot searched once per season
McBride, Alb (2004)	114	75	50	114	4 parallel transects 120-m wide	1 year	Weekly, bi-weekly
Melancthon, Ont (Phase I)	45	NA	NA	45	35m radius	5 months	Weekly, twice weekly
Meyersdale, PA (2004)	20	30	80	20	130 m x 120 m	6 weeks	Daily (half turbines), weekly (half turbines)

Appendix D5. Summary of all publicly-available post-construction monitoring studies, with project characteristics and select study methodologies.

Project Name	Total # of turbines	Total MW	Tower size (m)	Number turbines searched	Plot Size	Length of Study	Survey frequency
Moraine II, MN	33	49.5	82.5	30	200 m x 200 m	1 year	Weekly (migratory), monthly (non-migratory)
Mount Storm, WV (Fall 2008)	82	164	78	27	varied	3 months	Weekly (18 turbines), daily (9 turbines)
Mount Storm, WV (2009)	132	264	78	44	varied	4.5 months	Weekly (28 turbines), daily (16 turbines)
Mount Storm, WV (2010)	132	264	78	24	20 to 60 m from turbine	6 months	Daily
Mount Storm, WV (2011)	132	264	78	24	varied	6 months	Daily
Mountaineer, WV (2003)	44	66	80	44	60-m radius	7 months	Weekly, monthly
Mountaineer, WV (2004)	44	66	80	44	130 m x 120 m	6 weeks	Daily, weekly
Munnsville, NY (2008)	23	34.5	69.5	12	120 m x 120 m	Spring, summer, fall	Weekly
Nine Canyon, WA	37	48.1	60	37	90-m radius	1 year	Bi-monthly (spring, summer, fall), monthly (winter)
Noble Altona, NY	65	97.5	80	22	120 m x 120 m	Spring, summer, fall	Daily, weekly
Noble Bliss, NY (2008)	67	100	80	23	120 m x 120 m	Spring, summer, fall	Daily (8 turbines), 3-day (8 turbines), weekly (7 turbines)
Noble Bliss, NY (2009)	67	100	80	23	120 m x 120 m	Spring, summer, fall	Weekly, 8 turbines searched daily from July 1 to August 15
Noble Chateaugay, NY	71	106.5	80	24	120 m x 120 m	Spring, summer, fall	Weekly
Noble Clinton, NY (2008)	67	100	80	23	120 m x 120 m	Spring, summer, fall	Daily (8 turbines), 3-day (8 turbines), weekly (7 turbines)

Appendix D5. Summary of all publicly-available post-construction monitoring studies, with project characteristics and select study methodologies.

Project Name	Total # of turbines	Total MW	Tower size (m)	Number turbines searched	Plot Size	Length of Study	Survey frequency
Noble Clinton, NY (2009)	67	100	80	23	120 m x 120 m	Spring, summer, fall	Daily (8 turbines), weekly (15 turbines), all turbines weekly from July 1 to August 15
Noble Ellenburg, NY (2008)	54	80	80	18	120 m x 120 m	Spring, summer, fall	Daily (6 turbines), 3-day (6 turbines), weekly (6 turbines)
Noble Ellenburg, NY (2009)	54	80	80	18	120 m x 120 m	Spring, summer, fall	Daily (6 turbines), weekly (12 turbines), all turbines weekly from July 1 to August 15
Noble Wethersfield, NY	84	126	80	28	120 m x 120 m	Spring, summer, fall	Weekly
NPPD Ainsworth, NE	36	20.5	70	36	220 m x 220 m	Spring, summer, fall	Bi-monthly
Oklahoma Wind Energy Center, OK	68	102	70	68	5-, 10-, 15-m circular transects	3 months (2 years)	Bi-monthly
Pebble Springs, OR	47	98.7	79	20	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Pine Tree, CA	90	135	65	40	NA	1 year	Bi-weekly
Pioneer Prairie I, IA (Phase II)	62	102.3	80	62 (57 road/pad) 5 full search plots	80 x 80m	1 year	Weekly (spring and fall), every two weeks (summer), monthly (winter)
Prairie Winds ND1 (Minot), ND	80	115.5	89	35	minimum of 100 m x 100 m	3 seasons	Bi-monthly
Prairie Winds ND1 (Minot), ND 2011	80	115.5	80	35	minimum 100 x 100m	3 season	Twice monthly

Appendix D5. Summary of all publicly-available post-construction monitoring studies, with project characteristics and select study methodologies.

Project Name	Total # of turbines	Total MW	Tower size (m)	Number turbines searched	Plot Size	Length of Study	Survey frequency
Prairie Winds (SD1), SD	108	162	80	50	200 x 200m	1 year	Twice monthly (spring, summer, fall), monthly (winter)
Prince Wind Farm, Ont (2006)	126	189	80	38	63-m radius	4 months	Daily, weekly
Prince Wind Farm, Ont (2007)	126	189	80	38 turbines from January 1st - July 8th, 126 turbines from July 9th-October 31st	63- to 45-m radius	10 months	Daily, weekly
Prince Wind Farm, Ont (2008)	126	189	80	126	45m radius	6.5 months	Daily, 3x/week, 2x/week
Red Canyon, TX	56	84	70	28	200 m x 200 m in fall and winter; 160 m x 160 m in spring and summer	1 year	Every 14 days in fall and winter; 7 days in spring, 3 days in summer
Ripley, Ont (2008)	38	76	64	38	80 m x 80 m	Spring, fall	Twice weekly for odd turbines; weekly for even turbines.
Ripley, Ont (Fall 2009)	38	76	64	38	80 m x 80 m	6 weeks	Twice weekly for odd turbines; weekly for even turbines.
Rugby, ND	71	149	78	32	200 m x 200 m	1 year	Weekly (spring, fall; migratory turbines), monthly (non-migratory turbines)
San Gorgonio, CA	3000	NA	24.4-42.7	NA	50-m radius	2 years	Quarterly
Searsburg, VT (2007)	11	7	65	11	20- to 55-m radius	Spring, fall	Weekly (fall migration)

Appendix D5. Summary of all publicly-available post-construction monitoring studies, with project characteristics and select study methodologies.

Project Name	Total # of turbines	Total MW	Tower size (m)	Number turbines searched	Plot Size	Length of Study	Survey frequency
Shiloh I, CA	100	150	65	100	105-m radius	3 years	Weekly
Shiloh II, CA	75	150	33 turbs = 115; 42 turbs = 125	25	100m radius	1 yr	Once/week
SMUD Solano, CA	22	15	65	22	60-m radius	1 year	Bi-monthly
Stateline, OR/WA (2002)	454	299	50	124	minimum 126 m x 126 m	17 months	Bi-weekly, monthly
Stateline, OR/WA (2003)	454	299	50	153	minimum 126 m x 126 m	1 year	Bi-weekly, monthly
Stateline, OR/WA (2006)	454	299	50	39	variable turbine strings	1 year	Bi-weekly
Stetson Mountain I, ME (2009)	38	57	80	19	76-m diameter	27 weeks (spring, summer, fall)	Weekly
Stetson Mountain I, ME (2011)	38	57	80	19	varied	6 months	Weekly
Stetson Mountain II, ME (2010)	17	25.5	80	17	varied	6 months	Weekly (3 turbines twice a week)
Summerview, Alb (2006)	39	70.2	67	39	140 m x 140 m	1 year	Weekly, bi-weekly (May to July, September)
Summerview, Alb (2008)	39	70.2	65	39	52-m radius; 2 spiral transects 7 m apart	Summer, fall (2 years)	Daily (10 turbines), weekly (29 turbines)
Tehachapi, CA	3300	NA	14.7 to 57.6	201	50-m radius	20 months	Quarterly

Appendix D5. Summary of all publicly-available post-construction monitoring studies, with project characteristics and select study methodologies.

Project Name	Total # of turbines	Total MW	Tower size (m)	Number turbines searched	Plot Size	Length of Study	Survey frequency
Top of Iowa, IA (2003)	89	80	71.6	26	76 m x 76 m	Spring, summer, fall	Once every 2 to 3 days
Top of Iowa, IA (2004)	89	80	71.6	26	76 m x 76 m	Spring, summer, fall	Once every 2 to 3 days
Tuolumne (Windy Point I), WA	62	136.6	80	21	180 m x 180 m	1 year	Monthly throughout the year, a sub-set of 10 turbines were also searched weekly during the spring, summer, and fall
Vansycle, OR	38	24.9	50	38	126 m x 126 m	1 year	Monthly
Vantage, WA	60	90	80	30	240 m x 240 m	1 year	Monthly, a subset of 10 searched weekly during migration
Wessington Springs, SD (2009)	34	51	80	20	200 m x 200 m	Spring, summer, fall	Bi-monthly
Wessington Springs, SD (2010)	34	51	80	20	200 m x 200 m	8 months	Bi-weekly (spring, summer, fall)
White Creek, WA (2007-2011)	89	204.7	80	89	180 m x 180 m & 240 m x 240 m	4 years	Twice a week, weekly and monthly
Wild Horse, WA	127	229	67	64	110 m from two turbines in plot	1 year	Monthly, weekly (fall, spring migration at 16 turbines)
Windy Flats, WA	114	262.2	NA	36 (plus 1 MET tower)	180 m x 180 m (120m at MET tower)	1 year	Monthly (spring, summer, fall, and winter), weekly (spring and fall migration)

Appendix D5. Summary of all publicly-available post-construction monitoring studies, with project characteristics and select study methodologies.

Project Name	Total # of turbines	Total MW	Tower size (m)	Number turbines searched	Plot Size	Length of Study	Survey frequency
Winnebago, IA	10	20	78	10	200 m x 200 m	1 year	Weekly (migratory), monthly (non-migratory)
Wolfe Island, Ont (May-June 2009)	86	197.8	80	86	60-m radius	Spring	43 twice weekly, 43 weekly
Wolfe Island, Ont (July-December 2009)	86	197.8	80	86	60-m radius	Summer, fall	43 twice weekly, 43 weekly
Wolfe Island, Ont (January-June 2010)	86	197.8	80	86	60-m radius	6 months	43 twice weekly, 43 weekly
Wolfe Island, Ont (July-December 2010)	86	197.8	80	86	50-m radius	6 months	43 twice weekly, 43 weekly
Wolfe Island, Ont (January-June 2011)	86	197.8	80	86	50-m radius	6 months	43 twice weekly, 43 weekly
Wolfe Island, Ont (July-December 2011)	86	197.8	80	86	50-m radius	6 months	43 twice weekly, 43 weekly

Appendix D5 (*continued*). Summary of all publicly-available post-construction monitoring studies, with project characteristics and select study methodologies.

Project, Location	Fatality Reference	Project, Location	Fatality Reference
Alite, CA	Chatfield et al. 2010	Lempster, NH (09)	Tidhar et al. 2010
Barton I & II, IA	Derby et al. 2011a	Lempster, NH (10)	Tidhar et al. 2011
Barton Chapel, TX	WEST 2011	Linden Ranch, WA	Enz and Bay 2011
Big Horn, WA	Kronner et al. 2008	Locust Ridge, PA (Phase II; 09)	Arnett et al. 2011
Biglow Canyon, OR (Phase I; 08)	Jeffrey et al. 2009a	Locust Ridge, PA (Phase II; 10)	Arnett et al. 2011
Biglow Canyon, OR (Phase I; 09)	Enk et al. 2010	Madison, NY	Kerlinger 2002b
Biglow Canyon, OR (Phase II; 09/10)	Enk et al. 2011a	Maple Ridge, NY (06)	Jain et al. 2007
Biglow Canyon, OR (Phase II; 10/11)	Enk et al. 2012b	Maple Ridge, NY (07)	Jain et al. 2009a
Biglow Canyon, OR (Phase III; 10/11)	Enk et al. 2012a	Maple Ridge, NY (08)	Jain et al. 2009d
Blue Sky Green Field, WI	Gruver et al. 2009	Marengo I, WA (09)	URS Corporation 2010b
Buena Vista, CA	Insignia Environmental 2009	Marengo II, WA (09)	URS Corporation 2010c
Buffalo Gap I, TX	Tierney 2007	Mars Hill, ME (07)	Stantec 2008
Buffalo Gap II, TX	Tierney 2009	Mars Hill, ME (08)	Stantec 2009a
Buffalo Mountain, TN (00-03)	Nicholson et al. 2005	McBride, Alb (04)	Brown and Hamilton 2004
Buffalo Mountain, TN (05)	Fiedler et al. 2007	Melancthon, Ont (Phase I)	Stantec Ltd. 2008
Buffalo Ridge, MN (94/95)	Osborn et al. 1996, 2000	Meyersdale, PA (04)	Arnett et al. 2005
Buffalo Ridge, MN (Phase I; 96)	Johnson et al. 2000a	Moraine II, MN	Derby et al. 2010d
Buffalo Ridge, MN (Phase I; 97)	Johnson et al. 2000a	Mount Storm, WV (Fall 08)	Young et al. 2009b
Buffalo Ridge, MN (Phase I; 98)	Johnson et al. 2000a	Mount Storm, WV (09)	Young et al. 2009a, 2010b
Buffalo Ridge, MN (Phase I; 99)	Johnson et al. 2000a	Mount Storm, WV (10)	Young et al. 2010a, 2011b
Buffalo Ridge, MN (Phase II;98)	Johnson et al. 2000a	Mount Storm, WV (11)	Young et al. 2011a, 2012b
Buffalo Ridge, MN (Phase II; 99)	Johnson et al. 2000a	Mountaineer, WV (03)	Kerns and Kerlinger 2004
Buffalo Ridge, MN (Phase II; 01/Lake Benton I)	Johnson et al. 2004	Mountaineer, WV (04)	Arnett et al. 2005
Buffalo Ridge, MN (Phase II; 02/Lake Benton I)	Johnson et al. 2004	Munnsville, NY (08)	Stantec 2009b
Buffalo Ridge, MN (Phase III; 99)	Johnson et al. 2000a	Nine Canyon, WA	Erickson et al. 2003b
Buffalo Ridge, MN (Phase III; 01/Lake Benton II)	Johnson et al. 2004	Noble Altona, NY	Jain et al. 2011b
Buffalo Ridge, MN (Phase III; 02/Lake Benton II)	Johnson et al. 2004	Noble Bliss, NY (08)	Jain et al.2009e
Buffalo Ridge I, SD (10)	Derby et al. 2010b	Noble Bliss, NY (09)	Jain et al. 2010a
Buffalo Ridge II, SD (11)	Derby et al. 2012a	Noble Chateaugay, NY	Jain et al. 2011c
Casselman, PA (08)	Arnett et al. 2009a	Noble Clinton, NY (08)	Jain et al. 2009c
Casselman, PA (09)	Arnett et al. 2010	Noble Clinton, NY (09)	Jain et al. 2010b
Casselman Curtailment, PA (08)	Arnett et al. 2009b	Noble Ellenburg, NY (08)	Jain et al. 2009b
Castle River, Alb (01)	Brown and Hamilton 2006a	Noble Ellenburg, NY (09)	Jain et al. 2010c
Castle River, Alb (02)	Brown and Hamilton 2006a	Noble Wethersfield, NY	Jain et al. 2011a
Cedar Ridge, WI (09)	BHE Environmental 2010	NPPD Ainsworth, NE	Derby et al. 2007
Cedar Ridge, WI (10)	BHE Environmental 2011	Oklahoma Wind Energy Center, OK	Piorkowski and O'Connell 2010
Cohocton/Dutch Hill, NY (09)	Stantec 2010	Pebble Springs, OR	Gritski and Kronner 2010b
Cohocton/Dutch Hills, NY (10)	Stantec 2011	Pine Tree, CA	BioResource Consultants 2010
Combine Hills, OR	Young et al. 2006	Pioneer Prairie I, IA (Phase II)	Chodachek et al. 2012
Combine Hills, OR (11)	Enz et al. 2012	PrairieWinds ND1 (Minot), ND	Derby et al. 2011c
Condon, OR	Fishman Ecological Services 2003	PrairieWinds ND1 (Minot), ND (11)	Derby et al. 2012c
Crescent Ridge, IL	Kerlinger et al. 2007	PrairieWinds SD1, SD	Derby et al. 2012d
Criterion, MD (11)	Young et al. 2012a	Prince Wind Farm, Ont (06)	Natural Resource Solutions 2009
Crystal Lake II, IA	Derby et al. 2010a	Prince Wind Farm, Ont (07)	Natural Resource Solutions 2009
Diablo Winds, CA	WEST 2006, 2008	Prince Wind Farm, Ont (08)	Natural Resource Solutions 2009
Dillon, CA	Chatfield et al. 2009	Red Canyon, TX	Miller 2008
Dry Lake I, AZ	Thompson et al. 2011	Ripley, Ont (08)	Jacques Whitford 2009
Dry Lake II, AZ	Thompson and Bay 2012	Ripley, Ont (Fall 09)	Golder Associates 2010
Elkhorn, OR (08)	Jeffrey et a. 2009b	Rugby, ND	Derby et al. 2011b
Elkhorn, OR (10)	Enk et al. 2011b	San Gorgonio, CA	Anderson et al. 2005
Elm Creek, MN	Derby et al. 2010c	Searsburg, VT (07)	Kerlinger 2002a
Elm Creek II, MN	Derby et al. 2012b	Shiloh I, CA	Kerlinger et al. 2010a
Erie Shores, Ont	James 2008	Shiloh II, CA	Kerlinger et al. 2010b
Foote Creek Rim, WY (Phase I; 99)	Young et al. 2003b	SMUD Solano, CA	Erickson and Sharp 2005
Foote Creek Rim, WY (Phase I; 00)	Young et al. 2003b, 2003d	Stateline, OR/WA (02)	Erickson et al. 2004
Foote Creek Rim, WY (Phase I; 01-02)	Young et al. 2003b, 2003d	Stateline, OR/WA (03)	Erickson et al. 2004
Forward Energy Center, WI	Grodsky and Drake 2011	Stateline, OR/WA (06)	Erickson et al. 2007
Fowler I, II, III, IN (10)	Good et al. 2011	Stetson Mountain I, ME (09)	Stantec 2009c
Fowler I, II, III, IN (11)	Good et al. 2012	Stetson Mountain I, ME (11)	Normandeau Associates 2011
Goodnoe, WA	URS Corporation 2010a	Stetson Mountain II, ME (10)	Normandeau Associates 2010
Grand Ridge I, IL	Derby et al. 2010g	Summerview, Alb (06)	Brown and Hamilton 2006b
Harrow, Ont (10)	Natural Resource Solutions 2011	Summerview, Alb (08)	Baerwald 2008
Harvest Wind, WA (10-12)	Downes and Gritski 2012a	Tehachapi, CA	Anderson et al. 2004

Appendix D5 (*continued*). Summary of all publicly-available post-construction monitoring studies, with project characteristics and select study methodologies.

Project, Location	Fatality Reference	Project, Location	Fatality Reference
Hay Canyon, OR	Gritski and Kronner 2010a	Top of Iowa, IA (03)	Jain 2005
High Sheldon, NY (10)	Tidhar et al. 2012a	Top of Iowa, IA (04)	Jain 2005
High Sheldon, NY (11)	Tidhar et al. 2012b	Tuolumne (Windy Point I), WA	Enz and Bay 2010
High Winds, CA (04)	Kerlinger et al. 2006	Vansycle, OR	Erickson et al. 2000a
High Winds, CA (05)	Kerlinger et al. 2006	Vantage, WA	Ventus Environmental Solutions 2012
Hopkins Ridge, WA (06)	Young et al. 2007	Wessington Springs, SD (09)	Derby et al. 2010f
Hopkins Ridge, WA (08)	Young et al. 2009c	Wessington Springs, SD (10)	Derby et al. 2011d
Jersey Atlantic, NJ	NJAS 2008a, 2008b, 2009	White Creek, WA (07-11)	Downes and Gritski 2012b
Judith Gap, MT (06-07)	TRC 2008	Wild Horse, WA	Erickson et al. 2008
Judith Gap, MT (09)	Poulton and Erickson 2010	Windy Flats, WA	Enz et al. 2011
Kewaunee County, WI	Howe et al. 2002	Winnebago, IA	Derby et al. 2010e
Kibby, ME (11)	Stantec 2012	Wolfe Island, Ont (May-June 09)	Stantec Ltd. 2010a
Kittitas Valley, WA (11-12)	Stantec Consulting 2012	Wolfe Island, Ont (July-Dec 09)	Stantec Ltd. 2010b
Klondike, OR	Johnson et al. 2003a	Wolfe Island, Ont (Jan-June 10)	Stantec Ltd. 2011a
Klondike II, OR	NWC and WEST 2007	Wolfe Island, Ont (July-Dec 10)	Stantec Ltd. 2011b
Klondike III (Phase I), OR	Gritski et al. 2010	Wolfe Island, Ont (Jan-June 11)	Stantec Ltd. 2011c
Klondike IIIa (Phase II), OR	Gritski et al. 2011	Wolfe Island, Ont (July-Dec 11)	Stantec Ltd. 2012
Leaning Juniper, OR	Gritski et al. 2008		

Post-Construction Monitoring Studies at the Dunlap Wind Energy Facility Carbon County, Wyoming

Draft Final Report
March 15, 2011 – February 28, 2014

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June 13, 2014

EXECUTIVE SUMMARY

In 2010, PacifiCorp Energy (PacifiCorp) developed the Dunlap Wind Energy Facility (DWEF) in Carbon County, Wyoming, with a name-plate capacity of 111 megawatts (MW) from 74 GE 1.5-MW wind turbines. The total number of bird and bat carcass discoveries at wind turbines and the two meteorological (met) towers on site was estimated based on the number of carcass discoveries found adjusted for searcher efficiency and scavenger removal bias and the proportion of the turbines searched. Additional studies at the DWEF included raptor nest surveys and recording incidental wildlife observations.

The primary objective of the post-construction monitoring study was to estimate the level of bird and bat mortality attributable to collisions with wind turbines and met towers for the entire DWEF on an annual basis. The monitoring study began after the wind energy facility became fully operational and was initiated on March 15, 2011. This report presents results of the third and final full year of monitoring and includes data collected from March 15, 2011 – February 28, 2014.

Approximately 35% (26) of the 74 turbines and both met towers were searched during the study period. A total of 550 turbine and met tower searches were conducted during the third monitoring year, and 32 bird carcasses were found during this period. Of the 32 bird carcasses found during the study, 22 (68.8%) were passerines, with the most common species being horned lark (six discoveries). Three (9.4%) of the carcass discoveries were raptors, including one golden eagle, one ferruginous hawk, and one American kestrel. The remaining carcass discoveries consisted of two waterbirds (6.3%) and single individuals of the following that each composed 3.1% of the carcass discoveries: unidentified waterfowl, common nighthawk, Eurasian collared dove, white-throated swift, broad-tailed hummingbird, and unidentified large bird. None of the bird carcass discoveries are federally listed species. The golden eagle is protected under the Bald and Golden Eagle Protection Act and all remaining bird casualties except one European starling and Eurasian collared dove are protected under the Migratory Bird Treaty Act.

Twenty-two bat carcass discoveries were found during the third year of monitoring, 21 of which were found on the 26 turbine search plots and one of which was found at a met tower. Fourteen of the 22 bat discoveries (63.6%) were hoary bats, five (22.7%) were too decomposed to allow for positive identification, and the remaining three were single individuals of little brown bat, silver-haired bat, and canyon bat (formally western pipistrelle) that each composed 4.5% of the bat carcass discoveries. No bat carcass discoveries involved federally listed species.

A total of 96.0% of the large birds and 40.0% of the small birds and bats were detected during searcher efficiency trials. Based on scavenger trial data, the mean removal time for small bird and bat carcasses (combined) was similar during migration (March 16 – May 15 and August 1 – October 31) and non-migration seasons, and averaged 12.7 days. Large bird carcasses lasted an average of 26.6 days during migration seasons and 10.4 days outside of the migration periods. Due to small sample sizes for bats, searcher efficiency and scavenging rate data for

small birds and bats were combined. Given the estimated searcher efficiency and scavenger removal rates, the average probability that a small bird or bat would remain in a search plot and be found during a scheduled search was 40.0% for turbines searched weekly during migration, 15.0% for turbines searched monthly during migration, and 16.0% for turbines searched monthly outside of the migration seasons. For large birds, these percentages were 84.0%, 56.0%, and 31.0%, respectively.

The adjusted fatality estimate for small birds at wind turbines was 2.84 fatalities/turbine/year (1.89 fatalities/MW/year). The estimated small bird fatality rate at met towers was 7.42 fatalities/met tower/year. Combining the mean annual fatality rates at turbines and met towers results in an estimate of approximately 225 small bird fatalities for the entire facility per year. The adjusted fatality estimate for all large birds (e.g., raptors, waterbirds, and waterfowl) at wind turbines was 0.44 fatalities/turbine/year (0.30 fatalities/MW/year). The estimated large bird fatality rate at met towers was 0.60 fatalities/met tower/year. Combining the mean annual fatality rates at turbines and met towers results in an estimate of approximately 34 large bird fatalities for the entire facility per year. The adjusted fatality estimate for raptors at wind turbines was 0.14 fatalities/turbine/year (0.09 fatalities/MW/year), which results in a total mortality estimate of approximately 10 raptors for the entire facility per year. No raptor fatalities were found at met towers. The adjusted fatality estimate for all birds combined at wind turbines was 3.29 fatalities/turbine/year (2.19 fatalities/MW/year). The estimated all bird fatality rate at met towers was 8.02 fatalities/met tower/year. Combining the mean annual fatality rates at turbines and met towers results in an estimate of approximately 259 bird fatalities for the entire facility per year. The adjusted fatality estimate for bats at wind turbines was 3.38 fatalities/turbine/year (2.25 fatalities/MW/year). The estimated bat fatality rate at met towers was 1.24 fatalities/met tower/year. Combining the mean annual fatality rates at turbines and met towers results in an estimate of approximately 252 bat fatalities for the entire facility per year.

Based on data collected during the first three years of operation of the DWEF, collision mortality of raptors was low-moderate compared to other wind energy facilities evaluated using similar methods in western North America. Mortality of all bird species combined at the DWEF was low compared to regional fatality estimates, while bat fatality rates were moderate relative to other projects across western North America.

The entire DWEF, as well as a 2.5-mile (4.0-kilometer [km]) buffer around the project turbines, were searched for active raptor nests. The objective of the raptor nest surveys was to determine the presence of active raptor nests in and near the study area to compare to preconstruction data on nesting raptors obtained during the 2009 baseline study. Two rounds have aerial surveys have been completed in 2014. In 2014, two occupied/active golden eagle nests, six occupied/active ferruginous hawk nests, and one occupied/inactive prairie falcon nest were identified. More active golden eagle and ferruginous hawk nests were identified in 2014 than any other year from 2009-2014.

The objective of incidental wildlife observations was to provide a record of wildlife observed within the DWEF while conducting monitoring activities. Although no pre-construction data are

available for some species at the DWEF, there is little information for many species on how they are affected by wind energy development. Therefore, even post-construction observational data on wildlife use near wind turbines provide meaningful information. Observations were made of 67 groups of birds totaling 73 individuals and comprising 11 species, all of which were raptors. The most common raptor species observed incidentally were golden eagle (29 groups of 33 birds), ferruginous hawk (14 groups totaling 16 birds), and red-tailed hawk (six observations of single individuals). The other eight raptor species were infrequently recorded during incidental observations. Other observations included four coyotes and one group of four swift fox. Due to the large number and consistent sightings, pronghorn antelope incidental observations were not documented. Pronghorn were observed throughout the DWEF during nearly every survey event.

To date, post-construction monitoring data are only available for one other wind energy facility in Wyoming, Foote Creek Rim. In addition, there are very few studies available from surrounding states. Results of this study further contribute to our understanding of effects on wildlife of wind energy developments in Wyoming and the Rocky Mountain West. As more wind power projects are built in the region, and additional studies become available, a clearer picture of the potential impacts will emerge.

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REPORT REFERENCE

Martinson, L., G. Johnson, and G. Didonato. 2014. Post-Construction Monitoring Studies at the Dunlap Wind Energy Facility, Carbon County, Wyoming. Draft Final Report: March 15, 2011 – February 28, 2014. Prepared for PacifiCorp Energy, Salt Lake City, Utah. Prepared by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming.

ACKNOWLEDGEMENTS

WEST, Inc. would like to thank PacifiCorp Energy for the opportunity to work on this project and build a relationship with them. WEST would also like to thank all parties involved, including EDF for their assistant while team members were onsite.

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Appendix C. Fatality Estimates for Bats at the Dunlap Wind Energy Facility for Monitoring Conducted from March 1, 2013 – February 28, 2014

INTRODUCTION

PacifiCorp Energy (PacifiCorp) owns and operates the Dunlap Wind Energy Facility (DWEF) in Carbon County, Wyoming, with a name-plate capacity of 111 megawatts (MW) from 74 GE 1.5-MW wind turbines. During the early stages of project development, the Wyoming Game and Fish Department (WGFD) and the US Fish and Wildlife Service (USFWS) expressed an interest in ensuring that potential post-construction impacts to wildlife be monitored. PacifiCorp Energy contracted Western EcoSystems Technology, Inc. (WEST) to implement a 3-year post-construction monitoring study at the DWEF to assess the level of impacts from operation of the wind energy facility to wildlife. This report provides the results of monitoring during the third and final year of the study, which covered the period March 15, 2011, through February 28, 2014. A Technical Advisory Committee (TAC) composed of PacifiCorp, the WGFD, and the USFWS was created to review the monitoring protocol, assess the study results, and prepare recommendations for PacifiCorp.

The purpose of the avian and bat post-construction monitoring was to estimate the annual number of avian and bat carcass discoveries attributable to wind energy collisions at the DWEF.

The monitoring study for the DWEF consisted of the following components:

1) Standardized carcass surveys of selected turbines and met towers within a square plot centered on the turbine or meteorological (met) tower;
2) Searcher efficiency trials to estimate the percentage of carcasses found by searchers;
3) Carcass removal trials to estimate the length of time that a carcass remained in the field for possible detection; and
4) Adjusted fatality estimates based on the results of searcher efficiency trials and carcass removal trials.

Raptor nest surveys also were conducted as part of the post-construction monitoring. A summary of incidental wildlife observed while conducting other work or travelling with the DWEF is also provided.

STUDY AREA

The DWEF is located approximately 10 miles (16.1 kilometers [km]) north of the town of Medicine Bow, Wyoming. Topography of the DWEF is primarily flat, with minimal topographic relief (Figure 1). Elevations range from approximately 6,750 to 7,200 feet (ft; 2,057 to 2,195 meters [m]). The DWEF is approximately 10,340 acres (16.16 square miles [mi^2]) in size and the predominant land cover type is a mix of grasslands and sagebrush (*Artemisia* spp.) communities.

The DWEF has 74 GE 1.5-MW turbines with a rotor diameter of 77 m (252 ft). The turbines are situated on 80-m (262-ft) tall steel tubular towers secured to concrete foundations. Two guyed met towers are also present within the DWEF (Figure 2).

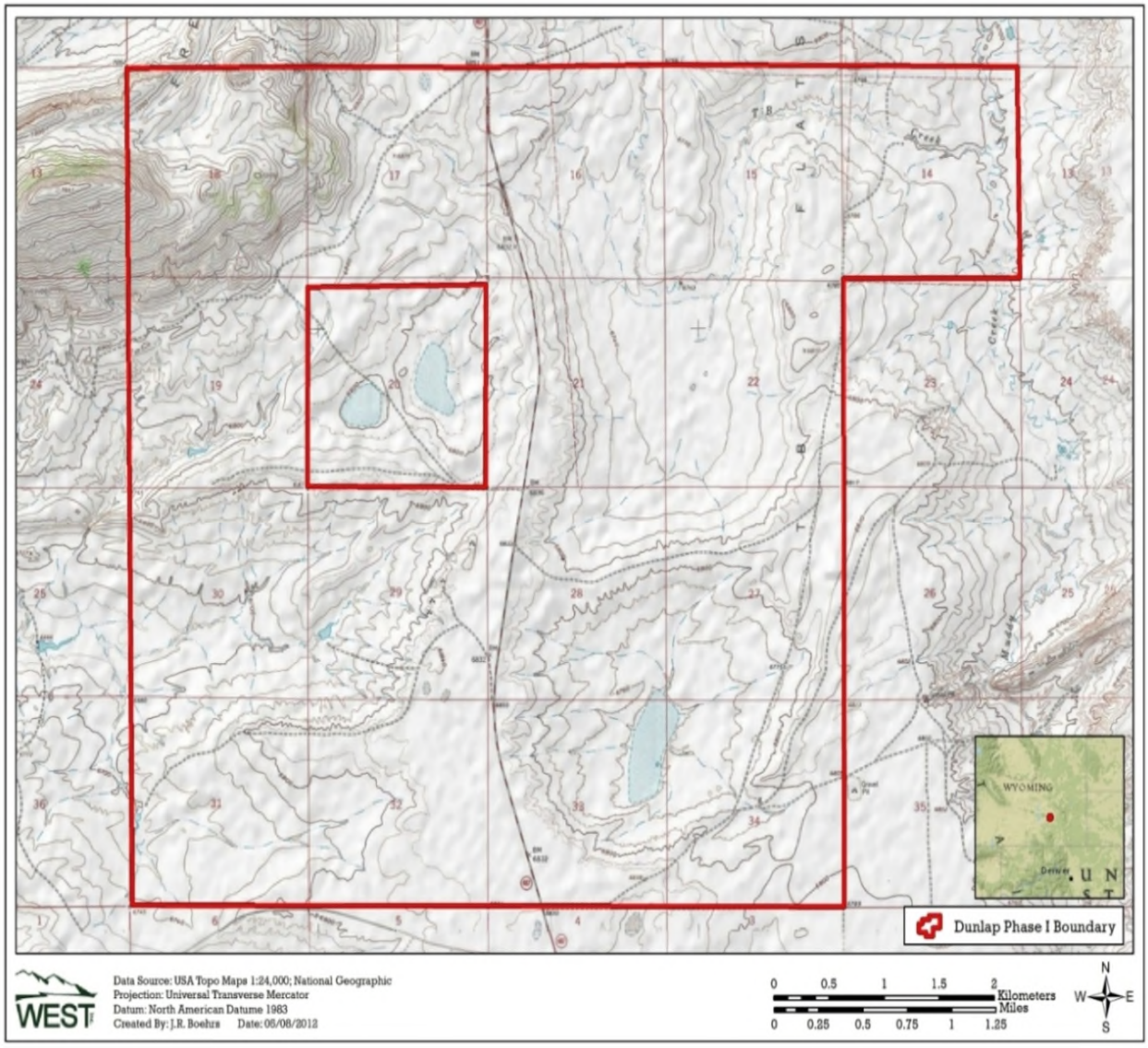

Figure 1. Location of the Dunlap Wind Energy Facility.

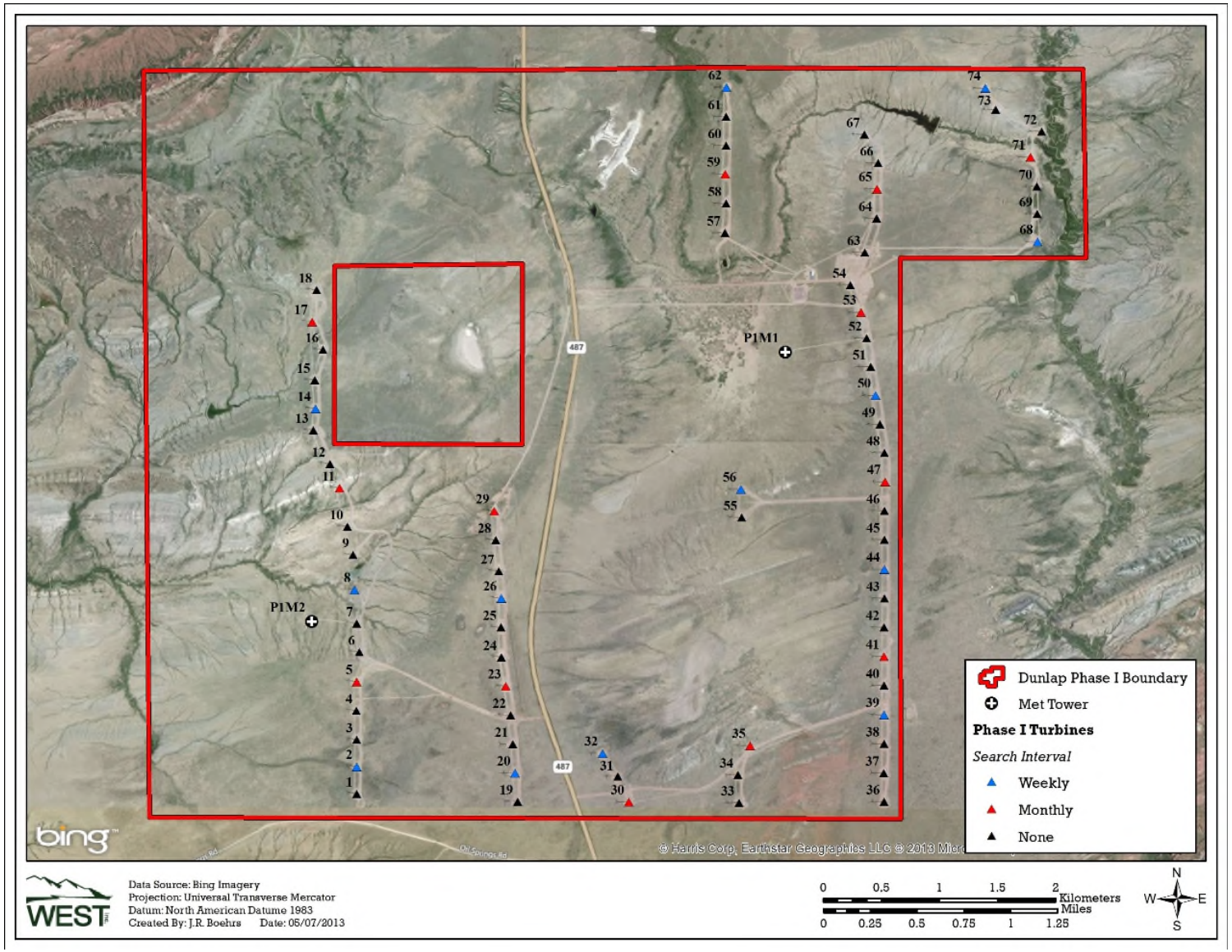

Figure 2. Location of carcass search plots at the Dunlap Wind Energy Facility.

METHODS

Casualty Surveys

The primary objective of the monitoring study was to estimate the level of bird and bat mortality attributable to collisions with wind turbines and met towers for the entire DWEF on an annual basis. The monitoring study began after the wind energy facility became fully operational and was initiated on March 15, 2011. This report presents results of the third and final full year of monitoring and includes data collected from March 1, 2013 to February 28, 2014.

The methods for the fatality study were broken into four primary components: 1) standardized carcass surveys of selected turbines and met towers, 2) searcher efficiency trials to estimate the percentage of carcasses found by searchers, 3) carcass removal trials to estimate the length of time that a carcass remains in the field for possible detection, and 4) adjusted fatality estimates for bird and bat species calculated using the results from searcher efficiency trials and carcass removal trials to estimate the total number of bird and bat fatalities within the DWEF.

There are three scenarios under which casualties were found in the DWEF: 1) during the standardized surveys for the study; 2) while observers were onsite, but not conducting a standardized search (i.e., an incidental find); and 3) by facility personnel or others onsite for other purposes, such as turbine maintenance. Casualties found by study observers, regardless of timing (i.e., during a standardized survey or not), were recorded by the methods described below. All casualties found within a search plot, even if outside of the standard survey period, were included in the dataset under the assumption that these casualties would have been found during standardized surveys. Casualties found by DWEF maintenance personnel were left in the field for WEST study personnel to record or were collected and recorded following PacifiCorp's procedures.

All bird and bat casualties located within the search areas, regardless of species, were recorded and a cause of death determined, if possible, based on field inspection of the carcass. The total number of bird and bat carcasses was estimated by adjusting for search frequency, removal bias (length of stay in the field), searcher efficiency bias (percent of carcasses found) and proportion of the turbines sampled. For carcasses where the cause of death was not apparent, the assumption that the carcass was a wind turbine collision casualty was made for the analysis. While this approach will likely lead to an overestimate of the true number of facility-related fatalities, this conservative approach has been used during most studies of wind energy facilities because of the relative high costs associated with obtaining accurate estimates of natural or reference mortality (see Johnson et al. 2000).

Field Methods

Twenty-six of the 74 turbines (35%) were selected for surveying using a systematic design with a random start (Figure 2). Square plots were established around the 26 turbines and systematically searched for carcasses. Search plots at turbines were 160 m (525 ft) on a side (80 m from the turbine) while search plots at met towers were 120 m (394 ft) on a side and centered on the met tower (with each side at 60 m [197 ft] from the tower).

Studies at facilities with other large turbines, such as the Klondike wind energy facility in Oregon (Johnson et al. 2003b), the Combine Hills facility, also in Oregon (Young et al. 2005), and the Crescent Ridge facility in

Illinois (Kerlinger et al. 2007), indicate most of the fatalities are found within the area that is roughly equivalent to the height of the turbine tower.

Standardized carcass surveys occurred at all 26 turbines and two met towers once every 4-week (28-day) period throughout the year with standardized surveys at half of these turbines (13) and the two met towers conducted once every week (seven days) during the spring (March 16–May 15) and fall (August 1–October 31) migration periods.

Standardized Carcass Surveys

The objective of the standardized carcass surveys was to systematically search wind turbines and met towers for bird and bat casualties. Study personnel were trained in proper search techniques prior to conducting the carcass surveys. Observers walked at a rate of approximately 45 to 60 m/minute (148 to 197 ft/min) along each transect. Transects were spaced 6 – 10 m (19.7 to 32.8 ft) apart, and observers scanned the areas on both sides to approximately 3 – 5 m (9.8 to 16.4 ft) for casualties as they walked each transect. To facilitate conducting the searches, a global positioning system (GPS) coordinate was obtained for each turbine or met tower being searched, and a shape file was created to show the boundary of the 160 X 160-m turbine or 120 X 120-m met tower plot. The observer then used a GPS with the downloaded shape files while searching each plot so that they could see exactly where they were within the plot to help maintain appropriate transect spacing. The “tracks” option (feature showing intact route alignment) also was used to help searchers ensure the entire plot was searched appropriately.

The condition of each carcass found was recorded using the following categories:

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

All carcasses were documented with a unique number and covered with a tarp or plastic bowl in the field. A copy of the data sheet for each carcass was maintained at the O&M PacifiCorp site manager office. For all casualties found, data recorded included species, sex and age (when possible), date and time collected, GPS location, condition (intact, scavenged, feather spot), and any comments regarding possible cause of death. All casualties were photographed as found.

Casualties found outside the formal search area by carcass search technicians were treated following the above protocol as closely as possible. Casualties observed in non-search areas (e.g., near a turbine not included in the search area) were coded as incidental discoveries and were documented in a similar fashion

as those found during standard searches. Casualties found by maintenance personnel and others not conducting the formal searches were similarly documented and included in the overall dataset.

Searcher Efficiency Trials

The objective of the searcher efficiency trials was to estimate the percentage of casualties found by observers. Searcher efficiency trials were conducted throughout the year. Searcher efficiency trials were conducted in the same areas as standardized carcass surveys and searcher efficiency was estimated by the type of carcass (bird or bat), size of carcass (birds only) and season. Estimates of searcher efficiency were used to adjust the total number of carcasses found for those missed by observers, correcting for detection bias.

Observers conducting carcass surveys did not know when searcher efficiency trials were being conducted or the location of the trial carcasses. A total of 58 carcasses (26 large birds, 30 small birds, and two bats) were placed on seven separate dates. Bird carcasses used for searcher efficiency trials were non-native/non-protected or commercially available species, including adult *Coturnix* quail, adult female mallards (*Anas platyrhynchos*), rock pigeons (*Columba livia*), and house sparrows (*Passer domesticus*), while bat carcasses were fresh carcasses found as fatalities during the study. Searcher efficiency trial carcasses were placed within study plots using a randomly generated distance and direction from the turbine. Two scheduled searcher efficiency trials were unable to be conducted due to safety concerns (site roads impassable and lightning)

All searcher efficiency trial carcasses were placed within the search area prior to that day's scheduled standardized carcass survey. Each trial carcass was discreetly marked (e.g., dark tape or thread placed on the leg of the trial carcass) so that it could be identified as a study carcass after it was found.

The number and location of the searcher efficiency trial carcasses found during the carcass surveys were recorded. The number of carcasses available for detection during each trial was determined immediately after the trial by the person responsible for distributing the trial carcasses.

Carcass Removal Trials

The objective of carcass removal trials was to estimate the average length of time a carcass remained in the study area and was potentially detectable. Carcass removal included removal by scavenging or decomposition. Removal trial carcasses were not placed in the standardized search plots in order to minimize the chance of confusing a trial bird or bat with a turbine casualty. Turbines not included in the standardized carcass surveys were randomly selected for inclusion in the removal trials. Trial carcasses were randomly placed at selected turbines within a plot of similar size to the actual search plots. Estimates of carcass removal were used to adjust the total number of carcasses found for those removed from the study area, correcting for removal bias.

Carcass removal trials were spread throughout the year to incorporate the effects of varying weather, climatic conditions, and scavenger densities. Trials were also placed during the day and in darkness to ensure scavengers were not keying in on trial placements. A total of 56 carcasses were placed for scavenger removal trials, including 27 large birds, 23 small birds, and six bats. The carcasses were placed across seven dates throughout the duration of the monitoring period. The bird carcass composition was similar to that used for searcher efficiency trials. Bat carcasses used for scavenger removal trials were those previously collected as fatalities on site.

Observers conducting carcass searches monitored the trial birds and bats over a 40-day period, checking the condition and presence of the carcasses every day for the first four days of the trial, and then on days seven, 10, 14, 20, 30, and 40. This schedule varied somewhat depending on weather and coordination with the other survey work. Removal trial carcasses were marked discreetly (e.g., ribbon around leg) for recognition by observers and other personnel, and left at the location until the end of the carcass removal trial. At the end of the 40-day period, any remaining evidence of the carcass was removed.

Statistical Analysis

Quality Assurance and Quality Control

Quality assurance and quality control (QA/QC) measures were implemented at all stages of the study, including in the field, during data entry and analysis, and report writing. Following field surveys, observers were responsible for inspecting data forms (on electronic tablets) for intactness and accuracy. Weekly summaries from the electronic database were compared to the summary forms and any errors detected were corrected. Irregular codes or data suspected as questionable were discussed with the observer or project manager. Errors, omissions, or problems identified in later stages of analysis were traced back to the summary data forms and table data, and appropriate changes in all steps were made.

Data Compilation and Storage

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

Fatality Estimates

Estimates of facility-related fatalities are based on:

1) Observed number of carcasses found during standardized searches during the monitoring period for which the cause of death was either unknown or was probably facility-related;
2) Non-removal rates expressed as the estimated average probability a carcass was expected to remain in the study area and be available for detection by the searchers during removal trials, and
3) Searcher efficiency expressed as the proportion of trial carcasses found by searchers during searcher efficiency trials.

The number of bird and bat fatalities attributable to operation of the wind energy facility, based on the number of bird and bat carcasses found at the facility whose death appears related to facility operation, is reported. All carcasses located within areas surveyed, regardless of species, were recorded and, if possible, a cause of death determined based on a cursory field necropsy. The total number of bird and bat fatalities was estimated by adjusting the number of carcasses found for removal and searcher efficiency bias. Fatality estimates are provided for five categories: 1) all birds, 2) small birds, 3) large birds, 4) raptors, and 5) bats. Only bird or bat carcasses found within the 26 turbine plots randomly selected for searches (and the met towers)

at the initiation of the study were used to estimate bird and bat fatality rates; incidental carcass discoveries found at other turbine plots were recorded but were not used in the estimates.

Definition of Variables

The following variables are used in the equations below:

- c_i the number of carcasses detected at plot *i* for the study period of interest (e.g., one monitoring year), for which the cause of death is either unknown or is attributed to the facility
- n the number of search plots
- k the number of turbines searched
- $\bar{c}$ the average number of carcasses observed per turbine per monitoring year
- s the number of carcasses used in removal trials
- s_c the number of carcasses in removal trials that remain in the study area after 40 days
- se standard error (square of the sample variance of the mean)
- t_i the time (in days) a carcass remains in the study area before it is removed, as determined by the removal trials
- $\bar{t}$ the average time (in days) a carcass remains in the study area before it is removed, as determined by the removal trials
- d the total number of carcasses placed in searcher efficiency trials
- p the estimated proportion of detectable carcasses found by searchers, as determined by the searcher efficiency trials
- I the average interval between standardized carcass searches, in days
- A proportion of the search area of a turbine actually searched
- $\hat{\pi}$ the estimated probability that a carcass is both available to be found during a search and is found, as determined by the removal trials and the searcher efficiency trials
- m the estimated annual average number of fatalities per turbine per year, adjusted for removal and searcher efficiency bias

Observed Number of Carcasses

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

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

Estimation of Carcass Non-Removal Rates

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

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

Estimation of Searcher Efficiency Rates

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

Estimation of Facility-Related Fatality Rates

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

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

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

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

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

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

Raptor Nest Surveys

The entire DWEF and a 2.5-mile (4.0-km) buffer around the study area were searched for active raptor nests. The objective of the raptor nest surveys was to determine the presence of active raptor nests in and near the study area to measure use of the project area by nesting raptors and to compare to preconstruction data on nesting raptors obtained during the 2009 baseline study (Johnson et al. 2009). Two rounds of aerial surveys were completed in 2014. Follow-up nest surveys will continue throughout the 2014 nesting season. The first round of aerial raptor nest surveys was conducted using a helicopter on April 11, 2014. The second round of aerial raptor nest surveys was conducted on May 2, 2014. All known nest locations from previous studies at the DWEF, as well as nest locations from nest databases maintained by the Bureau of Land Management (BLM), were surveyed to determine their status (occupied/unoccupied, active/inactive). To search for other, previously undocumented nests, the helicopter was used to search all suitable habitat (trees, cliffs, rock outcrops, powerlines, windmills) for nests. Surveys for nests were conducted while flying at a maximum altitude of 250 ft (76.2 m) and an approximate airspeed of 30 miles per hour (mph; 48 km per hour [kph]). When a nest was observed, the helicopter was moved to a position where it could be determined if the nest was occupied and what species was using the nest. Efforts were made to minimize disturbance to breeding raptors, including keeping the helicopter at a maximum distance from the nest in which the species could be determined. Locations of inactive nests were also recorded as they may become occupied during subsequent years. All nests, whether active or inactive, were given a unique identification number and the Universal Transverse Mercator (UTM) location was recorded with a GPS unit.

The USFWS drafted the *Eagle Conservation Plan Guidance Module 1 – Land-based Wind Energy (Version 2; 2013)*. Eagles refer to bald eagle (*Haliaeetus leucocephalus*) and golden eagle (*Aquila chrysaetos*). In this document, the following definitions are provided (note: no definition is provided for Active nest, only a reference to occupied nest):

> "Occupied nest – a nest used for breeding in the current year by a pair of eagles. Presence of an adult, eggs, or young, freshly molted feathers or plucked down, or current year's mutes (whitewash) suggest site occupancy. In years when food resources are scarce, it is not uncommon for a pair of eagles to occupy a nest yet never lay eggs; such nests are considered occupied.
>
> Unoccupied nest – those nests not selected by raptors for use in the current nesting season. See also inactive nest.
>
> Inactive nest – a bald eagle or golden eagle nest that is not currently being used by eagles as determined by the continuing absence of any adult, egg, or dependent young at the nest for at least 10 consecutive days immediately prior to, and including, at present. An inactive nest may become active again and remains protected under the Eagle Act" (Bald and Golden Eagle Protection Act [BGEPA] 1940).

The Region 6 USFWS has provided further guidance in the *Region 6 Recommendations for Avoidance and Minimization of Impacts to Golden Eagles at Wind Energy Facilities, April 11, 2013*:

> "An occupied nest is a nest used for breeding in the current year by a pair of eagles. Presence of an adult, eggs, or young, freshly molted feathers or plucked down, or current year's mutes (whitewash) suggest site occupancy. In years when food resources are scarce, it is not uncommon for a pair of eagles to occupy a nest yet never lay eggs; such nests are considered occupied (Eagle Conservation Plan Guidance [ECPG1] 2012, p. 32). For purposes of these recommendations, we define occupied GOEA nests as nest sites that were occupied at least once during the last five years or last five years of field surveys. Because GOEAs will often use the same nest in multiple years (Kochert and Steenhof 2012), there is a high likelihood that these nests could be occupied again during the life of the project.
>
> We define unoccupied golden eagle (GOEA) nests as those nests not selected by raptors for use in the current nesting season (ECPG; USFWS 2012, p. 33). For purposes of these recommendations, we define unoccupied GOEA nests as nest sites that were not occupied during the last five years or last five years of field surveys. It should be noted that occupied nests can be incorrectly assigned as unoccupied if the nests are not repeatedly surveyed during the same nesting season. Even if a nest was unoccupied in one or more years, it is still possible that eagles could reuse that nest in future years (Kochert and Steenhof 2012), especially since the intervals between nest reuse can be lengthy (Kochert and Steenhof 2012, Slater et al. 2013). Given that the anticipated life of a wind project is 30 years (though repowering could extend that indefinitely) it is likely that some unoccupied nests will become occupied during the life of the project. In addition, nests usually occur in areas of historical eagle use (due to topographic features and prey resources) and represent areas where eagles are expected to return in the future."

Based on guidance provided by the USFWS, raptor nests at DWEF in 2014 were classified as occupied – active or occupied – inactive. Occupied – active nests are those nests which have signage of use (or occupation) and have active nesting (eggs, chicks, or incubating bird). Occupied – inactive are those nests which have signage of use (or occupation) but did not have active nesting (i.e., no eggs, no chicks, or no incubating bird).

Incidental Wildlife Observations

The objective of incidental wildlife observations was to provide a record of wildlife observed within the DWEF while conducting monitoring activities. Although no pre-construction data are available for some species at the DWEF, there is little information for many species on how they are affected by wind energy development (Gamo 2010). Therefore, even post-construction observational data on wildlife use near wind turbines provide meaningful information. All raptors, unusual or unique birds, sensitive species, mammals, reptiles, and amphibians were recorded while conducting other study activities on site. Data recorded included date, time, species, number of individuals, sex/age class, distance from observer, activity, height above ground (for

bird species), and habitat. The location of sensitive species was recorded using GPS coordinates.

RESULTS

Standardized Carcass Surveys

Birds

Twenty-six wind turbines and two met towers were searched at the DWEF during the period March 1, 2013, to February 28, 2014, for a total of 550 turbine searches (Table 1). Thirty-two bird casualties were found during this period (Table 2). Of these, 31 were found during standardized searches or incidentally on the 26 turbine and two met tower study plots, and one was found at a turbine other than the 26 turbine study plots (Table 2, Appendix A).

Of the 32 bird casualties found during the study, 22 (68.8%) were passerines, with the most common species being horned lark (*Eromophila alpestris*; six carcass discoveries). Three (9.4%) of the carcass discoveries were raptors, including one golden eagle, one ferruginous hawk (*Buteo regalis*) and one American kestrel (*Falco sparverius*). The remaining carcass discoveries consisted of two waterbirds (6.3%) and single individuals of the following that each composed 3.1% of the carcass discoveries: unidentified waterfowl, common nighthawk (*Chordeiles minor*), Eurasian collared dove (*Streptopelia decaocto*), white-throated swift (*Aeronautes saxatalis*), broad-tailed hummingbird (*Selasphorus platycercus*) and unidentified large bird. None of the bird carcass discoveries are federally listed. The golden eagle is protected under the BGEPA (1940) and all remaining bird casualties except one European starling (*Sturnus vulgaris*) and the Eurasian collared dove are protected under the Migratory Bird Treaty Act (MBTA 1918).

Table 1. Summary of bird and bat casualties found at the Dunlap Wind Energy Facility, March 1, 2013 – February 28, 2014.

Season	Dates	# of Surveys	# of Plots Searched[a]	# Bird Species	# Bird Casualties	# Bat Species	# Bat Casualties
Spring	3/1 to 5/14	129	28	3	4	0	0
Summer	5/15 to 7/31	84	28	5	8	2	3
Fall	8/1 to 10/31	229	28	14	20	2	18
Winter	11/1 to 3/15	108	28	0	0	1	1
Overall		**550**	**28**	**19**	**32**	**4**	**22**

[a] includes 26 turbine and 2 meteorological tower search plots

Table 2. Total number of bird and bat casualties and the composition of casualties discovered at the Dunlap Wind Energy Facility from March 1, 2013 – February 28, 2014.

	Carcass Discoveries during Scheduled Searches		Incidental Carcass Discoveries at Search Plots*		Other Incidentals		Total	
Species	**Total**	**% Comp.**	**Total**	**% Comp.**	**Total**	**% Comp.**	**Total**	**% Comp.**
Birds								
horned lark	6	21.4	0	0	0	0	6	18.8
unidentified passerine	3	10.7	0	0	0	0	3	9.4
Brewer's sparrow	2	7.1	1	33.3	0	0	3	9.4
unidentified small bird	2	7.1	0	0	0	0	2	6.3
American coot	1	3.6	0	0	0	0	1	3.1
American kestrel	1	3.6	0	0	0	0	1	3.1
broad-tailed hummingbird	1	3.6	0	0	0	0	1	3.1
common nighthawk	1	3.6	0	0	0	0	1	3.1
European starling	1	3.6	0	0	0	0	1	3.1
ferruginous hawk	1	3.6	0	0	0	0	1	3.1
grasshopper sparrow	1	3.6	0	0	0	0	1	3.1
lark bunting	1	3.6	0	0	0	0	1	3.1
Lincoln's sparrow	1	3.6	0	0	0	0	1	3.1
unidentified large bird	1	3.6	0	0	0	0	1	3.1
unidentified waterfowl	1	3.6	0	0	0	0	1	3.1
vesper sparrow	1	3.6	0	0	0	0	1	3.1
western grebe	1	3.6	0	0	0	0	1	3.1
white-crowned sparrow	1	3.6	0	0	0	0	1	3.1
Wilson's warbler	1	3.6	0	0	0	0	1	3.1
Eurasian collared-dove	0	0	1	33.3	0	0	1	3.1
white-throated swift	0	0	1	33.3	0	0	1	3.1
golden eagle	0	0	0	0	1	100	1	3.1
Overall Birds	**28**	**100**	**3**	**100**	**1**	**100**	**32**	**100**
Bats								
hoary bat	14	63.6	0	0	0	0	14	63.6
unidentified bat	5	22.7	0	0	0	0	5	22.7
little brown bat	1	4.5	0	0	0	0	1	4.5
silver-haired bat	1	4.5	0	0	0	0	1	4.5
canyon bat	1	4.5	0	0	0	0	1	4.5
Overall Bats	**22**	**100**	**0**	**0**	**0**	**0**	**22**	**100**

*Carcass discoveries found incidentally on turbine search plots were included in analyses.

Of the 32 bird carcass discoveries, 13 were intact, four were scavenged, 10 were feather spots, three were dismembered and one (Eurasian collared dove) was injured (Appendix A). The USFWS was notified within 48 hours of the discovery of the one golden eagle carcass. The eagle carcass was covered with a tarp and left as found in the field until collected by a USFWS representative.

Of the 26 turbines systematically searched as part of the study, one turbine had five bird casualties, one turbine had three, three had two, 10 had one, and the remaining 11 turbines did not have any avian casualties (Figures 3 and 4). No turbines had more than one documented raptor carcass discovery (Appendix A). Three birds were found at met tower P1M2 and four birds were found at met tower P1M1 during the study.

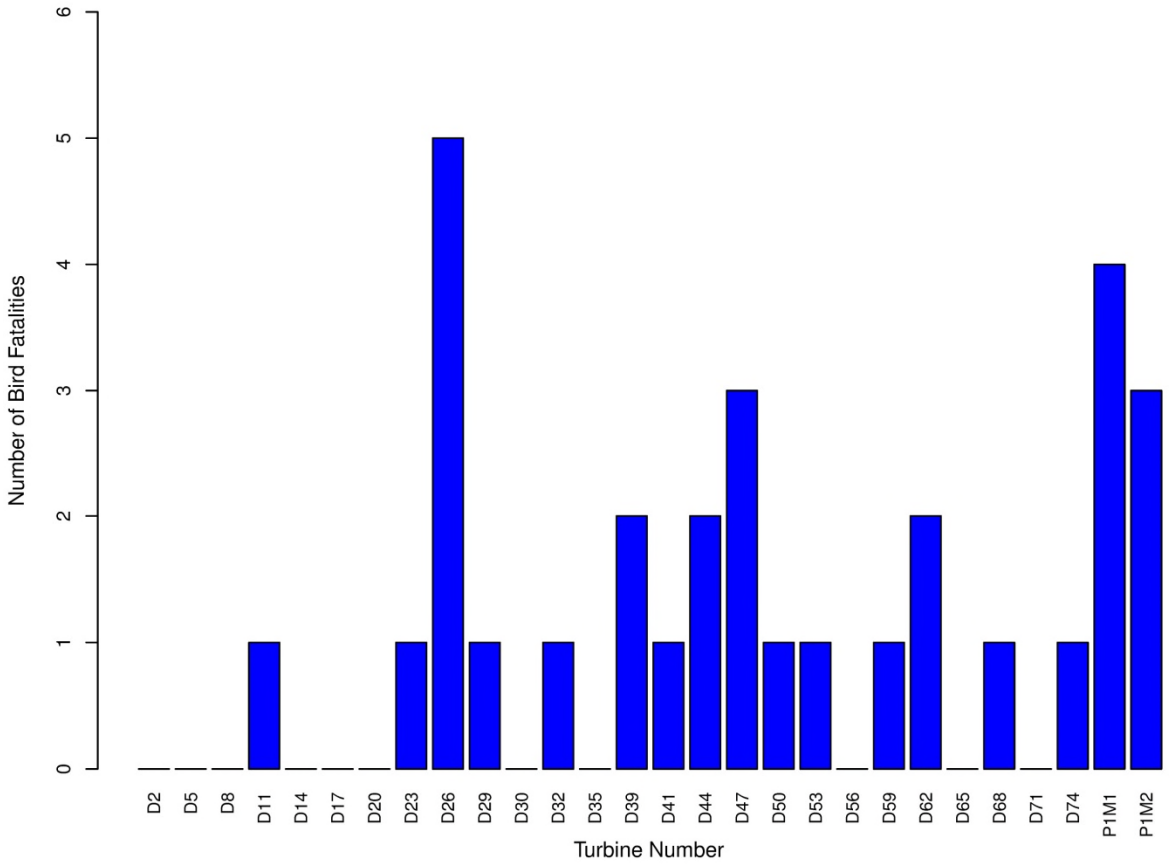

Figure 3. Number of bird carcass discoveries by turbine and meteorological (met) tower at the Dunlap Wind Energy Facility.

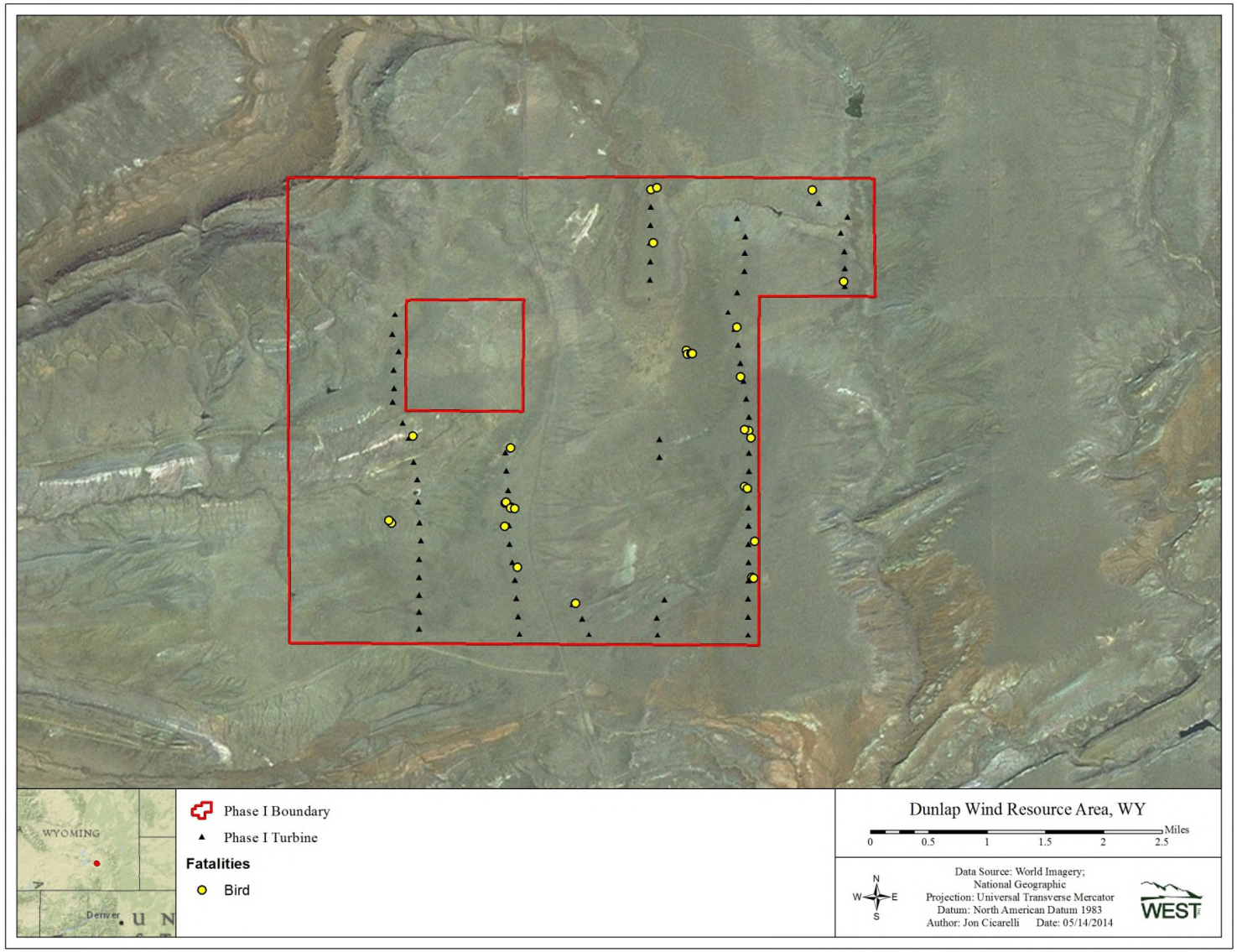

Figure 4. Location of bird casualties found at the Dunlap Wind Energy Facility.

In terms of distribution of casualties in relation to turbines, 25.0% were found less than 30 m (98 ft), 16.7% were found 30–60 m (98 to 197 ft), 37.5% were found 60–90 m (197 to 295 ft), and none were found more than 90 m from the nearest turbine (Table 3, Figure 5). For met towers, 42.9% of birds were found less than 20 m, 57.2% were found 20–60 m, and none were found more than 60 m from the tower (Table 4, Figure 6).

Table 3. Distribution of distances of bird and bat casualties from turbines at the Dunlap Wind Energy Facility.

Distance to Turbine (m)	% Bird Casualties	% Bat Casualties
0 to 10	12.5	14.3
10 to 20	4.2	19.0
20 to 30	8.3	4.8
30 to 40	4.2	33.3
40 to 50	8.3	4.8
50 to 60	4.2	4.8
60 to 70	12.5	14.3
70 to 80	16.7	4.8
80 to 90	8.3	0
>90	0	0

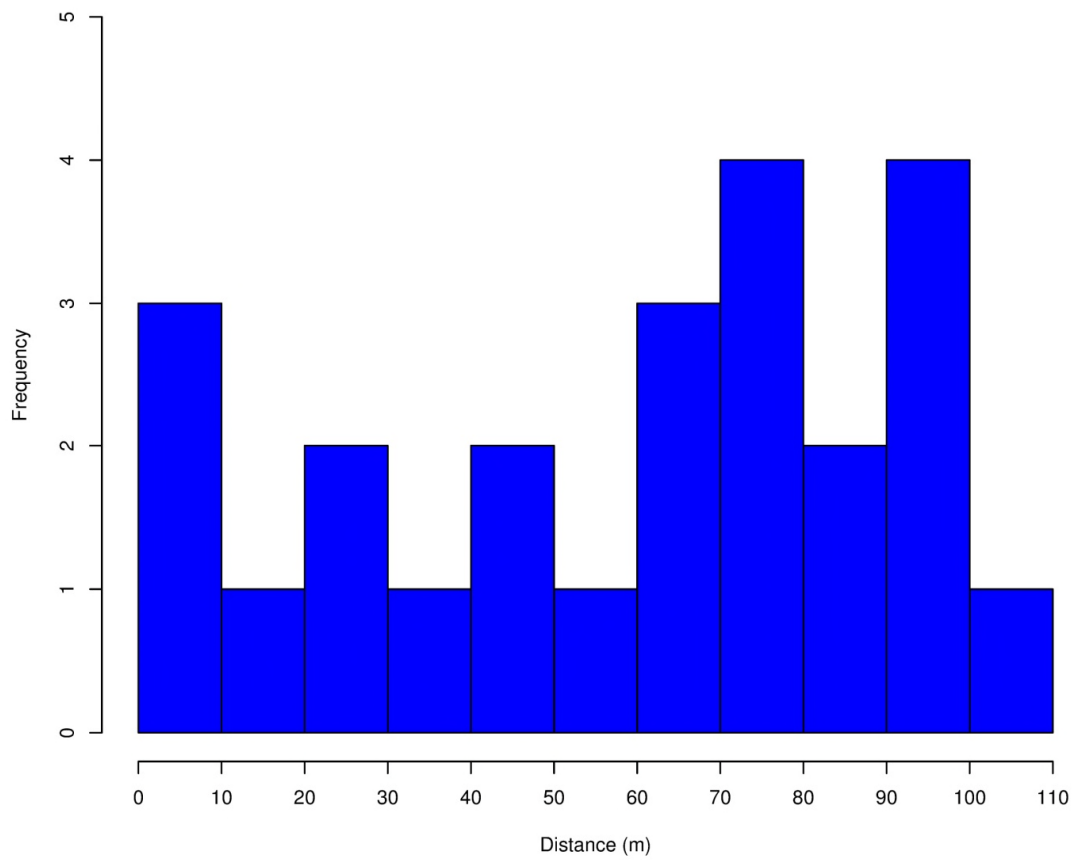

Figure 5. Distance of bird carcass discoveries from the turbines at the Dunlap Wind Energy Facility.

Table 4. Distribution of distances of bird and bat casualties from meteorological (met) towers at the Dunlap Wind Energy Facility.

Distance to Met Tower (m)	% Bird Casualties	% Bat Casualties
0 to 10	28.6	100
10 to 20	14.3	0
20 to 30	0	0
30 to 40	14.3	0
40 to 50	28.6	0
50 to 60	14.3	0
60 to 70	0	0

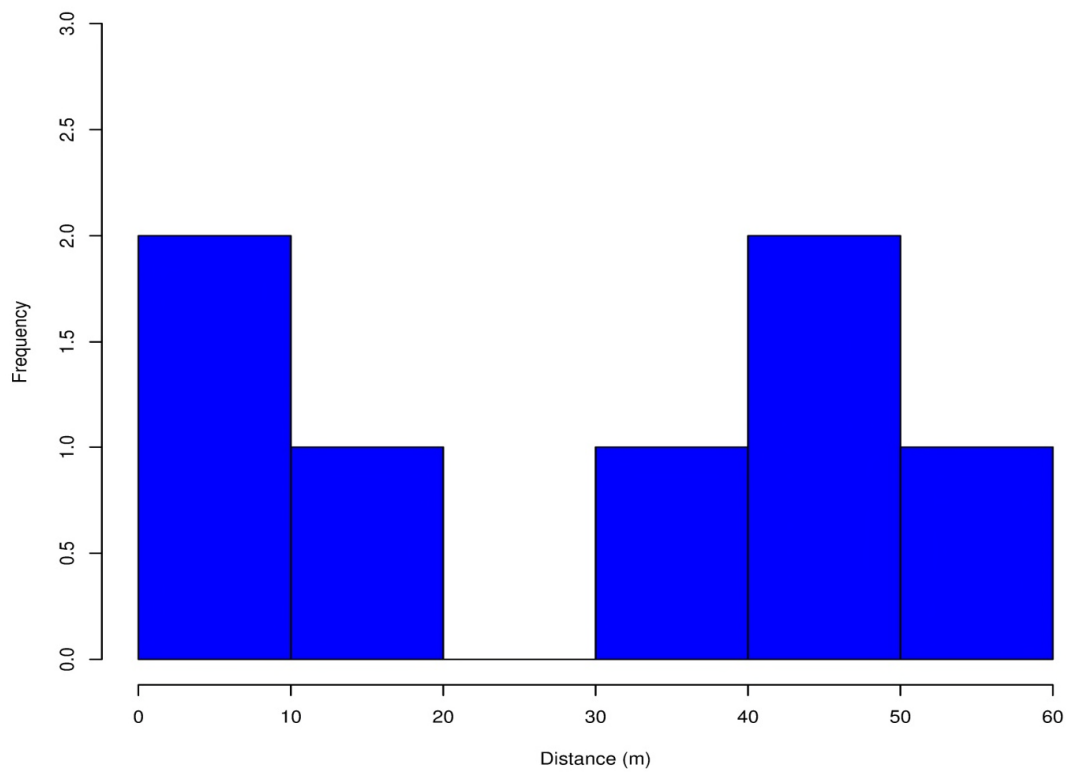

Figure 6. Distance of bird carcass discoveries from the meteorological (met) towers at the Dunlap Wind Energy Facility.

No bird casualties were found during winter at either turbines or met towers. Bird casualties at turbines were detected throughout the remainder of the year, but most occurred in early summer (June) and October (Figure 7). The majority of casualties found at met towers occurred in August and September (Figure 8).

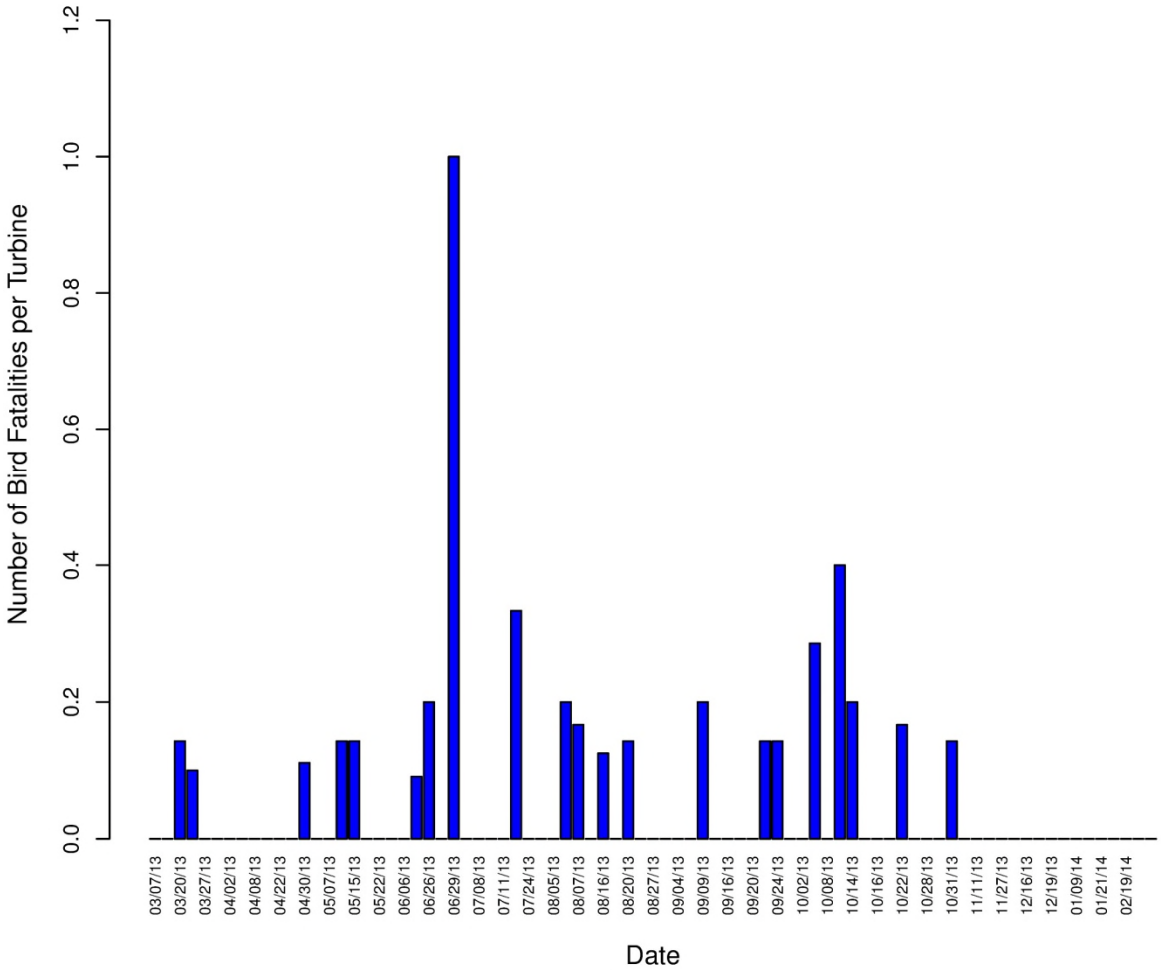

Figure 7. Timing of bird carcass discoveries at the turbines for the Dunlap Wind Energy Facility.

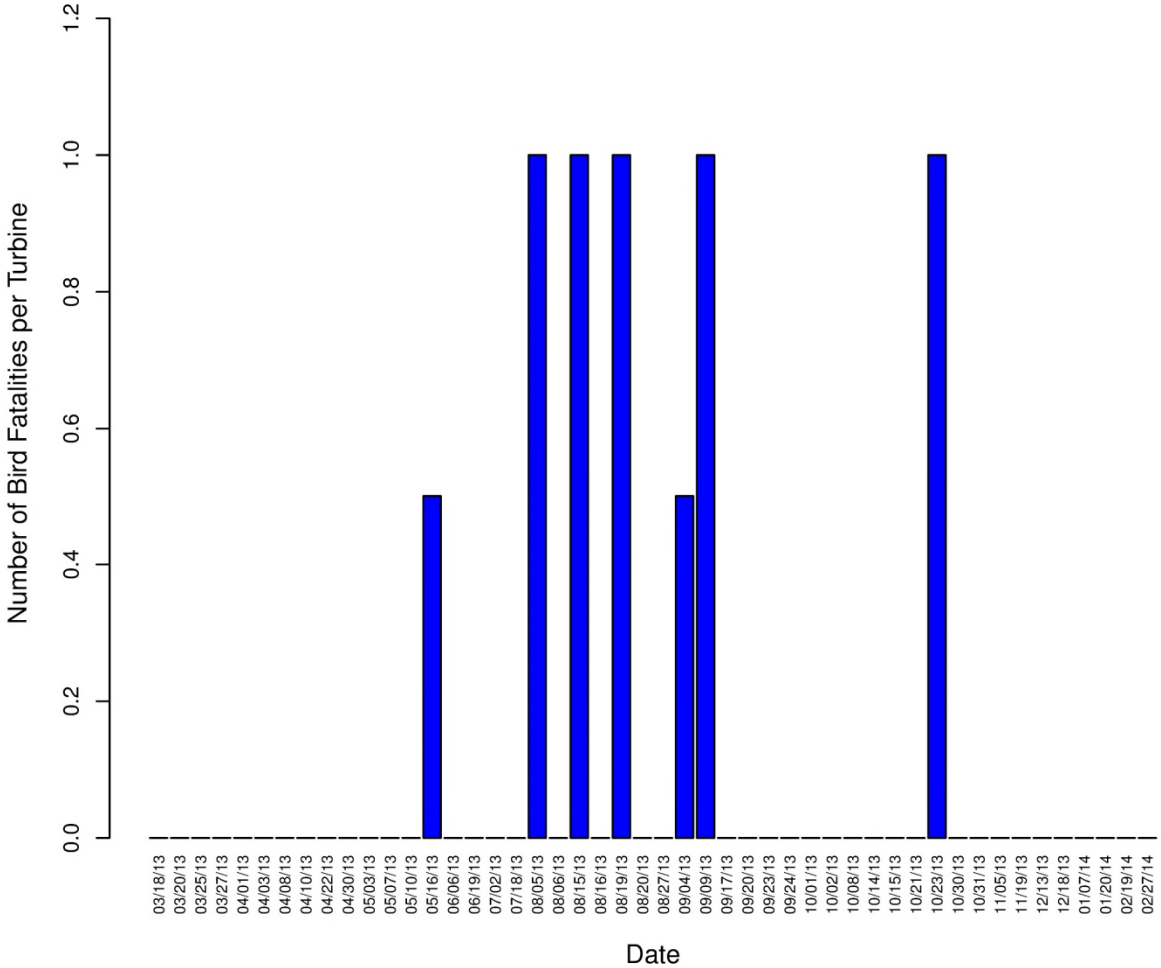

Figure 8. Timing of bird carcass discoveries at the meteorological (met) towers for the Dunlap Wind Energy Facility.

Bats

Twenty-two bat carcass discoveries were found during the third year of monitoring (Table 2), 21 of which were found on the 26 turbine search plots and one of which was found at a met tower (Figure 9). Fourteen of the 22 bat carcass discoveries (63.6%) were hoary bats (*Lasiurus cinereus*), five (22.7%) were too decomposed to allow for positive identification, and the remaining three were single individuals of little brown bat (*Myotis lucifugus*), silver-haired bat (*Lasionycteris noctivagans*), and canyon bat (*Parastrellus hesperus*) that each composed 4.5% of the bat carcass discoveries (Table 2). No bat carcass discoveries involved federally listed species. Eleven (50.0%) of the bats were intact, six (27.3%) were scavenged, and five (22.7%) were dismembered (Appendix A).

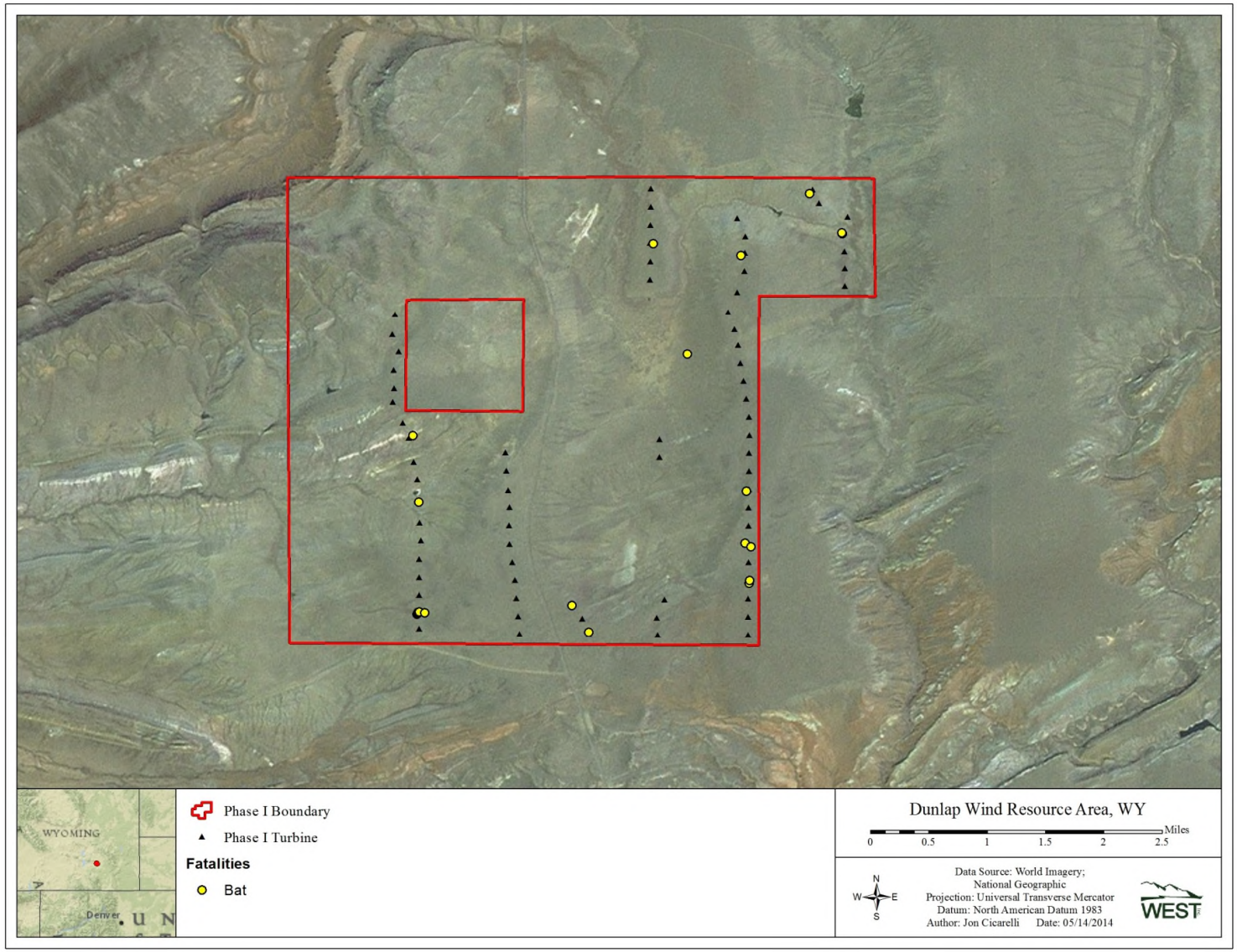

Figure 9. Location of bat casualties found at the Dunlap Wind Energy Facility.

One turbine had six bat carcass discoveries, four turbines had two carcass discoveries, eight turbines had one carcass discovery and the remaining 15 turbines did not have any bat carcass discoveries (Figure 10). A single bat carcass discovery was found at one of the two met towers. Of the 21 bat carcass discoveries found at turbines, 38.1% were found less than 30 m, 42.9% were found 30–60 m, 19.1% were found 60–80 m, and none were found more than 80 m from the nearest turbine (Table 3, Figure 11). The bat carcass found at a met tower was less than 10 m from the tower (Table 4).

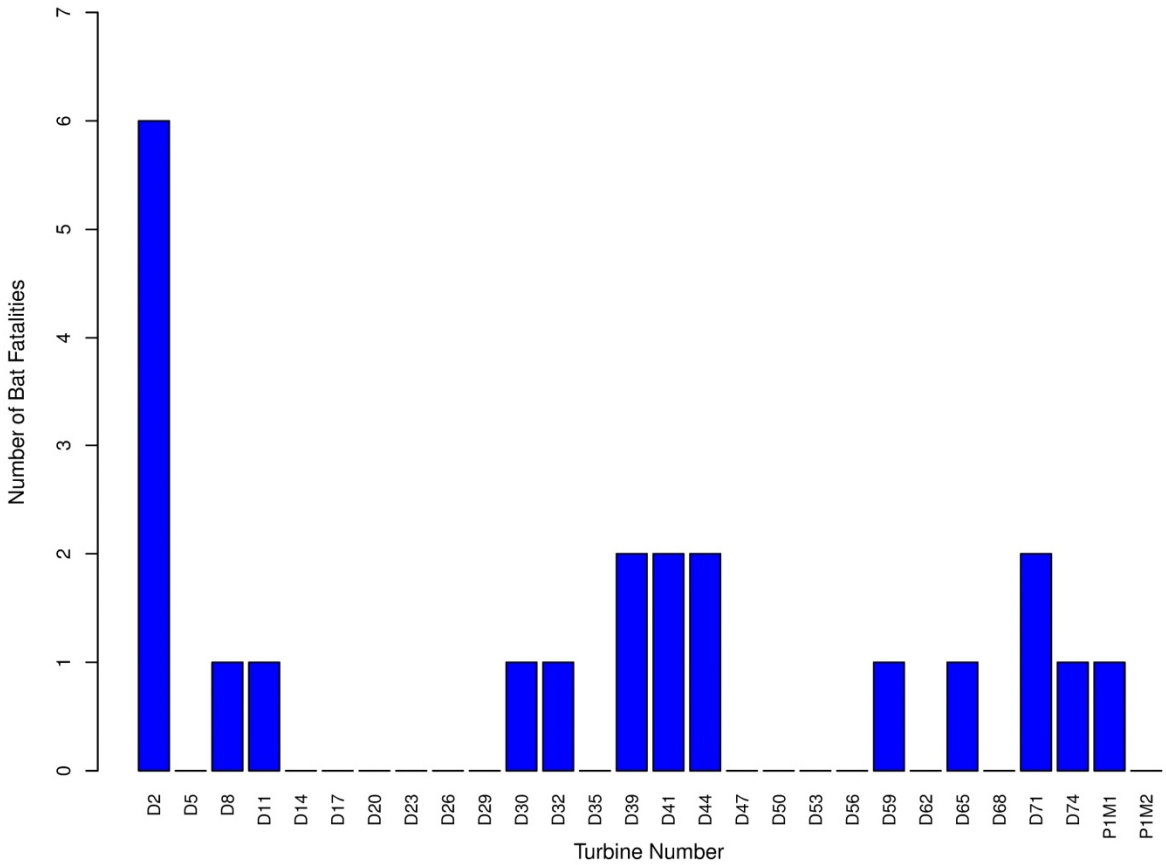

Figure 10. Number of bat carcass discoveries by turbine and meteorological (met) tower at the Dunlap Wind Energy Facility.

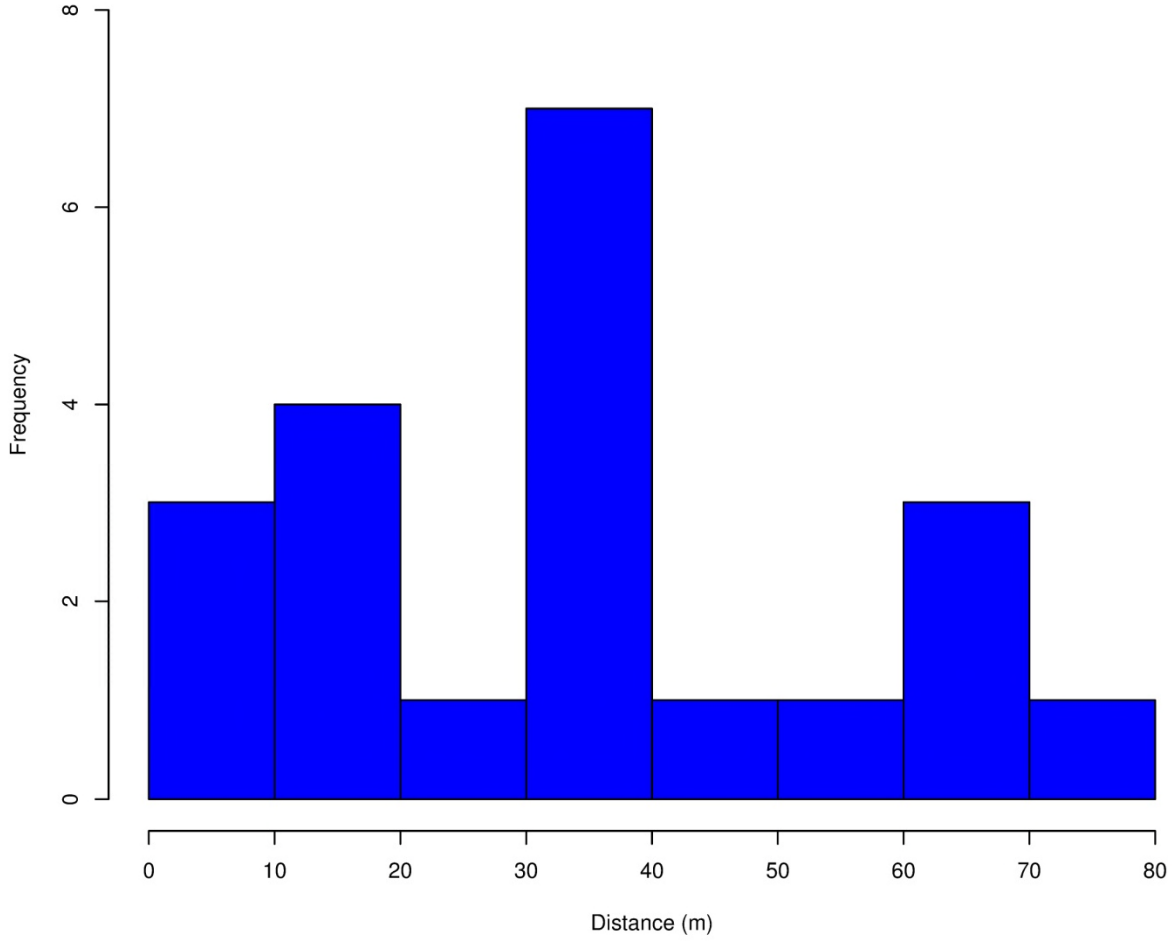

Figure 11. Distance of bat carcass discoveries from the turbines at the Dunlap Wind Energy Facility.

All bat carcass discoveries were detected during the period June 19 – November 5, 2013 (Figure 12; Appendix A). However, peak mortality occurred during the months of August and September 2013, when 15 bat carcasses (68.2%) were found (Appendix A). August was the peak month for bat collisions as nine carcasses (40.9%) were found during this month.

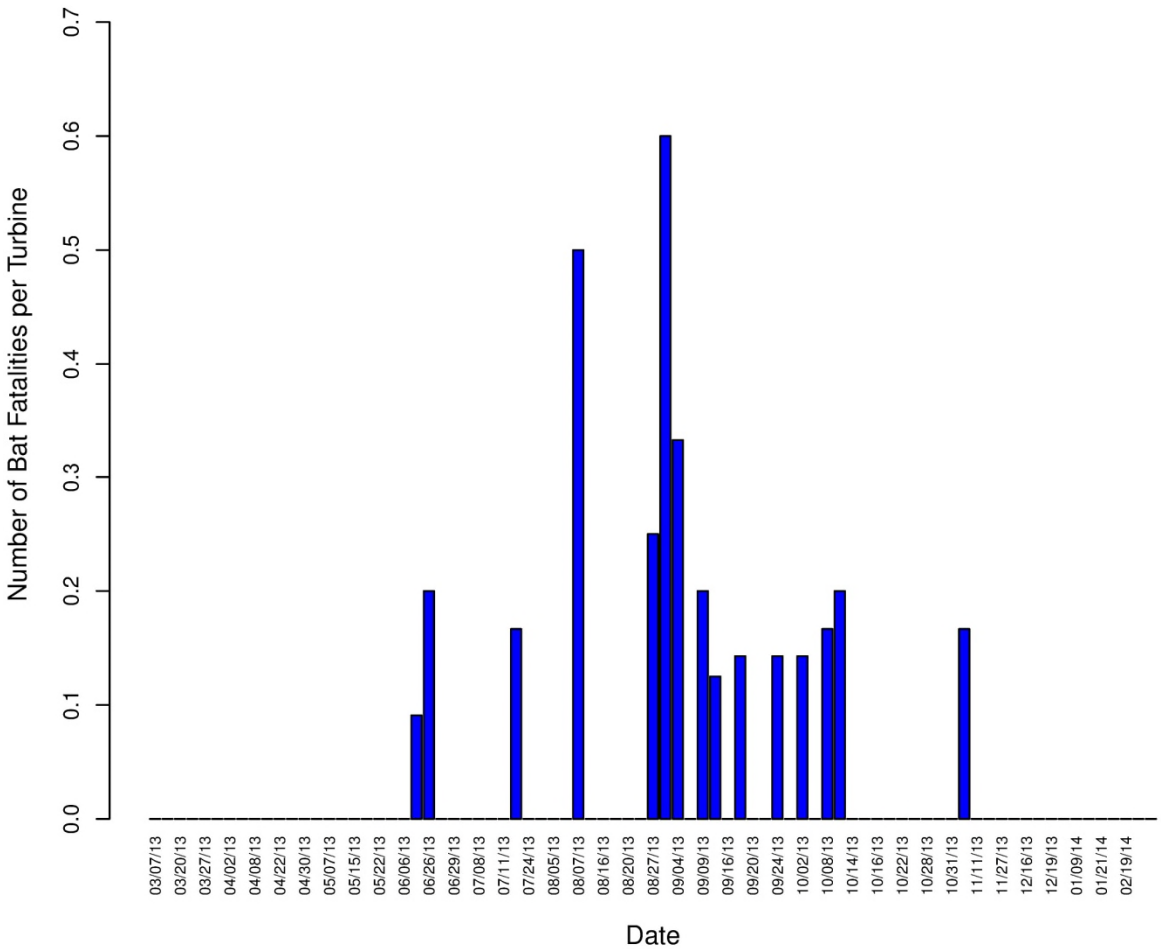

Figure 12. Timing of bat carcass discoveries at the turbines for the Dunlap Wind Energy Facility.

Bias Trials

A total of 96.0% of the large birds and 40.0% of the small birds and bats were detected during searcher efficiency trials (Table 5). Based on scavenger trial data, the mean removal time for small bird and bat carcasses (combined) was similar during migration and non-migration seasons, and averaged 12.7 days. Large bird carcasses lasted an average of 26.6 days during migration seasons and 10.4 days outside of the migration periods (Figure 13). Due to small sample sizes for bats, searcher efficiency and scavenging rates for small birds and bats were combined.

Given the estimated searcher efficiency and scavenger removal rates, the average probability that a small bird or bat would remain in a search plot and be found during a scheduled search was 40.0% for turbines searched weekly during migration, 15% for turbines searched monthly during migration, and 16% for turbines searched monthly outside of the migration seasons. For large birds, these percentages were 84.0%, 56.0%, and 31.0%, respectively (Appendix B).

Table 5. Searcher efficiency results at the Dunlap Wind Energy Facility as a function of carcass size. Because of the small number of bats used in searcher efficiency trials, bats were combined with small birds.

Size	Date	# Placed	# Available	# Found	% Found
Small Birds	5/16/2013	5	4	1	25.0
	5/24/2013	6	4	3	75.0
	6/19/2013	5	5	0	0
	9/17/2013	4	3	1	33.3
	1/7/2014	5	4	2	50.0
	2/19/2014	2	1	1	100.0
	2/21/2014	5	4	2	50.0
Small Bird Total		32	25	10	40.0
Large Birds	5/16/2013	3	3	2	66.7
	5/24/2013	2	2	2	100
	6/19/2013	3	3	3	100
	9/17/2013	4	4	4	100
	1/7/2014	4	4	4	100
	2/19/2014	6	6	6	100
	2/21/2014	4	3	3	100
Large Bird Total		26	25	24	96.0

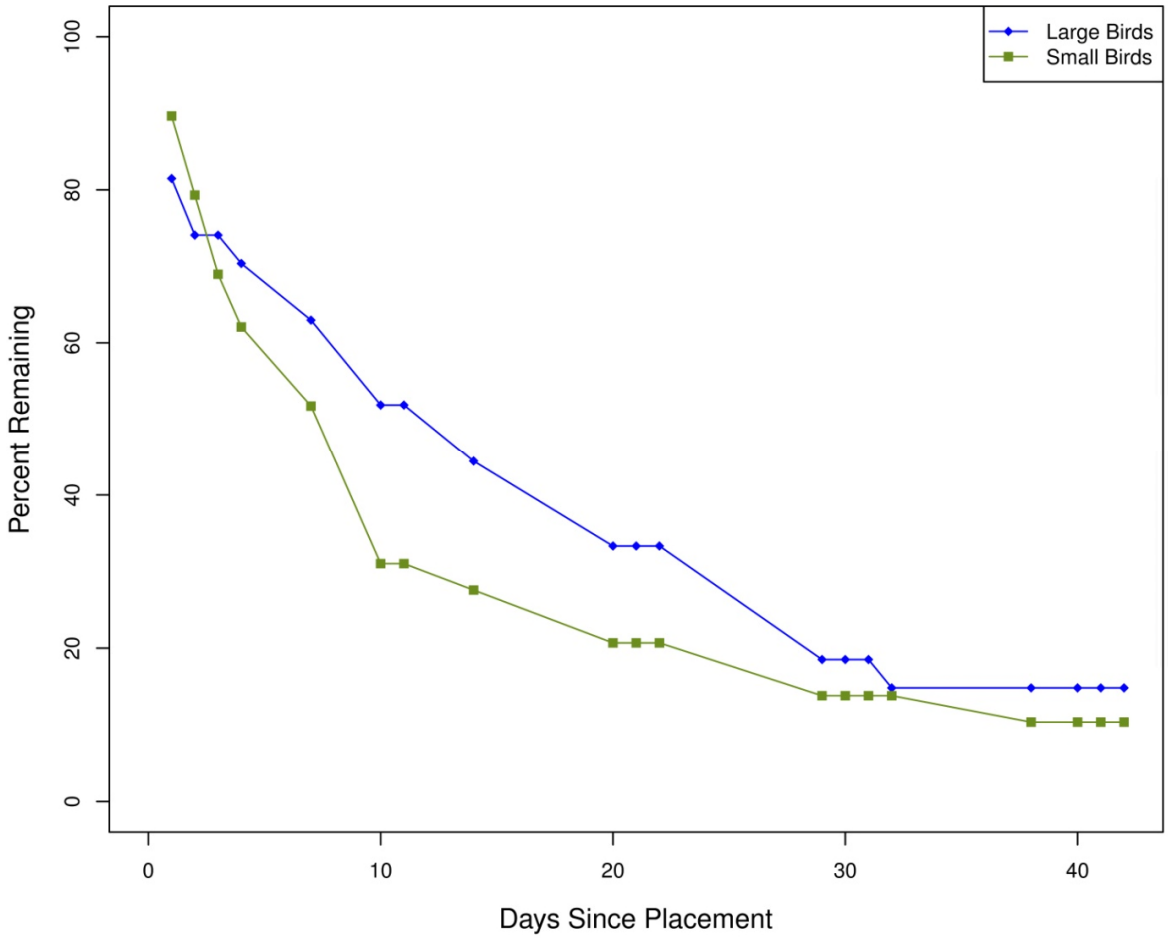

Figure 13. Carcass removal rates at the Dunlap Wind Energy Facility.

Adjusted Fatality Estimates

Small Birds

The adjusted fatality estimate for small birds at wind turbines was 2.84 fatalities/turbine/year (1.89 fatalities/MW/year; Table 6). The estimated small bird fatality rate at met towers was 7.42 fatalities/met tower/year (Table 7). Combining the mean annual fatality rates at turbines and met towers results in an estimate of approximately 225 small bird fatalities for the entire facility per year.

Large Birds

The adjusted fatality estimate for all large birds (e.g., raptors, waterbirds, and waterfowl) at wind turbines was 0.44 fatalities/turbine/year (0.30 fatalities/MW/year; Table 6). The estimated large bird fatality rate at met towers was 0.60 fatalities/met tower/year (Table 7). Combining the mean annual fatality rates at turbines and met towers results in an estimate of approximately 34 large bird fatalities for the entire facility per year.

Raptors

The adjusted fatality estimate for raptors at wind turbines was 0.14 fatalities/turbine/year (0.09 fatalities/MW/year; Table 6), which results in a total mortality estimate of approximately 10 raptors for the entire facility per year. No raptor fatalities were found at met towers.

All Birds

The adjusted fatality estimate for all birds combined at wind turbines was 3.29 fatalities/turbine/year (2.19 fatalities/MW/year; Table 6). The estimated all bird fatality rate at met towers was 8.02 fatalities/met tower/year (Table 7). Combining the mean annual fatality rates at turbines and met towers results in an estimate of approximately 259 bird fatalities for the entire facility per year.

Bats

The adjusted fatality estimate for bats at wind turbines was 3.38 fatalities/turbine/year (2.25 fatalities/MW/year; Table 6; Appendix C). The estimated bat fatality rate at met towers was 1.24 fatalities/met tower/year (Table 7; Appendix C). Combining the mean annual fatality rates at turbines and met towers results in an estimate of approximately 252 bat fatalities for the entire facility per year.

Table 6. Adjusted bird and bat fatality estimates for wind turbines at the Dunlap Wind Energy Facility from March 1, 2013 – February 28, 2014.

Fatality Type	Fatalities/Turbine/Year	Fatalities/MW/Year
Small Birds	2.84	1.89
Large Birds	0.44	0.30
Raptors	0.14	0.09
All Birds	3.29	2.19
Bats	3.38	2.25

For more details concerning correction factors and confidence intervals for both bird and bat fatality estimates, refer to Appendices B and C.

Table 7. Adjusted bird and bat fatality estimates for meteorological (met) towers at the Dunlap Wind Energy Facility from March 1, 2013 – February 28, 2014.

Fatality Type	# Fatalities/Met Tower/Year
Small Birds	7.42
Large Birds	0.60
Raptors	0
All Birds	8.02
Bats	1.24

For more details concerning correction factors and confidence intervals for both bird and bat fatality estimates, refer to Appendices B and C.

Raptor Nest Surveys

The entire DWEF, as well as a 2.5-mile buffer around the project turbines, was surveyed for raptor nests. The first round of aerial survey was completed on April 11, 2014. The second round of aerial nest surveys was completed on May 2, 2014. All nests in the BLM nest databases were checked during aerial surveys. Follow-up checks will be completed throughout the 2014 nesting season to monitoring nest success and identify chicks/fledglings.

Round 1 identified two occupied/active golden eagle nests within the 2.5-mile turbine buffer. Additionally, four occupied/active ferruginous hawk nests were observed. All occupied/active nests had an adult bird incubating. One occupied prairie falcon (*Falco mexicanus*) nest was observed. A prairie falcon pair was observed flying near the nest site.

Round 2 identified the same two occupied/active golden eagle nests within the 2.5-mile turbine buffer. Additionally, five occupied/active ferruginous hawk nests were identified. One of the ferruginous hawk nests was outside of the 2.5-mile survey area. One of the ferruginous hawk nests identified during Round 1 surveys was not active during the Round 2 survey; however, for the purpose of 2014 reporting, the nest will be identified as occupied/active. The prairie falcon nest was not active during the Round 2 survey. The nest will be considered occupied, but not active, during the 2014 season because active nesting was not observed.

In summary, two golden eagle nests were identified as occupied/active within the DWEF survey area in 2014; six ferruginous hawk nests were identified as occupied/active (one outside of the survey area); and one prairie falcon nest was identified as occupied/inactive (Figure 14).

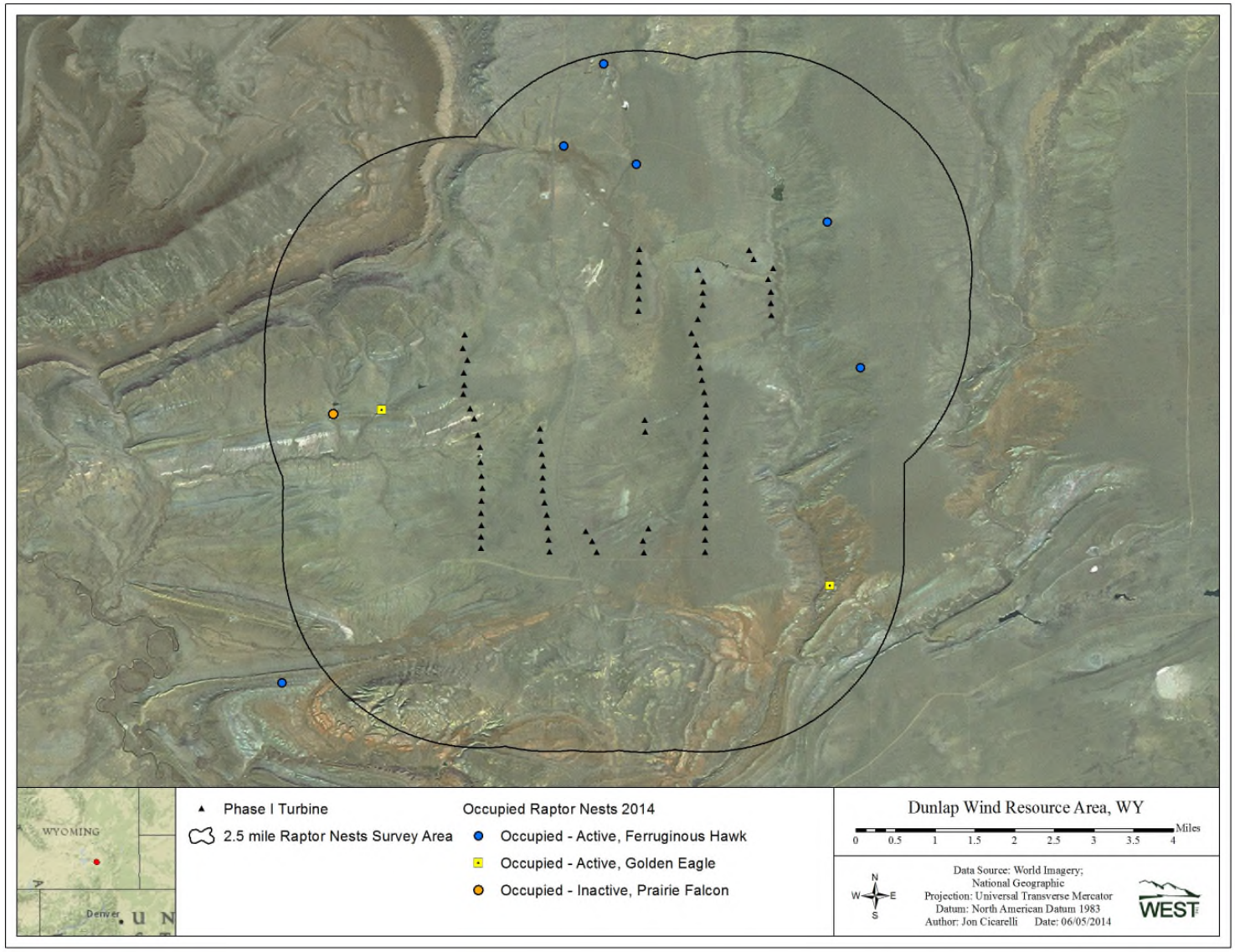

Figure 14. Dunlap Wind Energy Facility 2014 raptor nest survey results (as of May 2014).

Incidental Wildlife Observations

Observations were made of 67 groups of birds totaling 73 individuals and comprising 11 species, all of which were raptors (Table 8). The most common raptor species observed incidentally were golden eagle (29 groups of 33 birds), ferruginous hawk (14 observations totaling 16 birds) and red-tailed hawk (*Buteo jamaicensis*; six observations of single individuals). The other eight raptor species were infrequently recorded during incidental observations (Table 8). Other observations included four coyotes (*Canis latrans*) and one group of four swift fox (*Vulpes velox*; Table 8). Due to the large number and consistent sightings, pronghorn antelope (*Antilocapra americana*) incidental observations were not documented. Pronghorn were observed throughout the DWEF during nearly every survey event.

Table 8. Incidental wildlife observed while conducting all surveys at the Dunlap Wind Energy Facility from March 1, 2013 – February 28, 2014.

Species	Scientific Name	# grps	# obs
American kestrel	*Falco sparverius*	4	4
bald eagle	*Haliaeetus leucocephalus*	4	4
ferruginous hawk	*Buteo regalis*	14	16
golden eagle	*Aquila chrysaetos*	29	33
northern harrier	*Circus cyaneus*	1	1
peregrine falcon	*Falco peregrinus*	1	1
prairie falcon	*Falco mexicanus*	4	4
rough-legged hawk	*Buteo lagopus*	1	1
red-tailed hawk	*Buteo jamaicensis*	6	6
Swainson's hawk	*Buteo swainsoni*	1	1
turkey vulture	*Cathartes aura*	2	2
Bird Subtotal		**67**	**73**
coyote	*Canis latrans*	3	4
swift fox	*Vulpes velox*	1	4
Mammal Subtotal		**4**	**8**

DISCUSSION

Fatality Monitoring

Bird Fatalities at Dunlap

Raptor fatality estimates at turbines at the DWEF ranged from 0.09 to 0.12/MW/year over the 3-year study, and averaged 0.10 raptors/MW/year (Table 9). This estimate is low-moderate compared to estimated raptor fatality rates at 52 other wind energy facilities/studies in western North America (Figure 15). Compared to these other wind energy facilities/studies with publically-available raptor fatality data, the DWEF raptor fatality estimate ranked 22nd. Based on raptor use data collected during the baseline study (Johnson et al. 2009), the predicted raptor mortality rate was 0.06/MW/year.

The actual mortality rate based on a mean of three years of monitoring was somewhat higher than the predicted rate, but was within the 90% prediction interval, which was 0 – 0.32/MW/year (Johnson et al. 2009). No raptor casualties occurred at met towers during the 3-year study.

For all bird species combined, the estimated annual mortality rate at turbines ranged from 0.87 to 2.63 fatalities/MW/year, and averaged 1.90 birds/MW/year over the 3-year study (Table 9). Similar fatality estimates for all birds combined at wind turbines are available for 52 other wind energy facilities/studies across western North America. Compared to these other wind energy facilities/studies, the estimated bird fatality rate at the DWEF is low, ranking 33rd of the studies with similar avian fatality data (Figure 16). In addition to wind turbine related mortality, the estimated mean number of avian fatalities occurring at the two met towers on site ranged from 3.18 to 16.24, and averaged 9.15/tower/year (Table 10), which is approximately 3.2 times higher than the estimated 2.84 bird fatalities/turbine/year.

Table 9. Annual bird and bat fatality estimates for wind turbines at the Dunlap Wind Energy Facility, Carbon County, Wyoming.

	Wind Turbines											
	Fatalities/Turbine/Year				Fatalities/MW/Year				Total Number of Fatalities			
Fatality Type	**Year 1**	**Year 2**	**Year 3**	**Mean**	**Year 1**	**Year 2**	**Year 3**	**Mean**	**Year 1**	**Year 2**	**Year 3**	**Mean**
Small Birds	1.02	3.62	2.84	2.49	0.68	2.41	1.89	1.66	74	268	210	184
Large Birds	0.28	0.32	0.44	0.35	0.19	0.21	0.30	0.23	21	24	33	26
Raptors	0.18	0.15	0.14	0.16	0.12	0.10	0.09	0.10	13	11	10	12
All Birds	1.30	3.94	3.29	2.84	0.87	2.63	2.19	1.90	96	292	243	210
Bats	8.87	2.24	3.38	4.83	5.91	1.49	2.25	3.22	656	166	250	357

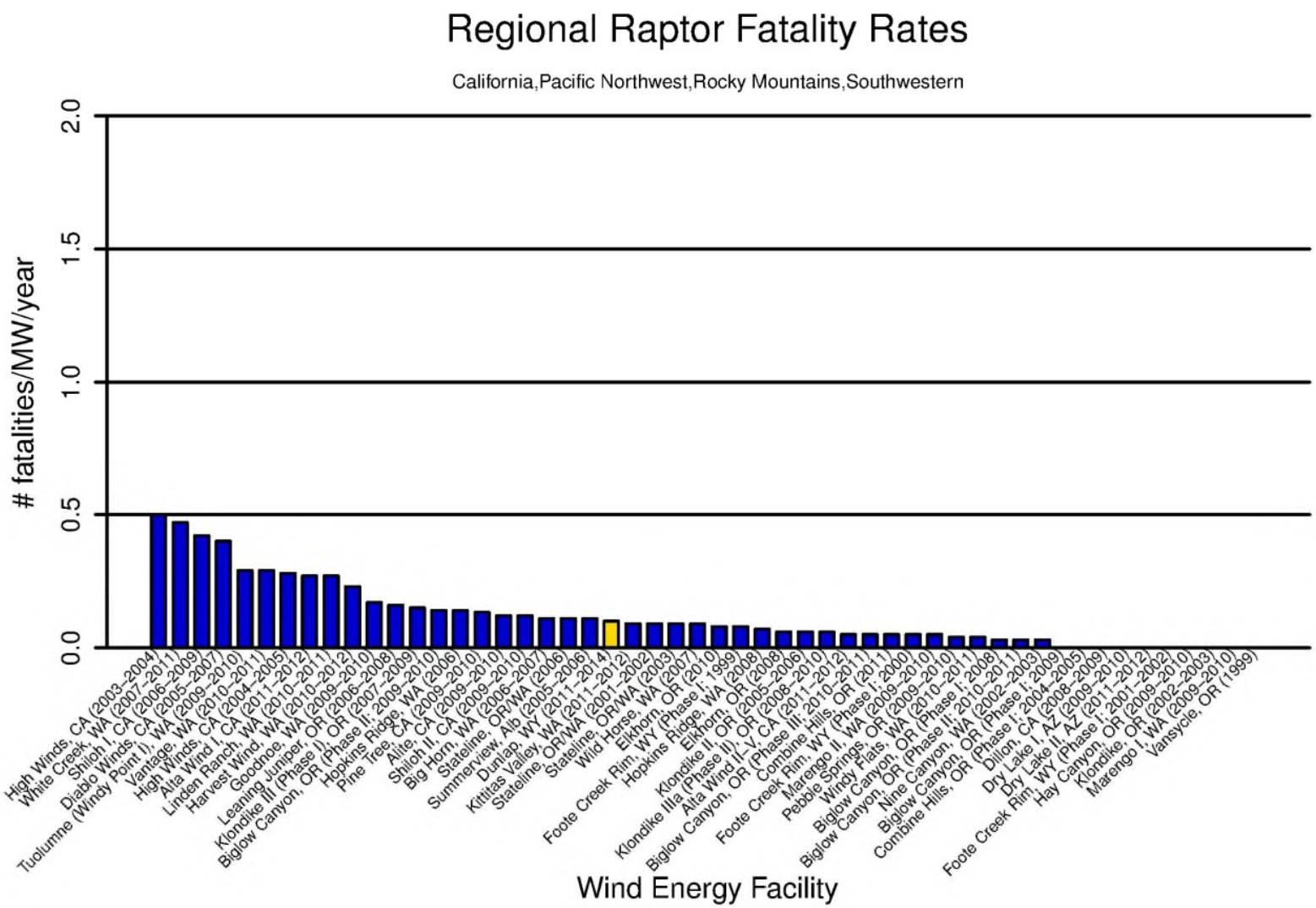

Figure 15. Fatality rates for raptors (number of raptors per megawatt per year) from comparable and publicly-available studies at wind energy facilities in western North America. The estimated 3-year mean fatality rate for the Dunlap Wind Energy Facility is highlighted in gold.

Figure 15 (*continued*). Fatality rates for raptors (number of raptors per megawatt per year) from comparable and publicly-available studies at wind energy facilities in western North America.

Data from the following sources:

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

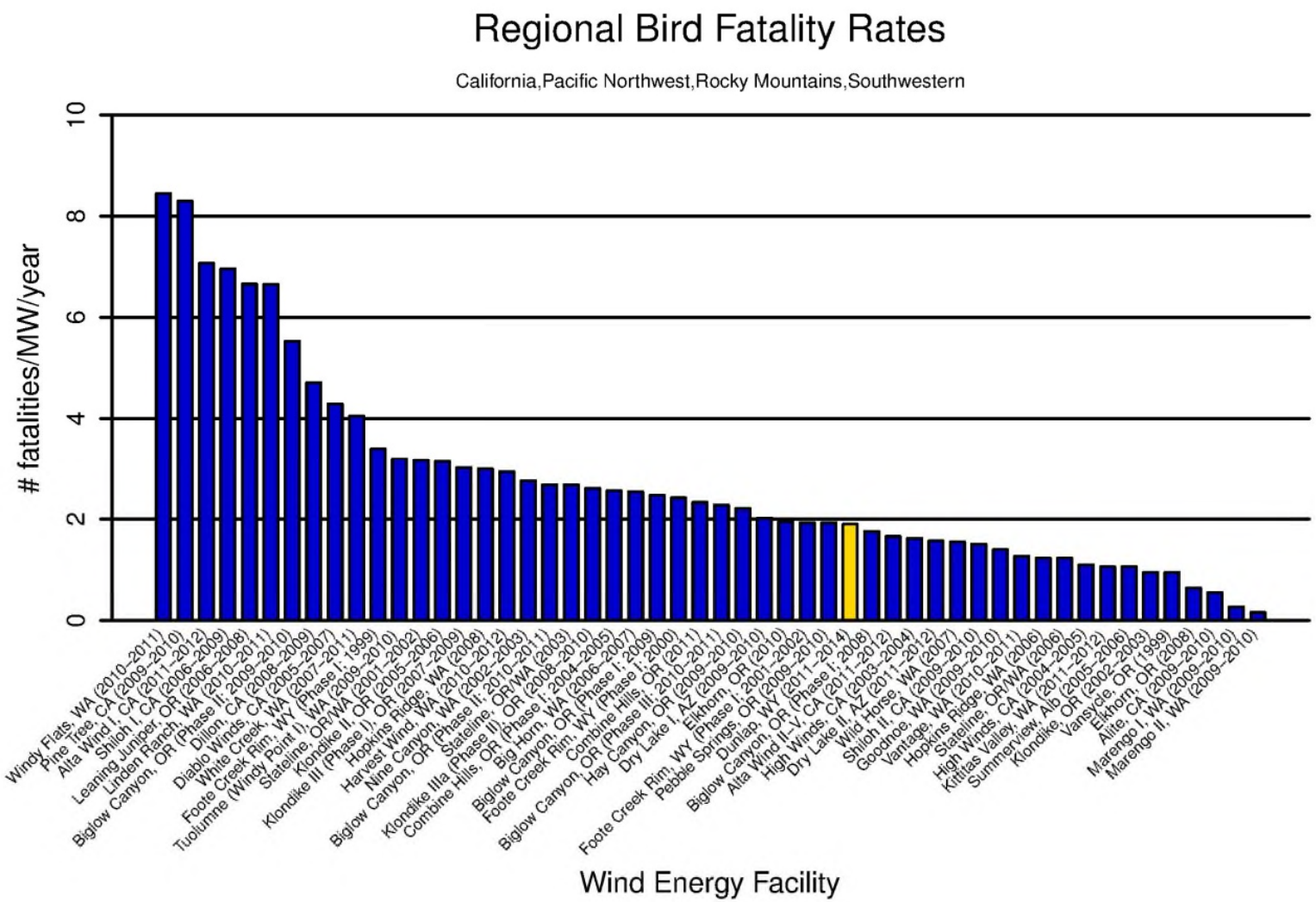

Figure 16. Fatality rates for all birds (number of birds per megawatt per year) from comparable and publicly-available studies at wind energy facilities in western North America. The estimated 3-year mean fatality rate for the Dunlap Wind Energy Facility is highlighted in gold.

Figure 16 (*continued*). Fatality rates for all birds (number of birds per megawatt per year) from comparable and publicly-available studies at wind energy facilities in western North America.

Data from the following sources:

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

Table 10. Annual bird and bat fatality estimates for meteorological towers at the Dunlap Wind Energy Facility, Carbon County, Wyoming.

	Meteorological Towers							
	Fatalities/Tower/Year				Total Number of Fatalities			
Fatality Type	**Year 1**	**Year 2**	**Year 3**	**Mean**	**Year 1**	**Year 2**	**Year 3**	**Mean**
Small Birds	2.63	16.24	7.42	8.76	5	32	15	18
Large Birds	0.56	0	0.60	0.39	1	0	1	1
Raptors	0	0	0	0	0	0	0	0
All Birds	3.18	16.24	8.02	9.15	6	32	16	18
Bats	0	0	1.24	0.41	0	0	2	1

Bat Fatalities at Dunlap

Bat fatality rates at the DWEF turbines ranged from 1.49 to 5.91 fatalities/MW/year, and averaged 3.22/MW/year over the 3-year study (Table 9). This is considered moderate on a regional basis; compared to 54 other wind energy facilities/studies in western North America, the DWEF ranked 7th (Figure 17). One bat fatality was found at a met tower over the 3-year study, resulting in a mean annual mortality rate at met towers of 0.41/tower/year (Table 10). Bats rarely collide with stationary tall structures such as communication towers (Johnson 2005) and to our knowledge this is the first documented bat mortality at a met tower within a wind energy facility.

Over the three years of study, with the exception of one little brown bat, one canyon bat, one unidentified *Myotis* and one eastern red bat (*Lasiurus borealis*), all identified bat fatalities found at the DWEF were either hoary or silver-haired bats. This species composition is similar to that of other wind energy facilities across western North America where the majority of casualties are either hoary or silver-haired bats (Gruver et al. 2011). Based on the timing of fatalities, and, again, similar to other wind energy facilities (Johnson 2005, Arnett et al. 2008, Gruver et al. 2011), it is likely that the majority of bat fatalities within the DWEF were composed of fall migrants.

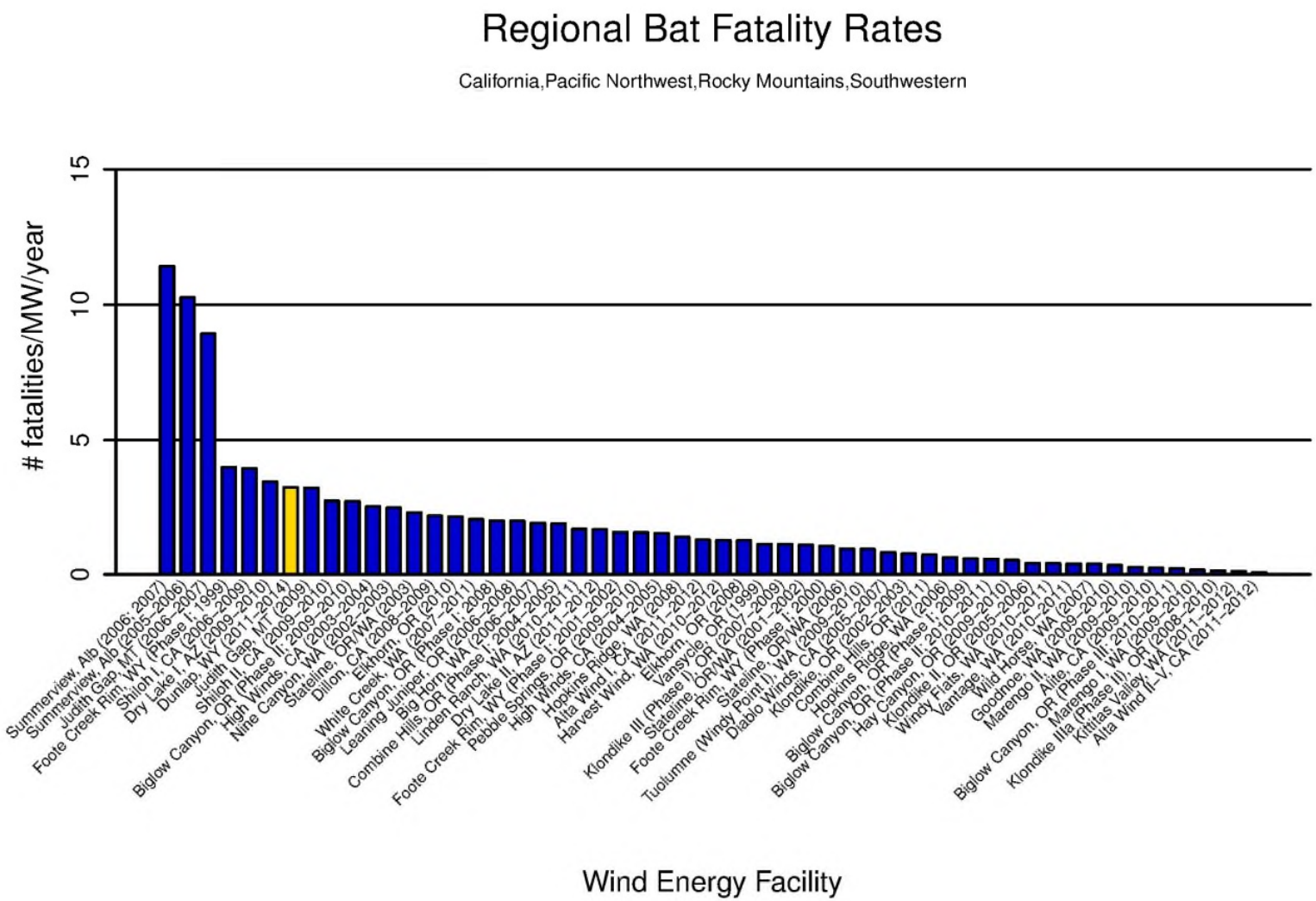

Figure 17. Fatality rates for bats (number of bats per megawatt per year) from comparable and publicly-available studies at wind energy facilities in western North America. The estimated 3-year mean fatality rate for the Dunlap Wind Energy Facility is highlighted in gold.

Figure 17 (*continued*). Fatality rates for bats (number of bats per megawatt per year) from comparable and publicly-available studies at wind energy facilities in western North America.

Data from the following sources:

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

Raptor Nest Data

Raptor nest activity varied throughout the 3-year study period. A total of 16 raptor nests were identified from 2009-2014 (Table 11, Figure 18). Three of the nests were golden eagles; seven were ferruginous hawks. No more than two golden eagle nests were occupied and active in any one year (2014). No more than six ferruginous hawk nests were active in any one year (2014). The year with the most occupied and active nests was 2014.

Comparisons between the 3-year study period and the pre-construction (2009) data are difficult due to the changes in survey area and methods. Survey areas included a 1-mile (1.6-km) buffer from Dunlap Phase I/II (2009), 2-mile (3.2-km) buffer from Phase I (2011), 2-mile buffer from project turbines (2012, 2013), and 2.5-mile buffer from project turbines (2014). Surveys methods changed from ground based (2009, 2011), to ground and aerial (2012, 2013), to all aerial surveys (2014). In years where only ground based surveys were completed, access to some areas was not granted by landowners; therefore, some nests were unable to be confidently surveyed. Regardless of survey area and methods, the construction and operation of the DWEF does not appear to have significantly affected raptor nesting activity in and around the project area.

Table 11. Dunlap Wind Energy Facility nest activity: 2009-2014.

		2009	2011	2012		2013		2014	
Nest ID	Species	Activity	Activity	Occupied (Y/N)	Activity	Occupied (Y/N)	Activity	Occupied (Y/N)	Activity
1	UNID	IA	NS	NS	-	NS	-	NS	-
2	Merlin	A	A	NS	-	NS	-	NS	-
3	GOEA	A	NS	NS	-	NS	-	NS	-
4	GHOW	A	A	NS	-	NS	-	NS	-
5	LEOW	A	IA	N	-	N	-	N	-
6	FEHA	A	IA	Y	A	Y	IA	Y	A
7	FEHA	A	NS	NS	-	NS	-	NS	-
8	FEHA	A	IA	Y	A	N	-	Y	A
9	FEHA	NS	NS	NS	-	NS	-	Y	A
10	FEHA	NS	IA	Y	A	Y	IA	Y	A
11	FEHA	NS	NS	Y	A	Y	A	Y	A
12	GOEA	NS	NS	N	-	Y	IA	Y	A
13	PRFA	NS	NS	Y	A	N	-	Y	IA
14	GOEA	NS	NS	Y	IA	Y	IA	Y	A
15	PRFA	NS	NS	N	-	Y	A	N	-
16	FEHA	NS	NS	NS	-	NS	-	Y	A

FEHA = ferruginous hawk; GHOW = great-horned owl (*Bubo virginianus*); GOEA = golden eagle; LEOW = long-eared owl (*Asio otus*); merlin (*Falco columbarius*); PRFA = prairie falcon; UNID = unidentified
NS - Not Surveyed (did not exist, not located, extremely poor condition, unable to obtain access, outside survey area)
IA - No nesting activity confirmed (i.e., no eggs or chicks observed or no active incubation observed)
A - Nesting activity confirmed (i.e., eggs or chicks present or bird observed in active incubation posture)
*Occupied nests were determined based on the presence of an adult, eggs, or young, freshly molted feathers or plucked down, or current years' mutes

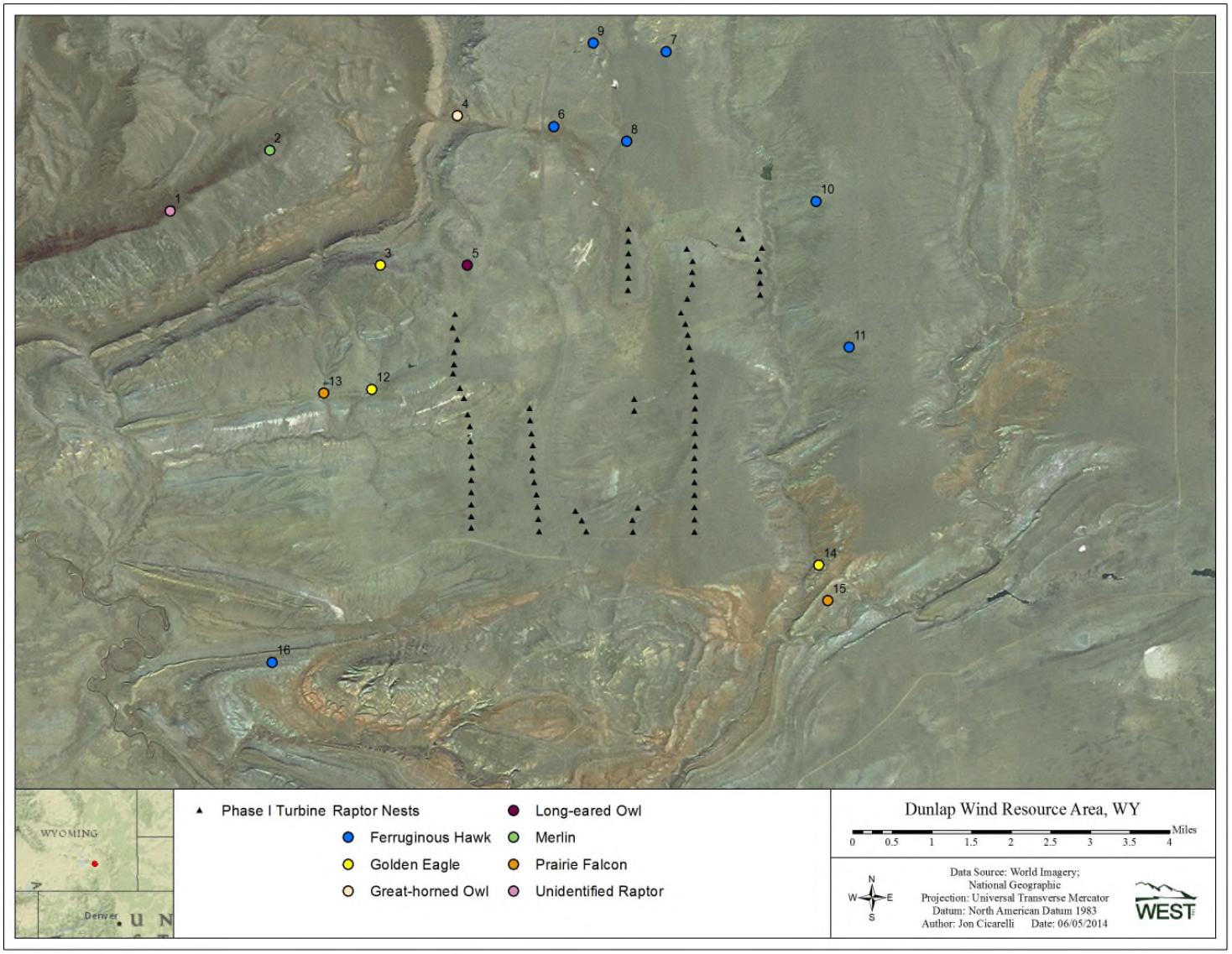

Figure 18. Dunlap Wind Energy Facility 2009-2014 raptor nest survey results.

CONCLUSIONS

Based on data collected during the first three years of operation of the DWEF, collision mortality of raptors was low-moderate compared to other wind energy facilities evaluated using similar methods in the western US. Mortality of all bird species combined at the DWEF is relatively low compared to regional fatality estimates. Bat fatality rates are considered moderate relative to other projects across western North America.

A total of 16 active raptor nests were identified from 2009-2014. Raptor nest activity was highest in 2014; therefore, the construction and operation of the DWEF does not appear to have had a negative effect on nesting raptors.

To date, post-construction monitoring data are only available for one wind energy facilities in Wyoming, Foote Creek Rim. In addition, there are very few studies available from surrounding states. Results of this study further contribute to our understanding of effects on wildlife of wind energy developments in Wyoming and the Rocky Mountain West. As more wind power projects are built in the region, and additional studies become available, a clearer picture of the potential impacts will emerge.

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Appendix A. Bird and Bat Fatalities Found During Fatality Monitoring at the Dunlap Wind Energy Facility from March 1, 2013 – February 28, 2014

Appendix A. Bird and bat fatalities found during fatality monitoring at the Dunlap Wind Energy Facility.

Date	Common Name	Location	Distance from Turbine (m)	Type of Find	Search Type	Condition
Birds						
3/20/2013	European starling	D62	3	Carcass Search	weekly	Intact
3/25/2013	horned lark	D62	83	Carcass Search	weekly	Feather Spot
4/30/2013	horned lark	D26	20	Carcass Search	weekly	Intact
5/10/2013	unidentified large bird	D26	94	Carcass Search	weekly	Feather Spot
5/15/2013	common nighthawk	D39	73	Carcass Search	weekly	Dismembered
5/16/2013	Brewer's sparrow	P1M2	10	Incidental Find	weekly	Intact
6/19/2013	unidentified passerine	D47	61	Carcass Search	monthly	Feather Spot
6/26/2013	horned lark	D11	52	Carcass Search	monthly	Feather Spot
6/26/2013	golden eagle	D25	73	Incidental Find	n/a	Dismembered
6/29/2013	unidentified waterfowl	D23	96	Carcass Search	monthly	Feather Spot
7/18/2013	lark bunting	D68	68	Carcass Search	weekly	Intact
7/18/2013	horned lark	D74	8	Carcass Search	weekly	Intact
8/5/2013	horned lark	P1M1	49	Carcass Search	weekly	Feather Spot
8/6/2013	unidentified bird (small)	D26	80	Carcass Search	weekly	Feather Spot
8/7/2013	broad-tailed hummingbird	D47	27	Carcass Search	monthly	Intact
8/15/2013	horned lark	P1M2	37	Carcass Search	weekly	Dismembered
8/16/2013	American kestrel	D59	47	Carcass Search	monthly	Intact
8/19/2013	Brewer's sparrow	P1M2	20	Carcass Search	weekly	Intact
8/20/2013	white-throated swift	D53	39	Incidental Find	monthly	Intact
9/4/2013	Wilson's warbler	P1M1	6	Carcass Search	weekly	Intact
9/9/2013	unidentified passerine	P1M1	46	Carcass Search	weekly	Feather Spot
9/9/2013	Lincoln's sparrow	D32	48	Carcass Search	weekly	Intact
9/23/2013	Brewer's sparrow	D44	30	Carcass Search	weekly	Scavenged
9/24/2013	ferruginous hawk	D29	89	Carcass Search	monthly	Intact
10/7/2013	western grebe	D39	80	Carcass Search	weekly	Intact
10/7/2013	American coot	D44	75	Carcass Search	weekly	Dismembered
10/9/2013	white-crowned sparrow	D47	97	Carcass Search	monthly	Intact
10/9/2013	unidentified passerine	D41	93	Carcass Search	monthly	Feather Spot
10/14/2013	unidentified bird (small)	D50	70	Carcass Search	weekly	Feather Spot
10/22/2013	vesper sparrow	D26	10	Carcass Search	weekly	Intact
10/23/2013	Eurasian collared-dove	P1M1	58	Incidental Find	weekly	Injured
10/31/2013	grasshopper sparrow	D26	110	Carcass Search	weekly	Intact

Appendix A. Bird and bat fatalities found during fatality monitoring at the Dunlap Wind Energy Facility.

Date	Common Name	Location	Distance from Turbine (m)	Type of Find	Search Type	Condition
Bats						
6/19/2013	unidentified bat	D30	38	Carcass Search	monthly	Dismembered
6/26/2013	silver-haired bat	D59	35	Carcass Search	monthly	Intact
7/18/2013	little brown bat	D71	18	Carcass Search	monthly	Intact
8/7/2013	hoary bat	D65	65	Carcass Search	monthly	Intact
8/7/2013	hoary bat	D71	12	Carcass Search	monthly	Intact
8/7/2013	hoary bat	D41	52	Carcass Search	monthly	Intact
8/27/2013	hoary bat	D8	9	Carcass Search	weekly	Scavenged
8/27/2013	hoary bat	P1M1	3	Carcass Search	weekly	Scavenged
8/27/2013	canyon bat	D2	9	Carcass Search	weekly	Intact
8/29/2013	hoary bat	D39	18	Carcass Search	weekly	Scavenged
8/29/2013	hoary bat	D44	40	Carcass Search	weekly	Scavenged
8/29/2013	hoary bat	D44	31	Carcass Search	weekly	Scavenged
9/4/2013	hoary bat	D2	39	Carcass Search	weekly	Intact
9/4/2013	hoary bat	D2	32	Carcass Search	weekly	Intact
9/9/2013	hoary bat	D32	19	Carcass Search	weekly	Intact
9/10/2013	unidentified bat	D2	9	Carcass Search	weekly	Dismembered
9/17/2013	hoary bat	D11	63	Carcass Search	monthly	Intact
9/24/2013	unidentified bat	D2	76	Carcass Search	weekly	Dismembered
10/2/2013	hoary bat	D39	26	Carcass Search	weekly	Scavenged
10/8/2013	unidentified bat	D2	33	Carcass Search	weekly	Dismembered
10/9/2013	hoary bat	D41	47	Carcass Search	monthly	Intact
11/5/2013	unidentified bat	D74	66	Carcass Search	weekly	Dismembered

Appendix B. Fatality Estimates for Birds at the Dunlap Wind Energy Facility for Monitoring Conducted from March 1, 2013 – February 28, 2014

Appendix B1. Fatality estimates for birds at wind turbines at the Dunlap Wind Energy Facility for monitoring conducted from March 1, 2013 – February 28, 2014.

	Migration				Non-Migration	
	Weekly		Monthly		Monthly	
Parameter	**Mean**	**CI**	**Mean**	**CI**	**Mean**	**CI**
Search Area Adjustment						
A (small birds)	1.0	-	1.0	-	1.0	-
A (large birds)	1.0	-	1.0	-	1.0	-
Observer Detection						
A (small birds)	0.40	(0.24–0.56)	0.40	(0.24–0.56)	0.40	(0.24–0.56)
A (large birds)	0.96	(0.88-1)	0.96	(0.88-1)	0.96	(0.88-1)
Observed Fatality Rates (fatalities/turbine/year)						
Small birds	0.69	(0.23-1.23)	0.31	(0.08-0.62)	0.15	(0.04-0.27)
Large birds	0.31	(0.08-0.62)	0.15	(0-0.31)	0.04	(0-0.12)
Raptors	0	-	0.15	(0-0.31)	0	-
Average Probability of Carcass Availability and Detected						
Small birds	0.40	(0.24-0.55)	0.15	(0.08-0.25)	0.16	(0.08-0.26)
Large birds	0.84	(0.73-0.9)	0.56	(0.38-0.71)	0.31	(0.2-0.41)
Adjusted Fatality Estimates (fatalities/turbine/year)-						
Small birds	1.71	(0.61-3.59)	2.03	(0.47-5.1)	0.97	(0.28-2.38)
Large birds	0.37	(0.09-0.76)	0.27	(0-0.62)	0.12	(0-0.38)
Raptors	0	-	0.27	(0-0.66)	0	-
All birds	2.08	(0.94-3.93)	2.30	(0.68-5.42)	1.09	(0.39-2.53)

Overall Adjusted Fatality Estimates (fatalities/turbine/year)	Migration		Non-Migration	
	Mean	**CI**	**Mean**	**CI**
Small birds	**1.87**	**(0.84-4)**	**0.97**	**(0.28-2.38)**
Large birds	**0.32**	**(0.11-0.58)**	**0.12**	**(0-0.38)**
Raptors	**0.14**	**(0-0.33)**	**0**	**-**
All birds	**2.19**	**(1.17-4.34)**	**1.09**	**(0.39-2.53)**

Appendix B2. Fatality estimates at meteorological (met) towers for birds at the Dunlap Wind Energy Facility for monitoring conducted from March 1, 2013 – February 28, 2014.

	Migration		Non-Migration	
	Weekly		Monthly	
Parameter	**Mean**	**CI**	**Mean**	**CI**
Search Area Adjustment				
A (small birds)	1.0	-	1.0	-
A (large birds)	1.0	-	1.0	-
Observer Detection				
A (small birds)	0.40	(0.24–0.56)	0.40	(0.24–0.56)
A (large birds)	0.96	(0.88-1)	0.96	(0.88-1)
Observed Fatality Rates (fatalities/met tower/year)				
Small birds	3.0	-	0	-
Large birds	0.5	(0-1)	0	-
Raptors	0	-	0	-
Average Probability of Carcass Availability and Detected-				
Small birds	0.40	(0.24-0.55)	0.16	(0.08-0.26)
Large birds	0.84	(0.73-0.9)	0.31	(0.2-0.41)
Adjusted Fatality Estimates (fatalities/met tower/year)-				
Small birds	7.42	(5.41-12.24)	0	-
Large birds	0.60	(0-1.27)	0	-
Raptors	0	-	0	-
All birds	8.02	(5.88-13.06)	0	-

Overall Adjusted Fatality Estimates (fatalities/met tower/year)	**Mean**	**CI**
Small birds	**7.42**	**(5.41-12.42)**
Large birds	**0.60**	**(0-1.27)**
Raptors	**0**	**-**
All birds	**8.02**	**(5.88-13.06)**

Appendix C. Fatality Estimates for Bats at the Dunlap Wind Energy Facility for Monitoring Conducted from March 1, 2013 – February 28, 2014

Appendix C1. Fatality estimates for bats at wind turbines at the Dunlap Wind Energy Facility for studies conducted from March 1, 2013 – February 28, 2014.

	Migration				Non-Migration	
	Weekly		Monthly		Monthly	
Parameter	**Mean**	**CI**	**Mean**	**CI**	**Mean**	**CI**
Search Area Adjustment						
A (bats)	1.0	-	1.0	-	1.0	-
Observer Detection						
A (bats)	0.4	(0.24-0.56)	0.4	(0.24-0.56)	0.4	(0.24-0.56)
Observed Fatality Rates (fatalities/turbine/year)						
Bats	0.92	(0.23-1.69)	0.38	(0.15-0.69)	0.15	(0.04-0.27)
Average Probability of Carcass Availability and Detected						
Bats	0.40	(0.24-0.55)	0.15	(0.08-0.25)	0.16	(0.08-0.26)
Adjusted Fatality Estimates (fatalities/turbine/year)-						
Bats	2.28	(0.62-5.32)	2.54	(0.73-6.45)	0.97	(0.28-2.29)

Overall Adjusted Fatality Estimates (fatalities/turbine/year)

	Migration		Non-Migration	
	Mean	**CI**	**Mean**	**CI**
Bats	**2.41**	**(1.08-5.26)**	**0.97**	**(0.28-2.29)**

Appendix C2. Fatality estimates for bats at meteorological (met) towers at the Dunlap Wind Energy Facility for monitoring conducted from March 1, 2013 – February 28, 2014.

	Migration		Non-Migration	
	Weekly		Monthly	
Parameter	**Mean**	**CI**	**Mean**	**CI**
Search Area Adjustment				
A (bats)	1.0	-	1.0	-
Observer Detection				
A (bats)	0.40	(0.24–0.56)	0.40	(0.24–0.56)
Observed Fatality Rates (fatalities/met tower/year)				
Bats	0.50	(0-1)	0	-
Average Probability of Carcass Availability and Detected				
Bats	0.40	(0.24-0.55)	0.16	(0.08-0.26)
Adjusted Fatality Estimates (fatalities/met tower/year)				
Bats	1.24	(0-3.14)	0	-

Overall Adjusted Fatality Estimates (fatalities/met tower/year)		
	Mean	**CI**
Bats	**1.24**	**(0-3.14)**

Appendix G. Post-Construction Nest Memorandums

NATURAL RESOURCES ◆ SCIENTIFIC SOLUTIONS

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Draft

TECHNICAL MEMORANDUM

DATE: December 11, 2014

TO: **PACIFICORP**

FROM: WEST, Inc.

RE: Dunlap – Raptor Nest Memo 2014

The following memorandum (memo) presents findings for the 2014 raptor nest surveys completed at the Dunlap Wind Energy Facility (DWEF). Informal nest surveys to determine occupancy were completed by onsite technicians in March. Aerial (helicopter) raptor nest surveys were conducted on April 11 and May 2, 2014. Additional ground surveys were completed (as accessed allowed) to determine nest success on June 19, 2014. The survey area was defined as a 2.5 mile buffer from project turbines (Figure 1).

Raptor Nest Surveys

The USFWS drafted the *Eagle Conservation Plan Guidance Module 1 – Land-based Wind Energy (Version 2; 2013)*. In this document the following definitions are provided (note: no definition is provided for Active nest, only a reference to occupied nest):

Occupied nest – a nest used for breeding in the current year by a pair of eagles. Presence of an adult, eggs, or young, freshly molted feathers or plucked down, or current year's mutes (whitewash) suggest site occupancy. In years when food resources are scarce, it is not uncommon for a pair of eagles to occupy a nest yet never lay eggs; such nests are considered occupied.

Unoccupied nest – those nests not selected by raptors for use in the current nesting season. See also inactive nest.

Inactive nest – a bald eagle or golden eagle nest that is not currently being used by eagles as determined by the continuing absence of any adult, egg, or dependent young at the nest for at

least 10 consecutive days immediately prior to, and including, at present. An inactive nest may become active again and remains protected under the Eagle Act.

The Region 6 USFWS has provided further guidance in the *Region 6 Recommendations for Avoidance and Minimization of Impacts to Golden Eagles at Wind Energy Facilities, April 11, 2013*:

An occupied nest is a nest used for breeding in the current year by a pair of eagles. Presence of an adult, eggs, or young, freshly molted feathers or plucked down, or current year's mutes (whitewash) suggest site occupancy. In years when food resources are scarce, it is not uncommon for a pair of eagles to occupy a nest yet never lay eggs; such nests are considered occupied (Eagle Conservation Plan Guidance [ECPG1] 2012, p. 32). For purposes of these recommendations, we define occupied GOEA nests as nest sites that were occupied at least once during the last five years or last five years of field surveys. Because GOEAs will often use the same nest in multiple years (Kochert and Steenhof 2012), there is a high likelihood that these nests could be occupied again during the life of the project. Nests form the center of activity during the breeding season and are often centers of activity during the non-breeding season as well (Marzluff et al. 1997). Buffering or otherwise protecting eagle nests should substantially decrease the probability of lethal take, as well as disturbance take, of eagles. Other raptors using the same nesting habitats as GOEA (e.g., prairie falcon) will also benefit from protection of GOEA nest sites.

We define unoccupied GOEA nests as those nests not selected by raptors for use in the current nesting season (ECPG 2012, p. 33). For purposes of these recommendations, we define unoccupied GOEA nests as nest sites that were not occupied during the last five years or last five years of field surveys. It should be noted that occupied nests can be incorrectly assigned as unoccupied if the nests are not repeatedly surveyed during the same nesting season. Even if a nest was unoccupied in one or more years, it is still possible that eagles could reuse that nest in future years (Kochert and Steenhof 2012), especially since the intervals between nest reuse can be lengthy (Kochert and Steenhof 2012, Slater et al. 2013). Given that the anticipated life of a wind project is 30 years (though repowering could extend that indefinitely) it is likely that some unoccupied nests will become occupied during the life of the project. In addition, nests usually occur in areas of historical eagle use (due to topographic features and prey resources) and represent areas where eagles are expected to return in the future.

Based on guidance provided by the USFWS, 2014 raptor nests at DWEF were classified as occupied – active or occupied – inactive. Additionally, fledgling success was determined for each nest when possible. Nests were named by the Township, Range, Section and unique nest ID for each section (e.g., Township 25, Range 78, Section 34, Nest 1 = 25783401).

Two occupied – active golden eagle nests were identified during the first round of aerial nest surveys (24792501 and 23780101; Figure 1). A golden eagle was observed on each nest, in an incubating posture. As of May 2 (second round aerial survey) chicks were not present; however, an adult was still observed incubating at both nest sites. Land access was not granted to the golden eagle nest (23780101) southeast of the project area; therefore, follow up

surveys were not conducted. The golden eagle nest (24792501) west of the project was monitored on foot on June 19, 2014. No adults were present at or near the nest site. No chicks were observed. Based on these observations, the nest was believed to be unsuccessful.

Table 1 lists the turbine closest to each golden eagle nest and the distance to that turbine.

Table 1. Dunlap 2014 Golden Eagle Nests and Turbine Distance

Nest ID	Closest Turbine	Distance to Closest Turbine (miles)
24792501	D-13	1.04
23780101	D-36	1.62

Additionally, six ferruginous hawk nests were identified as occupied–active during the nest surveys. Four ferruginous hawk nests (25783401, 24780401, 24780301, and 24782401) were active during the round 1 survey and two additional nests (inactive during round 1; 24781201 and 23791101) were active during the round 2 survey. Access to three ferruginous hawk nests was authorized. These three nests were surveyed on June 19 and July 25. Two chicks were confirmed in a cottonwood tree nest (24780401), two in an old windmill nest (24780301), and one in the northern ANS nest (24781201). The final nest check did not observe chicks in or near the nest sites; therefore, fledge success was assumed. Due to access restrictions, nest and fledge success could not be determined for ferruginous hawk nests 25783401, 2482401, or 23791101.

A prairie falcon nest (24792502) was identified as occupied (adult pair present in the area) during the round 1 survey; however, no activity was observed during round 2 surveys.

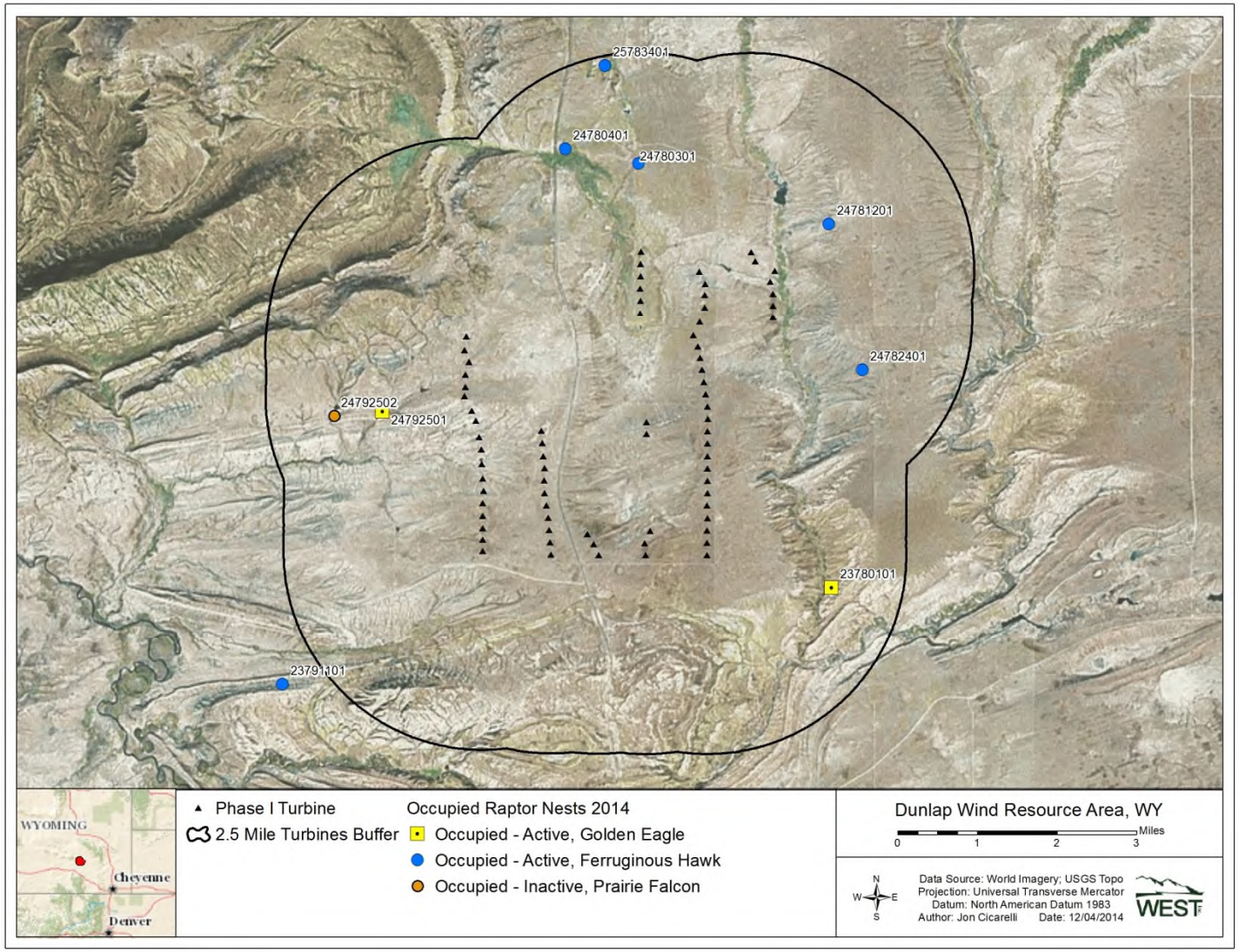

Figure 1. DWEF – 2014 Raptor Nest Surveys

NATURAL RESOURCES ◆ SCIENTIFIC SOLUTIONS

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Draft

TECHNICAL MEMORANDUM

DATE: October 28, 2015

TO: **PACIFICORP**

FROM: WEST, Inc.

RE: Dunlap – Raptor Nest Memo 2015

The following memorandum (memo) presents findings of the 2015 raptor nest surveys completed at the Dunlap Wind Energy Facility (DWEF). Two rounds of aerial (helicopter) raptor nest surveys and follow up ground surveys were completed during the 2015 nesting season. The survey area was defined as a 2.5 mile buffer from project turbines (Figure 1).

Raptor Nest Surveys

Methods

The raptor nest surveys followed the guidelines provided below. PacifiCorp discussed the methods with the USFWS prior to implementation. The surveys methods included multiple ground and aerial surveys. The objectives of the surveys were to identify potentially occupied eagle nests, track nest status throughout the nesting season, and ultimately determine nest success.

January 1 – mid-February: Informal checks were completed to verify potential territory occupation at known nest locations. A nest territory was considered potentially occupied if a pair of adults was observed in the general vicinity of the nest location. These checks were completed in coordination with other site activities (i.e., search efforts or curtailment).

Mid-February – late-March: The first round of aerial surveys was conducted on March 4, 2015 from a helicopter. The goal of the survey was to document all eagle nests (potentially new and historic) and determine if the nests were occupied. Known owl nests were targeted during this survey. One qualified WEST biologist and the helicopter pilot flew the survey area (2.5-mile

turbine buffer; Figure 1). Known nest data included previous WEST survey data and BLM nest data. Features within the survey area where nests were likely to occur (e.g., rocky outcrops, trees, man-made structures) were investigated for potential new nests.

Late-March – April: Ground checks were completed at occupied eagle nests (based on the results of the previous surveys) where access was authorized. The goal of this survey was to identify occupied eagle nests with incubating adults. Ferruginous hawks nests (historic) were also surveyed during this effort to verify potential used nest status. Surveys were triggered by the presence of an incubating adult at a highly visible nest (e.g., eagle nest visible from public road).

May: The second round of aerial survey was conducted from a helicopter on May 18, 2015. The goal of this survey was to identify chicks at occupied eagle nests (based on previous surveys) and the status of ferruginous hawk nests (assume incubating adults with eggs or chicks). This survey was conducted at least 60-days after the first aerial survey. Only eagle nests where an incubating adult was observed (unless property access did not allow a March-April check) were checked. All ferruginous hawk nests (historic and potentially new) were checked. Other raptor species were checked during this aerial survey and the nest status (i.e., incubating adult, eggs, chicks) were documented.

June – August: Ground checks were completed at eagle and ferruginous hawk nests that remained active (i.e., eggs or chicks) during previous surveys where access was authorized. The goal of this survey was to identify eagle and ferruginous hawk fledge success. Surveys were triggered by the fledge confirmation at a highly visible nest (e.g. eagle or ferruginous hawk nest visible from a public road).

Nests were named by the Township, Range, Section and a unique nest ID for each section (e.g., Township 23, Range 80, Section 29, Nest 1 = 23802901). Nest IDs remained the same for nests identified in 2014.

Results

The 2015 raptor nest survey results at DWEF are provided below (Table 1):

January 1 – mid-February: No golden eagle activity was observed near nests 23780101 or 24792501. Neither nest was considered occupied for the 2015 raptor nest season.

Mid-February – late-March (aerial survey on 3/4/15): No golden eagle activity was observed at nests 23780101 or 24792501.

Late-March – April (ground surveys 3/24/15; 4/22/15): A final ground check was completed at golden eagle nest 24792501. No golden eagle activity was observed. Access to golden eagle nest 23780101 was not authorized. A golden eagle was observed incubating on nest 24780401. Historically, this nest has been a successful ferruginous hawk nest. Ferruginous hawks were observed incubating on nests 24780301 and 24782401. Access to ferruginous hawk nest 24782401 was not authorized.

May (aerial survey on 5/18/15): A golden eagle was observed on nest 24780401. This nest is problematic to observe due to tree formation (i.e., full crown) and proximity of overhead transmission lines. Given the timing of the survey, it is likely a chick was present in the nest, but unable to be confirmed. At least one ferruginous hawk chick was observed at nest 24780301. At least two ferruginous hawk chicks were observed at nest 24781201. A ferruginous hawk was observed incubating on nest 24782401. A prairie falcon was observed incubating on nest 2479502. Four eggs were observed in prairie falcon nest 23780102.

June – August (ground surveys on 7/16/15; 7/27/15): One golden eagle fledgling was observed at nest 24780401. One ferruginous hawk fledgling was observed at nest 24780301 and 24781201. A second ferruginous hawk may have fledged at nest 24782401; however, this was not confirmed. Access to ferruginous hawk nest 24782401 was not authorized; therefore, chick production and fledge success could not be confirmed.

Summary

One golden eagle nest (24780401) was occupied and successfully fledged one young in 2015. Three ferruginous hawk nests (24780301, 24781201, and 24782401) were occupied in 2015 and at least two young successfully fledged.

Table 1. Dunlap 2015 Golden Eagle Nest Summary

Nest ID	Occupied	Successful	Comments
24792501	No	No	No golden eagle activity observed near nest in 2015
23780101	No	No	No golden eagle activity observed near nest in 2015
24780401	Yes	Yes	1 young fledged; prior to 2015 this nest has been a successful ferruginous hawk nest

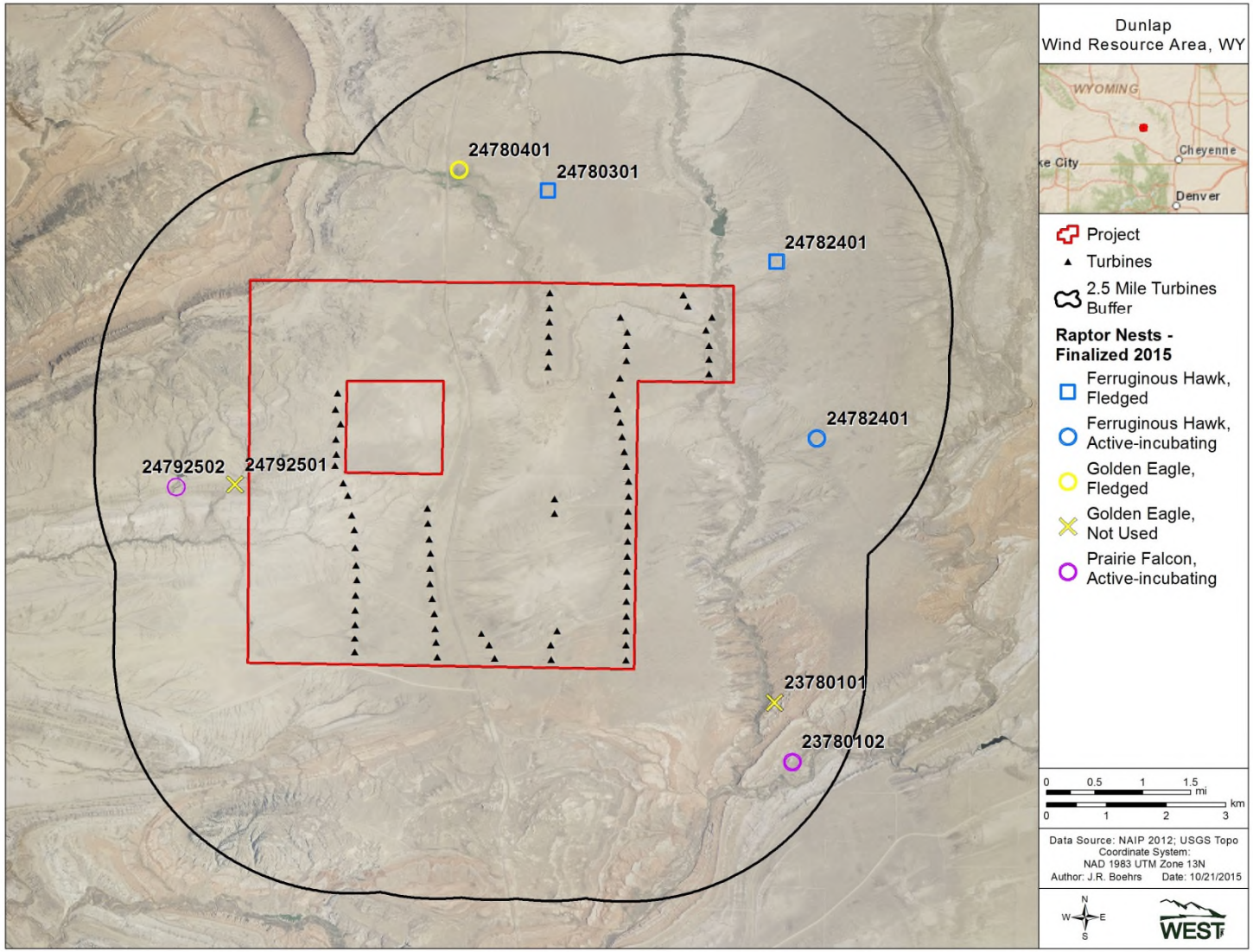

Figure 1. DWEF – 2015 Raptor Nest Surveys

Appendix G. Post-Construction Nest Memorandums

NATURAL RESOURCES ◆ SCIENTIFIC SOLUTIONS

Western **E**co**S**ystems **T**echnology, Inc. ◆ 415 W. 17th St Suite 200 ◆ Cheyenne, Wyoming 82001
Phone: 307.634.1756 ◆ Fax: 307.637.6981 ◆ Website: www.west-inc.com

Draft

TECHNICAL MEMORANDUM

DATE: November 18, 2016

TO: **PACIFICORP**

FROM: WEST, Inc.

RE: Dunlap – Raptor Nest Memo 2016

The following memorandum (memo) presents findings of the 2016 raptor nest surveys completed at the Dunlap Wind Energy Facility (DWEF). Two rounds of aerial (helicopter) raptor nest surveys and follow up ground surveys were completed during the 2016 nesting season. The survey area was defined as a 2.5 mile buffer from project turbines (Figure 1).

Raptor Nest Surveys

Methods

The raptor nest surveys followed the guidelines provided below. PacifiCorp discussed the methods with the USFWS prior to implementation. The surveys methods included multiple ground and aerial surveys. The objectives of the surveys were to identify potentially occupied eagle nests, track nest status throughout the nesting season, and ultimately determine nest success.

January 1 – mid-February: Informal checks were completed to verify potential territory occupation at known nest locations. A nest territory was considered potentially occupied if a pair of adults was observed in the general vicinity of the nest location. These checks were completed in coordination with other site activities (i.e., search efforts or curtailment).

Mid-February – late-March: The first round of aerial survey was conducted on March 8, 2016 from a helicopter. The goal of the survey was to document all eagle nests (potentially new and historic) and determine if the nests were occupied. Known owl nests were targeted during this survey. Two WEST biologists and the helicopter pilot flew the survey area (2.5-mile turbine

buffer; Figure 1). Known nest data included previous WEST survey data and BLM nest data. Features within the survey area where nests were likely to occur (e.g., rocky outcrops, trees, man-made structures) were investigated for potential new nests.

Late-March – April: Ground checks were completed at occupied eagle nests (based on the results of the previous surveys) where access was authorized. The goal of this survey was to identify occupied eagle nests with incubating adults. Ferruginous hawks nests (historic) were also surveyed during this effort to verify potential used nest status. Surveys were triggered by the presence of an incubating adult at a highly visible nest (e.g., eagle nest visible from public road).

May: The second round of aerial survey was conducted from a helicopter on May 20, 2016. The goal of this survey was to identify chicks at occupied eagle nests (based on previous surveys) and the status of ferruginous hawk nests (assume incubating adults with eggs or chicks). This survey was conducted at least 60-days after the first aerial survey. Only eagle nests where an incubating adult was observed (unless property access did not allow a March-April check) were checked. All ferruginous hawk nests (historic and potentially new) were checked. Other raptor species were checked during this aerial survey and the nest status (i.e., incubating adult, eggs, chicks) were documented.

June – August: Ground checks were completed at eagle and ferruginous hawk nests that remained active (i.e., eggs or chicks) during previous surveys where access was authorized. The goal of this survey was to identify eagle and ferruginous hawk fledge success. Surveys were triggered by the fledge confirmation at a highly visible nest (e.g. eagle or ferruginous hawk nest visible from a public road).

Nests were named by the Township, Range, Section and a unique nest ID for each section (e.g., Township 23, Range 80, Section 29, Nest 1 = 23802901). Nest IDs were initiated in 2014 and remained the same for 2016.

Results

The 2016 raptor nest survey results at DWEF are provided below (Table 1):

January 1 – mid-February: No golden eagle activity was observed near known nest sites in 2016. Previously identified eagle nests 23780101 and 24792501 were assumed to be unoccupied in 2016.

Mid-February – late-March (aerial survey on 3/8/16): No golden eagle activity was observed at nests 23780101 or 24792501.

Late-March – April (ground surveys 4/27/16 and 4/28/16): No golden eagle nesting activity was observed. Ferruginous hawk activity was observed at nest 24780401. This nest has been an active hawk and eagle nest in previous years. Ferruginous hawks were observed incubating on nests 24780301 and 24781201. Access to ferruginous hawk nest 24782401 was not authorized.

Ferruginous hawk activity was also observed at nest 23780901. This nest has been present, but not active in previous years.

May (aerial survey on 5/20/16): An incubating ferruginous hawk was observed at nests 24780401, 25783401, 24781201, 24782401, and 23780901. Two chicks were observed at ferruginous hawk nest 24780301. A dead adult ferruginous hawk was observed in nest 23791101. A great-horned owl was observed in a cliff cavity at nest 24792502. This was previously a prairie falcon nest.

June – August (ground surveys on 6/10/16, 7/1/16; 7/27/16): Multiple ferruginous hawk nests successfully fledged young in 2016. One young successfully fledged from nest 24780401; two young fledged from nest 24780301 and 24781201; three young fledged from nest 23780901. Access to ferruginous hawk nests 24782401 and 25783401 was not authorized; therefore, chick production and fledge success could not be confirmed.

Summary

No golden eagle nests were occupied in the survey area during 2016 surveys. Four ferruginous hawk nests (24780401, 24780301, 24781401, and 23780901) successfully fledge young. Two additional ferruginous hawk nests (24782401 and 25783401) were identified as active, but could not be checked for fledglings due to access restrictions.

Table 1. Dunlap 2016 Golden Eagle Nest Summary

Nest ID	Occupied	Successful	Comments
24792501	No	No	No golden eagle activity observed near nest in 2016
23780101	No	No	No golden eagle activity observed near nest in 2016

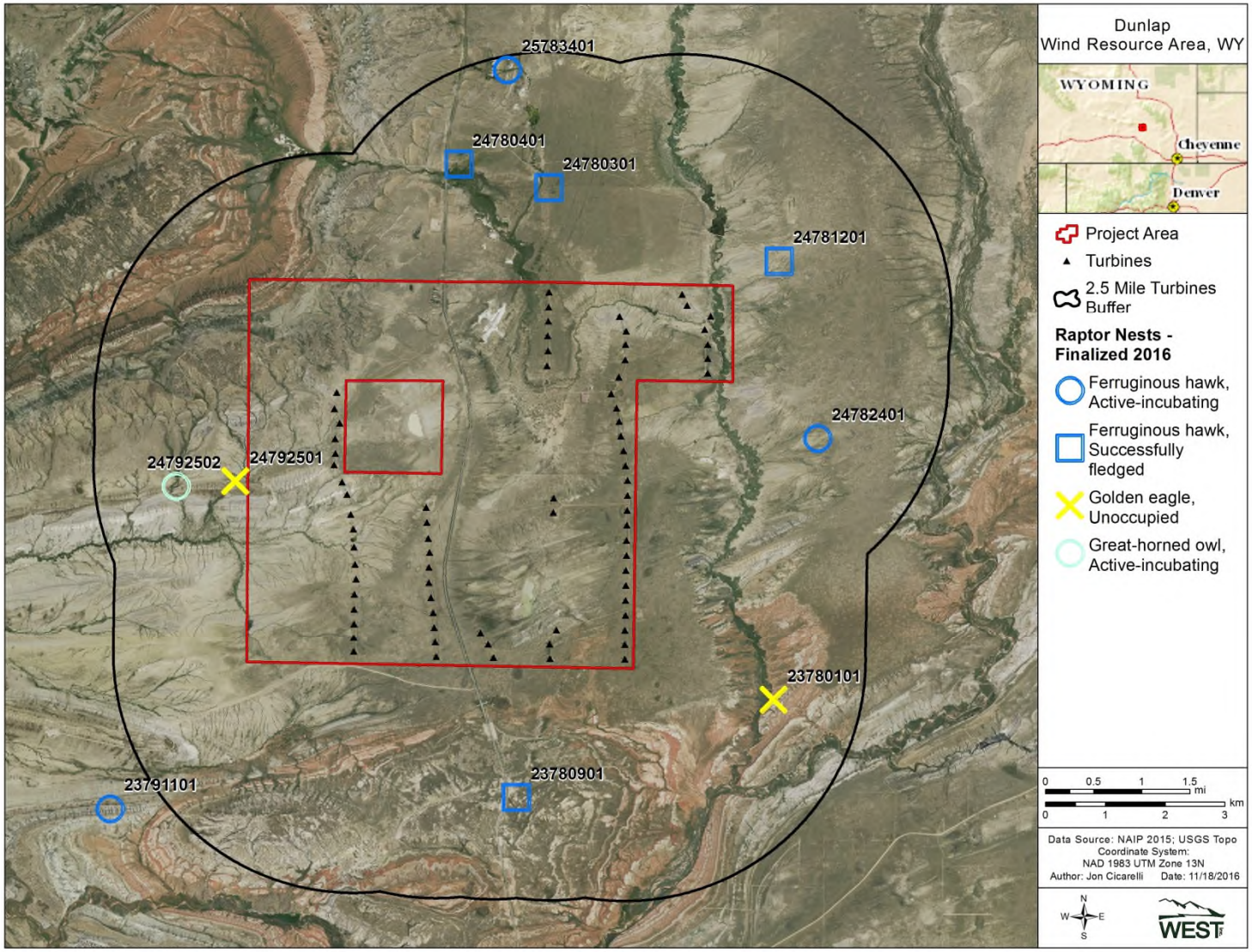

Figure 1. DWEF – 2016 Raptor Nest Surveys

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draft

TECHNICAL MEMORANDUM

Date: December 12, 2017

To: Travis Brown; PacifiCorp

From: Luke Martinson and Terri Harvey; WEST, Inc.

Subject: Dunlap – 2017 Raptor Nest Survey

Introduction

The following memorandum (memo) presents findings of the 2017 raptor nest surveys completed at the Dunlap Wind Energy Facility (DWEF). Two rounds of aerial (helicopter) raptor nest surveys and follow up ground surveys were completed during the 2017 nesting season. The survey area was defined as a 2.5-mile buffer from Project turbines (Figure 1).

Raptor Nest Surveys

Methods

The raptor nest surveys followed the guidelines provided below. PacifiCorp discussed the methods with the USFWS prior to implementation. The survey methods included multiple ground and aerial surveys. The objectives of the surveys were to identify potentially occupied eagle nests, track nest status throughout the nesting season, and ultimately determine nest success.

January 1 – mid-February: Informal checks were completed to verify potential territory occupation at known nest locations. A nest territory was considered potentially occupied if a pair of adults was observed in the general vicinity of the nest location. These checks were completed in coordination with other site activities (i.e., search efforts).

Mid-February – late-March: The first round of aerial survey was conducted on March 2, 2017 from a helicopter. The goal of the survey was to document all eagle nests (potentially new and

historic) and determine if the nests were occupied. Known owl nests were also targeted during this survey. Two WEST biologists and the helicopter pilot flew the survey area (2.5-mile turbine buffer; Figure 1). Known nest data included previous WEST survey data and BLM nest data. Features within the survey area where nests were likely to occur (e.g., rocky outcrops, trees, man-made structures) were investigated for potential new nests.

Late-March – April: Ground checks were completed at occupied eagle nests (based on the results of the previous surveys) where access was authorized. The goal of this survey was to identify occupied eagle nests with incubating adults. Ferruginous hawks nests (historic) were also surveyed during this effort to verify potential used nest status. Surveys were triggered by the presence of an incubating adult at a highly visible nest (e.g., eagle nest visible from public road).

May: The second round of aerial survey was conducted from a helicopter on May 8, 2017. The goal of this survey was to identify chicks at occupied eagle nests (based on previous surveys) and the status of ferruginous hawk nests (assume incubating adults with eggs or chicks). This survey was conducted at least 60 days after the first aerial survey. Only eagle nests where an incubating adult was observed (unless property access did not allow a March-April check) were checked. All ferruginous hawk nests (historic and potentially new) were checked. Other raptor species were checked during this aerial survey and the nest status (i.e., incubating adult, eggs, chicks) were documented.

June – August: Ground checks were completed at eagle and ferruginous hawk nests that remained active (i.e., eggs or chicks) during previous surveys and where access was authorized. The goal of this survey was to identify eagle and ferruginous hawk fledge success. Surveys were triggered by the fledge confirmation at a highly visible nest (e.g. eagle or ferruginous hawk nest visible from a public road).

Nests were named by the Township, Range, Section and a unique nest ID for each section (e.g., Township 23, Range 80, Section 29, Nest 1 = 23802901). Nest IDs were initiated in 2014 and remained the same for 2017.

Results

The 2017 raptor nest survey results at DWEF are provided below (Table 1):

January 1 – mid-February 2017 (ground surveys 2/20/17): No activity was observed at previously identified eagle nest 23780101. On 2/20/17 an adult golden eagle was observed flying through the area near nest 24792501; however, the eagle did not approach or land near the nest.

Mid-February – late-March (aerial survey on 3/2/17): No golden eagle activity was observed at nests 23780101 or 24792501. Both nests were assumed to be unoccupied in 2017. No activity was detected at any ferruginous hawk nests during this survey round.

Late-March – April (ground surveys 4/14/17 and 4/17/17): No golden eagle nesting activity was observed at nest 24792501. Access was not authorized to golden eagle nest 23780101. Incubating adults were observed at ferruginous hawk nests 24781001 and 23780901. Flooding prohibited access to ferruginous hawk nest 24781201, but observation from a distance with binoculars and spotting scope indicated an incubating adult. A ferruginous hawk was observed perched on the ground about a kilometer away from nest 24780401 and later in the morning an adult was observed on the nest. An adult ferruginous hawk was observed landing on nest 25783401. Access to ferruginous hawk nest 24782401 was not authorized and status could not be determined.

May (aerial survey on 5/8/17): No activity or evidence of nesting was observed at golden eagle nests 23780101 or 24792501. Incubating ferruginous hawks were observed at nests 24780401, 25783401, 24781201, 24782401, 24781001, and 23780901. Four prairie falcon eggs were observed in nest 23780102.

June – August (ground surveys on 6/9/17 and 7/10/17): On 6/9/17 ferruginous hawk nest 23780901 was empty. A single ferruginous hawk of indeterminate age was in the area, making short flights from rock to rock. Considering the stage of other nests in the area, it is unlikely this was a fledgling. This nest is assumed to have failed. Three ferruginous hawk nests successfully fledged young in 2017. Three young successfully fledged from nest 24781201 and 24781001 and one young from nest 24780401. Access to ferruginous hawk nest 25783401 is restricted to viewing from the highway which limited viewing opportunities. Nest success could not be confirmed. Access to ferruginous hawk nest 24782401 was not authorized and therefore success could not be verified at this nest.

Summary

No golden eagle nests were occupied in the survey area during 2017 surveys. Three ferruginous hawk nests (24781201, 24780401, and 24781001) successfully fledged young; one ferruginous hawk nest (23780901) was assumed to have failed; and two ferruginous hawk nests (25783401 and 24782401) could not be monitored due to access restrictions. One prairie falcon nest was observed to contain eggs.

Table 1. Dunlap 2017 Golden Eagle Nest Summary

Nest ID	Occupied	Successful	Comments
24792501	No	No	No golden eagle activity observed near nest in 2017
23780101	No	No	No golden eagle activity observed near nest in 2017

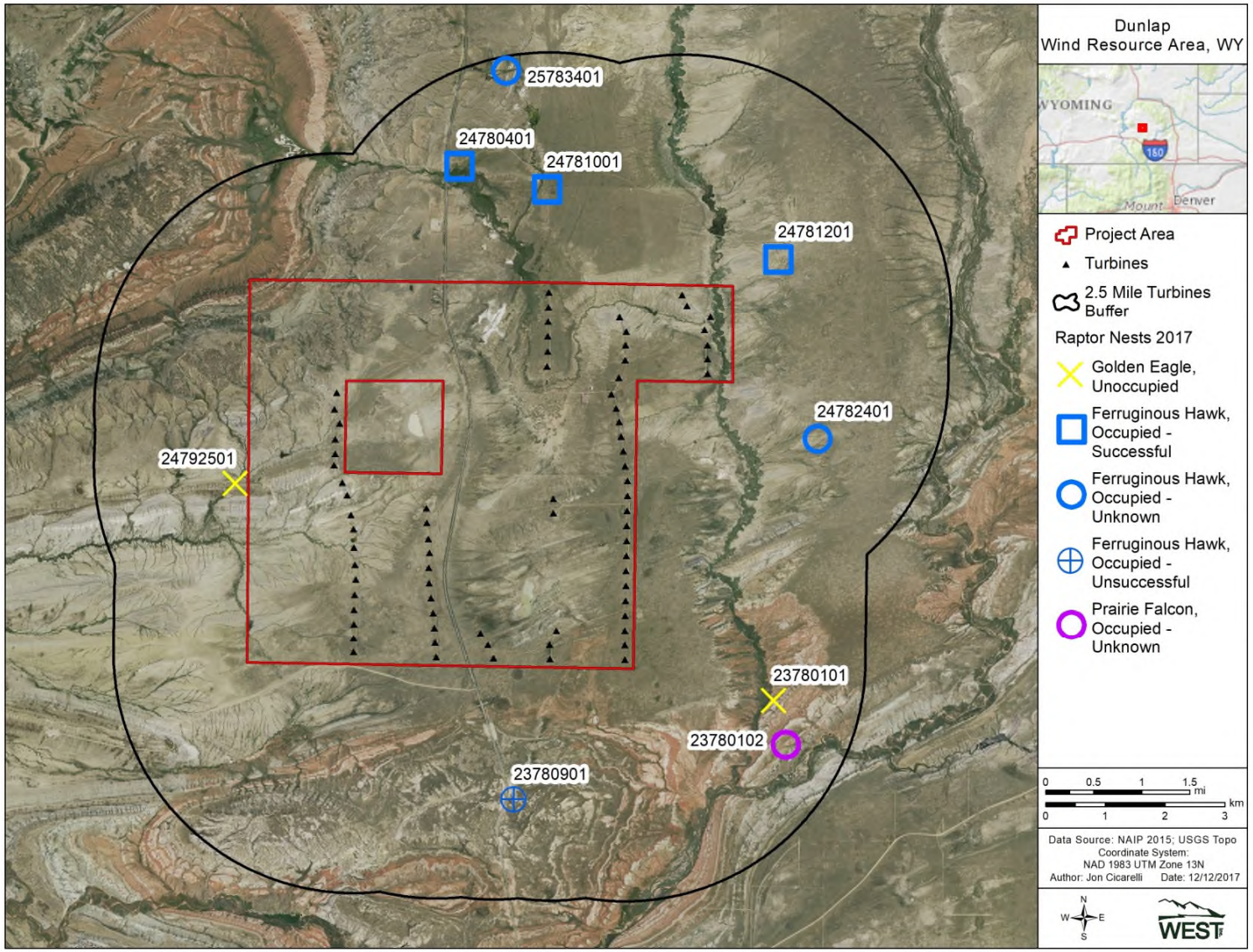

Figure 1. DWEF – 2017 Raptor Nest Survey