APPENDIX K: BIOLOGICAL REPORTS (REVISED)

Redacted
EFSEC redaction code 13:
Fish and wildlife:
Sensitive fish and wildlife
data. RCW 42.56.430

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22. 2021 WDFW Data Request Regarding Potential Impacts to Pronghorn from Wind and Solar Energy Development at the Horse Heaven Clean Energy Center, Benton County, Washington (Tetra Tech and WEST 2021)
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27. 2023 2023 Raptor Nest Surveys for the Horse Heaven Clean Energy Center, Benton County, Washington (Jansen 2023b) [redacted]

ENVIRONMENTAL & STATISTICAL CONSULTANTS

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DATE: August 17, 2017 *Public Draft - For Distribution*

TO: Horse Heaven Wind Farm, LLC

FROM: Erik Jansen, Western Ecosystems Technology, Inc.

RE: 2017 Raptor Nest Survey Report for the proposed Horse Heaven Wind Project, Benton County, Washington.

Introduction

Horse Heaven Wind Farm, LLC (Horse Heaven) is developing the proposed Horse Heaven Wind Project (Project) in Benton County, Washington. Western Ecosystems Technology, Inc. (WEST) was contracted by Horse Heaven to conduct aerial raptor nest surveys within the Project and surrounding area. Surveys for nests of all raptor species were conducted within a 2-mile (mi; 3.2-kilometer [km]) buffer of the Project, while surveys specifically for bald eagle (*Haliaeetus leucocehalus*) and golden eagle (*Aquila chrysaetos*) nests were conducted within a 10-mi (16-km) buffer of the Project (Survey Area). The initial aerial survey was conducted in late March, 2017, with a follow-up survey completed in early May. This memorandum summarizes the characteristics of the Survey Area, survey methodology, and results of the 2017 raptor nest surveys at the Project.

Survey Area

The Survey Area was developed by buffering the Project boundary by 2-mi and 10-mi in a Geographic Information System (GIS). The Survey Area consisted of the Project and surrounding buffers, which included portions of Benton and Franklin Counties, Washington (Figure 1). The Project is located within the Horse Heaven Hills which is an anticline ridge of the Yakima Folds within the larger Columbia Plateau Ecoregion (Clarke and Bryce 1997). Topography within the Project is composed primarily of rolling to incised hills with a broad northeast-facing rampart along the northern perimeter of the Project boundary (Figure 2). The highly-eroded drainages along the rampart expose basalt cliffs and ledges that are suitable for nesting raptors. Isolated trees and small tree stands are found along drainage bottoms also provide nesting habitat. On the southern side of the rampart, the landscape transitions to relatively rolling topography with shallow, meandering canyons that drain south into the Columbia River. The Yakima River and Columbia River are located along the edges of the Survey Area and contain trees and cliffs suitable for nesting raptors.

Land cover within the Survey Area is a mosaic of dryland and irrigated agriculture, shrub-steppe grasslands, and rural/urban development (Figure 2). Agriculture crop is the dominate land cover throughout the Project and surrounding Survey Area. Shrub-steppe grasslands are found in topographically steep areas where agriculture was not possible. A third of the Survey Area contains rural/urban development including portions of the tri-cities metro area (Richmond, Kennewick and Pasco), Benton City and unincorporated rural areas. Much of the Survey Area is privately owned and actively managed for agriculture and livestock grazing. The 63 wind turbine Nine Canyon Wind Project is located directly to the east of the proposed Project.

Methods

Prior to aerial surveys, WEST conducted a literature search (Kalasz and Buchanan 2016) and coordinated with Washington Department of Fish and Wildlife (WDFW) biologists to identify previously documented raptor nests in the Survey Area and to review survey protocol.

Two rounds of double-observer (i.e., a primary and secondary observer) aerial nest surveys, flown/completed at least 30 days apart, were conducted in a Robinson R-44 Raven II helicopter with bubble windows that provided excellent visibility (Pagel et al. 2010, USFWS 2013). The first aerial survey was conducted by two qualified WEST biologists on March 31, 2017 and a follow-up survey occurred on May 10, 2017. The initial survey was conducted during a time period that overlapped the primary early nesting period of eagles in the Pacific Northwest, when breeding pairs are exhibiting courtship, nest-building, and/or incubation behaviors. The follow-up survey was performed at a time when eagles and other raptors are actively engaged in mid- to late breeding season reproductive activities (e.g., incubating, brooding, feeding nestlings), and when raptors engaged in ongoing nesting activities would be reliably on or around nests.

During the first survey, coverage included the 10-mi buffer around the Project and utilized an intuitive controlled survey method. Intuitive controlled surveys focused on areas with the highest potential to support raptor nests including cliffs, rock outcrops, incised drainages and canyons, and large trees. During the second survey, WEST biologists revisited previously located raptor nests to evaluate reproductive nesting status and revisited high-quality nesting habitat to search for new nests and later nesting raptor species (e.g., Swainson's hawk [*Buteo swainsoni*]).

During surveys, the helicopter was positioned to allow thorough visual inspection of all appropriate habitat features. In general, the helicopter maintained a distance of at least 20 meters (m; 66 feet [ft]) from cliff faces and nests (Pagel et al. 2010). When nests were located, the helicopter reduced speed and adjusted flight track to allow for a clear view of the nest for documentation and photographing. For each nest or group of nests, a Global Positioning System (GPS) location was recorded, a photograph was taken, and nest attribute data were collected (Table 1). A group of nests was defined as two or more nests that occurred on the same tree, shelf, or cliff face within close proximity to one another (e.g., approximately 25 m [80 ft]).

WEST categorized basic nesting territories and nest use following Steenhof and Newton (2007). Nesting territories were classified as occupied if any of the following were observed at the nest structure: (1) an adult in an incubating position, (2) eggs, (3) nestlings or fledglings, (4) occurrence of an adult (or, sometimes sub-adult), (5) a newly constructed or refurbished stick nest in the area where territorial behavior of an eagle had been observed early in the breeding season, or (6) a recently repaired nest with fresh sticks (clean breaks) or fresh boughs on top, and/or droppings and/or molted feathers on its rim or underneath. A nesting territory that is not occupied is termed unoccupied. Nests within occupied territories were further classified as “active” if an egg or eggs had been laid or nestlings were observed, or “inactive” if no eggs or chicks were present. Although territories considered occupied often have active nests, nests that were once active may become inactive due to abandonment or nest failure (i.e., territory status may change from unoccupied to occupied, but may not change from occupied to unoccupied in a season; however, nest status may change from inactive to active or vice versa in a season). If an adult was on the nest during the first survey but the previously-occupied nest was vacant during the second survey, the nest status was defined as “unknown.”

Results

A total of 21 raptor nests were located within the Survey Area in 2017. One bald eagle (Nest 18) was located at the confluence of the Yakima River and Columbia River and adjacent to State Highway 240 and several nature preserves approximately 7.7 miles northeast of the Project (Photo 1). The nest contained one chick approximately 21 days old at the time of the second survey (April 30).

Of the 21 nests documented, 11 had territory occupancy and eight (72 percent) had signs of active nesting. Two occupied ferruginous hawk (*B. regalis*) nests were documented during surveys, of which, one adult was sitting on Nest 3 during both surveys and is assumed active. Nest 3 was located in a [redacted]. The occupied inactive ferruginous hawk nest (Nest 8) had one adult standing on top of the nest during the first survey and was in good condition (Table 1, Photo 2). Seven additional unoccupied inactive nests were characteristic of nests built by ferruginous hawks and found within two miles of the Project. These unoccupied, inactive nests were located on the ground (n = 6 nests) and cliff ledge (n = 1 nest) and had the size and form typical of ferruginous hawk construction. Five of the nests were in poor to fair condition, indicating no recent maintenance or nesting activities had occurred and were most likely old territories (Photo 3). An adult ferruginous hawk was flushed from the ground and observed in flight, but could not be attributed to a particular nest (Photo 4).

Of the four red-tailed hawks (*B. jamaicensis*) that were observed on the nest during the first survey, three nests contained one to two chicks between 14–21 days old during the second survey (Nest 1, Nest 9, and Nest 12). The fourth nest observed with a red-tailed hawk during the first survey did not contain sign of nesting during the second survey and was considered occupied inactive.

Two great-horned owls (*Bubo virginianus*) were observed nesting within 2 miles of the Project. One of the nests (Nest 14) had an adult incubating on the nest during the first survey and two owlets standing adjacent to the nest during the second survey. One additional nest (Nest 2) had an adult owl sitting on the nest during the first survey with two red-tailed hawks perched on an adjacent tree. The nest was abandoned by the second survey with no sign of nesting activity.

One occupied active Swainson's hawk nest was observed during the second survey near the center of the Project. The nest was vacant during the first survey and is presumed the adult arrived between the first and second surveys. No eggs or young were observed but the adult remained sitting tight on the nest.

While not a raptor per se, one common raven (*Corvus corax*) nest (Nest 6) was recorded because ravens and raptors are known to use similar-sized nests. The nest was located in the center of the Project on top of an old windmill and had an adult on the nest during the first and second surveys.

The remaining 3 unoccupied nests (Nest 5 and Nest 20) were located in trees within the Project. Two nests were located within the tree at Nest 5 and one at Nest 20. Neither nest(s) location had sign of territory occupancy or nesting activity during either survey.

In Washington, the bald eagle is considered a federal and state species of concern[1] (USFWS 2008, WDFW 2013) and protected by the Migratory Bird Treaty Act (MBTA)[2] and Bald and Golden Eagle Protection Act (BGEPA)[3]. Similarly, in Washington the ferruginous hawk is considered a federal species of concern (USFWS 2008) but is also listed as state threatened[4] due to population declines (WDFW 2013). The red-tailed hawk, great-horned owl, Swainson's hawk and common raven are species protected under the MBTA.

[1] In Washington, a sensitive species is defined as a native species that is vulnerable or declining and is likely to become endangered or threatened in a significant portion of its range within the state without cooperative management or removal of threats (Washington Administrative Code [WAC] 232-12-011).

[2] As defined in 50 Code of Federal Regulation (CFR) §20.11

[3] As defined in 50 CFR §21.11

[4] In Washington, a threatened species is defined as a native species that is likely to become endangered within the foreseeable future throughout a significant portion of its range within the state without cooperative management or removal of threats (WAC 232-12-011).

[REDACTED DUE TO SENSITIVE INFORMATION]

Figure 1. Survey area and raptor nest locations documented during aerial surveys of Horse Heaven, March and April, 2017.

[REDACTED DUE TO SENSITIVE INFORMATION]

Figure 2. Aerial photograph and raptor nest locations documented during aerial surveys of Horse Heaven, March and April, 2017.

Table 1. Final 2017 raptor nest results for aerial surveys conducted February 22 and April 30 at the proposed Horse heaven Wind Project, Washington. Coordinates UTM Z11N.

Nest ID	Species	Territory Status	Breeding Status	Nest Substrate	Easting	Northing	Comment
01	Red-tailed Hawk	Occupied	Active	Tree	[redacted]	[redacted]	Adult on nest first survey; one chick approximately 14-day old chick on nest second survey
02	Great-horned Owl	Occupied	Unknown	Tree	[redacted]	[redacted]	Adult GHOW on nest first survey, two RTHA perched on adjacent tree; No sign of nesting or adults second survey
03	Ferruginous Hawk	Occupied	Active	Tree	[redacted]	[redacted]	Adult perched on nest first survey; adult sitting in nest second survey
04	Unknown Raptor	Unoccupied	Inactive	Ground	[redacted]	[redacted]	Characteristic of ferruginous hawk nest; large nest in fair condition; no sign of nesting either survey
05	Unknown Raptor	Unoccupied	Inactive	Tree	[redacted]	[redacted]	Two nests located in one tree; no sign of nesting either survey
06	Common Raven	Occupied	Active	Windmill	[redacted]	[redacted]	Adult on nest first and second survey
07	Red-tailed Hawk	Occupied	Inactive	Tree	[redacted]	[redacted]	Adult on nest first survey; no sign of nesting of adult observed second survey
08	Ferruginous Hawk	Occupied	Inactive	Ground	[redacted]	[redacted]	Adult on nest first survey; no sign of nesting of adult observed second survey
09	Red-tailed Hawk	Occupied	Active	Tree	[redacted]	[redacted]	Adult on nest first survey; two chicks approximately 21-day old second survey; cottonwood tree

Table 1. Final 2017 raptor nest results for aerial surveys conducted February 22 and April 30 at the proposed Horse heaven Wind Project, Washington. Coordinates UTM Z11N.

Nest ID	Species	Territory Status	Breeding Status	Nest Substrate	Easting	Northing	Comment
10	Unknown Raptor	Unoccupied	Inactive	Ground	[redacted]	[redacted]	Characteristic of ferruginous hawk nest; nest poor condition, no recent maintenance
11	Unknown Raptor	Unoccupied	Inactive	Ground	[redacted]	[redacted]	Characteristic of ferruginous hawk nest; nest poor condition, no recent maintenance
12	Red-tailed Hawk	Occupied	Active	Cliff	[redacted]	[redacted]	Adult on nest first survey; one chick approximately 21-day old second survey
13	Unknown Raptor	Unoccupied	Inactive	Ground	[redacted]	[redacted]	Characteristic of ferruginous hawk nest; nest poor condition, no recent maintenance
14	Great-horned Owl	Occupied	Active	Tree	[redacted]	[redacted]	Adult on nest first survey; two young owls (branchlets) standing in tree adjacent to nest second survey
15	Unknown Raptor	Unoccupied	Inactive	Cliff	[redacted]	[redacted]	Characteristic of ferruginous hawk nest; nest poor condition, no recent maintenance
16	Unknown Raptor	Unoccupied	Inactive	Ground	[redacted]	[redacted]	Characteristic of ferruginous hawk nest; nest fair condition, no recent maintenance
17	Unknown Raptor	Unoccupied	Inactive	Ground	[redacted]	[redacted]	Characteristic of ferruginous hawk nest; nest good condition, no recent maintenance
18	Bald Eagle	Occupied	Active	Tree	[redacted]	[redacted]	Adult on nest first survey, mate perched in tree adjacent to river; One chick approximately 21-day old second survey

Table 1. Final 2017 raptor nest results for aerial surveys conducted February 22 and April 30 at the proposed Horse heaven Wind Project, Washington. Coordinates UTM Z11N.

Nest ID	Species	Territory Status	Breeding Status	Nest Substrate	Easting	Northing	Comment
19	Swainson's Hawk	Occupied	Active	Tree	[redacted]	[redacted]	Not observed first survey; adult on nest second survey
20	Unknown Raptor	Unoccupied	Inactive	Tree	[redacted]	[redacted]	Not observed first survey; no sign of nesting or adults observed second survey

[1] Occupied = 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; Unoccupied = no sign of nesting or territory occupancy in the current nesting season; DNLO = did not locate during surveys

[2] Active = eggs or young observed within nest at the time of survey; Inactive = no adults, eggs or young observed within nest at time of survey; Unknown = unknown breeding status

[REDACTED DUE TO SENSITIVE INFORMATION]

Photo 1. Bald eagle on Nest 18 along the Columbia River. Adult on nest. Photo March 30, 2017.

[REDACTED DUE TO SENSITIVE INFORMATION]

Photo 2. Occupied inactive ferruginous hawk Nest 8. Adult observed standing on nest during second survey. Photo March 30, 2017.

[REDACTED DUE TO SENSITIVE INFORMATION]

Photo 3. Example of an unoccupied inactive nest, characteristic of a ferruginous hawk. Nest 4 was in fair condition with slumping around the nest bowl and no sign of nesting during either survey. Photo March 30, 2017.

Photo 4. Adult ferruginous hawk in flight, flushed from ground during the first survey March 30, 2017.

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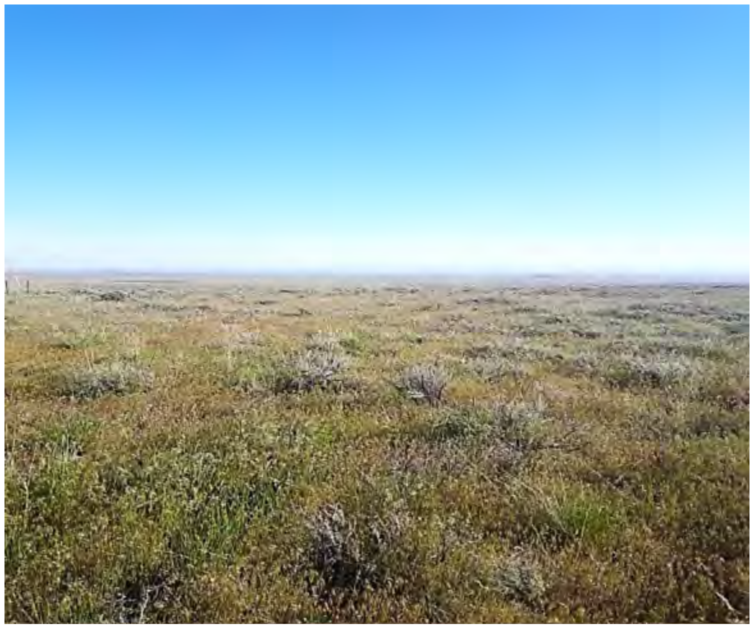
Wildlife Survey Report for the Horse Heaven Wind Project Benton County, Washington

Final Report

August 2017 – July 2018



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October 2018
(Revised)

EXECUTIVE SUMMARY

Horse Heaven Wind Farm, LLC is developing the proposed Horse Heaven Wind Energy Project (Horse Heaven and/or Project) in Benton County, Washington. Western EcoSystems Technology, Inc. (WEST) was contracted to conduct biological baseline studies at the Project which included avian use surveys, raptor nest surveys, and a landcover assessment. Additionally, observations of rare and sensitive species were documented incidental to protocol wildlife surveys. This report summarizes the methodology and results of field surveys conducted at Horse Heaven during 2017–2018. Research at the Project was designed to help address the questions posed under Tier 3 of the US Fish and Wildlife Service (USFWS) Land-Based Wind Energy Guidelines and Stage 2 of the Eagle Conservation Plan Guidance document. The principal objective of the study was to provide site-specific bird and landcover data that would be useful to evaluate potential impacts from the proposed wind energy facility. Field surveys included 1) fixed-point surveys for small and large birds, 2) raptor nest surveys, and 3) landcover mapping.

The Project is located in the Columbia Plateau Ecoregion and comprised predominantly of agriculture (73%) followed by grassland (25%), and shrub-steppe (2%). Fixed-point bird surveys estimated the seasonal, spatial, and temporal use patterns of birds within the Project. Fixed-point surveys were conducted at 13 points twice a month for one full year (August 11, 2017 – July 16, 2018). Point counts included 10-minute surveys for small birds within a 100-m radius plot followed by 60-minute surveys large birds within an 800-meter radius plot. Raptor nest surveys were conducted within 10 miles of the Project from helicopter and by ground during the 2017 and 2018 nesting seasons. Dominant landcover within the Project was classified and mapped using remotely sensed data and field-verified.

A total of 322 surveys of each survey type (i.e., small bird and large bird) were conducted during 25 survey rounds. Passerines comprised the majority of avian use during small bird use surveys, which was highest during winter (10.85 birds/100-m plot/10-min) similar between spring and fall (5.17 and 5.14 birds/100-m plot/10-min, respectively) and were lowest during summer with 4.87 birds/100-m plot/10-min. Horned lark and western meadowlark accounted for 85.8% of the 2,205 total birds observed. One observation of a sagebrush sparrow, a state candidate species for listing, was documented during spring.

Observations of waterbirds, specifically sandhill crane, had the greatest influence on overall large bird use which was highest in spring (11.69 birds/800-m plot/60-min survey), followed by fall (9.03 birds/800-m plot/60-min survey), winter (8.56 birds/800-m plot/60-min survey), and lowest in summer (2.48 birds/800-m plot/60-min survey). Sandhill crane was the most frequently observed waterbird which consisted of 8 groups of 552 individuals that was highest during spring (5.03 birds/800-m/60-min) followed by fall (1.56 birds/800-m/60-min). No cranes were observed landing in the Project and typically flew above the RSH (90%). Avoidance behaviors by cranes at operational wind facilities suggest that collision risk would be low. In addition to sandhill crane, several sensitive large bird species were documented during surveys and

include American white pelican, bald and golden eagle, and ferruginous hawk. Based on low use and flight behavior (e.g., exposure rate), collision risk for these species is thought to be low.

Based on species composition of the most common raptor fatalities at other wind energy facilities and species composition of raptors observed at the Project during the surveys, the majority of the fatalities of diurnal raptors may consist of Swainson's hawk, red-tailed hawk, American kestrel and northern harrier. It is expected that risk to raptors would be unequal across seasons, with the highest risk during spring and summer.

Three golden eagles were observed flying within the 800-m survey plot and below 200-m above ground level (AGL) for a total of 35 eagle minutes. A fourth golden eagle was observed outside the survey plot (approximately 1–2 km) and was recorded as an incidental observation. One of the three eagle observations was of an adult for 30 eagle minutes. The individual was circling low and calling; likely influenced by the presence of the surveyor. Golden eagles were documented during the spring and fall migration. Two bald eagles were observed flying with the 800-m survey plot and below 200-m AGL for six eagle minutes. Bald eagles were documented only during winter. No roosts or concentrations of eagles were noted during surveys. Based on low eagle use at the Project (2–3 observations during 322 survey hours), intermittent sources of prey and no nesting habitat in proximity to the project, collision risk to bald and golden eagles appears low.

Of the 33 raptor nests documented within 10-miles of the Project in 2018, 21 nests were previously documented during aerial surveys conducted in 2017. The difference in the number of nests among years was attributed primarily to an increase of red-tailed hawk and Swainson's hawk nests within and adjacent to the Project; of which several nests were discovered later in the year after aerial surveys were completed. Species of note included a nesting bald eagle located approximately 7.7 miles northeast of the Project and a ferruginous hawk nesting in a tree within the Project during both survey years. Nesting habitat within the project consists of small, isolated tree stands along drainage bottoms and associated with buildings/farmsteads. Steep, rocky drainages bisect the broad escarpment that borders the Project to the northeast and contains suitable ferruginous hawk nest habitat.

Landcover at the Project is consistent with the matrix of agriculture and grasslands commonly found in the region. Native shrub-steppe was highly fragmented with small patches scattered throughout the Project.

STUDY PARTICIPANTS

Western EcoSystems Technology, Inc.

Erik Jansen	Project Manager
Samantha Brown	Report Writer
Ray Tupling	Statistician
Jean Paul Wilson	Data Analyst
Carissa Goodman	Data Manager
Kori Hutchinson	Field Supervisor
Joshua Parrot	Field Biologist
Kelsey Lotz	Field Biologist

REPORT REFERENCE

Jansen, E. W. and S. R. Brown. 2018. Wildlife Survey Report for the Horse Heaven Wind Project, Benton County, Washington. Final Report: August 11, 2017 – July 16, 2018. Prepared for Horse Heaven Wind Farm, Boulder Colorado. Prepared by Western EcoSystems Technology, Inc. (WEST), Corvallis, Oregon.

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NOTES ON UNITS

Imperial Units are used throughout this document, with the exception of the use of meters when describing avian use survey methodology, where metric is used to be consistent with guidelines. Conversions are provided below.

Unit Conversions

Imperial	Metric
1 foot	0.3048 meter
3.28 feet	1 meter
1 mile	1.61 kilometer
0.621 mile	1 kilometer
1 acre	0.40 hectare
2.47 acre	1 hectare
Common Conversions	
Imperial	**Metric**
0.06 miles	100 meters
0.12 miles	200 meters
0.5 miles	800 meters
10 miles	16.1 kilometers

INTRODUCTION

Horse Heaven Wind Farm, LLC is developing the proposed Horse Heaven Wind Energy Project (Horse Heaven and/or Project) in Benton County, Washington. Western EcoSystems Technology, Inc. (WEST) was contracted to conduct biological baseline studies at the Project starting in August 2017 which included avian use surveys, raptor nest surveys, and a landcover assessment. Additionally, observations of rare and sensitive species were documented incidental to protocol wildlife surveys. This report summarizes the methodology and results of field surveys conducted at Horse Heaven during August 2017 through July 2018.

Research at the Project was designed to comply with recommendations described by the Washington Department of Fish and Wildlife (WDFW) Wind Power Guidelines (WDFW 2009), Tier 3 of the US Fish and Wildlife Service (USFWS) Land-Based Wind Energy Guidelines (USFWS 2012), Stage 2 of the Eagle Conservation Plan Guidance (USFWS 2013) and associated Final Eagle Rule (USFWS 2016).

The principal objectives of the study were to: 1) provide site-specific bird data that would be useful to evaluate potential impacts from the proposed wind energy facility, and 2) identify and delineate landcover within the Project to identify potentially suitable habitat for state or federally-listed threatened, endangered or sensitive species, and inform potential WDFW mitigation calculations (WDFW 2009).

PROJECT AREA

The 25,815 acre (40.3 mi^2) Project area is located in Benton County, Washington, located within the Horse Heaven Hills which is an anticline ridge of the Yakima Folds within the larger Columbia Plateau Ecoregion (Clarke and Bryce 1997). Topography within the Project is composed primarily of rolling to incised hills with a broad northeast-facing rampart along the northern perimeter of the Project boundary (Figure 1). The highly-eroded drainages along the rampart create numerous canyons that bisect the Project (Badger Canyon, Coyote Canyon, Taylor Canyon) and expose basalt cliffs and ledges. On the southern side of the rampart, the landscape transitions to relatively rolling topography with shallow, meandering canyons that drain south into the Columbia River.

Land cover within the Project area is a mosaic of dryland and irrigated agriculture, shrub-steppe grasslands, and rural/urban development (Figure 1). Agriculture crop is the dominate land cover throughout the Project and surrounding area. Shrub-steppe grasslands are found in topographically steep areas where agriculture was not possible. Much of the Project area is privately owned and actively managed for dryland agriculture and livestock grazing. The 63 wind turbine Nine Canyon Wind Project is located directly to the east of the proposed Project.

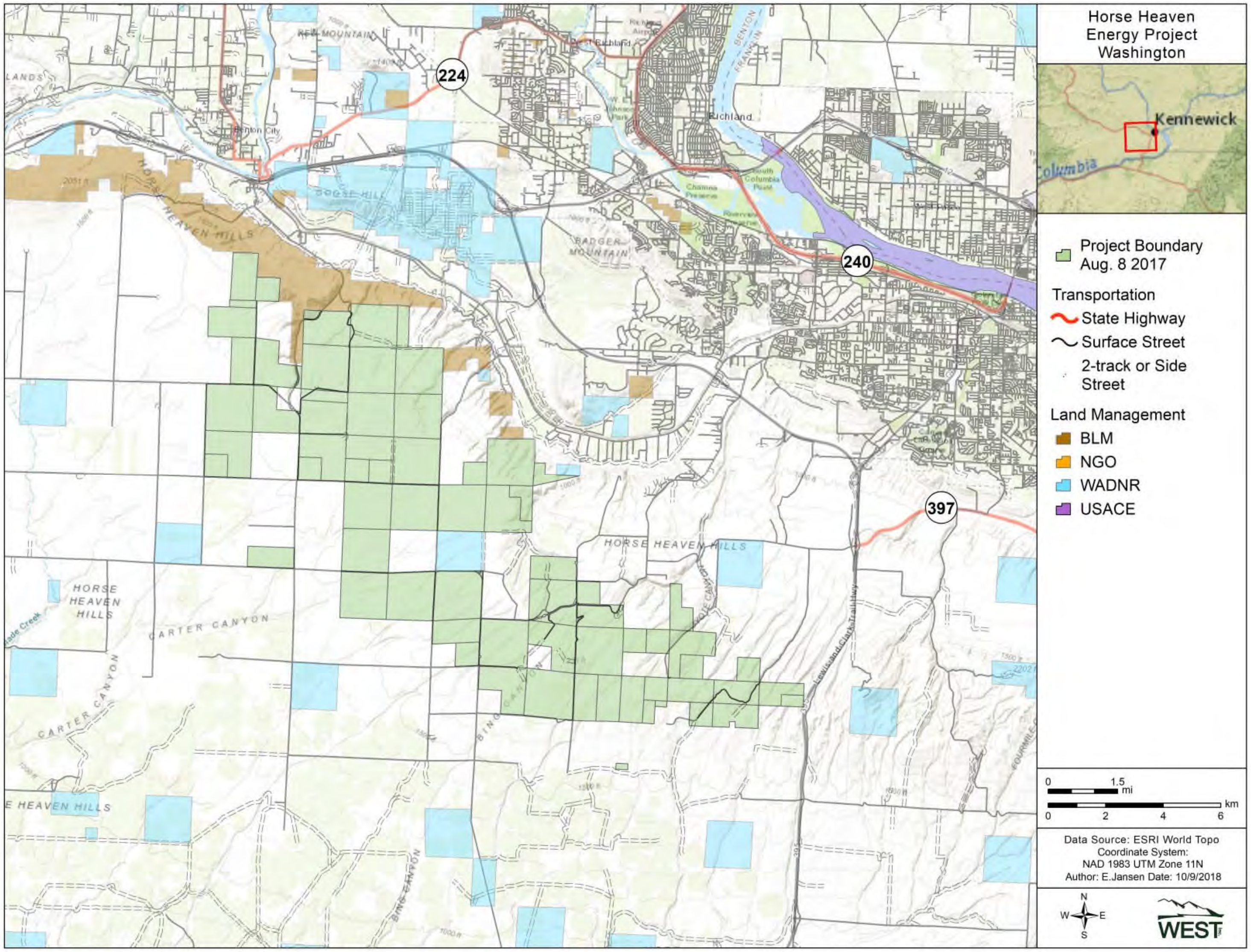

Figure 1. Regional features surrounding the Horse Heaven Wind Project, Benton County, Washington.

METHODS

The study at the Project consisted of the following: 1) fixed-point avian use surveys, 2) aerial raptor nest surveys, 3) landcover mapping, and 4) incidental wildlife observations. Prior to surveys, field survey protocols were reviewed with biologists from the WDFW and USFWS at an in-person meeting in Portland, Oregon on September 19, 2017 and through written comments on September 21, 2017.

Fixed-Point Bird Use Surveys

Survey Design

The USFWS describes survey guidelines in the Eagle Conservation Plan Guidance (ECPG; USFWS 2013), and has codified those guidelines into standards in the recent Final Rule (USFWS 2016; 50 CFR Parts 13 and 22, §22.26). The standards specify the protocols for station establishment, level of survey effort, and data collection related to bald and golden eagles. Because of their specificity, these standards were used to structure the survey design and sampling effort, to the extent possible, for all avian surveys. Data collection for all surveys used commonly-used survey methods (Ralph et al. 1993) and followed protocols specified in USFWS 2016 for eagles, specifically.

Fixed-point count stations were established by placing a point nearest to the farthest western proposed turbine location, then picking from a list of randomly-generated numbers that corresponded to a proposed turbine location. Numbers were discarded and redrawn if 800-m radius survey plots substantially overlapped (e.g., >50%). Point placement was microsited (e.g., minor shifts of approximately 100 m) in the field to maximize the surrounding viewshed and were placed on publically accessible roads. A total of 13 survey points were established within the proposed Project area to comply with ECPG recommended survey coverage of 30% of the area within one kilometer (km) of turbines to be covered by 800-m radius observation plot (Figure 2). A full survey round was completed every two weeks (e.g., twice per month) and the order which points were surveyed was rotated each round so points were surveyed at different times of the day.

Two types of surveys were conducted at each of the 13 survey points: a 10-minute small bird survey followed by 60-minute large bird survey to maximize the detectability of focal species per USFWS (2016). Surveys were conducted by one observer; points were not surveyed concurrently to minimize the potential for duplicating individuals within a survey, allowing surveys to be considered independent samples from each other.

Survey Schedule

The survey schedule was designed to document bird use and behavior across seasons within the Project area. Surveys were conducted from August 11, 2017 to July 16, 2018. Surveys were conducted twice a month during all seasons which were defined as spring (March 03 to May 27), summer (May 28 to August 10), fall (August 11 to November 28), and winter (November 29 to March 02). A survey of all 13 points (e.g., a survey round) occurred over multiple days, depending on the amount of available daylight which varied by season, accessibility, and weather conditions. Surveys were conducted during daylight hours.

Small Bird Use Surveys

The objective of small bird use surveys was to collect data on species occurrence, and the spatial and temporal patterns of avian use with a particular focus on passerines and other non-raptors. However, if sensitive species that were classified as large birds (e.g., sandhill crane [*Antigone canadensis*]) or raptors (e.g., eagles) were observed within 100-m survey plot, they were recorded and included as incidental observations. All auditory and visual bird observations within a 100-m circular plot were recorded for a 10-min sample period. For each observation, data recorded included:

- species or closest species group (e.g., unidentified passerine)
- sex
- age
- number of individuals
- distance (m)
- behavior
- flight height above ground level (max, min)
- flight direction
- habitat

Large Bird Use Surveys

The objective of large bird use surveys was to collect data on species occurrence and the spatial and temporal patterns of avian use with a particular focus on eagles, other raptors, and non-raptors such as sandhill crane. Large birds were defined as all raptor species and any bird larger than a common raven. Surveys for large birds were conducted at the same 13 points that were used for all bird surveys. All auditory and visual bird observations within an 800-m circular plot were recorded for a 60-min sample period. Consistent with the ECPG and Final Rule, WEST recorded all eagle observations, the total number of minutes an eagle was observed within the 800-m survey plot and whether the bird was flying above or below 200-m above ground level (AGL) or perched. A minute was tallied at the top of the full minute and rounded to the nearest minute in situations of partial time. A flight path of the large-bird observation was delineated on a topographic inset map and digitized into a Geographic Information System (GIS). In addition to the minute data and flight paths, similar data were collected during large bird survey as during the small bird surveys.

Percent survey coverage of thirteen 800-m survey plots within 1-km of the proposed turbines was calculated by dividing the area of the 800-m survey plot by the 1-km turbine buffer.

Bird Use Statistical Analyses

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 and included all observations of birds detected within the survey plot. In some cases, the tally may represent repeated sightings of the same individual during separate visits. For example, a sum of 50 observations of prairie falcon (*Falco mexicanus*) may be 50 unique birds, or it may be one bird observed on 50 separate visits, or something in between. Species richness by season was calculated by averaging the total number of species observed within each plot during a visit, then averaging across plots within each visit, followed by averaging across visits within the season. Overall species richness was calculated as a weighted average of seasonal values by the number of days in each season. Species diversity and richness were compared among seasons for fixed-point bird use surveys.

Bird Use, Percent of Use and Frequency of Occurrence

For generating standardized fixed-point bird use estimates, small birds recorded within a 100-m survey radius at any time and large birds recorded within the 800-m radius plot at any time were used in the analysis. The metric used to measure mean bird use was the number of birds per survey per plot. These standardized estimates of mean bird use were used to compare differences between bird types and seasons. Mean use by season was calculated by summing the total number of birds seen within each plot during a visit, then averaging across plots within each visit, followed by averaging across visits within the season. Overall mean use was calculated as a weighted average of seasonal values by the number of days in each season.

Bird Flight Height and Behavior

Bird flight heights are important metrics to assess potential risk exposure. Flight height information was used to calculate the percentage of birds observed flying within the rotor-swept height (RSH) for turbines likely to be used at the Project. These analyses were conducted for large bird use surveys only. A RSH for potential collision with a turbine blade of 25 to 150 m (82 to 492 ft) AGL was used for the purposes of the analysis. The flight height recorded during the initial observation was used to calculate the percentage of birds flying within the RSH and mean flight height. The percentage of birds flying within the RSH at any time was calculated using the lowest and highest flight heights recorded.

Bird Exposure Index

The bird exposure index is used as a relative measure of species-specific risk of turbine collision and the species most likely to occur as fatalities at the wind energy facility. These analyses were conducted for large bird use surveys only. A relative index of bird exposure (R) was calculated for bird species observed during the large bird survey using the following formula:

$$R = A \times P_f \times P_t$$

Where A equals the mean relative use for species i 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 RSH. The exposure index does not account for other possible collision risk factors, such as avoidance probabilities or inter/intra-specific behaviors. The first flight height was selected because there was a concern about the observer biasing the flight height of the bird. The thought was the first flight height would be the most independent measurement of bias from the observer that exists.

Spatial Use

Flight paths from large bird use surveys were used to identify patterns of spatial use based on topography surrounding each point count station. If identified, species-specific patterns of concentrated use could be used to identify potential areas of increased risk of turbine collision during the operation of the Project. Flight paths delineated in the field and digitized in GIS were compared to the underlying topographic features which included the broad escarpment, associated draws, and the adjacent side slopes. In addition, patterns of spatial use were compared across seasons to determine whether patterns of spatial use coincided with specific time periods.

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 surveys, observers were responsible for inspecting data forms for completeness, accuracy, and legibility. Potentially erroneous data was identified using a series of database queries. Irregular codes or data suspected as being 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® Structured Query Language (SQL) Server database was developed to store, organize, and retrieve survey data. Data were keyed into the electronic database using a pre-defined protocol to facilitate subsequent QA/QC and data analysis. All data forms and electronic data files were retained for reference.

Raptor Nest Surveys

Survey Preparation and Consultation

Prior to aerial surveys in 2017, WEST conducted a literature search (Kalasz and Buchanan 2016) and coordinated with Washington Department of Fish and Wildlife (WDFW) biologists to identify previously documented raptor nests in the Survey Area and to review survey protocol. During each survey year, the Project boundary was buffered by 2-miles and 10-miles to create the Survey Area. Compared to 2017, the Project boundary expanded in 2018 to the northwest. WEST developed a survey plan by plotting previously-identified eagle and non-eagle nests on maps and digital tablets (LG, Seoul, South Korea) with navigational software (Gaia GPS) that was used during aerial surveys.

Aerial Survey Methods

Each survey year, two rounds of double-observer (i.e., a primary and secondary observer) aerial nest surveys were conducted at least 30 days apart in a Robinson R-44 Raven II helicopter with bubble windows that provided excellent visibility (Pagel et al. 2010, USFWS 2013). The first survey was conducted during a time period that overlapped the primary early nesting period of eagles in the Pacific Northwest, when breeding pairs are exhibiting courtship, nest-building, and/or egg-laying and incubation behaviors (Isaacs 2018). A second survey was conducted when eagles are actively engaged in mid- to late breeding season reproductive activities (e.g., incubating, brooding, feeding nestlings), and when eagles engaged in ongoing nesting activities would be reliably on or around nests (Watson 2010, Isaacs 2018).

During the first survey round, coverage included the 2-mi and 10-mi radius survey area around the Project. All stick nests that could be constructed by any raptor species were documented within the 2-mi survey area, whereas only stick nests constructed by golden eagle or bald eagles were documented within 10 miles of the Project. Surveys utilized an intuitive controlled survey method which focused on areas with the highest potential to support raptor nests including cliffs, rock outcrops, incised drainages and canyons, and large trees. During the second survey, WEST biologists revisited previously located raptor nests to evaluate reproductive nesting status and revisited high-quality nesting habitat to search for new nests and later nesting raptor species (e.g., Swainson's hawk [*Buteo swainsoni*]).

During aerial surveys, the helicopter was positioned to allow thorough visual inspection of all appropriate habitat features. In general, the helicopter maintained a distance of no closer than 66 feet (20 m) from cliff faces and nests. When a nest was located, the helicopter reduced speed and adjusted the flight track to allow for a clear view of the nest for documentation and photographing. The amount of time spent circling/searching a particular area or the distance to which a nest was approached was adjusted when raptors, particularly eagles, were present on/near the nest to minimize survey-related disturbance (e.g., flushing). In the event of nestlings, deference was provided and survey of nests directly adjacent to the nestlings (e.g., within 200 m) were aborted.

For each nest or group of nests (e.g., nest site), a Global Positioning System (GPS) location was recorded, a photograph was taken, and nest attribute data were collected. A nest site was defined as two or more nests that occurred on the same shelf, cliff face or tree within close proximity to one another (e.g., approximately 80 feet [25 m]).

WEST categorized nest occupancy following Steenhof et al. (2017) which builds on the research described below. As recommended by Steenhof et al. (2017) the terms "active" and "inactive" to describe nest occupancy or the reproductive status of raptors (particularly eagles) at a particular nest is avoided due to the inconsistent use of the ambiguous term throughout research and technical documents. Associated nest "activity" can be inferred from the observations of nest maintenance, presence of adult or young. The definitions of terms used in this report include:

- **Occupied Nest:** an occupied nest may contain (1) an adult eagle in an incubating position, (2) eggs, (3) nestlings or fledglings, (4) occurrence of an adult (or, sometimes sub-adult), (5) a newly constructed or refurbished stick nest in the area where territorial behavior of an eagle was observed early in the breeding season, or (6) a recently repaired nest with fresh sticks (clean breaks) or fresh boughs on top, and/or droppings and/or molted feathers on its rim or underneath. A nesting territory that is not occupied is termed unoccupied (Postupalsky 1974, Millsap et al. 2015).

- **Unoccupied Nest:** No sign of adults, young, nest tending or other behavior that indicates nest occupancy during the raptor nesting period.

Landcover Assessment and Mapping

Dominant vegetation types at the Project were mapped to identify potentially suitable habitat for sensitive plant and wildlife species, to help guide surveys for sensitive species within development corridors, or to inform mitigation requirements for temporary and permanent impacts to habitat resulting from Project development. Vegetation types were identified using 2017 and 2018 aerial imagery and remotely sensed data that included the National Landcover Dataset (USGS 2011), National Wetland Inventory (USFWS 2017), and portions of the Project was field-verified. Landcover types were defined as the following:

- Shrub-steppe – synonymous with shrub/scrub in the NLCD (Homer et al. 2015) Areas dominated by shrubs; less than 5-m tall with shrub canopy typically greater than 20% of total vegetation. This class includes true shrubs, young trees in an early successional stage or trees stunted from environmental conditions.

- Grassland – synonymous with grassland/herbaceous in the NLCD (Homer et al. 2015). Areas dominated by grammanoid or herbaceous vegetation, generally greater than 80% of total vegetation. Grasslands enrolled in the Conservation Reserve Program (CRP) are included in this classification. These areas are not subject to intensive management such as tilling, but may be utilized for grazing.

- Developed – synonymous with developed/open space in the NLCD (Homer et al. 2015). Includes areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20% of total cover. These areas most commonly include large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes.

- Agriculture – areas used for the production of annual crops, such as wheat, other grain crops, and also perennial woody crops such as orchards and vineyards. Crop vegetation accounts for greater than 20% of total vegetation. This class also includes all land being actively tilled.

Incidental Observations

Incidental wildlife observations provide records of wildlife seen outside of the standardized surveys. All listed or sensitive species, unusual or unique birds, mammals, reptiles, or amphibians were recorded in a similar fashion to standardized surveys. The date, species, number of individuals, behavior, and height above ground (for bird species) were recorded.

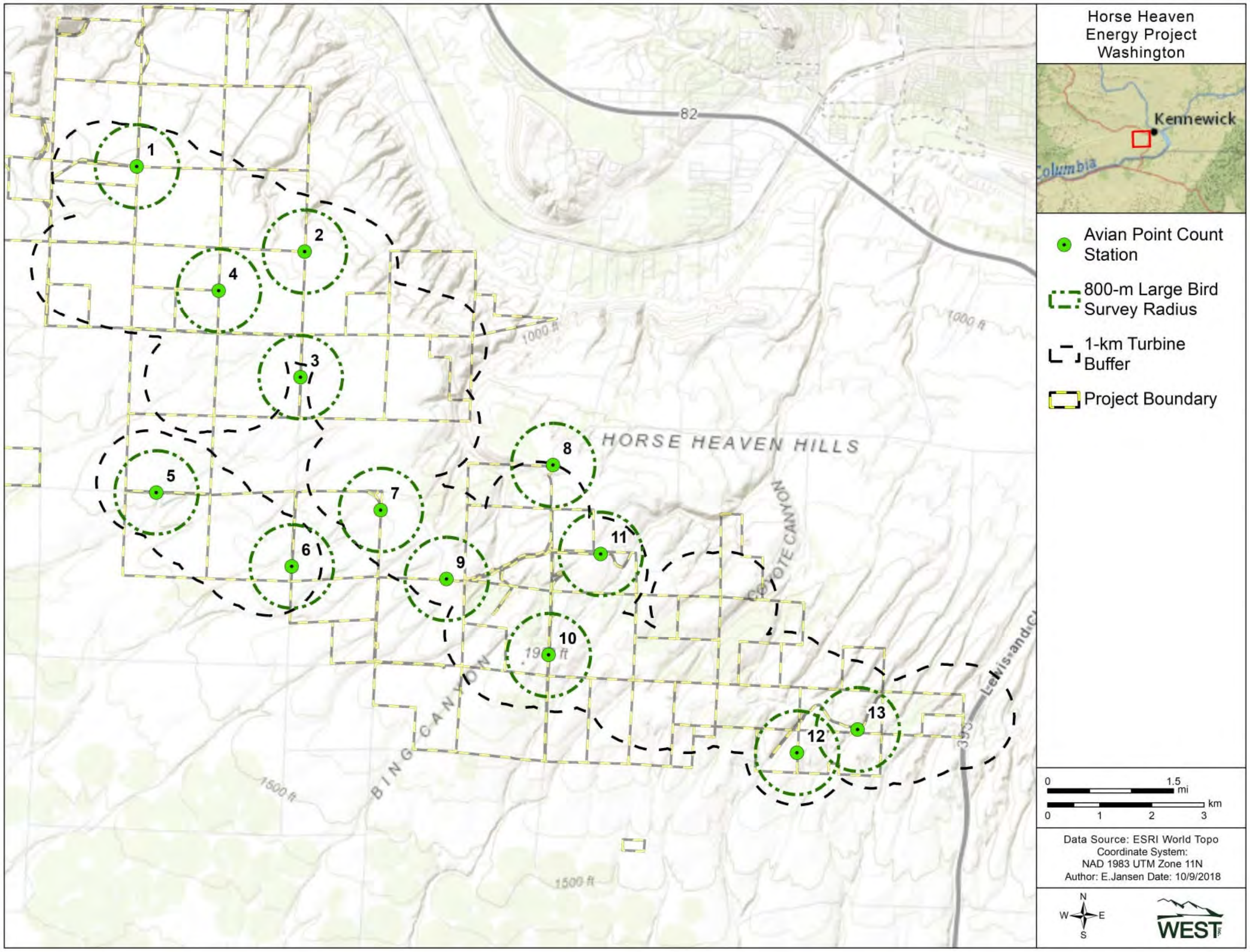

Figure 2. Avian point count survey locations and 800-m radius plots for large bird use surveys at the Horse Heaven Wind Energy Project, Benton County, Washington. 100-m small bird use surveys were conducted at the same points.

RESULTS

Fixed-Point Bird Use Surveys

Survey Coverage and Effort

In a 2-dimentional plane, the survey coverage of the 800-m survey plots within 1-km of the proposed boundary was approximately 31% coverage, slightly over the suggested coverage by the USFWS (USFWS 2016).

Twenty five rounds of small-bird and 25 rounds of large-bird use surveys for a total of 322 surveys of each type were conducted at the Project from August 11, 2017 – July 16, 2018. Survey effort varied across seasons due to inaccessibility during certain times throughout the survey year and a construct of how seasons were delineated (Tables 1a and 1b).

Bird Diversity and Species Richness

During small bird surveys, 20 unique species were observed within 100-m radius plot during the year-long survey effort (Table 1a). Bird diversity (the number of unique species observed) was highest during the fall (15 species), followed by spring (10 species), summer (8 species), and lowest during winter (6 species). Seasonally, species richness small-bird species richness was highest during spring (1.22 species/100-m plot/10-min survey) and decreased over the course of the year and was lowest in winter (0.74 species/100-m plot/10-min survey).

Table 1a. Summary of species richness (species/100-m plot/10-min survey), and sample size by season and overall during the fixed-point small bird use surveys at the Horse Heaven Wind Project from August 11, 2017 – July 16, 2018.

Season	Number of Visits	# Surveys Conducted	# Unique Species	Species Richness
				Small Birds
Spring	6	77	10	1.22
Summer	4	52	8	1.21
Fall	8	104	15	1.09
Winter	7	89	6	0.74
Overall	**25**	**322**	**20**	**1.06**

During large bird use surveys, 24 unique species were observed within 800-m radius plots during the year-long survey effort (Table 1b). Large bird diversity was highest during spring (18 species), followed by fall (13 species), winter (12 species) and lowest during summer (8 species). Overall, species richness was 1.85 (species/800-m plot/60-min survey) with the highest species richness observed in spring (2.44 species/800-m plot/60-min survey), and lowest during summer (1.27 species/800-m plot/60-min survey; Table 1b).

Table 1b. Summary of species richness (species/800-m plot/60-min survey), and sample size by season during the fixed-point large bird use surveys at the Horse Heaven Wind Project from August 11, 2017 – July 16, 2018.

Season	Number of Visits	# Surveys Conducted	# Unique Species	Species Richness
				Large Birds
Spring	6	77	18	2.44
Summer	4	52	8	1.27
Fall	8	104	13	1.95
Winter	7	88	12	1.66
Overall	**25**	**322**	**24**	**1.85**

Bird Use, Percent of Use, and Frequency of Occurrence

Mean bird use, percent of use, and frequency of occurrence were calculated by season for small bird and large bird types (Table 2a and 2b) and species (Appendix A1-2 and B1-2). The following summarizes results of each survey type and describes characteristics for each bird group; relevant species-specific results are then presented for each species group.

During small bird use surveys, a total of 2,205 individuals were recorded within 799 separate groups (Appendix A1). Overall small bird use was 3.62 birds/100-m plot/10-min with the highest use in winter (10.85 birds/100-m plot/10-min). Small bird mean use in the remaining seasons were similar between spring and fall (5.17 and 5.14 birds/100-m plot/10-min, respectively) and were lowest during summer with 4.87 birds/100-m plot/10-min (Table 4a). Passerines comprised the majority of observations during all seasons and were observed most frequently during spring (85.9% of all surveys) and least frequently during winter (62.4% of all surveys). High small bird use during winter although observed less frequently indicates larger bird groups (e.g., flocking behavior) during this time of year (Appendix A). Unidentified small birds and woodpeckers were observed less often with unidentified small birds being observed fall and winter with 0.40 and 0.37 birds/100-m plot/10-min, respectively, and woodpeckers (northern flicker [*Colaptes auratus*]) only observed during fall (0.03 bird/100-m plot/10-min; Table 4a).

During large bird use surveys, a total of 2,740 individuals were recorded within 941 separate groups (Appendix A2). Of the 24 species observed, three species (13% of all species) composed 54% (*n* = 1,481 individuals) of all observations: sandhill crane (*Antigone canadensis*; *n* = 552 individuals), rock pigeon (*Columba livia*; *n* = 477 individuals), and common raven (*n* = 452 individuals; Appendix A2). Large bird use was highest in spring (11.69 birds/800-m plot/60-min survey), followed by fall (9.03 birds/800-m plot/60-min survey), winter (8.56 birds/800-m plot/60-min survey), and lowest in summer (2.48 birds/800-m plot/60-min survey; Table 1b). Higher large bird use during spring was attributed to large groups of waterbirds primarily sandhill cranes, as well as a consistent use of corvids (Table 2b). Overall low summer use was attributed to marked decrease in species abundance across all species groups compared to other seasons, with the exception of Swanson's hawk (*Buteo swainsoni*; Appendix B2).

Passerines

Despite the higher use by passerines during winter, species diversity and richness was low and comprised primarily of two species of passerines (10% of all species) that composed approximately 86% (*n* = 1,894 individuals) of all observations: horned lark (*Eremophila alpestris*; *n* = 1,797 individuals), and western meadowlark (*Sturnella neglecta*; *n* = 97 individuals; Appendix A1). Horned lark had the highest use by any one species during all seasons of the study (4.51, 3.65, 3.32, and 10.18 birds/100-m plot/10-min, respectively), and the western meadowlark followed with the highest use occurring during spring and fall with 0.36 birds/100-m plot/10-min for both seasons.

Waterbirds

Waterbirds had the highest use during spring with 5.03 birds/800-m plot/60-min, followed by fall, summer, and winter (1.56, 0.02, and 0.00 birds/800-m/60-min, respectively; Appendix B2). Observations of waterbirds, specifically sandhill crane, had the greatest influence on overall large bird use. High spring observations of sandhill cranes consisted of two groups of 390 individuals (Appendix A2), followed by fall observations of six groups of 162 individuals, and no observations during summer and winter. American white pelican was the only other waterbird observed with only a summer use of 0.02 birds/800-m plot/60-mins.

Waterfowl

Waterfowl had the highest use during the winter (3.65 birds/800-m plot/60-min), followed by fall (1.68 birds/800-m/60-min), and spring and summer with no use. Canada goose use was highest during winter (3.65 birds/800-m plots/60-min) consisting of nine observations of approximately 214 total individuals followed by fall with four observations of 175 individuals (Appendix A2). An observation of one group of snow goose (*Chen caerulescens*) comprised of approximately 100 individuals was also documented during the winter for a mean use of 1.3 birds/800-m plot/60-mins.

Shorebirds

Long-billed curlew (*Numenius americanus*) was the only shorebird species observed during large bird use surveys and were only documented during spring surveys when two groups of two individuals total were observed (0.03 birds/800-m plot/60-min survey).

Diurnal Raptors

Seasonal and species-specific variability in diurnal raptor use were observed during large bird use surveys. Diurnal raptor use were similar throughout the study with high use occurring during fall (2.22 raptors/800-m plot/60-min; Table 2b), followed by summer, spring, and winter (1.67, 1.54, and 1.43 raptors/800-m plot/60-min, respectively). Relatively higher use during fall was influenced by increased observations of northern harrier (*Circus cyaneus*) where there were 100 observations of 110 total individuals (Appendix A2). During the survey period, eagles had relatively low use compared to other species where use during fall and winter was 0.02 eagles/800-m plot/60-min, 0.01 eagles/800-m plot/60-min during the spring and no eagles were observed during summer.

Table 2a. Mean bird use (number of birds/plot[a]/10-min survey), percent of total use (%), and frequency of occurrence (%) for each bird type and species by season during the fixed-point small bird use surveys at the Horse Heaven Wind Project from August 11, 2017 – July 16, 2018.

	Mean Use				% of Use				% Frequency			
Type/Species	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
Passerines	5.71	4.87	4.71	10.48	100	100	91.6	96.6	85.9	82.7	66.3	62.4
Woodpeckers	0	0	0.03	0	0	0	0.6	0	0	0	1.9	0
Unidentified Birds	0	0	0.4	0.37	0	0	7.9	3.4	0	0	8.7	1.1
Overall	**5.71**	**4.87**	**5.14**	**10.85**	**100**	**100**	**100**	**100**				

[a] 100-m radius plot for all bird use surveys.

Table 2b. Mean bird use (number of birds/plot[a]/60-min survey), percent of total use (%), and frequency of occurrence (%) for each bird type and species by season during the fixed-point large bird use surveys at the Horse Heaven Wind Project from August 11, 2017 – July 16, 2018.

	Mean Use				% of Use				% Frequency			
Type/Species	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
Waterbirds	5.03	0.02	1.56	0	43	0.8	17.3	0	2.7	1.9	4.8	0
Waterfowl	0	0	1.68	3.65	0	0	18.6	42.7	0	0	2.9	9.0
Shorebirds	0.03	0	0	0	0.2	0	0	0	2.6	0	0	0
Gulls/Terns	2.31	0	0	0	19.7	0	0	0	10.3	0	0	0
Diurnal Raptors	1.54	1.67	2.22	1.43	13.2	67.4	24.6	16.8	71.3	63.5	73.1	60.0
Accipiters	0.03	0	0.04	0	0.2	0	0.4	0	2.6	0	3.8	0
Buteos	0.98	1.29	0.76	0.57	8.4	51.9	8.4	6.6	60.8	59.6	36.5	31.7
Northern Harrier	0.42	0.17	1.05	0.66	3.6	7.0	11.6	7.7	29.9	11.5	49	38.2
Eagles	0.01	0	0.02	0.02	0.1	0	0.2	0.3	1.3	0	1	1.1
Falcons	0.08	0.21	0.29	0.16	0.7	8.5	3.2	1.9	7.7	9.6	18.3	13.2
Other Raptors	0.03	0	0.07	0.02	0.2	0	0.7	0.3	2.6	0	6.7	2.2
Owls	0	0	0	0.01	0	0	0	0.2	0	0	0	1.3
Upland Game Birds	0.03	0.06	0	0	0.2	2.3	0	0	2.7	3.8	0	0
Doves/Pigeons	0.94	0.35	2	2.01	8.1	14.0	22.2	23.5	29.9	11.5	9.6	8.9
Large Corvids	1.82	0.38	1.57	1.45	15.6	15.5	17.4	16.9	72.9	21.2	52.9	53.5
Overall	**11.69**	**2.48**	**9.03**	**8.56**	**100**	**100**	**100**	**100**				

[a] 800-meter radius plot for large birds.

Eagles

A total of four golden eagle observations were documented during large bird use surveys for a total of 35 eagle minutes (Table 3). On April 9, 2018 an adult golden eagle was observed at Point 13 circling below 200 m AGL and within 800-m of the observer for 30 minutes of the 60 minute survey (Table 3, Appendix E). The eagle flew out of the 800-m survey plot during the survey but repeatedly returned and circle soared over the observer while calling. On the same day, an additional observation of an adult golden eagle was recorded at Point 12 for four minutes below 200 m AGL but at a distance of 1,000–1,200 m from the observer and was considered an incidental observation and not included in the eagle minute tally. It is likely the second observation was of the same individual based on the territorial behavior of the eagle and the flight direction of the eagle toward Point 13 during the second observation, On November 18, 2017, a pair of juvenile golden eagles was observed hunting at Point 8. One eagle was first observed perched in a field and subsequently flew between 10–60m AGL with the second eagle for a total of five minutes within the 800-m survey plot (Table 3, Appendix E). Together, golden eagles were recorded for 66 minutes total and 35 minutes within the 800-m survey plot and flying below 200-m AGL (Table 3, Appendix E).

A total of two bald eagle observations were documented during large bird use surveys for a total of six eagle minutes (Table 3). On February 5, 2017, one adult bald eagle was observed at Point 8 flying approximately 150 m AGL 675–800 m from the observer for a total of three eagle minutes. Forty four minutes after the eagle flew out of the survey plot and exited the area, another observation of an adult eagle was recorded flying 100-180 m AGL at the edge of the 800m survey plot for an additional three eagle minutes. It is likely both eagle observations were of the same individual based on the adult plumage observed in both eagles. Together, bald eagles were recorded for nine minutes total and six minutes within the 800-m survey plot and flying below 200-m AGL (Table 3, Appendix E).

Table 3. Eagle observations at the Horse Heaven Wind Project from August 11, 2017 – July 16, 2018.

	Spring	Summer	Fall	Winter
Total Surveys (hrs.)	77	52	104	88
Golden Eagle				
# Observations	1[a]	0	2	0
# Minutes Observed	60	0	6	0
Minutes < 800-m, < 200-m AGL	30	0	5	0
Bald Eagle				
# Observations	0	0	0	2[b]
# Minutes Observed	0	0	0	9
Minutes < 800-m, < 200-m AGL	0	0	0	6

[a] One additional eagle was observed during spring > 800-m from Point 12 and was considered an incidental observation. The incidental observation is most likely the same individual that was observed at Point 13 for 60 minutes.
[b] The two bald eagle observations are likely of the same individual.

Bird Flight Height and Behavior

Flight height characteristics, based on initial flight height observations and estimated use, were estimated for large bird groups (Table 4) and species (Appendix C). During fixed-point bird use surveys, 825 groups of large birds were observed flying within the 800-m plot, totaling 2,417 individuals. Overall, 43.5% of large birds were recorded flying within the RSH, 35.1% were below the RSH, and 21.4% were flying above the RSH. Waterbirds, which exhibited the highest overall use, were observed flying primarily (90%) above the RSH although had a mean flight height of 133-m AGL (Table 4). Less than half (39%) of all raptors were observed flying within the RSH, which was influenced by the number of northern harrier and falcons that typically flew below the RSH (84–96% of observations). Considering *Buteos* only (e.g., red-tailed hawk, Swainson's hawk, and rough-legged hawk), 71% of all individuals were observed flying within the RSH at a mean flight height of 40-m AGL. Individuals observed within the waterfowl group had the largest percent of individuals flying in the RSH (90%) which were primarily attributed to Canada geese.

Table 4. Flight height characteristics by bird type[a] and raptor subtype during fixed-point large bird use surveys at the Horse Heaven Wind Project from August 11, 2017 – July 16, 2018.

Bird Type	# Groups Flying	# Obs Flying	Mean Flight Height (m)	% Obs Flying	% within Flight Height Categories		
					0 - 25 m	25 - 150 m[b]	> 150 m
Waterbirds	8	503	133.75	91	0	9.9	90.1
Waterfowl	14	489	110.36	100	0	90.2	9.8
Shorebirds	0	0	0	0	0	0	0
Gulls/Terns	10	180	60	100	2.8	90	7.2
Diurnal Raptors	468	494	24.65	87.4	61.1	38.5	0.4
Accipiters	6	6	13.17	100	83.3	16.7	0
Buteos	220	236	39.61	86.8	29.2	70.8	0
Northern Harrier	195	205	6.41	98.1	96.1	3.9	0
Eagles	4	4	115	80	0	75	25
Falcons	32	32	13.06	51.6	84.4	15.6	0
Other Raptors	11	11	55.91	100	36.4	54.5	9.1
Owls	0	0	0	0	0	0	0
Upland Game Birds	0	0	0	0	0	0	0
Doves/Pigeons	43	334	16.98	69.6	59.3	40.7	0
Large Corvids	282	417	16.51	92.1	82.3	17.3	0.5
Large Birds Overall	**825**	**2,417**	**24.41**	**88.6**	**35.1**	**43.5**	**21.4**

[a] 800-meter (m) radius plot for large bird use surveys.
[b] The likely "rotor-swept height" for potential collision with a turbine blade, or 25 to 150 m (82 to 492 ft) above ground level.

Bird Exposure Index

A relative exposure index, which is a function of initial flight height and relative abundance (defined as the use estimate), was calculated for each large bird species. Those species that had exposure to the RSH are listed in Table 5, and a complete list of all species is presented in Appendix C. Canada goose had the highest exposure index of 0.98 which was over twice as high than any other large bird species. Despite only 13 observations of Canada goose groups in-flight, approximately 90% of observed flight occurred in the RSH which resulted in a relatively high exposure index. Rock pigeon had the second highest exposure index (0.4), which was influenced by large group sizes and high number of individuals within observed groups. Despite having the highest total number of observations and highest observed use, sandhill crane had a relatively low exposure index (0.15) due to the percentage of groups flying within the RSH when first observed (9.8%, Table 5). Of the raptor species, Swainson's hawk had the highest exposure index (0.24) followed by red-tailed hawk (0.14).

Table 5. Relative exposure index and flight characteristics for bird species[a] during fixed-point large bird use surveys at the Horse Heaven Wind Project from August 11, 2017 – July 16, 2018.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within RSH[b] based on Initial obs	Exposure Index	% Within RSH at Anytime
Canada goose	13	1.11	100	87.7	0.98	94.3
rock pigeon	41	1.41	69.6	41.0	0.40	52.4
California gull	6	0.40	100	88.7	0.36	88.7
snow goose	1	0.33	100	100	0.33	100
Swainson's hawk	78	0.36	83.7	79.3	0.24	93.1
common raven	279	1.34	92.0	17.4	0.21	32.2
sandhill crane	7	1.65	90.9	9.8	0.15	82.5
red-tailed hawk	59	0.22	84.7	72.1	0.14	85.2
unidentified gull	4	0.14	100	93.6	0.13	93.6
rough-legged hawk	71	0.23	92.5	59.5	0.13	78.4
unidentified *Buteo*	9	0.04	84.6	81.8	0.03	81.8
northern harrier	195	0.62	98.1	3.9	0.02	9.3
unidentified raptor	11	0.03	100	54.5	0.02	81.8
American kestrel	29	0.18	50.9	17.2	0.02	27.6
golden eagle	2	<0.01	66.7	100	<0.01	100
American white pelican	1	<0.01	100	100	<0.01	100
ferruginous hawk	3	<0.01	100	33.3	<0.01	66.7
Cooper's hawk	3	<0.01	100	33.3	<0.01	33.3
bald eagle	2	<0.01	100	50.0	<0.01	100

[a] Only includes species with exposure index values; see Appendix C for full listing.
[b] The likely "rotor-swept height" for potential collision with a turbine blade, or 25 to 150 m (82 to 492 ft) above ground level.

Spatial Use

Substantially higher small bird use was observed at three survey points and included Point 3 (15.9 birds/100-m plot/10-min survey), Point 4 (15.2 birds/100-m plot/10-min survey), and Point 7 (12.0 birds/100-m plot/10-min survey; Figures 3 and 5). Points 3 and 4 are located in the middle to western end of the Project, and Point 7 is located in the center of the Project area. High annual mean use of horned lark, particularly of larger groups during winter, was observed at these survey points (Appendix D). Landcover surrounding high use survey points were composed primarily of agriculture (dryland wheat) which did not represent a unique habitat type on the landscape.

Large birds were observed at each point in the Project; use was highest at Point 7 (26.1 birds/800-m plot/ 60-min; Figures 4 and 5). Overall higher avian use at Points 7 was influenced primarily by large groups of waterbirds, particularly sandhill cranes, which flew over the Project during spring and fall (Appendix D). Common raven, northern harriers and the *Buteo* group had relatively higher use at Point 7 compared to other points (Appendix D) and were often observed flying through the survey plot or hunting within the wheat fields and along the county road.

Diurnal raptors were observed throughout the Project with higher use at points within the center (Points 6, 7, and 8) and east (Points 12 and 13) of the Project (Appendix D). Points 6, 7, and 8 had slightly higher diurnal raptor use than other survey points (2.48, 2.88, and 2.68 birds/ 800-m plot/60-mins, respectively; Appendix D). Despite the occurrence of an occupied Swainson's hawk nest within or adjacent to the 800-m survey plot at Points 6, 8, 11, and 13, higher avian use at those Points resulted from observations of doves (Points 6 and 13), gulls (Point 8) and waterfowl (Point 11). Points 1 and 2, which were located nearest to the northern escarpment which could be used as updrafts, did not show a noticeable increase in diurnal raptor use (Figure 5). The inconsistent pattern of use throughout the Project area could be a result of the overall homogeneity of the landcover, seasonal variability of foraging resources, or lack of topographic complexity within the Project.

The majority of sandhill cranes were observed at Points 3 and 7 and only during spring and fall (Appendix B2). No other areas of consistent use or concentrated flight paths were noted (Appendix E). Suitable stopover habitat (large wetland/agricultural matrix or inundated agricultural fields) were not present during surveys.

Bald and golden eagles were recorded at Points 8 and 13 with higher use occurring at points 8 and 13 (0.04 and 0.16 eagles/ 800-m plot/60-min, respectively). With a limited number of eagle observations, no obvious flyways or areas of concentration were observed and occurrence within the Project was likely associated with seasonal movements and foraging behavior.

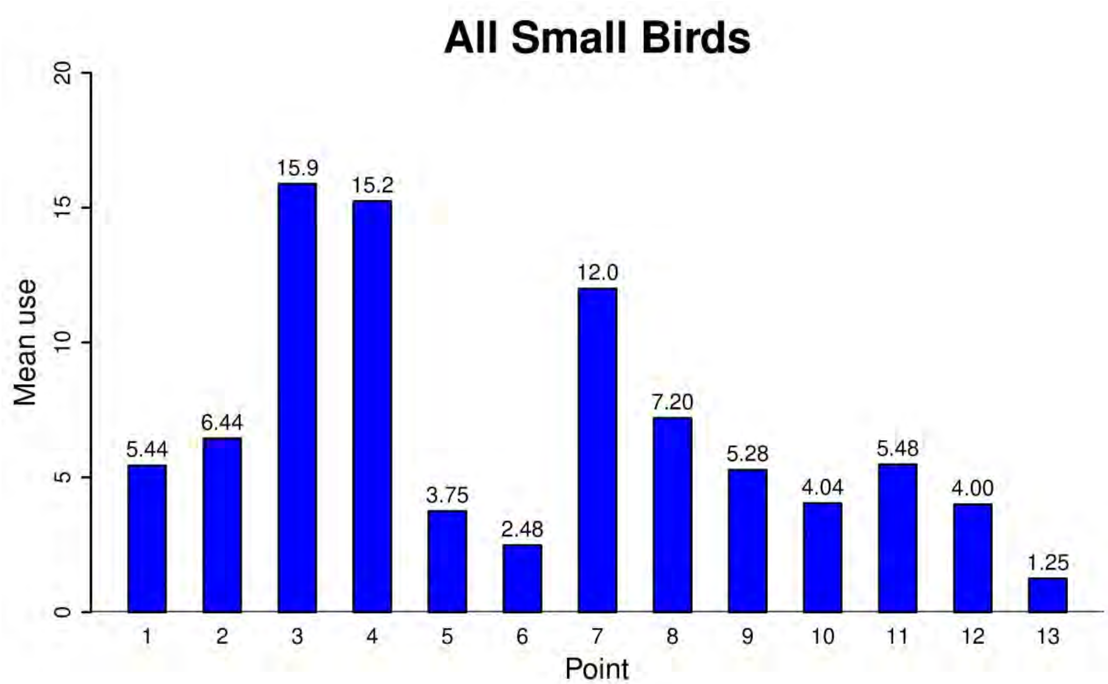

Figure 3. Mean use by point by all small birds at the Horse Heaven Wind Project during small bird use surveys from August 11, 2017 to July 16, 2018.

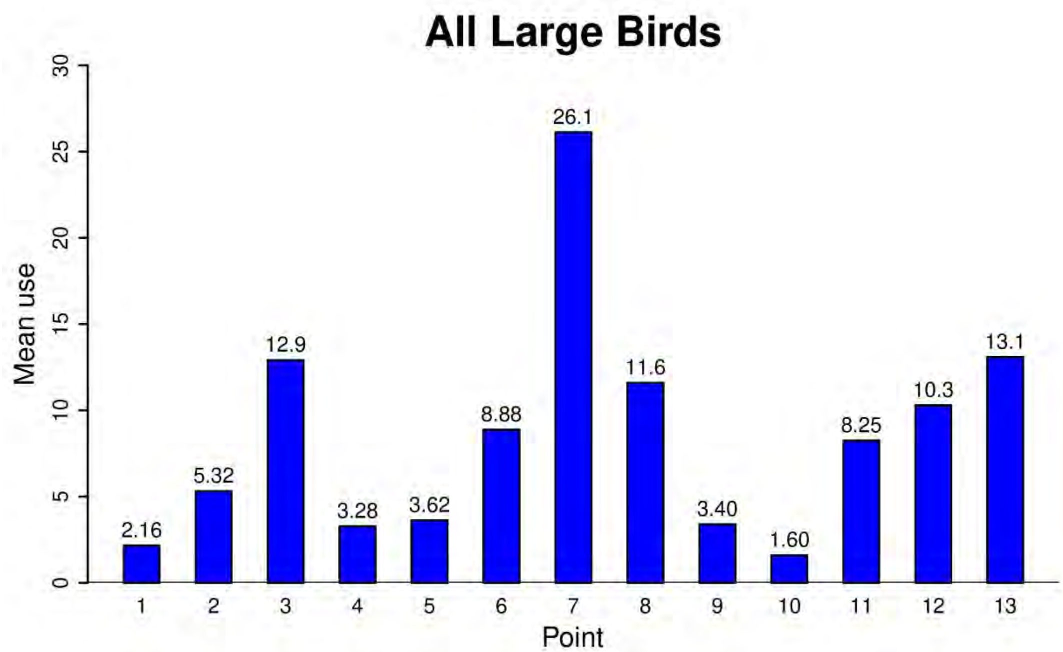

Figure 4. Relative large bird use by observation point during fixed-point bird use surveys at the Horse Heaven Wind Project from August 11, 2017 to July 16, 2018.

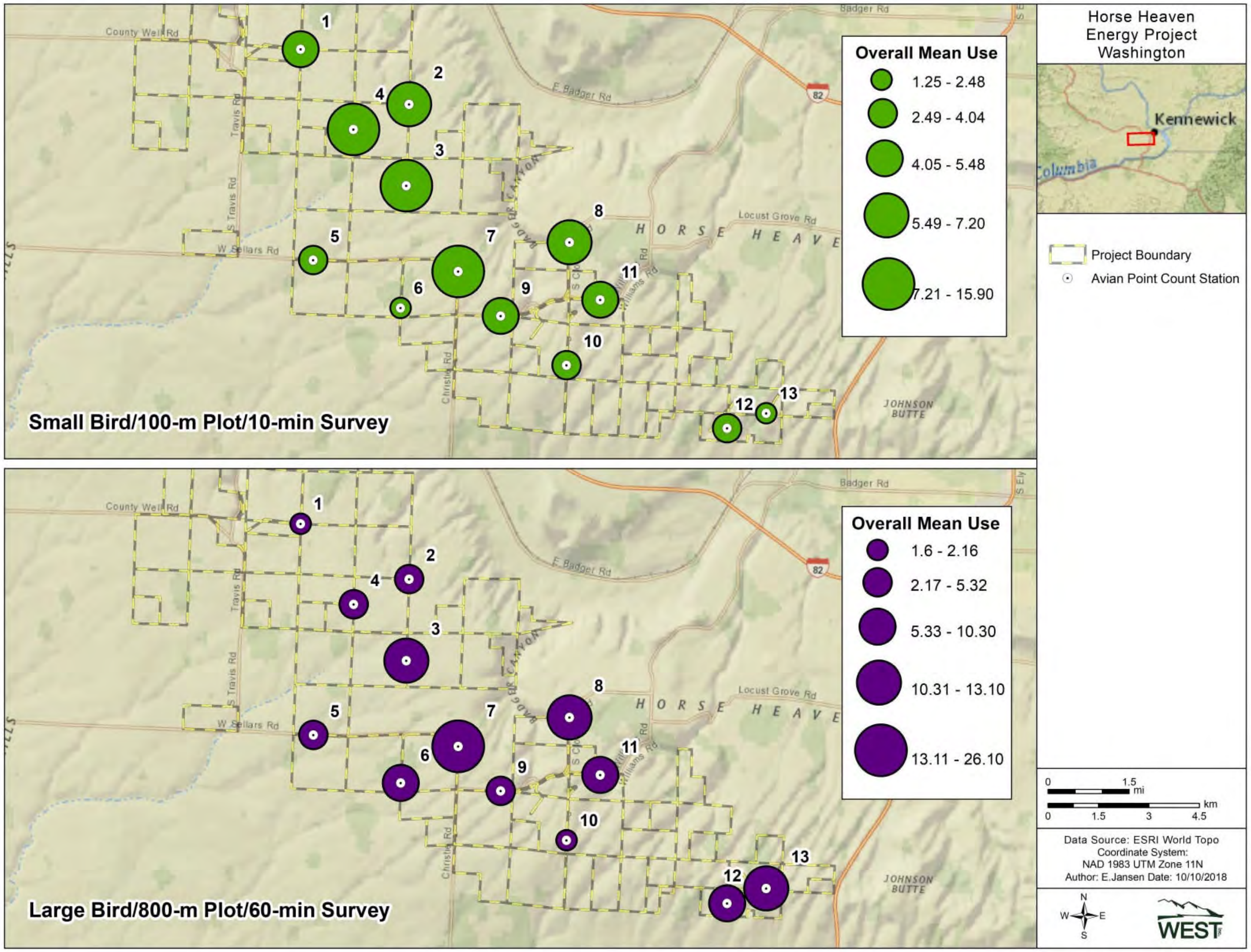

Figure 5. Overall avian use by point count observed during fixed-point surveys at the Horse Heaven Wind Project from August 11, 2017 to July 16, 2018. Note the varying scales of the graduated symbology between the two figure panes.

Sensitive Species Observations

Six sensitive bird species and one sensitive mammal species was recorded during 2017–2018 wildlife surveys (Table 6). Bald eagle and golden eagle are listed under the Bald and Golden Eagle Protection Act of 1940 and have a permit process available to cover incidental take for otherwise lawful activities (USFWS 2016). Due to population increases, the American white pelican was recently down listed to state threatened (Stinson 2016) whereas the sandhill crane is listed as state endangered (Stinson 2017). No longer considered a federal candidate species for the Endangered Species Act, the Washington ground squirrel remains a candidate species for state listing.

Table 6. Summary of sensitive species observed during avian use survey and as incidental wildlife observations from August 11, 2017 – July 16, 2018.

			Point Count		Incidental		Total	
Species	**Scientific Name**	**Status**	**# of grps**	**# of obs**	**# of grps**	**# of obs**	**# of grps**	**# of obs**
American white pelican	*Pelecanus erythrorhynchos*	WA-T	1	1	0	0	1	1
bald eagle	*Haliaeetus leucocephalus*	BCC	2	2	1	1	3	3
ferruginous hawk	*Buteo regalis*	WA-T	3	3	0	0	3	3
golden eagle	*Aquila chrysaetos*	BCC	3	3	1	1	4	4
sagebrush sparrow	*Arremisiospiza nevadensis*	WA-C	1	1	0	0	1	1
sandhill crane	*Antigone canadensis*	WA-E	8	552	0	0	8	552
Washington ground squirrel	*Urocitellus washingtoni*	WA-C	--*	--	5*	5*	--*	--
Total	**7 species**		**18**	**562**	**7**	**7**	**20**	**564**

BCC = Migratory Birds of Conservation Concern designated by USFWS 2008 and related regulations (e.g., Migratory Bird Treaty Act 1918, Bald and Golden Eagle Act of 1940).
WA-E = Washington state endangered species designated by WA Administrative Code (WAC) 220-610-010
WA-T = Washington state threatened species designated by WAC 220-200-010
WA-C = Washington state candidate species designated by WAC 220-610-110
Washington state monitored species are not included (WDFW 2005, 2015)
Sources:
Federal: USFWS 2017 (https://ecos.fws.gov/ipac/). BCC list derived from iPaC and Project boundary
State: WDFW 2017 (https://wdfw.wa.gov/conservation/endangered/state_listed_species.pdf)
* observed incidentally in-between point count surveys but stopped keeping track of WAGS because activity was so prevalent in spring 2017.

Raptor Nest Surveys

2017 Aerial Surveys

A total of 21 raptor nests were located within the Survey Area in 2017 during aerial surveys conducted March 31 and May 10 (Jansen 2017). Of the 21 nests documented, 11 nests (55%) were occupied; of the 11 occupied nests, eight nests had adults incubating or young observed in the nest (Appendix F). A total of 6 different species were recorded during the nest surveys, red-tailed hawk was the most prevalent species in the Survey Area followed by ferruginous hawk and great-horned owl.

A pair of bald eagles was observed near Nest 18 which was located at the confluence of the Yakima River and Columbia River and adjacent to State Highway 240 and several nature preserves approximately 7.7 miles northeast of the Project. The nest contained one chick approximately 21 days old at the time of the second survey (April 30). Two nests (Nest 3 and 8) were occupied by ferruginous hawk of which, one adult was sitting on Nest 3 during both surveys and is assumed active. Nest 3 was located in [redacted] 13. The occupied inactive ferruginous hawk nest (Nest 8) had one adult standing on top of the nest during the first survey and was in good condition (Appendix F1). Seven additional unoccupied inactive nests were characteristic of nests built by ferruginous hawks and found within two miles of the Project. These unoccupied, inactive nests were located on the ground (n = 6 nests) and cliff ledge (n = 1 nest) and had the size and form typical of ferruginous hawk construction. Five of the nests were in poor to fair condition, indicating no recent maintenance or nesting activities had occurred and were most likely old territories. One adult ferruginous hawk was flushed from the ground and observed in flight, but could not be attributed to a particular nest.

Of the four red-tailed hawks that were observed on the nest during the first survey, three nests contained one to two chicks between 14–21 days old during the second survey (Nest 1, Nest 9, and Nest 12). The fourth nest observed with a red-tailed hawk during the first survey did not contain signs of nesting during the second survey and was considered occupied inactive.

Two great-horned owls were observed nesting within two miles of the Project. One of the nests (Nest 14) had an adult incubating on the nest during the first survey and two owlets standing adjacent to the nest during the second survey. One additional nest (Nest 2) had an adult owl sitting on the nest during the first survey with two red-tailed hawks perched on an adjacent tree. The nest was abandoned by the second survey with no sign of nesting activity.

One occupied active Swainson's hawk nest was observed during the second survey near the center of the Project. The nest was vacant during the first survey and is presumed the adult arrived between the first and second surveys. The adult was observed sitting in an incubating position.

While not a raptor per se, one common raven (*Corvus corax*) nest (Nest 6) was recorded because ravens and raptors are known to use similar-sized nests. The nest was located in the center of the Project on top of an old windmill and had an adult on the nest during the first and second surveys.

The remaining 3 unoccupied nests (Nest 5 and Nest 20) were located in trees within the Project. Two nests were located within the tree at Nest 5 and one at Nest 20. Neither nest(s) location had signs of nesting activity during either survey.

2018 Aerial Surveys

A total of 33 nests were observed in the Survey Area during the 2018 raptor nest surveys conducted March 5 and May 10. Of the 33 nests, 19 (58%) were occupied; of the 19 occupied nests, 14 contained eggs or young and the remaining five nests had an adult incubating during the last survey (Appendix F). Similar to 2017 surveys, a total of 6 different species were recorded during the nest surveys. Red-tailed hawk was the most prevalent species in the Survey Area followed by Swainson's hawk and great-horned owl (Table 7).

The occupied bald eagle nest in 2017 (Nest 18) was reoccupied in 2018 and contained 2 chicks approximately 21 days old during the second survey (May 10). Similarly, the occupied ferruginous hawk nest (Nest 3) that was previously documented in 2017 was reoccupied and contained an incubating adult during the second survey

Six of the eight red-tailed hawk nests documented in 2018 were previously undocumented with the majority of nests located to the north of the Project, along an old railroad grade (Appendix F, Figure 7). All red-tailed hawk nests were occupied with either eggs or young in the nest during the second survey.

Of the six Swainson's hawk nests occupied in 2018, two were discovered during point count surveys, after aerial surveys concluded. Four of the six occupied Swainson's hawk nests contained eggs or young during the second survey (Appendix F).

Two nests occupied by great-horned owl were observed during the 2018 nest surveys. Nest 7 contained an adult with one egg in the nest bowl; however during the second survey the nest bowl was empty with no sign of adults or young. Nest 20 contained at least one egg and one adult owl during the second survey; one owlet was observed on the nest during the second survey.

The same common raven nest that was occupied in 2017 was reoccupied in 2018 and located on top of an old windmill. One adult was observed incubating during the second survey.

Of the 14 unoccupied nests, 11 were located on the ground or cliff and were indicative of ferruginous hawk construction. Based on the poor to fair condition of the 11 nests in 2017 and 2018, these nests have not been used for three or more years.

2017–2018 Nest Survey Comparison

In 2017 there were a total of 21 nests found within the Survey Area and in 2018 an additional 12 nests were located. The increase in the number of nests between years was due to the construction of *Buteo* nests; red-tailed hawks in deciduous trees along an old railroad grade located north of the Project and Swainson's hawks in isolated trees scattered throughout the Project. The number of occupied red-tailed hawk and Swainson's hawk nests increased between 2017 and 2018 and contributed to the majority of the raptor nest use (73%) in 2018 (Table 7).

Eight nests were occupied in 2017 were re-occupied again in 2018 (Nests 2, 3, 6, 7, 9, 14, 18, and 19; Appendix F1 and F2). Of the eight nests occupied in successive years, five (62.5%) contained the same species. Nest 18 was a reoccurring bald eagle nest that had two young approximately 21 days old during the second survey in 2017 and 2018. A ferruginous hawk was observed on Nest 3 each year in an incubating posture during the second survey. A Swainson's hawk occupied a tree nest (Nest 19) in the middle of the Project, adjacent to a common raven nest (Nest 6) on a windmill that was also occupied each survey year. Nest 9 was occupied by a red-tailed hawk and contained at least one young on the second survey each year. Occupied nests with a different species between years typically had a great-horned owl during one of the two survey years.

Although more nests were documented within 2-miles of the Project in 2018 compared to 2017, nest density decreased because the Survey Area was over twice as large in 2018 (Table 7). Nest density decreased for all species in 2018, except for Swainson's hawk which tripled and red-tailed hawk which remained relatively stable between years (Table 7).

Table 7. Raptor nest results within 2-miles of the proposed Horse Heaven Wind Project, Washington. Aerial surveys conducted March 31 and May 10 2017 and March 05 and May 10 2018. Supplemental ground surveys were conducted during summer 2018.

Species Obs. On Nest	2017		2018	
	# Nests	Nest Density (#/mi²)[a]	# Nests	Nest Density (#/mi²)[a]
Bald Eagle[b]	1	0.000	1	0.000
Ferruginous Hawk	2	0.027	1	0.007
Swainson's Hawk	1	0.013	6	0.039
Red-tailed Hawk	4	0.054	8	0.052
Great-horned Owl	2	0.027	2	0.013
Common Raven	1	0.013	1	0.007
Unoccupied	10	0.134	14	0.090
Total	21	0.268	33	0.210

[a] Nest Density = # Nests within 2-mi of Project / (Project Area + 2-mi All Raptor Survey Area). 2017 = 74.66 mi^2; 2018 = 152.60 mi^2

[b] Located outside the two-mile Survey Area.

[REDACTED DUE TO SENSITIVE INFORMATION]

Figure 6. Raptor nest locations documented during aerial surveys of the Horse Heaven Wind Project, March 31 and May 10, 2017.

[REDACTED DUE TO SENSITIVE INFORMATION]

Figure 7. Raptor nest locations documented during aerial surveys of the Horse Heaven Wind Project, March 5 and May 10, 2018.

Landcover Assessment and Mapping

Four landcover types were found within the 25,815 acre Project boundary (Appendix G). The predominant landcover type within the Project was agriculture (73%) followed by grassland (25%), and shrub-steppe (2%; Table 8). Digitized landcover data showed concurrence with landcover classes from the NLCD (Appendix G). Shrub/scrub and grassland (e.g., shrub-steppe) habitat are important breeding, nesting, and foraging habitats for a number of sensitive wildlife species, including several observed during avian use surveys (e.g., sagebrush sparrow, grasshopper sparrow, long-billed curlew). Shrub-steppe is classified as a priority habitat in Washington and has various mitigation ratios for temporary and permanent impacts (WDFW 2009). Except in a small number of areas, shrub-steppe habitat was only present in isolated patches across the Project area that was primarily in ravines with steep sides where agricultural practices were too difficult to perform. The majority of these areas were more common on the eastern side of the Project area. Although public records are not available, many grasslands were enrolled in CRP.

Table 8. Digitized landcover types found at the Project. August 2018.

Landcover Type	Area (ac)	Area (mi2)	% Comp
Agriculture	18,911	29.5	73.3%
Grassland	6,333	9.9	24.5%
Shrub-steppe	537	0.8	2.1%
Developed	34	0.1	0.1%
Total	25,815	40.3	100.0%

Incidental Observations

Seven bird species and one bird group were observed incidentally at the Project, totaling 29 individuals (Table 9). All species except the short-eared owl were observed (n = 2) during point count surveys which were documented in-transit between points. One bird species was considered listed or sensitive species and is discussed in the sensitive species section. Although there were large numbers of sandhill cranes observed during protocol surveys they were not observed incidentally between surveys.

Four mammal species were observed at the Project (Table 9). Of note, solitary pronghorn antelope were observed in mid-May 2017 and early September 2018; the age and sex of the animal was unknown. While not considered a listed or sensitive species, pronghorn population numbers in Washington are very low (e.g., < 300 individuals) and reintroduction efforts are currently underway (WDFW 2018). Washington ground squirrels were observed burrowing along road margins while the surveyor traveled between points and is considered a state candidate species for listing. Two additional mammal species, the black-tailed deer and coyote were documented in the Project and are common throughout the area.

Table 9. Incidental wildlife observed while conducting all surveys at the Horse Heaven Wind Project from August 11, 2017 – July 16, 2018.

Species	Scientific Name	# grps	# obs
bald eagle*	*Haliaeetus leucocephalus*	1	1
red-tailed hawk	*Buteo jamaicensis*	1	1
Swainson's hawk	*Buteo swainsoni*	1	2
great horned owl	*Bubo virginianus*	1	1
short-eared owl	*Asio flammeus*	2	2
bank swallow	*Riparia riparia*	1	20
Say's phoebe	*Sayornis saya*	1	1
unidentified hummingbird	N/A	1	1
Avian Subtotal	**7 species | 1 group**	**9**	**29**
Washington ground squirrel	*Urocitellus washingtoni*	5	5
black-tailed deer	*Odocoileus hemionus columbianus*	1	5
coyote	*Canis latrans*	2	4
pronghorn	*Antilocapra americana*	2	2
Mammal Subtotal	**4 species**	**10**	**16**

* Also a listed/sensitive species.

DISCUSSION

The bird species observed in the Project during the study were typical to those commonly found in agricultural, shrub-steppe and grasslands within the Columbia Plateau. Bird use was highest for species common and widespread in the region and the bird community observed coincided with the assemblage expected based on habitat in the Project and surrounding area. For example, horned lark were wide spread in the Project and were predominantly observed during winter where individuals likely utilized the agricultural lands for foraging. Sandhill cranes were only observed during spring and fall when individuals were likely moving between their summer and winter ranges.

Seasonal patterns of use were observed for small birds. Small bird use was highest in winter which likely reflected the increase in abundance of horned lark. With the exception of horned lark, small bird use was typically higher during spring and fall and lower in winter. Horned lark was the most prevalent small bird species observed during the survey year and influenced the small bird seasonal patterns observed at Horse Heaven.

Overall large bird use was higher during spring and fall, likely due to the Project's location in the Pacific Flyway and the stopover habitat available in the surrounding area. Sandhill crane had the highest mean use of all birds due to the large flock numbers that flew over the Project. The region surrounding the Project contains various agricultural and crop lands that could provide valuable stopover locations for migrating sandhill cranes; however based on high flight heights and patterns it is likely the species is predominantly passing over the Project area rather than utilizing resources in the area. Certain areas within the Project (primarily in ravines and small sections of non-cultivated lands) provided some suitable nesting habitat for raptors (e.g., cliff, escarpments or trees). Overall diurnal raptor use was generally consistent across the Project area with and overall large bird use concentrated in the center of the Project. Several large bird groups of interest for the Project are discussed separately, below.

Waterbirds

The waterbird group accounted for the highest mean use but contained only two species both of which are of conservation interest; American white pelican (state threatened) and sandhill crane (state endangered). Only one American white pelican was observed during summer despite the fact in Washington, the largest breeding colony of American white pelicans is on Badger Island, located 12 miles northeast of the Project near Kennewick (Stinson 2016). No large bodies of water that provide suitable pelican foraging habitat is present in the Project.

As discussed, sandhill crane was the majority of large bird observations at the Project and had the highest use during spring and fall. Higher crane use was at the center of the Project (Point 7), but there does not appear to be a strong association for the observed sandhill crane use at that particular survey point and the surrounding area. This suggests individuals observed during surveys were likely passing over the Project. Despite the pattern of high use at the Project, sandhill cranes do not seem especially vulnerable to turbine collisions. This is based primarily on the observed flight height behavior which was a little over 90% of individuals that flew above the RSH zone. This flight behavior is supported by studies that have shown sandhill cranes are likely to avoid wind turbines (Nagy et al. 2013, Derby et al. 2013, Pearse et al. 2016). Due to the observed numbers of cranes, continued use of the Project during spring and fall is anticipated. However, due to the absence of roosting sites or foraging habitat within and directly adjacent (e.g., <1 mile) to the Project, combined with avoidance behavior of turbines by cranes, collision risk to cranes appears low.

Considering the Project does not contain open water or foraging habitat for waterbirds, it is presumed that birds are traveling over the Project between stopover habitat (e.g., potholes and agricultural fields) located to the north, south, and east of the Project. Based on stable populations of waterbirds and the potential to avoid the proposed wind project, it is likely direct impacts or displacement of waterbird species would not have population-level effects.

Waterfowl

Canada goose and snow goose were the two species that comprised the waterfowl group. Mean use was highest in winter which was primarily attributed to Canada goose use during that time. Although Canada goose was observed at relatively low numbers they did show to have the highest exposure risk out of all large bird species for turbine collisions at 0.98 when the next closest exposure risk was at 0.40 (rock pigeon). Most observations of Canada goose were on the far west and east side of the Project, illustrating little use in the middle of the project. Despite relatively higher use of waterfowl compared to other species groups, waterfowl do not seem especially vulnerable to turbine collisions. In an analysis of 116 studies of bird mortality at over 70 operating wind facilities, waterfowl composed 2.7% of 4,975 fatalities found (Erickson et al. 2014).

Considering the Project does not contain open water or foraging habitat for waterfowl, it is presumed that birds are traveling over the Project between stopover habitat (e.g., potholes and agricultural fields) located to the north, south, and east of the Project. However, wheat fields that become inundated with water in the spring or fall provide suitable foraging habitat and are found in the northwestern Project area (Appendix G). Birds that utilize this type of resource are at greater risk of turbine collision as bird use in these agricultural habitats may be higher.

Diurnal Raptors

Diurnal raptor use was highest during the fall and summer periods when northern harrier, red-tailed hawks, Swainson's hawks and American kestrel use increased. Summer coincides with the post-fledging period when juveniles begin to increase their home range and adults decrease their fidelity to nesting territories. Swainson's hawk and American kestrels accounted for the majority of use during summer. American kestrels are typically less at risk to turbine strikes because of their lower flight behavior. In contrast, Swainson's hawk had greater risk of turbine strikes given that of the 78 groups of Swainson's hawks observed in-flight, 79.3% were within the RSH at initial observation making them somewhat more susceptible to turbine collisions. Generally, Swainson's hawk and red-tailed hawk use was higher at points in proximity to occupied nests (Appendix E). It has been shown that individuals, particularly juveniles, exhibiting kiting and other hunting behavior have an increased risk of collision with turbines (Watson et al. 2018).

Fall migration coincides with the large-scale movement of many raptor species to more southern latitudes where they over-winter. Observations of red-tailed hawks and northern harriers increased during fall migration; Swainson's hawk use peaked in summer post nesting but is considered a highly migratory species. Based on the higher relative use of *Buteos* and harriers during fall and summer, and flight behavior which results in a higher exposure index, there is higher potential for Swainson's hawk and red-tailed hawk fatalities compared to other raptor species. Fatalities of all three raptor species (Swainson's hawk, red-tailed hawk, and northern harrier) have been documented at operating wind projects.

Ferruginous hawks were observed during large bird surveys and during raptor nest surveys. In general, overall use was low when compared to other diurnal raptor use in the area. Ferruginous hawks were only observed during spring with very low mean use which translated into a very low exposure index for turbine collisions (<0.01). The number of unoccupied nests whose construction was indicative of ferruginous hawk suggests higher nest occupancy in the Horse Heaven Hills prior to 2017 nest surveys. A 2010 survey of 192 ferruginous hawk territories in Washington resulted in the lowest number of occupied territories (19%) over a 14-year period, which indicates a persistent population decline in Washington (WDFW 2012).

<u>Use Comparison</u>

Diurnal raptors occur in most areas with the potential for wind energy development (National Research Council [NRC] 2007). Annual mean raptor use at the Project was scaled to 20-minute to compare with other wind energy facilities in Washington and Oregon that implemented similar protocols and had data for three or four seasons. Of the 24 wind projects with publically available data, raptor use at the Project (0.795 raptors/800-m/20-min) was in the upper tail of the range of raptor use estimates (0.25–1.1 raptors/800-m/20-min; Figure 8). The Project's raptor use level was similar to that documented at the Klondike II and Leaning Juniper Projects in Oregon (NWC and WEST 2007, Gritski et al. 2008). The coinciding raptor fatality estimates at the two Projects were 0.6 and 0.16 raptors/MW/year, respectively, which were low compared to the highest raptor fatality estimate at the White Creek Project in Washington (0.47 raptors/MW/year; Appendix H).

Raptor nest density has been used as a metric to inform potential fatality rates post-construction (Watson et al. 2018); however, the evidence from the nest density/fatality relationship has been mixed (Marques et al. 2014). In the CPE, several studies show that raptor fatalities occur more often of species with higher nest densities (Johnson and Erickson 2011, Kolar 2013). Compared to raptor nest densities at proposed or operating wind projects within the CPE, nest density of within and surrounding the Project was near the median both survey years (Appendix I). Of the 15 wind energy studies in Washington and Oregon that reported nesting density (NWC and ABR 2009), the Project was ranked sixth in 2017 (0.268 nests/mi^2) and ninth in 2018, which was tied with Juniper Canyon and Stateline (0.21 nests/mi^2; range = 0.03–0.45 nests/mi^2; Appendix I).

<u>Bald and Golden Eagles</u>

Two adult bald eagles were observed during large bird use surveys for a total of nine eagle minutes. Observations of bald eagles within the Project may be associated with the occupied bald eagle nest along the Columbia River that was documented during spring 2017 and 2018 aerial surveys. Bald eagles were observed during winter when individuals typically range widely to migrate or in search of food (Kalasz and Buchanan 2016). No open water or typical bald eagle foraging resource is found in the Project; the nearest being the Columbia River, located approximately 5-miles northwest. In eastern Washington, the risk of bald eagle collision with wind turbines may be lower compared to other regions due to lower population densities (Kalasz and Buchanan 2016). Based on the distance of the Project to the nearest nest, absence of typical foraging resources (e.g., open water) and low use during 2017–2018 surveys, collision risk to bald eagles appears low.

Four golden eagles were observed during large bird use survey during the year-long survey. Of the four individuals documented, three individuals were within the survey plot. During fall 2017, two juvenile golden eagle were observed at survey Point 8, located in the north central side of the Project for a total of 6 eagle minutes. In the spring of 2018, one adult golden eagle was observed at survey Point 12 (incidental observation) and Point 13, both of which are located at the most eastern side of the Project. In total, golden eagles accounted for 66 minutes, of which, 35 were considered eagle minutes (USFWS 2013). The majority of eagle minutes consisted of one individual circling the observer for the entire survey. The adult eagle was flying low, consistently calling for the duration of the survey. No nest or young were observer and it is unknown if there was carrion in the area. Bird attraction to surveyors has been discussed as a potential source of data bias (Buckland et al. 2001, Thompson 2002); however, this behavior has not been well documented in the literature for golden eagles. The large number of eagle minutes observed from one individual, seemingly attracted to the surveyor, may disproportionately increase the risk profile of golden eagle at the Project.

Using a nine-year study of 17 golden eagles within the Columbia Plateau that found golden eagle use correlated with the proximity to nests, terrain complexity, and prey abundance researchers were able to create conservative estimates to caution wind development within 8 miles of an active golden eagle nest (Watson et al. 2014). No golden eagle nests were observed within 10 miles of the Project during aerial nest survey conducted in spring 2017 and 2018. Based on the absence of eagle nests within 10 miles of the Project, intermittent sources of prey and low use (three golden eagle observations with 36 eagle minutes documented during 2017-2018), golden eagle collision risk with turbines appears low.

Landcover

Based on the WDFW Wind Power Guidance, no mitigation is required for impacts (temporary or permanent) to agriculture (cropland or pasture) or developed/disturbed areas which are considered Class IV habitats and have generally low value to wildlife and native plants (WDFW 2009). The remaining two habitat types, shrub-steppe and grassland (including CRP lands), are considered Class III cover types requiring a 0.1:1 mitigation ratio for temporary impacts (in addition to restoring the temporarily impacted habitat) and a 1:1 ratio for permanent impacts. Shrub-steppe and grassland vegetation communities provide important breeding and foraging habitat for a number of sensitive wildlife species, and shrub-steppe is classified as a priority habitat in Washington (WDFW 2009). Grasslands within the Project area are likely classified into one of two categories: 1) areas along the margins of tilled agricultural fields or along drainages which are too steep to be cultivated or 2) parcels that are currently enrolled in the CRP. In general, it is unknown which non-cultivated grassland parcels are CRP lands as this information is not publicly available; however, for the purposes of habitat mitigation, CPR lands and grasslands are functionally similar and are both considered Class III habitats (WDFW 2009).

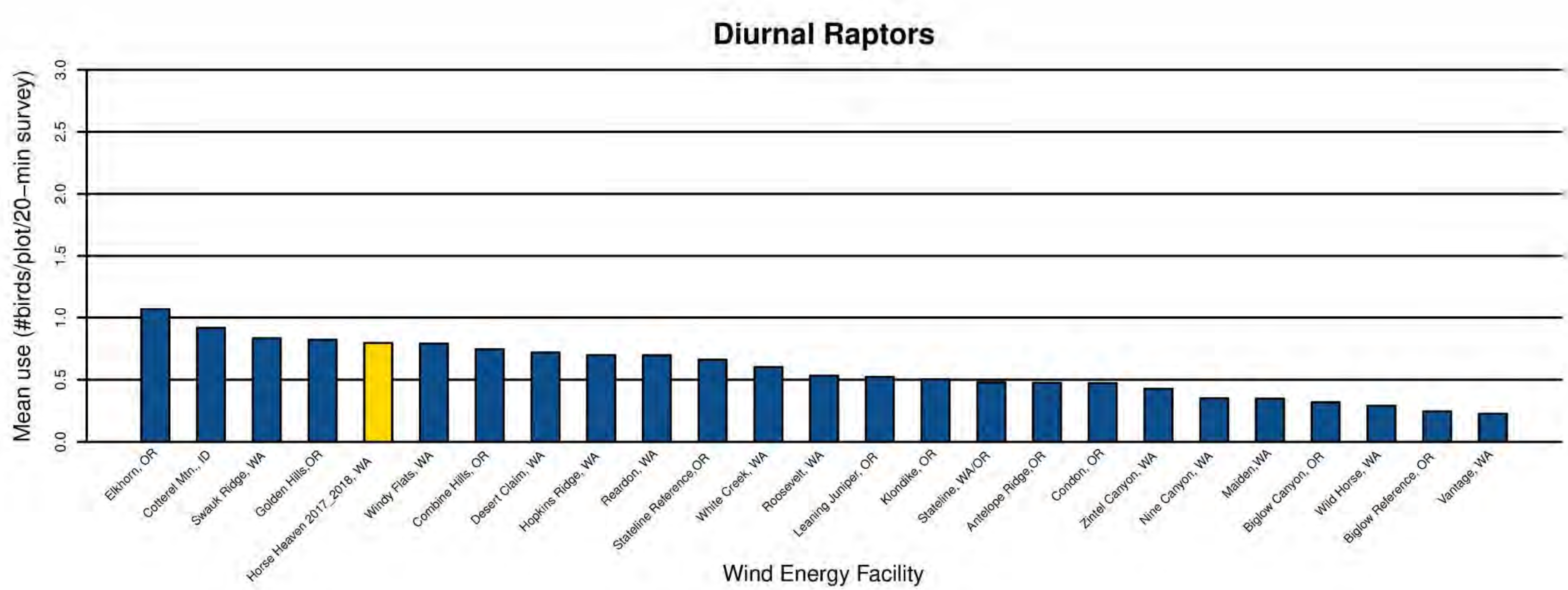

Figure 8. Comparison of estimated annual diurnal raptor use during fixed-point large bird use surveys at the Horse Heaven Wind Project from August 11, 2017 – July 16, 2018 and diurnal raptor use at other Oregon and Washington Wind Resource Areas with three or four seasons of raptor use data.

CONCLUSIONS

Tier 3 studies are used to address questions regarding impacts that could not be sufficiently addressed using available literature (i.e., during Tier 1 and 2 desktop analyses). These studies provide additional data that, when combined with available literature reviewed in previous tiers, allow for a better-informed assessment of the risk of significant adverse impacts to species of concern at the Project. Strong seasonal patterns of occurrence and use were observed in many of the species documented during the year-long survey. For example, many small bird species were only observed during the spring and/or fall migratory period with low use observed during summer which suggests limited breeding bird diversity at the Project. Horned lark was the most abundant small bird species observed in all seasons and accounted for nearly 94% of all small bird use in winter which suggests a robust year-long presence at the Project. Increased large bird use during the spring breeding season was influenced by large groups of sandhill cranes which flew over the Project, the majority of the time (90%) above the height of the rotor swept area (25-150 m AGL). Collision risk of sandhill crane may be reduced by flying over the Project and above RSH; however, some species such as the migratory Swainson's hawk may be at greater risk because of the local nesting population (six occupied nests in 2018), and their tendency to fly within the RSH. Accounting for the seasonal occurrence of bird species and areas where use may increase due to nesting may be an effective measure to minimize potential impacts to birds at the Project (Watson et al. 2018).

Collision risk was highest for Canada goose, an abundant species throughout its range, and relatively low for some raptors and other species of concern (e.g., American pelican, sandhill crane, ferruginous hawk, and long-billed curlew). Based on data from other publically available wind projects in Oregon and Washington, diurnal raptor fatality rates are expected to be within the range of fatality rates observed at other facilities. To date, overall fatality rates for birds at wind energy facilities have been consistently low, and the most recent, comprehensive, and robust studies of overall bird fatality rates at US wind facilities have produced fatality rate estimates ranging from 2.96–4.11 birds per MW, and no Project data suggests the Project would fall outside this range.

This study also was designed to document use of bald and golden eagles, following the ECPG survey recommendations and the final rule (USFWS 2013, 2016). During the year of surveys, two bald eagles were observed flying within the risk cylinder for six minutes and three golden eagles were observed flying in the risk cylinder for 35 minutes. Golden eagle collision risk appears high based on the number of golden eagle minutes; however, the risk profile consisted of two golden eagle observations, of which one observation was likely influenced by the presence of the surveyor and may overestimate golden eagle collision risk at the Project. Washington ground squirrels exist along the Project roads; however, no raptors were observed actively and consistently hunting squirrel colonies during over 320 hours of large bird survey. This may be due to the smaller size of the squirrel or because of the limited amount of time squirrels spend above ground (WDFW, per comm.). Together, the distance of eagle nests from the Project, lack of suitable prey base and low use during 322 hours of observation suggests collision risk to eagles is low. An additional year of large bird surveys is currently underway (2018–2019) will provide additional information on eagle use and risk at the Project.

Landcover at the Project is consistent with the matrix of agriculture and grasslands commonly found in the region. Native shrub-steppe was highly fragmented with small patches scattered throughout the Project. Many of the grasslands delineated in the landcover classification were enrolled in CRP and may be converted back to agriculture in the future if contracts expire or financial conditions change.

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Appendix A. Summary of the Number of Observations and Groups Recorded by Species and Bird Type for 10-minute Small Bird Use Surveys (Appendix A1) and 60-minute Large Bird Use Surveys (Appendix A2) at the Horse Heaven Wind Project from August 11, 2017 to July 16, 2018.

Appendix A1. Summary of individuals and group observations by bird type and species for 10-minute fixed-point small bird use surveys at the Horse Heaven Wind Project from August 11, 2017 – July 16, 2018.

		Spring		Summer		Fall		Winter		Total	
Type/Species	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Passerines		274	440	181	253	175	491	154	942	784	2126
bank swallow	*Riparia riparia*	1	20	7	18	1	2	0	0	9	40
barn swallow	*Hirundo rustica*	3	10	2	3	5	28	0	0	10	41
Brewer's blackbird	*Euphagus cyanocephalus*	3	6	1	1	1	5	0	0	5	12
chipping sparrow	*Spizella passerina*	0	0	0	0	1	1	0	0	1	1
cliff swallow	*Petrochelidon pyrrhonota*	0	0	2	3	2	5	0	0	4	8
dark-eyed junco	*Junco hyemalis*	0	0	0	0	1	1	0	0	1	1
European starling	*Sturnus vulgaris*	5	19	0	0	1	2	1	1	7	22
golden-crowned sparrow	*Zonotrichia atricapilla*	0	0	0	0	0	0	1	1	1	1
grasshopper sparrow	*Ammodramus savannarum*	0	0	1	1	0	0	0	0	1	1
horned lark	*Eremophila alpestris*	233	348	147	190	121	345	137	914	638	1797
house sparrow	*Passer domesticus*	0	0	0	0	0	0	1	1	1	1
sagebrush sparrow	*Artemisiospiza nevadensis*	1	1	0	0	0	0	0	0	1	1
Savannah sparrow	*Passerculus sandwichensis*	2	2	0	0	1	2	0	0	3	4
Say's phoebe	*Sayornis saya*	1	1	0	0	0	0	0	0	1	1
song sparrow	*Melospiza melodia*	0	0	0	0	1	3	0	0	1	3
spotted towhee	*Pipilo maculatus*	0	0	0	0	1	1	0	0	1	1
unidentified sparrow	*NA*	0	0	0	0	1	1	0	0	1	1
unidentified swallow	*NA*	0	0	2	6	0	0	0	0	2	6
western kingbird	*Tyrannus verticalis*	0	0	8	18	1	3	0	0	9	21
western meadowlark	*Sturnella neglecta*	24	27	11	13	24	38	11	19	70	97
white-crowned sparrow	*Zonotrichia leucophrys*	1	6	0	0	13	54	3	6	17	66
Woodpeckers		0	0	0	0	3	3	0	0	3	3
northern flicker	*Colaptes auratus*	0	0	0	0	3	3	0	0	3	3
Unidentified Birds		0	0	0	0	11	42	1	34	12	76
unidentified bird (small)	*NA*	0	0	0	0	11	42	1	34	12	76
Overall		**274**	**440**	**181**	**253**	**189**	**536**	**155**	**976**	**799**	**2,205**

Appendix A2. Summary of individuals and group observations by bird type and species for 60-minute fixed-point large bird use surveys at the Horse Heaven Wind Project from April 11, 2017 – July 16, 2018.

		Spring		Summer		Fall		Winter		Total	
Type/Species	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Waterbirds		**2**	**390**	**1**	**1**	**6**	**162**	**0**	**0**	**9**	**553**
American white pelican	*Pelecanus erythrorhynchos*	0	0	1	1	0	0	0	0	1	1
sandhill crane	*Antigone canadensis*	2	390	0	0	6	162	0	0	8	552
Waterfowl		**0**	**0**	**0**	**0**	**4**	**175**	**10**	**314**	**14**	**489**
Canada goose	*Branta canadensis*	0	0	0	0	4	175	9	214	13	389
snow goose	*Chen caerulescens*	0	0	0	0	0	0	1	100	1	100
Shorebirds		**2**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**2**
long-billed curlew	*Numenius americanus*	2	2	0	0	0	0	0	0	2	2
Gulls/Terns		**10**	**180**	**0**	**0**	**0**	**0**	**0**	**0**	**10**	**180**
California gull	*Larus californicus*	6	133	0	0	0	0	0	0	6	133
unidentified gull	*NA*	4	47	0	0	0	0	0	0	4	47
Diurnal Raptors		**120**	**120**	**84**	**87**	**205**	**235**	**125**	**128**	**534**	**570**
Accipiters		**2**	**2**	**0**	**0**	**4**	**4**	**0**	**0**	**6**	**6**
Cooper's hawk	*Accipiter cooperii*	1	1	0	0	2	2	0	0	3	3
sharp-shinned hawk	*Accipiter striatus*	1	1	0	0	2	2	0	0	3	3
Buteos		**76**	**76**	**64**	**67**	**69**	**82**	**47**	**50**	**256**	**275**
ferruginous hawk	*Buteo regalis*	3	3	0	0	0	0	0	0	3	3
red-tailed hawk	*Buteo jamaicensis*	22	22	10	10	29	31	9	9	70	72
rough-legged hawk	*Buteo lagopus*	21	21	0	0	21	22	35	37	77	80
Swainson's hawk	*Buteo swainsoni*	26	26	50	52	18	28	0	0	94	106
unidentified buteo	*NA*	4	4	4	5	1	1	3	4	12	14
Northern Harrier		**32**	**32**	**9**	**9**	**100**	**110**	**59**	**59**	**200**	**210**
northern harrier	*Circus cyaneus*	32	32	9	9	100	110	59	59	200	210
Eagles		**2**	**2**	**0**	**0**	**2**	**2**	**2**	**2**	**6**	**6**
bald eagle	*Haliaeetus leucocephalus*	0	0	0	0	0	0	2	2	2	2
golden eagle	*Aquila chrysaetos*	2	2	0	0	2	2	0	0	4	4
Falcons		**6**	**6**	**11**	**11**	**23**	**30**	**15**	**15**	**55**	**62**
American kestrel	*Falco sparverius*	6	6	11	11	21	28	12	12	50	57
prairie falcon	*Falco mexicanus*	0	0	0	0	2	2	1	1	3	3
unidentified falcon	*NA*	0	0	0	0	0	0	2	2	2	2
Other Raptors		**2**	**2**	**0**	**0**	**7**	**7**	**2**	**2**	**11**	**11**
unidentified raptor	*NA*	2	2	0	0	7	7	2	2	11	11
Owls		**2**	**2**	**0**	**0**	**0**	**0**	**3**	**3**	**5**	**5**
great horned owl	*Bubo virginianus*	2	2	0	0	0	0	3	3	5	5

Appendix A2. Summary of individuals and group observations by bird type and species for 60-minute fixed-point large bird use surveys at the Horse Heaven Wind Project from April 11, 2017 – July 16, 2018.

		Spring		Summer		Fall		Winter		Total	
Type/Species	Scientific Name	# grps	# obs	# grps	# obs	# grps	# obs	# grps	# obs	# grps	# obs
Upland Game Birds		**2**	**2**	**3**	**3**	**0**	**0**	**0**	**0**	**5**	**5**
ring-necked pheasant	*Phasianus colchicus*	2	2	3	3	0	0	0	0	5	5
Doves/Pigeons		**26**	**72**	**6**	**18**	**12**	**208**	**9**	**182**	**53**	**480**
mourning dove	*Zenaida macroura*	3	3	0	0	0	0	0	0	3	3
rock pigeon	*Columba livia*	23	69	6	18	12	208	9	182	50	477
Large Corvids		**99**	**141**	**16**	**20**	**111**	**165**	**83**	**130**	**309**	**456**
American crow	*Corvus brachyrhynchos*	2	3	0	0	0	0	0	0	2	3
black-billed magpie	*Pica hudsonia*	0	0	0	0	0	0	1	1	1	1
common raven	*Corvus corax*	97	138	16	20	111	165	82	129	306	452
Overall		**263**	**909**	**110**	**129**	**338**	**945**	**230**	**757**	**941**	**2,740**

Appendix B. Mean Use, Percent of Use, and Frequency of Occurrence for Small Bird (Appendix B1) and Large Bird (Appendix B2) Types and Species Observed during Fixed-Point Surveys at the Horse Heaven Wind Project from August 11, 2017 to July 16, 2018.

Appendix B1. Mean small bird use (number of all birds/100-meter plot/10-min survey), percent of total use (%), and frequency of occurrence (%) for each bird type and species by season during the fixed-point surveys at the Horse Heaven Wind Project from August 11, 2017 – July 16, 2018.

	Mean Use				% of Use				% Frequency			
Type/Species	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
Passerines	**5.71**	**4.87**	**4.71**	**10.48**	**100**	**100**	**91.6**	**96.6**	**85.9**	**82.7**	**66.3**	**62.4**
bank swallow	0.26	0.35	0.02	0	4.5	7.1	0.4	0	1.3	11.5	1.0	0
barn swallow	0.13	0.06	0.27	0	2.2	1.2	5.2	0	3.8	3.8	4.8	0
Brewer's blackbird	0.08	0.02	0.05	0	1.3	0.4	0.9	0	2.6	1.9	1.0	0
chipping sparrow	0	0	<0.01	0	0	0	0.2	0	0	0	1.0	0
cliff swallow	0	0.06	0.05	0	0	1.2	0.9	0	0	3.8	1.9	0
dark-eyed junco	0	0	<0.01	0	0	0	0.2	0	0	0	1.0	0
European starling	0.25	0	0.02	0	4.3	0	0.4	0	6.5	0	1.0	0
golden-crowned sparrow	0	0	0	0.01	0	0	0	0.1	0	0	0	1.1
grasshopper sparrow	0	0.02	0	0	0	0.4	0	0	0	1.9	0	0
horned lark	4.51	3.65	3.32	10.18	79.0	75.1	64.5	93.8	80.7	69.2	54.8	60.2
house sparrow	0	0	0	0.01	0	0	0	0.1	0	0	0	1.1
sagebrush sparrow	0.01	0	0	0	0.2	0	0	0	1.4	0	0	0
Savannah sparrow	0.03	0	0.02	0	0.4	0	0.4	0	2.6	0	1.0	0
Say's phoebe	0.01	0	0	0	0.2	0	0	0	1.3	0	0	0
song sparrow	0	0	0.03	0	0	0	0.6	0	0	0	1.0	0
spotted towhee	0	0	<0.01	0	0	0	0.2	0	0	0	1.0	0
unidentified sparrow	0	0	<0.01	0	0	0	0.2	0	0	0	1.0	0
unidentified swallow	0	0.12	0	0	0	2.4	0	0	0	3.8	0	0
western kingbird	0	0.35	0.03	0	0	7.1	0.6	0	0	9.6	1.0	0
western meadowlark	0.36	0.25	0.36	0.21	6.2	5.1	6.9	2	20.9	15.4	16.3	8.1
white-crowned sparrow	0.08	0	0.52	0.07	1.5	0	10.1	0.6	1.4	0	10.6	2.2
Woodpeckers	**0**	**0**	**0.03**	**0**	**0**	**0**	**0.6**	**0**	**0**	**0**	**1.9**	**0**
northern flicker	0	0	0.03	0	0	0	0.6	0	0	0	1.9	0
Unidentified Birds	**0**	**0**	**0.40**	**0.37**	**0**	**0**	**7.9**	**3.4**	**0**	**0**	**8.7**	**1.1**
unidentified bird (small)	0	0	0.40	0.37	0	0	7.9	3.4	0	0	8.7	1.1
Overall	**5.71**	**4.87**	**5.14**	**10.85**	**100**	**100**	**100**	**100**				

Appendix B2. Mean large bird use (number of large birds/800-meter plot/60-min survey), percent of total use (%), and frequency of occurrence (%) for each large bird type and species by season during the fixed-point surveys at the Horse Heaven Wind Project from August 11, 2017 – July 16, 2018.

	Mean Use				% of Use				% Frequency			
Type/Species	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
Waterbirds	**5.03**	**0.02**	**1.56**	**0**	**43.0**	**0.8**	**17.3**	**0**	**2.7**	**1.9**	**4.8**	**0**
American white pelican	0	0.02	0	0	0	0.8	0	0	0	1.9	0	0
sandhill crane	5.03	0	1.56	0	43.0	0	17.3	0	2.7	0	4.8	0
Waterfowl	**0**	**0**	**1.68**	**3.65**	**0**	**0**	**18.6**	**42.7**	**0**	**0**	**2.9**	**9**
Canada goose	0	0	1.68	2.35	0	0	18.6	27.5	0	0	2.9	7.7
snow goose	0	0	0	1.30	0	0	0	15.2	0	0	0	1.3
Shorebirds	**0.03**	**0**	**0**	**0**	**0.2**	**0**	**0**	**0**	**2.6**	**0**	**0**	**0**
long-billed curlew	0.03	0	0	0	0.2	0	0	0	2.6	0	0	0
Gulls/Terns	2.31	0	0	0	19.7	0	0	0	10.3	0	0	0
California gull	1.71	0	0	0	14.6	0	0	0	7.7	0	0	0
unidentified gull	0.60	0	0	0	5.2	0	0	0	5.1	0	0	0
Diurnal Raptors	**1.54**	**1.67**	**2.22**	**1.43**	**13.2**	**67.4**	**24.6**	**16.8**	**71.3**	**63.5**	**73.1**	**60**
Accipiters	0.03	0	0.04	0	0.2	0	0.4	0	2.6	0	3.8	0
Cooper's hawk	0.01	0	0.02	0	0.1	0	0.2	0	1.3	0	1.9	0
sharp-shinned hawk	0.01	0	0.02	0	0.1	0	0.2	0	1.3	0	1.9	0
Buteos	0.98	1.29	0.76	0.57	8.4	51.9	8.4	6.6	60.8	59.6	36.5	31.7
ferruginous hawk	0.04	0	0	0	0.3	0	0	0	4.1	0	0	0
red-tailed hawk	0.28	0.19	0.30	0.10	2.4	7.8	3.3	1.2	23.3	13.5	21.2	8.3
rough-legged hawk	0.27	0	0.21	0.42	2.3	0	2.3	4.9	20.6	0	14.4	25.9
Swainson's hawk	0.33	1.0	0.25	0	2.9	40.3	2.8	0	21.8	46.2	9.6	0
unidentified buteo	0.05	0.1	0	0.05	0.4	3.9	0	0.6	5.1	7.7	0	3.5
Northern Harrier	0.42	0.17	1.05	0.66	3.6	7.0	11.6	7.7	29.9	11.5	49	38.2
northern harrier	0.42	0.17	1.05	0.66	3.6	7.0	11.6	7.7	29.9	11.5	49	38.2
Eagles	0.01	0	0.02	0.02	0.1	0	0.2	0.3	1.3	0	1.0	1.1
bald eagle	0	0	0	0.02	0	0	0	0.3	0	0	0	1.1
golden eagle	0.01	0	0.02	0	0.1	0	0.2	0	1.3	0	1.0	0
Falcons	0.08	0.21	0.29	0.16	0.7	8.5	3.2	1.9	7.7	9.6	18.3	13.2
American kestrel	0.08	0.21	0.27	0.13	0.7	8.5	3	1.5	7.7	9.6	17.3	9.9
prairie falcon	0	0	0.02	0.01	0	0	0.2	0.1	0	0	1.9	1.1
unidentified falcon	0	0	0	0.02	0	0	0	0.3	0	0	0	2.2

Appendix B2. Mean large bird use (number of large birds/800-meter plot/60-min survey), percent of total use (%), and frequency of occurrence (%) for each large bird type and species by season during the fixed-point surveys at the Horse Heaven Wind Project from August 11, 2017 – July 16, 2018.

	Mean Use				% of Use				% Frequency			
Type/Species	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
Other Raptors	0.03	0	0.07	0.02	0.2	0	0.7	0.3	2.6	0	6.7	2.2
unidentified raptor	0.03	0	0.07	0.02	0.2	0	0.7	0.3	2.6	0	6.7	2.2
Owls	**0**	**0**	**0**	**0.01**	**0**	**0**	**0**	**0.2**	**0**	**0**	**0**	**1.3**
great horned owl	0	0	0	0.01	0	0	0	0.2	0	0	0	1.3
Upland Game Birds	0.03	0.06	0	0	0.2	2.3	0	0	2.7	3.8	0	0
ring-necked pheasant	0.03	0.06	0	0	0.2	2.3	0	0	2.7	3.8	0	0
Doves/Pigeons	**0.94**	**0.35**	**2.00**	**2.01**	**8.1**	**14.0**	**22.2**	**23.5**	**29.9**	**11.5**	**9.6**	**8.9**
mourning dove	0.04	0	0	0	0.3	0	0	0	1.3	0	0	0
rock pigeon	0.90	0.35	2.00	2.01	7.7	14.0	22.2	23.5	28.6	11.5	9.6	8.9
Large Corvids	**1.82**	**0.38**	**1.57**	**1.45**	**15.6**	**15.5**	**17.4**	**16.9**	**72.9**	**21.2**	**52.9**	**53.5**
American crow	0.04	0	0	0	0.3	0	0	0	2.6	0	0	0
black-billed magpie	0	0	0	0.01	0	0	0	0.1	0	0	0	1.1
common raven	1.78	0.38	1.57	1.44	15.2	15.5	17.4	16.8	71.6	21.2	52.9	53.5
Overall	**11.69**	**2.48**	**9.03**	**8.56**	**100**	**100**	**100**	**100**				

Appendix C. Species Exposure Indices for Large Birds during Fixed-Point Bird Use Surveys at the Horse Heaven Wind Project from August 11, 2017 to July 16, 2018.

Appendix C. Relative exposure index and flight characteristics for each bird species during the fixed-point 60-minute large bird use surveys at the Horse Heaven Wind Project from August 11, 2017 – July 16, 2018.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within RSH based on initial obs	Exposure Index	% Within RSH at anytime
Canada goose	13	1.11	100	87.7	0.98	94.3
rock pigeon	41	1.41	69.6	41.0	0.40	52.4
California gull	6	0.40	100	88.7	0.36	88.7
snow goose	1	0.33	100	100	0.33	100
Swainson's hawk	78	0.36	83.7	79.3	0.24	93.1
common raven	279	1.34	92.0	17.4	0.21	32.2
sandhill crane	7	1.65	90.9	9.8	0.15	82.5
red-tailed hawk	59	0.22	84.7	72.1	0.14	85.2
unidentified gull	4	0.14	100	93.6	0.13	93.6
rough-legged hawk	71	0.23	92.5	59.5	0.13	78.4
unidentified *Buteo*	9	0.04	84.6	81.8	0.03	81.8
northern harrier	195	0.62	98.1	3.9	0.02	9.3
unidentified raptor	11	0.03	100	54.5	0.02	81.8
American kestrel	29	0.18	50.9	17.2	0.02	27.6
golden eagle	2	<0.01	66.7	100	<0.01	100
American white pelican	1	<0.01	100	100	<0.01	100
ferruginous hawk	3	<0.01	100	33.3	<0.01	66.7
Cooper's hawk	3	<0.01	100	33.3	<0.01	33.3
bald eagle	2	<0.01	100	50.0	<0.01	100
ring-necked pheasant	0	0.02	0	0	0	0
mourning dove	2	<0.01	66.7	0	0	0
American crow	2	<0.01	100	0	0	0
sharp-shinned hawk	3	<0.01	100	0	0	33.3
prairie falcon	2	<0.01	66.7	0	0	0
long-billed curlew	0	<0.01	0	0	0	0
unidentified falcon	1	<0.01	50.0	0	0	0
great horned owl	0	<0.01	0	0	0	0
black-billed magpie	1	<0.01	100	0	0	0

RSH: The likely "rotor swept heights" for potential collision with a turbine blade, or 25-150 m (82-492 ft) above ground level (AGL).

Appendix D. Mean Use by Point for Small Birds (Appendix D1) and Large Birds (Appendix D2) during Fixed-Point Bird Use Surveys at the Horse Heaven Wind Project from August 11, 2017 to July 16, 2018.

Appendix D1. Mean use (number of birds/10-minute survey) by point for small birds[a], major bird types, observed at the Horse Heaven Wind Project during fixed-point bird use surveys from August 11, 2017 – July 16, 2018.

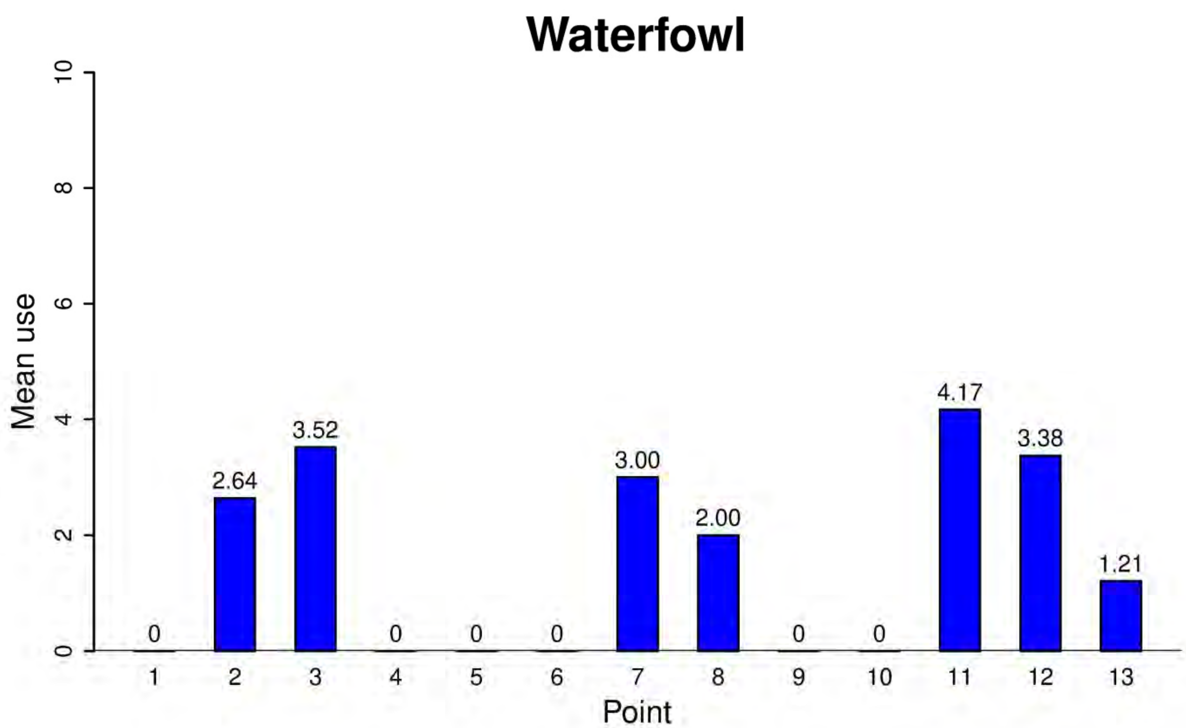
	Survey Point												
Bird Type	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Passerines	5.44	6.40	15.84	13.56	3.75	2.48	11.92	6.44	5.28	3.48	5.48	4.00	1.25
Woodpeckers	0	0	0	0	0	0	0	0.12	0	0	0	0	0
Unidentified Birds	0	0.04	0.04	1.68	0	0	0.08	0.64	0	0.56	0	0	0
All Small Birds	**5.44**	**6.44**	**15.88**	**15.24**	**3.75**	**2.48**	**12.00**	**7.20**	**5.28**	**4.04**	**5.48**	**4.00**	**1.25**

[a]. 100-meter (m) radius plot for small birds.

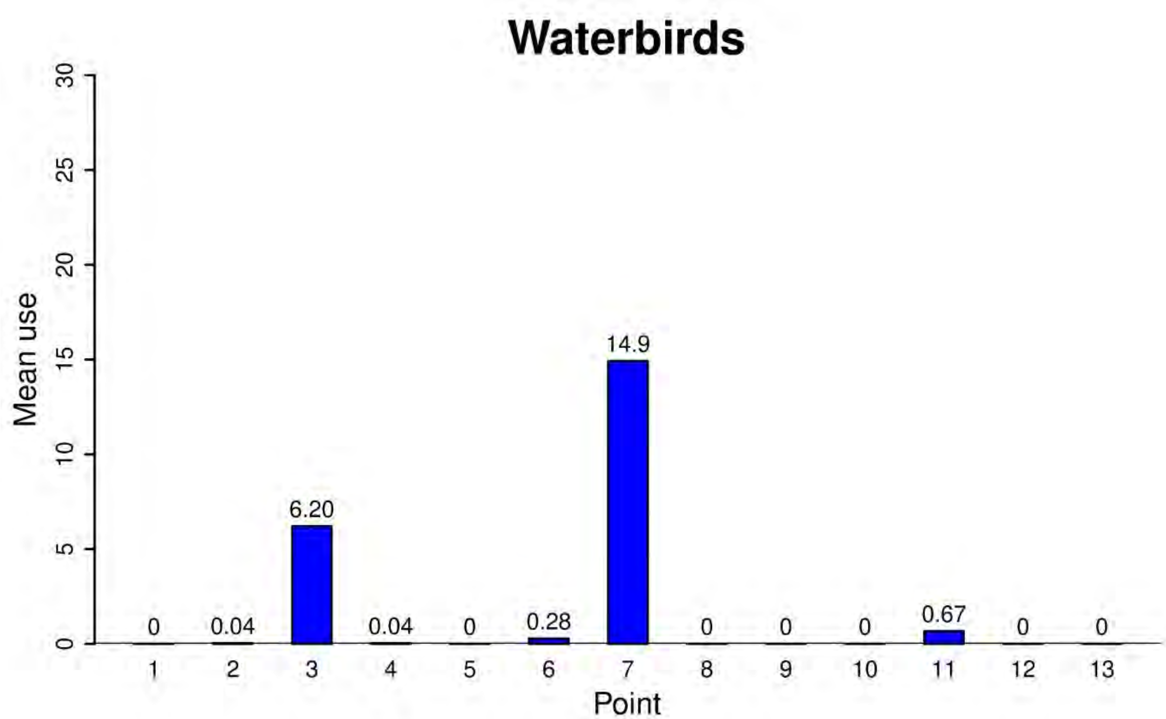
Appendix D2. Mean use (number of birds/60-minute survey) by point for all large birds[a], major bird types, and diurnal raptor subtypes observed at the Horse Heaven Wind Project during large bird use surveys from August 11, 2017 – July 16, 2018.

Bird Type	Survey Point												
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Waterbirds	0	0.04	6.20	0.04	0	0.28	14.92	0	0	0	0.67	0	0
Waterfowl	0	2.64	3.52	0	0	0	3.00	2.00	0	0	4.17	3.38	1.21
Shorebirds	0	0	0.04	0.04	0	0	0	0	0	0	0	0	0
Gulls/Terns	0	0	0	0.52	0	0	0.52	4.76	0.12	0	1.25	0	0.08
Diurnal Raptors	1.08	1.24	1.52	1.84	1.46	2.48	2.88	2.68	1.44	0.64	1.21	2.17	2.25
Accipiters	0	0	0.04	0	0	0	0	0	0	0.04	0.04	0.08	0.04
Buteos	0.28	0.40	0.44	0.68	1.00	1.48	1.72	1.24	0.92	0.40	0.67	0.75	1.04
Northern Harrier	0.44	0.68	0.84	1.08	0.38	0.48	0.72	0.76	0.40	0.16	0.21	1.21	1.12
Eagles	0	0	0	0	0	0	0	0.16	0	0	0	0	0.04
Falcons	0.36	0.08	0.20	0.08	0	0.52	0.32	0.44	0.12	0	0.29	0.08	0
Other Raptors	0	0.08	0	0	0.08	0	0.12	0.08	0	0.04	0	0.04	0
Owls	0	0	0	0	0	0	0	0	0	0	0.04	0	0
Upland Game Birds	0	0	0	0	0	0	0.04	0.04	0	0.12	0	0	0
Doves/Pigeons	0.16	0	0.08	0	0	4.12	3.00	0.88	0.24	0	0.17	2.67	8.33
Large Corvids	0.92	1.40	1.56	0.84	2.17	2.00	1.76	1.24	1.60	0.84	0.75	2.08	1.21
All Large Birds	**2.16**	**5.32**	**12.92**	**3.28**	**3.62**	**8.88**	**26.12**	**11.60**	**3.40**	**1.60**	**8.25**	**10.29**	**13.08**

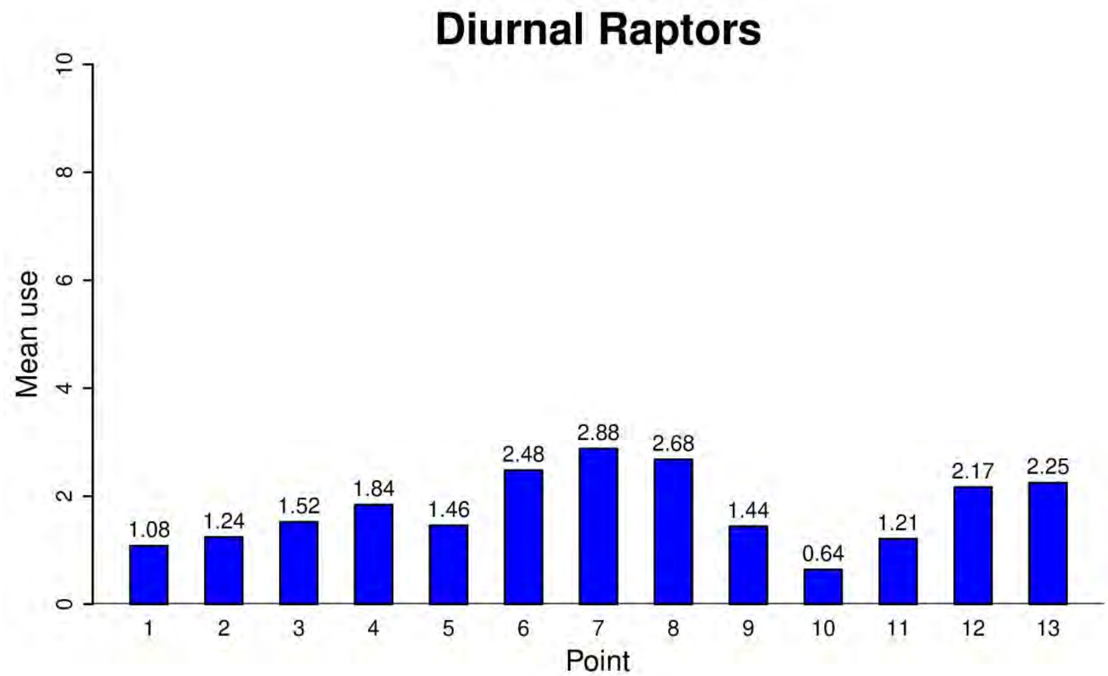
[a]. 800-meter (m) radius plot for large birds.



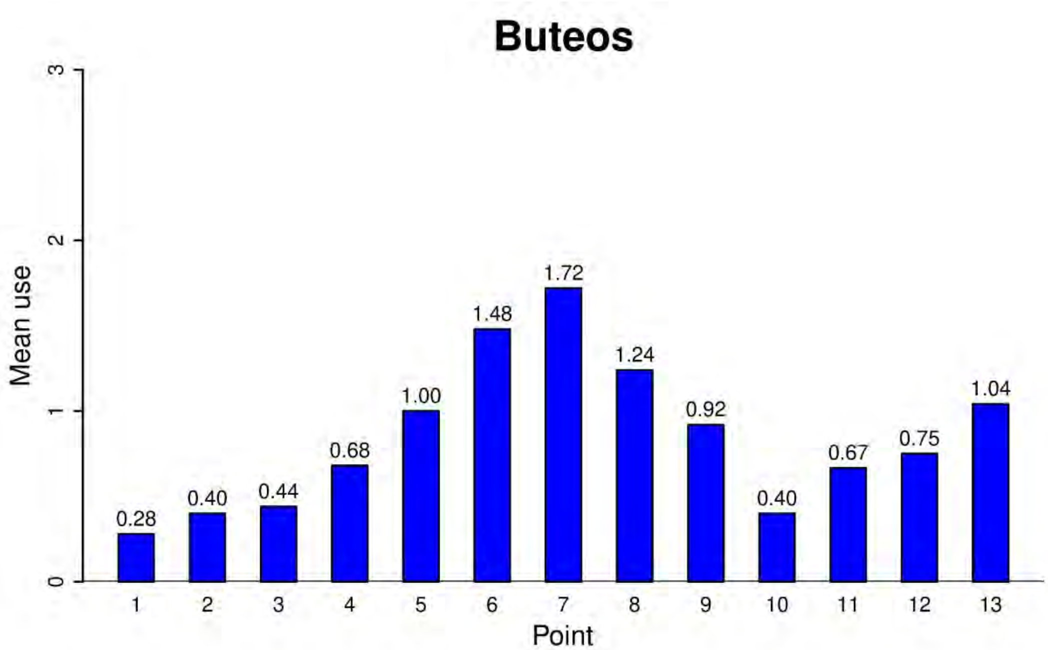
Appendix D3. Mean use by point by waterfowl at the Horse Heaven Wind Project during large bird use surveys from August 11, 2017 to July 16, 2018.



Appendix D4. Mean use by point by waterbird at the Horse Heaven Wind Project during large bird use surveys from August 11, 2017 to July 16, 2018. High mean use at point 7 represents large numbers of sandhill cranes.



Appendix D5. Mean raptor use by point during fixed-point large bird use surveys at the Horse Heaven Wind Project from August 11, 2017 to July 16, 2018.



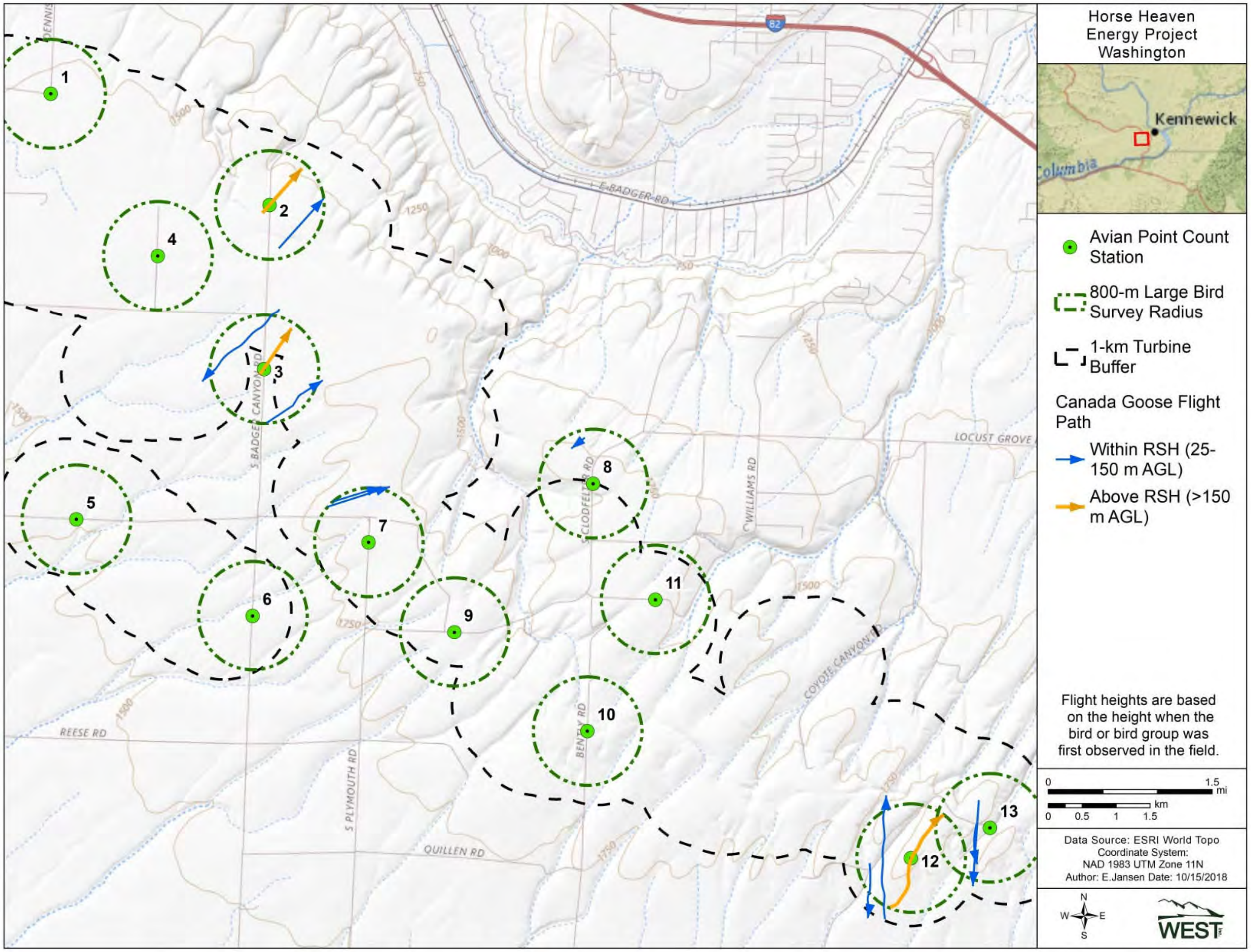
Appendix D6. Mean *Buteo* use by point during fixed-point large bird use surveys at the Horse Heaven Wind Project from August 11, 2017 to July 16, 2018.

Appendix E. Large Bird Flight Paths Observed at the Horse Heaven Wind Project from August 11, 2017 to July 16, 2018.

Select species* include:

- Canada goose (Appendix E1)
- Red-tailed hawk (Appendix E2)
- Swainson's hawk (Appendix E3)
- Sandhill crane (Appendix E4)
- Bald eagle (Appendix E5)
- Golden eagle (Appendix E6)

* Flight path data for all mapped large birds available upon request.



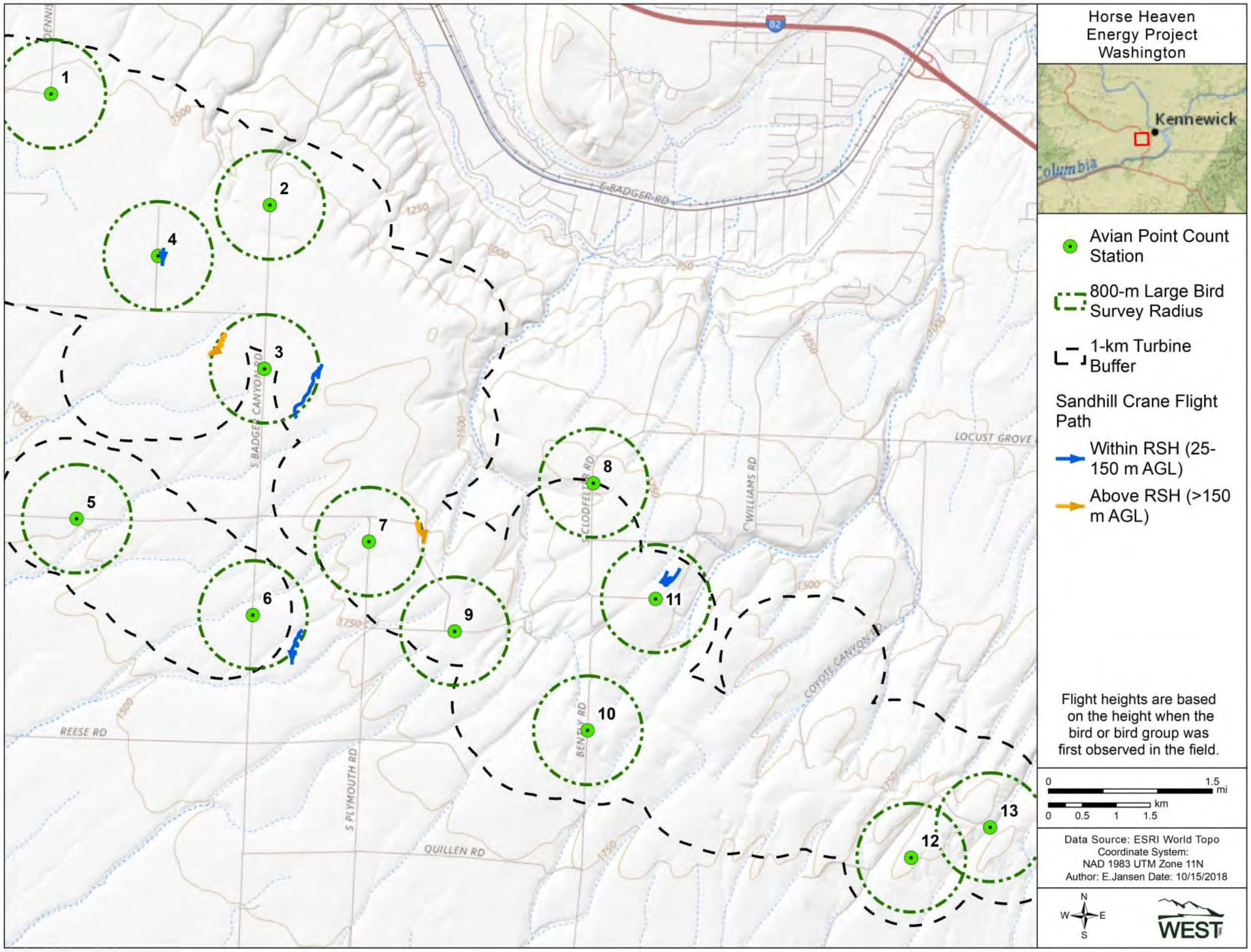
Appendix E1. Canada goose flight paths (*n* = 13) recorded at the Horse Heaven Wind Project during large bird use surveys conducted August 11, 2017 to July 16, 2018.

[REDACTED DUE TO SENSITIVE INFORMATION]

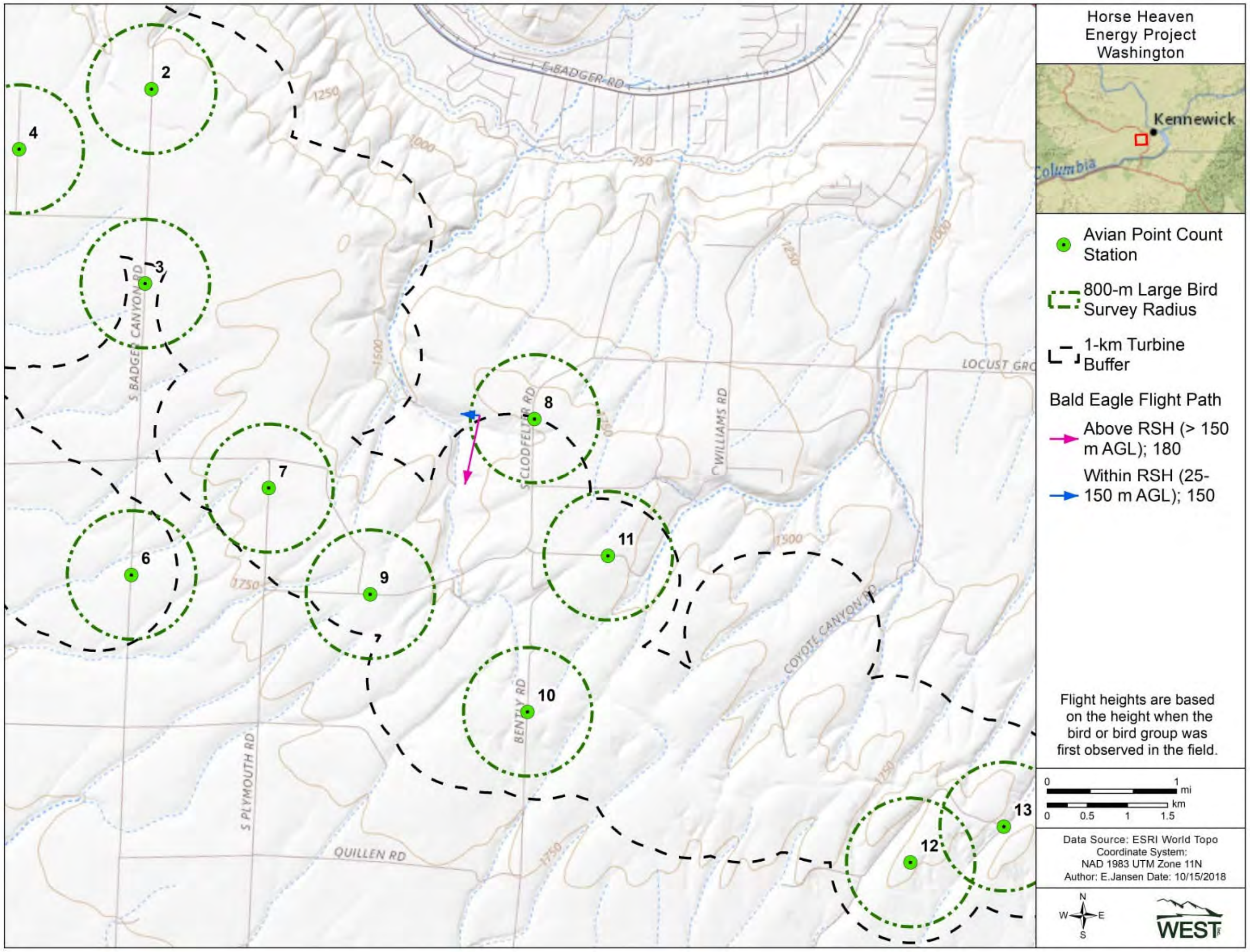
Appendix E2. Red-tailed hawk flight paths (*n* = 67) recorded at the Horse Heaven Wind Project during large bird use surveys conducted August 11, 2017 to July 16, 2018.

[REDACTED DUE TO SENSITIVE INFORMATION]

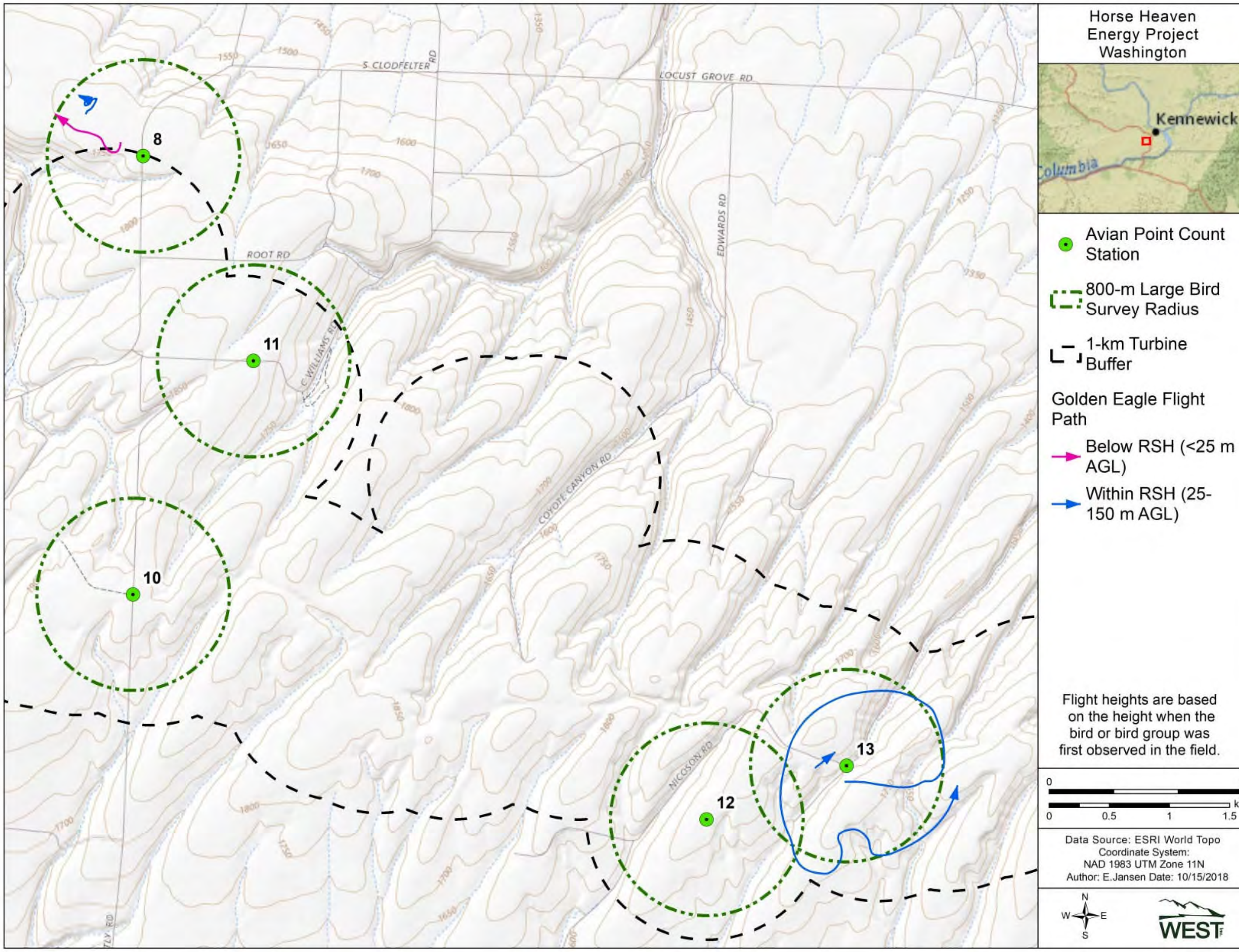
Appendix E3. Swainson's hawk flight paths (*n* = 77) recorded at the Horse Heaven Wind Project during large bird use surveys conducted August 11, 2017 to July 16, 2018.



Appendix E4. Sandhill crane flight paths (n = 7) recorded at the Horse Heaven Wind Project during large bird use surveys conducted August 11, 2017 to July 16, 2018.



Appendix E5. Bald eagle flight paths (*n* = 2) recorded at the Horse Heaven Wind Project during large bird use surveys conducted August 11, 2017 to July 16, 2018.



Appendix E6. Golden eagle flight path (*n* = 4) recorded at the Horse Heaven Wind Project during large bird use surveys conducted August 11, 2017 to July 16, 2018.

Appendix F. 2017 (Appendix F1) and 2018 (Appendix F2) Raptor Nest Survey Results from Aerial and Ground Surveys conducted at the Horse Heaven Wind Project.

Appendix F1. 2017 raptor nest results for aerial surveys conducted March 31 and May 10 at the proposed Horse Heaven Wind Project, Washington.

Nest ID	Species	Nest Status	Nest Substrate	Comment
1	Red-tailed Hawk	Occupied	Tree	Adult on nest first survey; one chick approximately 14-day old chick on nest second survey
2	Great-horned Owl	Occupied	Tree	Adult GHOW on nest first survey, two RTHA perched on adjacent tree; No sign of nesting or adults second survey
3	Ferruginous Hawk	Occupied	Tree	Adult perched on nest first survey; adult sitting in nest second survey
4	Unknown Raptor	Unoccupied	Ground	Characteristic of ferruginous hawk nest; large nest in fair condition; no sign of nesting either survey
5	Unknown Raptor	Unoccupied	Tree	**Two nests located in one tree**; no sign of nesting either survey
6	Common Raven	Occupied	Windmill	Adult on nest first and second survey
7	Red-tailed Hawk	Occupied	Tree	Adult on nest first survey; no sign of nesting of adult observed second survey
8	Ferruginous Hawk	Occupied	Ground	Adult on nest first survey; no sign of nesting of adult observed second survey
9	Red-tailed Hawk	Occupied	Tree	Adult on nest first survey; two chicks approximately 21-day old second survey; cottonwood tree
10	Unknown Raptor	Unoccupied	Ground	Characteristic of ferruginous hawk nest; nest poor condition, no recent maintenance
11	Unknown Raptor	Unoccupied	Ground	Characteristic of ferruginous hawk nest; nest poor condition, no recent maintenance
12	Red-tailed Hawk	Occupied	Cliff	Adult on nest first survey; one chick approximately 21-day old second survey
13	Unknown Raptor	Unoccupied	Ground	Characteristic of ferruginous hawk nest; nest poor condition, no recent maintenance
14	Great-horned Owl	Occupied	Tree	Adult on nest first survey; two young owls (branchlets) standing in tree adjacent to nest second survey

Appendix F1. 2017 raptor nest results for aerial surveys conducted March 31 and May 10 at the proposed Horse Heaven Wind Project, Washington.

Nest ID	Species	Nest Status	Nest Substrate	Comment
15	Unknown Raptor	Unoccupied	Cliff	Characteristic of ferruginous hawk nest; nest poor condition, no recent maintenance
16	Unknown Raptor	Unoccupied	Ground	Characteristic of ferruginous hawk nest; nest fair condition, no recent maintenance
17	Unknown Raptor	Unoccupied	Ground	Characteristic of ferruginous hawk nest; nest good condition, no recent maintenance
18	Bald Eagle	Occupied	Tree	Adult on nest first survey, mate perched in tree adjacent to river; One chick approximately 21-day old second survey
19	Swainson's Hawk	Occupied	Tree	Not observed first survey; adult on nest second survey
20	Unknown Raptor	Unoccupied	Tree	Not observed first survey; no sign of nesting or adults observed second survey

[1] Occupied = 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; Unoccupied = no sign of nesting or territory occupancy in the current nesting season.

Appendix F2. 2018 raptor nest results for aerial surveys conducted March 5 and May 10 and ground surveys throughout summer 2018 at the proposed Horse Heaven Wind Project, Washington.

Nest ID	2018 Species	Nest Status	Nest Substrate	2017 Spp.	Comment
1	Unknown Raptor	Unoccupied	Tree	RTHA	
2	Swainson's Hawk	Occupied	Tree	GHOW	One adult sitting on the nest during second survey.
3	Ferruginous Hawk	Occupied	Tree	FEHA	One adult sitting on the nest during second survey; eggs observed.
4	Unknown Raptor	Unoccupied	Ground	UNRA	Large-sized nest
5	Unknown Raptor	Unoccupied	Tree	UNRA	Two nests located in one tree; no sign of nesting either survey. Nests in poor condition
6	Common Raven	Occupied	Windmill	CORA	One adult sitting on the nest; eggs observed
7	Great-horned Owl	Occupied	Tree	RTHA	Adult with eggs in nest during first survey; vacant second survey
8	Unknown Raptor	Unoccupied	Ground	FEHA	Characteristic ferruginous hawk nest. Good condition.
9	Red-tailed Hawk	Occupied	Tree	RTHA	One young observed during second survey
10	Unknown Raptor	Unoccupied	Ground	UNRA	Characteristic ferruginous hawk nest. Poor condition.
11	Unknown Raptor	Unoccupied	Ground	UNRA	Characteristic ferruginous hawk nest. Poor condition.

Appendix F2. 2018 raptor nest results for aerial surveys conducted March 5 and May 10 and ground surveys throughout summer 2018 at the proposed Horse Heaven Wind Project, Washington.

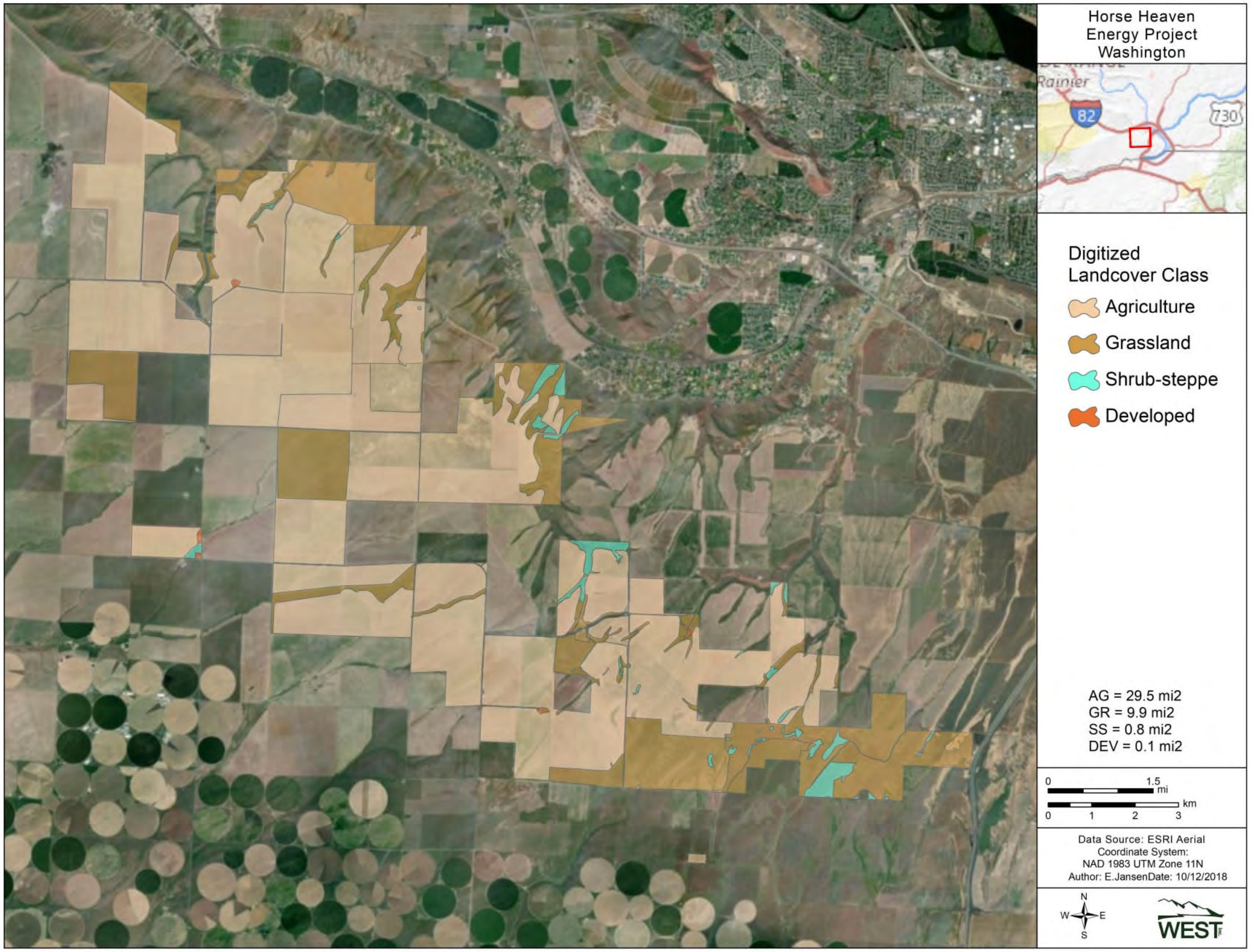
Nest ID	2018 Species	Nest Status	Nest Substrate	2017 Spp.	Comment
12	Unknown Raptor	Unoccupied	Cliff	RTHA	
13	Unknown Raptor	Unoccupied	Ground	UNRA	Characteristic ferruginous hawk nest. Poor condition.
14	Red-tailed Hawk	Occupied	Tree	GHOW	One chick observed second survey.
15	Unknown Raptor	Unoccupied	Ground	UNRA	Characteristic ferruginous hawk nest. Poor condition.
16	Unknown Raptor	Unoccupied	Ground	UNRA	Characteristic ferruginous hawk nest. Good condition.
17	Unknown Raptor	Unoccupied	Ground	UNRA	Characteristic ferruginous hawk nest. Good condition.
18	Bald Eagle	Occupied	Tree	BAEA	2 young approximately 21 days old on second survey
19	Swainson's Hawk	Occupied	Tree	SWHA	Adult incubating second survey.
20	Great-horned Owl	Occupied	Tree	UNRA	One young observed second survey
21	Red-tailed Hawk	Occupied	Tree	NA	New 2018 nest. One adult sitting on the nest during second survey.
22	Unknown Raptor	Unoccupied	Ground	NA	New 2018 nest.

Appendix F2. 2018 raptor nest results for aerial surveys conducted March 5 and May 10 and ground surveys throughout summer 2018 at the proposed Horse Heaven Wind Project, Washington.

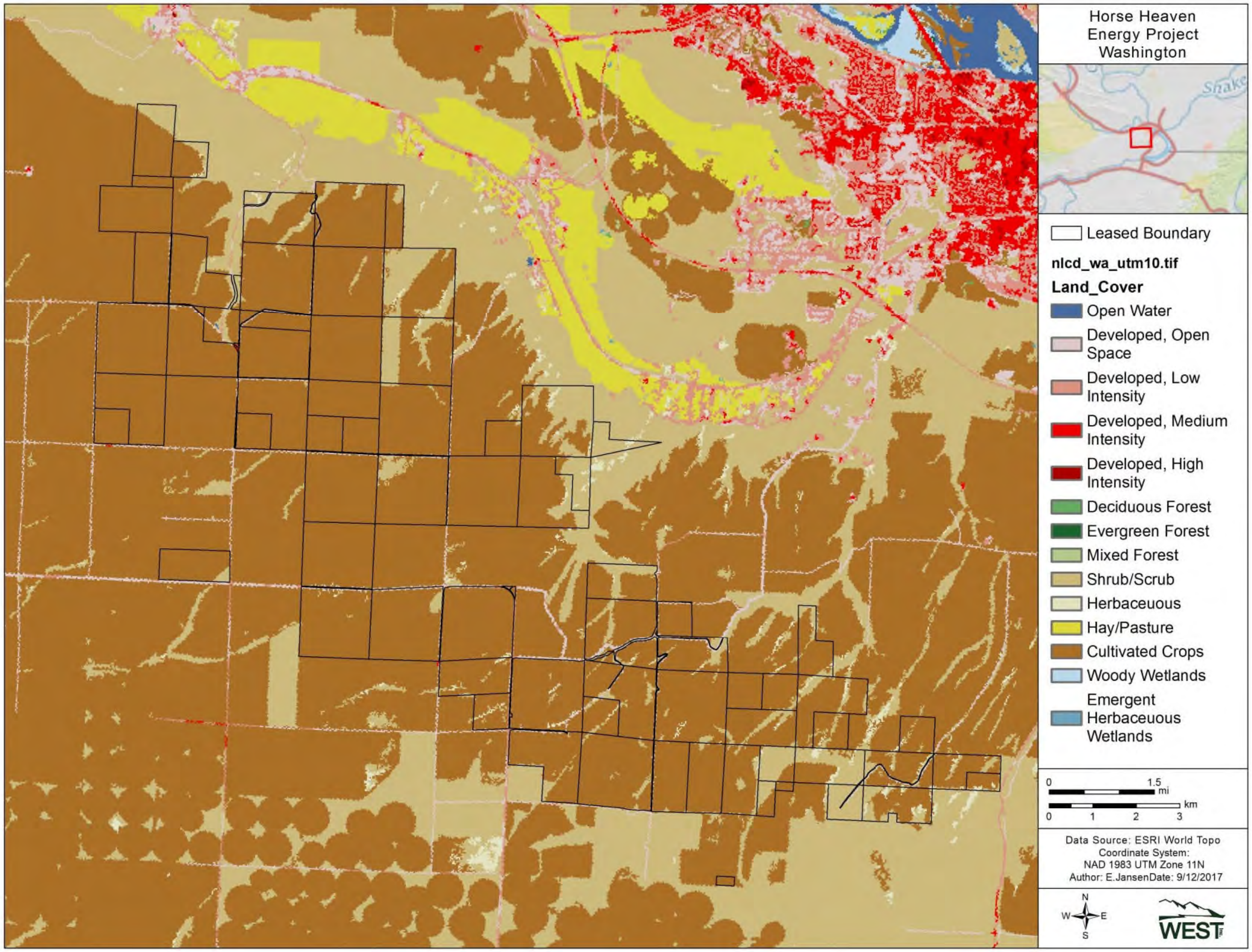
Nest ID	2018 Species	Nest Status	Nest Substrate	2017 Spp.	Comment
23	Red-tailed Hawk	Occupied	Tree	NA	New 2018 nest. Two young observed in nest second survey.
24	Red-tailed Hawk	Occupied	Tree	NA	New 2018 nest. One young observed second survey.
25	Red-tailed Hawk	Occupied	Tree	NA	New 2018 nest. One adult sitting on the nest during second survey.
26	Red-tailed Hawk	Occupied	Tree	NA	New 2018 nest. Two young observed during second nest survey.
27	Red-tailed Hawk	Occupied	Tree	NA	New 2018 nest. Two young observed during second nest survey.
28	Swainson's Hawk	Occupied	Tree	NA	New 2018 nest. Two fledglings observed in mid-July during point count surveys.
29	Swainson's Hawk	Occupied	Tree	NA	New 2018 nest. Three eggs observed during second nest survey.
30	Unknown Raptor	Unoccupied	Ground	NA	New 2018 nest. Characteristic ferruginous hawk nest. Poor condition.
31	Swainson's Hawk	Occupied	Tree	NA	New 2018 nest. Three fledglings in nest in late June. One juvenile flying with adult in mid-Aug. Remains of two fledglings found within 50-m of nest mid-Aug.
32	Swainson's Hawk	Occupied	Tree	NA	New 2018 nest. In pine tree adjacent to ranch house. Three young observed in nest early July. Two juveniles observed flying around nest with adults mid-Aug.

[1] Occupied = 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; Unoccupied = no sign of nesting or territory occupancy in the current nesting season.

Appendix G. Landcover at the Project from field mapping (Appendix G1) and the National Landcover Database (Appendix G2) at the Horse Heaven Wind Project.



Appendix G1. Digitized Landcover at the Horse Heaven Wind Project.



Appendix G2. NLCD Landcover at the Horse Heaven Wind Project.

Appendix H. Oregon and Washington Raptor Use and Fatality Rate Summary Table.

Appendix H. Wind energy facilities in Oregon and Washington with publicly-available and comparable use and fatality data for raptors.

Wind Energy Facility	Raptor Use Estimate[A]	Raptor Fatality Estimate[B]	No. of Turbines	Total MW
Horse Heaven	**0.795**	**NA**	**NA**	**NA**
	Pacific Northwest			
White Creek, WA (2007-2011)	NA	0.47	89	204.7
Tuolumne (Windy Point I), WA (2009-2010)	0.77	0.29	62	136.6
Vantage, WA (2010-2011)	NA	0.29	60	90
Linden Ranch, WA (2010-2011)	NA	0.27	25	50
Harvest Wind, WA (2010-2012)	NA	0.23	43	98.9
Goodnoe, WA (2009-2010)	NA	0.17	47	94
Leaning Juniper, OR (2006-2008)	0.522	0.16	67	100.5
Klondike III (Phase I), OR (2007-2009)	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 (2006-2007)	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 (2007)	0.291	0.09	127	229
Stateline, OR/WA (2001-2002)	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
Elkhorn, OR (2008)	1.07	0.06	61	101
Klondike II, OR (2005-2006)	0.504	0.06	50	75
Klondike IIIa (Phase II), OR (2008-2010)	NA	0.06	51	76.5
Combine Hills, OR (2011)	0.746	0.05	104	104
Biglow Canyon, OR (Phase III; 2010-2011)	0.318	0.05	76	174.8
Marengo II, WA (2009-2010)	NA	0.05	39	70.2
Windy Flats, WA (2010-2011)	NA	0.04	114	262.2
Pebble Springs, OR (2009-2010)	NA	0.04	47	98.7
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
Nine Canyon, WA (2002-2003)	0.35	0.03	37	48.1
Hay Canyon, OR (2009-2010)	NA	0	48	100.8
Biglow Canyon, OR (Phase I; 2009)	0.318	0	76	125.4
Marengo I, WA (2009-2010)	NA	0	78	140.4
Klondike, OR (2002-2003)	0.504	0	16	24
Vansycle, OR (1999)	0.66	0	38	24.9
Combine Hills, OR (Phase I; 2004-2005)	0.746	0	41	41

A=number of raptors/plot/20min survey
B=number of fatalities/MW/year

Appendix H (*continued*). Wind energy facilities in Oregon and Washington with fatality data for all bird species. Data from the following sources:

Wind Energy Facility	Estimate Reference
Big Horn, WA (06-07)	Kronner et al. 2008
Biglow Canyon, OR (Phase I; 08)	Jeffrey et al. 2009a
Biglow Canyon, OR (Phase I; 09)	Enk et al. 2010
Biglow Canyon, OR (Phase II; 09-10)	Enk et al. 2011a
Biglow Canyon, OR (Phase II; 10-11)	Enk et al. 2012b
Biglow Canyon, OR (Phase III; 10-11)	Enk et al. 2012a
Combine Hills, OR (Ph. I; 04-05)	Young et al. 2006
Combine Hills, OR (11)	Enz et al. 2012
Elkhorn, OR (08)	Jeffrey et al. 2009b
Elkhorn, OR (10)	Enk et al. 2011b
Goodnoe, WA (09-10)	URS Corporation 2010a
Harvest Wind, WA (10-12)	Downes and Gritski 2012a
Hay Canyon, OR (09-10)	Gritski and Kronner 2010a
Hopkins Ridge, WA (06)	Young et al. 2007
Hopkins Ridge, WA (08)	Young et al. 2009c
Kittitas Valley, WA (11-12)	Stantec 2012
Klondike, OR (02-03)	Johnson et al. 2003
Klondike II, OR (05-06)	NWC and WEST 2007
Klondike III, OR (Phase I; 07-09)	Gritski et al. 2010
Klondike IIIa, OR (Phase II; 08-10)	Gritski et al. 2011
Leaning Juniper, OR (06-08)	Gritski et al. 2008
Linden Ranch, WA (10-11)	Enz and Bay 2011
Marengo I, WA (09-10)	URS Corporation 2010b
Marengo II, WA (09-10)	URS Corporation 2010c
Nine Canyon, WA (02-03)	Erickson et al. 2003b
Pebble Springs, OR (09-10)	Gritski and Kronner 2010b
Stateline, OR/WA (01-02)	Erickson et al. 2004
Stateline, OR/WA (03)	Erickson et al. 2004
Stateline, OR/WA (06)	Erickson et al. 2007
Tuolumne (Windy Point I), WA (09-10)	Enz and Bay 2010
Vansycle, OR (99)	Erickson et al. 2000b
Vantage, WA (10-11)	Ventus 2012
White Creek, WA (07-11)	Downes and Gritski 2012b
Wild Horse, WA (07)	Erickson et al. 2008
Windy Flats, WA (10-11)	Enz et al. 2011

Appendix I. Estimated Raptor Nest Densities at Other Regional Proposed and Existing Wind Projects Located in Comparable Columbia Plateau Ecoregion Environments.

Appendix I. Estimated raptor nest densities at other regional proposed and existing wind projects located in comparable Columbia Plateau Ecoregion environments. Project data from Table 11 *in* NWC and ABR 2009.

Project[a]	Raptor Nest Density (#/mi²), rounded								
	Sum Density	*Buteos*				Eagle	Falcon	Owl	Accip.
		SWHA[b]	RTHA	FEHA	UNBU	GOEA	PRFA	GHOW	SSHA
Rattlesnake Road, OR	0.45	0.19	0.13	0.05	0.00	0.00	0.08	0.00	0.00
Hopkins Ridge, WA	0.42	0.01	0.27	0.01	0.05	0.00	0.00	0.08	0.00
Leaning Juniper I and II, OR	0.41	0.18	0.16	0.03	0.00	0.00	0.02	0.02	0.00
Goodnoe Hills/Imrie, WA (1 mile radius search area)	0.37	0.05	0.27	0.00	0.00	0.00	0.00	0.05	0.00
Columbia Hills, WA	0.30	0.04	0.18	0.00	0.00	0.02	0.02	0.02	0.02
Horse Heaven, WA 2017 (this study)	**0.27**	**0.01**	**0.05**	**0.03**	**0.13**	**0.00**	**0.00**	**0.03**	**0.00**
Golden Hills, OR	0.25	0.04	0.16	0.00	0.00	0.00	0.00	0.05	0.00
Klondike I and II, OR (5 mile radius search area)	0.23	0.07	0.11	0.00	0.00	0.01	0.00	0.04	0.00
Horse Heaven, WA 2018 (this study)	**0.21**	**0.04**	**0.05**	**0.01**	**0.09**	**0.00**	**0.00**	**0.01**	**0.00**
Juniper Canyon, WA 2007-2008	0.21	0.06	0.05	0.03	0.02	0.03	0.01	0.01	0.00
Stateline OR/WA	0.21	0.03	0.08	0.03	0.00	0.00	0.00	0.07	0.00
Klondike III, OR	0.20	0.04	0.11	0.00	0.01	0.00	0.00	0.03	0.00
Wild Horse, WA	0.16	0.00	0.12	0.00	0.00	0.00	0.02	0.02	0.00
Windy Flats, WA	0.15	0.00	0.13	0.00	0.00	0.00	0.00	0.02	0.00
Big Horn, WA	0.11	0.00	0.06	0.00	0.00	0.00	0.01	0.04	0.00
Zintel Canyon, WA	0.08	0.04	0.02	0.02	0.00	0.00	0.00	0.00	0.00
Nine Canyon, WA	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Average Density	**0.24**	**0.05**	**0.12**	**0.01**	**0.02**	**0.00**	**0.01**	**0.03**	**0.00**

[a] References for projects: Rattlesnake Road (Kronner et al., 2007a); Hopkins Ridge (Young et al., 2003c); Leaning Juniper I and II (Kronner et al., 2005); Goodnoe Hills/Imrie (NWP, 2009); Juniper Canyon (NWC, 2008); Columbia Hills (Erickson et al., 2002b); Golden Hills (Jeffrey et al., 2008a); Stateline (Erickson et al., 2004; NWC and WEST, 2001; Erickson et al., 2002b); Klondike I and II (Johnson et al., 2002a), Klondike III (Mabee et al., 2005), Wild Horse (Erickson et al., 2003b), Windy Flats (ENE, 2007); Big Horn (Johnson and Erickson, 2004); Nine Canyon and Zintel Canyon (WEST and NWC, 2001; WEST and NWC, 2002; Erickson et al., 2002b).

[b] SWHA = Swainson's hawk, RTHA = red-tailed hawk, GHOW = great-horned owl, FEHA = ferruginous hawk, UNBU = unknown species of the genus *Buteo,* GOEA = golden eagle, PRFA = prairie falcon, GHOW = great-horned owl, SSHA = sharp-shinned hawk

BAT ACOUSTIC SURVEY REPORT

Horse Heaven Wind Project
Benton County, WA

Prepared for:

Horse Heaven Wind Farm, LLC

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Boulder, Colorado 80301

Prepared by:

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January 2019

EXECUTIVE SUMMARY

In August 2017 Western EcoSystems Technology, Inc. (WEST) initiated a study of bat activity at the proposed Horse Heaven Wind Project (Project), located in Benton County, Washington. The study was designed to 1) evaluate seasonal levels of bat activity at the Project, including periods of expected peak activity, 2) identify species occurring at the Project during the study period, and 3) provide context of bat activity at the Project relative to other publicly available data.

WEST conducted acoustic surveys at the Project during two periods: from August 19, 2017 through October 30, 2017, and again from May 14, 2018 through October 29, 2018. During the 2017 study period, one Anabat SD2 Active Bat Detector was placed near the ground at 1.5 meters (5.0 feet) at the base of a meteorological (met) tower. During the 2018 study period, the same ground-based detector location was used and data collection was supplemented with an additional Anabat SD2 detector raised to approximately 45 m on the same met tower. The tower was located in shrub-steppe habitat, which is a sub-dominant land cover type at the Project yet representative of where future turbine placement may occur.

During the 72 detector-nights surveyed in 2017, the average bat activity rate (± standard error) was 0.33 ± 0.08 bat passes per detector-night. Approximately 91.6% of bat passes were produced by low-frequency, tree-roosting bats (e.g., silver-haired bat, hoary bat); automated identification of bat calls using Kaleidoscope Pro 4.2.0 determined that silver-haired bats were the most frequently detected species, occurring on 14% of detector-nights. During the 303 detector-nights surveyed in 2018 the average bat activity rate was 0.27 ± 0.05 bat passes per detector-night, and similar to 2017, low-frequency bats were detected most frequently, accounting for 98.7% of all bat passes and comprising primarily silver-haired bats. One high-frequency bat species (canyon bat) was detected during both study periods. Neither Townsend's big-eared bat nor pallid bat, both of which are Washington State Candidate Species and could potentially occur at the Project, were detected during the study, and no federal or state-listed bat species were detected.

Overall, bat activity at the Project documented during the bat activity study in 2017 and 2018 at (0.33 bat passes per detector-night) was well below the Rocky Mountains regional average of 4.02 bat passes per detector-night, which is the closest region with publicly available activity data (no activity data from the Pacific Northwest is available for comparison). The average fatality rate of 1.19 bats per megawatt per year in the Pacific Northwest is low compared to the Rocky Mountain regional average of 4.90 bats per megawatt per year (bats/MW/year). Bat fatalities from the operational Nine Canyon Wind Facility, located adjacent to the Project was 2.47 bats/MW/year and consisted of silver-haired bats and hoary bats. If risk patterns at the Project are similar to patterns at Nine Canyon and elsewhere in the Pacific Northwest and Rocky Mountains, it is likely that species composition and fatality rates at the Project would be similar.

STUDY PARTICIPANTS

Western EcoSystems Technology, Inc.

Erik Jansen	Project Manager
Samantha Brown	Report Compiler
Quentin Hays	Report Reviewer
Donald Solick	Bat Biologist
Mandy Kauffman	Statistician
Kori Hutchison	Field Coordinator
Joshua Parrott	Field Technician

REPORT REFERENCE

Hays Q., S. R. Brown, and E. W. Jansen. 2019. Bat Acoustic Survey Report, Horse Heaven Wind Project, Benton County, Washington. Prepared for Horse Heaven Wind Farm, LLC, Boulder, CO. Prepared by Western EcoSystems Technology, Inc. (WEST), Corvallis, Oregon. January 24, 2019.

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INTRODUCTION

During 2017 and 2018, Western EcoSystems Technology, Inc. (WEST) completed a study of bat activity at the proposed Horse Heaven Wind Project (Project) in accordance with recommendations in the US Fish and Wildlife Service (USFWS) *Land-Based Wind Energy Guidelines* (USFWS 2012) and the Washington Department of Fish and Wildlife (WDFW) *Wind Power Guidelines* (WDFW 2009). Although it remains unclear whether bat activity patterns in baseline acoustic data predict post-construction fatality risk (Hein et al. 2013a), ultrasonic detectors collect information on spatial distribution, timing, and species composition that can provide insight into the potential impacts of wind development on bats in a particular area (Kunz et al. 2007a, Britzke et al. 2013) and inform potential collision minimization strategies (Weller and Baldwin 2012). WEST conducted a bat activity study at the Project with the primary objectives to: 1) evaluate seasonal levels of bat activity at the Project, including periods of expected peak activity; and, 2) identify species occurring at the Project during the study period, 3) provide context of bat activity at the Project relative to other publicly-available data. The following report describes the results of acoustic surveys conducted at the Project from August 19, 2017 – October 30, 2017 and May 14, 2018 – October 29, 2018.

STUDY AREA

The 51,263 acre (80.1 mi^2) Project area is located in Benton County, Washington, within the Horse Heaven Hills, an anticline ridge of the Yakima Folds within the larger Columbia Plateau Ecoregion (Clarke and Bryce 1997). Topography within the Project consists primarily of rolling hills and incised drainages, with a broad northeast-facing rampart along the northern Project boundary (Figure 1). The highly-eroded drainages along the rampart create numerous canyons that bisect the Project (Badger Canyon, Coyote Canyon, Taylor Canyon) and expose basalt cliffs and ledges. On the southern side of the rampart, the landscape transitions to rolling topography with shallow, meandering canyons that drain south into the Columbia River.

Land cover within the Project is a mosaic of seed crops associated with dryland and irrigated agriculture, shrub-steppe grasslands, and rural/urban development (Figure 2). Agricultural crop cover dominates the Project and surrounding area. Shrub-steppe grasslands are found in topographically steep areas. The entire Project is privately owned of which much is actively managed for dryland agriculture and livestock grazing. The 63-turbine Nine Canyon Wind Project is located approximately 4.5 miles east of the Project.

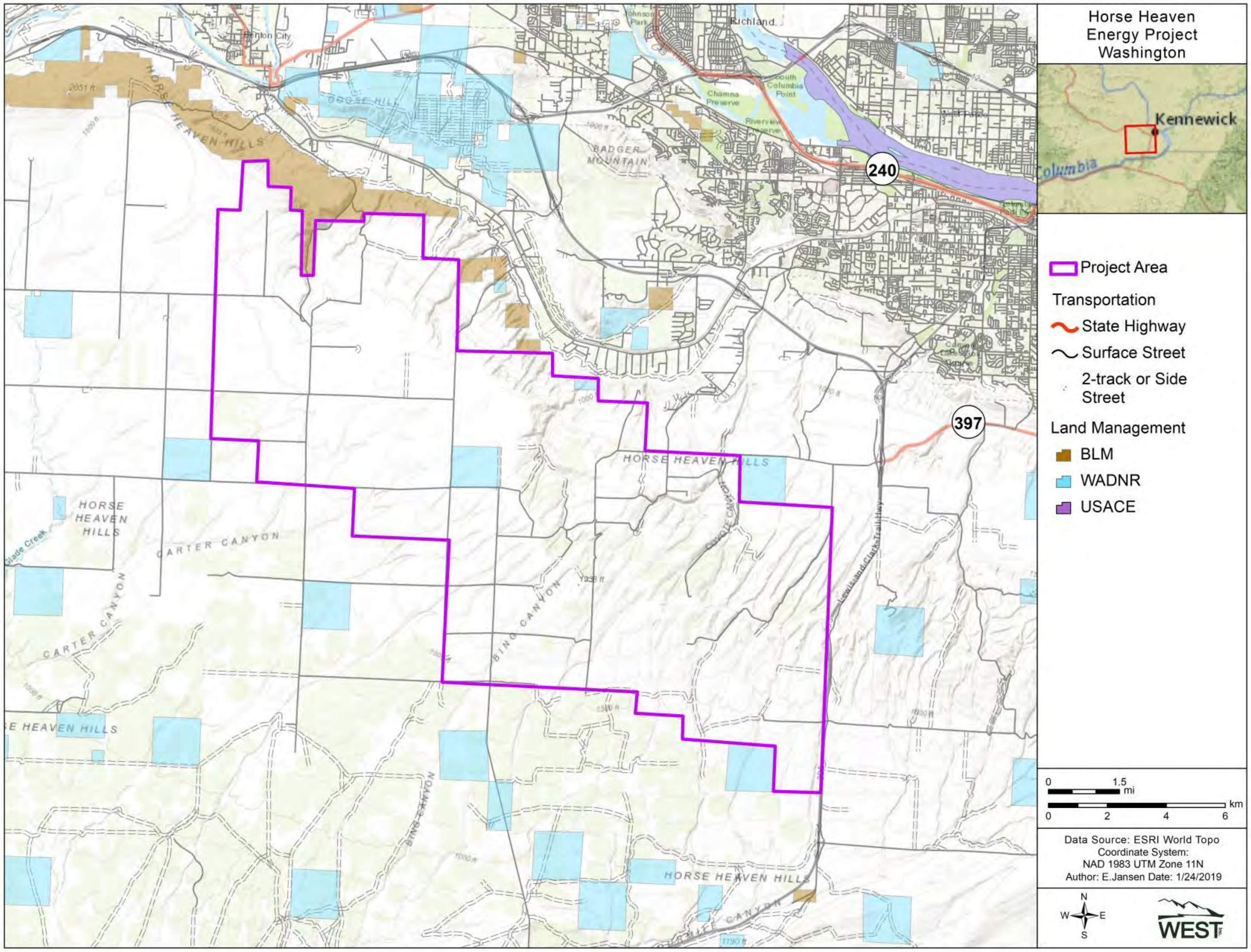

Figure 1. Location of the proposed Horse Heaven Wind Project, Benton County, Washington.

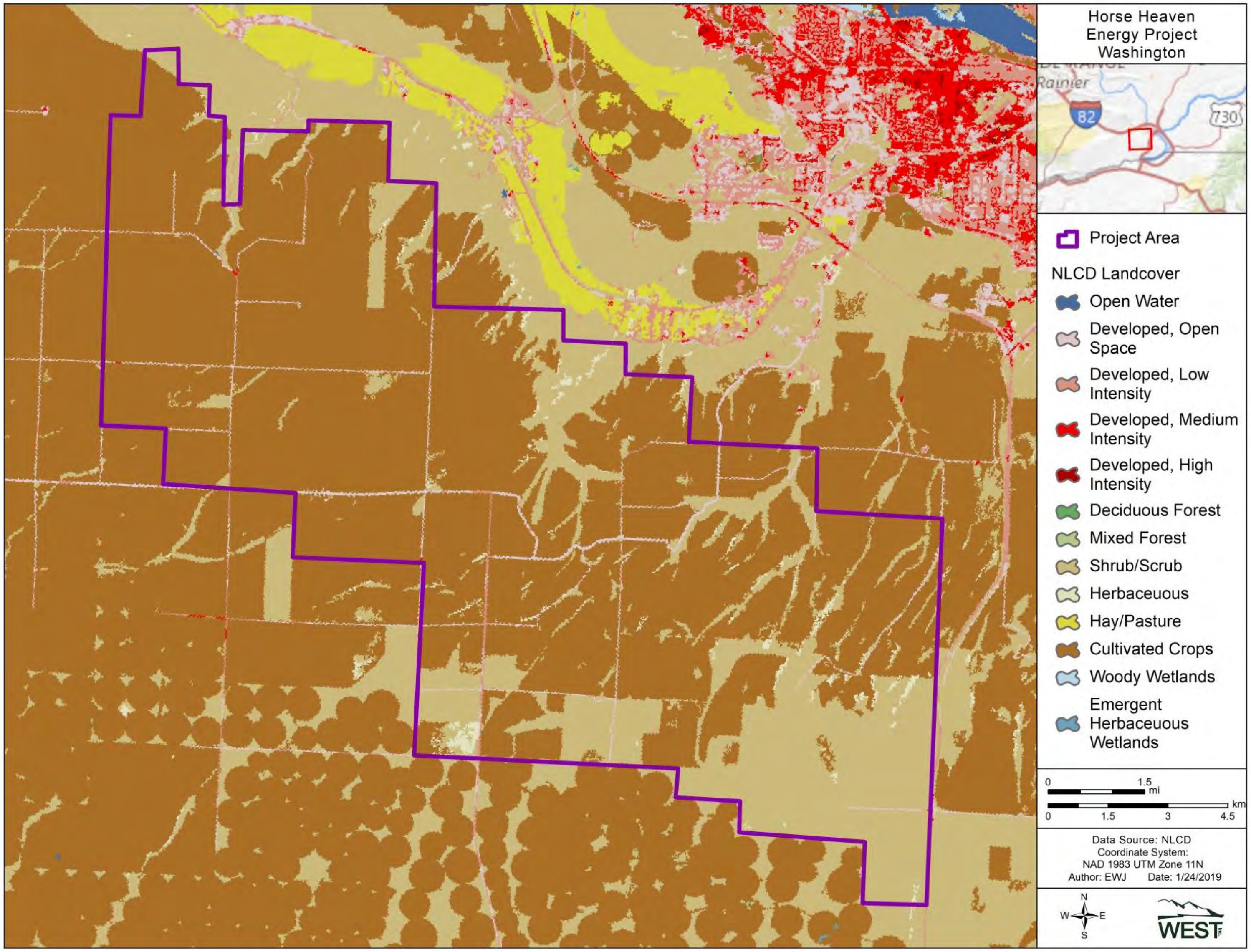

Figure 2. Land cover types within the proposed Horse Heaven Wind Project, Benton County, Washington.

Overview of Bat Diversity

Twelve species of bats potentially occur at the Project (Hayes and Wiles 2013, International Union for the Conservation of Nature [IUCN] 2017; Table 1). None of these species are federally listed under the Endangered Species Act of 1973 and none are listed as threatened, endangered, or sensitive by the state of Washington (Washington Department of Fish and Wildlife [WDFW] 2016). However, the Townsend's big-eared bat (*Corynorhinus townsendii*) and pallid bat (*Antrozous pallidus*) are state candidate species (WDFW 2016).

Table 1. Bat species with potential to occur in the Horse Heaven Wind Project categorized by echolocation call frequency.

Common Name	Scientific Name
High-Frequency (> 30 kilohertz [kHz])	
California bat	*Myotis californicus*
canyon bat[1]	*Parastrellus hesperus*
little brown bat[1]	*Myotis lucifugus*
long-legged bat[1]	*Myotis volans*
western long-eared bat[1]	*Myotis evotis*
western small-footed bat[4]	*Myotis ciliolabrum*
Yuma bat	*Myotis yumanensis*
Low-Frequency (15 – 30 kHz)	
big brown bat[1]	*Eptesicus fuscus*
hoary bat[1,2]	*Lasiurus cinereus*
pallid bat[3]	*Antrozous pallidus*
silver-haired bat[1,2]	*Lasionycteris noctivagans*
Townsend's big-eared bat[3]	*Corynorhinus townsendii*

Source: Hayes and Wiles (2013), IUCN 2017

[1]species known to have been killed at wind energy facilities (species reported by: Anderson et al. 2004, Kunz et al. 2007b, Baerwald 2008, Miller 2008)

[2]Long-distance migrant

[3]Washington state candidate species (WDFW 2016)

METHODS

Bat Acoustic Surveys

Sampling Stations

Bat activity levels and composition can vary with height above ground level (AGL; Baerwald and Barclay 2009, Collins and Jones 2009, Müeller et al. 2013), and high-flying bat species are at greater risk of collision with turbines (Roemer et al. 2017). Therefore, it is useful to monitor activity at different heights (Kunz et al. 2007b). Because most North American bat species spend at least some time flying at relatively low heights, acoustic detectors deployed near the ground may detect a more complete sample of the bat species present within a given area; however, elevated acoustic detectors may provide a more accurate assessment of bat species flying at rotor-swept heights (Kunz et al. 2007b, Müeller et al. 2013; but see Amorim et al. 2012).

WEST conducted acoustic surveys to estimate levels of bat activity at the Project during fall (2017) and summer and fall (2018), which includes the expected period of peak activity for migratory bats in eastern Washington (i.e., late summer through fall). Sampling occurred at a meteorological (met) tower in the southeastern corner of the Project. During 2017, only the ground detector (HHg1) was deployed due to the timing of meteorological (met) tower construction; during 2018, both a ground detector (HH1g) and a raised detector (HH1r) were deployed. Anabat SD2 ultrasonic bat detectors (Titley™ Scientific, Columbia, Missouri) were placed at a met tower in the southeastern corner of the Project. Microphones for each detector were deployed at different heights: a ground detector with a microphone elevated slightly (i.e., approximately 1.5 m [5.0 ft]; ground unit) to improve the quality of sound recordings (e.g., to reduce recordings of insect calls), and a raised detector with a microphone raised approximately 45 m (148 ft; raised unit) on the met tower. Detectors were checked every two weeks to swap compact flash cards, batteries, and to ensure units were properly functioning. At the end of each sample period, detectors were decommissioned and brought back from the field for maintenance and calibration.

Large weatherproof boxes housed the detectors and external deep-cycle batteries for protection from weather and wildlife. Microphones were protected by PVC elbows with drain holes that extended outside the container and helped minimize the potential for water damage due to rain. The raised Anabat microphone was elevated on the met tower using a pre-installed pulley system. Microphones were encased in a Bat-Hat weatherproof housing (EME Systems, Berkeley, California), and attached to a coaxial cable that transmitted ultrasonic sound data to an Anabat detector at the base of the tower. The Bat-Hat weatherproof housing was modified by replacing the Plexiglas reflector plate with a 45-degree angle PVC elbow, for better comparability with data collected by detectors on the ground (Britzke et al. 2010).

Survey Schedule

Acoustic monitoring surveys were conducted at the Project during two study periods: from August 19, 2017 through October 30, 2017, and again from May 14, 2018 through October 29, 2018. A second monitoring year was conducted to sample the full length of summer and fall seasons when resident and migratory bats could be present. Detectors were programmed to turn on approximately 30 minutes (min) before sunset and turn off approximately 30 minutes after sunrise each day. To elucidate seasonal activity patterns, the second year was divided into two seasons: summer (May 14 – August 18) and fall (August 19 – October 29). A broader fall migratory period was considered July 30 – October 14 (McGuire and Boyle 2013).

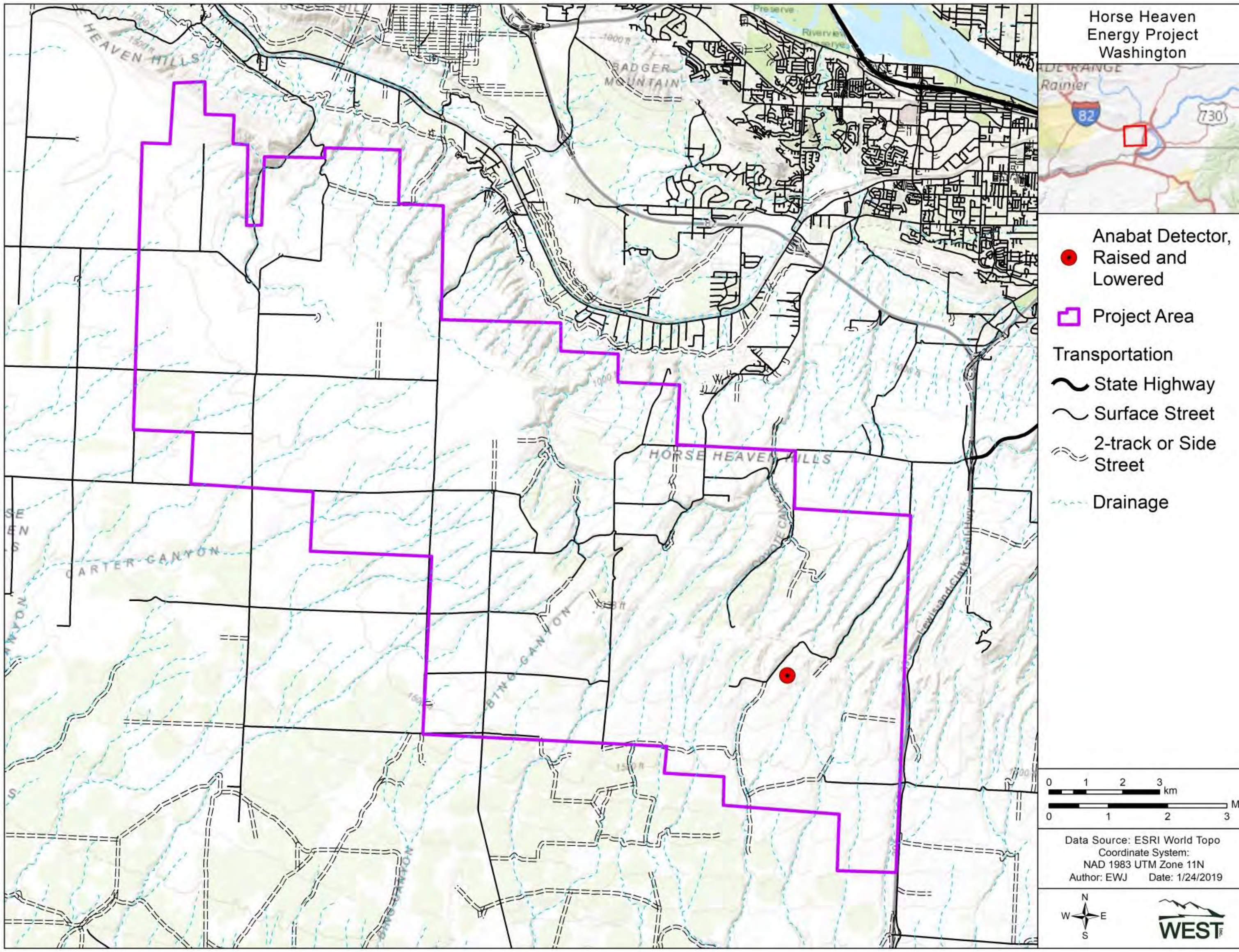

Figure 3. Location of sampling station used during the bat acoustic surveys at the proposed Horse Heaven Wind Project.

Data Collection and Call Analysis

Anabat detectors use a broadband high-frequency microphone to detect the echolocation calls of bats. Incoming echolocation calls are digitally processed and stored on a high-capacity compact flash card. The resulting files can be viewed in appropriate software (e.g., Analook©) as digital sonograms that show changes in echolocation call frequency over time. Frequency versus time displays were used to separate bat calls from other types of ultrasonic noise (e.g., wind, insects), and to determine the call frequency category and, when possible, the species of bat that generated the calls.

To standardize acoustic sampling effort at the Project, Anabat detectors were calibrated and sensitivity levels were set to six (Larson and Hayes 2000), a level that balanced the goal of recording bat calls against the need to reduce interference from other sources of ultrasonic noise (Brooks and Ford 2005).

For ground (HH1g) and raised (HH1r) detectors, bat passes were sorted into two groups based on their minimum frequency. High-frequency (HF) bats such as little brown bat (*Myotis lucifugus*), and canyon bats (*Parastrellus hesperus*), have minimum frequencies greater than 30 kilohertz (kHz). Low-frequency (LF) bats such as big brown bats (*Eptesicus fuscus*), silver-haired bats (*Lasionycteris noctivagans*), and hoary bats (*Lasiurus cinereus*) typically emit echolocation calls with minimum frequencies between 15 and 30 kHz.

Species-level identification of bat calls was completed with the automated identification feature in Kaleidoscope 4.2.0 (Wildlife Acoustics, Concord, Massachusetts) using the Bats of North America classifier 4.2.0 at the most sensitive setting. Kaleidoscope is currently the only program available for automated classification of zero crossing (e.g., Anabat) files for bat species in the US and was used to select for the 12 bat species that potentially occur at the Project (Table 1).

Statistical Analysis

The standard metric for measuring bat activity, the number of bat passes per detector-night, was used as an index of bat activity at the Project. A bat pass was defined as a sequence of at least two echolocation calls (pulses) produced by an individual bat with no pause between calls of more than one second (Fenton 1980, White and Gehrt 2001, Gannon et al. 2003). A detector-night was defined as one detector operating for one entire night. The terms bat pass and bat call are used interchangeably. Bat passes per detector-night was calculated for all bats, for HF bats, and for LF bats. Bat pass rates represent indices of bat activity and do not represent numbers of individuals. The number of bat passes was determined by an experienced bat biologist using Analook©.

Mean bat activity was calculated by detector station and overall. The period of peak sustained bat activity was defined as the seven-day period with the highest average bat activity. This and all multi-detector averages were calculated as unweighted averages of total activity at each detector.

Risk Assessment

Collision with wind turbine blades is thought to be the primary risk to bats at operating wind energy facilities (Arnett et al. 2008), though direct mortality through barotrauma (Baerwald et al. 2008) and other indirect effects such as displacement (Katzner et al. 2016) may occur. The intent of the risk assessment is to use pre-construction bat activity data and mortality information from operating wind facilities to assess the potential level of bat fatalities at the Project. The intent of the risk assessment is not to predict the number of fatalities, but rather to provide context for data collected at the Project; the risk assessment is therefore qualitative, rather than quantitative. In order to assess potential bat fatality rates at the Project, bat activity data collected in 2018 at the Project were compared to activity data from other wind energy facilities in the Rocky Mountains region, which is the closest region with publicly available activity data; no publicly available bat activity data exists from the Pacific Northwest. The nearest operating wind energy facility to the Project is the Nine Canyon Wind Facility (Nine Canyon), located approximately five miles east. Although pre-construction activity was not collected for Nine Canyon, fatality estimates from standardized carcass searches conducted during 2002–2003 (Erickson et al. 2003) and bat fatalities found incidentally by operations staff over 14 years of project operation (2005–2018) are reported for comparison.

Among currently available studies that measured both preconstruction bat activity and subsequent operational fatality rates, most data were collected during known periods of peak activity (i.e., fall) using Anabat (i.e., non-full spectrum) detectors placed near the ground. To facilitate comparisons to these studies, this report uses only the mean activity rate from the HH1g during 2018, as this detector was placed near the ground and sampled the full period of peak bat activity (i.e., late summer through fall).

RESULTS

2017 Bat Acoustic Surveys

Bat Activity

Bat activity was documented at one detector station in the Project for a total of 72 detector-nights between August 19 and October 30, 2017 (Figure 4). The detector station operated for 99% of the study period and documented an overall mean of 0.33 ± 0.08 bat passes per detector-night (Table 2; Figure 4). The period of peak bat activity occurred from September 3 through September 9, 2017 (Figure 5).

Table 2. Bats detected and total bat passes per station from August 19 through October 30, 2018 at the ground detector (HH1g) at Horse Heaven Wind Project in Benton County, Washington.

Station	HF Bats	LF Bats	All Bats	Detector Nights	Bat Passes
HH1g	2	22	24	72	0.33±0.08

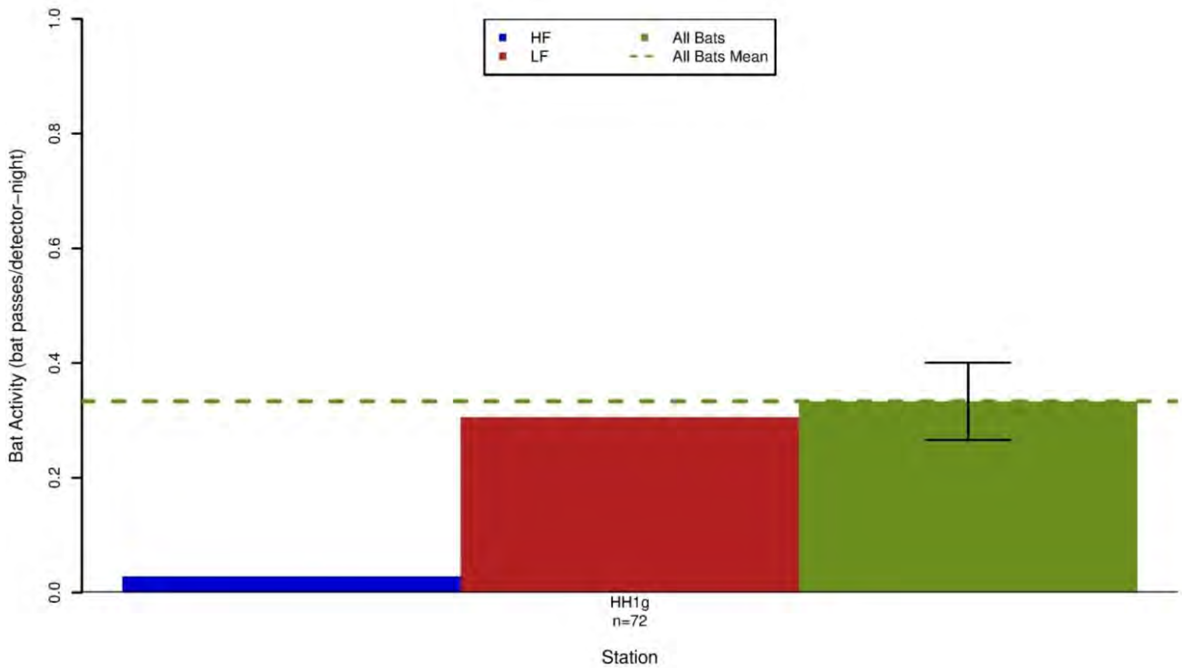

Figure 4. Number of high-frequency (HF) and low-frequency (LF) bat passes per detector-night recorded during August 19 – October 30, 2017 at the Horse Heaven Wind Project, Benton County, Washington.

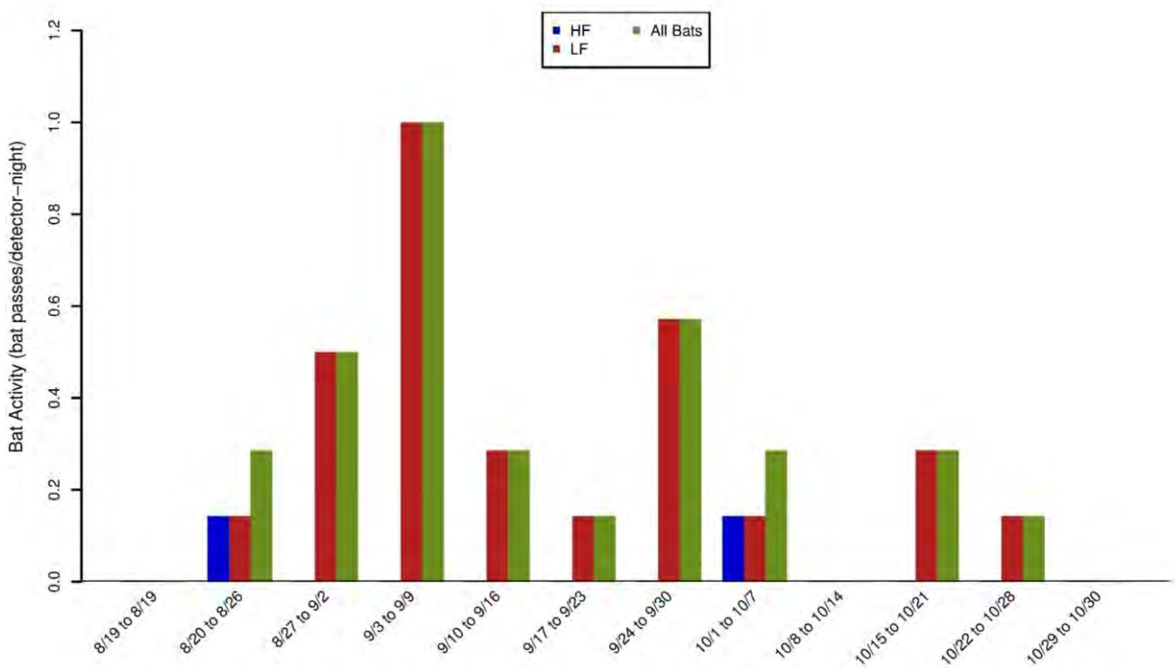

Figure 5. Weekly bat activity during August 19 – October 30 at the Horse Heaven Wind Project in Benton County, Washington.

Species Composition

During the survey season, 91.6% of bat passes were classified as LF (silver-haired bat, hoary bat, big brown bat), and 8.3% of bat passes were classified as HF (canyon bat; Figure 4). Kaleidoscope Pro identified bat calls for four of the 12 species identified as having potential to occur at the Project (Table 2; Table 3). Townsend's big-eared bat and pallid bat calls were not identified during the study. Silver-haired bat was the primary species documented during the study period, detected on 14% of detector-nights (Table 3). Hoary bat was the next most commonly detected species, occurring on approximately 6% of detector-nights (Table 3). Big brown bat and canyon bat were both detected on less than 1% of detector-nights (Table 3). No federally or state-listed bat species were detected.

Table 3. The number (percent composition) of detector-nights a bat species was recorded at the ground detector (HH1g) at Horse Heaven Wind Project, August 19, 2017 – October 30, 2017.

Common Name	Bat Call Frequency	Total[1]
	High-Frequency (> 30 kHz)	
canyon bat	1 (1)	1 (1)
	Low-Frequency (< 30 kHz)	
big brown bat	1 (1)	1 (1)
hoary bat	4 (6)	4 (6)
silver-haired bat	10 (14)	10 (14)

[1] 72 detector nights total

2018 Bat Acoustic Surveys

Bat Activity

Bat activity was documented at two detector stations in the Project for a total of 303 detector-nights between May 14 and October 29, 2018. The ground detector station had a total of 163 detector nights while the raised station had a total of 140 detector nights (Table 4). The detector stations operated for 90% of the study period and bat activity at both detector stations was a mean of 0.27 ± 0.05 bat passes per detector-night (Table 4). The period of overall peak bat activity occurred from September 13 through September 19, 2018 (Figure 6).

Table 4. Bats detected and total bat passes per station from May 14 through October 29, 2018 at the Horse Heaven Wind Project in Benton County, Washington.

Station	HF Bats	LF Bats	All Bats	Detector Nights	Bat Passes
HH1g	1	53	54	163	0.33±0.08
HH1r	0	28	28	140	0.20±0.05
Total	1	81	82	303	**0.27±0.05**

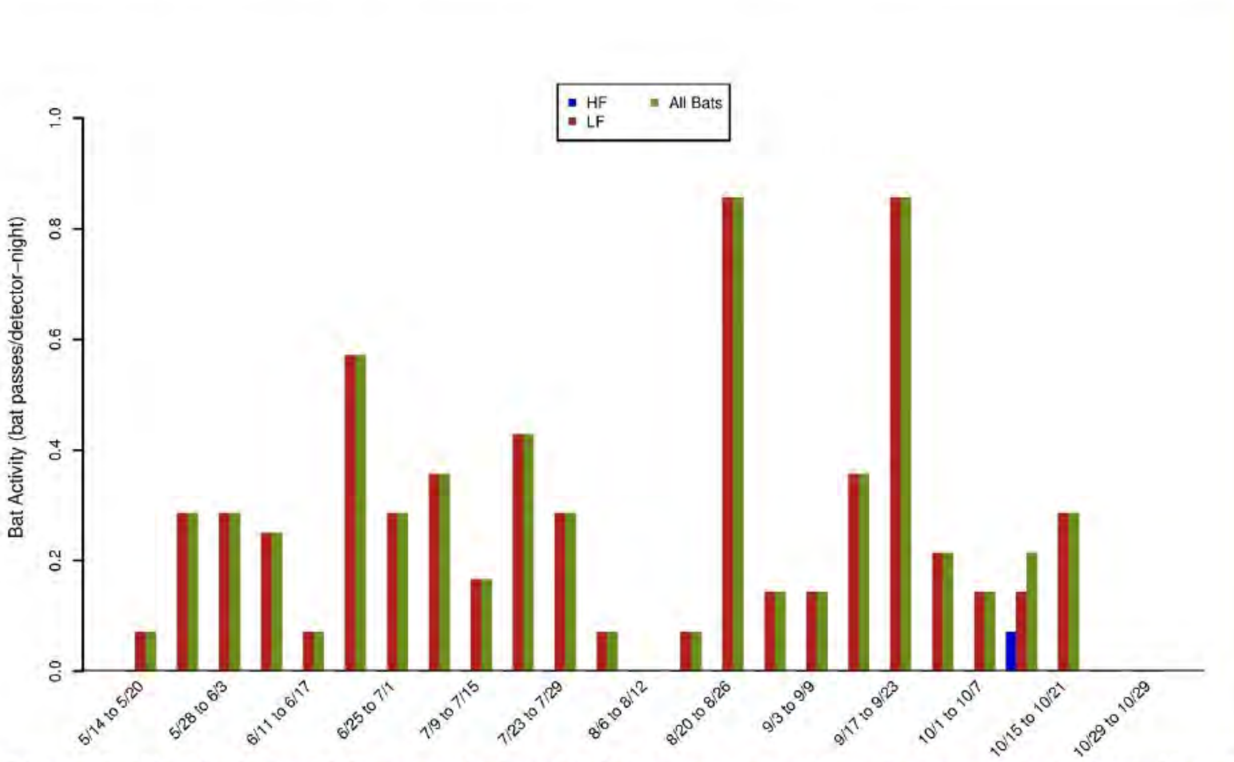

Figure 6. Weekly bat activity recorded as high frequency and low frequency bats from May 14 through October 29, 2018 at the Horse Heaven Wind Project in Benton County, Washington.

Species Composition

During the 2018 survey period, 98.7% of bat passes were classified as LF (silver-haired bat, hoary bat, big brown bat), and 1.2% of bat passes were classified as HF (canyon bat; Table 5). Kaleidoscope Pro identified bat calls for four of the 12 species identified as having potential to occur at the Project (Table 1; Table 5). Similar to 2017, silver-haired bat was the primary species recorded during 2018, recorded on 15% of detector-nights (Table 5). Hoary bat and big brown bat were the next most commonly recorded species, occurring on approximately 3% and 2% of detector-nights, respectively (Table 5). Canyon bat was recorded on the ground-based detector only, for less than 1% of detector-nights (Table 5). No federal or state-listed bat species were recorded.

Table 5. The number (percent composition) of detector-nights a bat species was recorded at the ground detector (HH1g) and raised detector (HH1r) at the Horse Heaven Wind Project, May 14, 2018 – October 29, 2018.

Common Name	HH1g	HH1r	Total[1]
High-Frequency (> 30 kHz)			
canyon bat	2 (1)	0 (0)	2 (1)
Low-Frequency (< 30 kHz)			
big brown bat	7 (4)	0 (0)	7 (2)
hoary bat	3 (2)	6 (4)	9 (3)
silver-haired bat	30 (18)	15 (11)	45 (15)

[1] 303 detector nights total

Temporal Variation

Overall activity of all bats (LF and HF species) in 2018 was lowest in summer (0.22 ± 0.05 bat passes per detector-night), and highest in fall (0.32 ± 0.09), which was consistent with the pattern observed for the LF and HF species group (Table 6; Figure 6). Overall, HF bats comprised a small proportion of bat activity during all seasons compared to LF bats and were only recorded during mid-October (Table 6, Figure 6).

Bat activity at the ground detector station was higher than at the raised detector station throughout the study period, except during the summer months (May 14 – August 18, 2018), when activity at the raised detector station exceeded activity rates at the ground station (Figure 7). Activity by LF species was documented in the summer and fall, and only one HF bat (canyon bat) was recorded in the fall at the ground detector station (Table 6).

Table 6. Mean seasonal bat passes per detector-night by detector station and call frequency during the 2018 survey period within the Horse Heaven Wind Project in Benton County, Washington.

Station	Call Frequency[1]	Summer May 14 – August 18	Fall August 19 – October 29	Fall Migration Period July 30 – October 14
HH1g	LF	0.20 ± 0.05	0.49 ± 0.16	0.43 ± 0.15
	HF	0.00 ± 0.00	0.01 ± 0.01	0.01 ± 0.01
	AB	0.20 ± 0.05	0.50 ± 0.16	0.44 ± 0.15
HH1r	LF	0.25 ± 0.07	0.14 ± 0.05	0.12 ± 0.04
	HF	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
	AB	0.25 ± 0.07	0.14 ± 0.05	0.12 ± 0.04
Overall	**LF**	**0.22 ± 0.05**	**0.31 ± 0.09**	**0.27 ± 0.08**
	HF	**0.00 ± 0.00**	**0.01 ± 0.01**	**0.01 ± 0.01**
	AB	**0.22 ± 0.05**	**0.32 ± 0.09**	**0.28 ± 0.08**

[1] Call frequency: high–frequency (HF), low-frequency (LF), and all bats (AB).

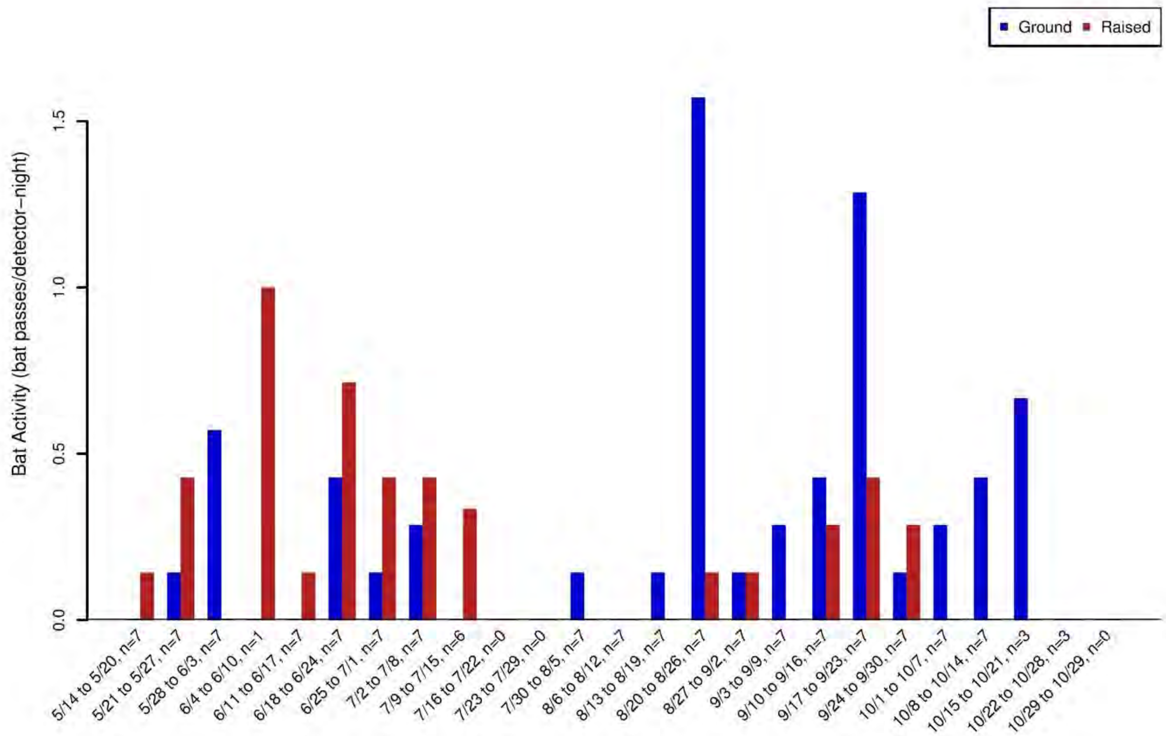

Figure 7. Number of bat passes per detector-night recorded at raised and ground level stations considered representative of future turbine locations in the Horse Heaven Wind Project area from May 14 – October 29, 2018.

RISK ASSESSMENT AND CONCLUSION

Consistent with the US Fish and Wildlife Service (USFWS) *Land-Based Wind Energy Guidelines* (USFWS 2012) and the Washington Department of Fish and Wildlife (WDFW) *Wind Power Guidelines* (WDFW 2009), WEST conducted a bat activity study at the Project with the primary objectives to: 1) evaluate seasonal levels of bat activity at the Project, including periods of expected peak activity, 2) identify species occurring at the Project during the study period, and 3) provide context of bat activity at the Project relative to other publicly available data. Results from the bat activity study include several important findings that are consistent with known patterns from other studies in the region. First, the species documented at the Project are commonly detected species which included silver-haired and hoary bats, both migratory tree-roosting bats. Second, the period of peak activity at the Project occurred during September 2017 and 2018, consistent with known migratory patterns. Third, bat activity rates documented at the Project were consistent with publicly available activity rates from the closest region (i.e., Rocky Mountains).

It is generally thought that pre-construction bat activity rates may be positively related to post-construction bat fatalities (Kunz et al. 2007b). However, to date, few studies of wind energy facilities that have recorded both bat passes per detector night and bat fatality rates, are publicly available (Appendix A). Given the limited availability of pre- and post-construction data sets, differences in protocols among studies (Ellison 2012), and significant ecological differences among geographically diverse facilities, the relationship between pre-construction activity and measured post-construction fatality rates has not been definitively established. In Canada, Baerwald and Barclay (2009) found a significant positive association between passage rates measured at 30 m (98 ft) above ground level and fatality rates for hoary and silver-haired bats across five sites in southern Alberta. However, a similar relationship has proven difficult to establish on a larger scale. The relatively few studies that have estimated both pre-construction activity and post-construction fatalities show results that trend toward a positive association between these rates, but lack statistically significant correlations. Hein et al. (2013a) compiled study results that included both pre- and post-construction data from the same projects, as well as pre- and post-construction data from facilities within the same regions to assess if pre-construction acoustic activity predicted post-construction fatality rates. Based on data from 12 sites, Hein et al. (2013a) did not find a statistically significant relationship (p = 0.07), although the trend was in the expected direction (i.e., higher activity was generally associated with higher fatalities and vice-versa). For these reasons, the current approach to assessing risk to bats using pre-construction acoustic data requires a qualitative analysis of activity levels, spatial and temporal relationships, species composition, and comparison to known regional activity and/or fatality patterns.

During the 2017 study period, 24 bat passes were recorded at the Project; 82 bat passes were recorded in 2018. The period of peak bat activity documented at the Project in 2017 was September 3 – September 9. The period of peak bat activity documented at the Project in 2018 was September 13 – September 19. The overall average bat activity rate at the Project recorded at HH1g in 2017 and 2018 was 0.33 bat passes per detector-night. These findings are in line with known regional patterns of increased bat activity during the fall. During this time, migratory bats (e.g., silver-haired bat, hoary bat) may begin moving toward wintering areas, and many species initiate reproductive behaviors (Cryan 2008). This period of increased landscape-scale movement and reproductive behavior is often associated with increased levels of bat fatalities at operational wind energy facilities (Arnett et al. 2008; Arnett and Baerwald 2013, Thompson et al. 2017). If risk patterns at the Project are consistent with known trends from the region and across the West, it is likely that most fatalities would occur during the fall.

Four species of bat were documented at the Project during the two-year bat activity study, including silver-haired bat, hoary bat, big brown bat, and canyon bat. The most frequently detected species during the 2017 and 2018 study periods was silver-haired bat, occurring on 14% and 15% of detector-nights, respectively. The next most frequently detected species was hoary bat, documented on 6% of detector-nights in 2017 and 3% of detector-nights in 2018. Big brown bat was detected on 1% of detector-nights in 2017, and 2% of detector-nights in 2018; canyon bat was detected on approximately 1% of detector nights in 2017 and less than 1% of detector-nights in 2018. Silver-haired bat and hoary bat are among the most commonly documented bat fatalities at wind energy facilities where these species occur (Cryan and Barclay 2009, Arnett and Baerwald 2013, Tetra Tech 2014, Thompson et al. 2017, AWWI 2018). Given these results and known patterns in bat fatalities at operational wind facilities, if risk trends are similar to elsewhere in the US, it is likely that silver-haired bat and hoary bat will have the highest risk of collision at the Project.

Overall, bat activity at the Project documented during the bat activity study in 2017 and 2018 at (0.33 bat passes per detector-night) was well below the Rocky Mountains regional average of 4.02 bat passes per detector-night (Appendix A), which is the closest region with publicly available activity data (no activity data from the Pacific Northwest is available for comparison). The average fatality rate of 1.19 bats per megawatt per year in the Pacific Northwest is low compared to the Rocky Mountain regional average of 4.90 bats per megawatt per year (bats/MW/year; Appendix A). The closest operational wind facility with publicly-available fatality data is the Nine Canyon Wind Facility (Nine Canyon), located approximately 5 mi east of the Project. During a year-long post-construction fatality study at Nine Canyon conducted 2002–2003, 27 bat fatalities were recorded and the fatality rate was estimated to be 2.47 bats/MW/year (Erickson et al. 2003). Of the 27 bat fatalities, 20 were found during August 5 through October 24 which coincides with fall migration. All fatalities consisted of silver-haired bats (15) or hoary bats (12; Erickson et al. 2003). During 14 years of operational monitoring at Nine Canyon (2005–2018), two bat fatalities were reported in 2007 and consisted of one hoary bat and one silver haired bat. Bat species composition was consistent with species expected although likely under represents the number of actual bat fatalities because systematic surveys that accounted for scavenging rates or searcher efficiency were not conducted during operational monitoring. If risk patterns at the Project are similar to patterns at Nine Canyon and elsewhere in the Pacific Northwest and Rocky Mountains, it is likely that species composition and fatality rates at the Project would be similar.

Bat fatalities have been discovered at most monitored wind energy facilities in North America and globally (Arnett et al. 2016), ranging from zero (Chatfield and Bay 2014) to 40.2 bats/megawatt/year (Hein et al. 2013b; Appendix A) in the US. In 2012, an estimated 600,000 bats died as a result of interactions with wind turbines in the US (Hayes 2013), and hoary bat population viability may be threatened by fatalities caused by wind turbines (Frick et al. 2017). To date, post-construction monitoring studies of wind energy facilities in North America show that: a) collision mortality is greatest for migratory tree-roosting species (e.g., hoary bat and silver-haired bat; Thompson et al. 2017), which make up approximately 78% of reported bat fatalities; b) the majority of fatalities occur during the fall migration season (Thompson et al. 2017); and c) most fatalities occur on nights with relatively low wind speeds (e.g., less than 6.0 m per second [19.7 ft per second]; Arnett et al. 2008, 2013; Arnett and Baerwald 2013). Finally, a recent meta-analysis suggests that bat mortality rates at wind facilities increase as relative grassland cover (or open cover) decreases (Thompson et al. 2017), suggesting that facilities or turbines in forested areas have higher fatality rates than facilities or turbines that lack surrounding tree cover. Given these trends and the results from the bat activity study at the Project in 2017 and 2018, it is likely that bat mortality at the Project, once operational, would: a) be low, similar to other Pacific Northwest facilities including nearby Nine Canyon; b) consist primarily of migratory, tree-roosting species (i.e., silver-haired bat, hoary bat); and c) occur mainly in the fall.

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Appendix A. North American Fatality Summary Tables

Appendix A. Wind energy facilities in North America with comparable activity and fatality data for bats, separated by geographic region. Activity estimate given as bat passes per detector-night. Fatality estimate given as the number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Bat Activity Estimate	Bat Activity Dates	Fatality Estimate	No. of Turbines	Total MW
Horse Heaven (2017–2018)	**0.33**	8/19/17 – 10/31/17 5/14/18 – 10/29/18			
	Pacific Northwest				
Mean	**--**		**1.19**	**99**	**134.1**
Palouse Wind, WA (2012-2013)			4.23	58	104.4
Biglow Canyon, OR (Phase II; 2009-2010)			2.71	65	150
Nine Canyon, WA (2002-2003)			2.47	37	48.1
Stateline, OR/WA (2003)			2.29	454	299
Elkhorn, OR (2010)			2.14	61	101
White Creek, WA (2007-2011)			2.04	89	204.7
Biglow Canyon, OR (Phase I; 2008)			1.99	76	125.4
Leaning Juniper, OR (2006-2008)			1.98	67	100.5
Big Horn, WA (2006-2007)			1.9	133	199.5
Combine Hills, OR (Phase I; 2004-2005)			1.88	41	41
Linden Ranch, WA (2010-2011)			1.68	25	50
Pebble Springs, OR (2009-2010)			1.55	47	98.7
Hopkins Ridge, WA (2008)			1.39	87	156.6
Harvest Wind, WA (2010-2012)			1.27	43	98.9
Elkhorn, OR (2008)			1.26	61	101
Vansycle, OR (1999)			1.12	38	24.9
Klondike III (Phase I), OR (2007-2009)			1.11	125	223.6
Stateline, OR/WA (2001-2002)			1.09	454	299
Stateline, OR/WA (2006)			0.95	454	299
Tuolumne (Windy Point I), WA (2009-2010)			0.94	62	136.6
Klondike, OR (2002-2003)			0.77	16	24
Combine Hills, OR (2011)			0.73	104	104
Hopkins Ridge, WA (2006)			0.63	83	150
Biglow Canyon, OR (Phase I; 2009)			0.58	76	125.4
Biglow Canyon, OR (Phase II; 2010-2011)			0.57	65	150
Hay Canyon, OR (2009-2010)			0.53	48	100.8
Windy Flats, WA (2010-2011)			0.41	114	262.2
Klondike II, OR (2005-2006)			0.41	50	75
Vantage, WA (2010-2011)			0.4	60	90
Wild Horse, WA (2007)			0.39	127	229
Goodnoe, WA (2009-2010)			0.34	47	94
Marengo II, WA (2009-2010)			0.27	39	70.2
Biglow Canyon, OR (Phase III; 2010-2011)			0.22	76	174.8
Marengo I, WA (2009-2010)			0.17	78	140.4
Klondike IIIa (Phase II), OR (2008-2010)			0.14	51	76.5
Kittitas Valley, WA (2011-2012)			0.12	48	100.8
	Rocky Mountains				
Mean	**4.02**		**4.90**	**70**	**85.0**
Summerview, Alb (2006; 2007)	7.65[A]	07/15/06-07-09/30/06-07	11.42	39	70.2
Summerview, Alb (2005-2006)			10.27	39	70.2
Judith Gap, MT (2006-2007)			8.93	90	135

Appendix A. Wind energy facilities in North America with comparable activity and fatality data for bats, separated by geographic region. Activity estimate given as bat passes per detector-night. Fatality estimate given as the number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Bat Activity Estimate	Bat Activity Dates	Fatality Estimate	No. of Turbines	Total MW
Foote Creek Rim, WY (Phase I; 1999)			3.97	69	41.4
Judith Gap, MT (2009)			3.2	90	135
Milford I, UT (2010-2011)			2.05	58	145
Milford I & II, UT (2011-2012)			1.67	107	160.5 (58.5 Phase I, 102 Phase II)
Foote Creek Rim, WY (Phase I; 2001-2002)	2.2[A,B]	6/15/01-9/1/01	1.57	69	41.4
Foote Creek Rim, WY (Phase I; 2000)	2.2[A,B]	6/15/00-9/1/00	1.05	69	41.4

A = Activity rate was averaged across phases and/or years
B = Activity rate calculated by WEST from data presented in referenced report

Appendix A (*continued*). Wind energy facilities in North America with comparable activity and fatality data for bats. Data from the following sources:

Facility	Activity Estimate	Fatality Estimate	Facility	Activity Estimate	Fatality Estimate
Big Horn, WA (06-07)		Kronner et al. 2008	Klondike III (Phase I), OR (07-09)		Gritski et al. 2010
Biglow Canyon, OR (Phase I; 08)		Jeffrey et al. 2009b	Klondike IIIa (Phase II), OR (08-10)		Gritski et al. 2011
Biglow Canyon, OR (Phase I; 09)		Enk et al. 2010	Leaning Juniper, OR (06-08)		Gritski et al. 2008
Biglow Canyon, OR (Phase II; 09-10)		Enk et al. 2011b	Linden Ranch, WA (2010-2011)		Enz and Bay 2011
Biglow Canyon, OR (Phase II; 10-11)		Enk et al. 2012b	Marengo I, WA (2009-2010)		URS Corporation 2010b
Biglow Canyon, OR (Phase III; 10-11)		Enk et al. 2012a	Marengo II, WA (2009-2010)		URS Corporation 2010c
Combine Hills, OR (Phase I; 04-05)		Young et al. 2006	Milford I & II, UT (2011-2012)		Stantec 2011b
Combine Hills, OR (11)		Enz et al. 2012	Milford I, UT (2010-2011)		Stantec 2012b
Elkhorn, OR (08)		Jeffrey et a. 2009a	Nine Canyon, WA (2002-2003)		Erickson et al. 2003
Elkhorn, OR (10)		Enk et al. 2011a	Palouse Wind, WA (12-13)		Stantec 2013a
Foote Creek Rim, WY (Phase I; 99)		Young et al. 2003a	Pebble Springs, OR (09-10)		Gritski and Kronner 2010b
Foote Creek Rim, WY (Phase I; 00)	Gruver 2002	Young et al. 2003a, 2003b	Stateline, OR/WA (01-02)		Erickson et al. 2004
Foote Creek Rim, WY (Phase I; 01-02)		Young et al. 2003a, 2003b	Stateline, OR/WA (03)		Erickson et al. 2004
Goodnoe, WA (09-10)		URS Corporation 2010a	Stateline, OR/WA (06)		Erickson et al. 2007
Harvest Wind, WA (10-12)		Downes and Gritski 2012a	Summerview, Alb (05-06)		Brown and Hamilton 2006
Hay Canyon, OR (09-10)		Gritski and Kronner 2010a	Summerview, Alb (06; 07)	Baerwald 2008	Baerwald 2008
Hopkins Ridge, WA (06)		Young et al. 2007	Tuolumne (Windy Point I), WA (09-10)		Enz and Bay 2010
Hopkins Ridge, WA (08)		Young et al. 2009	Vansycle, OR (99)		Erickson et al. 2000
Judith Gap, MT (06-07)		TRC 2008	Vantage, WA (10-11)		Ventus 2012
Judith Gap, MT (09)		Poulton and Erickson 2010	White Creek, WA (07-11)		Downes and Gritski 2012b
Kittitas Valley, WA (11-12)		Stantec Consulting Services 2012	Wild Horse, WA (07)		Erickson et al. 2008
Klondike, OR (02-03)		Johnson et al. 2003	Windy Flats, WA (10-11)		Enz et al. 2011
Klondike II, OR (05-06)		NWC and WEST 2007			

SITE CHARACTERIZATION STUDY REPORT

Badger Canyon Wind Project
Benton County, Washington

Prepared for:

Badger Canyon MW LLC

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WEST Inc.

EXECUTIVE SUMMARY

The proposed Badger Canyon Wind Project (Project) includes an area of approximately 41,289 acres (64.51 square miles) of primarily private land in Benton County, Washington. Wpd Wind Projects, Inc. is proposing to develop this area under the auspices of a wholly-owned subsidiary, Badger Canyon MW, LLC. This Site Characterization Study (SCS) is intended to fulfill the tasks described in the US Fish and Wildlife Service (USFWS) Land-Based Wind Energy Guidelines (WEG) for Tier 2 site characterization and the USFWS Eagle Conservation Plan Guidance (ECPG) for Stage 1 site assessment, and to help guide formulation of specific detailed surveys for the Project. Specifically, the information contained herein reflects a desktop analysis of publicly available information that pertains to plants, animals, and habitat features that may be important considerations during Project planning and development. Environmental resources within the Project boundary (Project area) were examined through a search of existing data. In addition, an initial reconnaissance-level site visit was conducted in December 2017, to provide additional cursory, baseline information on landscape and habitat features potentially important during Project development.

The dominant land cover type at the Project is cultivated dry land wheat farming, comprising over 92% of the Project area. Much smaller patches of shrub/scrub and grassland habitat, as well as developed areas (farmsteads) are present throughout the Project. One special status plant species, the state threatened woven-spore lichen, is known to occur within five miles of the Project but is not likely to occur within the Project boundary. Additionally, four rare and/or high quality plant communities have been documented in the region, all along the northern boundary of the Project. Two Washington Department of Fish and Wildlife (WDFW) Priority Habitats (freshwater wetland and shrub-steppe) have also been identified in the area, primarily to the north of the Project.

There are 15 diurnal raptor species and seven owl species that may occur in or near the Project area at some point during the year. Of the raptor species with potential to occur within the Project area, one species is state threatened (ferruginous hawk), two species are state candidates for listing (golden eagle and burrowing owl), and two species are state Priority Species (bald eagle and prairie falcon). Nesting habitat for tree-nesting raptor species (e.g., Swainson's hawk, red-tailed hawk) is present in scattered, isolated trees within the Project area and surrounding region, while ground-nesting species (e.g., burrowing owl, northern harrier) have the potential to nest throughout the Project, and cliffs to the north of the Project provide nesting substrate for species such as ferruginous hawk and barn owl.

Sixteen bat species have the potential to occur in and around the Project, with eight species having an approximate range and habitat requirements that overlap the Project area. The only listed or candidate bat species in Washington are Townsend's big-eared bat and Keen's myotis, both of which are State candidates for listing; however, Keen's myotis occupy only the extreme northwestern corner of the state and Townsend's big-eared bats are unlikely to occur within the Project due to a general lack of roosting and hibernating sites.

Three wildlife species listed as state threatened or endangered by the WDFW have at least some potential to occur within the Project: American white pelican, ferruginous hawk, and sandhill crane. An additional 12 species (six birds, four mammals, and two reptiles) are considered State candidates for listing. No species currently listed, or candidates for listing, under the USFWS Endangered Species Act have the potential to occur within the Project.

Based on this SCS, significant adverse impacts to special status species are not anticipated; however, due to the potential for occurrence of some sensitive plant and wildlife species within the Project area, it is recommended that Tier 3 site-specific studies be conducted to further refine risk assessments for these species. The following Tier 3 studies are recommended prior to construction in order to more clearly assess the potential risk to sensitive plants and wildlife: vegetation/land cover mapping, year-round large bird/eagle use surveys, small bird use surveys, raptor nest surveys with particular emphasis on bald and golden eagles, bat acoustic surveys, rare plant surveys, and a wetlands and waters of the US survey.

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INTRODUCTION

Many wind energy developers now choose to utilize the US Fish and Wildlife Service (USFWS) voluntary wind project development guidelines, which provide a template for a tiered planning process when exploring a potential wind energy project. The Land-based Wind Energy Guidelines (WEG; USFWS 2012) are intended to function in concert with the USFWS Eagle Conservation Plan Guidance (ECPG; USFWS 2013), and promote intentional tiered project development which strategically assesses and minimizes impacts to wildlife. This tiered approach includes: Tier 1 - Preliminary Site Evaluation; Tier 2 - Site Characterization; Tier 3 - Field Studies to Document Site Wildlife and Habitat and Predict Project Impacts; Tier 4 - Post-construction Studies to Document Impacts; Tier 5 - Other Post-construction Studies. This document addresses Tier 2 Site Characterization recommendations for the proposed Badger Canyon Wind Project and serves to identify potential biotic and abiotic resource issues at the Project. Identification of resource issues early in the planning process allows developers of wind energy facilities to identify, avoid, and minimize future problems which may occur. This document will be used to guide the Tier 3 field studies necessary to evaluate identified resources of concern within the proposed Badger Canyon Wind Project (Project).

STUDY AREA

Regional Setting

The Project lies within the semi-arid Columbia Plateau Ecological region, which encompasses a large portion of south central Washington (Washington Biodiversity Council 2008). The Columbia Plateau tilts upward and southward into the Great Basin of eastern Oregon, western Idaho, and northern Nevada, and is bordered by the Cascades to the west, the Okanogan Highlands to the north, the Rockies to the east, and the Blue Mountains to the southeast. The Columbia and Snake rivers are the dominant topographic features of the Columbia Plateau; in Washington, the plateau is bisected by the Columbia River. Today, the areas with suitable soil are used for agriculture; crops include wheat (*Triticum* spp.), alfalfa (*Medicago sativa*), potatoes (*Solanum tuberosum*), grass hay, and vineyards. Other areas within the region are used for cattle grazing. In the Yakima Valley to the north and the Columbia Basin to the south, irrigated agriculture is prevalent and includes pastures, orchards, and vineyards. Hops (*Humulus lupulus*) and field crops are also commonly grown. In un-cultivated areas, this ecoregion is characterized by arid sagebrush- (*Artemisia* spp.) steppe and grassland. The regional climate can by typified as arid to semiarid with low precipitation, warm to hot dry summer, and relatively cold winters (Franklin 1973). Mean annual temperature in the region is 59° Fahrenheit (15° Celcius), with mean annual precipitation of 10 inches (25 centimeters; Franklin 1973, Daly 2000).

Over the last two decades, the Columbia Plateau Ecoregion of eastern Washington and Oregon has experienced extensive wind energy developed. In Washington alone, there are currently 20 operating wind energy facilities with a total installed capacity of 3,075 megawatts (MW), the majority of which are located in the Columbia Plateau (American Wind Energy Association

(AWEA) 2017). In Benton County, where the proposed Project is located, there is currently only one operating facility, the Nine Canyon wind energy facility, located approximately 10 miles (mi; 16.1 kilometers [km]) to the east-southeast of the Project.

Project Area

The proposed Project area encompasses approximately 41,288.94 acres (ac; 64.51square miles [mi^2]; Project area) within Benton County in southeastern Washington, approximately two mi (3.2 km) south of Benton City and 10 mi west of the city of Kennewick (Figure 1). The roughly east-west Chandler Butte ridgeline rests between Benton City and the Project area. Topography within the Project area is gently sloping, with elevations ranging from 371 meters (m; 1,217 feet [ft]) in the southwest corner of the Project to 573 m (1,880 ft) along the eastern edge of the Project (Figure 2). The Horse Heaven Hills, an anticline ridge of the Yakima Folds, lies along the northeastern border of the Project. On the southern side of the ridge, the landscape transitions to relatively rolling topography with shallow, meandering canyons that drain southwest into the Columbia River. At its closest point, the Columbia River runs approximately eight mi (12.9 km) to the northeast of the Project and wraps around the Project to the east and south (Figure 1). The Yakima River flows eastward into the Columbia approximately two mi to the north of the Project (Figure 1).

Modern land use within the Project area is almost entirely tilled dry-land agriculture (wheat) with remnants of native shrub-steppe habitat still present along the northern boundary of the Project area (Figures 3 and 4). A network of county and a few private roads traverse the Project area. Representative photos of the land cover types and landscape features within the Project area are included in Appendix A.

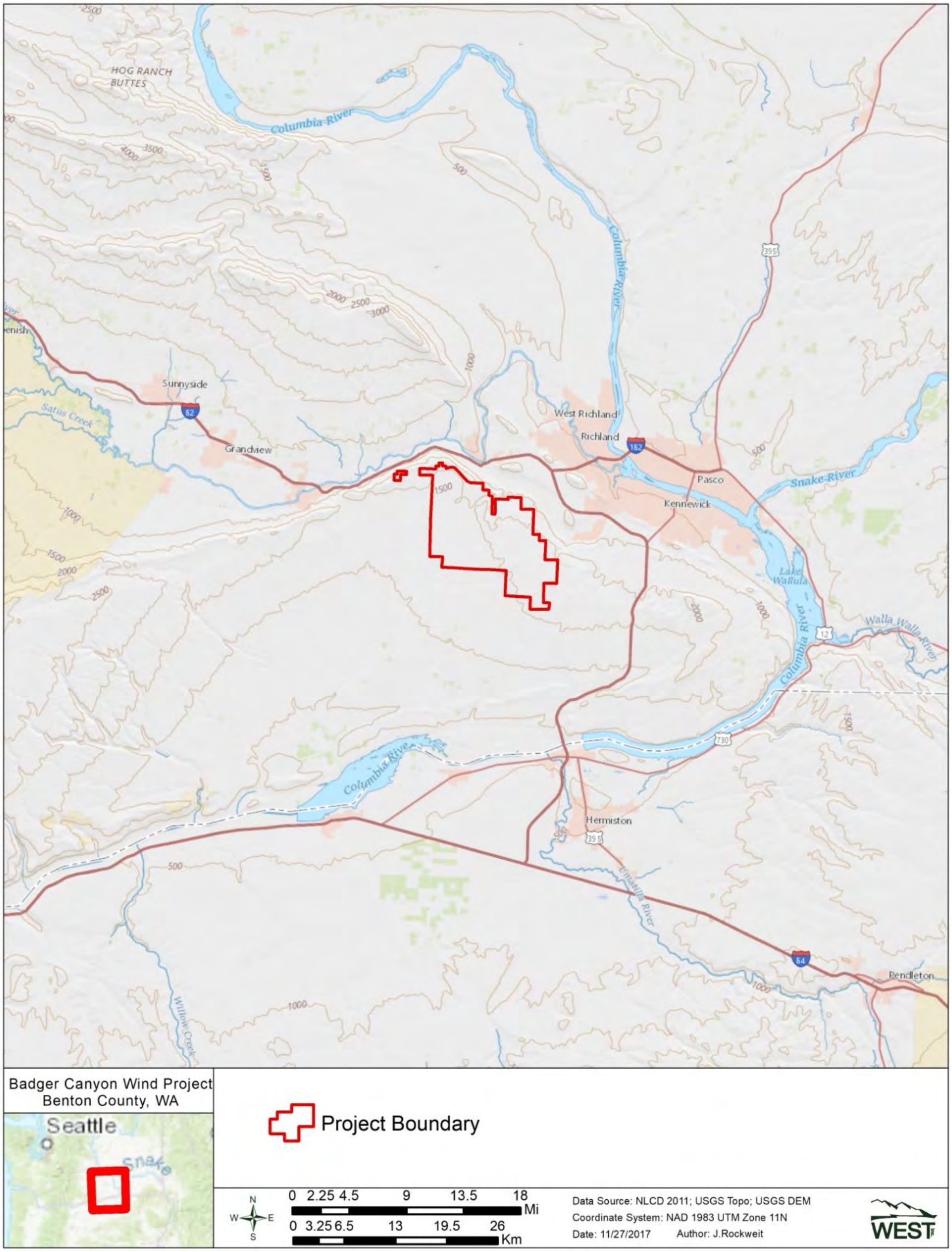

Figure 1. Location of the Badger Canyon Wind Project, Benton County, Washington.

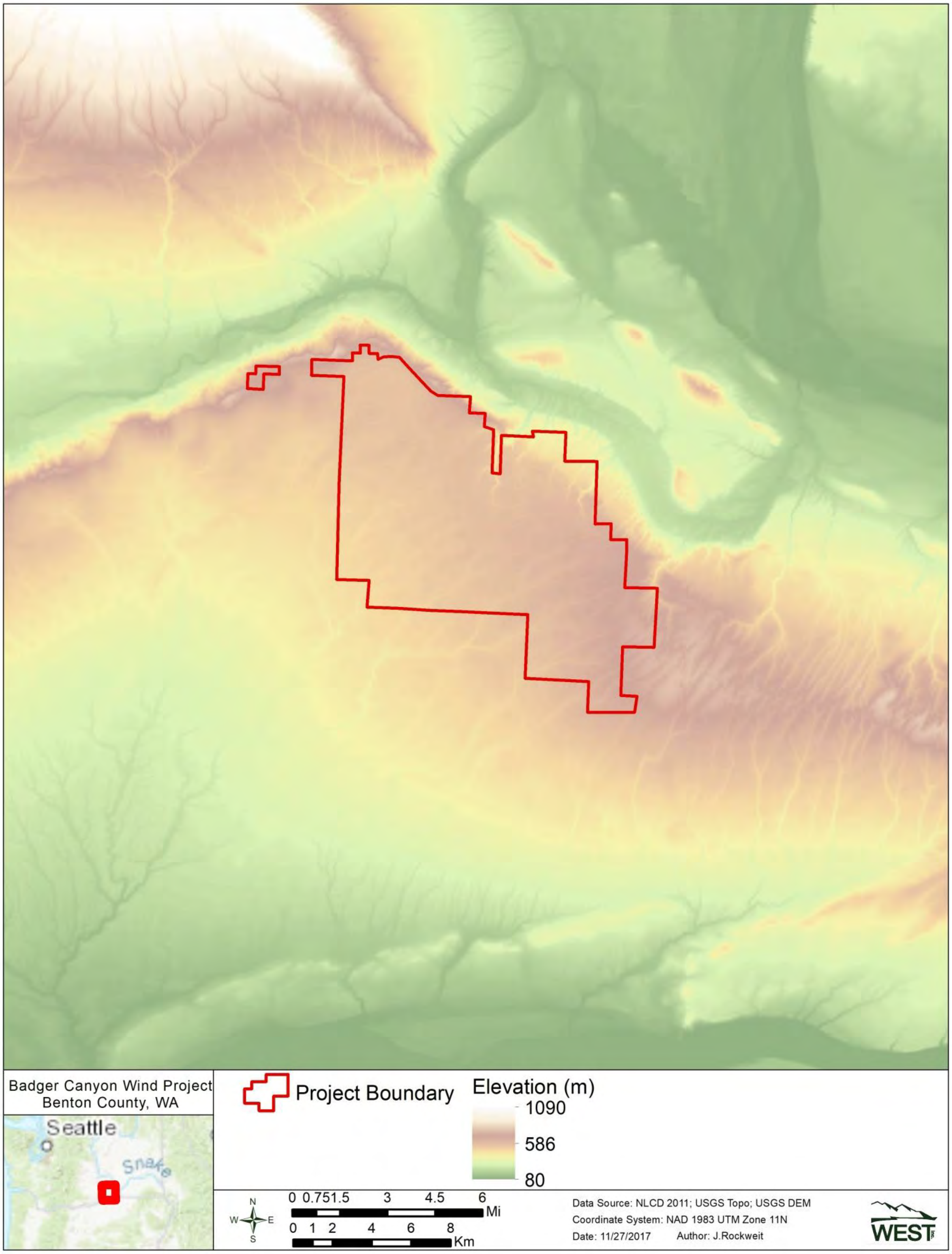

Figure 2. Digital elevation model of the Badger Canyon Wind Project area.

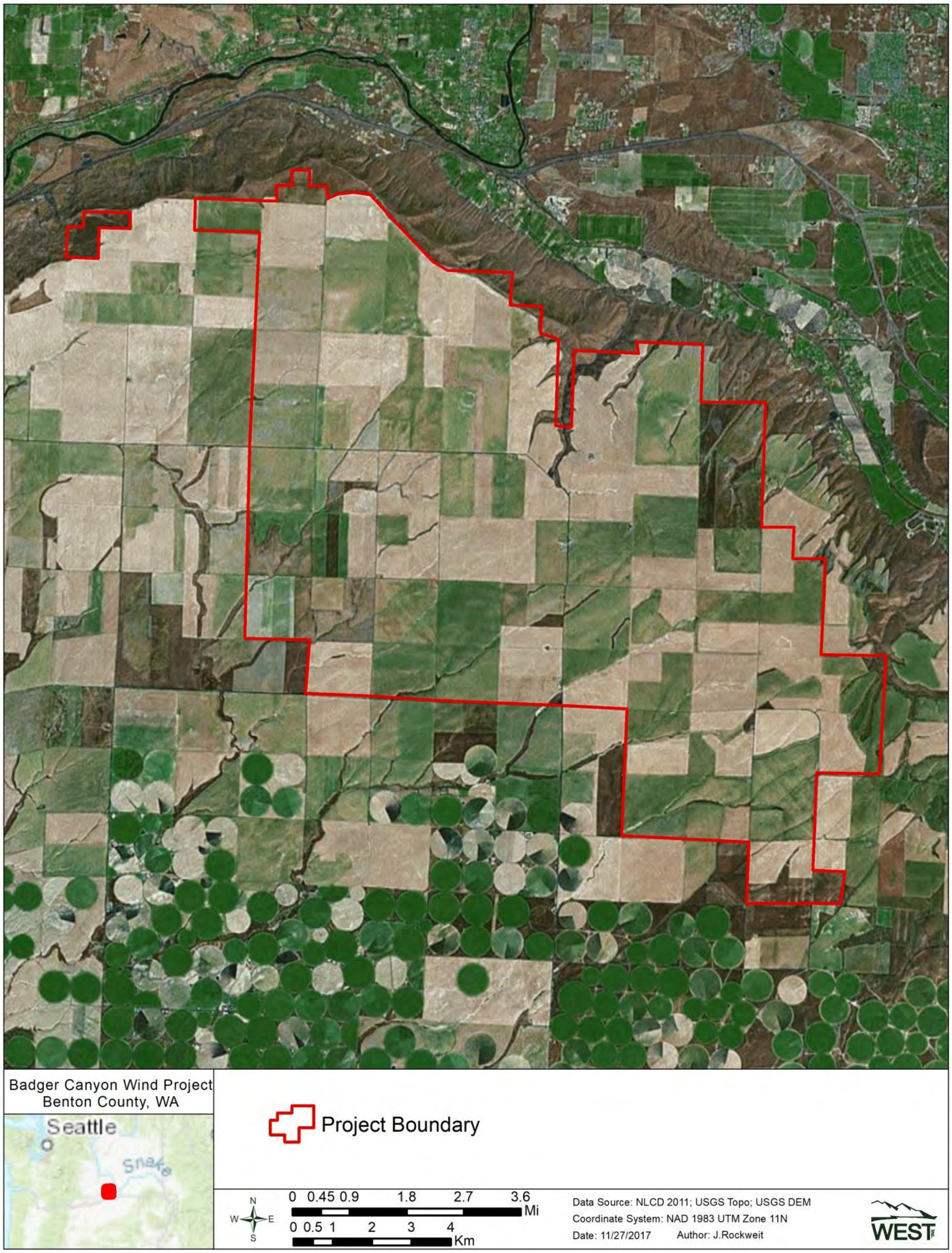

Figure 3. Aerial photograph of the Badger Canyon Wind Project area.

METHODS

Environmental resources within the Project and surrounding area were examined through a search of existing publicly available data and an initial reconnaissance-level site visit. The initial site visit occurred on December 11, 2017 and entailed a preliminary examination of the area from accessible public and private roads. Biological features and potential wildlife habitat assessed during the site visit included plant communities and wetlands, topographic and geological features, potential raptor nesting habitat, habitat for prey populations, and potential bat roosting and foraging habitat. Photographs of the Project area are presented in Appendix A.

Published literature, field guides, and public data sets were among the resources reviewed to identify known environmental resources within the Project area and surrounding region. The information presented in this analysis was obtained from the following sources:

- Bat Conservation International (BCI) species accounts and range maps (BCI 2017);
- List of Important Bird Areas (IBAs) by the National Audubon Society (Audubon 2017 2017);
- Priority Habitats and Species (PHS) database, maintained by the Washington Department of Fish and Wildlife (WDFW; 2017a);
- Published or available literature regarding wind-energy impacts to wildlife, with an emphasis on projects in the Columbia Plateau Ecoregion;
- Published literature, WDFW species status reports, and other publically-available information on the life history and range for special status species;
- State or federally protected nature preserves and lands protected by The Nature Conservancy (US Geological Survey [USGS] 2017a; The Nature Conservancy 2017);
- TNC and American Wind Wildlife Institute's (AWWI) Wind and Wildlife Landscape Assessment Tool (AWWI 2017);
- US Department of Agriculture (USDA) Soil Survey Geographic (SSURGO) data (USDA Natural Resource Conservation Service [NRCS] 2017);
- USFWS Critical Habitat designations (USFWS 2016);
- USFWS National Wetland Inventory (NWI) data (USFWS NWI 2016);
- USFWS county-level species occurrence information (USFWS 2017);
- USGS National Land Cover Dataset (NLCD; USGS NLCD 2011);
- USGS topographic maps and digital elevation data (USGS 2017, USGS DEM 2016);
- Washington Natural Heritage Program (WNHP) spatial dataset of rare or at-risk plants and plant communities (WNHP 2017b);
- Washington State Species of Concern Lists, maintained by the WDFW (2017b); and

- WNHP online *Field Guide to the Rare Plants of Washington* (WHNP 2017a).

WEST determined the likelihood a sensitive animal or plant species may occur within the Project by considering the species' range, habitat suitability within the Project, species' mobility, population size, and records of occurrence within or adjacent to the Project. A similar assessment was made for sensitive plant communities and habitats. Based on these factors, the likelihood of occurrence was defined for each sensitive species/community using the following categories:

- None – Project outside the species known range, no suitable habitat within the Project, restricted mobility and small population size.
- Unlikely – Project outside the species known range and suitable habitat appears absent within the Project; however, due to the species mobility and population size, species may occur within the Project during migration or other times of the year.
- Possible – Project is located within the range of the species but contains marginal suitable habitat; species highly mobile and may occur year-round.
- Likely – Project is located within the range of the species and contains suitable habitat; records of species occurrence in the surrounding area but absent from the Project.
- Occurs – Records of species occurrence within the Project based on PHS and/or WNHP data or other survey data.

LAND COVER AND HABITATS

Land Use/Land Cover

The proposed Project area encompasses 41,288.94 ac (64.51 mi^2). According to the USGS NLCD (2011; Homer et al. 2015), the dominant cover type within the Project area is cultivated cropland, covering 38,028.09 ac (59.42 mi^2), or 92.1% of the Project (Table 1; Figure 4). Much smaller patches of shrub/scrub cover types are present throughout the Project, comprising an additional 6.1% of the Project area (2,520.30 ac [3.94 mi^2]; Table 1; Figure 4). The remaining 1.8% is covered by small amounts of developed areas (primarily roads; 671.98 ac [1.05 mi^2]), grassland/herbaceous cover types (67.60 acres [0.11 mi^2]), and open water (0.98 acres [< 0.01 mi^2]; Table 1; Figure 4).

Table 1. Land use and habitat types present within the Badger Canyon Wind Project.

Cover Type	Acres	Percent Composition (%)
Cultivated Crops	38,028.09	92.1
Shrub/scrub	2,520.30	6.1
Developed, Open Space	564.06	1.4
Developed, Low Intensity	100.13	0.2
Grassland/Herbaceous	67.60	0.2
Developed, Medium Intensity	7.79	< 0.1
Open Water	0.98	< 0.1
Total	**41,288.94**	**100**

Data obtained from USGS NLCD, compiled from satellite imagery (USGS NLCD 2011; Homer et al. 2015).

Wetlands and Riparian Areas

Digital NWI data (USFWS NWI 2016) are available for the Project area; however, formal wetland delineations have not been completed. According to the NWI, less than 0.1% of the Project area is composed of wetland habitat. The majority of this wetland habitat (7.59 ac; 93.9%) is riverine which is contained within a network of unnamed intermittent drainages located throughout the Project (Figure 5). The remaining 0.49 ac of wetland habitat is present within a single emergent wetland in the southeastern portion of the Project (Figure 5). At its closest point, the Yakima River runs approximately 2-3 mi (3.2-4.8 km) from the northwest corner of the Project. The majority of the Project area drains to the southwest into the Columbia River, with a much smaller portion of the Project along the northeastern boundary ultimately draining northeast into the Columbia and northwest into the Yakima River (Figures 3 and 5).

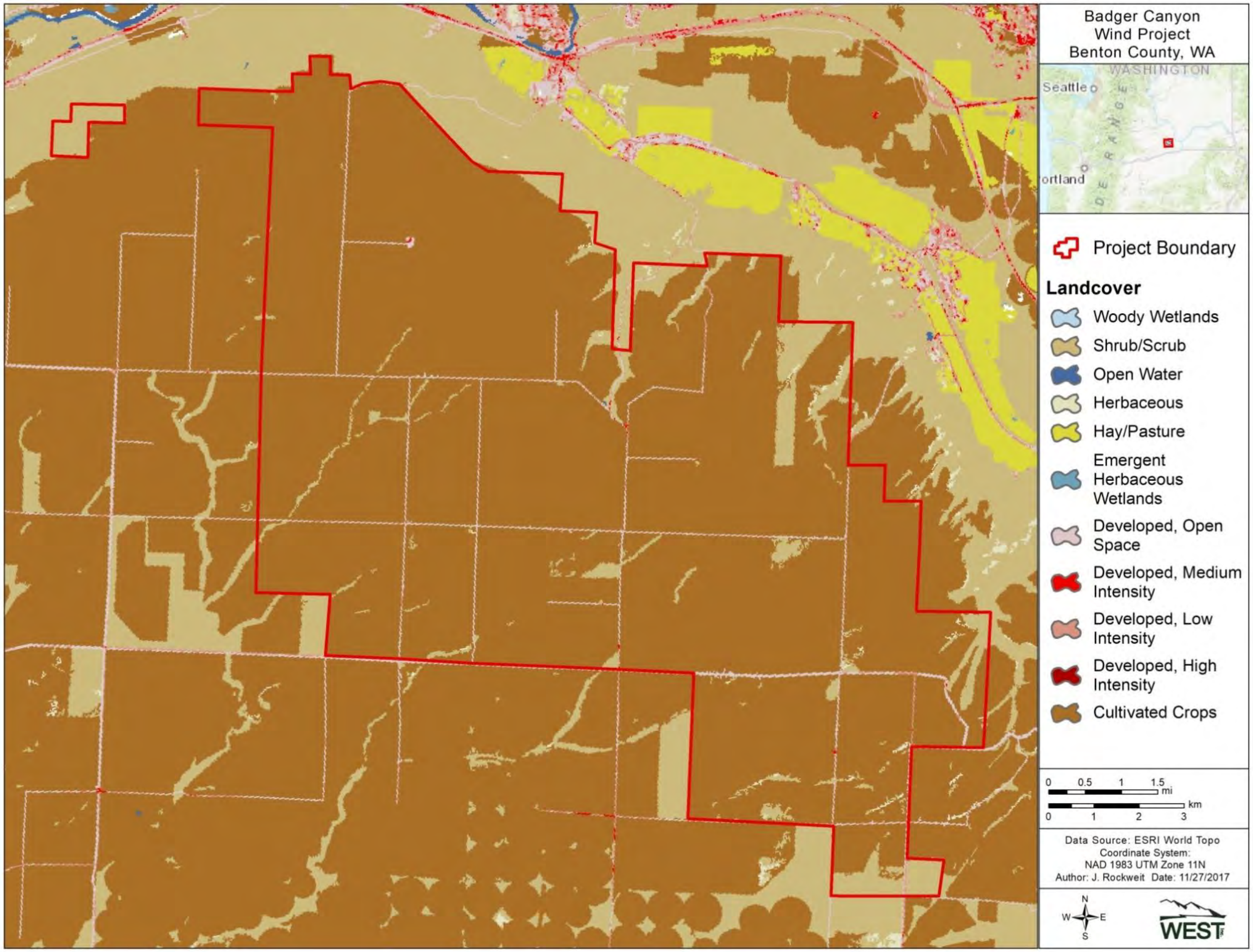

Figure 4. Land cover within the Badger Canyon Wind Project (USGS NLCD 2011).

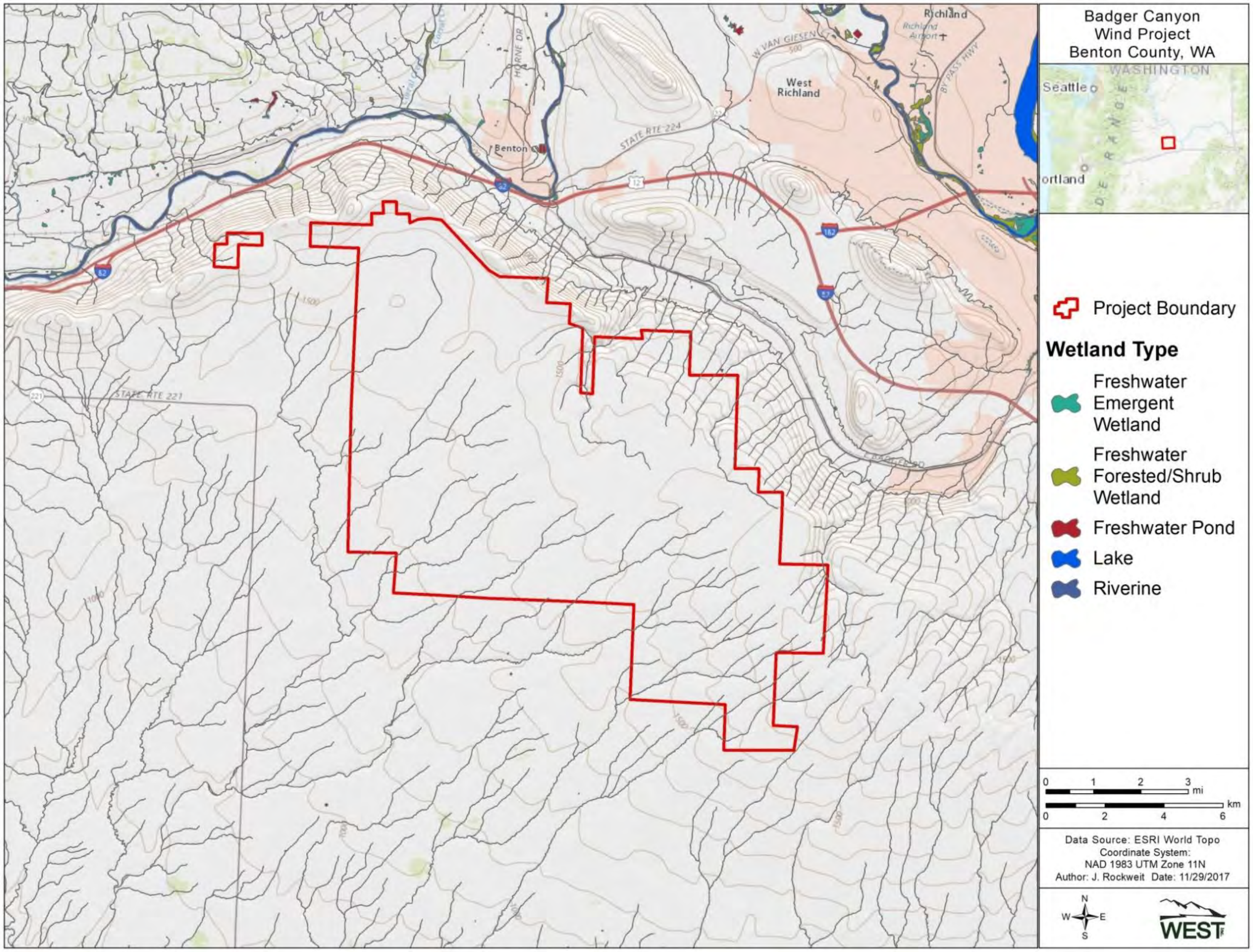

Figure 5. National Wetland Inventory map of the Badger Canyon Wind Project (USFWS NWI 2016).

Priority Habitats

The PHS List, maintained by the WDFW, is a catalog of habitats and species considered to be priorities for conservation and management. Priority habitats are habitat types or elements with unique or significant value to a diverse assemblage of species. The PHS online database identified two Priority Habitats occurring within three mi (4.8 km) of the Project: freshwater emergent wetland and shrub-steppe (Table 2; WDFW 2017a).

Table 2. Priority Habitats occurring in the vicinity of the Badger Canyon Wind Project.

Habitat	Description	Potential for Occurrence in the Project area
Freshwater emergent wetland	Lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water (WDFW 2008).	**Present**. Small emergent wetland documented within southeastern portion of Project (WDFW 2017a), but some potential for other small wetlands throughout the Project.
Shrub-steppe	Non-forested vegetation type consisting of one or more layers of perennial bunchgrasses and a conspicuous but discontinuous layer of shrub (WDFW 2008).	**Possible.** Vast majority of Project is cultivated cropland; however, small patches of remnant scrub-steppe may be present. Documented shrub-steppe habitat occurs along the northern boundary of the Project (WDFW 2017a; WNHP 2017b).

Occurrence data obtained from WDFW 2017a

Rare Plants and Plant Communities

The WNHP maintains a database containing information on the location of federal and/or state listed and rare plants and rare and/or high quality plant communities across the state (WNHP 2017b). According to a search of the online database only a single special-status plant species is known to occur within five miles of the Project. The woven-spore lichen (*Texosporium sancti-jacobi*), a state threatened species and federal species of concern, has been documented at four separate locations in shrub-steppe habitat within approximately one mi (1.6 km) of the Project. The woven-spore lichen inhabits arid to semi-arid native shrub-steppe, grassland, biscuit scabland, or savannah communities, on flat to gentle north-facing slopes (WNHP 2017a). Given the preponderance of cultivated cropland throughout the Project area and lack of native vegetation and north-facing slopes, this species is unlikely to occur within the Project.

In addition to the woven-spore lichen, the WHNP lists four rare and/or high quality plant communities that have been identified within five mi of the Project. These include: rock buckwheat (*Erigonum sphaerocephalus*)/Sandburg bluegrass (*Poa secunda*), Douglas buckwheat (*E. douglasii*)/Sandburg bluegrass, big sagebrush (*Artemisia tridentata*)/Idaho fescue (*Festuca idahoensis*), and Wyoming big sagebrush (*A. t. wyomingensis*)/bluebunch wheatgrass (*Pseudoregneria spicata*; Figure 6). Each of these plant communities has been documented in native shrub-steppe ecosystems occurring along the northern boundary of the Project (Figure 6). Again, due to the current agricultural land uses within the Project, native shrub-steppe habitat with the potential to support these rare/high quality plant communities is unlikely to occur within the Project. It should be noted, however, that the WNHP dataset represents an ongoing and incomplete inventory of Washington's rare plants and ecosystems and does not preclude the need for field surveys.

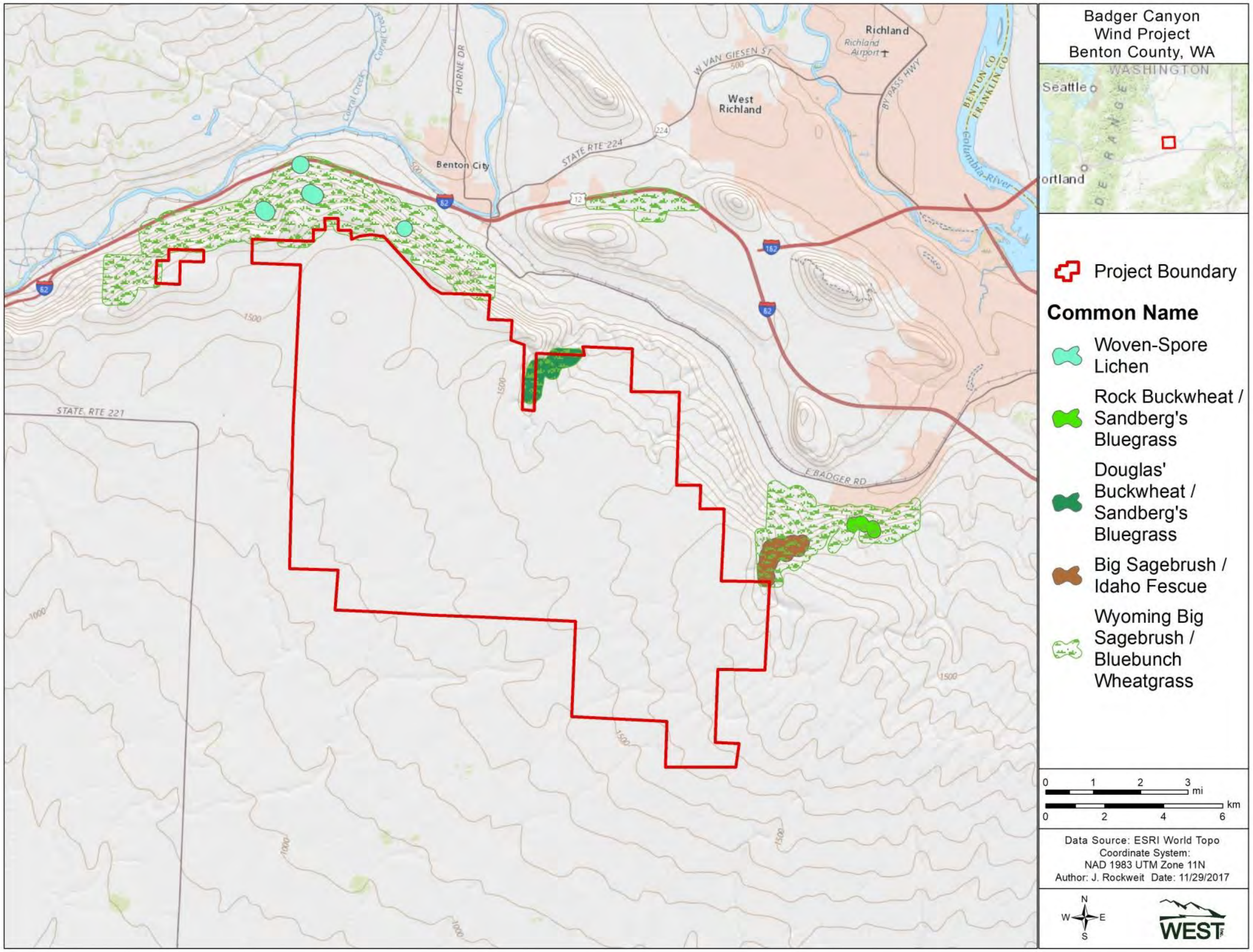

Figure 6. Known locations of rare plants and plant communities in the vicinity of the Badger Canyon Wind Project. Data from the Washington Natural Heritage Program (WNHP; 2017b).

WILDLIFE RESOURCES

Federal and State Listed Species

Based on review of State and federal special-status species lists and occurrence information (USFWS 2017, WDFW 2017a, WDFW 2017b), no wildlife species currently listed, or candidates for listing, under the federal Endangered Species Act (ESA) have the potential to occur within the Project. However, 16 State-listed or candidate wildlife species have at least some potential to occur in the Project, including ten bird species, four mammal species, and two reptile species (Table 3). Also included in the list are WDFW Priority Species (five birds and two mammals) which have been identified as priorities for conservation and management and are known to occur in the region (WDFW 2017a; Table 3). Additionally, while the bald eagle (*Haliaeetus leucocephalus*) is no longer a federal or State threatened species, it is included in the list as it is protected, along with the golden eagle, under the federal Bald and Golden Eagle Protection Act (BGEPA 1940). Impacts to eagles are of particular concern at wind energy facilities nation-wide and are discussed in greater detail in the sections below.

Of the 18 special-status species with potential to occur in the Project, six species (burrowing owl [*Athene cunicularia*], ferruginous hawk [*Buteo regalis*], loggerhead shrike [*Lanius ludovicianus*], prairie falcon [*Falco mexicanus*], black-tailed jackrabbit [*Lepus californicus*], and Townsend's ground squirrel [*Urocitellus townsendii townsendii*]) have been documented as occurring within two miles of the Project (WDFW 2017a). An additional eight species are likely or have potential to occur in the Project: American white pelican (*Pelecanus erythrorhynchos*), bald eagle, golden eagle (*Aquila chrysaetos*), sandhill crane (*Grus canadensis*), Vaux swift (*Chaetura vauxi*), white-tailed jackrabbit (*Lepus townsendii*), sagebrush lizard (*Sceloporus graciosus*), and striped whipsnake (*Masticophis taeniatus*). The remaining four species are unlikely to occur: sagebrush sparrow (*Artemisiospiza nevadensis*), greater sage grouse (*Centrocerus urophasianus*), sage thrasher (*Oreoscoptes montanus*), and Townsend's big-eared bat (*Coryhorhinus townsendii*). General habitat requirements and the potential for occurrence for each of these species is presented below in Table 3.

Table 3. State and/or federal listed or candidate wildlife species, or state Priority Species, with potential to occur within the Badger Canyon Wind Project.

Species	Status	Habitat	Potential for Occurrence in the Project area
Birds			
American white pelican *Pelecanus erythrorhynchos*	ST	Breeds primarily on isolated islands in freshwater lakes and forages in shallow areas (Stinson 2016). Nests on Columbia River dredge islands near the Tri-Cities (Stinson 2016).	**Possible.** Suitable habitat not present within Project but may fly over area between foraging areas; known to nest on Badger Island approximately 20 miles east of the Project (Stinson 2016).
Bald eagle *Haliaeetus leucocephalus*	BGEPA, PS	Nests in trees or cliffs near water, typically along shorelines, lakes, reservoirs, and rivers; feeds on fish and carrion.	**Likely.** Uncommon year-round visitor to area; known to nest along Columbia River to the east and north of Project.
Burrowing owl *Athene cunicularia*	SC, PS	Occurs in open areas; nests in burrows dug by badgers or other mammals; feeds on insects, small rodents, lizards, frogs, and small birds.	**Possible.** Common resident of Tri-Cities area from mid-April to early September (Ennor 1991); numerous documented breeding locations within several miles of the Project (WDFW 2017a); foraging and nesting habitat present throughout Project area.
Ferruginous hawk *Buteo regalis*	ST, PS	Occurs in open prairie habitat and commonly feeds on ground squirrels, rabbits, and hares; nests in trees, cut banks, cliffs, and rocky pinnacles (Ennor 1991)	**Likely.** Common in Tri-Cities area during breeding season; numerous nest sites documented within several miles of the Project, particularly along escarpment to the north (WDFW 2017a).
Golden eagle *Aquila chrysaetos*	SC, BGEPA	Breeds in hilly or mountainous areas, nests on rocky cliffs or isolated large trees. Common prey species include ground squirrels, marmots, rabbits, and hares.	**Likely.** While not known to nest in Benton County, may occur as uncommon visitor to area, particularly during spring and fall migration (Hayes 2013).
Loggerhead shrike *Lanius ludovicianus*	SC	Uses open habitats with scattered shrubs; typically nests in mature sagebrush habitat; feeds on insects, small mammals, birds, reptiles, and amphibians.	**Likely.** Documented at several locations to the north of the Project (WDFW 2017a); nesting and foraging habitat present, particularly in shrub-steppe habitat to north of Project, but also in agricultural areas within site.
Prairie falcon *Falco mexicanus*	PS	Inhabits arid environments of eastern Washington and nests on cliffs usually associated with native steppe and shrub-steppe habitats. Known to breed in most counties in central and eastern Washington; largest wintering populations in Washington are in central Columbia Basin including Benton County (Hays and Dobler 2004).	**Likely.** Documented in numerous locations within several miles of Project area (WDFW 2017a). Potential to nest in cliffs along Columbia River and occur year round in the Project.

Table 3. State and/or federal listed or candidate wildlife species, or state Priority Species, with potential to occur within the Badger Canyon Wind Project.

Species	Status	Habitat	Potential for Occurrence in the Project area
Sagebrush sparrow *Artemisiospiza nevadensis*	SC, PS	Restricted to open shrub lands and grasslands with mature big sagebrush stands; nests on the ground or in sagebrush; feeds on insects.	**Unlikely.** Suitable mature sagebrush habitat appears to be absent from Project; species more likely to occur in shrub-steppe habitat to north of Project.
Greater sage grouse *Centrocerus urophasianus*	ST	Inhabits shrub-steppe where it is closely associated with sagebrush; majority of diet comprised of sagebrush, grasses, forbs, and insects; historically occurred throughout eastern Washington (WDFW 2012a).	**Unlikely.** Project falls outside of species' current range (WDFW 2012a); suitable shrub-steppe habitat appears very limited in Project area.
Sage thrasher *Oreoscoptes montanus*	SC	Inhabits open, shrub-steppe habitats, preferring areas dominated by sagebrush or bitterbrush with native grasses intermixed. Post-breeding, often moves into thickets such as along creek drainages.	**Unlikely.** Preferred habitat appears to be absent from Project; more likely in shrub-steppe habitats to north of Project.
Sandhill crane *Grus canadensis*	SE	Nesting habitat ranges from open meadows to deep bogs and marshes; migration stopover and staging areas occur primarily near croplands where waste grains are available near wetlands.	**Possible.** Breeding in Washington occurs only in western Yakima and Klickitat counties (Stinson 2017); possible to occur during migration or as transients during post-breeding; cropland within Project may provide stopover habitat.
Vaux swift *Chaetura vauxi*	SC	Inhabits riparian thickets, woodlands, orchards, rocky cliffs, talus slopes, and rimrock areas (Ennor 1991)	**Possible.** Nesting and roosting habitat not present within Project area; may occur during migration.
Mammals			
Black-tailed jackrabbit *Lepus californicus*	SC, PS	Occurs in sagebrush and rabbitbrush dominated habitats as well as areas of mixed grassland and shrub (WDFW 2012d);	**Possible.** Suitable habitat appears to be present; however, known to be rare within Project area (WDFW pers. comm.). Documented occurrence within several miles to the north of the Project (WDFW 2017a).
Townsend's big eared bat *Coryhorhinus townsendii*	SC	In Washington, occurs in a variety of arid and moist lowland habitats including shrub-steppe (WDFW 2012c); roosts in caves, lava tubes, mines, old buildings, and bridges.	**Unlikely.** Suitable roosting habitat appears to be absent from Project area; some potential to occur as a rare visitor; has not been documented as occurring in the southern Columbia Basin (WDFW 2012c).

Table 3. State and/or federal listed or candidate wildlife species, or state Priority Species, with potential to occur within the Badger Canyon Wind Project.

Species	Status	Habitat	Potential for Occurrence in the Project area
Townsend's ground squirrel *Urocitellus townsendii townsendii*	SC, PS	Inhabits shrub-steppe, native grasslands, pastures, orchards, vineyards, highway margins, vacant lots, and the banks of canals; occurs only in Washington in the Columbia Basin west of the Columbia River, including throughout Benton County.	**Likely.** Known to occur at a number of locations to north of Project area (WDFW 2017a); suitable habitat appears to be present.
White-tailed jackrabbit *Lepus townsendii*	SC	Occurs in open, grassy, or sagebrush plains; where the range of the two jackrabbits species overlaps, white-tailed jackrabbits tends to be more common in bunchgrass habitats with less shrub cover (WDFW 2012d).	**Possible.** Suitable habitat appears to be present; however, known to be rare within Project area (WDFW pers. comm.)
Reptiles			
Sagebrush lizard *Sceloporus graciosus*	SC	Associated with vegetated sand dunes and sandy habitats that support shrubs and have large areas of bare ground.	**Possible.** Project falls within species' range and suitable sandy habitat may be present within Project area.
Striped whipsnake *Masticophis taeniatus*	SC	Inhabits shrub-steppe habitats within the driest portions of the central Columbia Basin (WDFW 2012b).	**Possible.** Historical records for the species in Benton County (WDFW 2012b); suitable habitat may be present within the Project.

SE: state-listed endangered species; ST: state-listed threatened species; SC: state candidate species for listing; PS: state priority species; BGEPA: species protected under the Bald and Golden Eagle Protection Act (BGEPA 1940)

Species status from WDFW (2017b)

Birds

Bird Migration

The Project is located within the Pacific Flyway and numerous birds likely migrate through landscape. The Project contains stopover habitat (i.e., habitat where migratory species may stop to rest, drink, and refuel) for raptors, songbirds, waterfowl, and shorebirds in the form of cropland and pastures with much smaller areas of disturbed shrub, grassland, and wetland habitat. In general, high-quality stopover habitat such as riparian/wetland habitat, forest, and shrubland is absent from Project area. Based on USFWS NWI data there are less than eight ac of wetland habitat in the Project area, the majority of which is present within unnamed ephemeral drainages throughout the Project's croplands. There is some potential for migrating waterfowl, shorebirds, and waterbirds to use these areas seasonally, as well as flooded agricultural fields, as stopover habitats; however, given the limited amount of such habitat, use is not expected to be substantial.

Several factors influence the migratory paths of raptors; one of the most significant influences is geography. Ridgelines and the shorelines of large bodies of water are used by migrating raptors because they provide conditions necessary for energy-efficient travel over long distances (Liguori 2005) and serve as navigational aids. For these reasons, raptors tend to follow corridors or pathways along prominent ridges with defined edges or along shorelines during migration. While higher, north-south trending ridgelines are generally west of the Project area, there is some potential for escarpments along the river corridors in the region, particularly the ridge along the northern boundary of the Project and south of the Yakima River, to be used by both resident and migrating raptors. At their closest points, the Yakima River runs approximately two mile to the north of the Project and the Columbia River runs approximately eight miles to the northeast of the Project (Figure 1). Trees and associated habitats along the rivers likely provide perch sites and foraging areas for raptors and other species during migration.

Passerines are by far the most abundant bird group in most terrestrial ecosystems and are the most commonly reported fatalities at wind energy facilities (NRC 2007). In inland areas, it is generally assumed that nocturnal migrating passerines move in broad fronts rather than along specific topographical features (Gauthreaux et al. 2003, NRC 2007). Many species of songbirds migrate at night and may collide with tall man-made structures, though no large mortality events on the scale of those observed at communication towers (National Wind Coordinating Committee [NWCC] 2004) have been documented at wind energy facilities in North America. Large numbers of passerines have collided with lighted communication towers and buildings when foggy conditions and spring or fall migration coincide. Birds appear to become confused by structural lighting during foggy or low-ceiling conditions and fly in circles around lighted structures until they become exhausted or collide with the structure (Erickson et al. 2001a). Most collisions at communication towers are attributed to the guy wires on these structures. At the nearby Nine Canyon wind energy facility, a nocturnal migration radar study was conducted in fall 2000 and spring 2001 (Mabee and Cooper 2000, Erickson et al. 2001b). Results of the study indicated that approximately 86% of birds flew at altitudes above the maximum proposed turbine height of 80 m (262 ft). Nocturnal migration studies at the Stateline and Vansycle wind energy facilities, approximately 24 mi (38.6 km) to the southeast of the Project, revealed similar mean flight altitudes despite having greater topographic relief within their immediate areas than the Nine Canyon facility (Mabee and Cooper 2004).

Avian collision fatality data from studies conducted at 30 wind energy facilities across North America were examined to estimate how many night migrants collide with turbines and towers and how aviation obstruction lighting relates to collision fatalities (Kerlinger et al. 2010). Fatality rates, adjusted for scavenging and searcher efficiency, of nighttime migrants at turbines 54 to 125 m (117 to 410 ft) in height ranged from less than one bird/turbine/year to approximately seven birds/turbine/year, with generally higher rates recorded in eastern North America and lower rates in the West. Multi-bird fatality events (defined as more than three birds killed in one night at a single turbine) were extremely rare and were not related to turbine lighting. The largest mortality events attributed to turbines at US wind energy facilities to date include 14 migrant songbirds found at two turbines during spring migration at Buffalo Ridge, Minnesota (Johnson et al. 2002), and 27 migrants at the Mountaineer facility in West Virginia (Kerns and Kerlinger 2004). The West Virginia mortalities apparently occurred during inclement weather and the fatalities occurred at a turbine near a heavily lit substation. Most migrant songbird casualties recorded during systematic carcass searches at turbines have been a single fatality found during a single search (Erickson et al. 2001a). Furthermore, no significant differences were detected when comparing songbird mortality at lit and unlit turbines. From this research, red flashing Federal Aviation Administration (FAA) lighting on turbines does not appear to be an attractant to nocturnal migrants and turbines appear to be at heights below typical migration flight elevations.

In the Pacific Northwest region of the US (i.e., Oregon and Washington), overall bird fatality rates at wind energy facilities have ranged from 0.16 birds/MW/year at the Marengo II facility in Columbia County, Washington to 8.45 birds/MW/year at the Windy Flats facility in Klickitat County, Washington (URS Corporation 2010b, Enz et al. 2011). During a one-year fatality monitoring study at the nearby Nine Canyon facility, the overall bird fatality rate was estimated to be 3.59 bird fatalities/turbine/year or 2.76 birds/MW/year (Erickson et al. 2003). During the study, 36 bird fatalities (28 small birds and eight large birds) representing 13 species were found at turbine search plots during the study. The species most commonly found as fatalities were horned lark (*Eremophila alpestris*; 36 fatalities) and ring-necked pheasant (*Phasianus colchius*; five fatalities). Of the 36 bird fatalities reported during the study, 28 were passerine species but only six were classified as nocturnal migrants (Erickson et al. 2003).

Important Bird Areas

The Audubon Society has identified Important Bird Areas (IBAs) throughout the Western Hemisphere that provide essential habitat for birds (Audubon 2017). These IBAs include sites for breeding, wintering, and migrating birds and can range from only a few acres to thousands of acres in size. There are three recognized IBAs within 20 miles (32.2 km) of the Project: the Yakima River Delta and the Hanford Reach, located to the north of the Project, and the Umatilla, located south of the Project (Figure 7). While the IBAs are all more than five mi from the Project, given the location of the IBA, birds moving between these areas have the potential to pass through or near the Project.

The Yakima River Delta IBA, located approximately seven mi (11.3 km) to the northeast of the Project (Figure 7), is centered on the confluence of the Yakima and Columbia Rivers. The IBA includes open freshwater, marsh, mudflat, and sand and gravel shore, supporting five species of state or federal listed or candidate species, up to 12 species of raptors, as well as many species of waterfowl, shorebirds and other water-dependent species. The site is also important for its riparian forests lining the river which provide perches for eagles, cormorants, herons, and kingfishers.

The Hanford Reach IBA comprises a 56-km stretch of the Columbia River and its near-shore environment. This IBA, which is designated as the Hanford Reach National Monument, is the last free-flowing section of one of the largest rivers in the US. The southern extent of the IBA lies approximately eight mi (12.9 km) to the north of the Project (Figure 7). The area supports a high concentration of wintering bald eagles and waterfowl, cliffs providing nesting habitat for swallows, owls, hawks, and falcons, and the river provides fish for American white pelicans, gulls, and cormorants.

The Umatilla IBA, located about 12 miles (19.3 km) to the south of the Project (Figure 7), is comprised of the Umatilla National Wildlife Refuge. This IBA includes a varied mix of habitat including open water, sloughs, shallow marsh, seasonal wetlands, cropland, islands, and shrub-steppe. The IBA is vital to migrating waterfowl, bald eagles, colonial nesting birds and other migratory and resident wildlife in an area where wetlands and other natural habitats are otherwise scarce.

US Fish and Wildlife Service Birds of Conservation Concern

The USFWS lists 28 species as birds of conservation concern (BCC) within the Great Basin Bird Conservation Region (BCR), within which the Project is located (USFWS 2008). These species have been identified as vulnerable to population declines in the area by the USFWS (2008). Several species are also State and/or federal listed or candidate species (e.g., ferruginous hawk, golden eagle, loggerhead shrike, sage thrasher, sagebrush sparrow) and are discussed in greater detail in the listed species section above. Although some of these BCC species may use habitats in the Project vicinity during migration or nesting (e.g., wetlands, shrub-steppe habitat), the majority of the Project area is comprised of agricultural lands with limited ecological value to most BCCs in the region.

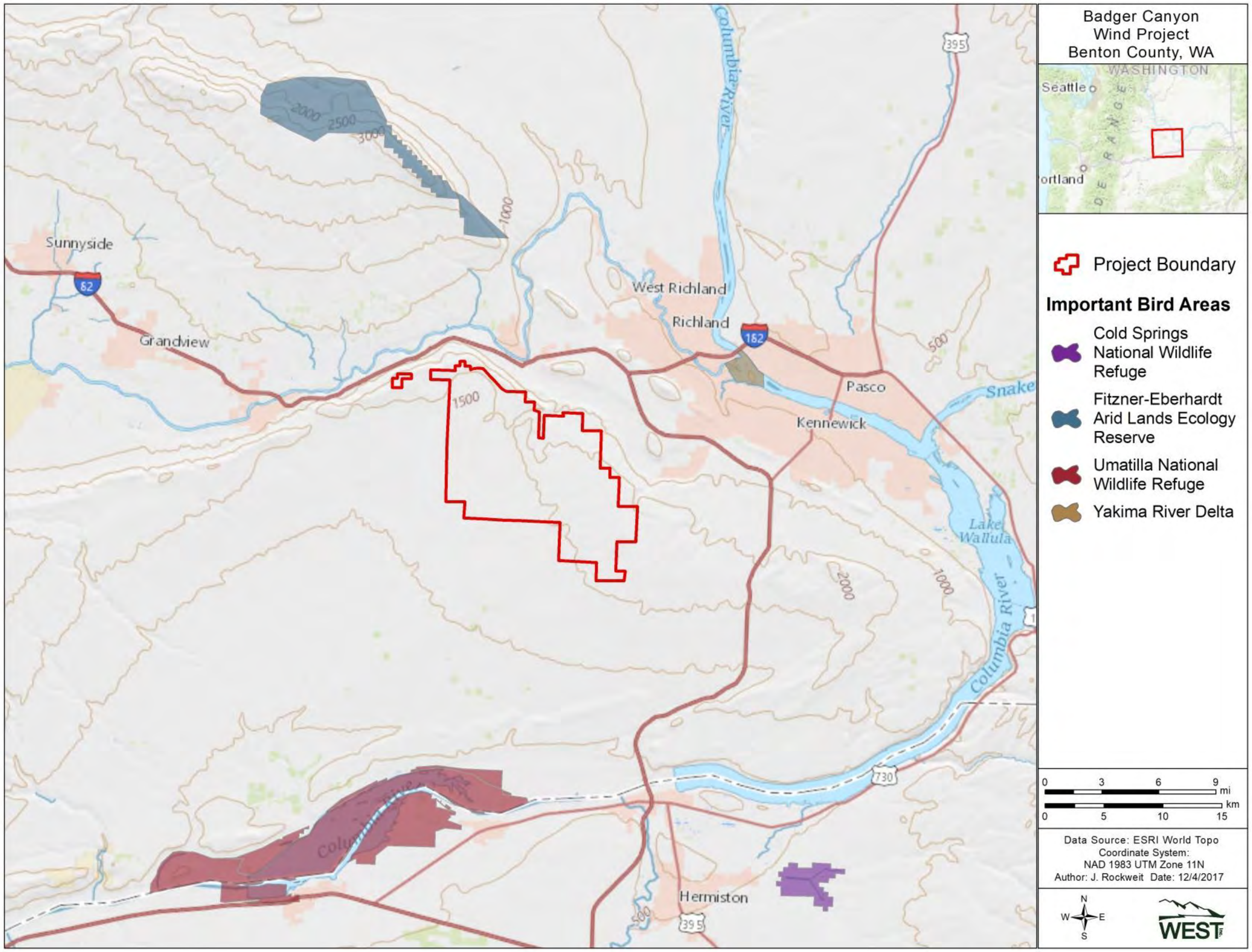

Figure 7. Location of Important Bird Areas occurring in the vicinity of the Badger Canyon Wind Project, Benton County, Washington.

Raptors

Diurnal raptors occur in most areas with the potential for wind energy development and have shown susceptibility to the potentially adverse impact of wind energy development (NRC 2007). Fifteen diurnal raptor species and seven owl species have at least some potential to occur within the Project area for at least part of the year. Of these, eight species are likely to breed within the Project or surrounding area and likely occur regularly within the Project: northern harrier (*Circus cyaneus*), Swainson's hawk (*Buteo swainsoni*), red-tailed hawk (*B. jamaicensis*), ferruginous hawk, American kestrel (*Falco sparverius*), barn owl (*Tyto alba*), great-horned owl (*Bubo virginianus*), and burrowing owl. One additional species, rough-legged hawk (*B. lagopus*) is a common winter resident of the area. Eight species are considered uncommon permanent residents and/or breeders in the region; however, suitable nesting and foraging habitat is generally absent from the Project area and these species are likely to occur only as uncommon to rare visitors to the Project: osprey (*Pandion haliaetus*), golden eagle, bald eagle, peregrine falcon (*F. peregrinus*), prairie falcon, long-eared owl (*Asio otus*), short-eared owl (*A. flammeus*), and western screech owl (*Megascops kennicottii*). Five additional species may occur during migration or as uncommon winter residents in the region: sharp-shinned hawk (*Accipiter striatus*), Cooper's hawk (*A. cooperii*), northern goshawk (*A. gentilis*), merlin (*F. columbarius*), and snowy owl (*B. scandiacus*). Of the raptor species potentially occurring within the Project, one is State threatened (ferruginous hawk), two are State candidates for listing (golden eagle and burrowing owl), and four are considered WDFW Priority Species (bald eagle, burrowing owl, ferruginous hawk, and prairie falcon; WDFW 2017b).

Based on fatality monitoring studies conducted at 29 operating wind energy facilities in the Pacific Northwest with publically available data, diurnal raptor fatality rates have ranged from zero to 0.47 raptors/MW/year (Young et al. 2006, Erickson et al. 2000, Johnson et al. 2003, URS Corporation 2010a, Enk et al. 2010, Gritski and Kronner 2010, Downes and Gritski 2012). During a one-year fatality monitoring study at the nearby Nine Canyon facility in 2002-2003, only two raptors (one American kestrel and one short-eared owl) were found within search plots resulting in an estimated raptor fatality rate of 0.05 raptors/MW/year (Erickson et al. 2003). To date, the most common raptor species documented during fatality searches conducted at wind energy facilities in the Pacific Northwest have been American kestrels and red-tailed hawks (WEST, unpublished database). Based on publically available reports compiled by WEST (WEST, unpublished database), only five ferruginous hawk fatalities and one burrowing owl fatality have been reported in Washington and Oregon

<u>Eagles</u>

Both bald and golden eagles are protected under the federal Bald and Golden Eagle Protection Act (BGEPA; 1940), and in Washington, the golden eagle is a State candidate for listing (WDFW 2017b). Currently, the relative level of eagle use of the Project area is unknown, though both bald and golden eagles are known to occur in the region. While nesting habitat for both species is absent from the Project area, both species may forage throughout the site, particularly during winter or migration seasons. The golden eagle is considered an uncommon year-round resident of the Columbia Plateau (Seattle Audubon Society [SAS] 2017). Based on statewide golden eagle nest surveys conducted in 2013, 158 breeding pairs of golden eagles are estimated in the state (Hayes 2013). The majority of nesting territories in the state occurred in Okanogan County and the Columbia Plateau ecoregion; however, WDFW reported no known nest sites in Benton County (Hayes 2013).

Alternatively, the bald eagle is considered a fairly common resident of the Columbia Plateau in winter, but only occurs rarely in summer (SAS 2017). As of 2015, the total number of known bald eagle territories in the state was 1,334, with the number of nests increasing annually each year since 2005 (Kalasz and Buchanan 2016). Bald eagles typically nest near large bodies of water, such as lakes or larger rivers; however, they also require trees that are sufficiently large and have the branch structure necessary to support an eagle nest. Based on data from the Washington Survey Data Management database, historical bald eagle nesting territories are located along the Columbia River, approximately eight and 21 miles (12.9 and 33.8 km) to the northeast and east of the Project, respectively (Kalasz and Buchanan 2016). Nest sites and breeding season foraging habitat for bald eagles are absent from the Project, therefore, the species is unlikely to occur during the breeding season. Bald eagles are more likely to occur in the winter, potentially foraging on carrion once their primary prey (fish) becomes more scarce (Kalasz and Buchanan 2016).

For reasons not well-understood, golden eagles are known to have a higher susceptibility to collisions with wind turbine rotors than are bald eagles (Allison 2012). A small number of wind projects in five western states all located within high-quality golden eagle breeding habitat, have produced substantially larger numbers of golden eagle fatalities, with fatality rate estimates as high as 15-70 golden eagles per year (Allison 2012). Nonetheless, most wind energy facilities that have been constructed within the golden eagle's geographic range, including all wind energy projects that have been constructed outside of golden eagle breeding habitat, have resulted in very small numbers of recorded fatalities (zero to three per project; Allison 2012). Within the Pacific Northwest region of the US (i.e., Washington and Oregon), six golden eagle fatalities have been reported in publicly available reports from four different wind energy facilities (URS Corporation 2010a, Enk et al. 2011, Enz and Bay 2012, Enz et al. 2012). To date, no bald eagle fatalities have been reported in publicly available reports at facilities in the Pacific Northwest (WEST, unpublished database). Over the course of one year of pre-construction avian use surveys conducted at the nearby Nine Canyon wind energy facility in Benton County, only one golden eagle and one unidentified eagle were recorded during the study (Ericksonet al. 2001b). No eagle fatalities were documented during a one-year post-construction fatality monitoring study at the Nine Canyon facility (Erickson et al. 2003). While the publicly available data suggests eagle mortality at wind energy facilities in the Pacific Northwest may be relatively low, publicly available data is limited to relatively short fatality monitoring studies (1-2 years typically) at facilities that have, in many cases, been operational for less than 10 years.

Year round eagle/large bird use surveys, consistent with the USFWS ECPG (USFWS 2013) and WEG (USFWS 2012), will help estimate use of the Project area by eagles and other raptor species.

Potential Raptor Nesting Habitat

Limited nesting habitat is available for raptors within the Project area. Scattered isolated trees are present throughout the Project at current or abandoned farmsteads that may provide nest sites for red-tailed hawks, Swainson's hawks, and great-horned owls. Grasslands, pasture and cropland may provide habitat for ground-nesting species, such as burrowing owls, northern harriers, and short-eared owls. Just north of the Project boundary, within the canyons of the Horse Heaven Hills, cliffs and cut banks may provide nest sites for ferruginous hawks and barn owls. Riparian forest habitat along the Yakima River likely supports the highest density of nesting raptors within several miles of the Project. Nesting habitat for bald and golden eagles is absent from the Project area.

A raptor nest survey, including surveys for bald and golden eagle nests within a 10-mile radius of the Project area, and surveys for all raptor nests within two miles of the Project area, would help evaluate potential impacts to nesting raptors from the construction and operation of the Project.

Areas of Potentially High Prey Density

Small- and medium-sized mammals comprise the primary prey base for many raptor species, although birds and insects may also contribute to the diet of many raptor species. Large aggregations of prey species (e.g., prairie dog colonies) are not present in the Project area; however, there are a number of other rodent (e.g., ground squirrels and chipmunks), lagomorphs (e.g., black-tailed jackrabbit), and passerines (i.e., songbirds), particularly those associated with agricultural lands, that are likely to occur throughout the Project. Rodents may be most concentrated along field edges and roads (Preston 1990, Rosenzweit 1989). Waterfowl and waterbirds are also potential prey for eagles and other large raptors; however, perennial and ephemeral water sources in and near the Project area are limited. Flooded agricultural fields may provide foraging opportunities for large raptors during wet periods, and grain fields may attract small mammals which in turn may attract foraging raptors. Larger streams and rivers and lakes which provide fish for raptors such as bald eagles and osprey are absent from the Project. Overall, given the habitat types available within the Project area (i.e., >90% tilled agriculture) there is limited potential or for concentrated prey sources to occur.

Bats

Due to the lack of full understanding of bat populations in North America, species and relative abundance of bats occurring within the Project area are difficult to determine. Based on range maps and species accounts from BCI (2017), 16 species of bat are known to occur in Washington, with eight species having an approximate range and habitat requirements that include the Project area: pallid bat (*Antrozous pallidus*), big brown bat (*Eptesicus fuscus*), silver-haired bat (*Lasionycteris noctivagans*), hoary bat (*Lasiurus cinereus*), California bat (*Myotis californicus*), little brown bat (*M. lucifugus*), dark-nosed small-footed myotis (*M. melanorhinus*), and canyon bat (*Parastrellus hesperus*). While roosting habitat for the majority of bat species is generally absent from the Project area, each of the species listed above have the potential to forage within, or migrate through, the Project area. The only listed or candidate bat species in

Washington are Townsend's big-eared bat and Keen's myotis (*M. keenii*), both of which are state candidates for listing (WDFW 2017b); however, Keen's myotis occupy only the extreme northwestern corner of the state and Townsend's big-eared bats are unlikely to occur within the Project due to a general lack of roosting and hibernating sites.

Studies conducted at wind energy facilities have documented use of areas within and around these facilities by resident or breeding bats during the summer reproductive period; however, these species are rarely found as casualties at turbines (Johnson 2005). To date, most bat casualties at wind energy facilities in the Columbia Plateau have been migratory species (e.g., hoary and silver-haired bats (Johnson and Erickson 2011), which conduct relatively long fall migrations between summer roosts and wintering areas. For unknown reasons, bat mortality rates are disproportionately high during the fall. However, it may be that tree-roosting bats fly at lower altitudes above ground level (AGL) during spring migration than during fall migration. For example, hoary bats fly one to five m (three to 16 ft) above the ground while migrating through New Mexico in the spring, but apparently not in the fall (Cryan and Veilleux 2007). Similarly, a hoary bat collided with an aircraft above Oklahoma at an altitude of 8,000 ft (2,438 m) in October of 2001 (Peurach 2003), which may support the theory that bats generally fly at higher altitudes in the fall.

In the Pacific Northwest, bat fatality rates at wind energy facilities have varied widely, ranging from 0.12 bats/MW/year at the Kittitas Valley facility in Kittitas County, Washington (Stantec 2012) to 4.23 bats/MW/year at the Palouse facility in Whitman County, Washington (Stantec 2013). During the one-year post-construction fatality monitoring study at the nearby Nine Canyon facility, the bat fatality rate was estimated at 2.47 bats/MW/year (Erickson et al. 2003), which falls near the middle of the range of fatality rates for the Pacific Northwest. Consistent with the results from other studies in the Pacific Northwest and across the county, 20 of the 27 total bat fatalities (74%) documented at Nine Canyon, were found during the late summer/early fall period and all 27 fatalities comprised just two species: silver-haired bat and hoary bat (Erickson et al. 2003).

SUMMARY

Table 4 summarizes key wildlife considerations for the Project. Of the wildlife species protected by or under review through the federal ESA, none have the potential to occur within the Project area. Three species with state threatened or endangered status have at least some potential to occur in the Project area including: American white pelican, ferruginous hawk, and sandhill crane. An additional 12 species designated as state candidates for listing also have potential to occur within the Project including six birds, four mammals, and two reptiles. Both the golden and bald eagle, provided additional protection through the federal BGEPA, have the potential to occur within the area. One state-listed plant species (woven-spore lichen) and four rare and/or high quality plant communities are known to occur within five miles of the Project area; however, the likelihood of these species/communities occurring in the Project is very low due to the current predominate land use.

Fifteen diurnal raptor species and seven owl species have the potential to occur as residents and/or migrants in the Project area at some point during the year. Nesting habitat within the Project is limited to scattered, isolated trees and pasture/cropland (for ground-nesting raptors), but is more abundant in the surrounding landscape in trees, cliffs, and cut banks.

The Project area is located within the Pacific Flyway and numerous birds likely migrate through the region. The Project area is characterized by flat to gently sloping terrain that generally would not be expected to concentrate or funnel raptors during migration; however, the escarpment just north of the Project boundary, above the Yakima River, may be used by both resident and migrating raptors. Stopover habitat for songbirds, waterfowl, and shorebirds in the form of cropland/pasture and smaller amounts of shrubland is present with the Project area; however, these areas are generally not considered high-quality stopover habitat and are abundant across the landscape.

Relatively high bat mortality at other wind energy facilities in North America is a concern, and some species that appear to be at greatest risk, such as hoary and silver-haired bats, are likely to occur in the Project area, particularly during fall migration. At least eight bat species have the potential to occur within the Project area at some time during the year. While roosting habitat is generally lacking within the Project are for most of these species, the Project's pastures, croplands and limited riparian/wetland habitat may provide foraging and drinking habitat for some resident bat species.

Table 4. Summary of the potential for wildlife and plant conflicts in the proposed Badger Canyon Wind Project[1]; VH = Very High, H = High, M = Moderate, and L = Low

Issue	VH	H	M	L	Notes
Raptor nest sites			✓		Limited habitat for nesting raptors in Project area; higher potential for nesting in canyons and riparian areas to north of Project; potential for ferruginous hawk and burrowing owl nests (state listed/candidate species).
Concentrated raptor flight areas				✓	A number of raptors are likely to use the Project area but site characteristics not expected to concentrate raptor flight activity or migratory activity in any particular area. Escarpment above the Yakima River, just north of the Project area may see higher raptor use during migration and/or winter.
Avian migratory pathways				✓	Project area located along the Pacific Flyway, but limited high quality stopover habitat present; extensive riparian/wetland habitat absent. Potential use by migrating passerines, but not likely used as concentrated migration pathway or stopover area.
Raptor prey species			✓		Potential for rodents, lagomorphs, and prey bird species to occur within Project area, but not likely in high concentrations.
Federal protected wildlife species				✓	No federal listed, candidate, or under review species currently have the potential to occur within the Project; both bald and golden eagles, protected under the federal BGEPA have the potential to occur.

Table 4. Summary of the potential for wildlife and plant conflicts in the proposed Badger Canyon Wind Project[1]; VH = Very High, H = High, M = Moderate, and L = Low

Issue	VH	H	M	L	Notes
State protected wildlife species		✓			Sixteen state-listed or candidate species have at least some potential to occur.
Uniqueness of habitat				✓	Habitat and land use within the Project area is predominately agricultural. Two WDFW Priority Habitats and four WNHP rare/high quality plant communities are found in Project vicinity. Three IBAs are within 20 miles of Project.
Rare plants/ecosystems				✓	One federal and/or state listed plant known to occur within 5 miles of the Project area and four rare/high quality plant communities known to occur in region; all are unlikely to occur in Project.
Bats			✓		At least eight bat species have at least some potential to occur within the Project area, one of which is a state candidate for listing. Bat species that have shown relatively high levels of fatalities at wind energy facilities are likely to be present.

[1]Summarized for the Badger Canyon Wind Project as a whole but the habitat of the Project area varies in its ability to support species of concern.

USFWS Land-Based Wind Energy Guidelines Tier 2 Questions

Chapter 3 of the USFWS WEG (2012) includes seven Tier 2 questions which should be addressed during site characterization efforts. A contextual review of these questions after synthesis of a SCS report may help identify areas where existing data do not sufficiently address potential impacts to biological resources which may occur through development of a wind energy facility, and should serve to guide formulation of project-specific Tier 3 study plans intended to fill data gaps. This Badger Canyon SCS attempts to answer the Tier 2 questions through a desktop review of publicly available information. However, some data gaps remain; recommended field studies intended to fill data gaps are included in the following section (Conclusion and Next Steps). It is also useful to consider the seven Tier 2 questions individually in the context of this SCS; although the previous Summary section includes much pertinent information, it does not specifically relate SCS report findings to Tier 2 questions. The following list describes how this report has addressed specific Tier 2 questions, where information related to these questions can be found in this report, and what if any data gaps remain:

1. Are known species of concern present on the proposed site, or is habitat (including designated critical habitat) present for these species?

   No federal listed wildlife species have the potential to occur within the Project and no designated critical habitat is present within the Project or surrounding area. Sixteen State-listed or candidate species (10 birds, four mammals, and two reptiles) have at least some potential for occurrence (see Listed Species section). There is one federal or State-listed plant species known to occur within five mi of the Project, as well as four rare/high quality plant communities. Tier 3 field studies will help confirm presence or absence of many of these species (see Conclusion and Next Steps section).

2. Does the landscape contain areas where development is precluded by law or designated as sensitive according to scientifically credible information?

   A desktop review of publicly available information did not reveal any areas on the landscape where development is precluded by law. Two WDFW Priority Habitats are known to occur within 2 miles of the Project: freshwater wetland and scrub-steppe. Tier 3 field studies will help determine the presence or absence of any sensitive areas in the Project (see Conclusion and Next Steps section).

3. Are there plant communities of concern present or likely to be present at the site?

   There is one federal- and/or State-listed plant species (woven-spore lichen), as well as four rare and/or high quality plant communities known to occur in the Project vicinity. All are unlikely to occur in the Project (see Rare Plants and Ecosystems section). Tier 3 field studies will help determine the occurrence of plant communities of concern at the Project (see Conclusion and Next Steps section).

4. Are there known critical areas of congregation of species of concern, including, but not limited to: maternity roosts, hibernacula, staging areas, winter ranges, nesting sites, migration stopover or corridors, leks, or other areas of seasonal importance?

   There are no known critical areas of congregation of species of concern within the Project area and desktop analyses do not suggest any are likely to occur. Tier 3 field studies will help determine the presence or absence of critical congregation areas in (see Conclusion and Next Steps section).

5. Using best available scientific information has the developer or relevant federal, State, tribal, and/or local agency identified the potential presence of a population of a species of habitat fragmentation concern?

   The Project area consists exclusively of private lands managed for crop production and livestock grazing. As such, modern land use of the Project has already led to a fragmented landscape (see Table 1; Figures 3 and 4), and it is unlikely that populations of species with high fragmentation concern are present.

6. Which species of birds and bats, especially those known to be at risk by wind energy facilities, are likely to use the proposed site based on an assessment of site attributes?

   Many species of birds and bats are likely to use the Project area at some point during the year (see Raptors, Bird Migration, and Bats sections). There are 15 diurnal raptor species and seven owls which have the potential to occur within the Project. Of these, eight species may breed within the Project or Project vicinity, including the ferruginous hawk (state threatened) and burrowing owl (state candidate), as well as several other *sensitive bird species. Diurnal raptors and some owls are known to be at risk by wind energy facilities. There are at least eight species of bats with the potential to occur in the Project (see Bats section) including both hoary and silver-haired bats, which are known to be at risk by wind energy facilities. Tier 3 field studies will help refine the species present which are known to be at risk from wind energy facilities.*

7. Is there a potential for significant adverse impacts to species of concern based on the answers to the questions above, and considering the design of the proposed project?

   While the Project design has not yet been determined, based on the general location of the proposed Project and following a desktop review of publicly available information pertaining to the Project area, the potential for significant adverse impacts to species of concern due to development of the Project appears to be low. However, a number of pre-construction baseline biological studies are recommended in order to properly characterize site-specific wildlife use and evaluate the biotic resources in the Project area (see Conclusion and Next Steps section).

CONCLUSION AND NEXT STEPS

Based on this SCS, the Project does not appear to have a high potential for conflict with the majority of wildlife and plant issues listed in Table 12. Regardless, a number of pre-construction baseline wildlife and botanical studies are recommended for the Project with the purpose of characterizing wildlife use (particularly avian and bat use) within the Project area, estimating impacts of the proposed facility on sensitive wildlife and botanical resources, and to assist with siting turbines to minimize impacts to the extent practicable. Baseline studies recommended at this time are presented in Table 5 and include the following:

- Vegetation and land cover mapping following WDFW habitat classification standards and consistent with the Washington Wind Power Guidelines (WDFW 2009).
- Year round large bird/eagle use surveys consistent with recommendations presented in the USFWS ECPG (USFWS 2013), designed to characterize use of the Project area by large birds, with added emphasis on bald and golden eagle use of the Project area.
- Small bird use surveys, consistent with recommendations presented in the WEG (USFWS 2012) and the Washington Wind Power Guidelines (WDFW 2009), designed to evaluate small bird use of the Project area.
- Nesting raptor surveys with an emphasis on bald and golden eagles and other sensitive raptor species as recommended in the WEG (USFWS 2012), ECPG (USFWS 2013), and Washington Wind Power Guidelines (WDFW 2009).
- Bat acoustic monitoring at one meteorological tower location during the spring, summer, and fall using methods recommended in the WEG (USFWS 2012) and the Washington Wind Power Guidelines (WDFW 2009).

- Threatened, endangered, and sensitive species (TESS) surveys, inclusive of rare plants, following methods consistent with the Washington Wind Power Guidelines for surveying and evaluating impacts to special status TESS, plants and natural communities (WDFW 2009).

The large bird/eagle and small bird use surveys listed above should be sufficient to provide a baseline risk assessment for bird species possibly occurring within the Project area and the need for additional studies or more detailed spatial distribution mapping. Early and regular consultation with the USFWS and WDFW is recommended, as it is possible that additional species-specific surveys for sensitive bird, mammal, reptile, and plant species may be encouraged by these agencies. The following Table (Table 5) includes a column for Tier 2 questions. This is intended to highlight how recommended Tier 3 field studies will address information gaps identified during Tier 2 site characterization, and ties directly to information presented in the preceding USFWS Land-Based Wind Energy Guidelines Tier 2 section.

Table 5. Recommended Pre-construction Wildlife and Botanical Studies for the Badger Canyon Wind Energy Project.

Study	Purpose	Information Gaps Addressed from USFWS Tier 2 Question(s)	Timing
Vegetation/land cover mapping	To identify potentially suitable habitat for state or federal sensitive species and to calculate habitat mitigation ratios resulting from potential habitat disturbance.	Questions 1-3	Spring or summer
Large bird / Eagle use surveys	To assess spatial and temporal use of the Project area by bald and golden eagles and other raptor species	Question 1, Question 4, Question 6, Question 7	Year-round
Small bird use surveys	To assess spatial and temporal avian use of the Project area, with a focus of small bird use	Question 1, Question 4, Question 5, Question 6	Spring and fall migration periods
Nesting raptor surveys	To locate nests that may be subject to disturbance and/or displacement effects from Project construction and/or operation, particularly nests of bald or golden eagles or other sensitive raptor species	Question 1, Question 4, Question 5, Question 6, Question 7	Twice during late winter through early summer breeding season
Bat acoustic surveys	To estimate the level of, and seasonal and spatial patterns of, bat activity within the Project area	Question 1, Question 5, Question 6, Question 7	A continuous spring, summer, and fall survey period
TESS survey	To determine the presence, as well as the spatial distribution, of any state and federal threatened, endangered, or sensitive wildlife or rare plant species.	Question 1, Question 2, Question 3, Question 5, Question 7	Spring and early summer when target species are most readily identified (e.g., nesting or flowering)

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Appendix A. Photographs Taken During Tier 2 Site Visit to the Badger Canyon Wind Project on December 11-12, 2017


Photo 1. Taken from near northwest corner of Project area, looking to the west.


Photo 2. Taken from near northwest corner of Project area, looking to the south.

Photo 3. Taken near northwest corner of the Project, looking to southeast.

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DATE: October 30, 2018 *Public Draft - For Distribution*

TO: Joseph Wood and Jeffrey Wagner, wpd Wind Projects Inc.

FROM: Andrea Chatfield and Samantha Brown, WEST, Inc.

RE: Results of the 2018 vegetation and land cover mapping for the Badger Canyon Wind Project Study Area, Benton County, Washington.

INTRODUCTION

Badger Canyon MW LLC (Badger Canyon) is proposing to develop the Badger Canyon Wind Project (Project) in Benton County, Washington. Badger Canyon contracted Western EcoSystems Technology, Inc. (WEST) to conduct a vegetation and land cover assessment in the area where the Project is proposed (Study Area). This assessment was performed as recommended in the Washington Department of Fish and Wildlife (WDFW) Wind Power Guidelines (WDFW 2009). The resulting information can be used to identify potentially suitable habitat for sensitive plant and wildlife species, to help guide surveys for sensitive species within development corridors, and for informing mitigation requirements for temporary and permanent impacts to habitat resulting from Project development. This memorandum summarizes the methodology and results of the 2018 vegetation and land cover assessment within the Study Area.

SITE DESCRIPTION

Regional Setting

The Study Area lies within the semi-arid Columbia Plateau Ecological region, which encompasses a large portion of south central Washington (Washington Biodiversity Council 2008). The Columbia Plateau tilts upward and southward into the Great Basin of eastern Oregon, western Idaho, and northern Nevada, and is bordered by the Cascade Mountains to the west, the Okanogan Highlands to the north, the Palouse Hills to the east, and the Blue Mountains to the southeast. The Columbia and Snake rivers are the dominant topographic features of the Columbia Plateau; in Washington, the Plateau is bisected by the Columbia River. Today, the areas with suitable soil are used for agriculture; crops include wheat (*Triticum* spp.), alfalfa (*Medicago sativa*), potatoes (*Solanum tuberosum*), grass hay, and vineyards. Other areas within the region are used for livestock grazing. In the Yakima Valley to the north and the Columbia Basin to the south, irrigated agriculture is prevalent and includes pastures, orchards, and vineyards. Hops (*Humulus lupulus*) and field crops are also commonly grown. In un-cultivated areas, this ecoregion is characterized by arid sagebrush- (*Artemisia* spp.) steppe and grassland. The regional climate can by typified as arid to semiarid with low precipitation, warm to hot dry summer, and relatively cold winters (Franklin and Dryness 1973). Mean annual temperature in the region is 59° Fahrenheit (15° Celsius), with mean annual precipitation of 10 inches (25 centimeters; Franklin and Dryness 1973, Daly 2000).

Study Area

The Study Area encompasses 36,550 acres (14,791 hectares) of private and state-owned land within Benton County in southeastern Washington, approximately 2.4 miles (mi; 3.9 kilometers [km]) south of Benton City and 12.0 mi (19.2 km) west of the city of Kennewick (Figure 1). Topography within the Study Area is gently sloping, with elevations ranging from 1,193 feet (364 meters [m]) in the southwest corner of the Study Area to 1,860 feet (567 m) along the eastern edge of the Study Area. The Horse Heaven Hills, an anticline ridge of the Yakima Folds, lies along the northeastern border of the Study Area. On the southern side of the ridge, the landscape transitions to relatively rolling topography with shallow, meandering canyons that drain southwest into the Columbia River. At its closest point, the Columbia River runs approximately eight mi (12.9 km) to the northeast of the Study Area and wraps around the Study Area to the east and south (Figure 1). The Yakima River flows eastward into the Columbia approximately two mi (3.2 km) to the north of the Study Area (Figure 1).

The native vegetation of the Study Area consisted of a bluebunch wheatgrass (*Pseudoroegneria spicata*)-Idaho fescue (*Festuca idahoensis*) zonal association, which was predominately grassland and shrub-steppe with deciduous riparian forest and scrub along drainages (Franklin and Dyrness 1973). Today, native grassland and shrub-steppe habitats have been replaced by tilled dry-land agriculture (primarily wheat) with a smaller amount of uncultivated grassland, the majority of which is managed as part of the US Department of Agriculture Farm Service Agency's Conservation Reserve Program (CRP). Remnants of native shrub-steppe habitat are present within a few drainages, particularly in the southeastern portions of the Study Area. A network of county and a few private roads traverse the Study Area.

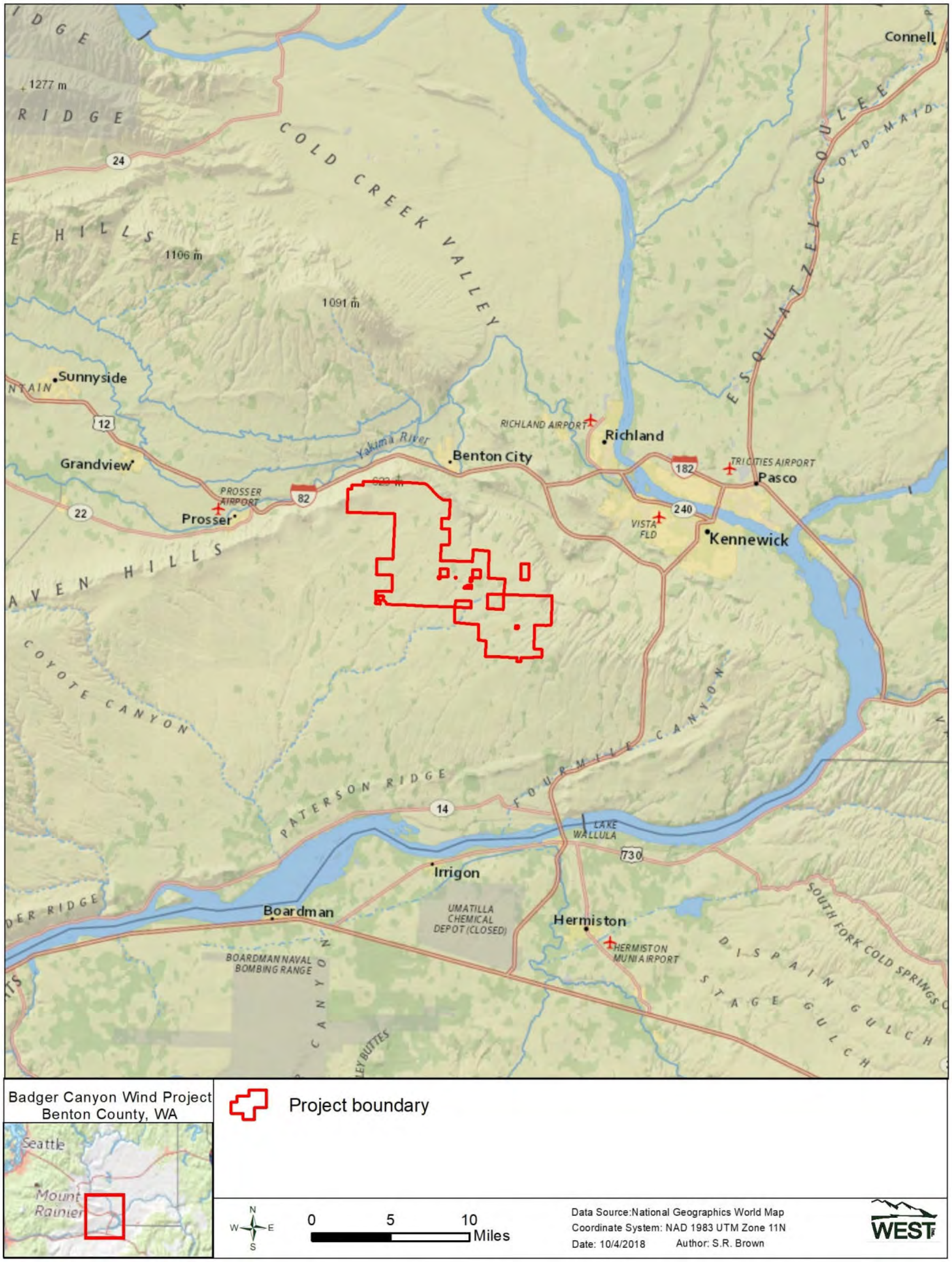

Figure 1. Location of the Badger Canyon Wind Project, Benton County, Washington.

METHODS

The objective of the 2018 vegetation and land cover assessment was to characterize and map the general vegetation and cover types across the Study Area. Land cover types mapped were consistent with those described by the WDFW (2009) and included the following:

- Shrub-steppe – areas dominated by shrubs less than 16.4 feet (5.0 m) tall;
- Grassland – uncultivated areas with herbaceous vegetation including CRP grasslands;
- Agriculture – cultivated cropland and pasture;
- Developed – urban areas, stand-alone structures/residences/farms, highways, and other disturbed areas.

The above land cover types were initially mapped using aerial imagery and remotely sensed data that included the National Landcover Dataset (USGS 2011) and National Wetland Inventory (USFWS 2018) which were then field-verified by a qualified WEST biologist. Following field-verification, a WEST Geographic Information System (GIS) specialist digitized the final habitat designations to create a vegetation/land cover map of the Study Area.

RESULTS

Based on the mapping effort, four vegetation/land cover types were identified within the Study Area. The predominant cover type was agriculture, encompassing 81.8% of the total Study Area (Table 1; Figure 2). Agricultural areas within the Study Area were primarily cultivated cropland consisting of dryland wheat. This was followed by grasslands which encompassed a further 16.5% of the Study Area (Table 1; Figure 2). Smaller areas of remnant shrub-steppe (1.4% of the Study Area; Table 1) were located primarily in the southeastern corner of the Study Area (Figure 2). Very small areas of development (mainly individual structures, residences, or farm buildings) were scattered throughout the Study Area, and composed the remaining 0.2% of the Study Area (Table 1, Figure 2).

Table 1. Vegetation/land cover types, acreages, and percent coverage within the Badger Canyon Wind Project Study Area, Benton County, Washington.

Vegetation/Land Cover Type	Total Acres	Percent Coverage
Agriculture	29,915.10	81.8
Grassland/CRP*	6,025.16	16.5
Shrub-Steppe	524.03	1.4
Developed	85.28	0.2
Total	**36,549.57**	**100**

*CRP=Conservation Reserve Program lands

Based on the WDFW Wind Power Guidance, no mitigation is required for impacts (temporary or permanent) to agriculture (cropland or pasture) or developed/disturbed areas which are considered Class IV habitats and have generally low value to wildlife and native plants (WDFW 2009). The remaining two land cover types, shrub-steppe and grassland (including CRP lands), are considered Class III habitats requiring a 0.1:1 mitigation ratio for temporary impacts (in addition to restoring the temporarily impacted habitat) and a 1:1 ratio for permanent impacts. Shrub-steppe and grassland vegetation communities provide important breeding and foraging habitat for a number of sensitive wildlife species, and shrub-steppe is classified as a priority habitat in Washington (WDFW 2009). Grasslands within the Study Area are likely classified into one of two categories: 1) areas along the margins of tilled agricultural fields or along drainages which are too steep to be cultivated or 2) parcels that are currently enrolled in the CRP. In general, it is unknown which non-cultivated grassland parcels are CRP lands as this information is not publicly available; however, for the purposes of habitat mitigation, CPR lands and grasslands are functionally similar and are both considered Class III habitats (WDFW 2009).

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Figure 2. Land cover types mapped within the Badger Canyon Wind Project Study Area, Benton County, Washington.

Bat Activity Study for the Badger Canyon Wind Project
Benton County, Washington

Final Report

May 11 – October 29, 2018

Prepared for:

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November 30, 2018

WEST Inc.

EXECUTIVE SUMMARY

In May 2018 Western EcoSystems Technology, Inc. (WEST) initiated a bat activity study at the proposed Badger Canyon Wind Project (Project) in Benton County, Washington. WEST designed bat acoustic surveys at the Project to evaluate levels of bat activity and species' use of the area during the period of expected peak activity (i.e., late spring through fall).

WEST conducted acoustic surveys is the area wehre the Project is proposed (Study Area) from 11 May through 29 October 2018. A single Wildlife Acoustics SM3 full-spectrum acoustic detector was outfitted with two microphones and deployed at a Project meteorological (met) tower representative of future turbine locations. One microphone was deployed near the ground, at approximately five feet (ft; 1.5 meters [m]), while the other microphone was raised on the met tower to approximately 148 ft (45 m) above ground level. The ground microphone is considered a ground sampling station, while the raised microphone is considered a raised sampling station. The met tower was located in grassland habitat, which is the dominant land cover type within the Study Area.

During the 172 detector-nights surveyed, the average bat activity rate (± standard error) documented at the ground sampling station was 1.27 ± 0.17 bat passes per detector-night, while the raised sampling station recorded an average bat activity rate of 0.96 ± 0.13 bat passes per detector-night. Approximately 94% of bat passes were produced by low-frequency, tree-roosting bats; automated identification of bat calls using Kaleidoscope Pro 4.2.0 determined that silver-haired bats were the most frequently detected species, occurring on approximately 24% of detector-nights. Two high-frequency bat species (canyon bat and little brown bat) were detected during the study period. Neither Townsend's big-eared bat nor pallid bat, both of which are state candidate species, were detected during the study. No federal or state-listed bat species were documented.

The overall bat activity rate at the ground sampling station (BC1g) within the Study Area (1.27 bat passes per detector-night) was below the Rocky Mountains regional average of 4.02 bat passes per detector-night, which is the closest region with publicly available activity data (no activity data from the Pacific Northwest is available for comparison). The average fatality rate for the Rocky Mountains is 4.90 bats/megawatt (MW)/year, significantly higher than the average fatality rate in the Pacific Northwest, which is 1.19 bats/MW/year. If risk patterns at the Project are similar to patterns elsewhere in the Pacific Northwest and Rocky Mountains, it is likely that fatality rates at the Project would be similarly low.

STUDY PARTICIPANTS

Western EcoSystems Technology

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INTRODUCTION

Western EcoSystems Technology, Inc. (WEST) completed a study of bat activity at the proposed Badger Canyon Wind Project (Project) in accordance with recommendations in the US Fish and Wildlife Service (USFWS) *Land-Based Wind Energy Guidelines* (USFWS 2012) and the Washington Department of Fish and Wildlife (WDFW) *Wind Power Guidelines* (WDFW 2009). Although it remains unclear whether bat activity patterns in baseline acoustic data predict post-construction fatality risk (Hein et al. 2013a), ultrasonic detectors do collect information on spatial distribution, timing, and species composition that can provide insight into the possible impacts of wind development on bats in a particular area (Kunz et al. 2007a, Britzke et al. 2013) and inform potential collision minimization strategies for a particular project (Weller and Baldwin 2012). WEST conducted acoustic surveys to estimate levels of bat activity and to determine which bat species occur in the area where the Project is proposed (Study Area). The following report describes the results of acoustic surveys conducted within the Study Area from 11 May through 29 October 2018.

STUDY AREA

The Study Area encompasses approximately 36,550 acres (14,791 hectares) of privately-owned land within Benton County in southeastern Washington, approximately 2.4 miles (mi; 3.9 kilometers [km]) south of Benton City and 12.0 mi (19.2 km) west of Kennewick (Figure 1). Topography within the Study Area is gently sloping, with elevations ranging from 1,150 feet (ft; 351 meters [m]) in the southwest corner to 1,860 ft (567 m) along the eastern edge. The Horse Heaven Hills, an anticline ridge of the Yakima Folds, lies along the northeastern border of the Study Area. South of the Horse Heaven Hills, the landscape transitions to relatively rolling topography with shallow, meandering canyons that drain southwest into the Columbia River. At its closest point, the Columbia River lies approximately eight mi (12.9 km) northeast of the Study Area (Figure 1). The Yakima River flows eastward into the Columbia approximately two mi (3.2 km) to the north of the Study Area (Figure 1).

Land cover within the Study Area primarily consists of wheat associated with dry-land agriculture, with a smaller amount of uncultivated grassland managed as part of the US Department of Agriculture Farm Service Agency's Conservation Reserve Program. A few scattered trees, primarily associated with farms and residences, are distributed throughout the Study Area. These trees, as well as some structures in developed areas, may provide roosting habitat for bats.

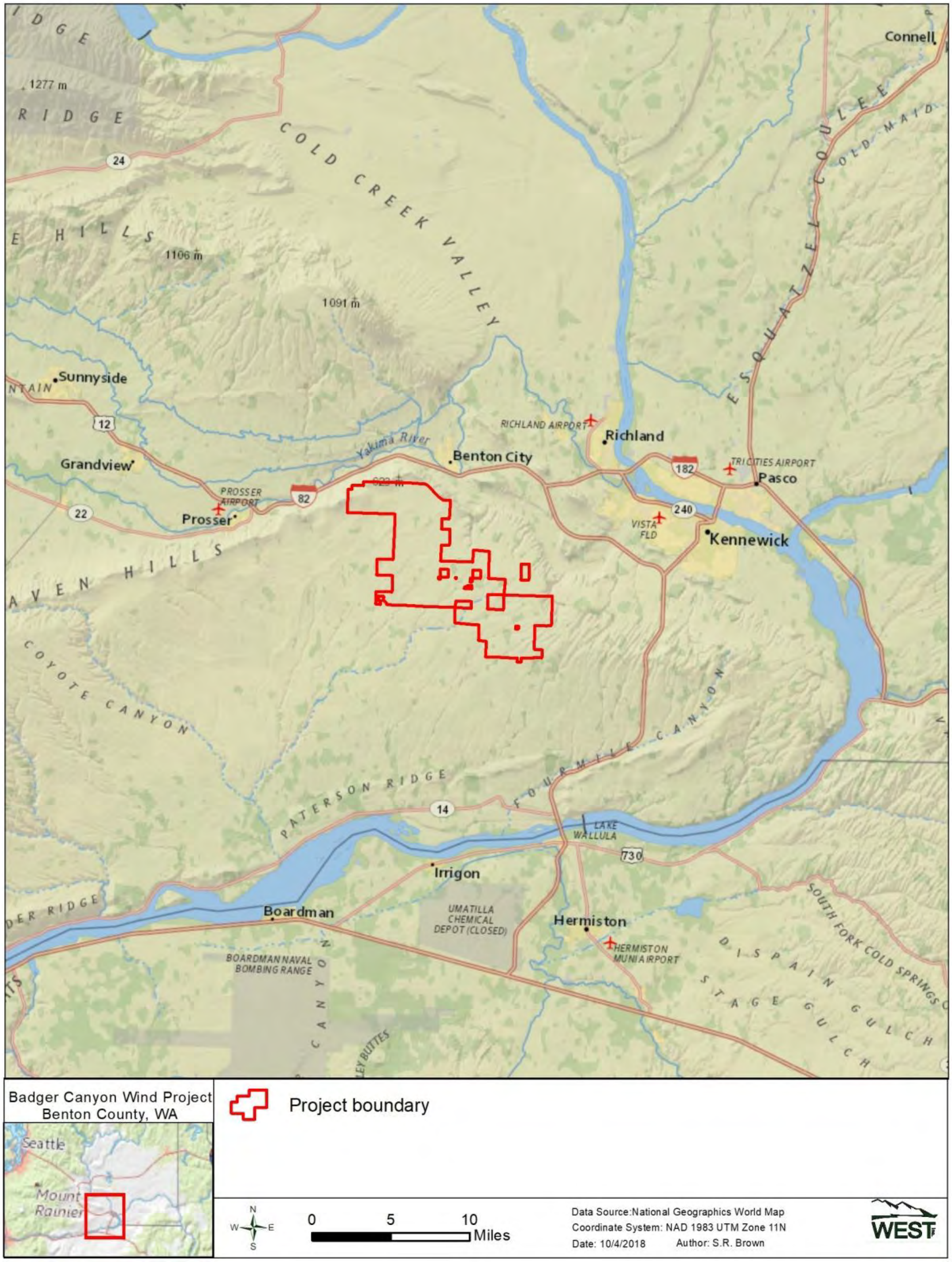

Figure 1. Location of the Badger Canyon Wind Project Study Area, Benton County, Washington.

Overview of Bat Diversity

Thirteen species of bats potentially occur in the Study Area (Hayes and Wiles 2013, International Union for the Conservation of Nature [IUCN] 2017; Table 1). None of these species are federally listed under the Endangered Species Act of 1973 and none are listed as threatened, endangered, or sensitive by the state of Washington (WDFW 2016). However, the Townsend's big-eared bat (*Corynorhinus townsendii*) and pallid bat (*Antrozous pallidus*), both of which have the potential to occur at the Project, are state candidate species (WDFW 2016).

Table 1. Bat species with potential to occur within the Badger Canyon Wind Project Study Area categorized by echolocation call frequency (International Union for Conservation of Nature [IUCN] 2017).

Common Name	Scientific Name
High-Frequency (> 30 kilohertz [kHz])	
California bat	*Myotis californicus*
canyon bat[1]	*Parastrellus hesperus*
little brown bat[1]	*Myotis lucifugus*
long-legged bat[1]	*Myotis volans*
western long-eared bat[1]	*Myotis evotis*
western small-footed bat[4]	*Myotis ciliolabrum*
Yuma bat	*Myotis yumanensis*
Low-Frequency (15 – 30 kHz)	
big brown bat[1]	*Eptesicus fuscus*
hoary bat[1,2]	*Lasiurus cinereus*
pallid bat[3]	*Antrozous pallidus*
silver-haired bat[1,2]	*Lasionycteris noctivagans*
Townsend's big-eared bat[3]	*Corynorhinus townsendii*
Very Low-Frequency (< 15 kHz)	
spotted bat	*Euderma maculatum*

Source: Hayes and Wiles (2013)
[1]species known to have been killed at wind energy facilities (species reported by: Anderson et al. 2004, Kunz et al. 2007b, Baerwald 2008, Miller 2008)
[2]Long-distance migrant
[3]Washington state candidate species (Washington Department of Fish and Wildlife [WDFW] 2016)

METHODS

Bat Acoustic Surveys

WEST conducted acoustic surveys to estimate levels of bat activity at the Project during the period of known activity for migratory and resident bats in eastern Washington. A single Wildlife Acoustics Song Meter (SM3) full-spectrum acoustic detector was deployed at a meteorological (met) tower on the Project on 11 May 2018 and documented bat activity through 29 October 2018 (Figure 2). The single detector comprised two sampling stations with separate microphones, one located near the ground at approximately five ft (1.5 m; station BC1g), and one raised on the met tower to approximately 148 ft (45 m; station BC1r). The detector and external deep-cycle battery were housed inside a large weatherproof box for protection from weather and wildlife.

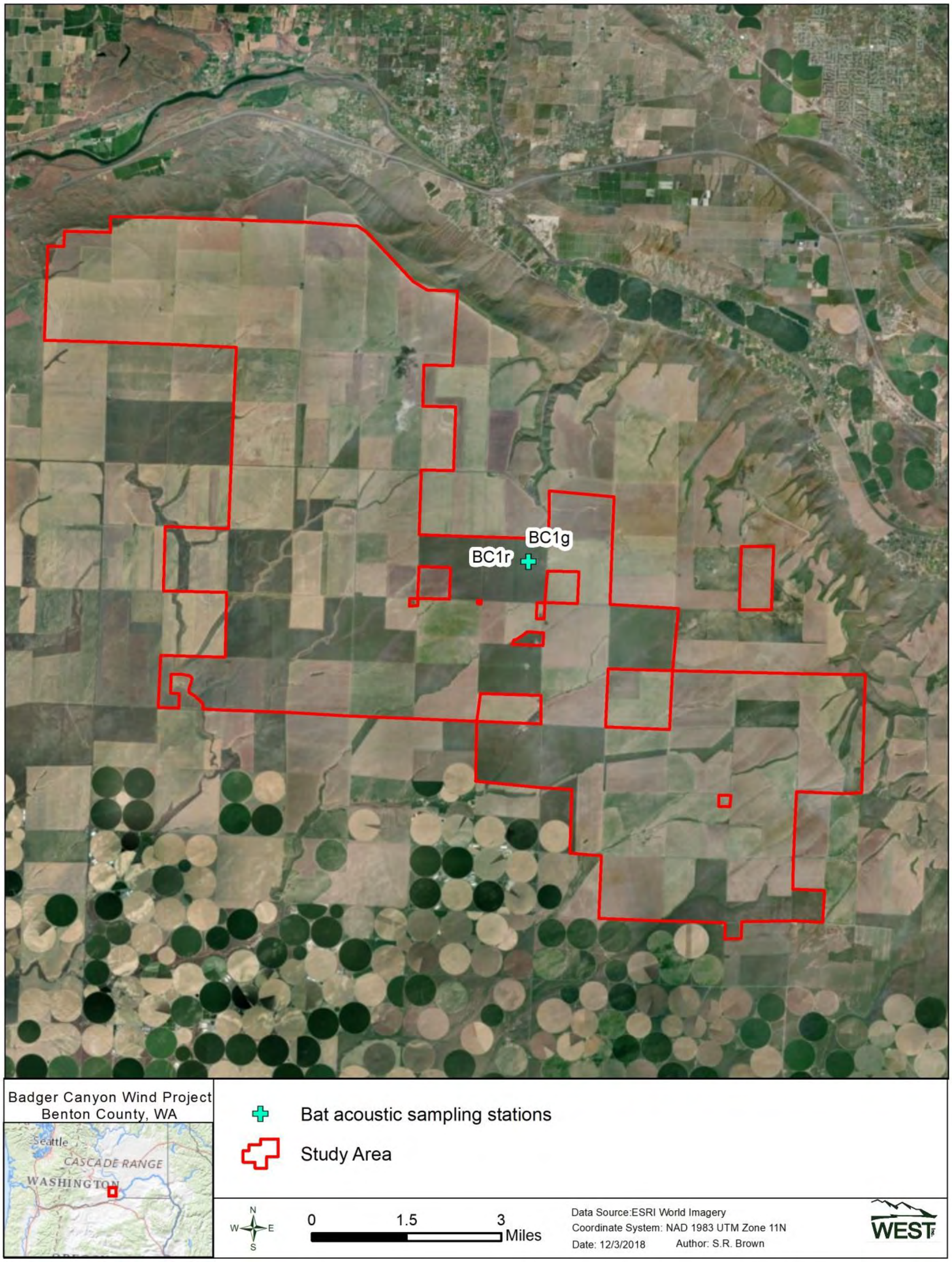

Figure 2. Location of sampling stations used during the bat activity study at the Badger Canyon Wind Project Study Area, Benton County, Washington.

Data Collection and Call Analysis

The Wildlife Acoustics Song Meter SM3 is a full-spectrum bat detector that records complete acoustic waveforms by sampling sound waves at 192 kilohertz (kHz). This high sampling rate enables the detector to make high-resolution recordings of sound amplitude data at all frequencies up to 96 kHz. High-quality recordings produced by the SM3 detector provide more information for making species-level identifications.

SM3 detectors use an omnidirectional microphone to detect and record bat echolocation calls that are then stored as files on one to four Secure Digital cards. During analysis, all recorded files were converted from full spectrum to zero cross (division ratio 8) using software program Kaleidoscope Pro (version 4.2.0; Wildlife Acoustics, Concord, Massachusetts). Noise files (e.g., wind or insect noise) were automatically filtered by Kaleidoscope into a Noise subfolder and not reviewed or included in results. All ultrasonic files were then viewed in Analook© software as digital sonograms that showed changes in echolocation call frequency over time. Frequency versus time displays were used to determine call frequency category and when possible, the species of bat that generated the calls.

For each detector station, bat passes were sorted into two groups based on minimum frequency. High-frequency (HF) bats, such as canyon bat (*Parastrellus hesperus*), have minimum echolocation or social call frequencies greater than 30 kHz. Low-frequency (LF) bats, such as big brown bats (*Eptesicus fuscus*), silver-haired bats (*Lasionycteris noctivagans*), and hoary bats (*Lasiurus cinereus*), typically produce calls with minimum frequencies below 30 kHz.

For species identification purposes, files identified as HF and LF were run through an automated acoustic identification program, Kaleidoscope Pro (version 4.2.0; Wildlife Acoustics, Maynard, Massachusetts). The Bats of North America classifier (version 4.2.0; Wildlife Acoustics) was used at the recommended sensitivity setting of neutral (zero) to select for the 13 bat species that potentially occur within the Study Area (Table 1).

Statistical Analysis

The standard metric for measuring bat activity, the number of bat passes per detector-night, was used as an index of bat activity within the Study Area. A bat pass was defined as a sequence of at least two echolocation calls (pulses) produced by an individual bat with no pause between calls of more than one second (Fenton 1980, White and Gehrt 2001, Gannon et al. 2003). A detector-night was defined as one detector operating for one entire night. The terms bat pass and bat call are used interchangeably in this report. Bat passes per detector-night was calculated for all bats, for HF bats, and for LF bats. Bat pass rates represent indices of bat activity and do not represent numbers of individuals. The number of bat passes was determined by an experienced bat biologist using Analook©.

Mean bat activity was calculated by detector station and overall. The period of peak sustained bat activity was defined as the seven-day period with the highest average bat activity. This and all multi-detector averages were calculated as unweighted averages of total activity at each detector.

Risk Assessment

Collision with wind turbine blades is the primary risk to bats at operating wind energy facilities (Arnett et al. 2008). The intent of the risk assessment is to use pre-construction bat activity data and other relevant information to describe the potential for bat fatalities at the Project. The intent of the risk assessment is not to predict the number of fatalities, but rather provide context for data collected within the Study Area. To asses the potential risk to bats at the Project, bat activity data collected within the Study Area in 2018 were compared to existing publicly available activity data from other wind energy facilities in the Rocky Mountains region. No publicly available bat activity data exists from the Pacific Northwest; data from the Rocky Mountains represent the closest region available for comparison.

Forecasting collision risk for bats at the Project is challenging for several reasons. First, there are relatively few publicly available studies presenting both pre-construction bat activity and post-construction fatality data, and the ecological differences among geographically dispersed facilities could limit the strength of inference. Further, as explained in detail below, there is no clear correlation between pre-construction bat activity and post-construction fatality data. Second, among studies with both pre-construction bat activity and post-construction fatality data, most pre-construction data were collected during the fall (i.e., the period of greatest risk) using Anabat™ zero-cross detectors (Titley Scientific™, Columbia, Missouri) placed near the ground. In contrast, this study used SM3 full-spectrum detectors near the ground and elevated near the rotor-swept area. Finally, the primary limitation of conducting a qualitative risk assessment for the Project is the difference in data collected by Anabat (used at most other projects) and SM3 detectors (used at the Project). Full-spectrum detectors, such as the SM3 units used at the Project, may record more bat passes per detector-night on average than the Anabat (zero-cross) units used for data collection at the majority of wind farms. Full-spectrum detectors have more sensitive microphones that sample more airspace, as well as different data processing algorithms (Solick et al. 2011, Adams et al. 2012), which may combine to result in higher activity rates than those measured by Anabat detectors. For this reason, activity levels recorded by SM3 detectors are not directly comparable to activity levels recorded by Anabat detectors, though trends in spatial and temporal activity rates collected by Anabat detectors can serve to contextualize trends in data collected using SM3 detectors. Differences in data collection technology (i.e., full-spectrum versus zero-cross detectors), and the resultant possibility that use of SM3 detectors rather than Anabat units at the Project led to increased collection of bat acoustic data should be considered. Inclusion of Anabat data in this report is for general discussion purposes only.

It is generally thought that pre-construction bat activity rates are positively related to post-construction bat fatalities (Kunz et al. 2007b). However, to date, few studies of wind energy facilities that have recorded both bat passes per detector night and bat fatality rates are publicly available (Appendix A). Given the limited availability of pre- and post-construction data sets, differences in protocols among studies (Ellison 2012), and significant ecological differences among geographically diverse facilities, the relationship between pre-construction activity and measured post-construction fatality rates has not been definitively established. In Canada, Baerwald and Barclay (2009) found a significant positive association between pass rates measured at 30 m (98 ft) above ground level and fatality rates for hoary and silver-haired bats across five sites in southern Alberta. However, on a continental scale, a similar relationship has proven difficult to establish. The relatively few studies that have estimated both pre-construction activity and post-construction fatalities show results that trend toward a positive association between activity and fatality rates, but lack statistically significant correlations. Hein et al. (2013a) compiled study results that included both pre- and post-construction data from the same projects, as well as pre- and post-construction data from facilities within the same regions to assess if pre-construction acoustic activity predicted post-construction fatality rates. Based on data from 12 sites, Hein et al. (2013a) did not find a statistically significant relationship (p = 0.07), although the trend was in the expected direction (i.e., higher activity was generally associated with higher fatalities and vice-versa). For these reasons, the current approach to assessing risk to bats using pre-construction acoustic data requires a qualitative analysis of activity levels, spatial and temporal relationships, species composition, and comparison to known regional activity and/or fatality patterns.

RESULTS

Bat Acoustic Surveys

Bat Activity

Bat activity was documented at two sampling stations within the Study Area for a total of 344 detector-nights between 11 May and 29 October 2018 (Table 2). Both sampling stations operated for 100% of the study period. Bat activity was slightly higher at ground sampling station BC1g than raised sampling station BC1r, with an overall average mean of 1.12 bat passes per detector-night for the entire study period (Table 2, Figure 3). The period of peak bat activity at the Project occurred from 5 September through 11 September 2018 (Figure 4).

Table 2. Results of bat acoustic surveys by sampling station conducted at the Badger Canyon Wind Project Study Area from 11 May – 29 October 2018. Passes are separated by call frequency: high frequency (HF) and low frequency (LF).

Detector Station	Type	Habitat	Number of HF Bat Passes	Number of LF Bat Passes	Total Bat Passes	Detector-Nights	Bat Passes/ Night*
BC1g	ground	grassland	19	200	219	172	1.27 ± 0.16
BC1r	raised	grassland	5	160	165	172	0.96 ± 0.14
Total			**24**	**360**	**384**	**344**	**1.12 ± 0.13**

*± bootstrapped standard error.

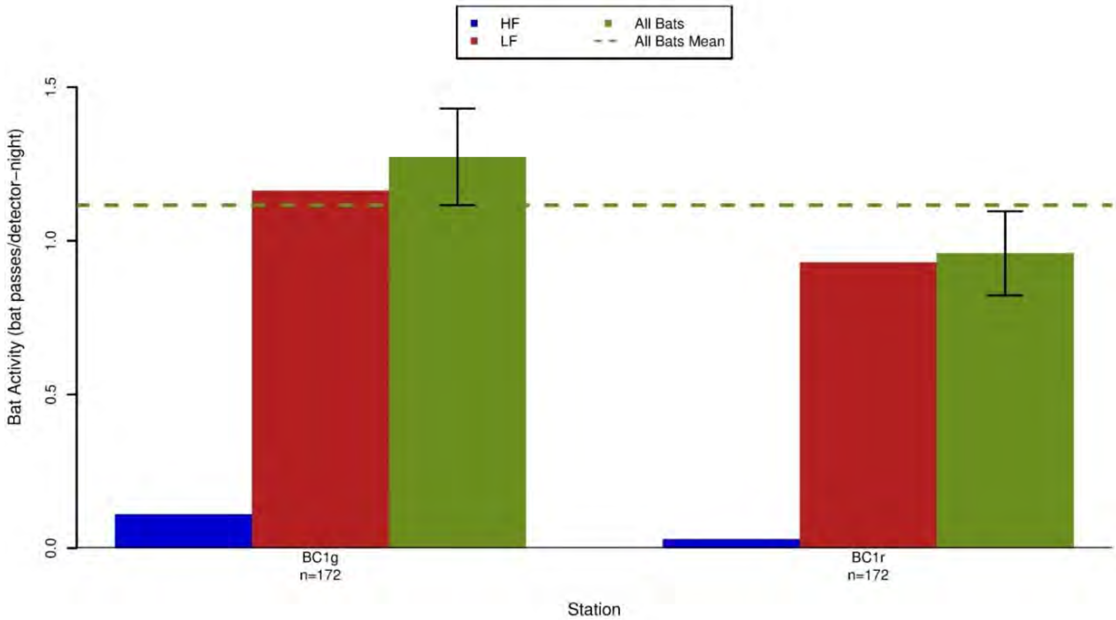

Figure 3. Bat passes per detector-night for high-frequency (HF), low-frequency (LF) and all bats recorded at the Badger Canyon Wind Project Study Area from 11 May – 29 October 2018. Bootstrapped standard errors are represented by black error bars on the 'All Bats' columns.

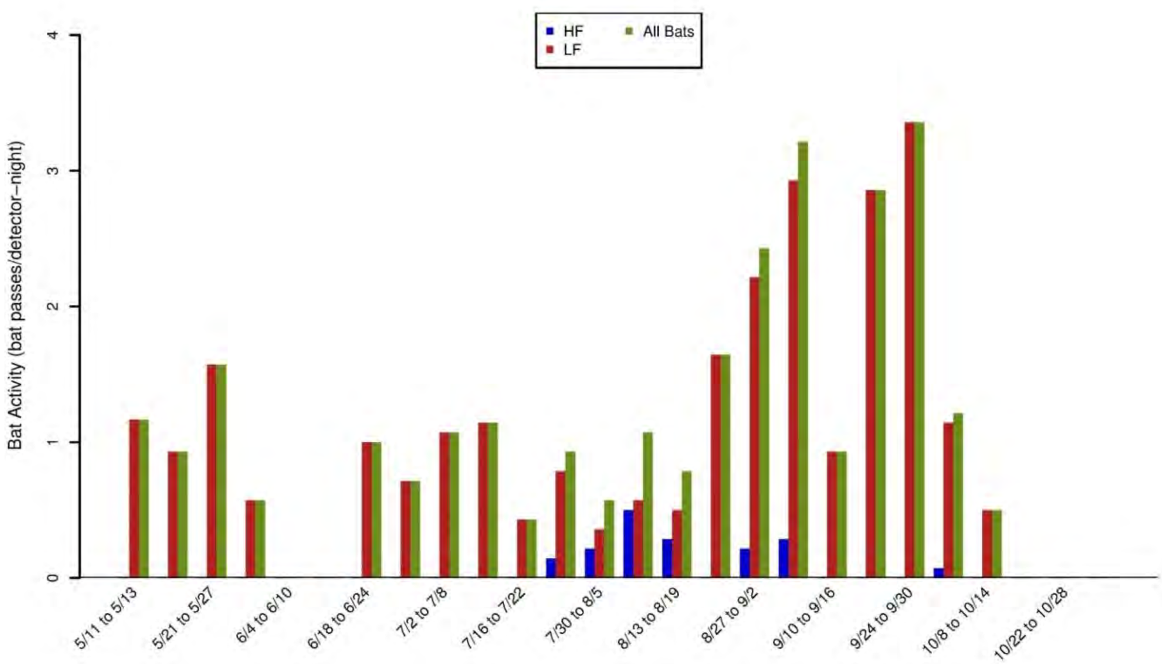

Figure 4. Weekly patterns of bat activity for high-frequency (HF), low-frequency (LF), and all bats at the Badger Canyon Wind Project Study Area from 11 May – 29 October 2018.

Species Composition

At both detector stations, approximately 93.7% of bat passes were classified as LF (e.g., big brown bat, hoary bat, silver-haired bat), and approximately 6.3% of bat passes were classified as HF (i.e., canyon bat, little brown bat; Table 3). Results from Kaleidoscope Pro automated call identification were reviewed by an experienced bat biologist: bat calls for five of the 12 species identified as having potential to occur within the Study Area were confirmed (Table 1; Table 3). Silver-haired bat was the primary species documented during the study period, detected on approximately 24% of detector-nights (Table 3). Hoary bat and big brown bat were the next most commonly detected species, occurring on approximately 14% and 6% of detector-nights, respectively (Table 3). Canyon bat was the most frequently detected HF bat, documented on approximately 3% of detector-nights; only two calls were confirmed from little brown bat during the study period (Table 3). Townsend's big-eared bat and pallid bat calls were not confirmed during the study period; no federal or state-listed bat species were detected.

Table 3. Nights (and percent) species present by sampling station at the Badger Canyon Wind Project Study Area from 11 May – 29 October 2018.

Common Name	BC1g*	BC1r*	Total*
High-Frequency (> 30 kHz)			
canyon bat	9 (5%)	0 (0%)	9 (3%)
little brown bat	2 (1%)	0 (0%)	2 (1%)
Low-Frequency (< 30 kHz)			
big brown bat	10 (6%)	9 (5%)	19 (6%)
hoary bat	23 (13%)	24 (14%)	47 (14%)
silver-haired bat	40 (23%)	41 (24%)	81 (24%)

*Nights species present
kHz = kilohertz

DISCUSSION AND RISK ASSESSMENT

Bat fatalities have been discovered at most monitored wind energy facilities in North America and globally (Arnett et al. 2016), with bat fatality rates in the US ranging from zero (Chatfield and Bay 2014) to 40.2 bats/megawatt (MW)/year (Hein et al. 2013b). In 2012, an estimated 600,000 bats died as a result of interactions with wind turbines in the US (Hayes 2013), and hoary bat population viability may be threatened by fatalities caused by wind turbines (Frick et al. 2017). Proximate causes of bat fatalities are primarily due to collisions with moving turbine blades (Grodsky et al. 2011, Rollins et al. 2012), but to a limited extent may also be caused by barotrauma (Baerwald et al. 2008). The underlying reasons bats approach wind turbines are still largely unknown (Cryan and Barclay 2009, Reimer et al. 2018).

Several key findings from the bat activity study at the Project are consistent with known patterns from other studies in the western US. First, the five bat species confirmed within the Study Area are known from throughout the region and the most commonly detected species (silver-haired and hoary bats) are migratory tree-roosting bats, a pattern consistent with known trends. Second, the period of peak activity during the study period occurred in the fall, consistent with known patterns from the region and throughout the western US. Third, bat activity rates documented at the Project were relatively consistent with activity rates from the closest region with publicly available data (i.e., Rocky Mountains region).

Approximately 93% of bat passes recorded within the Study Area were produced by three LF bat species, silver-haired bat, hoary bat, and big brown bat, which were documented on 24%, 14% and 6% of detector-nights, respectively. Low-frequency bats, including silver-haired and hoary bats, are the most commonly reported fatalities at many wind energy facilities in the US (Arnett et al. 2008, Arnett and Baerwald 2013, Thompson et al. 2017). Given these results and trends seen elsewhere in the US, LF bats including silver-haired bat and hoary bat would likely have the highest risk of collision at the Project.

Bat activity within the Study Area peaked in early September, which is consistent with known patterns from the region and throughout the western US. During the fall, migratory bats may begin moving toward wintering areas, and many species initiate reproductive behaviors (Cryan 2008). This period of increased landscape-scale movement and reproductive behavior is often associated with increased levels of bat fatalities at operational wind energy facilities (Arnett et al. 2008; Arnett and Baerwald 2013, Thompson et al. 2017). If risk patterns at the Project are consistent with known trends, it is likely that most fatalities would occur during the fall.

Overall, bat activity within the Study Area (1.12 bat passes per detector-night), as well as the average bat activity at the ground sampling station (1.27 bat passes per detector-night), were well below the Rocky Mountains regional average of 4.02 bat passes per detector-night (Appendix A), which is the closest region with publicly available activity data (no activity data from the Pacific Northwest is available for comparison). Corresponding post-construction bat fatality rates for the Rocky Mountains region range from 1.05 to 11.42 bats/MW/year, with an average of 4.02 bats/MW/year (Appendix A). As the relationship between pre-construction activity rates and post-construction fatality rates has not been definitively established (Hein et al. 2013; see Risk Assessment in Methods section p. 6-7), fatality rates documented at other facilities in the Pacific Northwest, where a majority of wind energy facilities are located along the Columbia Plateau, were used to assess potential risk to bats at the Project. At these Pacific Northwest facilities, bat fatality rates have ranged from 0.12 to 4.23 bats/MW/year with an average fatality rate of 1.19 bats/MW/year (Appendix A), which is somewhat lower than that documented in the Rocky Mountains region. If risk patterns at the Project are similar to patterns elsewhere in the Pacific Northwest, it is likely that fatality rates at the Project would be similarly low.

CONCLUSION

To date, post-construction monitoring studies of wind energy facilities in North America show that: a) collision mortality is greatest for migratory tree-roosting species (e.g., hoary bat and silver-haired bat; Thompson et al. 2017), which make up approximately 78% of reported bat fatalities; b) the majority of fatalities occur during the fall migration season (Thompson et al. 2017); and c) most fatalities occur on nights with relatively low wind speeds (e.g., less than 6.0

m per second [19.7 ft per second]; Arnett et al. 2008, 2013; Arnett and Baerwald 2013). Finally, a recent meta-analysis suggests that bat mortality rates at wind facilities increase as relative grassland cover (or open cover) decreases (Thompson et al. 2017), suggesting that facilities or turbines in forested areas have higher fatality rates than facilities or turbines that lack surrounding tree cover. Given these trends and the results from the bat activity study at the Project Study Area in 2018, it is likely that bat mortality at the Project, once operational, would be: a) low, similar to other Pacific Northwest facilities; b) consist primarily of migratory, tree-roosting species (i.e., silver-haired bat, hoary bat); and c) occur mainly in the fall.

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Appendix A. Pacific Northwest and Rocky Mountain Fatality Summary Tables

Appendix A. Wind energy facilities in the Pacific Northwest and Rocky Mountains region of North America with comparable activity and fatality data for bats, separated by geographic region. Activity estimate given as bat passes per detector-night. Fatality estimate given as the number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Bat Activity Estimate	Bat Activity Dates	Fatality Estimate	No. of Turbines	Total MW
Badger Canyon (2018)	**1.12**	5/11/18 – 10/29/18			
	Pacific Northwest				
Mean	**--**		**1.19**	**99**	**134.1**
Palouse Wind, WA (2012-2013)			4.23	58	104.4
Biglow Canyon, OR (Phase II; 2009-2010)			2.71	65	150
Nine Canyon, WA (2002-2003)			2.47	37	48.1
Stateline, OR/WA (2003)			2.29	454	299
Elkhorn, OR (2010)			2.14	61	101
White Creek, WA (2007-2011)			2.04	89	204.7
Biglow Canyon, OR (Phase I; 2008)			1.99	76	125.4
Leaning Juniper, OR (2006-2008)			1.98	67	100.5
Big Horn, WA (2006-2007)			1.9	133	199.5
Combine Hills, OR (Phase I; 2004-2005)			1.88	41	41
Linden Ranch, WA (2010-2011)			1.68	25	50
Pebble Springs, OR (2009-2010)			1.55	47	98.7
Hopkins Ridge, WA (2008)			1.39	87	156.6
Harvest Wind, WA (2010-2012)			1.27	43	98.9
Elkhorn, OR (2008)			1.26	61	101
Vansycle, OR (1999)			1.12	38	24.9
Klondike III (Phase I), OR (2007-2009)			1.11	125	223.6
Stateline, OR/WA (2001-2002)			1.09	454	299
Stateline, OR/WA (2006)			0.95	454	299
Tuolumne (Windy Point I), WA (2009-2010)			0.94	62	136.6
Klondike, OR (2002-2003)			0.77	16	24
Combine Hills, OR (2011)			0.73	104	104
Hopkins Ridge, WA (2006)			0.63	83	150
Biglow Canyon, OR (Phase I; 2009)			0.58	76	125.4
Biglow Canyon, OR (Phase II; 2010-2011)			0.57	65	150
Hay Canyon, OR (2009-2010)			0.53	48	100.8
Windy Flats, WA (2010-2011)			0.41	114	262.2
Klondike II, OR (2005-2006)			0.41	50	75
Vantage, WA (2010-2011)			0.4	60	90
Wild Horse, WA (2007)			0.39	127	229
Goodnoe, WA (2009-2010)			0.34	47	94
Marengo II, WA (2009-2010)			0.27	39	70.2
Biglow Canyon, OR (Phase III; 2010-2011)			0.22	76	174.8
Marengo I, WA (2009-2010)			0.17	78	140.4
Klondike IIIa (Phase II), OR (2008-2010)			0.14	51	76.5
Kittitas Valley, WA (2011-2012)			0.12	48	100.8
	Rocky Mountains				
Mean	**4.02**		**4.90**	**70**	**85.0**
Summerview, Alb (2006; 2007)	7.65[A]	07/15/06-07-09/30/06-07	11.42	39	70.2
Summerview, Alb (2005-2006)			10.27	39	70.2
Judith Gap, MT (2006-2007)			8.93	90	135

Appendix A. Wind energy facilities in the Pacific Northwest and Rocky Mountains region of North America with comparable activity and fatality data for bats, separated by geographic region. Activity estimate given as bat passes per detector-night. Fatality estimate given as the number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Bat Activity Estimate	Bat Activity Dates	Fatality Estimate	No. of Turbines	Total MW
Foote Creek Rim, WY (Phase I; 1999)			3.97	69	41.4
Judith Gap, MT (2009)			3.2	90	135
Milford I, UT (2010-2011)			2.05	58	145
Milford I & II, UT (2011-2012)			1.67	107	160.5 (58.5 Phase I, 102 Phase II)
Foote Creek Rim, WY (Phase I; 2001-2002)	2.2[A,B]	6/15/01-9/1/01	1.57	69	41.4
Foote Creek Rim, WY (Phase I; 2000)	2.2[A,B]	6/15/00-9/1/00	1.05	69	41.4

A = Activity rate was averaged across phases and/or years

B = Activity rate calculated by WEST from data presented in referenced report

Appendix A (*continued*). Wind energy facilities in the Pacific Northwest and Rocky Mountain regions of North America with comparable activity and fatality data for bats. Data from the following sources:

Facility	Activity Estimate	Fatality Estimate	Facility	Activity Estimate	Fatality Estimate
Big Horn, WA (06-07)		Kronner et al. 2008	Klondike III (Phase I), OR (07-09)		Gritski et al. 2010
Biglow Canyon, OR (Phase I; 08)		Jeffrey et al. 2009b	Klondike IIIa (Phase II), OR (08-10)		Gritski et al. 2011
Biglow Canyon, OR (Phase I; 09)		Enk et al. 2010	Leaning Juniper, OR (06-08)		Gritski et al. 2008
Biglow Canyon, OR (Phase II; 09-10)		Enk et al. 2011b	Linden Ranch, WA (2010-2011)		Enz and Bay 2011
Biglow Canyon, OR (Phase II; 10-11)		Enk et al. 2012b	Marengo I, WA (2009-2010)		URS Corporation 2010b
Biglow Canyon, OR (Phase III; 10-11)		Enk et al. 2012a	Marengo II, WA (2009-2010)		URS Corporation 2010c
Combine Hills, OR (Phase I; 04-05)		Young et al. 2006	Milford I & II, UT (2011-2012)		Stantec 2011b
Combine Hills, OR (11)		Enz et al. 2012	Milford I, UT (2010-2011)		Stantec 2012b
Elkhorn, OR (08)		Jeffrey et a. 2009a	Nine Canyon, WA (2002-2003)		Erickson et al. 2003
Elkhorn, OR (10)		Enk et al. 2011a	Palouse Wind, WA (12-13)		Stantec 2013a
Foote Creek Rim, WY (Phase I; 99)		Young et al. 2003a	Pebble Springs, OR (09-10)		Gritski and Kronner 2010b
Foote Creek Rim, WY (Phase I; 00)	Gruver 2002	Young et al. 2003a, 2003b	Stateline, OR/WA (01-02)		Erickson et al. 2004
Foote Creek Rim, WY (Phase I; 01-02)		Young et al. 2003a, 2003b	Stateline, OR/WA (03)		Erickson et al. 2004
Goodnoe, WA (09-10)		URS Corporation 2010a	Stateline, OR/WA (06)		Erickson et al. 2007
Harvest Wind, WA (10-12)		Downes and Gritski 2012a	Summerview, Alb (05-06)		Brown and Hamilton 2006
Hay Canyon, OR (09-10)		Gritski and Kronner 2010a	Summerview, Alb (06; 07)	Baerwald 2008	Baerwald 2008
Hopkins Ridge, WA (06)		Young et al. 2007	Tuolumne (Windy Point I), WA (09-10)		Enz and Bay 2010
Hopkins Ridge, WA (08)		Young et al. 2009b	Vansycle, OR (99)		Erickson et al. 2000
Judith Gap, MT (06-07)		TRC 2008	Vantage, WA (10-11)		Ventus 2012
Judith Gap, MT (09)		Poulton and Erickson 2010	White Creek, WA (07-11)		Downes and Gritski 2012b
Kittitas Valley, WA (11-12)		Stantec Consulting Services 2012	Wild Horse, WA (07)		Erickson et al. 2008
Klondike, OR (02-03)		Johnson et al. 2003	Windy Flats, WA (10-11)		Enz et al. 2011
Klondike II, OR (05-06)		NWC and WEST 2007			

SITE CHARACTERIZATION STUDY REPORT

Four Mile Wind Project
Benton County, Washington

Prepared for:

Four Mile MW LLC

Prepared by:

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EXECUTIVE SUMMARY

The proposed Four Mile Wind Project (Project) includes an area of approximately 35,186 acres (54.98 square miles) of private land in Benton County, Washington. Wpd Wind Projects, Inc. is proposing to develop this area under the auspices of a wholly-owned subsidiary, Four MW, LLC. This Site Characterization Study (SCS) is intended to fulfill the tasks described in the US Fish and Wildlife Service (USFWS) Land-Based Wind Energy Guidelines (WEG) for Tier 2 site characterization and the USFWS Eagle Conservation Plan Guidance (ECPG) for Stage 1 site assessment, and guide formulation of focused field surveys for the Project. Specifically, the information contained herein reflects a desktop analysis of publicly available information that pertains to plants, animals, and habitat features that may be important considerations during Project planning and development. Environmental resources within the Project boundary (Project area) were examined through a search of existing data. In addition, an initial reconnaissance-level site visit was conducted in December 2017, to provide additional cursory, baseline information on landscape and habitat features potentially important during Project development.

The dominant land cover types within the Project are cultivated dry land wheat farming and shrub/scrub, together comprising over 95% of the Project area. No special status (state and/or federal listed or rare) plant species are known to occur within five miles of the Project; however, one rare and/or high quality plant community has been documented in the region but is not likely to occur within the Project boundary. Four Washington Department of Fish and Wildlife (WDFW) Priority Habitats/Habitat Features (emergent wetland, forest/shrub wetland, shrub-steppe, and cliff/bluff) have also been identified in the Project or surrounding area.

There are 15 diurnal raptor species and seven owl species that may occur in or near the Project area at some point during the year. Of the raptor species with potential to occur within the Project area, one species is state threatened (ferruginous hawk), two species are State candidates for listing (golden eagle and burrowing owl), and two species are state Priority Species (bald eagle and prairie falcon). Nesting habitat for tree-nesting raptor species (e.g., Swainson’s hawk, red-tailed hawk, great horned owl) is present in scattered, isolated trees within the Project area and surrounding region, while ground-nesting species (e.g., burrowing owl, northern harrier, short-eared owl) have the potential to nest throughout the Project, and cliffs and cut banks to the north and east of the Project provide nesting substrate for species such as ferruginous hawk and barn owl.

Sixteen bat species have the potential to occur in and around the Project, with eight species having an approximate range and habitat requirements that overlap the Project area. The only listed or candidate bat species in Washington are Townsend’s big-eared bat and Keen’s myotis, both of which are State candidates for listing; however, Keen’s myotis occupy only the extreme northwestern corner of the state and Townsend’s big-eared bats are unlikely to occur within the Project due to a general lack of roosting and hibernating sites.

Three wildlife species listed as state threatened or endangered by the WDFW have at least some potential to occur within the Project: American white pelican, ferruginous hawk, and sandhill crane. An additional 12 species (six birds, four mammals, and two reptiles) are considered State candidates for listing. No species currently listed, or candidates for listing, under the USFWS Endangered Species Act have the potential to occur within the Project.

Based on this SCS, significant adverse impacts to special status species are not anticipated; however, due to the potential for occurrence of some sensitive wildlife and plant species/communities within the Project area, it is recommended that Tier 3 site-specific studies be conducted to further refine risk assessments for these species. The following Tier 3 studies are recommended prior to construction in order to more clearly assess the potential risk to sensitive plants and wildlife: vegetation/land cover mapping, year-round large bird/eagle use surveys, small bird use surveys, raptor nest surveys with particular emphasis on bald and golden eagles, bat acoustic surveys, and threatened, endangered and sensitive species surveys.

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INTRODUCTION

Many wind energy developers now choose to utilize the US Fish and Wildlife Service (USFWS) voluntary wind project development guidelines, which provide a template for a tiered planning process when exploring a potential wind energy project. The Land-based Wind Energy Guidelines (WEG; USFWS 2012) are intended to function in concert with the USFWS Eagle Conservation Plan Guidance (ECPG; USFWS 2013), and promote intentional tiered project development which strategically assesses and minimizes impacts to wildlife. This tiered approach includes: Tier 1 - Preliminary Site Evaluation; Tier 2 - Site Characterization; Tier 3 - Field Studies to Document Site Wildlife and Habitat and Predict Project Impacts; Tier 4 - Post-construction Studies to Document Impacts; Tier 5 - Other Post-construction Studies. Wpd Wind Project, Inc., operating under the auspices of Four Mile MW LLC, contracted Western EcoSystems Technology, Inc. (WEST) to develop a Tier 2 Site Characterization Study (SCS) for the proposed Four Mile Wind Project (Project). The overall purpose of the SCS is to identify the biotic and abiotic environmental characteristics of the Project, evaluate potential impacts to these resources from wind energy development, and determine what additional environmental resource surveys are warranted. Identification of resource issues early in the planning process allows developers of wind energy facilities to identify, avoid, and minimize future problems which may occur. The SCS will be used to guide the Tier 3 field studies necessary to evaluate identified resources of concern within the Project.

STUDY AREA

Regional Setting

The Project lies within the semi-arid Columbia Plateau Ecological region, which encompasses a large portion of south central Washington (Washington Biodiversity Council 2008). The Columbia Plateau tilts upward and southward into the Great Basin of eastern Oregon, western Idaho, and northern Nevada, and is bordered by the Cascades to the west, the Okanogan Highlands to the north, the Rockies to the east, and the Blue Mountains to the southeast. The Columbia and Snake rivers are the dominant topographic features of the Columbia Plateau; in Washington, the plateau is bisected by the Columbia River. Today, the areas with suitable soil are used for agriculture; crops include wheat (*Triticum* spp.), alfalfa (*Medicago sativa*), potatoes (*Solanum tuberosum*), grass hay, and vineyards. Other areas within the region are used for cattle grazing. In the Yakima Valley to the north and the Columbia Basin to the south, irrigated agriculture is prevalent and includes pastures, orchards, and vineyards. Hops (*Humulus lupulus*) and field crops are also commonly grown. In un-cultivated areas, this ecoregion is characterized by arid sagebrush- (*Artemisia* spp.) steppe and grassland. The regional climate can by typified as arid to semiarid with low precipitation, warm to hot dry summer, and relatively cold winters (Franklin 1973). Mean annual temperature in the region is 59° Fahrenheit (15° Celcius), with mean annual precipitation of 10 inches (25 centimeters; Franklin and Dryness 1973, Daly 2000).

Over the last two decades, the Columbia Plateau Ecoregion of eastern Washington and Oregon has experienced extensive wind energy development. In Washington alone, there are currently 20 operating wind energy facilities with a total installed capacity of 3,075 megawatts (MW), the majority of which are located in the Columbia Plateau (AWEA 2017). In Benton County, where the proposed Project is located, there is currently only one operating facility, the 96-MW Nine Canyon wind energy facility, located immediately adjacent to the northern boundary of the Project (Figure 3). Located just four mi (6.4 km) to the southeast of the Project, is the 300-MW Stateline wind energy facility in Walla Walla County, Washington and Umatilla County, Oregon.

Project Area

The proposed Project area encompasses approximately 35,186 acres (ac; 54.98 square miles [mi^2]; Project area) within Benton County in southeastern Washington, approximately seven miles (mi; 11.3 kilometers [km]) south of the city of Kennewick (Figure 1). Topography within the Project area generally consists of rolling hills bisected by meandering canyons that drain primarily to the south into the Columbia River. Elevations within the Project range from 117 m (384 ft) along the eastern boundary of the Project to 624 m (2,047 ft) in the central portion of the Project (Figure 2). The eastern boundary of the Project lies adjacent to the Columbia River as it bends around the Project area from the north to the southwest (Figure 1). The original vegetation of the Project area was a bluebunch wheatgrass (*Pseudoroegneria spicata*)-Idaho fescue (*Festuca idahoensis*) zonal association, which was predominately grassland and shrub-steppe with deciduous riparian forest and scrub along drainages (Franklin and Dyrness 1973). Today, agriculture and livestock grazing have converted the area to a mosaic of cultivated wheat fields, grazed shrub-steppe, and Conservation Reserve Program (CRV) grasslands (Figure 3). A network of county and a few private roads traverse the Project area. Representative photos of the land cover types and landscape features within the Project area are included in Appendix A.

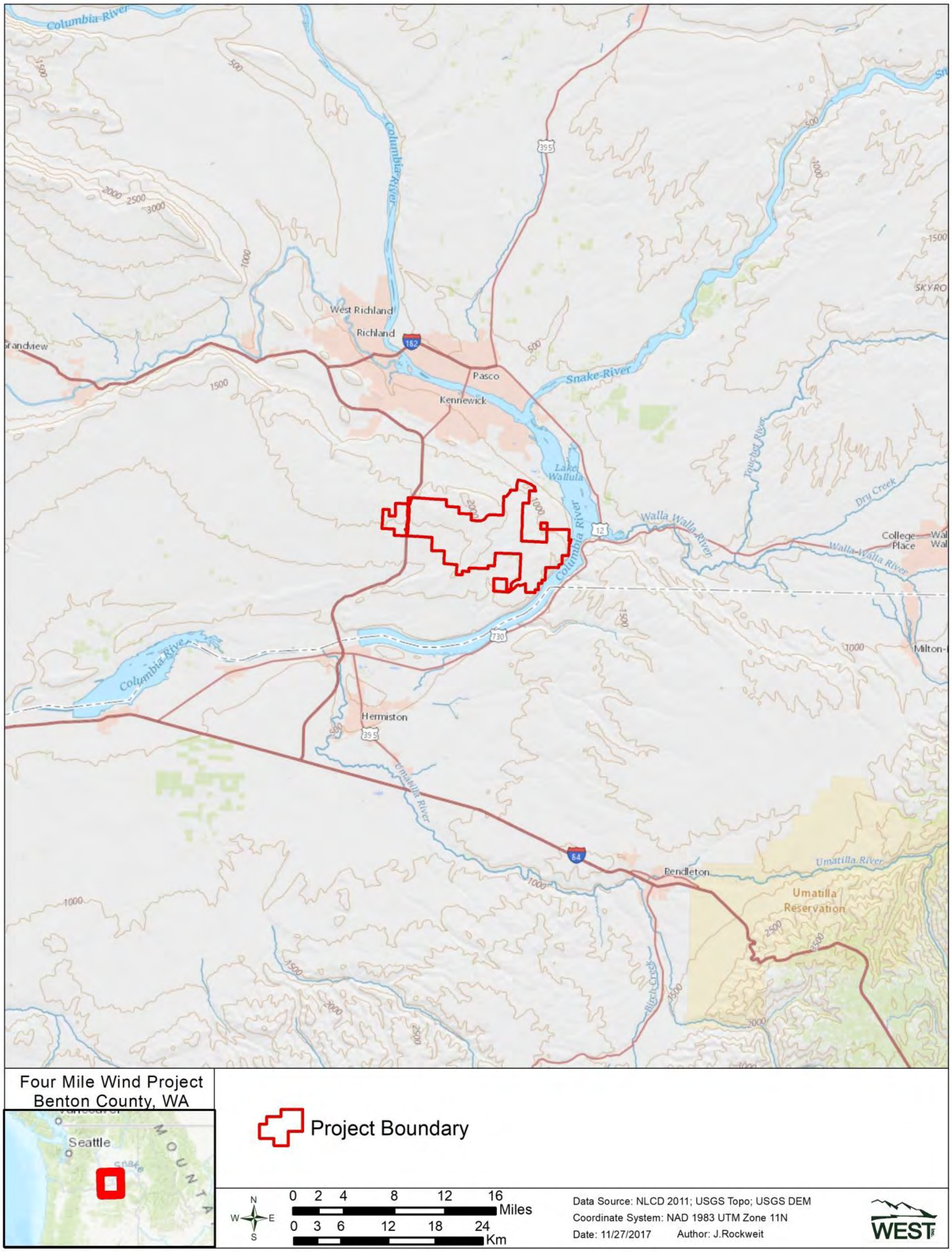

Figure 1. Location of the Four Mile Wind Project, Benton County, Washington.

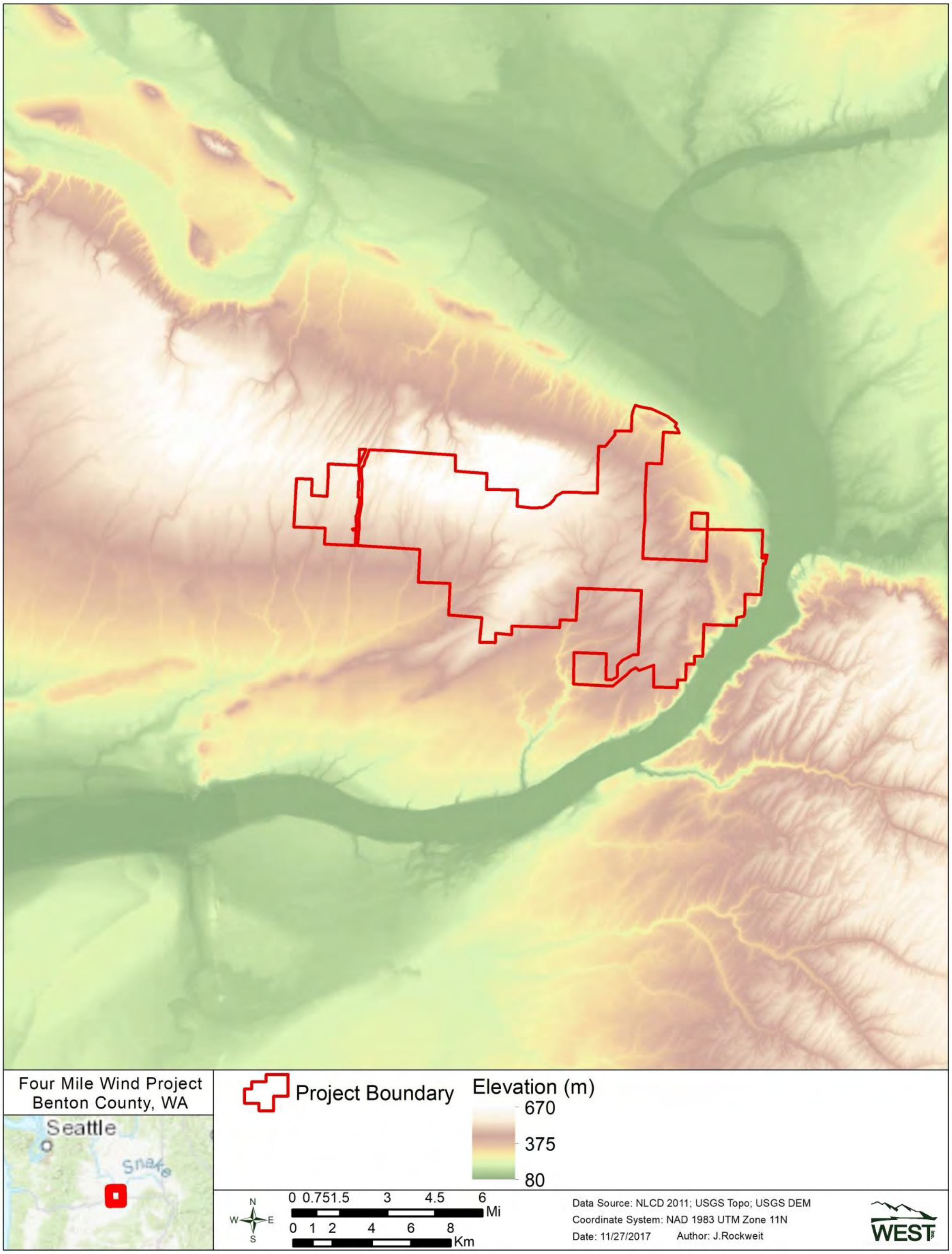

Figure 2. Digital elevation model of the Four Mile Wind Project area.

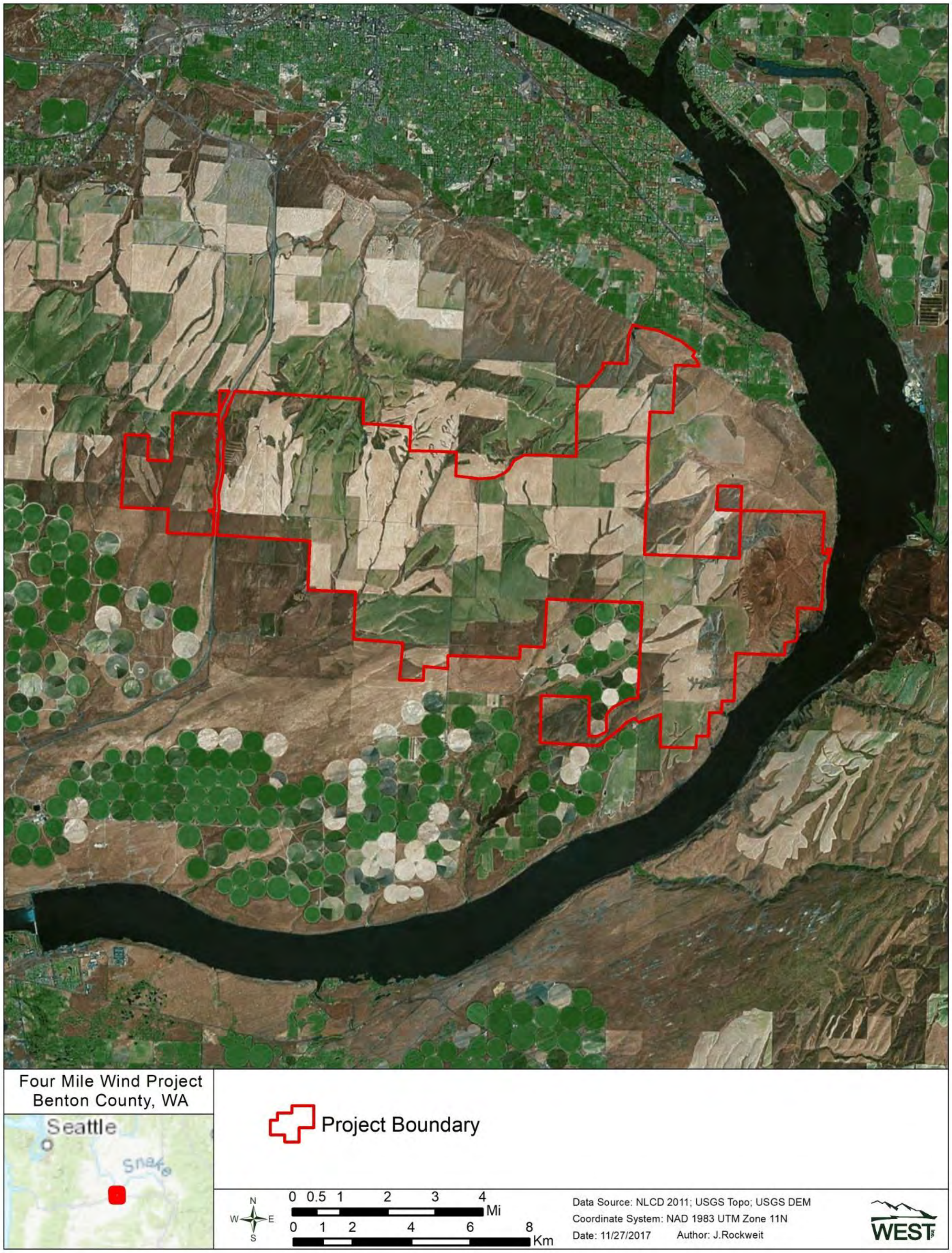

Figure 3. Aerial photograph of the Four Mile Wind Project area.

METHODS

Environmental resources within the Project and surrounding area were examined through a search of existing publicly available data and an initial reconnaissance-level site visit. The initial site visit occurred on December 11-12, 2017 and entailed a preliminary examination of the area from accessible public and private roads. Biological features and potential wildlife habitat assessed during the site visit included plant communities and wetlands, topographic and geological features, potential raptor nesting habitat, habitat for prey populations, and potential bat roosting and foraging habitat. Photographs of the Project area are presented in Appendix A.

Published literature, field guides, and public data sets were among the resources reviewed to identify known environmental resources within the Project area and surrounding region. The information presented in this analysis was obtained from the following sources:

- Bat Conservation International (BCI) species accounts and range maps (BCI 2017);
- List of Important Bird Areas (IBAs) by the National Audubon Society (Audubon 2017 2017);
- Priority Habitats and Species (PHS) database, maintained by the Washington Department of Fish and Wildlife (WDFW; 2017a);
- Published or available literature regarding wind-energy impacts to wildlife, with an emphasis on projects in the Columbia Plateau Ecoregion;
- Published literature, WDFW species status reports, and other publically-available information on the life history and range for special status species;
- State or federally protected nature preserves and lands protected by The Nature Conservancy (US Geological Survey [USGS] 2017a; The Nature Conservancy 2017);
- TNC and American Wind Wildlife Institute's (AWWI) Wind and Wildlife Landscape Assessment Tool (AWWI 2017);
- US Department of Agriculture (USDA) Soil Survey Geographic (SSURGO) data (USDA Natural Resource Conservation Service [NRCS] 2017);
- USFWS Critical Habitat designations (USFWS 2016);
- USFWS National Wetland Inventory (NWI) data (USFWS NWI 2016);
- USFWS county-level species occurrence information (USFWS 2017);
- USGS National Land Cover Dataset (NLCD; USGS NLCD 2011);
- USGS topographic maps and digital elevation data (USGS 2017, USGS DEM 2016);
- Washington Natural Heritage Program (WNHP) spatial dataset of rare or at-risk plants and plant communities (WNHP 2017b);
- Washington State Species of Concern Lists, maintained by the WDFW (2017b); and

- WNHP online *Field Guide to the Rare Plants of Washington* (WHNP 2017a).

WEST determined the likelihood a sensitive animal or plant species may occur within the Project by considering the species' range, habitat suitability within the Project, species' mobility, population size, and records of occurrence within or adjacent to the Project. A similar assessment was made for sensitive plant communities and habitats. Based on these factors, the likelihood of occurrence was defined for each sensitive species/community using the following categories:

- None – Project outside the species known range, no suitable habitat within the Project, restricted mobility and small population size.
- Unlikely – Project outside the species known range and suitable habitat appears absent within the Project; however, due to the species mobility and population size, species may occur within the Project during migration or other times of the year.
- Possible – Project is located within the range of the species but contains marginal suitable habitat; species highly mobile and may occur year-round.
- Likely – Project is located within the range of the species and contains suitable habitat; records of species occurrence in the surrounding area but absent from the Project.
- Occurs – Records of species occurrence within the Project based on PHS and/or WNHP data or other survey data.

LAND COVER AND HABITATS

Land Use/Land Cover

The proposed Project area encompasses 35,185.89 ac (54.98 mi^2). According to the USGS NLCD (2011; Homer et al. 2015), the dominant cover types within the Project area are cultivated cropland (18,997.53 ac [29.68 mi^2]) and shrub/scrub (14,480.68 ac [22.63 mi^2]) which cover 54.0% and 41.2% of the Project, respectively (Table 1; Figure 4). Much smaller areas of grassland/herbaceous cover types are present in the Project area (1,226.30 ac [1.92 mi^2]), primarily in the eastern most portion of the Project, and comprise an additional 3.5% of the total Project acreage (Table 1; Figure 4). The remaining 1.3% of the Project is comprise of small amounts of developed areas (primarily roads; 474.41 ac [0.74 mi^2]), open water (6.74 ac [0.01 mi^2]), and woody wetlands (0.14 ac [< 0.01 mi^2]; Table 1; Figure 4).

Table 1. Land use and habitat types present within the Four Mile Wind Project.

Cover Type	Acres	Percent Composition (%)
Cultivated Crops	18,997.63	54.0
Shrub/scrub	14,480.68	41.2
Grassland/Herbaceous	1,226.30	3.5
Developed, Open Space	453.35	1.3
Developed, Low Intensity	20.76	0.1
Open Water	6.74	< 0.1
Developed, Medium Intensity	0.30	< 0.1
Woody Wetlands	0.14	< 0.1
Total	35,185.89	**100**

Data obtained from USGS NLCD, compiled from satellite imagery (USGS NLCD 2011; Homer et al. 2015).

Wetlands and Riparian Areas

Digital NWI data (USFWS NWI 2016) are available for the Project area; however, formal wetland delineations have not been completed. According to the NWI, 0.8% of the Project area (279.43 ac [0.44 mi^2]) is composed of wetland habitat, all of which is classified as riverine (Figure 5). While no larger rivers or streams are present within the Project area, The Columbia River wraps around the Project area with the eastern boundary of the Project lying adjacent to the River (Figure 5). A network of meandering shallow canyons with ephemeral water flow traverse the Project area, ultimately draining into the Columbia River to the north, east and south (Figure 5).

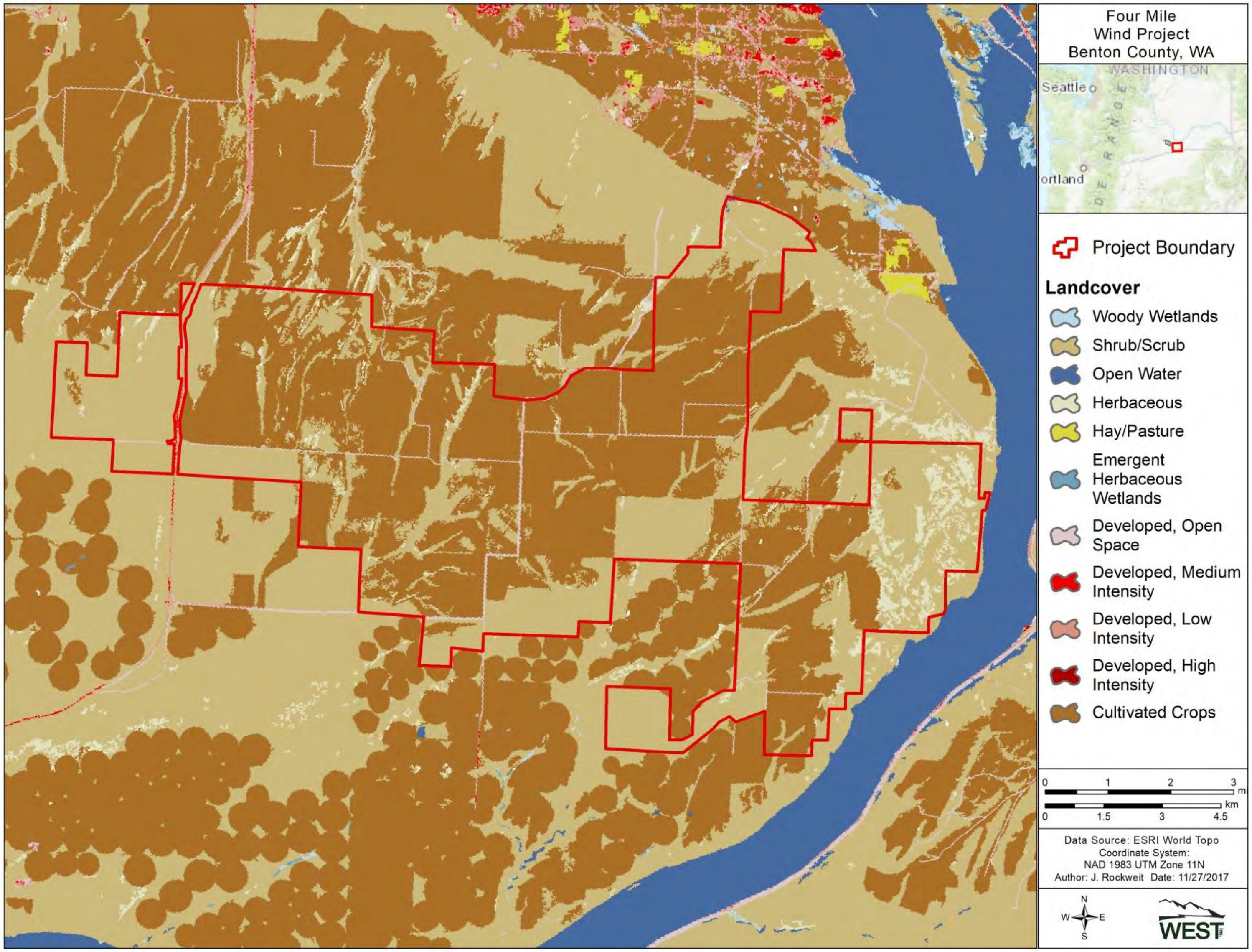

Figure 4. Land cover within the Four Mile Wind Project (USGS NLCD 2011; Homer et al. 2015).

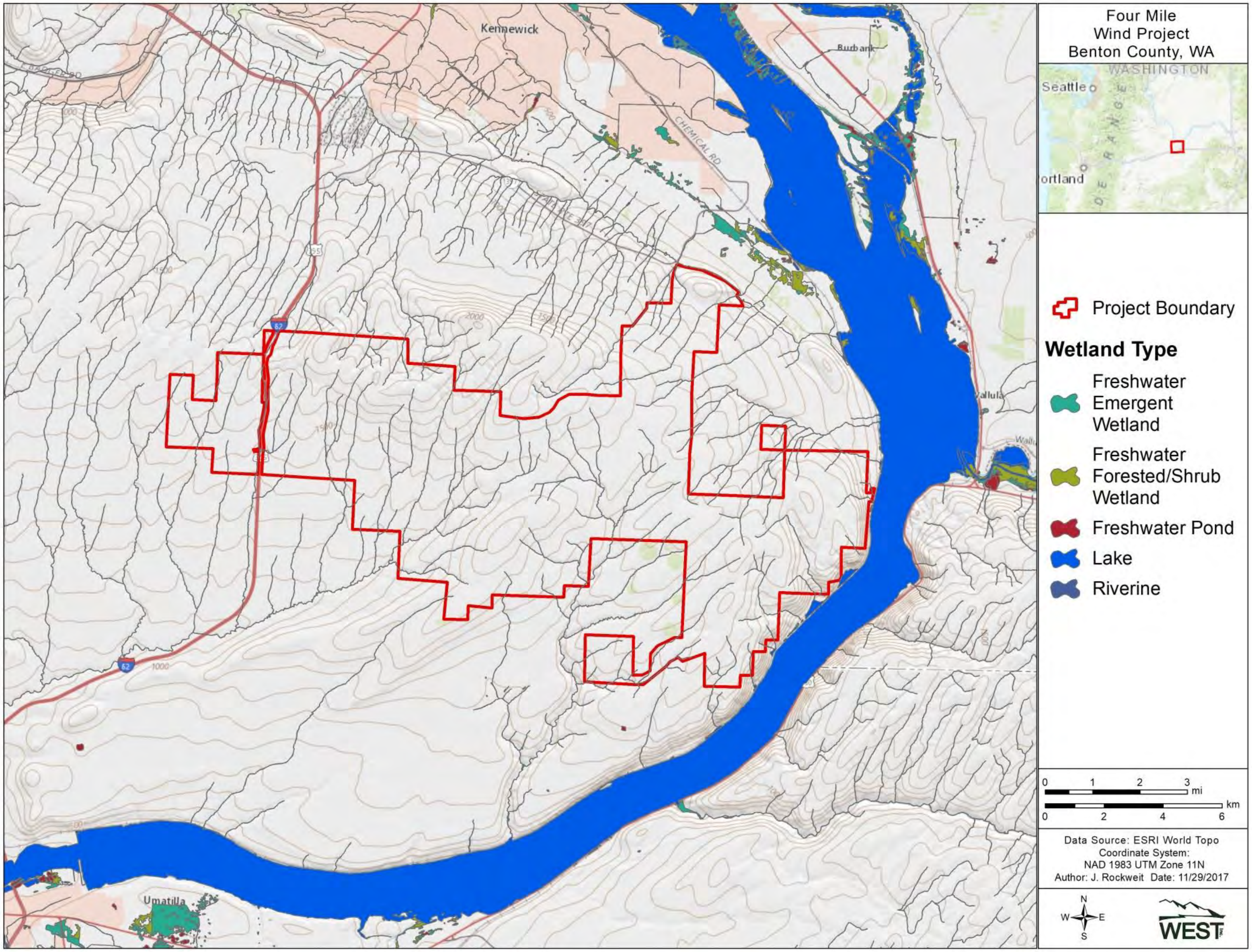

Figure 5. National Wetland Inventory map of the Four Mile Wind Project (USFWS NWI 2016).

Priority Habitats

The PHS List, maintained by the WDFW, is a catalog of habitats, habitat features and species considered to be priorities for conservation and management. Priority habitats are habitat types or elements with unique or significant value to a diverse assemblage of species. The PHS online database identified four Priority Habitats occurring within three mi (4.8 km) of the Project: freshwater emergent wetland, freshwater forested shrub, shrub-steppe, and cliffs/bluffs (Table 2; WDFW 2017a).

Table 2. Priority habitats occurring in the vicinity of the Four Mile Wind Project.

Habitat/Habitat Feature	Description	Potential for Occurrence in the Project area
Freshwater emergent wetland	Lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water (WDFW 2008).	**Possible**. Small emergent wetlands documented within agricultural lands immediately to south of Project, as well as areas to the east and north (WDFW 2017a); some potential for small wetlands to occur in Project.
Freshwater forested shrub	Lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water (WDFW 2008). Characterized by presence of trees and/or shrubs.	**Unlikely.** Small areas of forested/shrub wetland, associated with Columbia River, to north and east of Project, (WDFW 2017a); not likely to occur within Project area.
Shrub-steppe	Non-forested vegetation type consisting of one or more layers of perennial bunchgrasses and a conspicuous but discontinuous layer of shrub (WDFW 2008).	**Present.** Majority of Project is cultivated cropland and grazed shrubland; however, shrub-steppe has been documented in eastern portion of the Project and along several larger drainages within Projects (WDFW 2017a).
Cliff/bluffs	Characterized by land/rock that is greater than 25 feet high and occurs below 5,000 feet elevation (WDFW 2008).	**Unlikely.** Cliffs and bluffs do not appear to be present within Project area; however, they are documented along the Columbia River immediately to east and southeast of the Project (WDFW 2017a)

Data obtained from WDFW 2017a

Rare Plants and Plant Communities

The Washington Natural Heritage Program (WNHP) maintains a database containing information on the location of federal and/or state listed and rare plants and rare and/or high quality plant communities across the state (WNHP 2017b). According to a search of the online database no special status (state and/or federal listed or rare) plant species are known to occur within five miles of the Project. The WHNP does list a single rare and/or high quality plant community as occurring within five miles of the Project: Wyoming big sagebrush (*A. t. wyomingensis*)/bluebunch wheatgrass (Figure 6). This plant community has been identified in shrub-steppe habitat occurring within one mi (1.6 km) of the northern boundary of the Project

(Figure 6). It should be noted, however, that the WNHP dataset represents an ongoing and incomplete inventory of Washington's rare plants and ecosystems and does not preclude the need for field surveys. Due to the current agricultural land uses within the Project, native shrub-steppe habitat with the potential to support rare/high quality plant communities is unlikely to occur; however, vegetation and land cover mapping following WDFW habitat classification standards and consistent with the Washington Wind Power Guidelines (WDFW 2009) should be conducted to refine habitats present with the Project area and the potential for rare or sensitive plant species and communities.

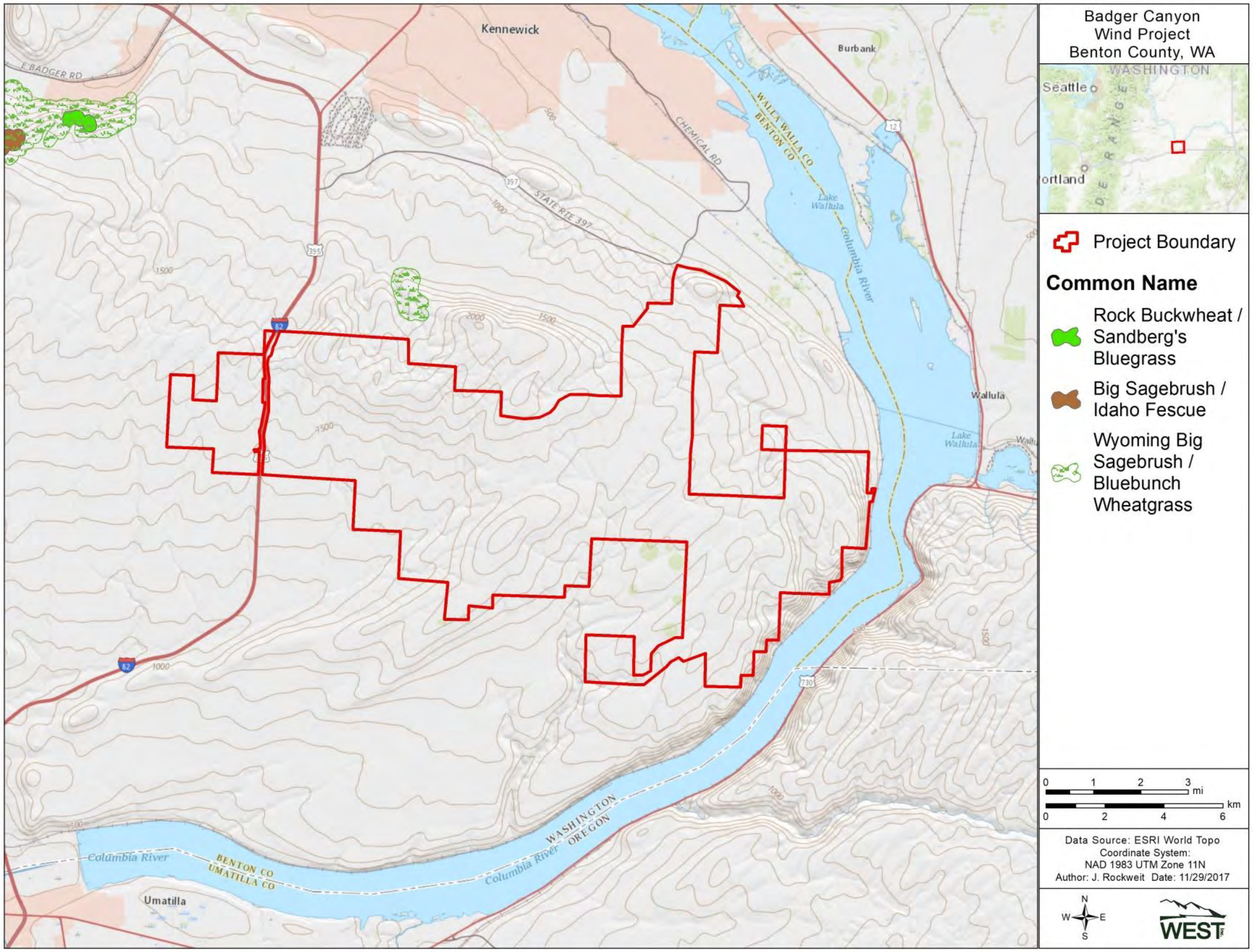

Figure 6. Known locations of rare plants and plant communities in the vicinity of the Four Mile Wind Project. Data from the Washington Natural Heritage Program (WNHP; 2017b).

WILDLIFE RESOURCES

Federal and State Listed Species

Based on review of State and federal special-status species lists and occurrence information (USFWS 2017, WDFW 2017a, WDFW 2017b), no wildlife species currently listed, or candidates for listing, under the USFWS Endangered Species Act (ESA) have the potential to occur within the Project. However, 16 State-listed or candidate wildlife species have at least some potential to occur in the Project, including ten bird species, four mammal species, and two reptile species (Table 3). Also included in the list are WDFW Priority Species (five birds and two mammals) which have been identified as priorities for conservation and management and are known to occur in the region (WDFW 2017a; Table 3). Additionally, while the bald eagle (*Haliaeetus leucocephalus*) is no longer a federal or State threatened species, it is included in the list as it is protected, along with the golden eagle, under the federal Bald and Golden Eagle Protection Act (BGEPA 1940). Impacts to eagles are of particular concern at wind energy facilities nation-wide and are discussed in greater detail in the sections below.

Of the 18 special-status species with potential to occur in the Project, six species (burrowing owl [*Athene cunicularia*], ferruginous hawk [*Buteo regalis*], loggerhead shrike [*Lanius ludovicianus*], prairie falcon [*Falco mexicanus*], sagebrush sparrow [*Artemisiospiza nevadensis*], and Townsend's ground squirrel [*Urocitellus townsendii townsendii*]) have been documented as occurring within two miles of the Project (WDFW 2017a). An additional nine species are likely or have potential to occur in the Project: American white pelican (*Pelecanus erythrorhynchos*), bald eagle, golden eagle (*Aquila chrysaetos*), sandhill crane (*Grus canadensis*), Vaux swift (*Chaetura vauxi*), black-tailed jackrabbit (*Lepus californicus*), white-tailed jackrabbit (*L. townsendii*), sagebrush lizard (*Sceloporus graciosus*), and striped whipsnake (*Masticophis taeniatus*). The remaining three species are unlikely to occur: greater sage grouse (*Centrocerus urophasianus*), sage thrasher (*Oreoscoptes montanus*), and Townsend's big-eared bat (*Coryhorhinus townsendii*). General habitat requirements and the potential for occurrence for each of these species is presented below in Table 3.

Table 3. State and/or federal listed or candidate wildlife species, or state Priority Species, with potential to occur within the Four Mile Project

Species	Status	Habitat	Potential for Occurrence in the Project area
Birds			
American white pelican *Pelecanus erythrorhynchos*	ST	Breeds primarily on isolated islands in freshwater lakes and forages in shallow areas (Stinson 2016). Nests on Columbia River dredge islands near the Tri-Cities (Stinson 2016).	**Possible.** Suitable habitat not present within Project but may fly over area between foraging areas; known to nest on Badger Island approximately four miles east of the Project (Stinson 2016), and known to occur in Walla Walla River Delta IBA 2 miles east of Project (Audubon 2017).
Bald eagle *Haliaeetus leucocephalus*	BGEPA, PS	Nests in trees or cliffs near water, typically along shorelines, lakes, reservoirs, and rivers; feeds on fish and carrion.	**Likely.** Uncommon year-round visitor to area; known to nest along Columbia River to the east and north of Project.
Burrowing owl *Athene cunicularia*	SC, PS	Occurs in open areas; nests in burrows dug by badgers or other mammals; feeds on insects, small rodents, lizards, frogs, and small birds.	**Possible.** Common resident of Tri-Cities area from mid-April to early September (Ennor 1991); numerous documented breeding locations within several miles of the Project (WDFW 2017a); foraging and nesting habitat present throughout Project area.
Ferruginous hawk *Buteo regalis*	ST, PS	Occurs in open prairie habitat and commonly feeds on ground squirrels, rabbits, and hares; nests in trees, cut banks, cliffs, and rocky pinnacles (Ennor 1991)	**Likely.** Common in Tri-Cities area during breeding season; numerous nest sites documented within several miles of the Project, particularly along [redacted] 13 [redacted] of Project (WDFW 2017a).
Golden eagle *Aquila chrysaetos*	SC, BGEPA	Breeds in hilly or mountainous areas, nests on rocky cliffs or isolated large trees. Common prey species include ground squirrels, marmots, rabbits, and hares.	**Present.** While not known to nest in Benton County, may occur as uncommon visitor to area, particularly during spring and fall migration (Hayes 2013). Observed within Project during December site visit.
Loggerhead shrike *Lanius ludovicianus*	SC	Uses open habitats with scattered shrubs; typically nests in mature sagebrush habitat; feeds on insects, small mammals, birds, reptiles, and amphibians.	**Likely.** Documented at several locations to the north of the Project (WDFW 2017a); nesting and foraging habitat present, particularly in shrub-steppe habitat in east of Project, but also in agricultural areas throughout site.

Table 3. State and/or federal listed or candidate wildlife species, or state Priority Species, with potential to occur within the Four Mile Project

Species	Status	Habitat	Potential for Occurrence in the Project area
Prairie falcon *Falco mexicanus*	PS	Inhabits arid environments of eastern Washington and nests on cliffs usually associated with native steppe and shrub-steppe habitats. Known to breed in most counties in central and eastern Washington; largest wintering populations in Washington are in central Columbia Basin including Benton County (Hays and Dobler 2004).	**Likely.** Documented in numerous locations within several miles of Project area (WDFW 2017a). Potential to nest in cliffs along Columbia River and occur year round in the Project.
Sagebrush sparrow *Artemisiospiza nevadensis*	SC, PS	Restricted to open shrub lands and grasslands with mature big sagebrush stands; nests on the ground or in sagebrush; feeds on insects.	**Possible.** Suitable sagebrush habitat may be present within Project, particularly in eastern portion of site.
Greater sage grouse *Centrocerus urophasianus*	ST	Inhabits shrub-steppe where it is closely associated with sagebrush; majority of diet comprised of sagebrush, grasses, forbs, and insects; historically occurred throughout eastern Washington (WDFW 2012a).	**Unlikely.** Project falls outside of species' current range (WDFW 2012a); suitable shrub-steppe habitat appears limited in Project area.
Sage thrasher *Oreoscoptes montanus*	SC	Inhabits open, shrub-steppe habitats, preferring areas dominated by sagebrush or bitterbrush with native grasses intermixed. Post-breeding, often moves into thickets such as along creek drainages.	**Possible.** Some areas of suitable shrub-steppe habitat may be present with Project, particularly in eastern portion of site.
Sandhill crane *Grus canadensis*	SE	Nesting habitat ranges from open meadows to deep bogs and marshes; migration stopover and staging areas occur primarily near croplands where waste grains are available near wetlands.	**Possible.** Breeding in Washington occurs only in western Yakima and Klickitat counties (Stinson 2017); possible to occur during migration or as transients during post-breeding; cropland within Project may provide stopover habitat.
Vaux swift *Chaetura vauxi*	SC	Inhabits riparian thickets, woodlands, orchards, rocky cliffs, talus slopes, and rimrock areas (Ennor 1991)	**Possible.** Nesting and roosting habitat not present within Project area; may occur during migration; known to occur in Walla Walla River Delta IBA 2 miles east of the Project in large numbers during fall migration (Audubon 2017).
Mammals			
Black-tailed jackrabbit *Lepus californicus*	SC, PS	Occurs in sagebrush and rabbitbrush dominated habitats as well as areas of mixed grassland and shrub (WDFW 2012d);	**Possible.** Suitable habitat appears to be present; however, known to be rare within Project area (WDFW pers. comm.).

Table 3. State and/or federal listed or candidate wildlife species, or state Priority Species, with potential to occur within the Four Mile Project

Species	Status	Habitat	Potential for Occurrence in the Project area
Townsend's big eared bat *Coryhorhinus townsendii*	SC	In Washington, occurs in a variety of arid and moist lowland habitats including shrub-steppe (WDFW 2012c); roosts in caves, lava tubes, mines, old buildings, and bridges.	**Unlikely.** Suitable roosting habitat appears to be absent from Project area; some potential to occur as a rare visitor; has not been documented as occurring in the southern Columbia Basin (WDFW 2012c).
Townsend's ground squirrel *Urocitellus townsendii townsendii*	SC, PS	Inhabits shrub-steppe, native grasslands, pastures, orchards, vineyards, highway margins, vacant lots, and the banks of canals; occurs only in Washington in the Columbia Basin west of the Columbia River, including throughout Benton County.	**Likely.** Known to occur at a number of locations in Project vicinity (WDFW 2017a); suitable habitat appears to be present.
White-tailed jackrabbit *Lepus townsendii*	SC	Occurs in open, grassy, or sagebrush plains; where the range of the two jackrabbits species overlaps, white-tailed jackrabbits tends to be more common in bunchgrass habitats with less shrub cover (WDFW 2012d).	**Possible.** Suitable habitat appears to be present; however, known to be rare in Project area (WDFW pers. comm.).
Reptiles			
Sagebrush lizard *Sceloporus graciosus*	SC	Associated with vegetated sand dunes and sandy habitats that support shrubs and have large areas of bare ground (WDFW 2012).	**Possible.** Project falls within species' range and suitable sandy habitat may be present within Project area.
Striped whipsnake *Masticophis taeniatus*	SC	Inhabits shrub-steppe habitats within the driest portions of the central Columbia Basin (WDFW 2012b).	**Possible.** Historical records for the species in Benton County (WDFW 2012b); suitable habitat may be present within the Project.

SE: state-listed endangered species; ST: state-listed threatened species; SC: state candidate species for listing; PS: state priority species; BGEPA: species protected under the Bald and Golden Eagle Protection Act (BGEPA 1940)

Species status from WDFW (2017b)

Birds

Bird Migration

The Project is located within the Pacific Flyway and numerous birds likely migrate across the landscape. The Project contains stopover habitat (i.e., habitat where migratory species may stop to rest, drink, and refuel) for raptors, songbirds, waterfowl, and shorebirds in the form of cropland and grazed shrubland with much smaller areas of grassland and wetland habitat. In general, high-quality stopover habitat such as riparian/wetland habitat, forest, and native shrub-steppe is absent from Project area. Based on USFWS NWI data there are approximately 280 ac of wetland habitat in the Project area, the majority of which is present within shallow canyons bisecting the Project's agricultural lands. There is some potential for migrating waterfowl, shorebirds, and waterbirds to use these areas seasonally, as well as flooded agricultural fields, as stopover habitats; however, given the limited amount of such habitat, use is not expected to be substantial.

Several factors influence the migratory paths of raptors; one of the most significant influences is geography. Ridgelines and the shorelines of large bodies of water are used by migrating raptors because they provide conditions necessary for energy-efficient travel over long distances (Liguori 2005) and serve as navigational aids. For these reasons, raptors tend to follow corridors or pathways along prominent ridges with defined edges or along shorelines during migration. While higher, north-south trending ridgelines are generally west of the Project area, there is some potential for escarpments along the Columbia River corridor to be used by both resident and migrating raptors. The Columbia River bends around the Project area and, at its closest point, lies adjacent to the eastern boundary of the Project (Figure 1). There is potential for raptors and other species such as waterfowl to use the river as a navigational aid during migration, and trees and associated habitats along the river likely provide perch sites and foraging areas for raptors and other species during migration. Additionally, portions of the Columbia River to the east and south of the Project have been identified as supporting concentrations of waterfowl (WDFW 2017a).

Passerines are by far the most abundant bird group in most terrestrial ecosystems and are the most commonly reported fatalities at wind energy facilities (NRC 2007). In inland areas, it is generally assumed that nocturnal migrating passerines move in broad fronts rather than along specific topographical features (Gauthreaux et al. 2003, NRC 2007). Many species of songbirds migrate at night and may collide with tall man-made structures, though no large mortality events on the scale of those observed at communication towers (National Wind Coordinating Committee [NWCC] 2004) have been documented at wind energy facilities in North America. Large numbers of passerines have collided with lighted communication towers and buildings when foggy conditions and spring or fall migration coincide. Birds appear to become confused by structural lighting during foggy or low-ceiling conditions and fly in circles around lighted structures until they become exhausted or collide with the structure (Erickson et al. 2001a). Most collisions at communication towers are attributed to the guy wires on these structures. At the adjacent Nine Canyon wind energy facility, a nocturnal migration radar study was conducted in fall 2000 and spring 2001 (Mabee and Cooper 2000, Erickson et al. 2001b). Results of the study indicated that approximately 86% of targets passing over the project area flew at altitudes above the maximum proposed turbine height of 80 m (262 ft). Nocturnal migration studies at the Stateline and Vansycle wind energy facilities, approximately four and 15 mi (6.4 and 24.1 km) to the southeast of the Project, respectively, revealed similar mean flight altitudes (Mabee and Cooper 2004).

Avian collision fatality data from studies conducted at 30 wind energy facilities across North America were examined to estimate how many night migrants collide with turbines and towers and how aviation obstruction lighting relates to collision fatalities (Kerlinger et al. 2010). Fatality rates, adjusted for scavenging and searcher efficiency, of nighttime migrants at turbines 54 to 125 m (117 to 410 ft) in height ranged from less than one bird/turbine/year to approximately seven birds/turbine/year, with generally higher rates recorded in eastern North America and lower rates in the West. Multi-bird fatality events (defined as more than three birds killed in one night at a single turbine) were extremely rare and were not related to turbine lighting. The largest mortality events attributed to turbines at US wind energy facilities to date include 14 migrant songbirds found at two turbines during spring migration at Buffalo Ridge, Minnesota (Johnson et al. 2002), and 27 migrants at the Mountaineer facility in West Virginia (Kerns and Kerlinger 2004). The West Virginia mortalities apparently occurred during inclement weather and the fatalities occurred at a turbine near a heavily lit substation. Most migrant songbird casualties recorded during systematic carcass searches at turbines have been a single fatality found during a single search (Erickson et al. 2001a). Furthermore, no significant differences were detected when comparing songbird mortality at lit and unlit turbines. From this research, red flashing Federal Aviation Administration (FAA) lighting on turbines does not appear to be an attractant to nocturnal migrants and turbines appear to be at heights below typical migration flight elevations.

In the Pacific Northwest region of the US (i.e., Oregon and Washington), overall bird fatality rates at wind energy facilities have ranged from 0.16 birds/MW/year at the Marengo II facility in Columbia County, Washington to 8.45 birds/MW/year at the Windy Flats facility in Klickitat County, Washington (URS Corporation 2010b, Enz et al. 2011). During a one-year fatality monitoring study at the adjacent Nine Canyon facility, the overall bird fatality rate was estimated to be 3.59 bird fatalities/turbine/year or 2.76 birds/MW/year (Erickson et al. 2003). During the study, 36 bird fatalities (28 small birds and eight large birds) representing 13 species were found at turbine search plots during the study. The species most commonly found as fatalities were horned lark (*Eremophila alpestris*; 36 fatalities) and ring-necked pheasant (*Phasianus colchius*; five fatalities). Of the 36 bird fatalities reported during the study, 28 were passerine species with only six classified as nocturnal migrants (Erickson et al. 2003). During three years of fatality monitoring at the Stateline facility just over the river to the southeast, overall bird fatality rates were similar, ranging from 1.23 to 3.17 bird fatalities/MW/year (Erickson et al. 2004, 2007).

Important Bird Areas

The Audubon Society has identified Important Bird Areas (IBAs) throughout the Western Hemisphere that provide essential habitat for birds (Audubon 2017). These IBAs include sites for breeding, wintering, and migrating birds and can range from only a few acres to thousands of acres in size. There are three recognized IBAs within 20 miles (32.2 km) of the Project: the Walla Walla River Delta to the east, the Yakima River Delta to the north, and the Umatilla to the southeast (Figure 7). While these IBAs are all more than two mi from the Project, given the location of the IBAs, birds moving between these areas have the potential to pass through or near the Project. Each IBA is described briefly below.

The Walla Walla River Delta, located at the confluence of the Walla Walla and Columbia Rivers, just two mi (3.2 km) east of the Project (Figure 7), comprises two broad mudflats and associated marshes which are part of the NcNary National Wildlife Refuge. The IBA is located just north of the Wallula Gap which is considered a flight corridor for many migratory birds (Audubon 2017). The delta supports large number of pelicans, waterfowl, shorebirds, and gulls, as well as an extraordinarily high population of Vaux’s swifts during fall migration (Audubon 2017).

The Yakima River Delta IBA, located approximately 10 mi (16.1 km) to the north of the Project (Figure 7), is centered on the confluence of the Yakima and Columbia Rivers. The IBA includes open freshwater, marsh, mudflat, and sand and gravel shore, supporting five species of state or federal listed or candidate species, up to 12 species of raptors, as well as many species of waterfowl, shorebirds and other water-dependent species. The site is also important for its riparian forests lining the river which provide perches for eagles, cormorants, herons, and kingfishers (Audubon 2017).

The Umatilla IBA, located about 17 miles (27.4 km) to the southwest of the Project (Figure 7), is comprised of the Umatilla National Wildlife Refuge. This IBA includes a varied mix of habitat including open water, sloughs, shallow marsh, seasonal wetlands, cropland, islands, and shrub-steppe. The IBA is vital to migrating waterfowl, bald eagles, colonial nesting birds and other migratory and resident wildlife in an area where wetlands and other natural habitats are otherwise scarce (Audubon 2017).

US Fish and Wildlife Service Birds of Conservation Concern

The USFWS lists 28 species as birds of conservation concern (BCC) within the Great Basin Bird Conservation Region (BCR), within which the Project is located (USFWS 2008). These species have been identified as vulnerable to population declines in the area by the USFWS (2008). Several species are also State and/or federal listed or candidate species or state priority species (e.g., ferruginous hawk, golden eagle, loggerhead shrike, sage thrasher, sagebrush sparrow) and are discussed in greater detail in the listed species section above. Although some of these BCC species may use habitats in the Project vicinity during migration or nesting (e.g., wetlands, shrub-steppe habitat), the majority of the Project area is comprised of agricultural lands with limited ecological value to most BCCs in the region.

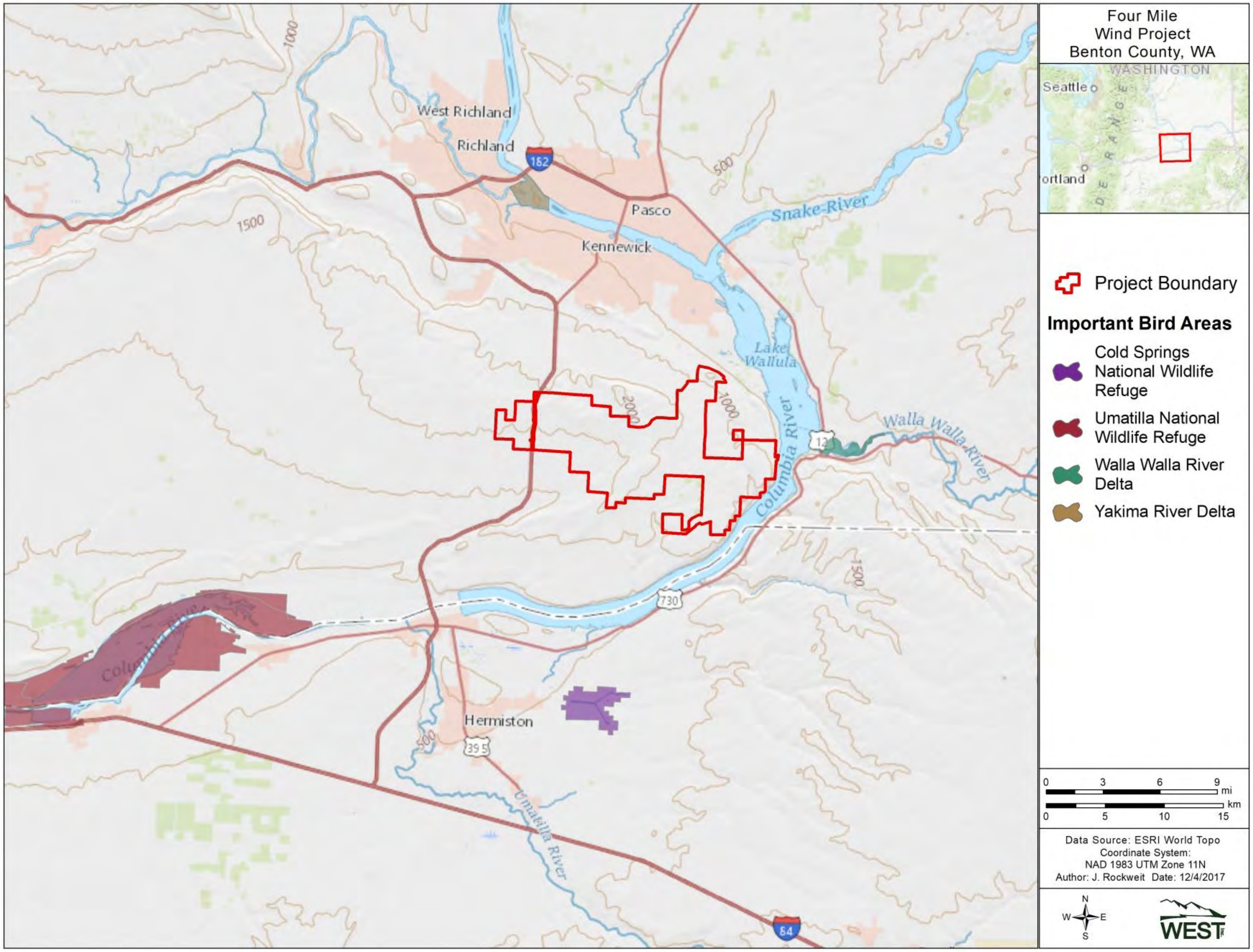

Figure 7. Location of Important Bird Areas occurring in the vicinity of the Four Mile Wind Project, Benton County, Washington.

Raptors

Diurnal raptors occur in most areas with the potential for wind energy development and have shown susceptibility to the potentially adverse impact of wind energy development (NRC 2007). Fifteen diurnal raptor species and seven owl species have at least some potential to occur within the Project area for at least part of the year. Of these, eight species are likely to breed within the Project or surrounding area and likely occur regularly within the Project: northern harrier (*Circus cyaneus*), Swainson's hawk (*Buteo swainsoni*), red-tailed hawk (*B. jamaicensis*), ferruginous hawk, American kestrel (*Falco sparverius*), barn owl (*Tyto alba*), great-horned owl (*Bubo virginianus*), and burrowing owl. One additional species, rough-legged hawk (*B. lagopus*) is a common winter resident of the area. Eight species are considered uncommon permanent residents and/or breeders in the region; however, suitable nesting and foraging habitat is generally absent from the Project area and these species are likely to occur only as uncommon to rare visitors to the Project: osprey (*Pandion haliaetus*), golden eagle, bald eagle, peregrine falcon (*F. peregrinus*), prairie falcon (*F. mexicanus*), long-eared owl (*Asio otus*), short-eared owl (*A. flammeus*), and western screech owl (*Megascops kennicottii*). Five additional species may occur during migration or as uncommon winter residents in the region: sharp-shinned hawk (*Accipiter striatus*), Cooper's hawk (*A. cooperii*), northern goshawk (*A. gentilis*), merlin (*F. columbarius*), and snowy owl (*B. scandiacus*). Of the raptor species potentially occurring within the Project, one is State threatened (ferruginous hawk), two are State candidates for listing (golden eagle and burrowing owl), and four species are considered WDFW Priority Species (bald eagle, burrowing owl, ferruginous hawk, and prairie falcon; WDFW 2017b).

Based on fatality monitoring studies conducted at 29 operating wind energy facilities in the Pacific Northwest with publically available data, diurnal raptor fatality rates have ranged from zero to 0.47 raptors/MW/year (Young et al. 2006, Erickson et al. 2000, Johnson et al. 2003, URS Corporation 2010, Enk et al. 2010, Gritski and Kronner 2010, Downes and Gritski 2012). During a one-year fatality monitoring study at the adjacent Nine Canyon facility in 2002-2003, only two raptors (one American kestrel and one short-eared owl) were found within search plots resulting in an estimated raptor fatality rate of 0.05 raptors/MW/year (Erickson et al. 2003). At the nearby Stateline wind energy facility, annual diurnal raptor fatality rates were estimated to range from 0.09 to 0.11 raptors/MW/year, based on three years of monitoring (Erickson et al. 2004, 2007). Raptor species (including owls) found as fatalities at Stateline consisted of 11 red-tailed hawks, seven American kestrels, two ferruginous hawks, one Swainson's hawk, one barn owl, and one short-eared owl (Erickson et al. 2004, 2007). To date, the most common raptor species documented during fatality searches conducted at wind energy facilities in the Pacific Northwest have been American kestrels and red-tailed hawks (WEST, unpublished database). Based on publically available reports compiled by WEST (WEST, unpublished database), only five ferruginous hawk fatalities and one burrowing owl fatality have been reported in Washington and Oregon.

<u>Eagles</u>

Both bald and golden eagles are protected under the Bald and Golden Eagle Protection Act (BGEPA; 1940), and in Washington, the golden eagle is a state candidate for listing (WDFW

2017b). Currently, the relative level of eagle use of the Project area is unknown, though both bald and golden eagles are known to occur in the region. While nesting habitat for both species is absent from the Project area, both species may forage throughout the site, particularly during winter or migration seasons. The golden eagle is considered an uncommon year-round resident of the Columbia Plateau (Seattle Audubon Society [SAS] 2017). Based on statewide golden eagle nest surveys conducted in 2013, 158 breeding pairs of golden eagles are estimated in the state (Hayes 2013). The majority of nesting territories in the state occurred in Okanogan County and the Columbia Plateau ecoregion; however, WDFW reported no known nest sites in Benton County (Hayes 2013).

Alternatively, the bald eagle is considered a fairly common resident of the Columbia Plateau in winter, but only occurs rarely in summer (SAS 2017). As of 2015, the total number of known bald eagle territories in the state was 1,334, with the number of nests increasing annually each year since 2005 (Kalasz and Buchanan 2016). Bald eagles typically nest near large bodies of water, such as lakes or larger rivers; however, they also require trees that are sufficiently large and have the branch structure necessary to support an eagle nest. Based on data from the Washington Survey Data Management database, historical bald eagle nesting territories are located along the Columbia River, approximately three and 12 miles (4.8 and 19.3 km) to the east and northwest of the Project, respectively (Kalasz and Buchanan 2016). Nest sites and breeding season foraging habitat for bald eagles are absent from the Project; however, due to the proximity of the eastern boundary of the Project are to the Columbia River and a historical bald eagle nesting territory, there is at least some potential for bald eagles to use the Project during the breeding season. Bald eagles are more likely to occur in the Project during the winter, potentially foraging on carrion once their primary prey (fish) becomes more scarce (Kalasz and Buchanan 2016).

For reasons not well-understood, golden eagles are known to have a higher susceptibility to collisions with wind turbine rotors than are bald eagles (Allison 2012). A small number of wind projects in five western states, all located within high-quality golden eagle breeding habitat, have produced substantially larger numbers of golden eagle fatalities, with fatality rate estimates as high as 15-70 golden eagles per year (Allison 2012). Nonetheless, most wind energy facilities that have been constructed within the golden eagle's geographic range, including all wind energy projects that have been constructed outside of golden eagle breeding habitat, have resulted in very small numbers of recorded fatalities (zero to three total per project; Allison 2012). Within the Pacific Northwest region of the US (i.e., Washington and Oregon), six golden eagle fatalities have been reported in publicly available reports from four different wind energy facilities (URS 2010, Enk et al. 2011, Enz and Bay 2012, Enz et al. 2012). To date, no bald eagle fatalities have been reported in publicly available reports at facilities in the Pacific Northwest (WEST, unpublished database). Over the course of a year-long pre-construction avian use study conducted at the adjacent Nine Canyon wind energy facility, only one golden eagle and one unidentified eagle were observed (Erickson et al. 2002). No eagle fatalities were documented during a one-year post-construction fatality monitoring study at the Nine Canyon facility (Erickson et al. 2003). While the publicly available data suggests eagle mortality at wind energy facilities in the Pacific Northwest may be relatively low, publicly available data is limited to relatively short fatality monitoring studies (1-2 years typically) at projects that have in many cases been operational for less than 10 years.

Year round eagle/large bird use surveys, consistent with the USFWS ECPG (USFWS 2013) and WEG (USFWS 2012), will help estimate use of the Project area by eagles and other raptor species.

Potential Raptor Nesting Habitat

Limited nesting habitat is available for raptors within the Project area. Scattered isolated trees, primarily associated with current or abandoned farmsteads, are present throughout the Project and may provide nest sites for red-tailed hawks, Swainson's hawks, and great-horned owls. Grasslands, pasture and cropland may provide habitat for ground-nesting burrowing owls and northern harriers. Cliffs, bluffs, and cut banks, though generally absent from Project area, are present in the surrounding region and likely provide nest sites for ferruginous hawks and barn owls. Riparian forest habitat along the Columbia River likely supports the highest density of nesting raptors within several miles of the Project.

A raptor nest survey, including surveys for bald and golden eagle nests within a 10-mile radius of the Project area, and surveys for all raptor nests within two miles of the Project area, would help evaluate potential impacts to nesting raptors from the construction and operation of the Project.

Areas of Potentially High Prey Density

Small- and medium-sized mammals comprise the primary prey base for many raptor species, although birds and insects may also contribute to the diet of many raptor species. Large aggregations of prey species (e.g., prairie dog colonies) are not present in the Project area; however there are a number of other rodent (e.g., ground squirrels and chipmunks), lagomorphs (e.g., black-tailed jackrabbit), and passerines (i.e., songbirds), particularly those associated with agricultural lands, that are likely to occur throughout the Project. Rodents may be most concentrated along field edges and roads (Preston 1990, Rosenzweit 1989). Waterfowl and waterbirds are also potential prey for eagles and other large raptors; however, perennial and ephemeral water sources in and near the Project area are limited. Flooded agricultural fields may provide foraging opportunities for large raptors during wet periods, and grain fields may attract small mammals which in turn may attract foraging raptors. Larger streams, rivers and lakes which provide fish for raptors such as bald eagles and osprey are absent from the Project; however, the Columbia River lies immediately to the east of the Project.

Bats

Due to the lack of full understanding of bat populations in North America, species and relative abundance of bats occurring within the Project area are difficult to determine. Based on range maps and species accounts from BCI (2017), 16 species of bat are known to occur in Washington, with eight species having an approximate range and habitat requirements that include the Project area: pallid bat (*Antrozous pallidus*), big brown bat (*Eptesicus fuscus*), silver-haired bat (*Lasionycteris noctivagans*), hoary bat (*Lasiurus cinereus*), California bat (*Myotis* *californicus*), little brown bat (*M. lucifugus*), dark-nosed small-footed myotis (*M. melanorhinus*), and canyon bat (*Parastrellus hesperus*). While roosting habitat for the majority of bat species is generally absent from the Project area, each of the species listed above have the potential to forage within, or migrate through, the Project area. The only listed or candidate bat species in Washington are Townsend's big-eared bat and Keen's myotis (*M. keenii*), both of which are state candidates for listing (WDFW 2017); however, Keen's myotis occupy only the extreme northwestern corner of the state and Townsend's big-eared bats are unlikely to occur within the Project due to a general lack of roosting and hibernating sites.

Studies conducted at wind energy facilities have documented use of areas within and around these facilities by resident or breeding bats during the summer reproductive period; however, these species are rarely found as casualties at turbines (Johnson 2005). To date, most bat casualties at wind energy facilities in the Columbia Plateau have been migratory species (e.g., hoary and silver-haired bats; Johnson and Erickson 2011), which conduct relatively long fall migrations between summer roosts and wintering areas. For unknown reasons, bat mortality rates are disproportionately high during the fall. However, it may be that tree-roosting bats fly at lower altitudes above ground level (AGL) during spring migration than during fall migration. For example, hoary bats fly one to five m (three to 16 ft) above the ground while migrating through New Mexico in the spring, but apparently not in the fall (Cryan and Veilleux 2007). Similarly, a hoary bat collided with an aircraft above Oklahoma at an altitude of 8,000 ft (2,438 m) in October of 2001 (Peurach 2003), which may support the theory that bats generally fly at higher altitudes in the fall.

In the Pacific Northwest, bat fatality rates at wind energy facilities have varied widely, ranging from 0.12 bats/MW/year at the Kittitas Valley facility in Kittitas County, Washington (Stantec 2012) to 4.23 bats/MW/year at the Palouse facility in Whitman County, Washington (Stantec 2013). During the one-year post-construction fatality monitoring study at the adjacent Nine Canyon facility, the bat fatality rate was estimated at 2.47 bats/MW/year (Erickson et al. 2003), which falls near the middle of the range of fatality rates for the Pacific Northwest. Similarly, at the nearby Stateline facility, bat fatalities rates have ranged from 0.95 to 2.29 bats/MW/year (Erickson et al. 2004, 2007). Consistent with the results from other studies in the Pacific Northwest and across the county, 20 of the 27 total bat fatalities (74%) documented at Nine Canyon, were found during the late summer/early fall period and all 27 fatalities comprised just two species: silver-haired bat and hoary bat (Erickson et al. 2003). At Stateline, Silver-haired and hoary bats comprised nearly 96% of bat fatalities (Erickson et al. 2004, 2007).

SUMMARY

Table 4 summarizes key wildlife considerations for the Project. Of the wildlife species protected by or under review through the federal ESA, none have the potential to occur within the Project area. Three species with state threatened or endangered status have at least some potential to occur in the Project area including: American white pelican, ferruginous hawk, and sandhill crane. An additional 12 species designated as state candidates for listing also have potential to occur within the Project including six birds, four mammals, and two reptiles. Both the golden and bald eagle, afforded additional protection under the federal BGEPA, have the potential to occur within the area. No state and/or federal special-status plant species are known to occur within five mi of the Project; however, one rare/high quality plant community has been documented approximately a mile north of the Project, and several WDFW Priority Habitats or Habitat Features are known to occur within several miles of the Project. Due to the current land use within the Project, the likelihood of special status plants and rare/high quality plant communities and habitats occurring within the Project area is low due to the current predominant land use; though some remnant patches of native shrub-steppe habitat may be present, particularly within the eastern portion of the Project.

Fifteen diurnal raptor species and seven owl species have the potential to occur as residents and/or migrants in the Project area at some point during the year. Nesting habitat within the Project is limited to scattered, isolated trees and pasture/cropland (for ground-nesting raptors), but is more abundant in the surrounding landscape in trees and along cliffs, and cut banks.

The Project area is located within the Pacific Flyway and numerous birds likely migrate through the region. The Project area is characterized by rolling hills that generally would not be expected to concentrate or funnel raptors during migration; however, escarpments along the Yakima and Columbia Rivers located to the north and east of the Project may receive higher use by both resident and migrating raptors. Additionally, trees and riparian habitats associated with the rivers likely provide perch sites and foraging habitat for migrating raptors, waterfowl, and other species. Portions of the Columbia River within several miles of the Project have been designated by the WDFW as waterfowl concentration areas. Stopover habitat for songbirds, waterfowl, and shorebirds in the form of cropland/pasture and smaller amounts of shrubland is present with the Project area; however, these areas are generally not considered high-quality stopover habitat and are abundant across the landscape.

Relatively high bat mortality at other wind energy facilities in North America is a concern, and some species that appear to be at greatest risk, such as hoary and silver-haired bats, are likely to occur in the Project area, particularly during fall migration. At least eight bat species have the potential to occur within the Project area at some time during the year. While roosting habitat is generally lacking within the Project area for most of these species, the Project's pastures, croplands, shrublands, and limited riparian/wetland habitat may provide foraging and drinking habitat for some resident bat species.

Table 4. Summary of the potential for wildlife and plant conflicts in the proposed Four Mile Wind Project[1]; VH = Very High, H = High, M = Moderate, and L = Low

Issue	VH	H	M	L	Notes
Raptor nest sites			✓		Limited habitat for nesting raptors in Project area; higher potential for nesting in canyons and cliffs to north and east of the Project; potential for ferruginous hawk and burrowing owl nests (state listed/candidate species). Historical bald eagle nest approximately three miles east of Project.
Concentrated raptor flight areas			✓		A number of raptors are likely to use the Project area. Columbia River just east of Project may concentrate raptors during migration; escarpments above river may receive higher raptor use during migration and/or winter.
Avian migratory pathways				✓	Project area located along the Pacific Flyway, but high-quality stopover habitat generally absent; extensive riparian/wetland habitat absent. Potential use by migrating passerines, but not likely used as concentrated migration pathway or stopover area.
Raptor prey species			✓		Potential for rodents, lagomorphs, and prey bird species to occur within Project area, but not likely in high concentrations.
Federal protected wildlife species				✓	No federal listed, candidate, or under review species currently have the potential to occur within the Project; both bald and golden eagles, protected under the federal BGEPA have the potential to occur.
State protected wildlife species		✓			Sixteen state-listed or candidate species have at least some potential to occur.
Uniqueness of habitat				✓	Habitat and land use within the Project area is predominately agricultural. Four WDFW Priority Habitats/Habitat Features and one WNHP rare/high quality plant community is found in Project vicinity. Three IBAs are within 20 miles of Project.
Rare plants/ecosystems				✓	No state and/or federal special-status plant species known to occur within 5 miles of the Project area; one rare/high quality plant community known to occur in region.
Bats			✓		At least eight bat species have at least some potential to occur within the Project area, one of which is a state candidate for listing. Bat species that have shown relatively high levels of fatalities at wind energy facilities are likely to be present.

[1]Summarized for the Four Mile Wind Project as a whole but the habitat of the Project area varies in its ability to support species of concern.

USFWS Land-Based Wind Energy Guidelines Tier 2 Questions

Chapter 3 of the USFWS WEG (2012) includes seven Tier 2 questions which should be addressed during site characterization efforts. A contextual review of these questions after synthesis of a SCS report may help identify areas where existing data do not sufficiently address potential impacts to biological resources which may occur through development of a wind energy facility, and should serve to guide formulation of project-specific Tier 3 study plans intended to fill data gaps. This Four Mile SCS attempts to answer the Tier 2 questions through a desktop review of publicly available information. However, some data gaps remain; recommended field studies intended to fill data gaps are included in the following section (Conclusion and Next Steps). It is also useful to consider the seven Tier 2 questions individually in the context of this SCS; although the previous Summary section includes much pertinent information, it does not specifically relate SCS report findings to Tier 2 questions. The following list describes how this report has addressed specific Tier 2 questions, where information related to these questions can be found in this report, and what if any data gaps remain:

1. Are known species of concern present on the proposed site, or is habitat (including designated critical habitat) present for these species?

   No federal listed wildlife species have the potential to occur within the Project and no designated critical habitat is present within the Project or surrounding area. Sixteen State listed or candidate species (10 birds, four mammals, and two reptiles) have at least some potential for occurrence in the Project (see Listed Species section). No State and/or federal special-status plant species are known to occur within five mi of the Project. Tier 3 field studies will help confirm presence or absence of many of these species (see Conclusion and Next Steps section).

2. Does the landscape contain areas where development is precluded by law or designated as sensitive according to scientifically credible information?

   A desktop review of publicly available information did not reveal any areas on the landscape where development is precluded by law. Four WDFW Priority Habitats are known to occur within 2 miles of the Project: emergent wetland, forest/shrub wetland, shrub-steppe and cliffs/bluffs. Tier 3 field studies will help determine the presence or absence of any sensitive areas in the Project (see Conclusion and Next Steps section).

3. Are there plant communities of concern present or likely to be present at the site?

   No State and/or federal special-status plant species are known to occur within five mi of the Project. One rare/high quality plant community is known to occur approximately one mile north of the Project (see Rare Plants and Plant Communities section). Tier 3 field studies will help determine the occurrence of plant communities of concern at the Project (see Conclusion and Next Steps section).

4. Are there known critical areas of congregation of species of concern, including, but not limited to: maternity roosts, hibernacula, staging areas, winter ranges, nesting sites, migration stopover or corridors, leks, or other areas of seasonal importance?

   There are no known critical areas of congregation of species of concern within the Project area and desktop analyses do not suggest any are likely to occur. Several portions of the Columbia River, within three miles of the Project, are recognized as *concentrated waterfowl areas. Tier 3 field studies will help determine the presence or absence of critical congregation areas in the Project (see Conclusion and Next Steps section).*

5. Using best available scientific information has the developer or relevant federal, state, tribal, and/or local agency identified the potential presence of a population of a species of habitat fragmentation concern?

   The Project area consists exclusively of private lands managed for crop production and livestock grazing. As such, modern land use of the Project has already led to a fragmented landscape (see Table 1; Figures 3 and 4), and it is unlikely that populations of species with high fragmentation concern are present.

6. Which species of birds and bats, especially those known to be at risk by wind energy facilities, are likely to use the proposed site based on an assessment of site attributes?

   Many species of birds and bats are likely to use the Project area at some point during the year (see Raptors, Bird Migration, and Bats sections). There are 15 diurnal raptor species and seven owls which have the potential to occur within the Project. Of these, eight species may breed within the Project or Project vicinity, including the ferruginous hawk (state threatened) and burrowing owl (state candidate), as well as several other sensitive bird species. Diurnal raptors and some owls are known to be at risk by wind energy facilities. There are at least eight species of bats with the potential to occur in the Project (see Bats section) including both hoary and silver-haired bats, which are known to be at risk by wind energy facilities. Tier 3 field studies will help refine the species present which are known to be at risk from wind energy facilities.

7. Is there a potential for significant adverse impacts to species of concern based on the answers to the questions above, and considering the design of the proposed project?

   While the Project design has not yet been determined, based on the general location of the proposed Project and following a desktop review of publicly available information pertaining to the Project area, the potential for significant adverse impacts to species of concern due to development of the Project appears to be low. However, a number of pre-construction baseline biological studies are recommended in order to properly characterize site-specific wildlife use and evaluate the biotic resources in the Project area (see Conclusion and Next Steps section).

CONCLUSION AND NEXT STEPS

Based on this SCS, the Project does not appear to have a high potential for conflict with the majority of wildlife and plant issues listed in Table 4. Regardless, a number of pre-construction baseline wildlife and botanical studies are recommended for the Project with the purpose of characterizing wildlife use (particularly avian and bat use) within the Project area, estimating impacts of the proposed facility on sensitive wildlife and botanical resources, and to assist with siting turbines to minimize impacts to the extent practicable. Baseline studies recommended at this time are presented in Table 5 and include the following:

- Vegetation and land cover mapping following WDFW habitat classification standards and consistent with the Washington Wind Power Guidelines (WDFW 2009).
- Year round large bird/eagle use surveys consistent with recommendations presented in the USFWS ECPG (USFWS 2013), designed to characterize use of the Project area by large birds, with an added emphasis on bald and golden eagles.
- Small bird use surveys, consistent with recommendations presented in the WEG (USFWS 2012) and the Washington Wind Power Guidelines (WDFW 2009), designed to evaluate small bird use of the Project area.
- Nesting raptor surveys with an emphasis on bald and golden eagles and other sensitive raptor species as recommended in the WEG (USFWS 2012), ECPG (USFWS 2013), and Washington Wind Power Guidelines (WDFW 2009).
- Bat acoustic monitoring at one meteorological tower location during the spring, summer, and fall using methods recommended in the WEG (USFWS 2012) and the Washington Wind Power Guidelines (WDFW 2009).
- Threatened, endangered, and sensitive species (TESS) surveys, inclusive of rare plants, following methods consistent with the Washington Wind Power Guidelines for surveying and evaluating impacts to TESS and natural communities (WDFW 2009).

The large bird/eagle and small bird use surveys listed above should be sufficient to provide a baseline risk assessment for bird species possibly occurring within the Project area and the need for additional studies or more detailed spatial distribution mapping. Early and regular consultation with the USFWS and WDFW is recommended, as it is possible that additional species-specific surveys for sensitive bird, mammal, reptile, or plant species may be encouraged by these agencies. The following Table (Table 5) includes a column for Tier 2 questions. This is intended to highlight how recommended Tier 3 field studies will address information gaps identified during Tier 2 site characterization, and ties directly to information presented in the preceding USFWS Land-Based Wind Energy Guidelines Tier 2 section.

Table 5. Recommended Pre-construction Wildlife and Botanical Studies for the Four Mile Wind Energy Project.

Study	Purpose	Information Gaps Addressed from USFWS Tier 2 Question(s)	Timing
Vegetation/land cover mapping	To identify potentially suitable habitat for state or federal sensitive species and to calculate habitat mitigation ratios resulting from potential habitat disturbance.	Questions 1-3	Spring or summer
Large bird / Eagle use surveys	To assess spatial and temporal use of the Project area by bald and golden eagles and other raptor species	Question 1, Question 4, Question 6, Question 7	Year-round
Small bird use surveys	To assess spatial and temporal avian use of the Project area, with a focus of small bird use	Question 1, Question 4, Question 5, Question 6	Spring and fall migration periods
Nesting raptor surveys	To locate nests that may be subject to disturbance and/or displacement effects from Project construction and/or operation, particularly nests of bald or golden eagles or other sensitive raptor species	Question 1, Question 4, Question 5, Question 6, Question 7	Twice during late winter through early summer breeding season
Bat acoustic surveys	To estimate the level of, and seasonal and spatial patterns of, bat activity within the Project area	Question 1, Question 5, Question 6, Question 7	A continuous spring, summer, and fall survey period
TESS survey	To determine the presence, as well as the spatial distribution, of any state and federal threatened, endangered, or sensitive wildlife or rare plant species.	Question 1, Question 2, Question 3, Question 5, Question 7	Spring and early summer when target species are most readily identified (e.g., nesting or flowering)

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Appendix A. Photographs Taken During Tier 2 Site Visit to the Four Mile Wind Project on December 11-12, 2017

Photo 1. Taken from meteorological (met) tower location (FM1) in eastern portion of Project, looking north.

Photo 2. Taken from met tower location (FM1) in eastern portion of the Project, looking southeast.

Photo 3. Taken from met tower location (FM2) in south-central portion of Project, looking north toward Nine Canyon.

Photo 4. Taken at met tower location (FM2) in south-central portion of Project, looking east.

Photo 5. Taken at met tower location (FM4) in northeastern corner of Project, looking south.

Photo 6. Taken at met tower location (FM4) in northeastern corner of Project, looking north.


Photo 7. Taken from southeastern portion of Project.

ENVIRONMENTAL & STATISTICAL CONSULTANTS

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DATE: November 14, 2018 *Public Draft - For Distribution*

TO: Joseph Wood and Jeffrey Wagner, wpd Wind Projects Inc.

FROM: Andrea Chatfield and Samantha Brown, WEST, Inc.

RE: Results of the 2018 vegetation and land cover mapping for the Four Mile Wind Project Study Area, Benton County, Washington.

INTRODUCTION

Four Mile MW LLC (Four Mile) is proposing to develop the Four Mile Wind Project (Project) in Benton County, Washington. Four Mile contracted Western EcoSystems Technology, Inc. (WEST) to conduct a vegetation and land cover assessment in the area where the Project is proposed. This assessment was performed as recommended in the Washington Department of Fish and Wildlife (WDFW) Wind Power Guidelines (WDFW 2009). The resulting information can be used to identify potentially suitable habitat for sensitive plant and wildlife species, to help guide surveys for sensitive species within development corridors, and for informing mitigation requirements for temporary and permanent impacts to habitat resulting from Project development. This memorandum summarizes the methodology and results of the 2018 vegetation and land cover assessment for the Project.

SITE DESCRIPTION

Regional Setting

The Study Area lies within the semi-arid Columbia Plateau Ecological region, which encompasses a large portion of south central Washington (Washington Biodiversity Council 2008). The Columbia Plateau tilts upward and southward into the Great Basin of eastern Oregon, western Idaho, and northern Nevada, and is bordered by the Cascade Mountains to the west, the Okanogan Highlands to the north, the Palouse Hills to the east, and the Blue Mountains to the southeast. The Columbia and Snake rivers are the dominant topographic features of the Columbia Plateau; in Washington, the Plateau is bisected by the Columbia River. Today, the areas with suitable soil are used for agriculture; crops include wheat (*Triticum* spp.), alfalfa (*Medicago sativa*), potatoes (*Solanum tuberosum*), grass hay, and vineyards. Other areas within the region are used for livestock grazing. In the Yakima Valley to the north and the Columbia Basin to the south, irrigated agriculture is prevalent and includes pastures, orchards, and vineyards. Hops (*Humulus lupulus*) and field crops are also commonly grown. In un-cultivated areas, this ecoregion is characterized by arid sagebrush- (*Artemisia* spp.) steppe and grassland. The regional climate can by typified as arid to semiarid with low precipitation, warm to hot dry summer, and relatively cold winters (Franklin and Dryness 1973). Mean annual temperature in the region is 59° Fahrenheit (15° Celsius), with mean annual precipitation of 10 inches (25 centimeters; Franklin and Dryness 1973, Daly 2000).

Study Area

The proposed Study Area encompasses 35,987 acres (14,563 hectares) of private and state-owned land within Benton County in southeastern Washington, approximately seven miles (11.3 kilometers) south of the city of Kennewick (Figure 1). Topography within the Study Area generally consists of rolling hills bisected by meandering canyons that drain primarily to the south and east into the Columbia River. Elevations range from approximately 630 feet (192 meters [m]) along the northeastern boundary of the Study Area to 2,010 feet (613 m) in the northwest. The eastern boundary of the Study Area lies adjacent to the Columbia River as it bends around the Study Area from the north to the southwest (Figure 1).

The native vegetation of the Study Area consisted of a bluebunch wheatgrass (*Pseudoroegneria spicata*)-Idaho fescue (*Festuca idahoensis*) zonal association, which was predominately grassland and shrub-steppe with deciduous riparian forest and scrub along drainages (Franklin and Dyrness 1973). Today, agriculture and livestock grazing have converted the area to a mosaic of cultivated wheat fields and grasslands managed under the US Department of Agriculture Farm Service Agency's Conservation Reserve Program (CRP), with a few smaller patches of remnant shrub-steppe habitat throughout. In general, shrub-steppe is located in topographically steep area, such as along drainages, where crop cultivation is not possible. A network of county and a few private roads traverse the Study Area.

METHODS

The objective of the 2018 vegetation and land cover assessment was to characterize and map the general vegetation and cover types across the Study Area. Land cover types mapped were consistent with those described by the WDFW (2009) and included the following:

- Shrub-steppe – areas dominated by shrubs less than 16.4 feet (5.0 m) tall;
- Grassland – uncultivated areas with herbaceous vegetation including CRP grasslands;
- Agriculture – cultivated cropland and pasture;
- Developed – urban areas, stand-alone structures/residences/farms, highways, and other disturbed areas.

The above land cover types were initially mapped using aerial imagery and remotely sensed data that included the National Landcover Dataset (USGS 2011) and National Wetland Inventory (USFWS 2018) which were then field-verified by a qualified WEST biologist. Following field-verification, a WEST Geographic Information System (GIS) specialist digitized the final habitat designations to create a vegetation/land cover map of the Study Area.

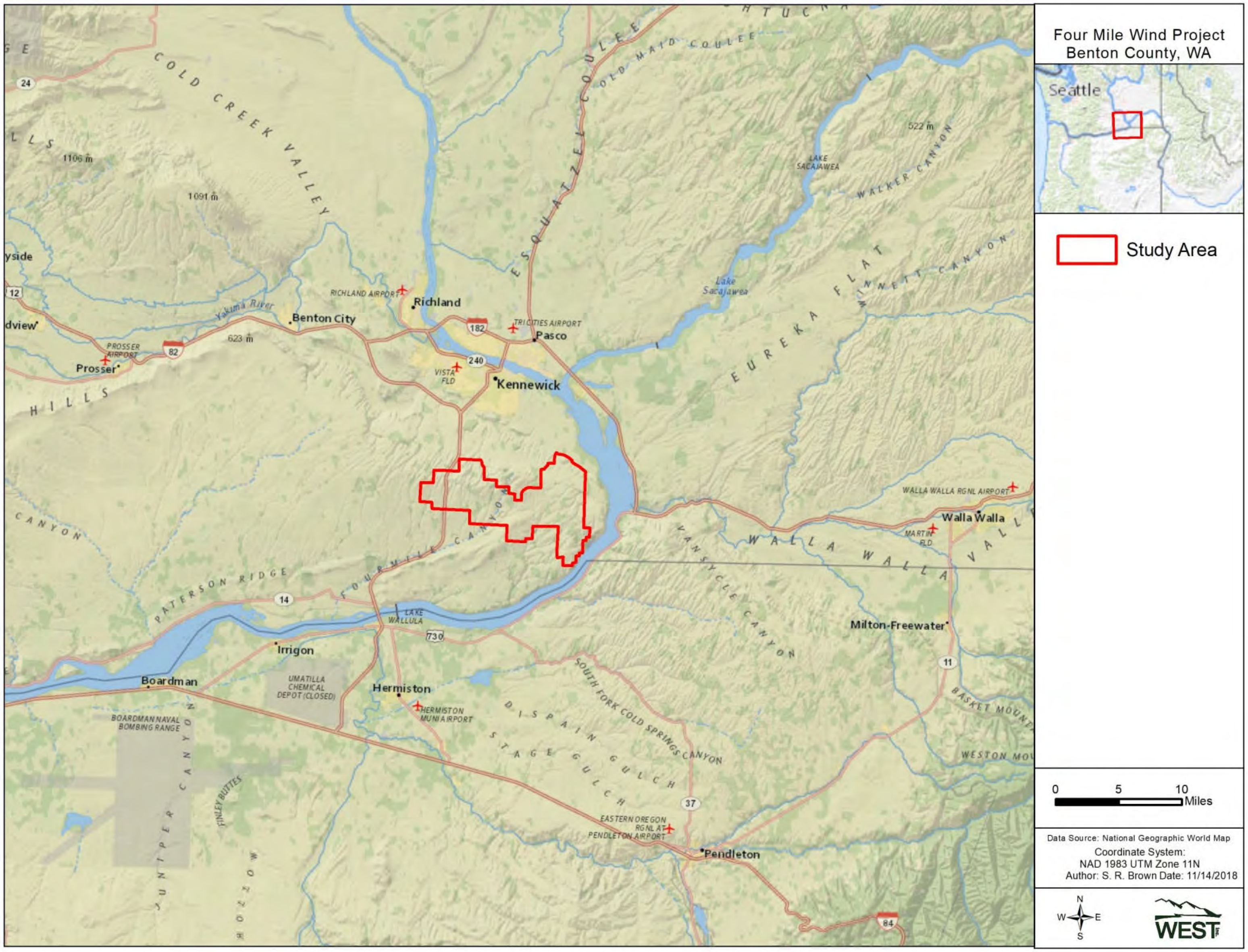

Figure 1. Location of the Four Mile Wind Project, Benton County, Washington.

RESULTS

Based on the mapping effort, four vegetation/land cover types were identified within the Study Area (Table 1). The predominant land cover type was agriculture, encompassing 53.2% of the total Study Area. Agricultural areas within the Study Area were primarily cultivated croplands consisting of dryland wheat, and were more extensive in the central portions of the Study Area. This was followed by grasslands which encompassed a further 29.5% of the Study Area (Table 1; Figure 2). Smaller areas of remnant shrub-steppe (16.5% of the Study Area) were located primarily in the northeast and west of the Study Area (Figure 2). Developed areas, including Highway 82 and individual structures, residences, and farms, were scattered throughout the area and composed the remaining 0.9% of the Study Area (Table 1; Figure 2).

Table 1. Vegetation/land cover types, acreages, and percent coverage within the Four Mile Wind Project Study Area, Benton County, Washington.

Vegetation/Land Cover Type	Total Acres	Percent Coverage
Agriculture	19,130.00	53.2
Grassland/CRP*	10,605.90	29.5
Shrub-Steppe	5,935.85	16.5
Developed	315.27	0.9
Total	**35,987.02**	**100**

*CRP=Conservation Reserve Program lands

Based on the WDFW Wind Power Guidance, no mitigation is required for impacts (temporary or permanent) to agriculture (cropland or pasture) or developed/disturbed areas which are considered Class IV habitats and have generally low value to wildlife and native plants (WDFW 2009). The remaining two land cover types, shrub-steppe and grassland (including CRP lands), are considered Class III habitats requiring a 0.1:1 mitigation ratio for temporary impacts (in addition to restoring the temporarily impacted habitat) and a 1:1 ratio for permanent impacts. Shrub-steppe and grassland vegetation communities provide important breeding and foraging habitat for a number of sensitive wildlife species, and shrub-steppe is classified as a priority habitat in Washington (WDFW 2009). Grasslands within the Study Area are likely classified into one of two categories: 1) areas along the margins of tilled agricultural fields or along drainages which are too steep to be cultivated or 2) parcels that are currently enrolled in the CRP. In general, it is unknown which non-cultivated grassland parcels are CRP lands as this information is not publicly available; however, for the purposes of habitat mitigation, CPR lands and grasslands are functionally similar and are both considered Class III habitats (WDFW 2009).

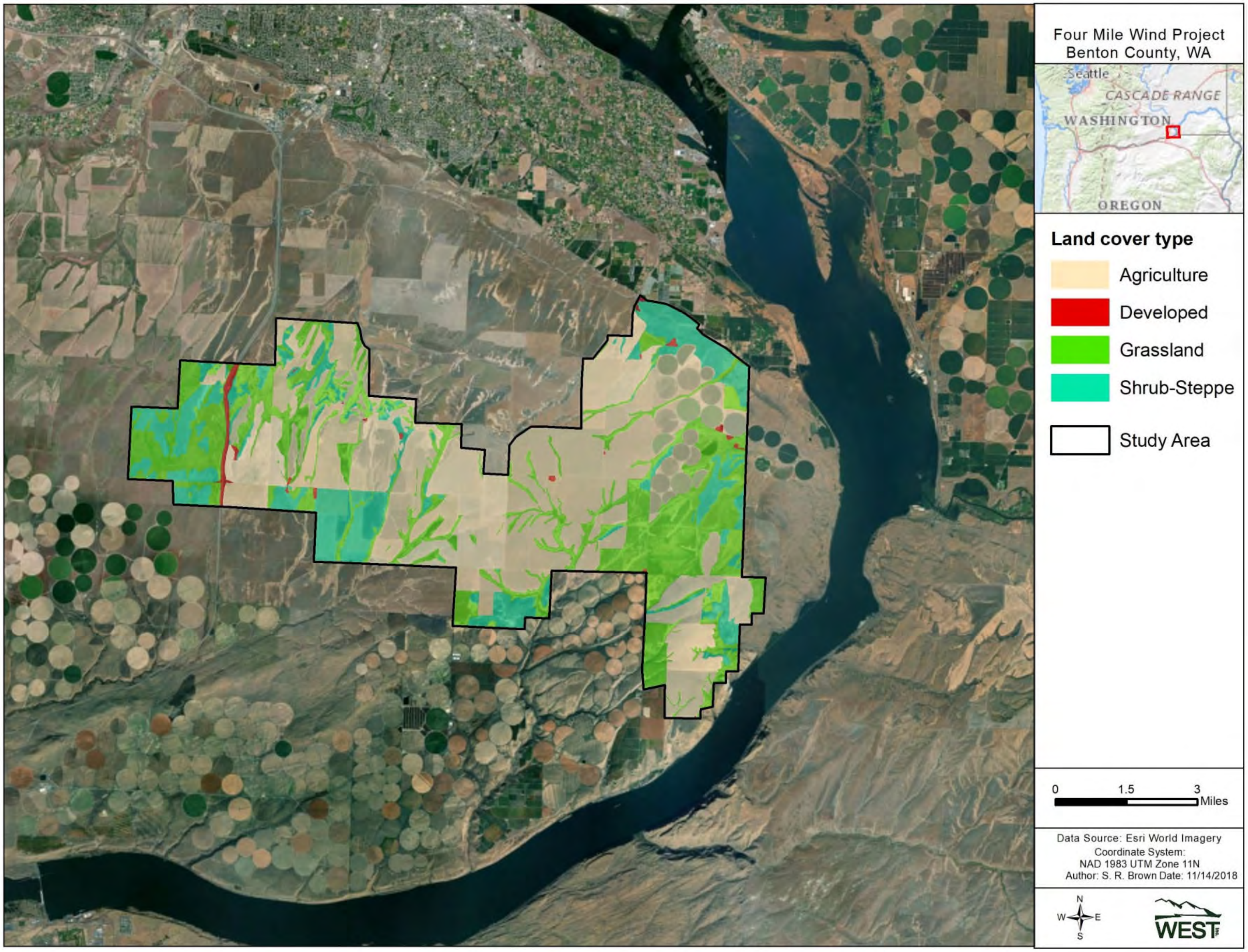

Figure 2. Land cover types mapped within the Four Mile Wind Project Study Area, Benton County, Washington.

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ENVIRONMENTAL & STATISTICAL CONSULTANTS

2725 NW Walnut Boulevard Corvallis, OR 97330
Phone: 307-634-1756 ◆ www.west-inc.com ◆ Fax: 307-637-6981

DATE: October 17, 2018

TO: Joseph Wood and Jeffrey Wagner, wpd Wind Projects Inc.

FROM: Andrea Chatfield and Samantha Brown, WEST, Inc.

RE: Results of the 2018 Townsend's ground squirrel (*Urocitellus townsendii*) habitat assessment for the proposed substation at the Four Mile Wind Project, Benton County, Washington.

Introduction

Four Mile MW LLC (Four Mile) is proposing to develop the Four Mile Wind Project (Project) in Benton County, Washington. Four Mile contracted Western EcoSystems Technology, Inc. (WEST) to conduct a habitat assessment for Townsend's ground squirrel (*Urocitellus townsendii*) within an approximately 25-acre (10.1-hectare) parcel (Study Area) proposed for construction of the Project's substation (Figure 1). This memorandum summarizes the methodology and results of the Townsend's ground squirrel habitat assessment conducted within the Study Area in October 2018.

Status and Natural History

Townsend's ground squirrel (occurring south of the Yakima River) is a candidate for state listing, and is also considered a Priority Species in Washington (WDFW 2018a, 2018b). Townsend's ground squirrel is a ground dwelling species that constructs and utilizes burrows within high desert shrubland and grasslands habitats (NatureServe 2016). The species typically inhabits arid shrub-steppe and native grasslands; however, pastures, orchards, vineyards, highway margins, and vacant city lots are also used (WDFW 2011). Burrows, which are often grouped into large colonies, are used for shelter, protection from predators, and food storage, as well as for hibernation for up to eight months of the year (WDFW 2011). The ground squirrel's diet largely comprises green herbaceous vegetation, including Sandberg's bluegrass (*Poa secunda*), western tansymustard (*Descurainia secunda*), lupine (*Lupinus laxiflorus*), and woollypod milkvetch (*Astragalus purshii*; WDFW 2011). Historically, the Townsend's ground squirrel's range encompassed several states including Washington, Oregon, Idaho, and Nevada but with habitat loss, degradation, and fragmentation, it is estimated that less than 10% of its original habitat remains (NatureServe 2016). Most of the species' geographic range has been converted to agriculture, and much of the remaining shrub-steppe is being degraded by cheatgrass (*Bromus tectorum*) and other exotic annuals. The species is now restricted to the Columbia Basin in Washington, west of the Columbia River (WDFW 2011), and has been documented at a number of locations within several miles of the Project area (WDFW 2018a).

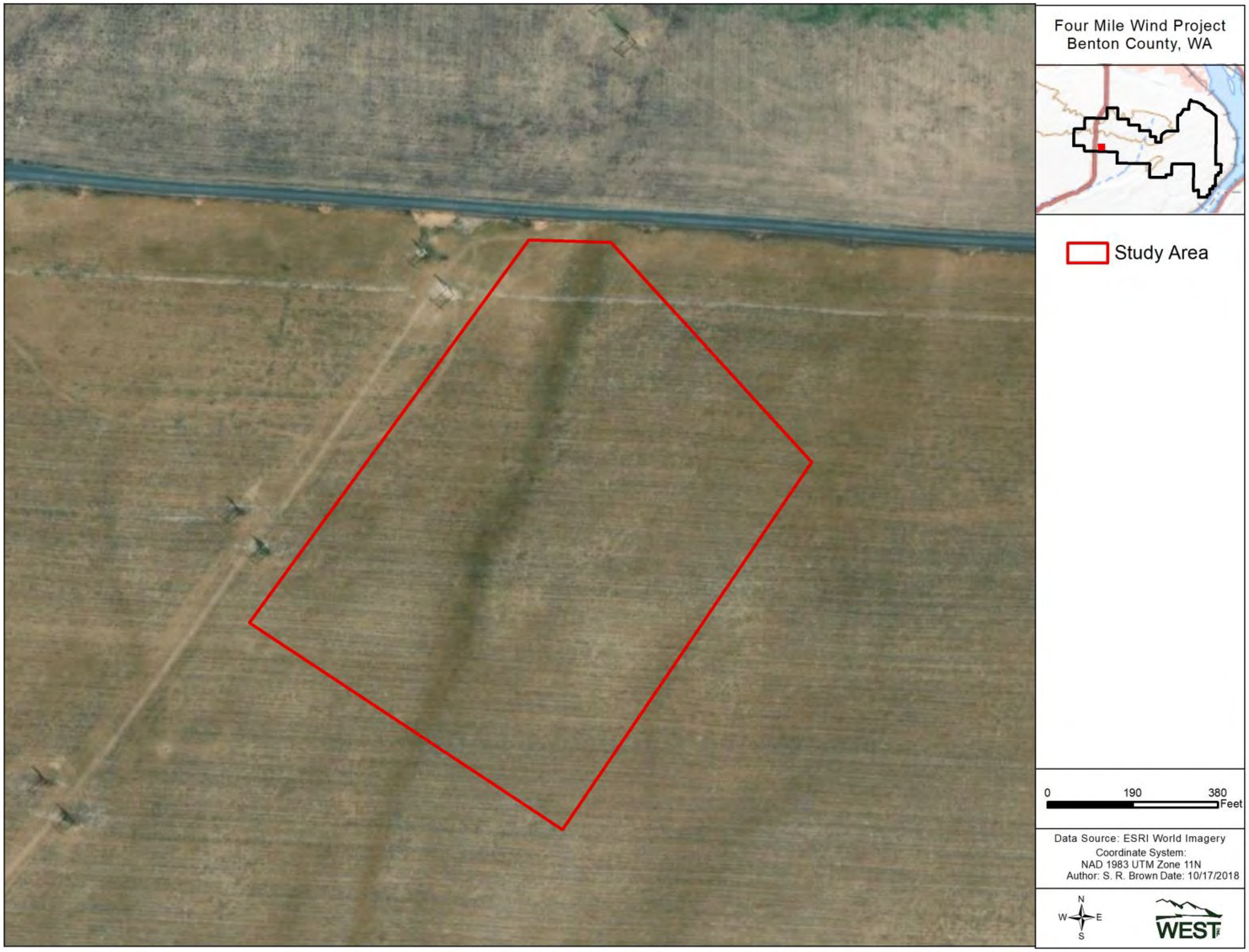

Figure 1. Location of the Study Area evaluated during the 2018 Townsend's ground Squirrel habitat assessment at the Four Mile Wind Project, Benton County, Washington.

Study Area

The Study Area consists of an approximately rectangular 25-acre parcel of privately-owned land in the southwestern portion of larger Project area (Figure 1). The Study Area is located about 50 feet (ft; 15 meters [m]) south of Beck Road and 100 ft (30 m) east of an existing transmission line (Figure 1). Land use within the Study Area is agriculture, consisting entirely of cultivated wheat (*Triticum* spp.) fields (Photo 1). Topography of the Study Area is generally flat with an average elevation of approximately 1,420 ft (433 m).

Methods

The objective of the habitat assessment was to evaluate the Study Area with respect to suitability for Townsend's ground squirrel occupancy, while also surveying the Study Area for any signs of ground squirrel presence. Prior to the field survey, a desktop assessment was conducted using information on modeled suitable habitat and habitat connectivity for Townsend's ground squirrel provided by the Washington Wildlife Habitat Connectivity Working Group (WHCWG; 2012). This was followed by a field survey, conducted on October 4, 2018, by a trained WEST field biologist who surveyed the 20-acre parcel by walking meandering parallel transects spaced approximately 160 ft (50 m) apart throughout the Study Area. While walking the transects, the biologist scanned the surrounding area for signs (burrows, tracks, scat, calls, and visual observations) of Townsend's ground squirrel activity within the Study Area. While the field survey was conducted outside of the species' period of activity above ground (typically February – June), it was assumed ground squirrel burrows with sign of recent use would be evident within the Study Area, if present.

Results

Based on modelling of suitable habitat and connectivity for Townsend's ground squirrel by the WHCWG, the Study Area falls outside of designated Habitat Concentration Areas or areas of connectivity for Townsend's ground squirrel. According to the WHCWG habitat model, the Study Area is classified as having a habitat value of 0-0.25, the lowest habitat value on a scale of 0 (lowest) to 1 (highest; WHCWG 2012). A field survey of the Study Area confirmed this assessment. The entire Study Area, as well as areas immediately surrounding the Study Area, are composed of tilled agricultural lands (Photo 1). Cultivated croplands are not considered suitable habitat for Townsend's ground squirrel, and no signs of Townsend's ground squirrel were observed within the Study Area. Several burrows were recorded within the Study Area but were determined to be too small for ground squirrels and exhibited signs of use by kangaroo rats (*Dipodomys* spp.; Photo 2).

Conclusion

Based on Townsend's ground squirrel habitat modelling, lands within the Study Area provide low-value habitat for the species. During the field survey, no sign of Townsend's ground squirrel was observed during the field survey and suitable shrubland or grassland habitat is not present within, or in areas adjacent to the Study Area. Based on the desktop review and field survey, the species is not expected to occur within the Study Area.

Photo 1. Overview of cultivated wheat field encompassing the entirety of the Study Area.

Photo 2. Active kangaroo rat (*Dipodomys* spp) burrow documented within the Study Area.

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Bat Activity Study for the Badger Canyon Wind Project
Benton County, Washington

Final Report

May 11 – October 29, 2018

Prepared for:

Four Mile MW LLC

205 SE Spokane Street, Suite 300
Portland, Oregon 97202

Prepared by:

Quentin Hays, Samantha Brown, and Andrea Chatfield

Western EcoSystems Technology, Inc.
2725 Northwest Walnut Boulevard
Corvallis, Oregon 97330

November 30, 2018

EXECUTIVE SUMMARY

In May 2018 Western EcoSystems Technology, Inc. (WEST) initiated a bat activity study at the proposed Four Mile Wind Project (Project) in Benton County, Washington. WEST designed bat acoustic surveys at the Project to evaluate levels of bat activity and species' use of the area during the period of expected peak activity (i.e., late spring through fall).

WEST conducted acoustic surveys in the area where the Project is proposed (Study Area) from 11 May through 29 October 2018. Two Wildlife Acoustics SM3 full-spectrum acoustic detectors, each outfitted with two microphones, were deployed at Project meteorological (met) towers in areas representative of future turbine locations. At each detector, one microphone was deployed near the ground, at approximately 5 feet (ft; 1.5 meters [m]), while the other microphone was raised on the met tower to approximately 148 ft (45 m) above ground level. The ground microphone is considered a ground sampling station, while the raised microphone is considered a raised sampling station. Both met towers were located in grassland habitat, which is the dominant land cover type within the Study Area, although sampling stations FM2g and FM2r were in relatively close proximity to cultivated cropland as well as a farm building and associated infrastructure.

During the 335 detector-nights surveyed, the average bat activity rate (± standard error) documented at the ground sampling stations was 1.02 ± 0.11 bat passes per detector-night, while the raised sampling stations recorded an average bat activity rate of 1.15 ± 0.12 bat passes per detector-night. Approximately 93% of bat passes were produced by low-frequency, tree-roosting bats; automated identification of bat calls using Kaleidoscope Pro 4.2.0 determined that silver-haired bats were the most frequently detected species, occurring on approximately 25% of detector-nights. Five high-frequency bat species (California bat, canyon bat, little brown bat, long-legged bat, and western long-eared bat) were detected during the study period. Neither Townsend's big-eared bat nor pallid bat, both of which are Washington state candidate species, were detected during the study. No federal or state-listed bat species were documented.

The overall bat activity rate within the Study Area, averaged between ground sampling stations (FM1g and FM2g; 1.02 bat passes per detector-night), was below the Rocky Mountains regional average of 4.02 bat passes per detector-night, which is the closest region with publicly available activity data; no activity data from the Pacific Northwest is available for comparison. The average fatality rate for the Rocky Mountains region is 4.90 bats/megawatt (MW)/year, significantly higher than the average fatality rate in the Pacific Northwest, which is 1.19 bats/MW/year. If risk patterns at the Project are similar to patterns observed elsewhere in the Pacific Northwest and Rocky Mountains, it is likely that fatality rates at the Project would be similarly low.

STUDY PARTICIPANTS

Western EcoSystems Technology

Andrea Chatfield	Project Manager
Quentin Hays	Lead Biologist
Samantha Brown	Report Compiler
Donald Solick	Bat Biologist
Larisa Bishop-Boros	Bat Biologist/Data Analyst
Samantha Brown	GIS Technician
Casi Lathan	Project Tracking and Data Manager
David Klein	Technical Editing Manager
Katie Wynne	Technical Editing Coordinator
Carissa Goodman	Technical Editor
Joshua Parrott	Field Technician

REPORT REFERENCE

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INTRODUCTION

Western EcoSystems Technology, Inc. (WEST) completed a study of bat activity at the proposed Four Mile Wind Project (Project) in accordance with recommendations in the US Fish and Wildlife Service (USFWS) *Land-Based Wind Energy Guidelines* (USFWS 2012) and the Washington Department of Fish and Wildlife (WDFW) *Wind Power Guidelines* (WDFW 2009). Although it remains unclear whether bat activity patterns in baseline acoustic data predict post-construction fatality risk (Hein et al. 2013a), ultrasonic detectors do collect information on spatial distribution, timing, and species composition that can provide insight into the possible impacts of wind development on bats in a particular area (Kunz et al. 2007a, Britzke et al. 2013) and inform potential collision minimization strategies for a particular project (Weller and Baldwin 2012). WEST conducted acoustic surveys to estimate levels of bat activity and to determine which bat species occur in the area where the Project is proposed (Study Area). The following report describes the results of acoustic surveys conducted within the Study Area from 11 May through 29 October 2018.

STUDY AREA

The Study Area encompasses approximately 35,987 acres (14,563 hectares) of private and state-owned land within Benton County in southeastern Washington, approximately seven miles (11.3 kilometers) south of the city of Kennewick (Figure 1). Topography within the Study Area consists of rolling hills bisected by meandering canyons that drain primarily to the south and east into the Columbia River. Elevations range from approximately 630 feet (ft; 192 meters [m]) along the northeastern boundary of the Study Area to 2,010 ft (613 m) in the northwest. The eastern boundary of the Study Area lies adjacent to the Columbia River as it bends around the Study Area from the north to the southwest.

Land cover within the Study Area primarily consists of wheat associated with dry-land agriculture, with a smaller amount of uncultivated grassland managed as part of the US Department of Agriculture Farm Service Agency's Conservation Reserve Program. Small areas of shrub-steppe are located in topographically steep areas, such as along drainages where cultivation of crops is not possible. A few scattered trees, primarily associated with farms and residences, are distributed throughout the Study Area. These trees, as well as some structures in developed areas, may provide roosting habitat for bats.

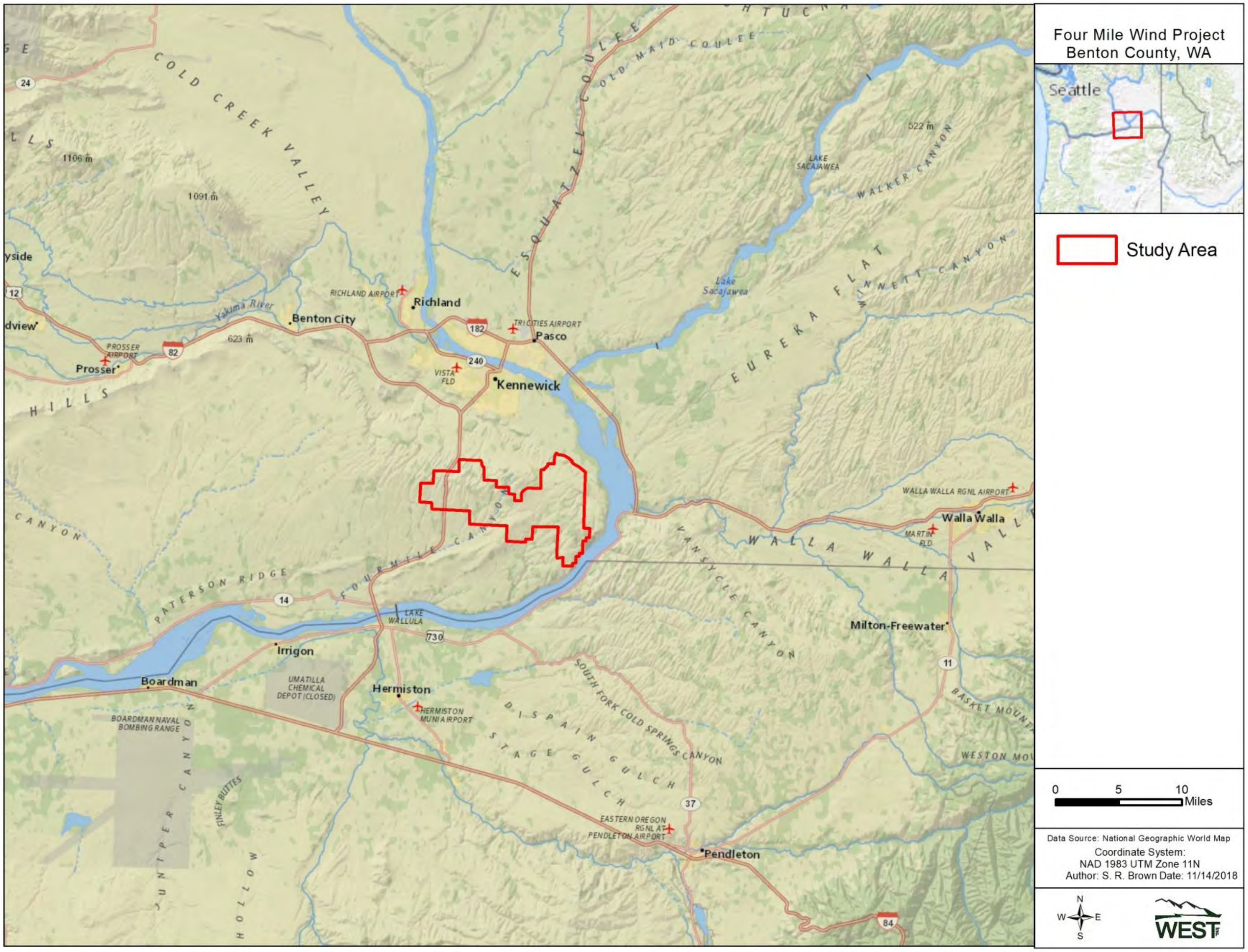

Figure 1. Location of the Four Mile Wind Project Study Area, Benton County, Washington.

Overview of Bat Diversity

Thirteen species of bats potentially occur in the Study Area (Hayes and Wiles 2013, International Union for the Conservation of Nature [IUCN] 2017; Table 1). None of these species are federally listed under the Endangered Species Act of 1973 and none are listed as threatened, endangered, or sensitive by the state of Washington (WDFW 2016). However, the Townsend's big-eared bat (*Corynorhinus townsendii*) and pallid bat (*Antrozous pallidus*), both of which have the potential to occur within the Study Area, are state candidate species (WDFW 2016).

Table 1. Bat species with potential to occur within the Four Mile Wind Project Study Area categorized by echolocation call frequency (International Union for Conservation of Nature [IUCN] 2017).

Common Name	Scientific Name
High-Frequency (> 30 kilohertz [kHz])	
California bat	*Myotis californicus*
canyon bat[1]	*Parastrellus hesperus*
little brown bat[1]	*Myotis lucifugus*
long-legged bat[1]	*Myotis volans*
western long-eared bat[1]	*Myotis evotis*
western small-footed bat[4]	*Myotis ciliolabrum*
Yuma bat	*Myotis yumanensis*
Low-Frequency (15 – 30 kHz)	
big brown bat[1]	*Eptesicus fuscus*
hoary bat[1,2]	*Lasiurus cinereus*
pallid bat[3]	*Antrozous pallidus*
silver-haired bat[1,2]	*Lasionycteris noctivagans*
Townsend's big-eared bat[3]	*Corynorhinus townsendii*
Very Low-Frequency (< 15 kHz)	
spotted bat	*Euderma maculatum*

Source: Hayes and Wiles (2013)
1species known to have been killed at wind energy facilities (species reported by: Anderson et al. 2004, Kunz et al. 2007b, Baerwald 2008, Miller 2008)
2Long-distance migrant
3Washington state candidate species (WDFW 2016)

METHODS

Bat Acoustic Surveys

WEST conducted acoustic surveys to estimate levels of bat activity within the Study Area during the period of known activity for migratory and resident bats in eastern Washington. A Wildlife Acoustics Song Meter (SM3) full-spectrum acoustic detector was deployed at each of two Project meteorological (met) towers on 11 May and documented bat activity within the Study Area through 29 October 2018. Both detectors were outfitted with two microphones; at each detector, one microphone was deployed near the ground, at approximately 5 feet (ft; 1.5 meters [m]), while the other microphone was raised on the met tower to approximately 148 ft (45 m) above ground level. The ground microphone is considered a ground sampling station (g), while the raised microphone is considered a raised sampling station (r); a total of four sampling stations were utilized during the study (FM1g, FM1r, FM2g and FM2r). Both met towers were located in grassland habitat, which is the dominant land cover type within the Study Area and representative of future turbine locations, although sampling stations FM2g and FM2r were in relatively close proximity to cultivated cropland as well as a farm building and associated infrastructure. Large weatherproof boxes housed the detectors and external deep-cycle batteries for protection from weather and wildlife.

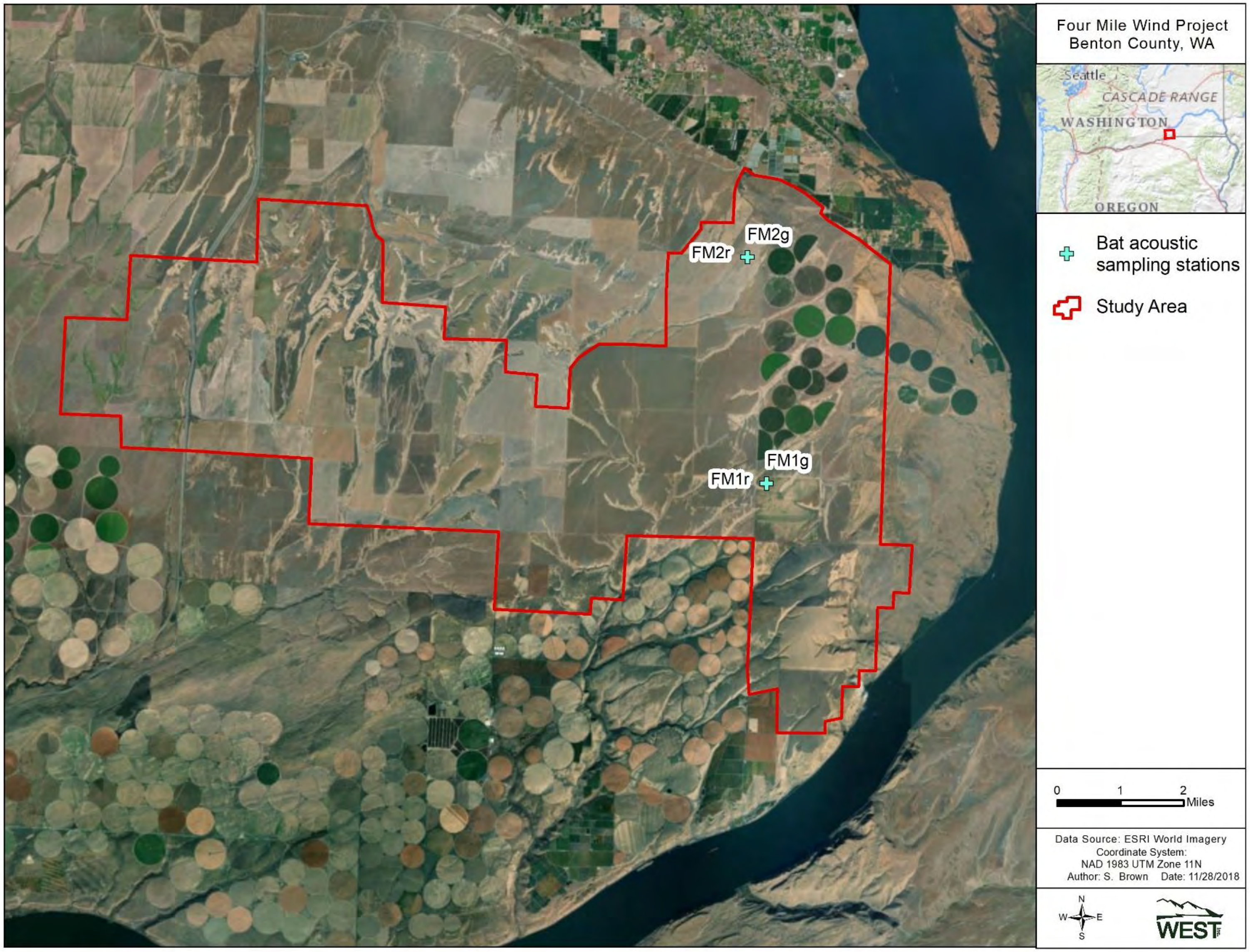

Figure 2. Location of sampling stations used during the bat activity study at the Four Mile Wind Project Study Area, Benton County, Washington.

Data Collection and Call Analysis

The Wildlife Acoustics Song Meter SM3 is a full-spectrum bat detector that records complete acoustic waveforms by sampling sound waves at 192 kilohertz (kHz). This high sampling rate enables the detector to make high-resolution recordings of sound amplitude data at all frequencies up to 96 kHz. High-quality recordings produced by the SM3 detector provide more information for making species-level identifications.

SM3 detectors use an omnidirectional microphone to detect and record bat echolocation calls that are then stored as files on one to four Secure Digital cards. During analysis, all recorded files were converted from full spectrum to zero cross (division ratio 8) using software program Kaleidoscope Pro (version 4.2.0; Wildlife Acoustics, Concord, Massachusetts). Noise files (e.g., wind or insect noise) were automatically filtered by Kaleidoscope into a Noise subfolder and not reviewed or included in results. All ultrasonic files were then viewed in Analook© software as digital sonograms that showed changes in echolocation call frequency over time. Frequency versus time displays were used to determine call frequency category and when possible, the species of bat that generated the calls.

For each detector station, bat passes were sorted into two groups based on minimum frequency. High-frequency (HF) bats, such as western long-eared bat (*Myotis evotis*), have minimum echolocation or social call frequencies greater than 30 kHz. Low-frequency (LF) bats, such as big brown bats (*Eptesicus fuscus*), silver-haired bats (*Lasionycteris noctivagans*), and hoary bats (*Lasiurus cinereus*), typically produce calls with minimum frequencies below 30 kHz.

For species identification purposes, files identified as HF and LF were run through an automated acoustic identification program, Kaleidoscope Pro (version 4.2.0; Wildlife Acoustics, Maynard, Massachusetts). The Bats of North America classifier (version 4.2.0; Wildlife Acoustics) was used at the recommended sensitivity setting of neutral (zero) to select for the 13 bat species that potentially occur within the Study Area (Table 1).

Statistical Analysis

The standard metric for measuring bat activity, the number of bat passes per detector-night, was used as an index of bat activity within the Study Area. A bat pass was defined as a sequence of at least two echolocation calls (pulses) produced by an individual bat with no pause between calls of more than one second (Fenton 1980, White and Gehrt 2001, Gannon et al. 2003). A detector-night was defined as one detector operating for one entire night. The terms bat pass and bat call are used interchangeably. Bat passes per detector-night was calculated for all bats, for HF bats, and for LF bats. Bat pass rates represent indices of bat activity and do not represent numbers of individuals. The number of bat passes was determined by an experienced bat biologist using Analook©.

Mean bat activity was calculated by detector station and overall. The period of peak sustained bat activity was defined as the seven-day period with the highest average bat activity. This and all multi-detector averages were calculated as unweighted averages of total activity at each detector.

Risk Assessment

Collision with wind turbine blades is the primary risk to bats at operating wind energy facilities (Arnett et al. 2008). The intent of the risk assessment is to use pre-construction bat activity data and other relevant information to describe the potential for bat fatalities at the Project. The intent of the risk assessment is not to predict the number of fatalities, but rather provide context for data collected within the Study Area. To asses the potential risk to bats at the Project, bat activity data collected within the Study Area in 2018 were compared to existing publicly available activity data from other wind energy facilities in the Rocky Mountains region. No publicly available bat activity data exists from the Pacific Northwest; data from the Rocky Mountains represent the closest region available for comparison.

Forecasting collision risk for bats at the Project is challenging for several reasons. First, there are relatively few publicly available studies presenting both pre-construction bat activity and post-construction fatality data, and the ecological differences among geographically dispersed facilities could limit the strength of inference. Further, as explained in detail below, there is no clear correlation between pre-construction bat activity and post-construction fatality data. Second, among studies with both pre-construction bat activity and post-construction fatality data, most pre-construction data were collected during the fall (i.e., the period of greatest risk) using Anabat™ zero-cross detectors (Titley Scientific™, Columbia, Missouri) placed near the ground. In contrast, this study used SM3 full-spectrum detectors near the ground and elevated near the rotor-swept area. Finally, the primary limitation of conducting a qualitative risk assessment for the Project is the difference in data collected by Anabat (used at most other projects) and SM3 detectors (used at the Project). Full-spectrum detectors, such as the SM3 units used at the Project, may record more bat passes per detector-night on average than the Anabat (zero-cross) units used for data collection at the majority of wind farms. Full-spectrum detectors have more sensitive microphones that sample more airspace, as well as different data processing algorithms (Solick et al. 2011, Adams et al. 2012), which may combine to result in higher activity rates than those measured by Anabat detectors. For this reason, activity levels recorded by SM3 detectors are not directly comparable to activity levels recorded by Anabat detectors, though trends in spatial and temporal activity rates collected by Anabat detectors can serve to contextualize trends in data collected using SM3 detectors. Differences in data collection technology (i.e., full-spectrum versus zero-cross detectors), and the resultant possibility that use of SM3 detectors rather than Anabat units at the Project led to increased collection of bat acoustic data should be considered. Inclusion of Anabat data in this report is for general discussion purposes only.

It is generally thought that pre-construction bat activity rates are positively related to post-construction bat fatalities (Kunz et al. 2007b). However, to date, few studies of wind energy facilities that have recorded both bat passes per detector night and bat fatality rates are publicly available (Appendix A). Given the limited availability of pre- and post-construction data sets, differences in protocols among studies (Ellison 2012), and significant ecological differences among geographically diverse facilities, the relationship between pre-construction activity and measured post-construction fatality rates has not been definitively established. In Canada, Baerwald and Barclay (2009) found a significant positive association between pass rates measured at 30 m (98 ft) above ground level and fatality rates for hoary and silver-haired bats across five sites in southern Alberta. However, on a continental scale, a similar relationship has proven difficult to establish. The relatively few studies that have estimated both pre-construction activity and post-construction fatalities show results that trend toward a positive association between activity and fatality rates, but lack statistically significant correlations. Hein et al. (2013a) compiled study results that included both pre- and post-construction data from the same projects, as well as pre- and post-construction data from facilities within the same regions to assess if pre-construction acoustic activity predicted post-construction fatality rates. Based on data from 12 sites, Hein et al. (2013a) did not find a statistically significant relationship ($p = 0.07$), although the trend was in the expected direction (i.e., higher activity was generally associated with higher fatalities and vice-versa). For these reasons, the current approach to assessing risk to bats using pre-construction acoustic data requires a qualitative analysis of activity levels, spatial and temporal relationships, species composition, and comparison to known regional activity and/or fatality patterns.

RESULTS

Bat Acoustic Surveys

Bat Activity

Bat activity was documented at four sampling stations within the Study Area for a total of 670 detector-nights between 11 May and 29 October 2018 (Table 2). The overall operational rate for all sampling stations was 97% of the study period, due to a battery failure at FM1 during a week in late May – early June. Bat activity was higher at ground sampling station FM2g, with an average activity rate of 1.41 bat passes per detector-night, than at FM1g, which documented an average activity rate of 0.63 bat passes per detector-night (Table 2, Figure 3). This is accounted for by a greater number of both HF and LF bat passes recorded at FM2g, likely due to the sampling station's relative proximity to human structures, which provide roosting habitat, as well as to varied topographic features north of FM1g, which also provide increased roosting habitat. However, the average activity rate recorded at FM2g was still markedly lower than the average activity rate recorded in the Rocky Mountains region (i.e., 4.02 bat passes per detector-night), and the activity rate averaged between both ground sampling stations was 1.02 (Table 2, Figure 3), again markedly lower than the Rocky Mountains region. The period of peak bat activity at the Project occurred from 16 September through 24 September 2018 (Figure 4).

Table 2. Results of bat acoustic surveys by sampling station conducted at the Four Mile Wind Project Study Area from 11 May – 29 October 2018. Passes are separated by call frequency: high frequency (HF) and low frequency (LF).

Detector Station	Type	Habitat	Number of HF Bat Passes	Number of LF Bat Passes	Total Bat Passes	Detector-Nights	Bat Passes/ Night*
FM1g	ground	grassland	8	95	103	163	0.63±0.12
FM1r	raised	grassland	2	152	154	163	0.94±0.11
FM2g	ground	grassland	41	202	243	172	1.41±0.17
FM2r	raised	grassland	4	230	234	172	1.36±0.14
Total			**55**	**679**	**734**	**670**	**1.09 ± 0.11**

*± bootstrapped standard error.

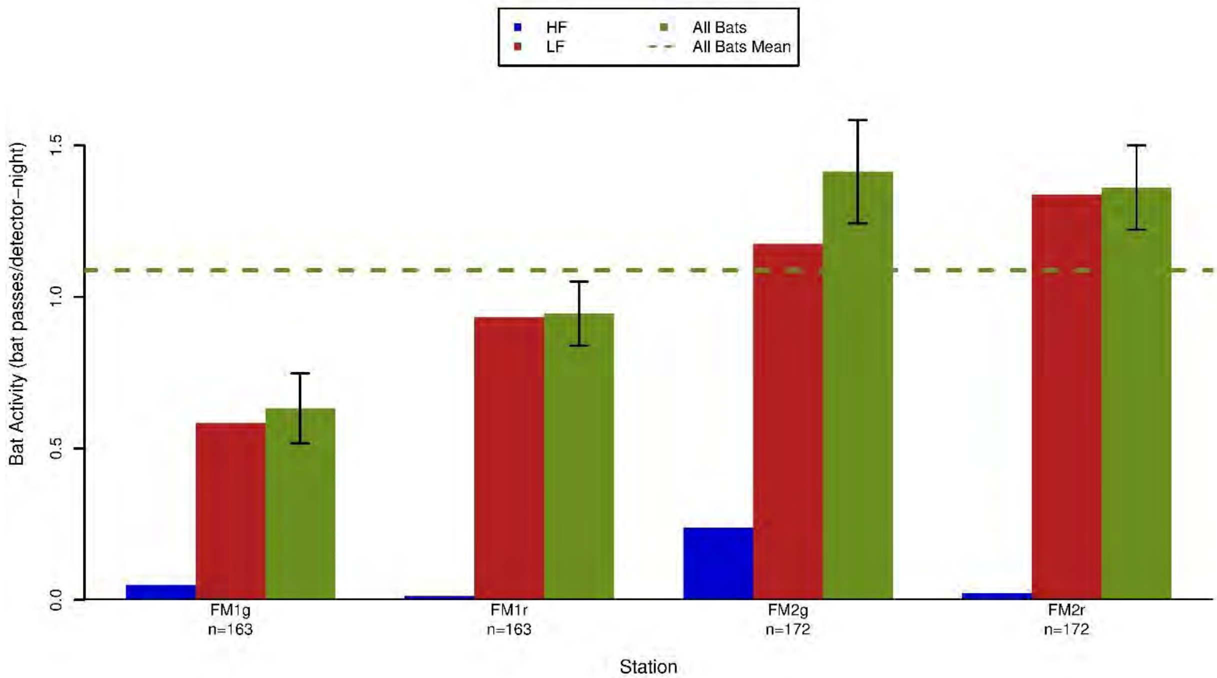

Figure 3. Bat passes per detector-night for high-frequency (HF), low-frequency (LF) and all bats recorded at the Four Mile Wind Project Study Area from 11 May – 29 October 2018. Bootstrapped standard errors are represented by black error bars on the 'All Bats' columns.

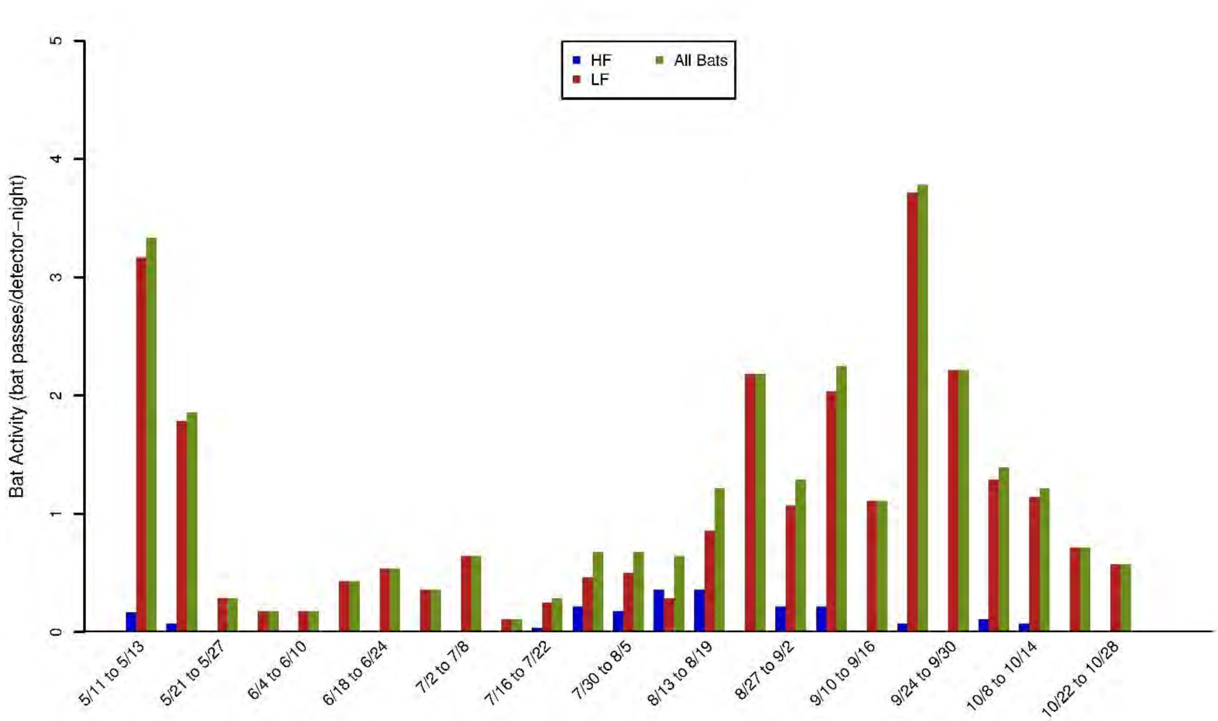

Figure 4. Weekly patterns of bat activity for high-frequency (HF), low-frequency (LF), and all bats at the Four Mile Wind Project Study Area from 11 May – 29 October 2018.

Species Composition

At all sampling stations, approximately 92.5% of bat passes were classified as LF (e.g., silver-haired bat, hoary bat, big brown bat), and approximately 7.5% of bat passes were classified as HF (i.e., California bat [*M. californicus*], canyon bat [*Parastrellus hesperus*], little brown bat [*M. lucifugus*], long-legged bat [*M. volans*], and western long-eared bat; Table 3). Results from Kaleidoscope Pro automated call identification were reviewed by an experienced bat biologist: bat calls for eight of the 13 species identified as having potential to occur within the Study Area were confirmed (Table 1; Table 3). Silver-haired bat was the primary species documented during the study period, detected on approximately 25% of detector-nights (Table 3). Hoary bat and big brown bat were the next most commonly detected species, occurring on approximately 14% and 5% of detector-nights, respectively (Table 3). Canyon bat was the most frequently detected HF bat, documented on approximately 2% of detector-nights, followed by little brown bat, which was documented on approximately 1% of detector-nights. California bat, long-legged bat and western long-eared bat were all documented on less than 1% of detector-nights during the study period (Table 3). Townsend's big-eared bat and pallid bat calls were not confirmed during the study period; no federal or state-listed bat species were detected.

Table 3. Nights (and percent) species present by sampling station at the Four Mile Wind Project Study Area from 11 May – 29 October 2018.

Common Name	FM1g*	FM1r*	FM2g*	FM2r*	Total
High-Frequency (> 30 kHz)					
California bat	0 (0%)	0 (0%)	1 (1%)	0 (0%)	1 (<1%)
canyon bat	1 (1%)	0 (0%)	10 (6%)	0 (0%)	11 (2%)
little brown bat	3 (2%)	0 (0%)	5 (3%)	0 (0%)	8 (1%)
long-legged bat	0 (0%)	0 (0%)	2 (1%)	0 (0%)	2 (<1%)
western long-eared bat	1 (1%)	0 (0%)	0 (0%)	0 (0%)	1 (<1%)
Low-Frequency (< 30 kHz)					
big brown bat	4 (2%)	6 (4%)	13 (8%)	8 (5%)	31 (5%)
hoary bat	5 (3%)	23 (14%)	20 (12%)	43 (25%)	91 (14%)
silver-haired bat	29 (18%)	40 (25%)	45 (26%)	55 (32%)	169 (25%)

*Nights species present
kHz = kilohertz

DISCUSSION AND RISK ASSESSMENT

Bat fatalities have been discovered at most monitored wind energy facilities in North America and globally (Arnett et al. 2016), with bat fatality rates in the US ranging from zero (Chatfield and Bay 2014) to 40.2 bats/megawatt (MW)/year (Hein et al. 2013b). In 2012, an estimated 600,000 bats died as a result of interactions with wind turbines in the US (Hayes 2013), and hoary bat population viability may be threatened by fatalities caused by wind turbines (Frick et al. 2017). Proximate causes of bat fatalities are primarily due to collisions with moving turbine blades (Grodsky et al. 2011, Rollins et al. 2012), but to a limited extent may also be caused by barotrauma (Baerwald et al. 2008). The underlying reasons bats approach wind turbines are still largely unknown (Cryan and Barclay 2009, Reimer et al. 2018).

Several key findings from the bat activity study at the Project are consistent with known patterns from other studies in the western US. First, the eight bat species confirmed within the Study Area are known from throughout the region and the most commonly detected species (silver-haired and hoary bats) are migratory tree-roosting bats, a pattern consistent with known trends. Second, the period of peak activity during the study period occurred in the fall, consistent with known patterns from the region and throughout the western US. Third, bat activity rates documented within the Study Area were relatively consistent with activity rates from the closest region with publicly available data (i.e., Rocky Mountains region).

Approximately 93% of bat passes recorded within the Study Area were produced by three LF bat species (i.e., silver-haired bat, hoary bat, big brown bat), which were documented on 25%, 14%, and 5% of detector-nights, respectively. Low-frequency bats, including silver-haired and hoary bats are the most commonly reported fatalities at many wind energy facilities in the US (Arnett et al. 2008, Arnett and Baerwald 2013, Thompson et al. 2017). Given these results and trends seen elsewhere in the US, LF bats including silver-haired bat and hoary bats would likely have the highest risk of collision at the Project.

Bat activity within the Study Area peaked in mid September, which is consistent with known patterns from the region and throughout the western US. During the fall, migratory bats may begin moving toward wintering areas, and many species initiate reproductive behaviors (Cryan 2008). This period of increased landscape-scale movement and reproductive behavior is often associated with increased levels of bat fatalities at operational wind energy facilities (Arnett et al. 2008; Arnett and Baerwald 2013, Thompson et al. 2017). If risk patterns at the Project are consistent with known trends, it is likely that most fatalities would occur during the fall.

Overall, bat activity Within the Study Area (1.09 bat passes per detector-night) was well below the Rocky Mountains regional average of 4.02 bat passes per detector-night (Appendix A), which is the closest region with publicly available activity data (no activity data from the Pacific Northwest is available for comparison). Corresponding post-construction bat fatality rates for the Rocky Mountains region range from 1.05 to 11.42 bats/MW/year, with an average of 4.90 bats/MW/year (Appendix A). As the relationship between pre-construction activity rates and post-construction fatality rates has not been definitively established (Hein et al. 2013; see Risk Assessment in Methods section p. 6-7), fatality rates documented at other facilities in the Pacific Northwest, where a majority of wind energy facilities are located along the Columbia Plateau, were used to assess potential risk to bats at the Project. At these Pacific Northwest facilities, bat fatality rates have ranged from 0.12 to 4.23 bats/MW/year with an average fatality rate of 1.19 bats/MW/year (Appendix A). This is considerably lower than that documented in the Rocky Mountains region. If risk patterns at the Project are similar to patterns elsewhere in the Pacific Northwest, it is likely that fatality rates at the Project would be similarly low.

CONCLUSION

To date, post-construction monitoring studies of wind energy facilities in North America show that: a) collision mortality is greatest for migratory tree-roosting species (e.g., hoary bat and silver-haired bat; Thompson et al. 2017), which make up approximately 78% of reported bat fatalities; b) the majority of fatalities occur during the fall migration season (Thompson et al. 2017); and c) most fatalities occur on nights with relatively low wind speeds (e.g., less than 6.0 m per second [19.7 ft per second]; Arnett et al. 2008, 2013; Arnett and Baerwald 2013). Finally, a recent meta-analysis suggests that bat mortality rates at wind facilities increase as relative grassland cover (or open cover) decreases (Thompson et al. 2017), suggesting that facilities or turbines in forested areas have higher fatality rates than facilities or turbines that lack surrounding tree cover. Given these trends and the results from the bat activity study within the Study Area in 2018, it is likely that bat mortality at the Project, once operational, would be: a) low, similar to other Pacific Northwest facilities; b) consist primarily of migratory, tree-roosting species (i.e., silver-haired bat, hoary bat); and c) occur mainly in the fall.

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Appendix A. Pacific Northwest and Rocky Mountain Fatality Summary Tables

Appendix A. Wind energy facilities in the Pacific Northwest and Rocky Mountains region of North America with comparable activity and fatality data for bats, separated by geographic region. Activity estimate given as bat passes per detector-night. Fatality estimate given as the number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Bat Activity Estimate	Bat Activity Dates	Fatality Estimate	No. of Turbines	Total MW
Four Mile (2018)	**1.02**	5/11/18 – 10/29/18			
	Pacific Northwest				
Mean	**--**		**1.19**	**99**	**134.1**
Palouse Wind, WA (2012-2013)			4.23	58	104.4
Biglow Canyon, OR (Phase II; 2009-2010)			2.71	65	150
Nine Canyon, WA (2002-2003)			2.47	37	48.1
Stateline, OR/WA (2003)			2.29	454	299
Elkhorn, OR (2010)			2.14	61	101
White Creek, WA (2007-2011)			2.04	89	204.7
Biglow Canyon, OR (Phase I; 2008)			1.99	76	125.4
Leaning Juniper, OR (2006-2008)			1.98	67	100.5
Big Horn, WA (2006-2007)			1.9	133	199.5
Combine Hills, OR (Phase I; 2004-2005)			1.88	41	41
Linden Ranch, WA (2010-2011)			1.68	25	50
Pebble Springs, OR (2009-2010)			1.55	47	98.7
Hopkins Ridge, WA (2008)			1.39	87	156.6
Harvest Wind, WA (2010-2012)			1.27	43	98.9
Elkhorn, OR (2008)			1.26	61	101
Vansycle, OR (1999)			1.12	38	24.9
Klondike III (Phase I), OR (2007-2009)			1.11	125	223.6
Stateline, OR/WA (2001-2002)			1.09	454	299
Stateline, OR/WA (2006)			0.95	454	299
Tuolumne (Windy Point I), WA (2009-2010)			0.94	62	136.6
Klondike, OR (2002-2003)			0.77	16	24
Combine Hills, OR (2011)			0.73	104	104
Hopkins Ridge, WA (2006)			0.63	83	150
Biglow Canyon, OR (Phase I; 2009)			0.58	76	125.4
Biglow Canyon, OR (Phase II; 2010-2011)			0.57	65	150
Hay Canyon, OR (2009-2010)			0.53	48	100.8
Windy Flats, WA (2010-2011)			0.41	114	262.2
Klondike II, OR (2005-2006)			0.41	50	75
Vantage, WA (2010-2011)			0.4	60	90
Wild Horse, WA (2007)			0.39	127	229
Goodnoe, WA (2009-2010)			0.34	47	94
Marengo II, WA (2009-2010)			0.27	39	70.2
Biglow Canyon, OR (Phase III; 2010-2011)			0.22	76	174.8
Marengo I, WA (2009-2010)			0.17	78	140.4
Klondike IIIa (Phase II), OR (2008-2010)			0.14	51	76.5
Kittitas Valley, WA (2011-2012)			0.12	48	100.8
	Rocky Mountains				
Mean	**4.02**		**4.90**	**70**	**85.0**
Summerview, Alb (2006; 2007)	7.65[A]	07/15/06-07-09/30/06-07	11.42	39	70.2
Summerview, Alb (2005-2006)			10.27	39	70.2
Judith Gap, MT (2006-2007)			8.93	90	135

Appendix A. Wind energy facilities in the Pacific Northwest and Rocky Mountains region of North America with comparable activity and fatality data for bats, separated by geographic region. Activity estimate given as bat passes per detector-night. Fatality estimate given as the number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Bat Activity Estimate	Bat Activity Dates	Fatality Estimate	No. of Turbines	Total MW
Foote Creek Rim, WY (Phase I; 1999)			3.97	69	41.4
Judith Gap, MT (2009)			3.2	90	135
Milford I, UT (2010-2011)			2.05	58	145
Milford I & II, UT (2011-2012)			1.67	107	160.5 (58.5 Phase I, 102 Phase II)
Foote Creek Rim, WY (Phase I; 2001-2002)	2.2[A,B]	6/15/01-9/1/01	1.57	69	41.4
Foote Creek Rim, WY (Phase I; 2000)	2.2[A,B]	6/15/00-9/1/00	1.05	69	41.4

A = Activity rate was averaged across phases and/or years
B = Activity rate calculated by WEST from data presented in referenced report

Appendix A (*continued*). Wind energy facilities in the Pacific Northwest and Rocky Mountain regions of North America with comparable activity and fatality data for bats. Data from the following sources:

Facility	Activity Estimate	Fatality Estimate	Facility	Activity Estimate	Fatality Estimate
Big Horn, WA (06-07)		Kronner et al. 2008	Klondike III (Phase I), OR (07-09)		Gritski et al. 2010
Biglow Canyon, OR (Phase I; 08)		Jeffrey et al. 2009b	Klondike IIIa (Phase II), OR (08-10)		Gritski et al. 2011
Biglow Canyon, OR (Phase I; 09)		Enk et al. 2010	Leaning Juniper, OR (06-08)		Gritski et al. 2008
Biglow Canyon, OR (Phase II; 09-10)		Enk et al. 2011b	Linden Ranch, WA (2010-2011)		Enz and Bay 2011
Biglow Canyon, OR (Phase II; 10-11)		Enk et al. 2012b	Marengo I, WA (2009-2010)		URS Corporation 2010b
Biglow Canyon, OR (Phase III; 10-11)		Enk et al. 2012a	Marengo II, WA (2009-2010)		URS Corporation 2010c
Combine Hills, OR (Phase I; 04-05)		Young et al. 2006	Milford I & II, UT (2011-2012)		Stantec 2011b
Combine Hills, OR (11)		Enz et al. 2012	Milford I, UT (2010-2011)		Stantec 2012b
Elkhorn, OR (08)		Jeffrey et a. 2009a	Nine Canyon, WA (2002-2003)		Erickson et al. 2003
Elkhorn, OR (10)		Enk et al. 2011a	Palouse Wind, WA (12-13)		Stantec 2013a
Foote Creek Rim, WY (Phase I; 99)		Young et al. 2003a	Pebble Springs, OR (09-10)		Gritski and Kronner 2010b
Foote Creek Rim, WY (Phase I; 00)	Gruver 2002	Young et al. 2003a, 2003b	Stateline, OR/WA (01-02)		Erickson et al. 2004
Foote Creek Rim, WY (Phase I; 01-02)		Young et al. 2003a, 2003b	Stateline, OR/WA (03)		Erickson et al. 2004
Goodnoe, WA (09-10)		URS Corporation 2010a	Stateline, OR/WA (06)		Erickson et al. 2007
Harvest Wind, WA (10-12)		Downes and Gritski 2012a	Summerview, Alb (05-06)		Brown and Hamilton 2006
Hay Canyon, OR (09-10)		Gritski and Kronner 2010a	Summerview, Alb (06; 07)	Baerwald 2008	Baerwald 2008
Hopkins Ridge, WA (06)		Young et al. 2007	Tuolumne (Windy Point I), WA (09-10)		Enz and Bay 2010
Hopkins Ridge, WA (08)		Young et al. 2009b	Vansycle, OR (99)		Erickson et al. 2000
Judith Gap, MT (06-07)		TRC 2008	Vantage, WA (10-11)		Ventus 2012
Judith Gap, MT (09)		Poulton and Erickson 2010	White Creek, WA (07-11)		Downes and Gritski 2012b
Kittitas Valley, WA (11-12)		Stantec Consulting Services 2012	Wild Horse, WA (07)		Erickson et al. 2008
Klondike, OR (02-03)		Johnson et al. 2003	Windy Flats, WA (10-11)		Enz et al. 2011
Klondike II, OR (05-06)		NWC and WEST 2007			

Avian Use Surveys at the Badger Canyon Wind Project, Benton County, Washington

Final Report

June 2018 – May 2019

Prepared for:

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WEST Inc.

Public Draft - For Distribution

EXECUTIVE SUMMARY

Badger Canyon MW LLC (Badger Canyon) is proposing to develop the Badger Canyon Wind Project (Project) in Benton County, Washington. To support the development of the Project, Badger Canyon contracted Western EcoSystems Technology, Inc. to conduct a pre-construction avian use study in the area where the Project is proposed (Study Area). The principle objective of the study was to assess the temporal and spatial use of the Study Area by large and small birds, including eagles and other species of regulatory or conservation concern.

Fixed-point avian use surveys were conducted at 28 points located throughout the Study Area from June 7, 2018 to May 28, 2019. Two separate surveys were conducted at each point every month: a 10-minute (min) small bird survey immediately followed by a 60-min large bird survey. Over the course of the study, 327 large bird surveys were completed and a total of 2,794 large bird observations representing 24 species were recorded. Large bird use was highest in fall, largely due to higher use by waterbirds and waterfowl during this season. Diurnal raptor use was also highest in fall (2.81 birds/plot/60-min survey), and lowest in winter (0.53). Nine separate diurnal raptor species were recorded during surveys, the most common of which was northern harrier (169 observations), which composed over a third (34%) of all diurnal raptor observations. This was followed by Swainson's hawk (93 observations), rough-legged hawk (84 observations), and red-tailed hawk (74 observations). Only a single eagle, a bald eagle observed in spring, was recorded during the study. Diurnal raptors were observed at all 28 points; however, relatively higher raptor use was recorded in the southeast portion of the Study Area, with the highest use recorded at Point 21 (3.08 birds/plot/60-min survey). Annual mean raptor use at the Project was scaled to 20-min to compare with other wind energy sites in Washington and Oregon that implemented similar protocols and had data for three or four seasons. Diurnal raptor use at the Project (0.73 raptors/plot/20-min) was well within the range of estimated raptor use at these other regional facilities.

Over the course of the 327 small bird surveys conducted during the study, a total of 2,233 small bird observations, representing 15 separate species, were recorded. The most abundant small bird species recorded was horned lark (2,061 observations) which composed 92.3% of all small bird observations. Three species, savannah sparrow, western meadowlark, and barn swallow composed an additional 5.0% of small bird observations. The highest small bird use was recorded in winter (13.81 birds/plot/10-min survey), followed by spring (6.11), fall (5.93), and summer (3.35). Small bird use varied widely across the 28 survey points, ranging from 1.45 to 22.58 birds/10-min survey.

During surveys or incidentally, six bird species of concern were recorded within the Study Area including one state-endangered species (sandhill crane), one state-threatened species (American white pelican), and one state candidate for listing (loggerhead shrike). Each of these species, in addition to prairie falcon and tundra swan, is also considered a state Priority Species. Bald eagles are protected under the federal Bald and Golden Eagle Protection Act.

To date, overall fatality rates for birds at wind energy facilities in the Pacific Northwest with publicly available data have been variable, ranging from 0.16 to 8.45 birds/megawatt (MW)/year, with fatality rates for diurnal raptors ranging from zero to 0.47 bird/MW/year. The Study Area is dominated by agricultural cover types (i.e., cultivated cropland) of limited value to most avian species, particularly species of conservation concern. While several species of concern were documented during the study, these observations were not unexpected for the region and these species are believed to at relatively low risk from Project development and operation given their use of the Study Area, and known interactions with turbines in the region. There is nothing in the data collected within the Study Area to date that would suggest the Project would fall outside of the range of impacts observed at other wind energy facilities in Oregon and Washington.

STUDY PARTICIPANTS

Andrea Chatfield	Project Manager
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REPORT REFERENCE

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INTRODUCTION

Badger Canyon MW LLC (Badger Canyon) is proposing to develop the Badger Canyon Wind Project (Project) in Benton County, Washington. To support the development of the Project, Badger Canyon contracted Western EcoSystems Technology, Inc. (WEST) to conduct a pre-construction avian use study in the area where the Project is proposed (Study Area). Study methodology was based upon the recommendations in the US Fish and Wildlife Service (USFWS) 2012 *Final Land-Based Wind Energy Guidelines* (WEG; USFWS 2012), Appendix C(1)(a) of the 2013 USFWS *Eagle Conservation Plan Guidelines* (ECPG; USFWS 2013), the USFWS 2016 *Revisions to Regulations for Eagle Incidental Take and Take of Eagle Nests* (Final Eagle Rule; 81 FR 91494 [December 16, 2016]), and the Washington Department of Fish and Wildlife (WDFW) Wind Power Guidelines (WDFW 2009). The principle objective of the study was to assess the temporal and spatial use of the Study Area by large and small birds, including eagles and other species of concern (USFWS 2012). This report summarizes methods and results from the year-long avian use study conducted at the proposed Project.

STUDY AREA

The Study Area encompasses 14,791 hectares (36,550 acres) of privately owned land within Benton County in southeastern Washington, approximately 3.9 kilometers (km; 2.4 miles [mi]) south of Benton City and 19.2 km (12.0 mi) west of the city of Kennewick (Figure 1). Topography is gently sloping, with elevations ranging from 351 meters (m; 1,150 feet [ft]) in the southwest corner of the Study Area to 567 m (1,860 ft) along the eastern edge of the Study Area. The Horse Heaven Hills, an anticline ridge of the Yakima Folds, lies along the northeastern border of the Study Area. On the southern side of the ridge, the landscape transitions to relatively rolling topography with shallow, meandering canyons that drain southwest into the Columbia River. At its closest point, the Columbia River runs approximately 12.9 km (8.0 mi) to the northeast of the Study Area and wraps around the Study Area to the east and south (Figure 1). The Yakima River flows eastward into the Columbia approximately 3.2 km (2.0 mi) to the north of the Study Area (Figure 1).

Historically, the native vegetation of the Study Area consisted of a bluebunch wheatgrass (*Pseudoroegneria spicata*)-Idaho fescue (*Festuca idahoensis*) zonal association, which was predominately grassland and shrub-steppe with deciduous riparian forest and scrub along drainages (Franklin and Dyrness 1973). Today, native grassland and shrub-steppe habitats have been replaced by tilled dry-land agriculture (primarily wheat) with a smaller amount of uncultivated grassland, the majority of which is managed as part of the US Department of Agriculture Farm Service Agency's Conservation Reserve Program. Based on vegetation and land cover mapping conducted within the Study Area, four vegetation/land cover types were identified within the Study Area (Chatfield and Brown 2018). The predominant cover type was agriculture, encompassing 81.8% of the total Study Area (Figure 2). Agricultural areas within the Study Area are primarily cultivated cropland consisting of dryland wheat. This was followed by grasslands which encompassed a further 16.5% of the Study Area (Figure 2). Smaller areas of remnant shrub-steppe (1.4% of the Study Area) were located primarily along drainages in the southeastern corner of the Study Area (Figure 2). Very small areas of development (mainly individual structures, residences, or farm buildings) are scattered throughout the Study Area, and compose the remaining 0.2% of the Study Area (Figure 2). Although the areas containing shrub-steppe are relatively small, shrub-steppe is considered an important habitat type for avian species, providing critical nesting and foraging opportunities (WDFW 2009). Trees primarily associated with farms and residences are scattered throughout the Study Area.

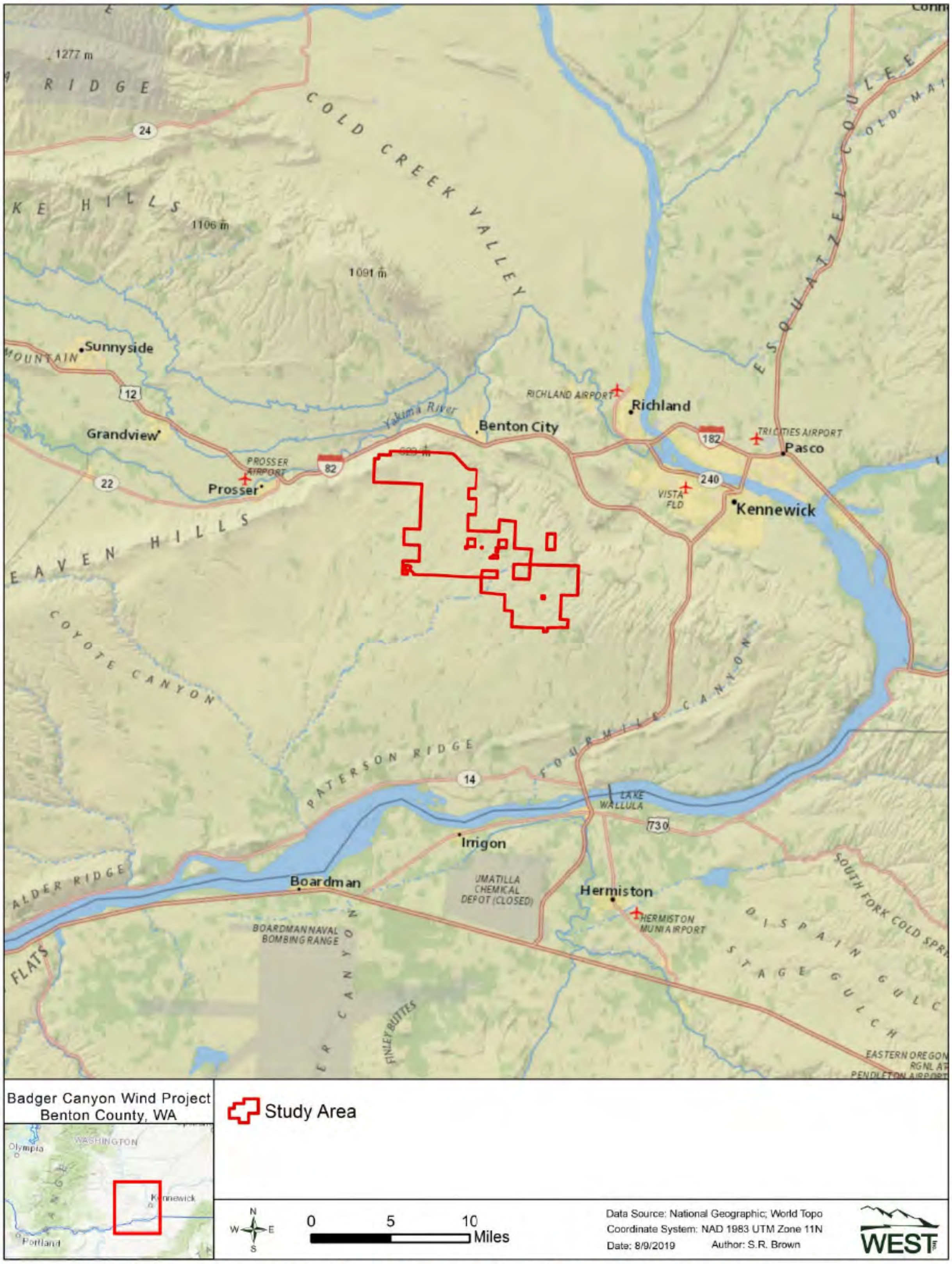

Figure 1. Location of the proposed Badger Canyon Wind Project, Benton County, Washington.

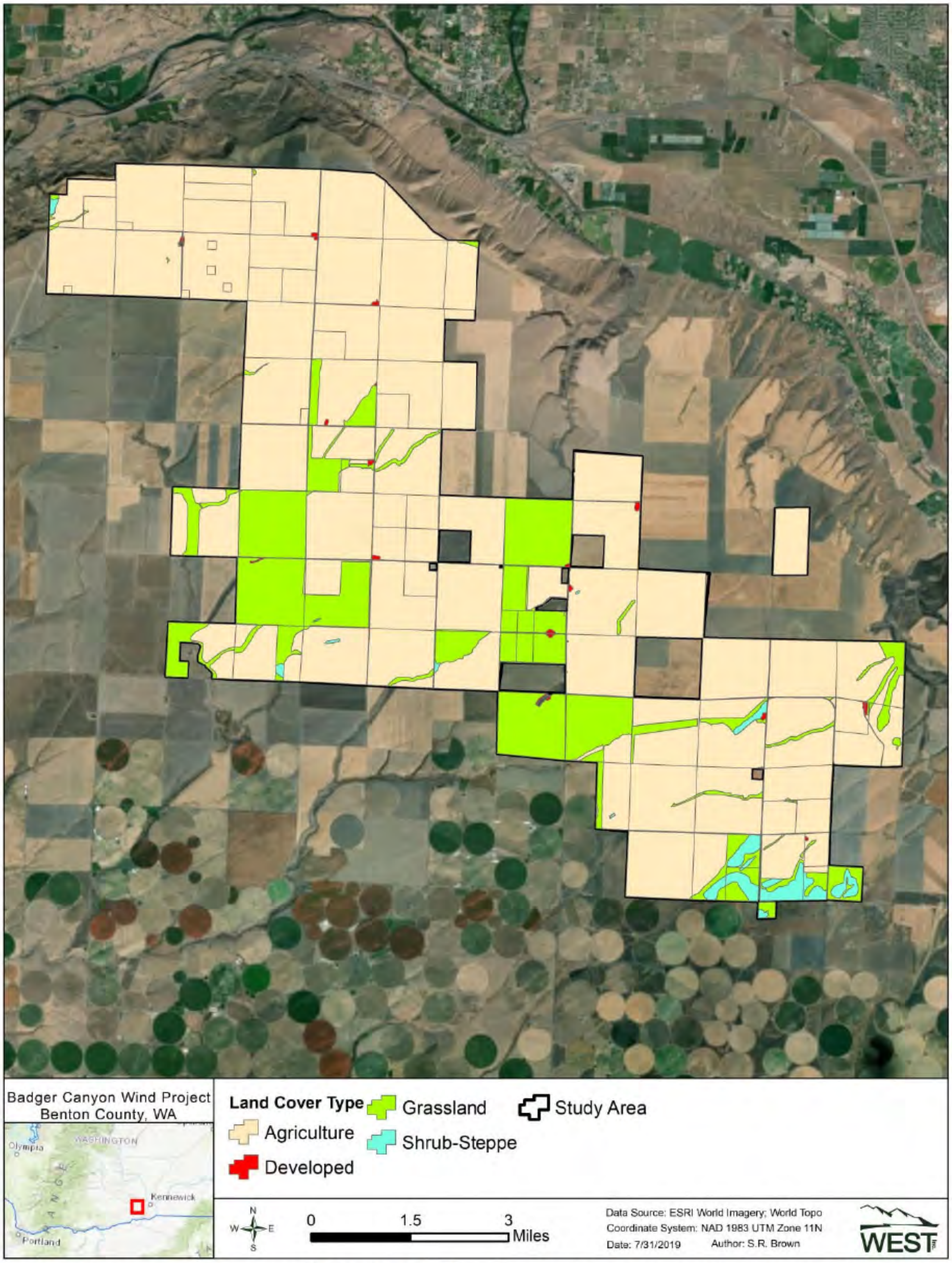

Figure 2. Land cover types and coverage within the Badger Canyon Wind Project Study Area, Benton County, Washington.

METHODS

Because of the need to collect information recommended by the USFWS specifically for eagles, the study design and survey methods primarily followed guidance from the ECPG and the Final Eagle Rule; however, this guidance is also appropriate for collecting data on other large bird species (e.g., other diurnal raptors, waterfowl, waterbirds). Because of the additional need to collect information on small bird species, small bird surveys were incorporated into the study design using guidance from the WEG and WDFW Wind Power Guidelines. Methods described below, therefore, are common for all birds (i.e., large and small birds, eagles, and other species of concern) except as noted.

Species of concern are defined per the WEG as any species that 1) is either a) listed as an endangered, threatened or candidate species under the Endangered Species Act, subject to the Migratory Bird Treaty Act (1918) or Bald and Golden Eagle Protection Act (BGEPA; 1940); b) is designated by law, regulation, or other formal process for protection and/or management by the relevant agency or other authority; or c) has been shown to be significantly adversely affected by wind energy development, and 2) is determined to be possibly affected by the Project (USFWS 2012).

Large birds are defined as waterbirds, waterfowl, shorebirds, gulls/terns, diurnal raptors (i.e., kites, accipiters, buteos, eagles, falcons, northern harrier, and osprey), owls, vultures, upland game birds, doves/pigeons, goatsuckers, large corvids (e.g., magpies, crows, and ravens). Small birds are defined as cuckoos, swifts/hummingbirds, woodpeckers, kingfishers, and passerines.

Study Design

Twenty-eight survey points were established in the Study Area to achieve a minimum of 30% coverage as recommended in the Final Eagle Rule (81 FR 91494 [December 16, 2016]; Figure 3). Each point was centered on a circular survey plot with an 800-m (2,625-ft) radius for large birds (including eagles) and 100-m (328-ft) radius for small birds (Reynolds et al. 1980, USFWS 2013, 81 FR 91494 [December 16, 2016]).

Surveys at all 28 points were conducted once per month during all seasons, as specified in the ECPG (USFWS 2013) and Final Eagle Rule (81 FR 91494 [December 16, 2016]), from June 7, 2018 to May 28, 2019. Seasons were defined: summer (June 1 – August 31), fall (September 1 – November 30), winter (December 1 – February 28), and spring (March 1 – May 31). Surveys were conducted during daylight hours and survey times at survey points were randomized to cover all daylight hours during a season. Surveys were conducted under all weather conditions except when visibility was less than 800 m horizontally and 200 m (656 ft) vertically.

Survey Methods

All Birds

Surveys at each point were conducted for a period of 70 minutes (min), with only small birds recorded during the first 10 min of the survey period, and only large birds (including eagles) recorded for the remaining 60 min of the survey period. Biologists recorded the following information for each survey: date, start and end time, and weather (i.e., temperature, wind speed, wind direction, precipitation, and percent cloud cover). Additionally, the following data were recorded for each group of birds observed:

- Observation number
- Species (or best possible identification)
- Number of individuals
- Sex and age class (if identifiable)
- Distance from survey plot center to the nearest 5-m (16-ft) interval (first & closest)
- Flight height above ground level (AGL) to the nearest 5-m interval (first, lowest, and highest)
- Flight direction (first observed)
- Habitat
- Activity (e.g., flying, perched)
- Observation type (visual or aural)
- Flight paths and perch locations of eagles, other diurnal raptors, waterbirds, and waterfowl

Eagles

Data were collected based on the recommendations in the ECPG (USFWS 2013) and the Final Eagle Rule (81 FR 91494 [December 16, 2016]) if a bald eagle (*Haliaeetus leucocephalus*) or golden eagle (*Aquila chrysaetos*) was observed during the survey period. Biologists recorded eagle behavior (i.e., flight height, distance from observer, activity) each minute, at the top of the minute, to provide an instantaneous count for every eagle observed, and age class (juvenile [1st year], immature or sub-adult [2nd to 4th year], adult [≥5th year]).

Incidental Observations

Incidental wildlife observations are wildlife seen outside of the standardized survey periods but within the Study Area and are focused on federal- or state-protected species, unusually large congregations of individuals, species not yet recorded during surveys, or eagle attractants (e.g., ground squirrel [*Urocitellus* spp.] colonies, areas with concentration of carrion). Data recorded for incidentally observed species were similar to that recorded during scheduled surveys, with the exception that minute by minute data were not recorded for eagles observed incidentally.

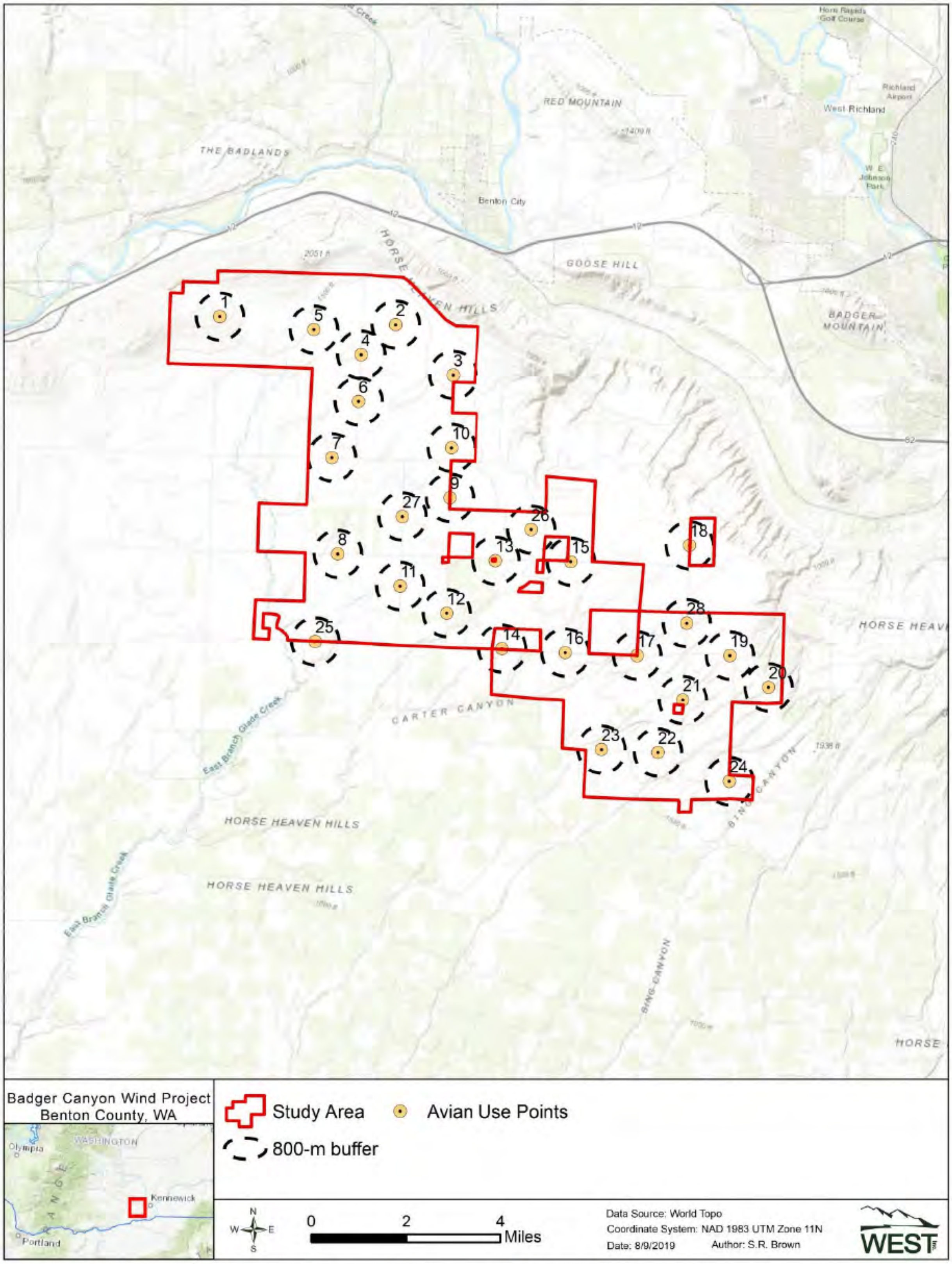

Figure 3. Location of survey points and plots used during fixed-point avian use surveys at the Badger Canyon Wind Project from June 7, 2018 to May 28, 2019.

Data Management

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 surveys, biologists were responsible for inspecting data forms for completeness, accuracy, and legibility. If errors or anomalies were found within the data, follow-up measures were implemented including discussions and review of field data with field technicians and/or project manager. Any errors, omissions, or problems identified in later stages of analysis were traced back to the raw data forms where appropriate changes and measures were implemented, no matter what stage of analysis. Multiple reviews were conducted as part of the QA/QC process.

Data Compilation and Storage

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

Statistical Analysis

A visit was defined as surveying all of the survey plots once and could occur across multiple dates but had to be completed in a single season (e.g., spring). If extreme weather conditions prevented all plots from being surveyed during a visit, then a visit might not have constituted a complete survey of all plots. A survey was defined as a single 10-min or 60-min count of birds. In some cases, a count of bird observations may represent repeated observations of the same individual. Only observations within the survey plot were included for data analysis.

Mean Use, Percent of Use, and Frequency of Occurrence

Mean use is the average number of birds observed per plot per survey for small or large birds. Small bird use (per 100-m plot per 10-min survey) and large bird use (per 800-m plot per 60-min survey) is calculated by: 1) summing birds per plot per visit, 2) averaging number of birds over plots within a visit, and 3) averaging number of birds across visits within a season. Overall mean use was calculated as an average of seasonal values weighted by the number of days in each season. Percent of use was calculated as the percentage of small or large bird use that was attributable to a particular bird type or species. Frequency of occurrence was calculated as the percent of surveys in which a particular bird type or species was observed.

Mean use and frequency of occurrence describe different aspects of relative abundance, in that mean use is based on the number of birds (i.e., large groups can produce high estimates), whereas frequency of occurrence is based on the number of groups (i.e., it is not influenced by group size). Qualitative comparisons were made with these metrics among bird types, seasons, and survey points to help one understand how birds are using the Project area over time and space.

Flight Height

Bird flight heights are important metrics to assess relative potential exposure to turbine blades and were used to calculate the percentage of large birds, small birds, and eagles observed flying within the rotor-swept height (RSH) of proposed turbines. A RSH of 25 to 150 m (82 to 492 ft) AGL was assumed for the purpose of the analysis. Flight height recorded during the initial observation was used to calculate mean flight height and the percentage of birds flying within the RSH.

Spatial Use

Mean use was calculated by survey point for large birds, small birds, and eagles to make spatial comparisons among the survey points. Additionally, flight paths of eagles, other diurnal raptors, waterbirds, and waterfowl were mapped during large bird use surveys to qualitatively show flight path location compared to Project area characteristics (e.g., topographic features) to identify if there were areas of concentration or consistent flight patterns within the Study Area.

Eagles

Eagle observations during surveys were summarized to provide flight heights (see Flight Height) and flight path maps (see Spatial Use). Minute data were examined to count eagle exposure minutes, defined as the number of minutes an eagle was observed in flight within the risk cylinder (defined as the area within 800 m of the survey point and up to 200 m AGL during the 60-min survey periods). The eagle exposure minutes per observation hour were reported by survey plot and month to enable spatial and temporal assessments of eagle exposure minutes recorded in the Study Area. Observations of perched eagles and those outside of survey plots were not considered eagle exposure minutes; however, the perch locations and flight paths of all eagles were mapped to qualitatively assess areas of eagle use within the Study Area.

RESULTS

Overall, 327 avian use surveys were conducted for large birds and 327 surveys were conducted for small birds (Table 1). Survey results are summarized below, supplemented by the appendices, which present species-level detail on numbers of groups and observations within the survey plot by season (Appendices A1 and A2), avian use, percent of use, and frequency of occurrence by season (Appendices B1 and B2), and mean use by survey point (Appendix C).

Table 1. Summary of survey effort at the Badger Canyon Wind Project in Benton County, Washington from June 7, 2018 to May 28, 2019.

	Large Birds		Small Birds	
Season[1]	**# Visits[2]**	**# Surveys[3]**	**# Visits[2]**	**# Surveys[3]**
Summer	3	83	3	83
Fall	3	84	3	84
Winter	3	76	3	76
Spring	3	84	3	84
Overall	**12**	**327**	**12**	**327**

[1] Season dates: Summer (June 1 – August 31), Fall (September 1 – November 30), Winter (December 1 – February 28), Spring (March 1 – May 31).

[2] A visit was defined as surveying all of the survey plots once within the Study Area and could occur across multiple dates but had to be completed in a single season.

[3] A survey was defined as a single 10-min or 60-min count of birds.

Large Birds

Twenty-four large bird species were observed or heard over the 327 hours of surveys during the year-long study. The greatest number of species was recorded in spring (17), followed by fall (12), winter (10), and summer (nine; Appendix A1). The most abundant large bird species were Canada goose (*Branta canadensis*; 806 observations in 17 separate groups) and sandhill crane (*Antigone canadensis*; 715 observations in seven separate groups; Appendix A1). Together, these two species composed 54.4% of all large bird observations and 72.2% of large bird observations in fall (Appendix A1). Diurnal raptors, represented by nine separate species, accounted for 17.8% of all large bird observations. The most abundant raptor species were northern harrier (*Circus hudsonius*; 169 observations), Swainson's hawk (*Buteo swainsoni*; 93 observations), rough-legged hawk (*B. lagopus*; 84 observations), and red-tailed hawk (*B. jamaicensis*; 74 observations; Appendix A1).

Mean Use, Percent of Use, and Frequency of Occurrence

Mean use, percent of use, and frequency of occurrence were calculated by season for large bird types (Figures 4a, 4b, 4c) and species (Appendices B1). Large bird mean use (observations/800-plot/60-min survey) was highest during fall (20.45), followed by spring (5.02), winter (4.99), and summer (3.07; Figure 4a; Appendix B1). Relatively high use in fall was largely attributed to higher use by waterbirds and waterfowl (8.01 and 6.76 observations/800-m plot/60-min survey, respectively) during that season (Figure 4a, Appendix B1). Among large bird types, diurnal raptors composed the greatest percentage of use in summer and spring (39.9% and 27.5%, respectively), while waterbirds composed the greatest percentage of use in fall (39.2%), and waterfowl composed the majority of use in winter (63.2%; Figure 4b, Appendix B1). Diurnal raptors and large corvids were the most frequently observed large bird types during all seasons, with diurnal raptors recorded during 32.1% to 79.8% of surveys seasonally and large corvids observed during 36.4% to 57.1% of surveys seasonally (Figure 4c; Appendix B1). Alternatively, waterbirds were recorded during less than 4.0% of surveys each season and waterfowl during less than 10.0% of surveys each season (Figure 4c; Appendix B1).

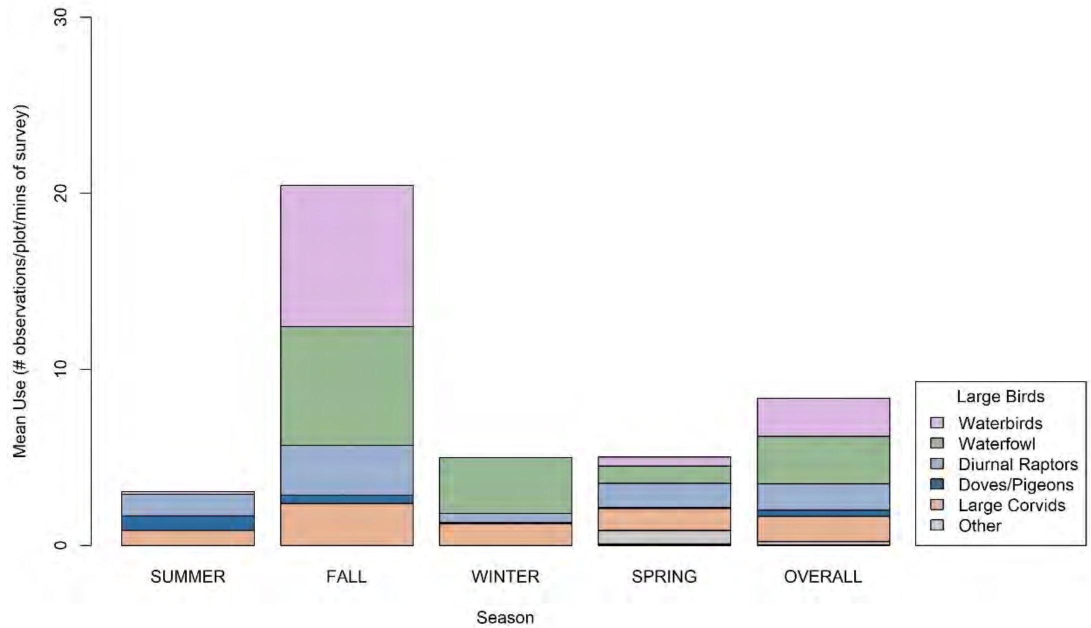

Figure 4a. Large bird mean use by season and bird type at the Badger Canyon Wind Project in Benton County, Washington from June 7, 2018 to May 28, 2019.

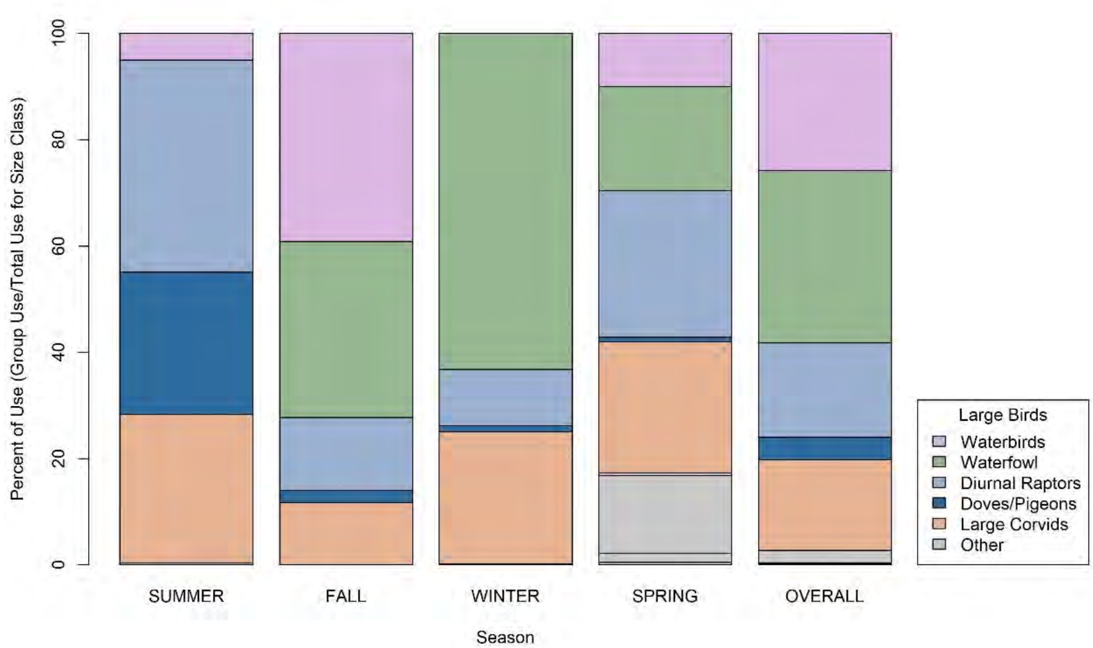

Figure 4b. Large bird percent of use by season and bird type at the Badger Canyon Wind Project in Benton County, Washington from June 7, 2018 to May 28, 2019.

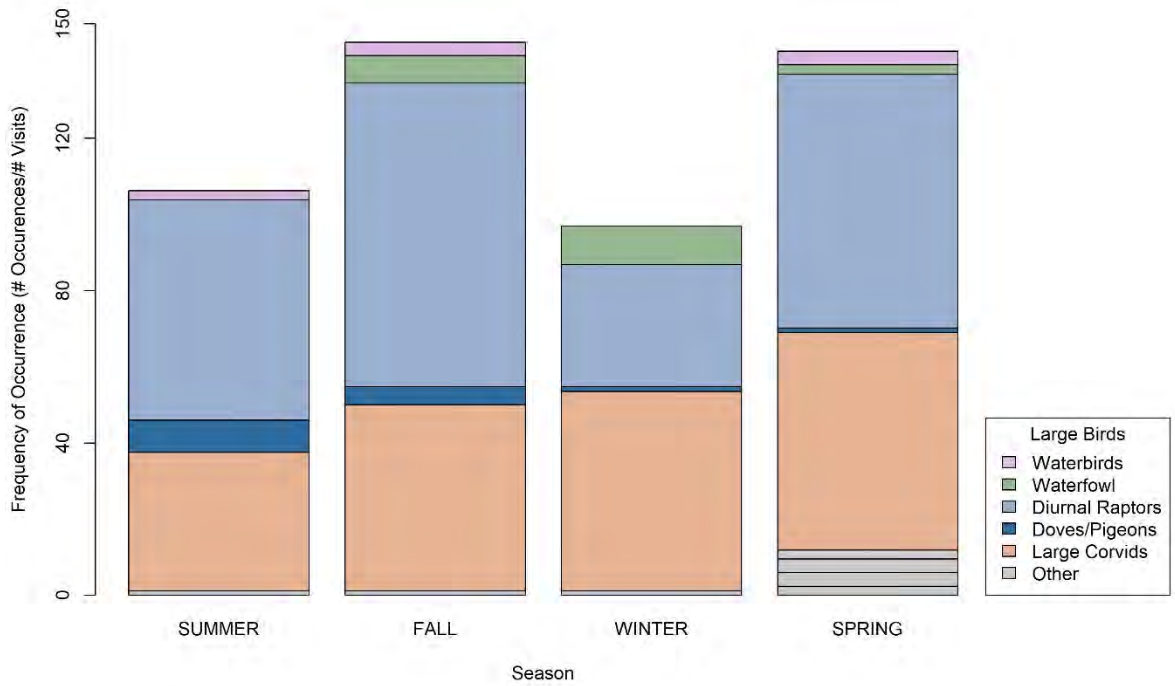

Figure 4c. Large bird frequency of occurrence by season and bird type at the Badger Canyon Wind Project in Benton County, Washington from June 7, 2018 to May 28, 2019.

Bird Flight Height

Mean large bird flight heights ranged from 18 m (60 ft) for doves/pigeons to 241 m (791 ft) for waterbirds. Bird types recorded most frequently within the RSH included vultures (100%), doves/pigeons (72.8%), and waterfowl (66.3%; Table 2). Overall, diurnal raptors were recorded flying within the RSH during 50.3% of observations, with 48.7% recorded below the RSH, and 0.9% recorded above (Table 2). Among diurnal raptor subtypes, the single eagle and accipiter observations were flying within the RSH, and the majority (80.9%) of buteos were recorded within the RSH, while northern harriers and falcons were most often observed flying below the RSH (Table 2). Nearly all (96.3%) of waterbird observations were recorded above the RSH (Table 2).

Table 2. Flight height characteristics by bird type and raptor subtype during 60-minute large bird use surveys at the Badger Canyon Wind Project in Benton County, Washington from June 7, 2018 to May 28, 2019.

Bird Type	# Groups Flying	# Obs. Flying	Mean Flight Height (m)	% Obs. Flying	% within Flight Height Categories <25 m	25-150 m[a]	>150 m
Waterbirds	**9**	**728**	**241**	**100**	**0**	**3.7**	**96.3**
Waterfowl	**20**	**906**	**113**	**100**	**3.9**	**66.3**	**29.8**
Shorebirds	**3**	**6**	**23**	**85.7**	**83.3**	**16.7**	**0**
Gulls/Terns	**5**	**62**	**37**	**100**	**74.2**	**25.8**	**0**
Diurnal Raptors	**434**	**439**	**36**	**88.5**	**48.7**	**50.3**	**0.9**
Accipiters	*1*	*1*	*30*	*100*	*0*	*100*	*0*
Buteos	*231*	*236*	*57*	*88.7*	*17.4*	*80.9*	*1.7*
Northern Harrier	*166*	*166*	*9*	*98.2*	*89.8*	*10.2*	*0*
Eagles	*1*	*1*	*80*	*100*	*0*	*100*	*0*
Falcons	*35*	*35*	*21*	*59.3*	*68.6*	*31.4*	*0*
Owls	**0**	**0**	**-**	**0**	**-**	**-**	**-**
Vultures	**2**	**2**	**75**	**100**	**0**	**100**	**0**
Upland Game Birds	**0**	**0**	**-**	**0**	**-**	**-**	**-**
Doves/Pigeons	**14**	**114**	**18**	**96.6**	**27.2**	**72.8**	**0**
Large Corvids	**223**	**432**	**26**	**91.9**	**42.1**	**57.9**	**0**
Large Birds Overall	**710**	**2,689**	**37**	**96.2**	**19.1**	**44.7**	**36.3**

[a] The likely "rotor-swept height" for potential collision with a turbine blade, or 25 to 150 m (85 to 492 feet) above ground level.

obs.=observations

Spatial Variation

Mean Use by Point

Large bird use varied widely across survey plots, ranging from 0.55 observations/survey at Point 9 to 36.75 at Point 23 (Appendix C). High variability in large bird use across the Study Area was largely driven by waterbird and waterfowl use documented at a subset of survey points, primarily in the eastern portion of the Study Area (Figure 3). The highest use values were from waterbirds recorded at Point 23 (25.00 observations/survey) and waterfowl recorded at Point 18 (18.00 observations/survey; Appendix C). Use by diurnal raptors was more consistent across the Study Area, ranging from 0.36 to 3.08 observations/survey (Appendix C). Use by other species groups (shorebirds, gulls/terns, owls, vultures, upland gamebirds, and doves/pigeons) was comparatively low and limited to only a few survey points across the Study Area (Appendix C).

Flight Paths

Flight paths of waterbirds, waterfowl, and diurnal raptors (including eagles) were mapped in the Study Area (Figures 5a and 5b). Consistent flight patterns were not evident for waterbirds or waterfowl (Figure 5a). Waterbird flight paths were recorded in low numbers across the Study Area, while waterfowl (primarily Canada goose) flight paths were somewhat more concentrated in the eastern third of the Study Area (Figure 5a). Diurnal raptor flight paths were recorded across the Study Area; however, the eastern half of the Study Area had a somewhat greater concentration of flight paths, particularly for buteos (e.g., red-tailed hawk and Swainson's hawk) and northern harriers (Figure 5b).

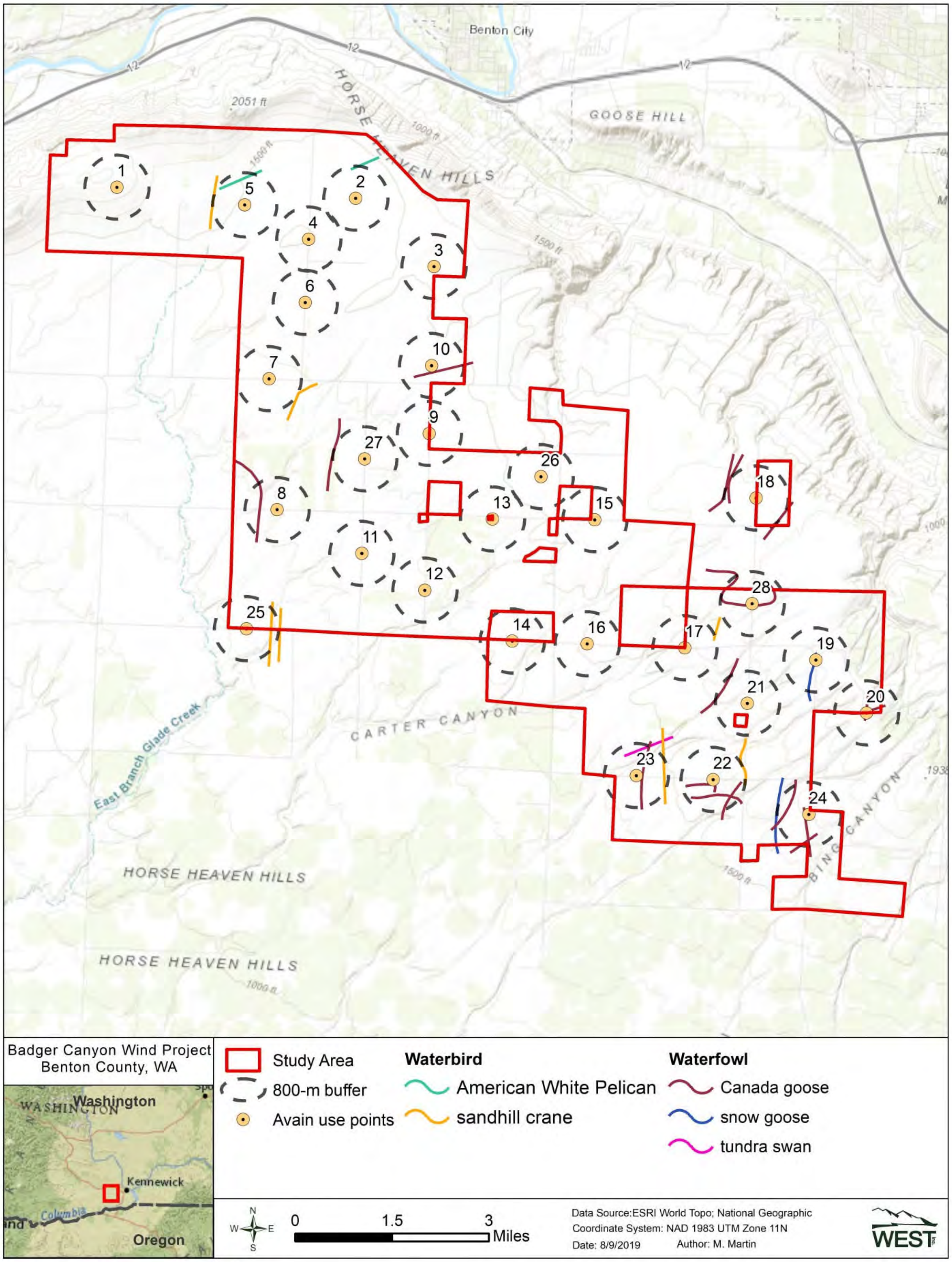

Figure 5a. Flight paths of waterbird and waterfowl species recorded during large bird surveys at the Badger Canyon Wind Project Study Area from June 7, 2018 to May 28, 2019

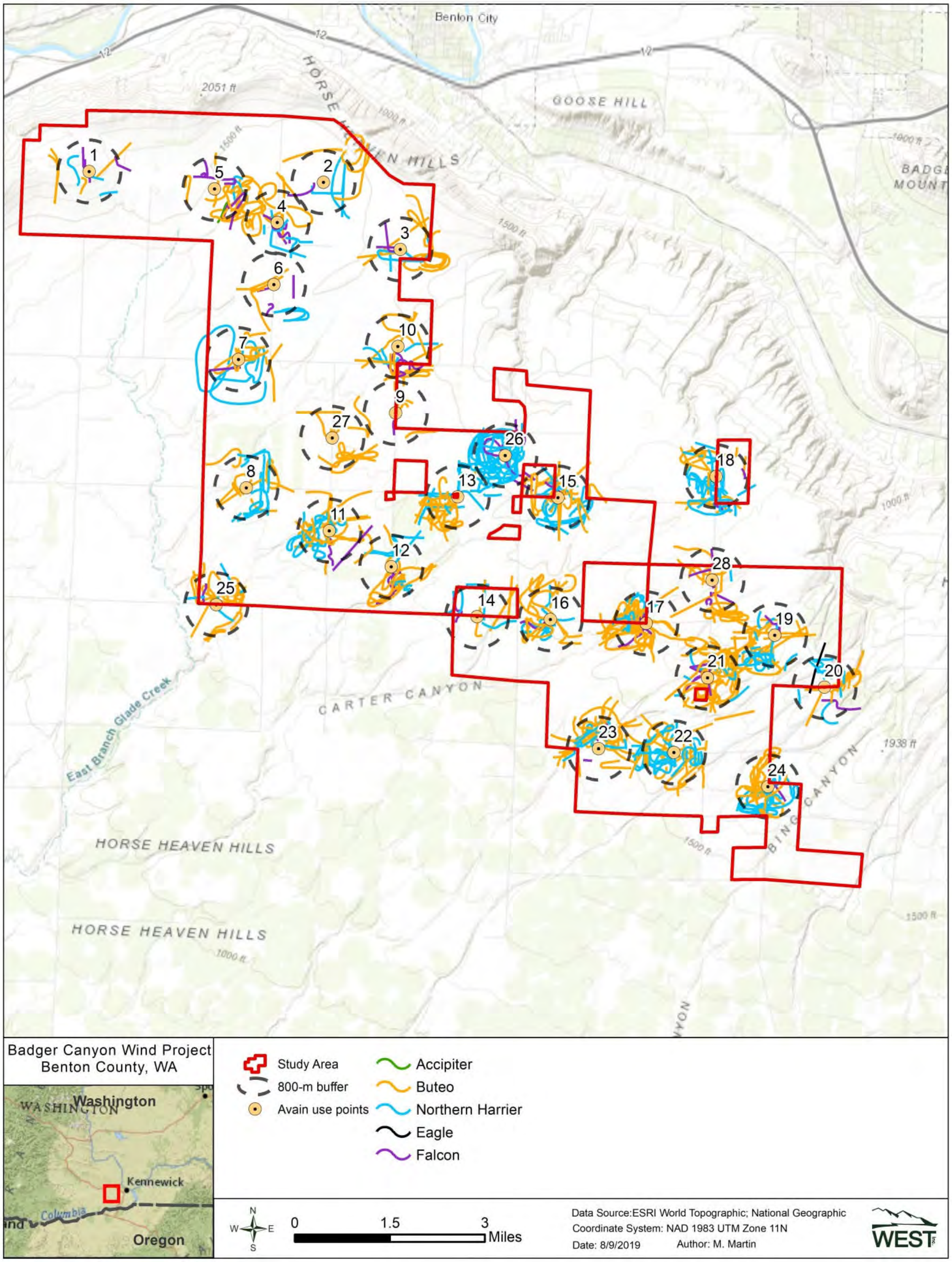

Figure 5b. Flight paths of diurnal raptor subtypes recorded during large bird surveys at the Badger Canyon Wind Project Study Area from June 7, 2018 to May 28, 2019.

Eagles

Over the course of 327 hours of surveys, only one bald eagle observation was recorded. The single bald eagle was observed in March at Point 20 (Figure 5b) for a total of three minutes in flight. This single observation resulted in one eagle exposure minute or 0.0031 exposure minutes per survey hour. No golden eagles were observed during the year-long study.

Small Birds

Fifteen species of small birds were observed or heard over the 327 hours of surveys during the year-long study. The greatest number of small bird species was recorded in spring (10), followed by summer (eight), fall (six), and winter (five; Appendix A2). The most commonly recorded species was horned lark (*Eremophila alpestris*) which composed 92.3% of all small bird observations (Appendix A2). Other species recorded in relatively high numbers included savannah sparrow (*Passerculus sandwichensis*), western meadowlark (*Sturnella neglecta*), and barn swallow (*Hirundo rustica*) which collectively composed another 5.0% of overall small bird observations (Appendix A2).

Mean Use

Small bird mean use (observations/100-m plot/10-min survey), composed entirely of use by passerines, was highest during winter (13.81), followed by spring (6.11), fall (5.93), and summer (3.35; Appendix B2). Horned lark composed between 84.8% and 98.2% of small bird use during each season (Appendix B2). After horned lark, cliff swallow (*Petrochelidon pyrrhonota*) had the highest use in summer, while western meadowlark had the highest use in fall, and savannah sparrow had the highest use in winter and spring (Appendix B2).

Spatial Variation

Small bird use ranged from 1.45 observations/100-m plot/10-min survey at Point 26 near the center of the Study Area to 22.58 at Point 22 in the southeast corner of the Study Area (Figure 1, Appendix C). Higher use at Point 22 was attributed to use by horned lark which dominated small bird use across survey points.

Incidental Observations

Nine avian species were recorded incidentally during the study (Table 3). Of these, two species were not observed during standardized surveys: loggerhead shrike (*Lanius ludovicianus*), and common nighthawk (*Chordeiles minor*; Table 3).

Table 3. Number of groups (grps) and observations (obs) for wildlife observed incidentally outside of the standardized avian use surveys at the Badger Canyon Wind Project from June 7, 2018 to May 28, 2019.

Species	Scientific Name	# grps	# obs
sandhill crane	*Antigone canadensis*	13	1,783
snow goose	*Chen caerulescens*	1	7
long-billed curlew	*Numenius americanus*	1	1
red-tailed hawk	*Buteo jamaicensis*	1	1
prairie falcon	*Falco mexicanus*	1	1
short-eared owl	*Asio flammeus*	1	1
barn swallow	*Hirundo rustica*	1	3
loggerhead shrike	*Lanius ludovicianus*	1	1
common nighthawk	*Chordeiles minor*	1	1
Total	**9 species**	**21**	**1,799**

Species of Concern

Six species of concern were recorded during avian use surveys or incidentally within the Study Area including one state-endangered species (sandhill crane), one state-threatened species (American white pelican [*Pelecanus erythrorhynchos*]), and one state candidate for listing (loggerhead shrike; WDFW 2019; Table 4). Each of these species, in addition to prairie falcon (*Falco mexicanus*) and tundra swan (*Cygnus columbianus*), is also considered a state Priority Species by the WDFW (2008). Bald eagle is protected under the federal BGEPA (1940).

Table 4. Groups and observations of species of concern recorded during avian use surveys or as incidental wildlife observations at the Badger Canyon Wind Project in Benton County, Washington from June 7, 2018 to May 28, 2019.

			Surveys		Incidental		Total	
Species	Scientific Name	Status*	# of grps	# of obs	# of grps	# of obs	# of grps	# of obs
sandhill crane	*Antigone canadensis*	SE, SP	7	715	13	1,783	20	2,498
American white pelican	*Pelecanus erythrorhynchos*	ST, SP	2	13	0	0	2	13
tundra swan	*Cygnus columbianus*	SP	1	35	0	0	1	35
bald eagle	*Haliaeetus leucocephalus*	BGEPA	1	1	0	0	1	1
prairie falcon	*Falco mexicanus*	SP	3	3	1	1	4	4
loggerhead shrike	*Lanius ludovicianus*	SC, SP	0	0	1	1	1	1
Total	**6 species**		**14**	**767**	**15**	**1,785**	**29**	**2,552**

grps=groups, obs=observations

*BGEPA = Bald and Golden Eagle Protection Act (BGEPA 1940) SE = state-endangered species; ST = state-threatened species; SC = state candidate species; SP = state priority species. State species status from Washington Department of Fish and Wildlife (2008, 2019).

DISCUSSION

The principal objective of this avian use study was to assess the temporal and spatial use of the Study Area by large and small birds, including eagles and other species of concern. Over the course of the year-long study, approximately 382 hours of large and small bird use surveys were completed and 5,027 bird observations comprising 39 separate species were recorded. Overall, large bird use varied substantially across seasons and across the Study Area; however, most of this variability was attributed to several relatively large groups of waterbirds and waterfowl observed primarily in the fall and in the eastern portion of the Study Area. Most of the waterbird observations (96.3%) were flying at heights well above the RSH of proposed turbines and not at risk of collision; however, the majority of waterfowl observations (66.3%) were flying within the RSH. Use by diurnal raptors was more consistent across seasons and across survey points. Seasonal use by diurnal raptors ranged from a low of 0.53 birds/800-m plot/60-min survey in winter to a high of 2.81 in fall. The most commonly recorded diurnal raptor species were northern harrier, Swainson's hawk, and rough-legged hawk.

In order to allow comparison with raptor use at other regional wind energy facilities in Washington and Oregon that implemented similar protocols and had data for three or four seasons, annual mean raptor use at the Project was recalculated for a 20-min survey period by using only the data collected during the first 20 min of the 60-min survey period. Based on this shorter survey period, diurnal raptor use at the Project (0.73 raptors/800-m plot/20-min survey) was on the higher end, but well the range of estimated raptor use at 23 regional wind energy facilities with publicly available data, ranking 19th out of 23 other sites (0.35-1.07 raptors/800-m plot/20-min survey; Figure 6).

Small bird use varied considerably across the Study Area; however, no clear spatial patterns of use were evident. Use by small birds was highest in winter (13.81 birds/100-m plot/10-min survey) and lowest in summer (3.35); however, use in all seasons was driven by horned lark which composed between 84.8% and 98.2% of overall small bird use in any given season.

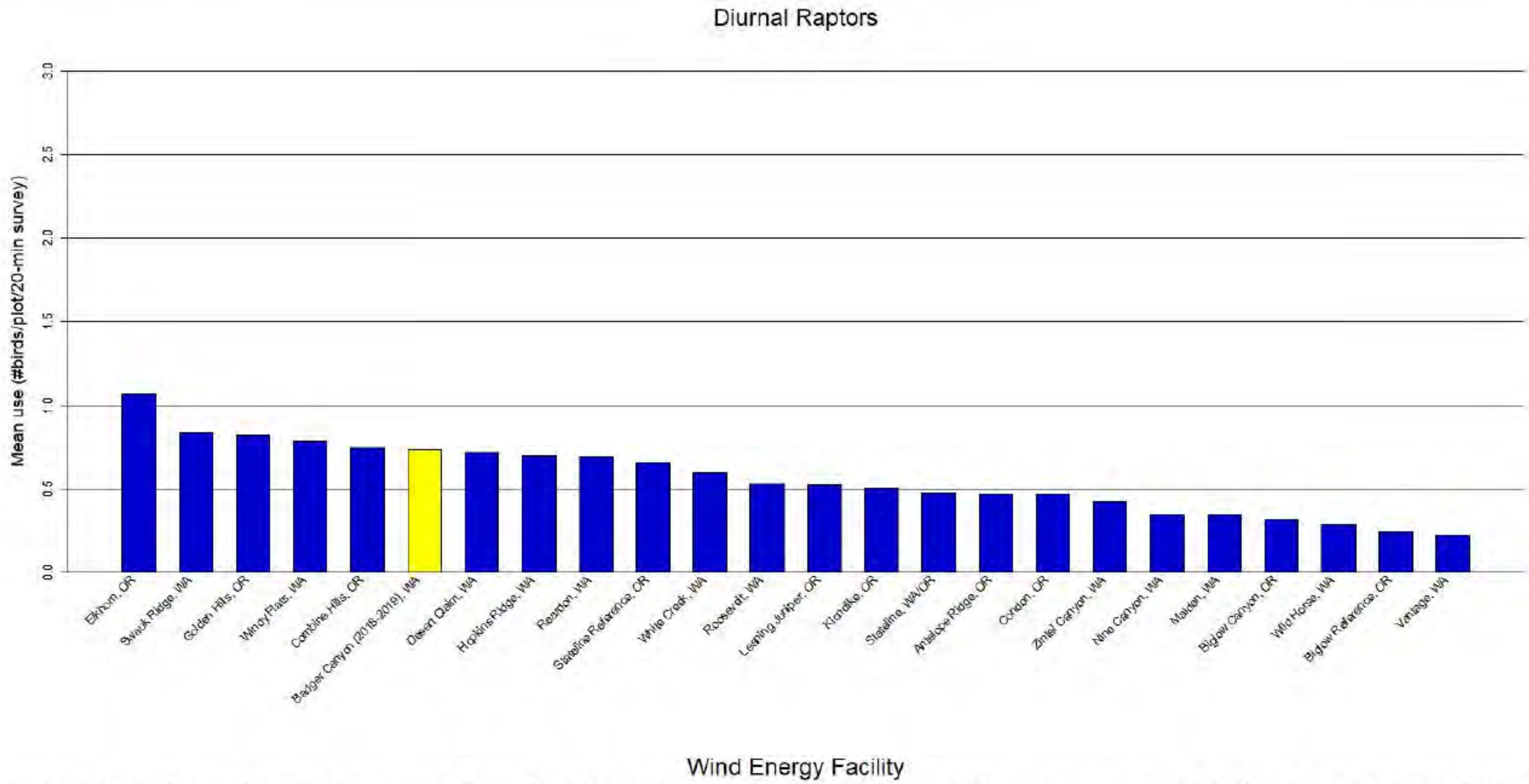

Figure 6. Comparison of estimated annual diurnal raptor use during fixed-point large bird use surveys at the Badger Canyon Wind Project from June 7, 2018 – May 28, 2019 and diurnal raptor use at other Oregon and Washington Wind Resource Areas with similarly collected data.

Figure 6 (*continued*). Comparison of estimated annual diurnal raptor use during fixed-point large bird use surveys at the Badger Canyon Wind Project from June 7, 2018 – May 28, 2019 and diurnal raptor use at other Oregon and Washington Wind Resource Areas with similarly collected data.

Data from the following sources:

Wind Energy Facility/Study	Report Citation	Wind Energy Facility/Study	Report Citation
Badger Canyon, WA	This study.		
Elkhorn, OR	WEST 2005a	Klondike, OR	Johnson et al. 2002
Swauk Ridge, WA	Erickson et al. 2003a	Stateline, WA/OR	Erickson et al. 2003b
Golden Hills, OR	Jeffrey et al. 2008	Antelope Ridge, OR	WEST 2009
Windy Flats, WA	Johnson et al. 2007	Condon, OR	Erickson et al. 2002a
Combine Hills, OR	Young et al. 2003a	Zintel Canyon, WA	Erickson et al. 2002b, 2003c
Desert Claim, WA	Young et al. 2003b	Nine Canyon, WA	Erickson et al. 2001
Hopkins Ridge, WA	Young et al. 2003c	Maiden, WA	Young et al. 2002
Reardon, WA	WEST 2005b	Biglow Canyon, OR	WEST 2005c
Stateline Reference, OR	URS et al. 2001	Wild Horse, WA	Erickson et al. 2003d
White Creek, WA	NWC and WEST 2005	Biglow Reference, OR	WEST 2005c
Roosevelt, WA	NWC and WEST 2004	Vantage, WA	Jeffrey et al. 2007
Leaning Juniper, OR	Kronner et al. 2005		

Species of Concern

During the study, six bird species of concern were recorded within the Study Area, none of which are unexpected for the region. These include the state-endangered sandhill crane, the state-threatened American white pelican, and the state candidate for listing loggerhead shrike. All three of these species are also considered Priority Species by the WDFW, along with tundra swan and prairie falcon. While not a state or federally listed species, bald eagles are protected under the federal BGEPA.

Sandhill Crane

Sandhill cranes were recorded within the Study Area during fall (four groups totaling 673 individuals) and spring (three groups totaling 42 individuals). Sandhill cranes typically use large freshwater marshes, prairie ponds, and marshy tundra during summer and grain fields or prairies during migration and winter. In Washington, sandhill cranes are known to breed only in Yakima and Klickitat counties (Stinson 2017). They typically use large freshwater marshes, prairie ponds, and marshy tundra during summer and grain fields or prairies during migration and winter. Although suitable breeding and stopover habitat is generally absent from the Study Area, there is potential for the species to migrate over the Project in spring and fall, which is supported by the data collected during this study. During surveys the majority (96.3%) of sandhill crane observations were recorded flying well above the RSH.

Waterbirds, including sandhill crane, do not appear to be particularly susceptible to collision with wind turbines. According to the National Research Council (2007) cumulative effects report, waterbirds composed about 1% of documented fatalities at 14 wind energy facilities. Waterbirds made up 0.2% of all bird fatalities (n = 4,975) in an analysis of 116 standardized monitoring studies conducted at over 70 wind energy facilities throughout the US and Canada (Erickson et al. 2014). Among publicly available reports reviewed by WEST, waterbirds accounted for just 0.2% of fatalities recorded during 41 studies at wind energy facilities in the Pacific Northwest region of North American (four of 1,942 total fatalities; see Appendix D for a list of facilities and references). The four waterbird fatalities documented at Pacific Northwest wind energy facilities were all great blue herons (*Ardea herodis*; see Appendix D). While no sandhill crane fatalities have been documented in the Pacific Northwest, several sandhill crane fatalities have been documented at facilities in other states. This includes one fatality documented at an older-generation facility at Altamont Pass in California (Smallwood and Karas 2009), and two fatalities from a facility in west Texas (Navarrete and Griffis-Kyle 2014 as cited in Gerber et al. 2014; Stehn 2011), documented as part of a wintering crane displacement study conducted by graduate student L. Navarrete of Texas Tech University.

Researchers at WEST monitored use by migrating sandhill cranes at five wind energy facilities in North and South Dakota from 2009 – 2013 for three years at each site. Concurrently, they searched underneath all turbines daily for fatalities of cranes. Cumulatively, observers spent 13,182 hours recording crane use over 1,305 days, and even though 42,727 sandhill crane observations were recorded, no fatalities of cranes were found beneath turbines (Derby et al. 2018). A crane monitoring study was conducted at the Forward Energy Center, a wind energy facility in southern Wisconsin located within 3.2 km (2.0 mi) of a large wetland used by sandhill cranes. No crane fatalities were found during the crane monitoring study in the fall of 2008, or during regular bird fatality monitoring studies conducted in the fall of 2008, spring and fall of 2009, and in the spring of 2010, even though sandhill cranes were observed in the study area (Grodsky et al. 2013).

Given the absence of suitable breeding and stopover habitat within the Project area and the available data regarding these species' interactions with wind turbines, impacts to sandhill crane resulting from Project development and operation are anticipated to be low.

American White Pelican

American white pelicans were recorded only during summer surveys (two groups totaling 13 individuals). These two groups were observed along the northwest boundary of the Study Area flying at an average of 250 m (820 ft) above mean sea level, well above the RSH. The American white pelican is known to nest on Columbia River dredge islands near the Tri-Cities (Stinson 2016), within 20 mi (32 km) of the Study Area. While suitable breeding and foraging habitat is not present within the Study Area, the species may fly over the Study Area while traveling between foraging areas.

Similar to sandhill crane and other waterbird species, American white pelicans do not appear to be particularly susceptible to collision with wind turbines. Based on publicly available data, no American white pelican fatalities have been documented at facilities in the Pacific Northwest (see Appendix D for a list of facilities and references). However, this may be the result of the siting of current wind energy facilities outside of pelican flight corridors. At least two American white pelican fatalities have been documented at wind energy facilities outside of Oregon and Washington, both of which were found at the Buffalo Ridge facility in South Dakota (Derby et al. 2010, 2012).

Given the absence of suitable breeding and stopover habitat within the Project area, the species' use of the Study Area, and the available data regarding these species' interactions with wind turbines, impacts to American white pelican resulting from Project development and operation are anticipated to be low.

Bald Eagle

Based on information compiled by the USFWS, there have been 49 documented bald eagle fatalities or injuries at wind energy facilities in the US between 2013 and 2018 (Kritz et al. 2018). The majority of bald eagle casualties occurred in the Upper Midwest, Intermountain West, and Alaska, with only single bald eagle fatalities documented in each of Oregon and Washington (Kritz et al. 2018).

The Columbia Plateau supports both breeding and wintering populations of bald eagles, generally at lower densities than areas west of the Cascades; however, bald eagle nests have increased annually across the state since 2005 (Kalasz and Buchanan 2016). While bald eagle nest sites and breeding season foraging habitat is absent from the Project area, the species is known to nest in areas adjacent to rivers and lakes. During eagle nest surveys conducted within a 16-km radius of the Study Area, two occupied bald eagle nests were documented (Chatfield et al. 2019). Both of these nests were located along the Yakima River approximately 11.9 km (7.4 mi) west of the Study Area and 13.2 km northeast of the Study Area (Chatfield et al. 2019). Based on the generally low direct impacts to bald eagles documented in the Pacific Northwest, the distance of eagle nests from the proposed Project boundary, and the very low use of the Study Area by bald eagles documented during the study, risk to bald eagles from the development and operation of the Project is anticipated to be low.

Prairie Falcon

During surveys, four prairie falcon observations were recorded within the Study Area: one during fall surveys, one incidentally in fall, and two during winter surveys. Prairie falcons are year-round residents of the region and, while nesting habitat is absent from the Study Area, the species may forage throughout the site's open grasslands and agricultural lands. No prairie falcon nests were documented in the vicinity of the Study Area during the 2019 aerial raptor nest surveys conducted for the Project (Chatfield et al. 2019).

Though prairie falcon fatalities have been documented at Pacific Northwest wind energy facilities, they have been relatively rare (three out of 154 total diurnal raptor fatalities; see Appendix D for a list of facilities and references). Given the relatively low use of the Project Area by prairie falcons and the low level of direct impacts reported for this species in the Pacific Northwest, risk to prairie falcons from development and operation of the Project is anticipated to be low.

Loggerhead Shrike

Only a single loggerhead shrike, recorded incidentally, was observed during the study, suggesting low use of the Study Area by this species. Loggerhead shrikes typically nest in mature shrub-steppe habitat; which is very limited within the Study Area (see Figure 2); however, the species will utilize grassland, agricultural land, and other open areas for foraging. Loggerhead shrike fatalities have been documented at wind energy facilities, particularly at facilities in California (see ICF International 2016; WEST 2008); however, no loggerhead shrike fatalities (out of 1,228 total passerine fatalities) have been reported in the Pacific Northwest (see Appendix D for a list of facilities and references). Given the low documented use the Study Area by this species and the very small amount of suitable nesting habitat, risk to loggerhead shrike from the development and operation of the Project is anticipated to be low.

Tundra Swan

A single group of tundra swans, comprising 35 individuals, was recorded in the Study Area during spring surveys. This group was recorded at Point 23 near the southern boundary of the Study Area, flying about 15 m (49 ft) AGL. In western North America, tundra swans breed in Alaska and the Canadian low arctic and winter mainly on the Pacific coast from British Columbia to California (NatureServe 2019). The Study Area lies within the migratory path of the tundra swan, and the species utilizes waterways in eastern Washington, such as the Columbia River, during its spring journey to northern breeding grounds. As a result, there is potential for tundra swans to fly over the Study Area or forage within the Study Area's agricultural fields during spring migration. Among 41 post-construction monitoring studies at facilities in the Pacific Northwest, no tundra swan fatalities have been documented (see Appendix D for a list of facilities and references). In the Pacific Northwest, waterfowl fatalities have composed 0.8% of overall avian mortality at wind energy facilities with publicly available data. The most common waterfowl fatalities have been Canada goose (six fatalities) and mallard (*Anas platyrhynchos*; four fatalities; Appendix D).

Given low use of the Study Area by tundra swans, risk of collision is anticipated to be low; however, the magnitude of this risk depends greatly on interannual use of the Study Area by swans during spring migration.

Avian Mortality at Regional Wind Energy Facilities

To date, overall fatality rates for birds at wind energy facilities in the Pacific Northwest with publicly available data have been variable, ranging from 0.16 to 8.45 birds/megawatt (MW)/year, with fatality rates for diurnal raptors ranging from zero to 0.47 bird/MW/year (Appendix D). At the nearby Nine Canyon facility, post-construction fatality monitoring conducted in 2002-2003 resulted in estimated mortality rates of 2.79 birds/MW/year and 0.03 diurnal raptors/MW/year (Erickson et al. 2003c). At the Windy Flats, Combine Hills, and Hopkins Ridge wind energy facilities in Oregon and Washington, where with pre-construction diurnal raptor use estimates were similar to that recorded at the Project (see Figure 6), corresponding post-construction diurnal raptor fatality rates ranged from zero to 0.14 raptors/MW/year (Young et al. 2006, 2007, 2009; Enz et al. 2011, 2012; Appendix D).

At wind energy facilities in the Pacific Northwest with publicly available fatality data, diurnal raptors have composed 7.9% of all documented avian fatalities (154 out of 1,942 total avian fatalities; see Appendix D for a list of facilities and references). In the Pacific Northwest, 12 separate diurnal raptor species have been found as fatalities, the most common of which have been American kestrel (*Falco sparverius*; 35.7%), red-tailed hawk (31.2%), and Swainson's hawk (9.1%; see

Appendix D for a list of facilities and references). During the year-long fatality monitoring study at Nine Canyon, only one diurnal raptor fatality was documented, an American kestrel (Erickson et al. 2003c). Based on the composition of turbine-related raptor fatalities in the region, and the composition of diurnal raptors observed during this study, the diurnal raptor species most likely impacted by the Project are American kestrel and red-tailed hawk.

CONCLUSIONS

Tier 3 studies are used to address questions regarding impacts that could not be sufficiently addressed using available literature (i.e., during Tier 1 and 2 desktop analyses). These studies provide additional data that, when combined with available literature reviewed in previous tiers, allow for a better-informed assessment of the risk of significant adverse impacts to species of concern at the Project. The Study Area is dominated by agricultural cover types (i.e., cultivated cropland) of limited value to most avian species, particularly species of conservation concern. Several species of concern were documented during the study; however, these were not unexpected for the region and are believed to be at low risk from Project development and operation given their use of the Study Area, and known interactions with turbines in the region. Nothing in the data collected within the Study Area to date suggests that the Project would fall outside of the range of impacts observed at other wind energy facilities in Oregon and Washington.

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Appendix A. All Bird Types and Species Observed at the Badger Canyon Wind Project Study Area during Avian Use Surveys, June 7, 2018 – May 28, 2019

Appendix A1. Numbers of groups and observations by bird type and species for 60-minute large bird use surveys at the Badger Canyon Wind Project in Benton County, Washington from June 7, 2018 to May 28, 2019.

Type/Species	Scientific Name	Summer # grps	Summer # obs	Fall # grps	Fall # obs	Winter # grps	Winter # obs	Spring # grps	Spring # obs	Total # grps	Total # obs
Waterbirds		**2**	**13**	**4**	**673**	**0**	**0**	**3**	**42**	**9**	**728**
sandhill crane	*Antigone canadensis*	0	0	4	673	0	0	3	42	7	715
American white pelican	*Pelecanus erythrorhynchos*	2	13	0	0	0	0	0	0	2	13
Waterfowl		**0**	**0**	**8**	**568**	**9**	**255**	**3**	**83**	**20**	**906**
Canada goose	*Branta canadensis*	0	0	8	568	7	190	2	48	17	806
snow goose	*Chen caerulescens*	0	0	0	0	2	65	0	0	2	65
tundra swan	*Cygnus columbianus*	0	0	0	0	0	0	1	35	1	35
Shorebirds		**0**	**0**	**0**	**0**	**0**	**0**	**4**	**7**	**4**	**7**
long-billed curlew	*Numenius americanus*	0	0	0	0	0	0	4	7	4	7
Gulls/Terns		**0**	**0**	**0**	**0**	**0**	**0**	**5**	**62**	**5**	**62**
California gull	*Larus californicus*	0	0	0	0	0	0	1	35	1	35
ring-billed gull	*Larus delawarensis*	0	0	0	0	0	0	4	27	4	27
Diurnal Raptors		**100**	**102**	**236**	**236**	**42**	**42**	**112**	**116**	**490**	**496**
Accipiters		*0*	*0*	*1*	*1*	*0*	*0*	*0*	*0*	*1*	*1*
sharp-shinned hawk	*Accipiter striatus*	0	0	1	1	0	0	0	0	1	1
Buteos		*73*	*75*	*114*	*114*	*14*	*14*	*59*	*63*	*260*	*266*
red-tailed hawk	*Buteo jamaicensis*	13	14	41	41	3	3	16	16	73	74
rough-legged hawk	*Buteo lagopus*	0	0	60	60	11	11	12	13	83	84
unidentified buteo	*Buteo spp*	5	6	4	4	0	0	5	5	14	15
Swainson's hawk	*Buteo swainsoni*	55	55	9	9	0	0	26	29	90	93
Northern Harrier		*14*	*14*	*96*	*96*	*15*	*15*	*44*	*44*	*169*	*169*
northern harrier	*Circus hudsonius*	14	14	96	96	15	15	44	44	169	169
Eagles		*0*	*0*	*0*	*0*	*0*	*0*	*1*	*1*	*1*	*1*
bald eagle	*Haliaeetus leucocephalus*	0	0	0	0	0	0	1	1	1	1
Falcons		*13*	*13*	*25*	*25*	*13*	*13*	*8*	*8*	*59*	*59*
merlin	*Falco columbarius*	0	0	0	0	0	0	1	1	1	1
prairie falcon	*Falco mexicanus*	0	0	1	1	2	2	0	0	3	3
American kestrel	*Falco sparverius*	13	13	21	21	9	9	7	7	50	50
unidentified falcon	*Falco* spp.	0	0	3	3	2	2	0	0	5	5
Owls		**1**	**1**	**1**	**1**	**1**	**1**	**0**	**0**	**3**	**3**
short-eared owl	*Asio flammeus*	1	1	0	0	0	0	0	0	1	1
great horned owl	*Bubo virginianus*	0	0	1	1	1	1	0	0	2	2
Vultures		**0**	**0**	**0**	**0**	**0**	**0**	**2**	**2**	**2**	**2**
turkey vulture	*Cathartes aura*	0	0	0	0	0	0	2	2	2	2

Appendix A1. Numbers of groups and observations by bird type and species for 60-minute large bird use surveys at the Badger Canyon Wind Project in Benton County, Washington from June 7, 2018 to May 28, 2019.

		Summer		Fall		Winter		Spring		Total	
Type/Species	Scientific Name	# grps	# obs	# grps	# obs	# grps	# obs	# grps	# obs	# grps	# obs
Upland Game Birds		**0**	**0**	**0**	**0**	**0**	**0**	**2**	**2**	**2**	**2**
ring-necked pheasant	*Phasianus colchicus*	0	0	0	0	0	0	2	2	2	2
Doves/Pigeons		**10**	**69**	**4**	**40**	**1**	**5**	**1**	**4**	**16**	**118**
rock pigeon	*Columba livia*	4	62	4	40	1	5	1	4	10	111
mourning dove	*Zenaida macroura*	6	7	0	0	0	0	0	0	6	7
Large Corvids		**45**	**71**	**66**	**200**	**68**	**95**	**66**	**104**	**245**	**470**
common raven	*Corvus corax*	45	71	66	200	68	95	66	104	245	470
Overall		**158**	**256**	**319**	**1,718**	**121**	**398**	**198**	**422**	**796**	**2,794**

Regardless of distance from observer

obs=observations; grps=groups

Appendix A2. Numbers of groups and observations by bird type and species for 10-minute small bird use surveys at the Badger Canyon Wind Project in Benton County, Washington from June 7, 2018 to May 28, 2019.

		Summer		Fall		Winter		Spring		Total	
Type/Species	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Passerines		**163**	**278**	**186**	**498**	**126**	**944**	**195**	**513**	**670**	**2,233**
Blackbirds/Orioles		*9*	*9*	*9*	*10*	*7*	*8*	*10*	*14*	*35*	*41*
Brewer's blackbird	*Euphagus cyanocephalus*	0	0	0	0	0	0	1	2	1	2
western meadowlark	*Sturnella neglecta*	9	9	9	10	7	8	6	7	31	34
European starling	*Sturnus vulgaris*	0	0	0	0	0	0	3	5	3	5
Finches/Crossbills		*0*	*0*	*0*	*0*	*1*	*2*	*1*	*3*	*2*	*5*
American goldfinch	*Spinus tristis*	0	0	0	0	1	2	1	3	2	5
Flycatchers		*2*	*2*	*0*	*0*	*0*	*0*	*1*	*3*	*3*	*5*
western kingbird	*Tyrannus verticalis*	2	2	0	0	0	0	1	3	3	5
Grassland/Sparrows		*146*	*244*	*173*	*478*	*117*	*932*	*181*	*483*	*617*	*2,137*
grasshopper sparrow	*Ammodramus savannarum*	6	6	0	0	0	0	2	3	8	9
American pipit	*Anthus rubescens*	0	0	3	4	0	0	0	0	3	4
horned lark	*Eremophila alpestris*	139	237	165	466	114	923	169	435	587	2,061
savannah sparrow	*Passerculus sandwichensis*	0	0	4	7	3	9	10	45	17	61
vesper sparrow	*Pooecetes gramineus*	1	1	0	0	0	0	0	0	1	1
chipping sparrow	*Spizella passerina*	0	0	1	1	0	0	0	0	1	1
Swallows		*6*	*23*	*3*	*9*	*0*	*0*	*1*	*3*	*10*	*35*
barn swallow	*Hirundo rustica*	1	4	3	9	0	0	1	3	5	16
cliff swallow	*Petrochelidon pyrrhonota*	2	12	0	0	0	0	0	0	2	12
bank swallow	*Riparia riparia*	1	3	0	0	0	0	0	0	1	3
unidentified swallow		2	4	0	0	0	0	0	0	2	4
Thrushes		*0*	*0*	*0*	*0*	*1*	*2*	*1*	*7*	*2*	*9*
American robin	*Turdus migratorius*	0	0	0	0	1	2	1	7	2	9
Unidentified Passerine		*0*	*0*	*1*	*1*	*0*	*0*	*0*	*0*	*1*	*1*
Overall		**163**	**278**	**186**	**498**	**126**	**944**	**195**	**513**	**670**	**2,233**

Regardless of distance from observe

obs=observations; grps=group.

Appendix B. Bird Use, Percent of Use, and Frequency of Occurrence for Large Birds and Small Birds Observed during Avian Use Surveys at the Badger Canyon Wind Project from June 7, 2018 – to May 28, 2019

Appendix B1. Mean use (number of birds/plot[a]/60-minute survey), percent of use, and frequency of occurrence (%) for each large bird type and species by season during the avian use surveys at the Badger Canyon Wind Project in Benton County, Washington from June 7, 2018 to May 28, 2019.

	Mean Use				% of Use				% Frequency			
Type/Species	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring
Waterbirds	**0.15**	**8.01**	**0**	**0.50**	**5.0**	**39.2**	**0**	**10.0**	**2.4**	**3.6**	**0**	**3.6**
sandhill crane	0	8.01	0	0.50	0	39.2	0	10.0	0	3.6	0	3.6
American white pelican	0.15	0	0	0	5.0	0	0	0	2.4	0	0	0
Waterfowl	**0**	**6.76**	**3.15**	**0.99**	**0**	**33.1**	**63.2**	**19.7**	**0**	**7.1**	**10.0**	**2.4**
Canada goose	0	6.76	2.26	0.57	0	33.1	45.3	11.4	0	7.1	7.1	1.2
snow goose	0	0	0.89	0	0	0	17.9	0	0	0	2.9	0
tundra swan	0	0	0	0.42	0	0	0	8.3	0	0	0	1.2
Shorebirds	**0**	**0**	**0**	**0.08**	**0**	**0**	**0**	**1.7**	**0**	**0**	**0**	**3.6**
long-billed curlew	0	0	0	0.08	0	0	0	1.7	0	0	0	3.6
Gulls/Terns	**0**	**0**	**0**	**0.74**	**0**	**0**	**0**	**14.7**	**0**	**0**	**0**	**3.6**
California gull	0	0	0	0.42	0	0	0	8.3	0	0	0	1.2
ring-billed gull	0	0	0	0.32	0	0	0	6.4	0	0	0	2.4
Diurnal Raptors	**1.23**	**2.81**	**0.53**	**1.38**	**39.9**	**13.7**	**10.6**	**27.5**	**57.8**	**79.8**	**32.1**	**66.7**
Accipiters	*0*	*0.01*	*0*	*0*	*0*	*<0.1*	*0*	*0*	*0*	*1.2*	*0*	*0*
sharp-shinned hawk	0	0.01	0	0	0	<0.1	0	0	0	1.2	0	0
Buteos	*0.90*	*1.36*	*0.19*	*0.75*	*29.4*	*6.6*	*3.7*	*14.9*	*49.4*	*51.2*	*16.2*	*39.3*
red-tailed hawk	0.17	0.49	0.04	0.19	5.6	2.4	0.8	3.8	9.8	26.2	4.0	14.3
rough-legged hawk	0	0.71	0.15	0.15	0	3.5	2.9	3.1	0	31.0	12.1	11.9
unidentified buteo	0.07	0.05	0	0.06	2.4	0.2	0	1.2	6.0	4.8	0	6.0
Swainson’s hawk	0.66	0.11	0	0.35	21.4	0.5	0	6.9	38.4	7.1	0	20.2
Northern Harrier	*0.17*	*1.14*	*0.19*	*0.52*	*5.5*	*5.6*	*3.8*	*10.4*	*10.8*	*52.4*	*16.4*	*38.1*
northern harrier	0.17	1.14	0.19	0.52	5.5	5.6	3.8	10.4	10.8	52.4	16.4	38.1
Eagles	*0*	*0*	*0*	*0.01*	*0*	*0*	*0*	*0.2*	*0*	*0*	*0*	*1.2*
bald eagle	0	0	0	0.01	0	0	0	0.2	0	0	0	1.2
Falcons	*0.16*	*0.30*	*0.15*	*0.10*	*5.0*	*1.5*	*3.1*	*1.9*	*10.8*	*27.4*	*11.9*	*9.5*
merlin	0	0	0	0.01	0	0	0	0.2	0	0	0	1.2
prairie falcon	0	0.01	0.02	0	0	<0.1	0.5	0	0	1.2	2.4	0
American kestrel	0.16	0.25	0.11	0.08	5.0	1.2	2.1	1.7	10.8	23.8	9.5	8.3
unidentified falcon	0	0.04	0.02	0	0	0.2	0.5	0	0	3.6	2.4	0
Owls	**0.01**	**0.01**	**0.01**	**0**	**0.4**	**<0.1**	**0.2**	**0**	**1.2**	**1.2**	**1.2**	**0**
short-eared owl	0.01	0	0	0	0.4	0	0	0	1.2	0	0	0
great horned owl	0	0.01	0.01	0	0	<0.1	0.2	0	0	1.2	1.2	0
Vultures	**0**	**0**	**0**	**0.02**	**0**	**0**	**0**	**0.5**	**0**	**0**	**0**	**2.4**
turkey vulture	0	0	0	0.02	0	0	0	0.5	0	0	0	2.4
Upland Game Birds	**0**	**0**	**0**	**0.02**	**0**	**0**	**0**	**0.5**	**0**	**0**	**0**	**2.4**

Appendix B1. Mean use (number of birds/plot[a]/60-minute survey), percent of use, and frequency of occurrence (%) for each large bird type and species by season during the avian use surveys at the Badger Canyon Wind Project in Benton County, Washington from June 7, 2018 to May 28, 2019.

	Mean Use				% of Use				% Frequency			
Type/Species	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring
ring-necked pheasant	0	0	0	0.02	0	0	0	0.5	0	0	0	2.4
Doves/Pigeons	**0.82**	**0.48**	**0.06**	**0.05**	**26.8**	**2.3**	**1.2**	**0.9**	**8.4**	**4.8**	**1.2**	**1.2**
rock pigeon	0.74	0.48	0.06	0.05	24.0	2.3	1.2	0.9	2.4	4.8	1.2	1.2
mourning dove	0.08	0	0	0	2.8	0	0	0	6.0	0	0	0
Large Corvids	**0.86**	**2.38**	**1.24**	**1.24**	**27.9**	**11.6**	**24.8**	**24.6**	**36.4**	**48.8**	**52.4**	**57.1**
common raven	0.86	2.38	1.24	1.24	27.9	11.6	24.8	24.6	36.4	48.8	52.4	57.1
Overall	**3.07**	**20.45**	**4.99**	**5.02**	**100**	**100**	**100**	**100**				

[a] 800-meter radius plot for large birds

Appendix B2. Mean bird use (number of birds/plot[a]/10-minute survey), percent of use, and frequency of occurrence (%) for each small bird type and species by season during the avian use surveys at the Badger Canyon Wind Project in Benton County, Washington from June 7, 2018 to May 28, 2019.

	Mean Use				% of Use				% Frequency			
Type/Species	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring
Passerines	**3.35**	**5.93**	**13.81**	**6.11**	**100**	**100**	**100**	**100**	**70.0**	**72.6**	**63.8**	**83.3**
Passerines(Subtype)	*0*	*0.01*	*0*	*0*	*0*	*0.2*	*0*	*0*	*0*	*1.2*	*0*	*0*
unidentified passerine	0	0.01	0	0	0	0.2	0	0	0	1.2	0	0
Blackbirds/Orioles	*0.11*	*0.12*	*0.10*	*0.17*	*3.3*	*2.0*	*0.7*	*2.7*	*9.8*	*9.5*	*4.0*	*10.7*
Brewer's blackbird	0	0	0	0.02	0	0	0	0.4	0	0	0	1.2
western meadowlark	0.11	0.12	0.10	0.08	3.3	2.0	0.7	1.4	9.8	9.5	4.0	6.0
European starling	0	0	0	0.06	0	0	0	1.0	0	0	0	3.6
Finches/Crossbills	*0*	*0*	*0.02*	*0.04*	*0*	*0*	*0.2*	*0.6*	*0*	*0*	*1.2*	*1.2*
American goldfinch	0	0	0.02	0.04	0	0	0.2	0.6	0	0	1.2	1.2
Flycatchers	*0.02*	*0*	*0*	*0.04*	*0.7*	*0*	*0*	*0.6*	*1.2*	*0*	*0*	*1.2*
western kingbird	0.02	0	0	0.04	0.7	0	0	0.6	1.2	0	0	1.2
Grassland/Sparrows	*2.94*	*5.69*	*13.66*	*5.75*	*87.7*	*96.0*	*98.9*	*94.2*	*63.9*	*70.2*	*63.8*	*81.0*
grasshopper sparrow	0.07	0	0	0.04	2.2	0	0	0.6	3.7	0	0	1.2
American pipit	0	0.05	0	0	0	0.8	0	0	0	3.6	0	0
horned lark	2.85	5.55	13.55	5.18	85.1	93.6	98.2	84.8	63.9	69.0	63.8	77.4
savannah sparrow	0	0.08	0.11	0.54	0	1.4	0.8	8.8	0	4.8	2.4	10.7
vesper sparrow	0.01	0	0	0	0.4	0	0	0	1.2	0	0	0
chipping sparrow	0	0.01	0	0	0	0.2	0	0	0	1.2	0	0

Appendix B2. Mean bird use (number of birds/plot[a]/10-minute survey), percent of use, and frequency of occurrence (%) for each small bird type and species by season during the avian use surveys at the Badger Canyon Wind Project in Benton County, Washington from June 7, 2018 to May 28, 2019.

	Mean Use				% of Use				% Frequency			
Type/Species	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**
Swallows	*0.28*	*0.11*	*0*	*0.04*	*8.3*	*1.8*	*0*	*0.6*	*7.2*	*3.6*	*0*	*1.2*
barn swallow	0.05	0.11	0	0.04	1.4	1.8	0	0.6	1.2	3.6	0	1.2
cliff swallow	0.15	0	0	0	4.4	0	0	0	2.4	0	0	0
bank swallow	0.04	0	0	0	1.1	0	0	0	1.2	0	0	0
unidentified swallow	0.05	0	0	0	1.5	0	0	0	2.4	0	0	0
Thrushes	*0*	*0*	*0.02*	*0.08*	*0*	*0*	*0.2*	*1.4*	*0*	*0*	*1.2*	*1.2*
American robin	0	0	0.02	0.08	0	0	0.2	1.4	0	0	1.2	1.2
Unidentified Passerine	*0*	*0.01*	*0*	*0*	*0*	*0.2*	*0*	*0*	*0*	*1.2*	*0*	*0*
Overall	**3.35**	**5.93**	**13.81**	**6.11**	**100**	**100**	**100**	**100**				

[a] 100-meter radius plot for small birds.

Appendix C. Mean Use by Point for All Birds, Bird Types, and Diurnal Raptor Subtypes during Avian Use Surveys at the Badger Canyon Wind Project from June 7, 2018 – to May 28, 2019

Appendix C. Mean use (number of large birds/60-minute survey; number of small birds/10-minute survey) by point for large bird types, diurnal raptor subtypes, all large birds, and all small birds at the Badger Canyon Wind Project, Benton County, Washington from June 7, 2018 to May 28, 2019.

Obs. Pt.	Waterbirds	Waterfowl	Shorebirds	Gulls/Terns	Diurnal Raptors	*Accipiters*	*Buteos*	*Northern Harrier*	*Eagles*	*Falcons*	Owls	Vultures	Upland Game Birds	Doves/ Pigeons	Large Corvids	All Large Birds	All Small Birds
1	0	0	0	0	0.91	*0*	*0.36*	*0.27*	*0*	*0.27*	0	0	0	0	1.36	2.27	13.73
2	1	0	0	0	0.67	*0*	*0.33*	*0.25*	*0*	*0.08*	0	0	0	0	0.83	2.50	6.33
3	0	0	0	0	1.00	*0*	*0.67*	*0.17*	*0*	*0.17*	0	0	0	0	0.67	1.67	9.33
4	0	0	0	0	1.08	*0*	*0.42*	*0.42*	*0*	*0.25*	0	0	0	0	0.42	1.50	10.50
5	17.58	0	0	0	1.17	*0.08*	*0.67*	*0.08*	*0*	*0.33*	0	0	0	0	1.33	20.08	3.75
6	0	0	0	0	0.67	*0*	*0.25*	*0.17*	*0*	*0.25*	0	0	0	0	1.42	2.08	5.08
7	1.25	0	0	0	0.92	*0*	*0.58*	*0.25*	*0*	*0.08*	0	0	0	0	10.08	12.25	9.33
8	0	2.18	0	0	1.36	*0*	*0.55*	*0.82*	*0*	*0*	0	0	0.09	0	2.00	5.64	2.18
9	0	0	0	0	0.36	*0*	*0.27*	*0*	*0*	*0.09*	0	0	0	0	0.18	0.55	3.18
10	0	0.83	0	0	1.50	*0*	*0.83*	*0.25*	*0*	*0.42*	0	0	0	0.17	0.25	2.75	2.08
11	0	0	0	0	1.42	*0*	*0.92*	*0.33*	*0*	*0.17*	0	0	0	0	2.25	3.67	4.50
12	0	0	0	0	1.33	*0*	*0.5*	*0.67*	*0*	*0.17*	0	0	0	0.08	0.42	1.83	6.42
13	0	0	0	0	1.83	*0*	*0.92*	*0.92*	*0*	*0*	0	0	0	0.08	1.17	3.08	12.67
14	0	0	0.09	0	0.82	*0*	*0.27*	*0.45*	*0*	*0.09*	0	0	0	0	1.55	2.45	2.73
15	0	0	0	1.27	2.36	*0*	*1.27*	*1.00*	*0*	*0.09*	0.27	0.09	0	0.36	1.00	5.36	3.55
16	0	0	0	2.92	1.58	*0*	*1.08*	*0.42*	*0*	*0.08*	0	0	0	0	1.42	5.92	3.58
17	2	0	0	0	2.25	*0*	*1.58*	*0.5*	*0*	*0.17*	0	0.08	0	0	2.58	6.92	5.67
18	0	18	0	0	2.82	*0*	*1.09*	*1.55*	*0*	*0.18*	0	0	0	0	1.00	21.82	5.27
19	0	2.08	0	0	2.17	*0*	*1.17*	*0.83*	*0*	*0.17*	0	0	0	4.75	0.58	9.58	6.67
20	0	3.50	0	0	1.75	*0*	*1.00*	*0.58*	*0.08*	*0.08*	0	0	0	0	1.58	6.83	8.83
21	0	12.50	0	0	3.08	*0*	*2.08*	*0.42*	*0*	*0.58*	0	0	0	1.58	0.33	17.50	3.08
22	0.25	4.08	0	1.08	2.58	*0*	*1.33*	*1.25*	*0*	*0*	0	0	0	0	0.75	8.75	22.58
23	25.00	9.17	0.42	0	1.83	*0*	*1.25*	*0.42*	*0*	*0.17*	0	0	0	0	0.33	36.75	11.08
24	0	17.55	0	0	1.45	*0*	*0.73*	*0.64*	*0*	*0.09*	0	0	0.09	3.09	1.91	24.09	10.18
25	13.58	0	0	0	1.58	*0*	*1.17*	*0.33*	*0*	*0.08*	0	0	0	0	1.92	17.08	4.67
26	0	0	0.09	0	2.00	*0*	*0.09*	*1.55*	*0*	*0.36*	0	0	0	0	0.91	3.00	1.45
27	0	7.17	0	0	0.50	*0*	*0.50*	*0*	*0*	*0*	0	0	0	0	0.83	8.50	7.00
28	0	1.73	0	0	1.45	*0*	*0.73*	*0.09*	*0*	*0.64*	0	0	0	0	1.00	4.18	4.55

Appendix D. Fatality Summary Table for the Pacific Northwest Region of North America

Appendix D. Publicly available and comparable all bird and diurnal raptor fatality estimates and habitat types from wind energy facilities in the Pacific Northwest (Oregon and Washington) region of North America.

Project Name	All Bird Fatality Rate (birds/MW/year)	Diurnal Raptor Fatality Rate (raptors/MW/year)	Predominant Habitat Type	Citation
Big Horn, WA (2006-2007)	2.54	0.11	agriculture/grassland	Kronner et al. 2008
Biglow Canyon, OR (Phase I; 2008)	1.76	0.03	agriculture/grassland	Jeffrey et al. 2009a
Biglow Canyon, OR (Phase I; 2009)	2.47	0	agriculture	Enk et al. 2010
Biglow Canyon, OR (Phase II; 2009-2010)	5.53	0.14	grassland/shrub-steppe, agriculture	Enk et al. 2011a
Biglow Canyon, OR (Phase II; 2010-2011)	2.68	0.03	grassland/shrub-steppe, agriculture	Enk et al. 2012a
Biglow Canyon, OR (Phase III; 2010-2011)	2.28	0.05	grassland/shrub-steppe, agriculture	Enk et al. 2012b
Combine Hills, OR (2011)	2.33	0.05	agriculture/grassland	Enz et al. 2012
Combine Hills, OR (Phase I; 2004-2005)	2.56	0	shrub/scrub & agriculture	Young et al. 2006
Elkhorn, OR (2008)	0.64	0.06	shrub/scrub & agriculture	Jeffrey et a. 2009b
Elkhorn, OR (2010)	1.95	0.08	agriculture	Enk et al. 2011b
Goodnoe, WA (2009-2010)	1.4	0.17	agriculture/grassland	URS Corporation (URS) 2010a
Harvest Wind, WA (2010-2012)	2.94	0.23	agriculture/grassland	Downes and Gritski 2012a
Hay Canyon, OR (2009-2010)	2.21	0	grassland/shrub-steppe and agriculture	Gritski and Kronner 2010a
Hopkins Ridge, WA (2006)	1.23	0.14	agriculture/grassland	Young et al. 2007
Hopkins Ridge, WA (2008)	2.99	0.07	agriculture	Young et al. 2009
Kittitas Valley, WA (2011-2012)	1.06	0.09	grassland	Stantec Consulting Services 2012
Klondike II, OR (2005-2006)	3.14	0.06	agriculture/grassland	Northwest Wildlife Consultants (NWC) and WEST 2007
Klondike III (Phase I), OR (2007-2009)	3.02	0.15	agriculture/grassland	Gritski et al. 2010
Klondike IIIa (Phase II), OR (2008-2010)	2.61	0.06	grassland and shrub-steppe	Gritski et al. 2011
Klondike, OR (2002-2003)	0.95	0	grassland/shrub-steppe	Johnson et al. 2003
Leaning Juniper, OR (2006-2008)	6.66	0.16	agriculture/grassland	Gritski et al. 2008
Linden Ranch, WA (2010-2011)	6.65	0.27	agriculture/grassland	Enz and Bay 2011
Marengo I, WA (2009-2010)	0.27	0	sagebrush-steppe, grassland	URS 2010b
Marengo II, WA (2009-2010)	0.16	0.05	grassland/shrub-steppe, agriculture	URS 2010c
Nine Canyon, WA (2002-2003)	2.76	0.03	agriculture	Erickson et al. 2003c

Appendix D. Publicly available and comparable all bird and diurnal raptor fatality estimates and habitat types from wind energy facilities in the Pacific Northwest (Oregon and Washington) region of North America.

Project Name	All Bird Fatality Rate (birds/MW/year)	Diurnal Raptor Fatality Rate (raptors/MW/year)	Predominant Habitat Type	Citation
Pebble Springs, OR (2009-2010)	1.93	0.04	agriculture	Gritski and Kronner 2010b
Stateline, OR/WA (2001-2002)	3.17	0.09	agriculture/grassland	Erickson et al. 2004
Stateline, OR/WA (2003)	2.68	0.09	Cropland, Developed, Grassland, Shrub Steppe, Winter Wheat	Erickson et al. 2004
Stateline, OR/WA (2006)	1.23	0.11	grassland/shrub-steppe, agriculture and forest	Erickson et al. 2007
Tucannon River, WA (2015)	1.5	0.16	Shrub-steppe, grassland	Hallingstad et al. 2016
Tuolumne (Windy Point I), WA (2009-2010)	3.2	0.29	grassland/shrub-steppe, agriculture	Enz and Bay 2010
Vansycle, OR (1999)	0.95	0	grassland	Erickson et al. 2000
Vantage, WA (2010-2011)	1.27	0.29	grassland/shrub-steppe, agriculture	Ventus Environmental Solutions 2012
White Creek, WA (2007-2011)	4.05	0.47	agriculture/grassland	Downes and Gritski 2012b
Wild Horse, WA (2007)	1.55	0.09	agriculture/grassland	Erickson et al. 2008
Windy Flats, WA (2010-2011)	8.45	0.04	agriculture/grassland	Enz et al. 2011

MW = megawatt

Avian Use Surveys at the Four Mile Wind Project, Benton County, Washington

Final Report

June 2018 – May 2019

Prepared for:

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Public Draft - For Distribution

EXECUTIVE SUMMARY

Four Mile MW LLC (Four Mile) is proposing to develop the Four Mile Wind Project (Project) in Benton County, Washington. To support the development of the Project, Four Mile contracted Western EcoSystems Technology, Inc. to conduct a pre-construction avian use study in the area where the Project is proposed (Study Area). The principle objective of the study was to assess the temporal and spatial use of the Study Area by large and small birds, including eagles and other species of regulatory or conservation concern.

Fixed-point avian surveys were conducted at 27 points (26 points located throughout the Study Area and one point southwest of the Study Area) from June 5, 2018 to May 29, 2019. Two separate surveys were conducted at each point every month: a 10-minute (min) small bird survey followed immediately by a 60-min large bird survey. Over the course of the study, 309 large bird surveys were completed and a total of 16,281 large bird observations representing 26 separate species were recorded. Large bird use was highest in winter, largely due to higher use by waterfowl which composed 94.1% of large bird use during that season. Flight paths for several species of waterfowl (Canada goose and snow goose) and waterbirds (American white pelican) were concentrated in the eastern third of the Study Area, likely due to its proximity to the Columbia River.

Diurnal raptor use was highest in fall (3.69 birds/plot/60-min survey) and lowest in summer (1.06). Eleven separate diurnal raptor species were recorded during surveys, the most abundant of which were northern harrier, red-tailed hawk, and rough-legged hawk which collectively composed 79.5% of all diurnal raptor observations. A total of five bald eagle observations were recorded during surveys, including four observations in winter and one in spring. Bald eagle observations recorded during the study resulted in a total of 10 eagle exposure minutes. Diurnal raptors were observed at all 27 survey points; however, relatively higher raptor use was recorded in the eastern portion of the Study Area with the highest use was recorded at Point 17. Annual mean raptor use at the Project was scaled to 20-min to compare with other wind energy sites in Washington and Oregon that implemented similar protocols and had data for three or four seasons. Diurnal raptor use at the Project (0.90 raptors/plot/20-min) fell within the range of the 23 other wind energy sites evaluated in the Pacific Northwest, ranking second from the highest.

Over the course of the 309 small bird surveys conducted during the study, a total of 1,632 small bird observations, representing 21 separate species, were recorded. The most abundant small bird species recorded was horned lark (1,125 observations) which composed 68.9% of all small bird observations. Three species, western meadowlark, European startling, and bank swallow composed an additional 18.0% of small bird observations. The highest small bird use was recorded in fall (6.49 birds/plot/10-min survey), followed by winter (5.81), spring (5.56), and summer (3.60). Small bird use varied widely across the 27 survey points, ranging from 0.58 to 17.58 birds/10-min survey; however, no obvious spatial patterns in use were evident.

During surveys or incidentally, six bird species of concern were recorded within the Study Area including one state-endangered species (sandhill crane), one state-threatened species (American white pelican), and two state candidates for listing (loggerhead shrike and sage thrasher). Each of these species, in addition to prairie falcon, is also considered a state Priority Species. Bald eagle is protected under the federal Bald and Golden Eagle Protection Act.

To date, overall fatality rates for birds at wind energy facilities in the Pacific Northwest with publicly available data have been variable, ranging from 0.16 to 8.45 birds/megawatt (MW)/year, with fatality rates for diurnal raptors ranging from zero to 0.47 bird/MW/year. The Study Area is dominated by agricultural cover types (i.e., cultivated cropland) of limited value to most avian species, particularly species of conservation concern. While several species of concern were documented during the study, these observations were not unexpected for the region and most of these species are believed to at relatively low risk from Project development and operation given their use of the Study Area, and known interactions with wind turbines in the region. One species of particular concern at the Project is American white pelican. Relatively large numbers of the species were documented flying at rotor-swept height through the eastern third of the Study Area suggesting this species may be at risk of collision with turbine blades.

STUDY PARTICIPANTS

Andrea Chatfield	Project Manager
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REPORT REFERENCE

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INTRODUCTION

Four Mile MW LLC (Four Mile) is proposing the development of the Four Mile Wind Project (Project) in Benton County, Washington. To support the development of the Project, Four Mile contracted Western EcoSystems Technology, Inc. (WEST) to conduct a pre-construction avian use study in the area where the Project is proposed (Study Area). Study methodology was based upon the recommendations in the US Fish and Wildlife Service (USFWS) 2012 *Final Land-Based Wind Energy Guidelines* (WEG; USFWS 2012), Appendix C(1)(a) of the 2013 USFWS *Eagle Conservation Plan Guidelines* (ECPG; USFWS 2013), the USFWS *Revisions to Regulations for Eagle Incidental Take and Take of Eagle Nests* (Final Eagle Rule; 81 FR 91494 [December 16, 2016]), and the Washington Department of Fish and Wildlife (WDFW) Wind Power Guidelines (WDFW 2009). The principle objective of the study was to assess the temporal and spatial use of the Study Area by large and small birds, including eagles and other species of concern (USFWS 2012). This report summarizes methods and results from the year-long avian use study conducted at the proposed Project.

STUDY AREA

The Study Area encompasses 14,563 hectares (35,987 acres) of privately owned and state-owned land within Benton County in southeastern Washington, approximately 11.3 kilometers (km; 7.0 miles [mi]) south of the city of Kennewick (Figure 1). Topography within the Study Area generally consists of rolling hills bisected by meandering canyons that drain primarily to the south and east into the Columbia River. Elevations range from approximately 192 meters (m; 630 feet [ft]) along the northeastern boundary of the Study Area to 613 m (2,010 ft) in the northwest. The eastern boundary of the Study Area lies adjacent to the Columbia River as it bends around the Study Area from the north to the southwest. The 96-megawatt (MW) Nine Canyon wind energy facility (Nine Canyon) is located immediately to the north of the Study Area and the 300-MW Stateline wind energy facility (Stateline) is located approximately 6.4 km (4.0 mi) to the southeast.

Historically, the native vegetation of the Study Area consisted of a bluebunch wheatgrass (*Pseudoroegneria spicata*)-Idaho fescue (*Festuca idahoensis*) zonal association, which was predominately grassland and shrub-steppe with deciduous riparian forest and scrub along drainages (Franklin and Dyrness 1973). Today, native grassland and shrub-steppe habitats have been replaced by tilled dry-land agriculture (primarily wheat) with a smaller amount of uncultivated grassland, the majority of which is managed as part of the US Department of Agriculture Farm Service Agency's Conservation Reserve Program. Based on vegetation and land cover mapping conducted within the Study Area, four vegetation/land cover types were identified within the Study Area (Chatfield and Brown 2018). The predominant land cover type was agriculture, encompassing 53.2% of the total Study Area. Agricultural areas within the Study Area were primarily cultivated croplands consisting of dryland wheat, and were more extensive in the central portions of the Study Area. This was followed by grasslands which encompassed a further 29.5% of the Study Area (Figure 2). Smaller areas of remnant shrub-steppe (16.5% of the Study Area) were located primarily in the northeastern and western portions of the Study Area (Figure 2).

Developed areas, including Highway 82 and individual structures, residences, and farms, were scattered throughout the area and composed the remaining 0.9% of the Study Area (Figure 2). Although the areas containing shrub-steppe are relatively small, shrub-steppe is considered an important habitat type for avian species, providing critical nesting and foraging opportunities (WDFW 2009). Trees primarily associated with farms and residences are scattered throughout the Study Area.

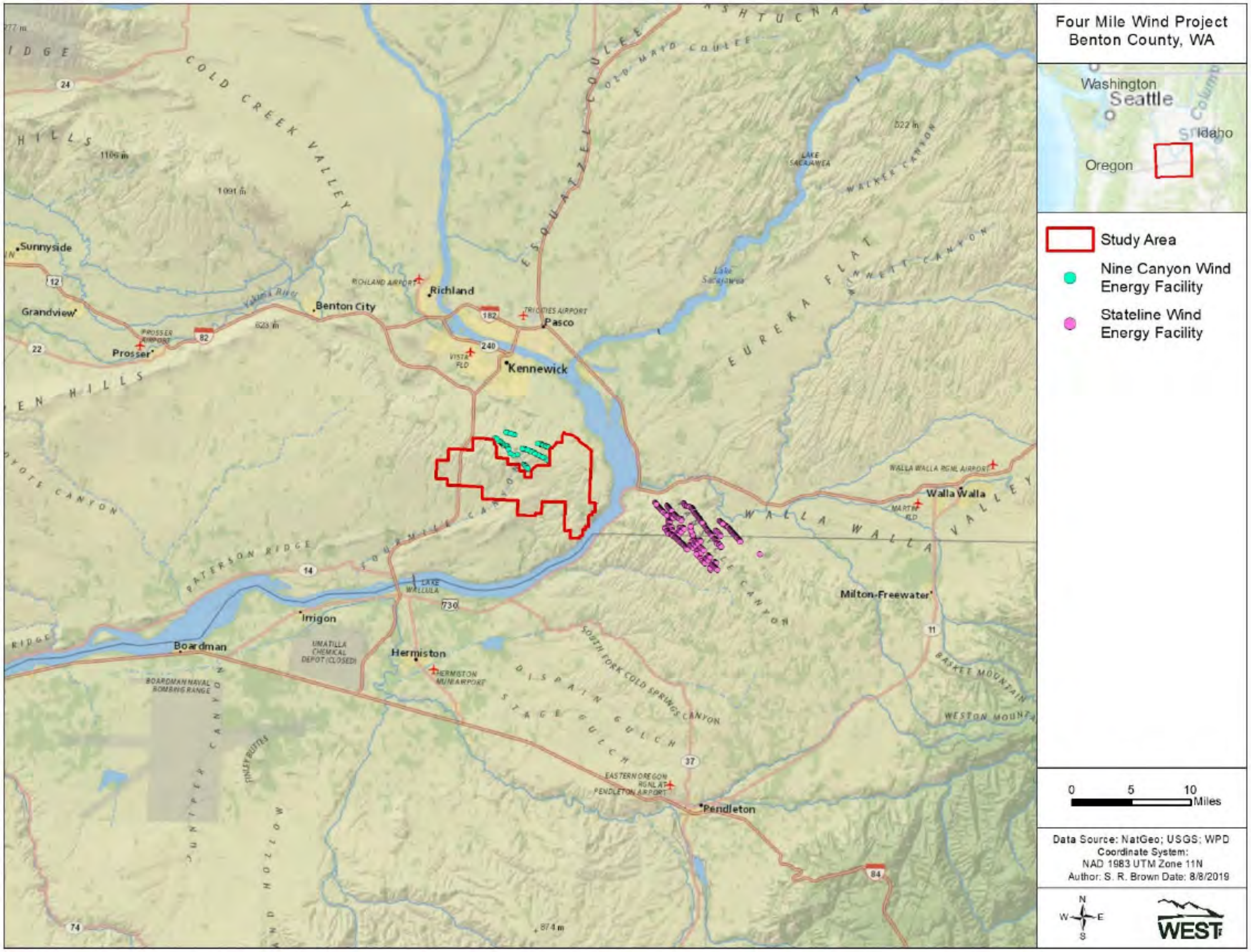

Figure 1. Location of the proposed Four Mile Wind Project, Benton County, Washington.

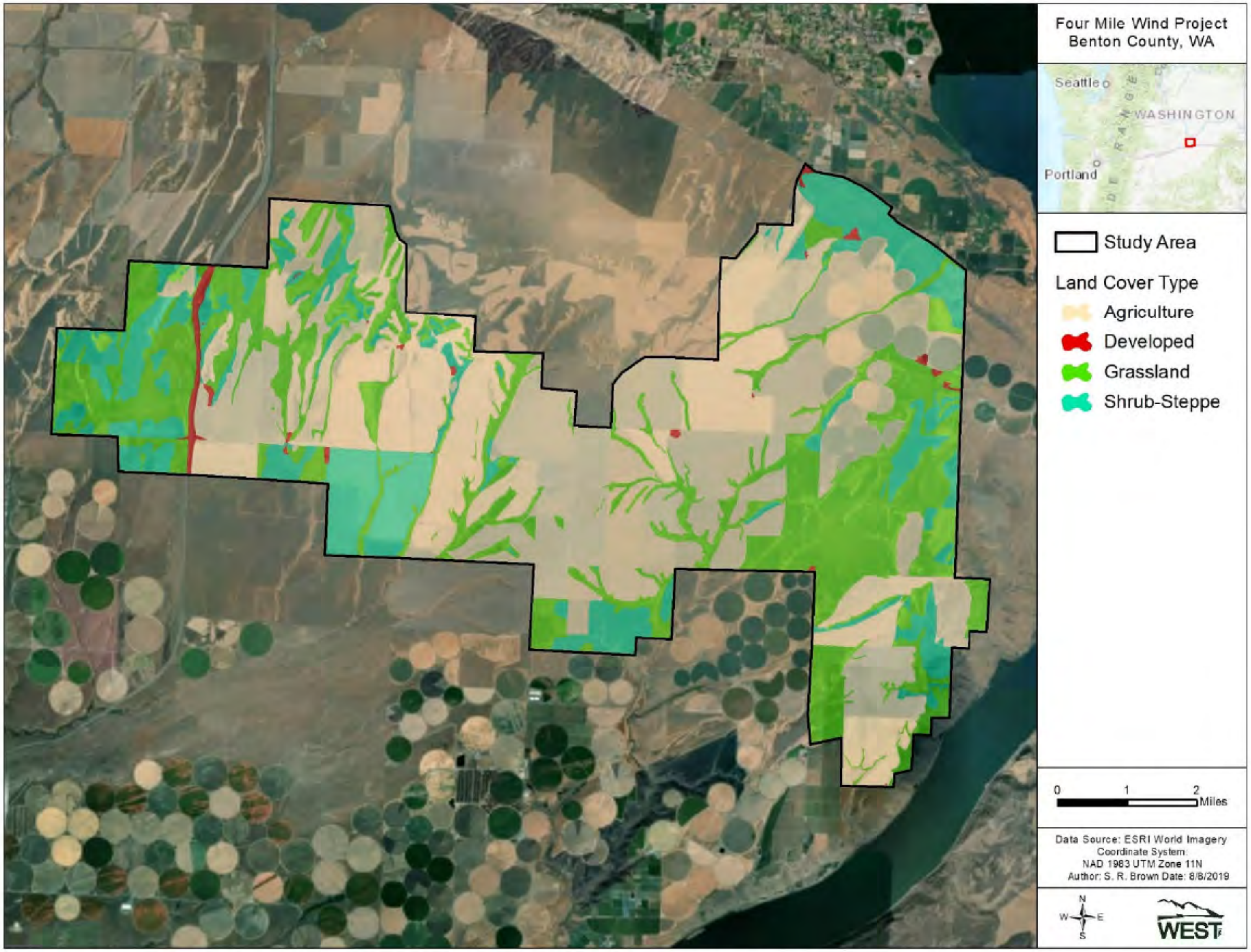

Figure 2. Land cover types and coverage within the Four Mile Wind Project Study Area, Benton County, Washington.

METHODS

Because of the need to collect information recommended by the USFWS specifically for eagles, the study design and survey methods primarily followed guidance from the ECPG and the Final Eagle Rule; however, this guidance is also appropriate for collecting data on other large bird species (e.g., other diurnal raptors, waterfowl, waterbirds). Because of the additional need to collect information on small bird species, small bird surveys were incorporated into the study design using guidance from the WEG and WDFW Wind Power Guidelines. Methods described below, therefore, are common for all birds (i.e., large and small birds, eagles, and other species of concern) except as noted.

Species of concern are defined per the WEG as any species that 1) is either a) listed as an endangered, threatened or candidate species under the Endangered Species Act, subject to the Migratory Bird Treaty Act (1918) or Bald and Golden Eagle Protection Act (BGEPA; 1940); b) is designated by law, regulation, or other formal process for protection and/or management by the relevant agency or other authority; or c) has been shown to be significantly adversely affected by wind energy development, and 2) is determined to be possibly affected by the Project (USFWS 2012).

Large birds are defined as waterbirds, waterfowl, shorebirds, gulls/terns, diurnal raptors (i.e., kites, accipiters, buteos, eagles, falcons, northern harrier, and osprey), owls, vultures, upland game birds, doves/pigeons, goatsuckers, large corvids (e.g., magpies, crows, and ravens). Small birds are defined as cuckoos, swifts/hummingbirds, woodpeckers, kingfishers, and passerines.

Study Design

Twenty-six survey points were established in the Study Area to achieve a minimum of 30% coverage as recommended in the Final Eagle Rule (81 FR 91494 [December 16, 2016]; Figure 3). An additional point (Point 27; Figure 3) was established approximately 7.1 km (4.4 mi) to the southwest of the Study Area in another area under evaluation by Four Mile. Each point was centered on a circular survey plot with an 800-m (2,625-ft) radius for large birds (including eagles) and 100-m (328-ft) radius for small birds (Reynolds et al. 1980, USFWS 2013, 81 FR 91494 [December 16, 2016]).

Surveys at all 27 points were conducted once per month during all seasons, as specified in the ECPG (USFWS 2013) and Final Eagle Rule (81 FR 91494 [December 16, 2016]), from June 5, 2018 to May 29, 2019. Seasons were defined: summer (June 1 – August 31), fall (September 1 – November 30), winter (December 1 – February 28), and spring (March 1 – May 31). Surveys were conducted during daylight hours and survey times at survey points were randomized to cover all daylight hours during a season. Surveys were conducted under all weather conditions except when visibility was less than 800 m horizontally and 200 m (656 ft) vertically.

Survey Methods

All Birds

Surveys at each point were conducted for a period of 70 minutes (min), with only small birds recorded during the first 10 min of the survey period, and only large birds (including eagles) recorded for the remaining 60 min of the survey period. Biologists recorded the following information for each survey: date, start and end time, and weather (i.e., temperature, wind speed, wind direction, precipitation, and percent cloud cover). Additionally, the following data were recorded for each group of birds observed:

- Observation number
- Species (or best possible identification)
- Number of individuals
- Sex and age class (if identifiable)
- Distance from survey plot center to the nearest 5-m (16-ft) interval (first and closest)
- Flight height above ground level (AGL) to the nearest 5-m interval (first, lowest, and highest)
- Flight direction (first observed)
- Habitat
- Activity (e.g., flying, perched)
- Observation type (visual or aural)
- Flight paths and perch locations of eagles, other diurnal raptors, waterbirds and waterfowl

Eagles

Data were collected based on the recommendations in the ECPG (USFWS 2013) and the Final Eagle Rule (81 FR 91494 [December 16, 2016]) if a bald eagle (*Haliaeetus leucocephalus*) or golden eagle (*Aquila chrysaetos*) was observed during the survey period. Biologists recorded eagle behavior (i.e., flight height, distance from observer, activity) each minute, at the top of the minute, to provide an instantaneous count for every eagle observed, and age class (juvenile [1st year], immature or sub-adult [2nd to 4th year], adult [≥5th year]).

Incidental Observations

Incidental wildlife observations are wildlife seen outside of the standardized survey periods but within the Study Area and are focused on federal- or state-protected species, unusually large congregations of individuals, species not yet recorded during surveys, or eagle attractants (e.g., ground squirrel [*Urocitellus* spp.] colonies, areas with concentration of carrion). Data recorded for incidentally observed species were similar to that recorded during scheduled surveys, with the exception that minute by minute data were not recorded for eagles observed incidentally.

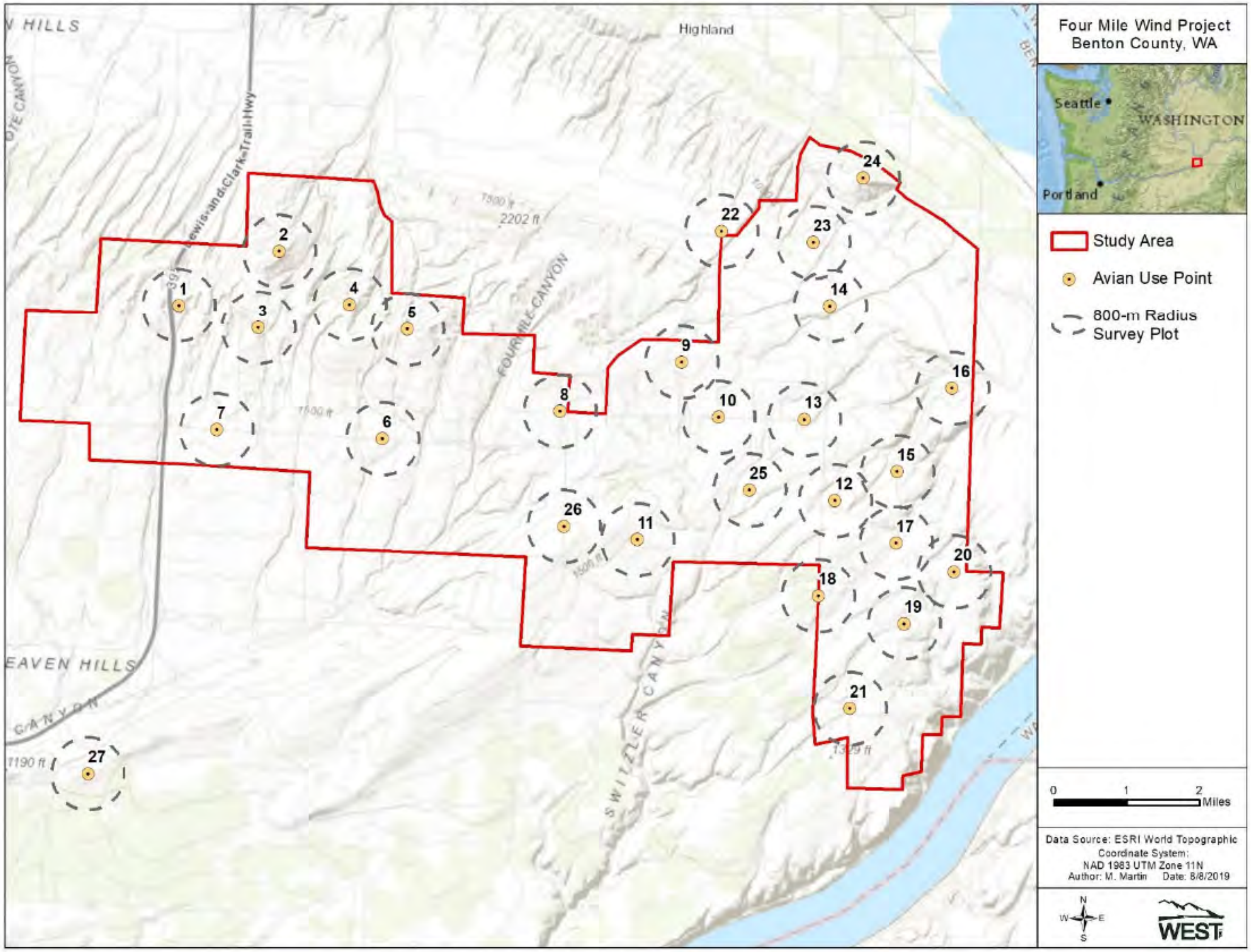

Figure 3. Location of survey points and plots used during fixed-point avian use surveys at the Four Mile Wind Project from June 5, 2018 to May 29, 2019.

Data Management

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 surveys, biologists were responsible for inspecting data forms for completeness, accuracy, and legibility. If errors or anomalies were found within the data, follow-up measures were implemented including discussions and review of field data with field technicians and/or project managers. Any errors, omissions, or problems identified in later stages of analysis were traced back to the raw data forms where appropriate changes and measures were implemented. Multiple reviews were conducted as part of the QA/QC process.

Data Compilation and Storage

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

Statistical Analysis

A visit was defined as surveying all of the survey plots once and could occur across multiple dates but had to be completed in a single season (e.g., spring). If extreme weather conditions prevented all plots from being surveyed during a visit, then a visit might not have constituted a complete survey of all plots. A survey was defined as a single 10-min or 60-min count of birds. In some cases, a count of bird observations may represent repeated observations of the same individual. Only observations within the survey plot were included for data analysis.

Mean Use, Percent of Use, and Frequency of Occurrence

Mean use is the average number of birds observed per plot per survey for small or large birds. Small bird use (per 100-m plot per 10-min survey) and large bird use (per 800-m plot per 60-min survey) is calculated by: 1) summing birds per plot per visit, 2) averaging number of birds over plots within a visit, and 3) averaging number of birds across visits within a season. Overall mean use was calculated as a weighted average of seasonal values by the number of days in each season. Percent of use was calculated as the percentage of small or large bird use that was attributable to a particular bird type or species. Frequency of occurrence was calculated as the percent of surveys in which a particular bird type or species was observed.

Mean use and frequency of occurrence describe different aspects of relative abundance, in that mean use is based on the number of birds (i.e., large groups can produce high estimates), whereas frequency of occurrence is based on the number of groups (i.e., it is not influenced by group size). Qualitative comparisons were made with these metrics among bird types, seasons, and survey points to help understand how birds are using the Project area over time and space.

Flight Height

Bird flight heights are important metrics to assess relative potential exposure to turbine blades and were used to calculate the percentage of eagles and other large birds observed flying within the rotor-swept height (RSH) of proposed turbines. A RSH of 25 to 150 m (82 to 492 ft) AGL was assumed for the purpose of the analysis. Flight height recorded during the initial observation was used to calculate mean flight height and the percentage of birds flying within the RSH.

Spatial Use

Mean use was calculated by survey point for large birds, small birds, and eagles to make spatial comparisons among the survey points. Additionally, flight paths of eagles, other diurnal raptors, waterbirds, and waterfowl were mapped during large bird use surveys to qualitatively show flight path location compared to Project area characteristics (e.g., topographic features) to identify if there were areas of concentration or consistent flight patterns within the Study Area.

Eagles

Eagle observations during surveys were summarized to provide flight heights (see Flight Height) and flight path maps (see Spatial Use). Minute data were examined to count eagle exposure minutes, defined as the number of minutes an eagle was observed in flight within the risk cylinder (defined as the area within 800 m of the survey point and up to 200 m AGL during the 60-min survey periods). The eagle exposure minutes per survey hour were reported by survey plot and month to enable spatial and temporal assessments of eagle exposure minutes recorded in the Study Area. Observations of perched eagles and those outside of survey plots were not considered eagle exposure minutes; however, the perch locations and flight paths of all eagles were mapped to qualitatively assess areas of eagle use within the Study Area.

RESULTS

Overall, 309 avian use surveys were conducted for large birds and 309 surveys were conducted for small birds (Table 1). Survey results are summarized below, supplemented by the appendices, which present species-level detail on numbers of groups and observations within the survey plot by season (Appendices A1 and A2), avian use, percent of use, and frequency of occurrence by season (Appendices B1 and B2), and mean use by survey point (Appendix C).

Table 1. Summary of survey effort at the Four Mile Wind Project in Benton County, Washington from June 5, 2018 to May 29, 2019.

	Large Birds		Small Birds	
Season[1]	**# Visits**[2]	**# Surveys**[3]	**# Visits**[2]	**# Surveys**[3]
Summer	3	79	3	79
Fall	3	81	3	81
Winter	3	69	3	69
Spring	3	80	3	80
Overall	**12**	**309**	**12**	**309**

[1] Season dates: Summer (June 1 – August 31), Fall (September 1 – November 30), Winter (December 1 – February 28), Spring (March 1 – May 31).

[2] A visit was defined as surveying all of the survey plots once within the Study Area and could occur across multiple dates but had to be completed in a single season.

[3] A survey was defined as a single 10-min or 60-min count of birds.

Large Birds

Twenty-six large bird species were observed or heard over the 309 hours of surveys during the year-long study. The greatest number of species was recorded in spring (18) followed by fall (17), winter (16), and summer (13; Appendix A1). The most abundant large bird species was snow goose (*Chen caerulescens*; 11,805 observations in 53 separate groups), followed by Canada goose (*Branta canadensis*; 1,315 observations in 28 separate groups; Appendix A1). Together, these two waterfowl species composed 80.6% of all large bird observations and 94.0% of large bird observations in winter (Appendix A1). Waterbirds, represented by two species, composed another 7.3% of overall large bird observations: sandhill crane (*Antigone canadensis*; 383 observations in three groups) and American white pelican (*Pelecanus erythrorhynchos*; 808 observations in 68 groups; Appendix A1). Diurnal raptors represented 3.9% of large bird observations and the most abundant raptor species were northern harrier (*Circus hudsonius*; 225 observations), red-tailed hawk (*Buteo jamaicensis*; 177 observations), and rough-legged hawk (*B. lagopus*; 99 observations; Appendix A1).

Mean Use, Percent of Use, and Frequency of Occurrence

Mean use, percent of use, and frequency of occurrence were calculated by season for large bird types (Figures 4a, 4b, 4c) and species (Appendices B1). Large bird mean use (observations/800-m plot/60-min survey) was highest during winter (160.00), followed by fall (23.10), spring (22.38), and summer (11.71; Figure 4a, Appendix B1). Among large bird types, waterfowl composed the greatest percentage of use in fall, winter, and spring (44.2%, 94.1%, and 74.0%, respectively), while waterbirds composed the greatest percentage of use in summer (77.0%; Figure 4b, Appendix B1). Diurnal raptors composed between 1.2% and 16.0% of total large bird use during each season (Figure 4b, Appendix B1). Diurnal raptors and large corvids were the most frequently observed large bird types during all seasons, with diurnal raptors recorded during 55.7% to 91.4% of surveys seasonally and large corvids observed during 31.6% to 80.8% of surveys seasonally (Figure 4c, Appendix B1). Alternatively, waterbirds were recorded during less than 30.0% of surveys each season and waterfowl were recorded during less than 34.0% of surveys each season (Figure 4c, Appendix B1).

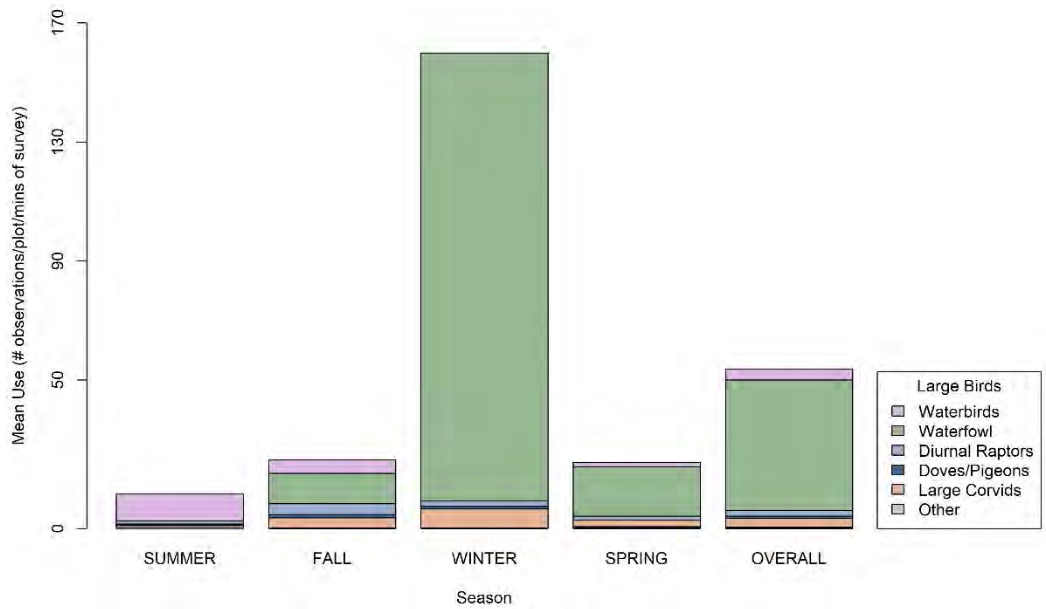

Figure 4a. Large bird mean use by season and bird type at the Four Mile Wind Project in Benton County, Washington from June 5, 2018 to May 29, 2019.

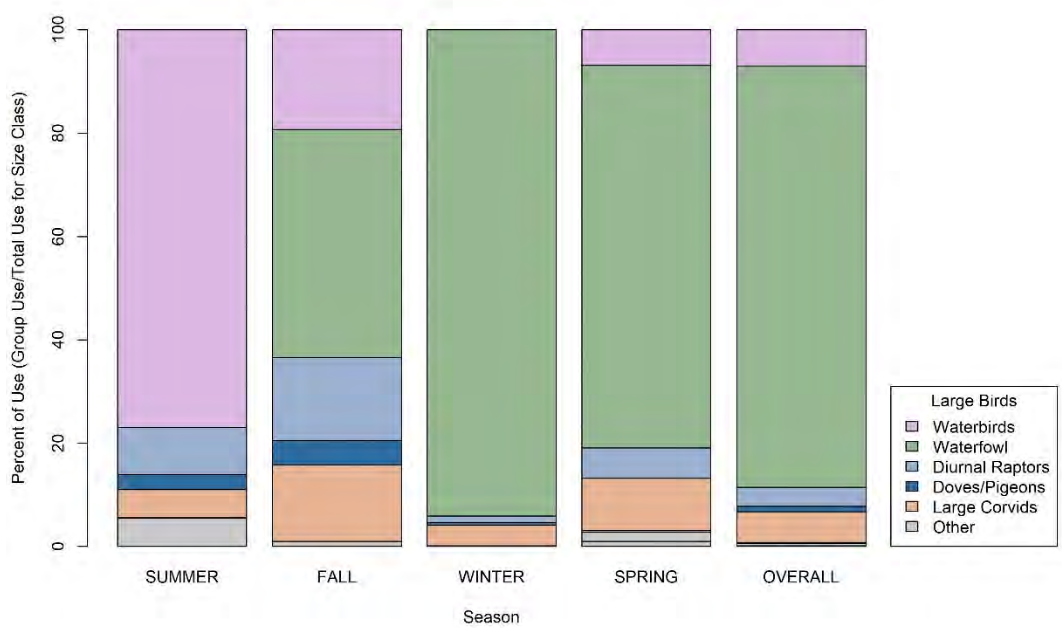

Figure 4b. Large bird percent of use by season and bird type at the Four Mile Wind Project in Benton County, Washington from June 5, 2018 to May 29, 2019.

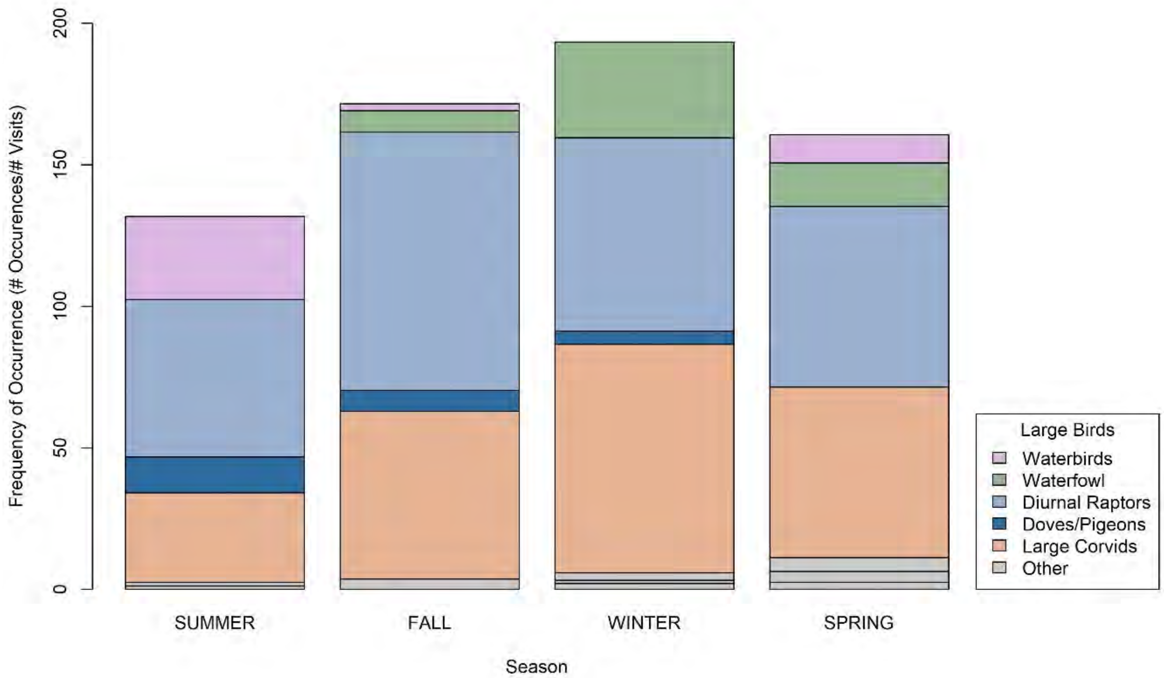

Figure 4c. Large bird frequency of occurrence by season and bird type at the Four Mile Wind Project in Benton County, Washington from June 5, 2018 to May 29, 2019.

Bird Flight Height

Mean large bird flight heights ranged from two m (seven ft) for upland game birds to 196 m (643 ft) for gulls/terns (Table 2). Bird types recorded most frequently within the RSH included waterfowl (71.0%), large corvids (67.4%), gulls/terns (65.9%), and waterbirds (60.5%; Table 2). Overall, diurnal raptors were recorded flying within the RSH during 48.5% of observations, with 50.5% recorded below the RSH, and 1.0% recorded above (Table 2). Among diurnal raptor subtypes the majority of accipiters, buteos, and eagles were recorded flying within the RSH, while northern harrier and falcons were more often recorded flying below the RSH (Table 2).

Table 2. Flight height characteristics by bird type and raptor subtype during 60-minute large bird use surveys at the Four Mile Wind Project in Benton County, Washington from June 5, 2018 to May 29, 2019.

Bird Type	# Groups Flying	# Obs Flying	Mean Flight Height (m)	% Obs Flying	% within Flight Height Categories		
					<25 m	25-150 m[a]	>150 m
Waterbirds	**71**	**1,191**	**123**	**100**	**0.3**	**60.5**	**39.3**
Waterfowl	**77**	**12,495**	**123**	**95.0**	**<0.1**	**71.0**	**28.9**
Shorebirds	**4**	**20**	**12**	**95.2**	**100**	**0**	**0**
Gulls/Terns	**5**	**82**	**196**	**100**	**0**	**65.9**	**34.1**
Diurnal Raptors	**494**	**511**	**35**	**81.1**	**50.5**	**48.5**	**1.0**
Accipiters	_5_	_5_	_111_	_100_	_0_	_80.0_	_20.0_
Buteos	_237_	_243_	_54_	_77.4_	_19.8_	_78.6_	_1.6_
Northern Harrier	_210_	_220_	_13_	_97.8_	_83.6_	_16.4_	_0_
Eagles	_5_	_5_	_66_	_100_	_40.0_	_60.0_	_0_
Falcons	_37_	_38_	_22_	_46.9_	_63.2_	_36.8_	_0_
Owls	**1**	**1**	**5**	**100**	**100**	**0**	**0**
Upland Game Birds	**2**	**4**	**2**	**11.4**	**100**	**0**	**0**
Doves/Pigeons	**22**	**112**	**23**	**65.1**	**48.2**	**51.8**	**0**
Large Corvids	**292**	**946**	**35**	**95.2**	**32.2**	**67.4**	**0.3**
Large Birds Overall	**968**	**15,362**	**49**	**94.4**	**4.3**	**68.9**	**26.8**

[a] The likely "rotor-swept height" for potential collision with a turbine blade, or 25 to 150 m (85 to 492 feet) above ground level.

Obs=observations

Spatial Variation

Mean Use by Point

Large bird use varied widely across survey plots, ranging from 2.36 observations/survey at Point 2 to 363.33 at Point 16 (Appendix C). High variability in large bird use across the Study Area was largely driven by waterfowl, and to a lesser extent, waterbirds, documented at a subset of survey points, primarily in the eastern third of the Study Area. At the two survey points with the highest overall large bird use (points 16 and 12), waterfowl composed 92.9% and 98.7% of that use. The highest use by waterbirds was recorded at points 1 and 16 (27.27 and 16.50 observations/survey, respectively; Appendix C). Use by diurnal raptors was more consistent across the Study Area, ranging from 0.75 to 5.00 observations/survey (Appendix C). Use by other species groups (shorebirds, gulls/terns, owls, upland gamebirds, and doves/pigeons) was comparatively low and limited to only a few survey points across the Study Area (Appendix C).

Flight Paths

Flight paths of waterbirds, waterfowl, and diurnal raptors (including eagles) were mapped in the Study Area (Figures 5a and 5b). Flight paths for several species of waterbirds and waterfowl, namely American white pelican, Canada goose, and snow goose, were concentrated in the eastern third of the Study Area, likely due to the proximity to the Columbia River (Figure 5a). Flight paths for diurnal raptors were more evenly distributed throughout the Study Area, with a somewhat higher concentration of flight paths in the eastern portion of the Study Area, and another concentration of flight paths, particularly for Buteos (e.g., red-tailed hawk and Swainson's hawk [*Buteo swainsoni*]), surrounding Point 1 in the northwest corner of the Study Area (Figure 5b).

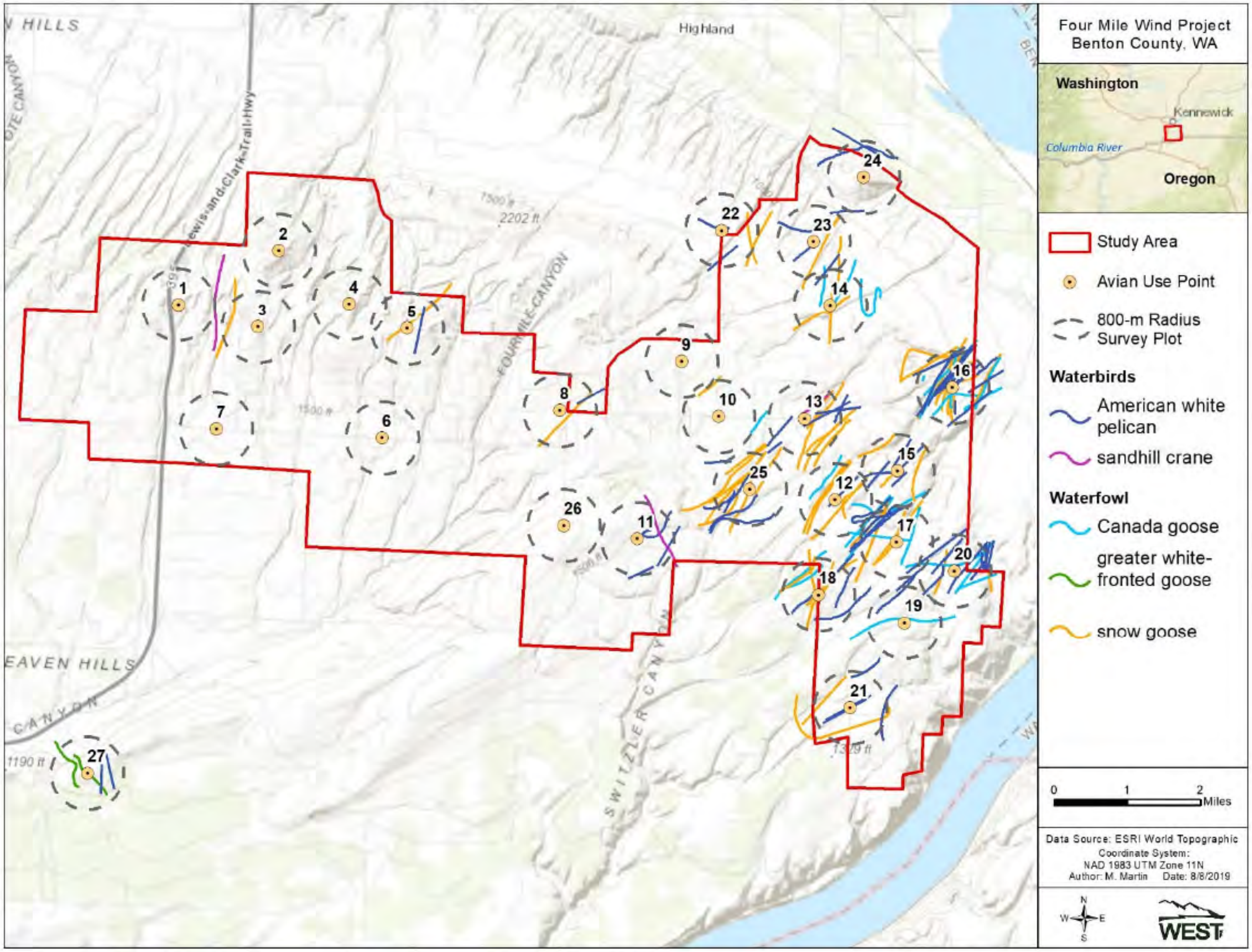

Figure 5a. Flight paths of waterbird and waterfowl species recorded during large bird surveys at the Four Mile Wind Project Study Area from June 5, 2018 to May 29, 2019.

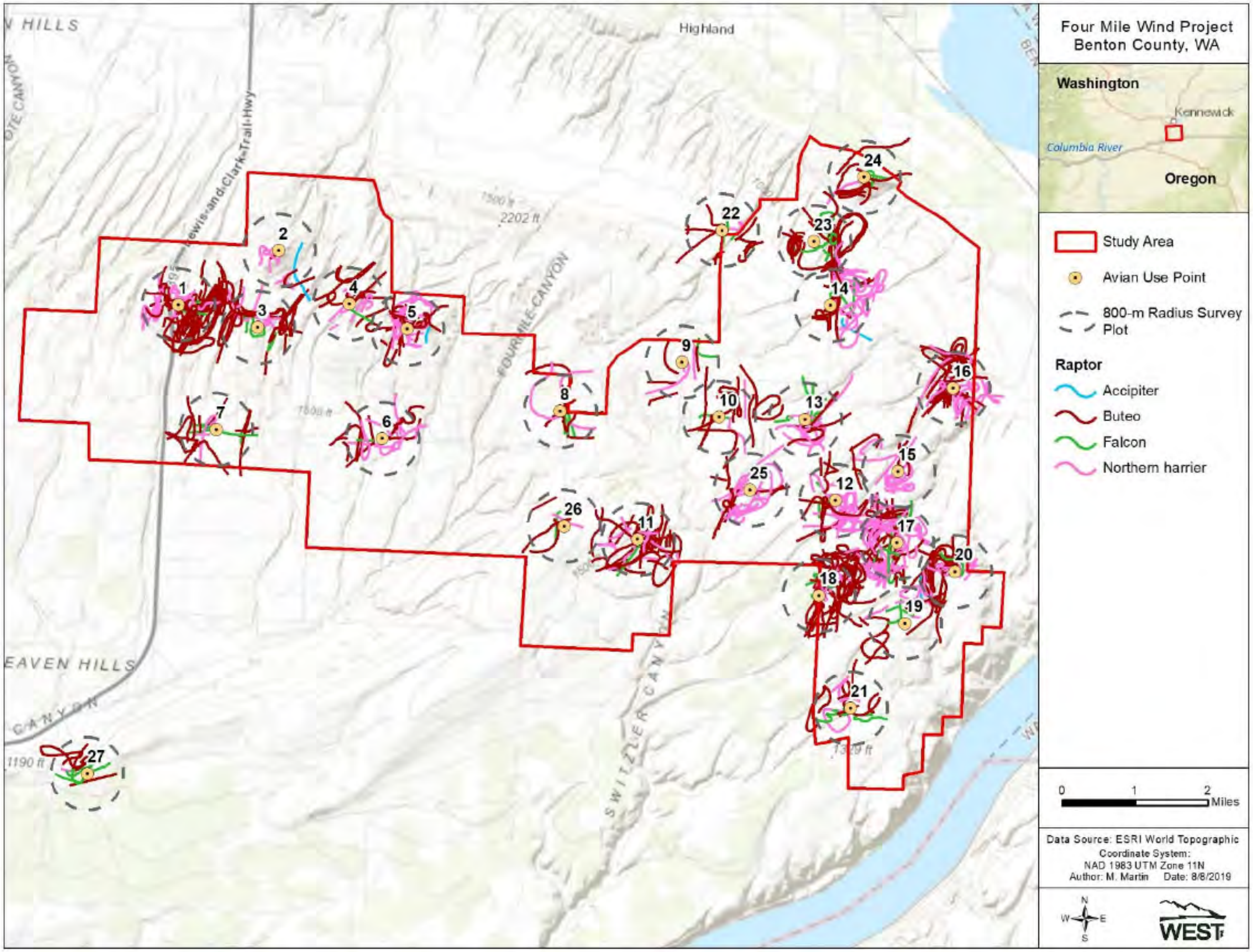

Figure 5b. Flight paths of diurnal raptor subtypes recorded during large bird surveys at the Four Mile Wind Project Study Area from June 5, 2018 to May 29, 2019.

Eagles

Over the course of 309 hours of survey, five bald eagle observations were recorded, including four observations in winter and one observation in spring (Table 3). These five bald eagle observations resulted in 32 minutes of flight and 10 bald eagle exposure minutes, or an exposure rate of 0.0324 exposure minutes per survey hour (Table 3). Bald eagles were observed at four survey points including two observations at Point 1, and single observations at points 12, 14, and 23 (Figure 5b, Appendix C). No golden eagles were observed during the year-long study.

Table 3. Bald eagle observations and exposure minutes* (min.) recorded during 60-minute large bird surveys conducted at the Four Mile Wind Project from June 5, 2018 to May 29, 2019.

Season	Survey Effort (Hours)	Observations	Flight Min.	Exposure Min.	Exposure Min./Survey Hour
Summer	79	0	0	0	-
Fall	81	0	0	0	-
Winter	69	4	28	8	0.1159
Spring	80	1	4	2	0.0250
Total	**309**	**5**	**32**	**10**	**0.0324**

* Exposure minutes are defined as flying behavior at or below 200 meters (m; 656 feet [ft]) and within 800 m (2,625 ft) of the survey location.

Small Birds

Twenty-one species of small birds were observed or heard over 51.5 hours of survey during the year-long study. The greatest number of small bird species was recorded in fall (12), followed by summer (11), spring (nine), and winter (five; Appendix A2). The most abundant species was horned lark (*Eremophila alpestris*), which composed 68.9% of all small bird observations (Appendix A2). Other abundant species included western meadowlark (*Sturnella neglecta*), European starling (*Sturnus vulgaris*), and bank swallow (*Riparia riparia*) which collectively composed another 18.0% of all small bird observations (Appendix A2).

Mean Use

Small bird mean use (observations/100-m plot/10-min survey) was highest during fall (6.49), followed by winter (5.81), spring (5.56), and summer (3.60; Appendix B2). Horned lark had the highest use of any small bird species during each season, composing between 43.4% and 81.7% of seasonal small bird use (Appendix B2). After horned lark, bank swallow had the highest use in summer, savannah sparrow (*Passerculus sandwichensis*) had the highest use in fall, American goldfinch (*Spinus tristis*) had the highest use in winter, and European starling had the highest use in spring (Appendix B2).

Spatial Variation

Small bird use ranged from 0.58 observations/100-m plot/10-min survey at Point 12 to 17.58 at Point 9 (Figure 3, Appendix C). Relatively high use at Point 9 was attributed entirely to use by horned lark.

Incidental Observations

Twelve species were recorded incidentally during the study (Table 4). Of these, six species were not observed during standardized surveys: American crow (*Corvus brachyrhynchos*), gray flycatcher (*Empidonax wrightii*), spotted towhee (*Pipilo maculatus*), lazuli bunting (*Passerina amoena*), loggerhead shrike (*Lanius ludovicianus*), and American robin (*Turdus migratorius*; Table 4).

Table 4. Number of groups (grps) and observations (obs) for wildlife observed incidentally outside of the standardized avian use surveys at the Four Mile Wind Project from June 5, 2018 to May 29, 2019.

Species	Scientific Name	# grps	# obs
sandhill crane	*Antigone canadensis*	3	155
snow goose	*Chen caerulescens*	1	200
killdeer	*Charadrius vociferus*	1	1
American crow	*Corvus brachyrhynchos*	1	85
western meadowlark	*Sturnella neglecta*	1	60
gray flycatcher	*Empidonax wrightii*	1	1
spotted towhee	*Pipilo maculatus*	2	2
sage thrasher	*Oreoscoptes montanus*	1	1
lazuli bunting	*Passerina amoena*	1	2
loggerhead shrike	*Lanius ludovicianus*	1	1
hermit thrush	*Catharus guttatus*	1	1
American robin	*Turdus migratorius*	1	65
Total	**12 species**	**15**	**574**

Species of Concern

Six species of concern were recorded during avian use surveys or incidentally within the Study Area including one state-endangered species (sandhill crane), one state-threatened species (American white pelican), and two state candidates for listing (loggerhead shrike and sage thrasher [*Oreoscoptes montanus*]; WDFW 2019; Table 5). Each of these species, in addition to prairie falcon (*Falco mexicanus*), is also considered a state Priority Species by the WDFW (2008). Bald eagle is protected under the federal BGEPA (1940).

Table 5. Groups and observations of species of concern recorded during avian use surveys or as incidental wildlife observations at the Four Mile Wind Project in Benton County, Washington from June 5, 2018 to May 29, 2019.

			Surveys		Incidental		Total	
Species	**Scientific Name**	**Status***	**# of grps**	**# of obs**	**# of grps**	**# of obs**	**# of grps**	**# of obs**
sandhill crane	*Antigone canadensis*	SE, SP	3	383	3	155	6	538
American white pelican	*Pelecanus erythrorhynchos*	ST, SP	68	808	0	0	68	808
bald eagle	*Haliaeetus leucocephalus*	BGEPA	5	5	0	0	5	5
prairie falcon	*Falco mexicanus*	SP	19	19	0	0	19	19
loggerhead shrike	*Lanius ludovicianus*	SC, SP	0	0	1	1	1	1
sage thrasher	*Oreoscoptes montanus*	SC, SP	2	2	1	1	3	3
Total	**6 species**		**97**	**1,217**	**5**	**157**	**102**	**1,374**

grps=groups, obs=observations

*BGEPA = Bald and Golden Eagle Protection Act (BGEPA 1940) SE = state endangered; ST = state threatened species; SC = state candidate species; SP = state priority species. State species status from Washington Department of Fish and Wildlife (2008, 2019).

DISCUSSION

The principal objective of this avian use study was to assess the temporal and spatial use of the Study Area by large and small birds, including eagles and other species of concern. Over the course of the year-long study, approximately 361 hours of large and small bird use surveys were completed and 17,913 bird observations comprising 47 separate species were recorded. Overall, large bird use varied substantially across seasons and across the Study Area; however, most of this variability was attributed to relatively large groups of waterfowl observed primarily in the winter and in the eastern portion of the Study Area. Although recorded in lower numbers than waterfowl, waterbirds composed the majority (77.0%) of large bird use in summer. The majority of waterfowl and waterbird observations (71.0% and 60.5%, respectively) were recorded flying at heights within the RSH of proposed turbines which may put these species at risk of collision with Project turbines. Use by diurnal raptors was more consistent across seasons and across survey points. Seasonal use by diurnal raptors ranged from a low of 1.06 birds/800-m plot/60-min survey in summer to a high of 3.69 in fall. The most commonly recorded diurnal raptor species included northern harrier, red-tailed hawk, and rough-legged hawk.

In order to allow comparison with raptor use at other regional wind energy facilities in Washington and Oregon that implemented similar protocols and had data for three or four seasons, annual mean raptor use at the Project was recalculated for a 20-min survey period by using only the data collected during the first 20 min of the 60-min survey period. Based on this shorter survey period, diurnal raptor use at the Project (0.90 raptors/800-m/20-min) was on the high end, but within the range of raptor use at 23 regional wind energy facilities with publicly available data, ranking second highest of 23 other sites (0.35-1.07 raptors/800-m/20-min; Figure 6). Diurnal raptor use at adjacent Nine Canyon was 0.35 raptors/800-m/20-min, while use at nearby Stateline was 0.47 (Figure 6).

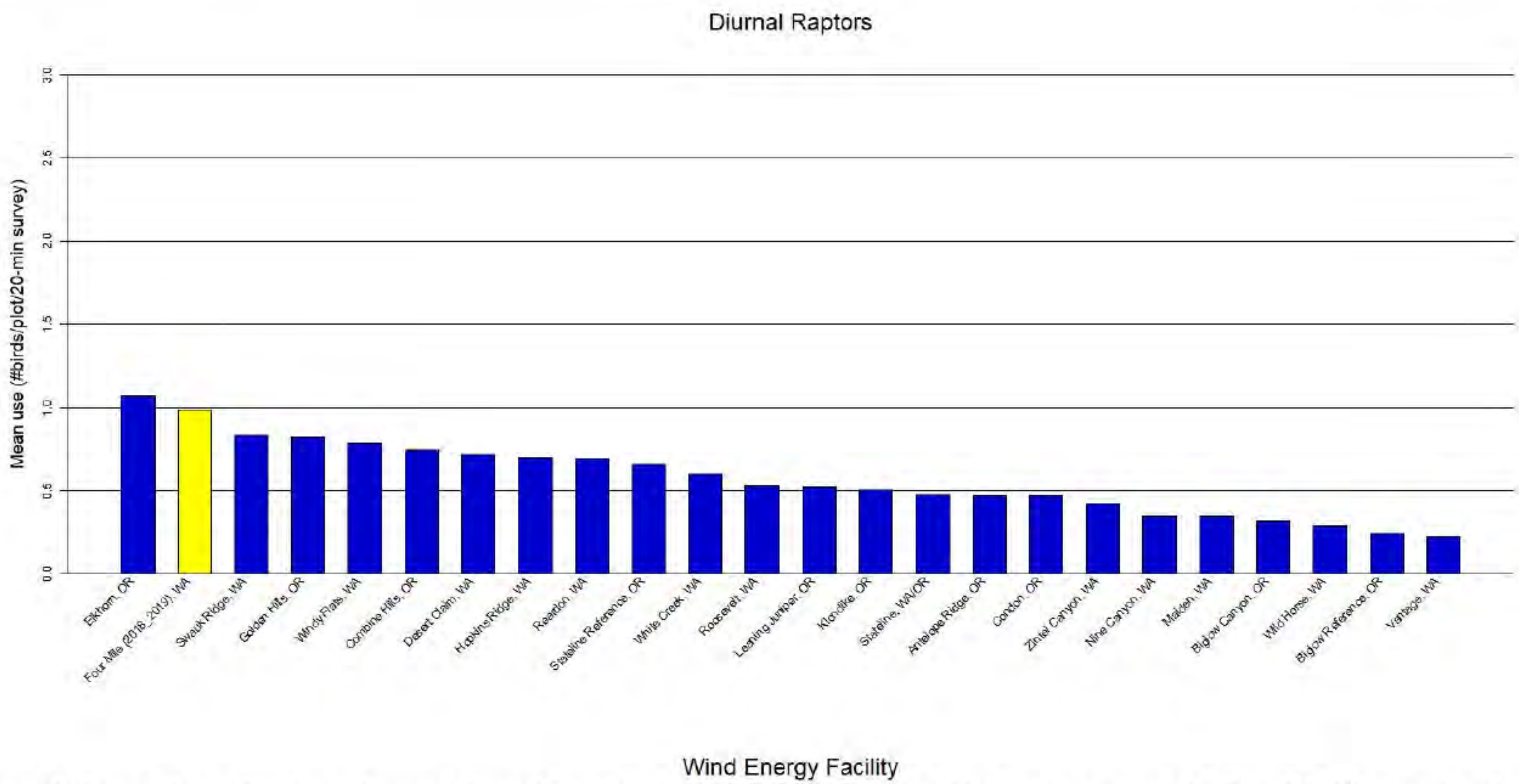

Figure 6. Comparison of estimated annual diurnal raptor use during fixed-point large bird use surveys at the Four Mile Wind Project from June 5, 2018 – May 29, 2019 and diurnal raptor use at other Oregon and Washington Wind Resource Areas with similarly collected data.

Figure 6 (*continued*). Comparison of estimated annual diurnal raptor use during fixed-point large bird use surveys at the Four Mile Wind Project from June 5, 2018 – May 29, 2019 and diurnal raptor use at other Oregon and Washington Wind Resource Areas with similarly collected data.

Data from the following sources:

Wind Energy Facility/Study	Report Citation	Wind Energy Facility/Study	Report Citation
Four Mile Wind Project, WA	This study.		
Elkhorn, OR	WEST 2005a	Klondike, OR	Johnson et al. 2002
Swauk Ridge, WA	Erickson et al. 2003a	Stateline, WA/OR	Erickson et al. 2003b
Golden Hills, OR	Jeffrey et al. 2008	Antelope Ridge, OR	WEST 2009
Windy Flats, WA	Johnson et al. 2007	Condon, OR	Erickson et al. 2002a
Combine Hills, OR	Young et al. 2003a	Zintel Canyon, WA	Erickson et al. 2002b, 2003c
Desert Claim, WA	Young et al. 2003b	Nine Canyon, WA	Erickson et al. 2001
Hopkins Ridge, WA	Young et al. 2003c	Maiden, WA	Young et al. 2002
Reardon, WA	WEST 2005b	Biglow Canyon, OR	WEST 2005c
Stateline Reference, OR	URS et al. 2001	Wild Horse, WA	Erickson et al. 2003d
White Creek, WA	NWC and WEST 2005	Biglow Reference, OR	WEST 2005c
Roosevelt, WA	NWC and WEST 2004	Vantage, WA	Jeffrey et al. 2007
Leaning Juniper, OR	Kronner et al. 2005		

Small bird use varied considerably across the Study Area; however, no clear spatial patterns of use were evident. Use by small birds was highest in fall (6.49 birds/100-m plot/10-min survey) and lowest in summer (3.60); however, use in all seasons was driven by horned lark which composed between 43.4% and 81.7% of all small bird use in any given season.

Species of Concern

During the study, six bird species of concern were recorded within the Study Area, none of which are unexpected for the region. These include the state-endangered sandhill crane, the state-threatened American white pelican, and the state candidates for listing loggerhead shrike and sage thrasher. All four of these species are also considered Priority Species by the WDFW, along with prairie falcon. While not a state or federally listed species, bald eagles are protected under the BGEPA.

Sandhill Crane

Sandhill cranes were recorded within the Study Area during fall (one group totaling 300 individuals) and spring (two groups totaling 83 individuals). Sandhill cranes typically use large freshwater marshes, prairie ponds, and marshy tundra during summer and grain fields or prairies during migration and winter. In Washington, sandhill cranes are known to breed only in Yakima and Klickitat counties (Stinson 2017). They typically use large freshwater marshes, prairie ponds, and marshy tundra during summer and grain fields or prairies during migration and winter. Although suitable breeding and stopover habitat is generally absent from the Study Area, there is potential for the species to migrate over the Project in spring and fall, which is supported by the data collected during this study. During surveys the majority (99.2%) of sandhill crane observations were recorded flying well above the RSH.

Waterbirds, including sandhill crane, do not appear to be particularly susceptible to collision with wind turbines. According to the National Research Council (2007) cumulative effects report, waterbirds composed about 1% of documented fatalities at 14 wind energy facilities. Waterbirds made up 0.2% of all bird fatalities (n = 4,975) in an analysis of 116 standardized monitoring studies conducted at over 70 wind energy facilities throughout the US and Canada (Erickson et al. 2014). Among publicly available reports reviewed by WEST, waterbirds accounted for just 0.2% of fatalities recorded during 41 studies at wind energy facilities in the Pacific Northwest region of North America (four of 1,942 total fatalities; see Appendix D for a list of facilities and references). The four waterbird fatalities documented at Pacific Northwest wind energy facilities were all great blue herons (*Ardea herodias*; see Appendix D). While no sandhill crane fatalities have been documented in the Pacific Northwest, several sandhill crane fatalities have been documented at facilities in other states. This includes one fatality documented at an older-generation facility at Altamont Pass in California (Smallwood and Karas 2009), and two fatalities from a facility in west Texas (Navarrete and Griffis-Kyle 2014 as cited in Gerber et al. 2014; Stehn 2011), documented as part of a wintering crane displacement study conducted by graduate student L. Navarrete of Texas Tech University.

Researchers at WEST monitored use by migrating sandhill cranes at five wind energy facilities in North and South Dakota from 2009 – 2013 for three years at each site. Concurrently, they searched underneath all turbines daily for fatalities of cranes. Cumulatively, observers spent 13,182 hours recording crane use over 1,305 days, and even though 42,727 sandhill crane observations were recorded, no fatalities of cranes were found beneath turbines (Derby et al. 2018). A crane monitoring study was conducted at the Forward Energy Center, a wind energy facility in southern Wisconsin located within 3.2 km (2.0 mi) of a large wetland used by sandhill cranes. No crane fatalities were found during the crane monitoring study in the fall of 2008, or during regular bird fatality monitoring studies conducted in the fall of 2008, spring and fall of 2009, and in the spring of 2010, even though sandhill cranes were observed in the study area (Grodsky et al. 2013).

Given the absence of suitable breeding and stopover habitat within the Project area, average flight heights well above the RSH, and the available data regarding these species' interactions with wind turbines, impacts to sandhill crane resulting from Project development and operation are anticipated to be low.

American White Pelican

American white pelicans were recorded in summer (58 groups totaling 705 individuals), fall (two groups totaling 61 individuals), and spring (eight groups totaling 42 individuals). American white pelicans are known to nest on Badger Island in the Columbia River, approximately 6.4 km (4.0 mi) east of the Study Area (Stinson 2016). While suitable breeding and foraging habitat for pelicans is not present within the Study Area, the species may fly over the Study Area during migration or while traveling between foraging areas, as evidenced by the survey data. The majority of pelicans observed during surveys were flying either in a southwest or northeast direction, suggesting movement between breeding areas on Columbia River dredge islands and foraging areas to the southwest of the Study Area. These groups of pelicans were recorded primarily at survey points within the eastern third of the Study Area and flying at an average height of 118 m (387 ft) above mean sea level, with the majority (88.7%) of groups flying within the RSH.

Similar to sandhill crane and other waterbird species, American white pelicans do not appear to be particularly susceptible to collision with wind turbines. Based on publicly available data, no American white pelican fatalities have been documented at facilities in the Pacific Northwest (see Appendix D for a list of facilities and references). However, this may be the result of the siting of current wind energy facilities outside of pelican flight corridors. At least two American white pelican fatalities have been documented at wind energy facilities outside of Oregon and Washington, both of which were found at the Buffalo Ridge facility in South Dakota (Derby et al. 2010, 2012). The flight behavior of pelicans recorded flying over the eastern portion of the Study Area suggests that these birds may be at risk of collision. While data on the ability of waterbirds and other avian species to avoid wind turbines on the landscape is scarce, at nearby Nine Canyon, located immediately to the north of the Project, no American white pelicans were found during a 15-month post-construction fatality monitoring study (Erickson et al. 2005). However, Nine Canyon is located to the west of the majority of pelican observations for the Project and the facility appears to lie just beyond the fight corridor used by pelicans traveling between sections of the Columbia River. During pre-construction avian use survey conducted at Nine Canyon, no American white pelican observations were recorded (Erickson et al. 2001, 2003c). At the proposed Project, it is likely that collision risk for pelicans would be limited to turbines constructed in the eastern half of the Study Area, and concentrated during the summer months; however, the magnitude of this risk is unclear.

Bald Eagle

Based on information compiled by the USFWS, there have been 49 documented bald eagle fatalities or injuries at wind energy facilities in the US between 2013 and 2018 (Kritz et al. 2018). The majority of bald eagle casualties occurred in the Upper Midwest, Intermountain West, and Alaska, with only single bald eagle fatalities documented in each of Oregon and Washington (Kritz et al. 2018).

The Columbia Plateau supports both breeding and wintering populations of bald eagles, generally at lower densities than areas west of the Cascades; however, bald eagle nests have increased annually across the state since 2005 (Kalasz and Buchanan 2016). While bald eagle nest sites and breeding season foraging habitat is absent from the Project area, the species is known to nest in areas adjacent to rivers and lakes. During eagle nest surveys conducted within a 16-km (10-mi) radius of the Study Area, five occupied bald eagle breeding territories were documented, with four of those territories containing an active bald eagle nest in 2019 (Chatfield et al. 2019). Bald eagle nests documented during the survey were located along the Columbia River and its tributaries and ranged from 4.0-16.0 km (2.5-10.0 mi) from the proposed Project boundary (Chatfield at al. 2019). Despite several occupied bald eagle nests in the vicinity of the Study Area, only a single bald eagle was recorded (March) during the spring and summer nesting season, suggesting even lower use of the Study Area by breeding eagles than migrating or wintering eagles. The remaining four bald eagle observations were recorded in December and January. Based on the generally low direct impacts to bald eagles documented in the Pacific Northwest and the low use of the Study Area by bald eagles documented during the study, risk to bald eagles from the development and operation of the Project is anticipated to be low.

Prairie Falcon

During surveys, 19 prairie falcon observations were recorded within the Study Area, with the majority of those observations recorded in fall and winter (each with seven observations). Prairie falcons are year-round residents of the region and, while nesting habitat is absent from the Study Area, the species may forage throughout the site's open grasslands and agricultural lands. No prairie falcon nests were documented in the vicinity of the Study Area during the 2019 aerial raptor nest surveys conducted for the Project (Chatfield et al. 2019).

Though prairie falcon fatalities have been documented at Pacific Northwest wind energy facilities, they have been relatively rare (three out of 154 total diurnal raptor fatalities; see Appendix D for a list of facilities and references). Given the relatively low use of the Study Area by prairie falcons and the low level of direct impacts reports for this species in the Pacific Northwest, risk to prairie falcons from development and operation of the Project is anticipated to be low.

Loggerhead Shrike

Only a single loggerhead shrike, recorded incidentally, was observed during the study, suggesting low use of the Study Area by this species. Loggerhead shrikes typically nest in mature shrub-steppe habitat; which is very limited within the Study Area (see Figure 2); however, the species will utilize grassland, agricultural land, and other open areas for foraging. Loggerhead shrike fatalities have been documented at wind energy facilities, particularly at facilities in California (see ICF International 2016; WEST 2008); however, no loggerhead shrike fatalities (out of 1,228 total passerine fatalities) have been reported in the Pacific Northwest (see Appendix D for a list of facilities and references). Given the low documented use the Study Area by this species and the very small amount of suitable nesting habitat, direct and indirect impacts to loggerhead shrike from the development and operation of the Project are anticipated to be low.

Sage Thrasher

Three sage thrasher observations were recorded during the study, including two recorded during surveys in September and one recorded incidentally in March. Given the timing of these observations, they were more likely migrating individuals passing through the Study Area than resident breeders. Sage thrashers require open shrub-steppe habitat for breeding which is limited in the Study Area (see Figure 2). Among 1,228 passerine fatalities recorded at wind energy facilities in the Pacific Northwest, only two sage thrasher fatalities have been documented (see Appendix D for a list of facilities and references). Given the low documented use the Study Area by this species and the very small amount of suitable shrub-steppe nesting habitat, direct and indirect impacts to sage thrashers from the development and operation of the Project are anticipated to be low.

Avian Mortality at Regional Wind Energy Facilities

To date, overall fatality rates for birds at wind energy facilities in the Pacific Northwest with publicly available data have been variable, ranging from 0.16 to 8.45 birds/MW/year, with fatality rates for diurnal raptors ranging from zero to 0.47 birds/MW/year (Appendix D). At adjacent Nine Canyon, post-construction fatality monitoring conducted in 2002-2003 resulted in estimated mortality rates of 2.79 birds/MW/year and 0.03 diurnal raptors/MW/year (Erickson et al. 2003c). During three years of fatality monitoring at nearby Stateline, annual overall bird mortality estimates ranged from 1.23 to 3.17 birds/MW/year, while annual diurnal raptor mortality estimates ranged from 0.09 to 0.11 raptors/MW/year (Erickson et al. 2005, 2007). At the Elkhorn and Windy Flats wind energy facilities in Oregon and Washington, where pre-construction diurnal raptor use estimates were similar to that recorded at the Project (see Figure 6), corresponding post-construction diurnal raptor fatality rates ranged from 0.04 to 0.08 raptors/MW/year (Jeffrey et al. 2009a, Enk et al. 2011a, Enz et al. 2011; Appendix D), which was only slightly higher than that reported at Nine Canyon (0.03 raptors/MW/year; Erickson et al. 2003c) immediately adjacent the Study Area (Appendix D).

At wind energy facilities in the Pacific Northwest with publicly available fatality data, diurnal raptors have composed 7.9% of all documented avian fatalities (154 out of 1,942 total avian fatalities; see Appendix D for a list of facilities and references). In the Pacific Northwest, 12 separate diurnal raptor species have been found as fatalities, the most common of which have been American kestrel (*Falco sparverius*; 35.7%), red-tailed hawk (31.2%), and Swainson's hawk (9.1%; see Appendix D for a list of facilities and references). During the year-long fatality monitoring study at Nine Canyon, only one diurnal raptor fatality was documented, an American kestrel (Erickson et al. 2003c). Based on the composition of turbine-related raptor fatalities in the region, and the composition of diurnal raptors observed during this study, the diurnal raptor species most likely to be directly impacted by the Project are American kestrel and red-tailed hawk.

CONCLUSIONS

Tier 3 studies are used to address questions regarding impacts that could not be sufficiently addressed using available literature (i.e., during Tier 1 and 2 desktop analyses). These studies provide additional data that, when combined with available literature reviewed in previous tiers, allow for a better-informed assessment of the risk of significant adverse impacts to species of concern at the Project. The Study Area is dominated by agricultural cover types (i.e., cultivated cropland) of limited value to most avian species, particularly species of conservation concern. Several species of concern were documented during the study; however, these were not unexpected for the region and most are believed to be at low risk from Project development and operation given their use of the Study Area, and known interactions with turbines in the region. One species of particular concern at the Project is American white pelican. Relatively large numbers of the species were documented flying at RSH through the eastern third of the Study Area suggesting this species may be at risk of collision with turbine blades. However, it is unclear whether this flight behavior will translate to high levels of mortality, or if the birds would be able to successfully avoid turbines by flying above the RSH or diverting their flight paths around the entire facility. With the exception of potential direct impacts to pelicans, there is nothing in the data collected within the Study Area to date that would suggest the Project would fall outside of the range of impacts observed at other wind energy facilities in Oregon and Washington.

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Appendix A. All Bird Types and Species Observed at the Four Mile Wind Project Study Area during Avian Use Surveys, June 5, 2018 – May 29, 2019

Appendix A1. Numbers of groups and observations by bird type and species for 60-minute large bird use surveys at the Four Mile Wind Project in Benton County, Washington from June 5, 2018 to May 29, 2019.

		Summer		Fall		Winter		Spring		Total	
Type/Species	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Waterbirds		**58**	**705**	**3**	**361**	**0**	**0**	**10**	**125**	**71**	**1,191**
sandhill crane	*Antigone canadensis*	0	0	1	300	0	0	2	83	3	383
American white pelican	*Pelecanus erythrorhynchos*	58	705	2	61	0	0	8	42	68	808
Waterfowl		**0**	**0**	**10**	**827**	**51**	**11,036**	**22**	**1,292**	**83**	**13,155**
greater white-fronted goose	*Anser albifrons*	0	0	0	0	0	0	2	35	2	35
Canada goose	*Branta canadensis*	0	0	1	12	16	846	11	457	28	1,315
snow goose	*Chen caerulescens*	0	0	9	815	35	10,190	9	800	53	11,805
Shorebirds		**0**	**0**	**0**	**0**	**1**	**4**	**4**	**17**	**5**	**21**
killdeer	*Charadrius vociferus*	0	0	0	0	1	4	4	17	5	21
Gulls/Terns		**1**	**50**	**0**	**0**	**0**	**0**	**4**	**32**	**5**	**82**
ring-billed gull	*Larus delawarensis*	0	0	0	0	0	0	1	25	1	25
unidentified gull		1	50	0	0	0	0	3	7	4	57
Diurnal Raptors		**84**	**84**	**284**	**299**	**140**	**141**	**105**	**106**	**613**	**630**
Accipiters		*1*	*1*	*4*	*4*	*0*	*0*	*0*	*0*	*5*	*5*
Cooper's hawk	*Accipiter cooperii*	1	1	0	0	0	0	0	0	1	1
unidentified accipiter	*Accipiter* spp.	0	0	2	2	0	0	0	0	2	2
sharp-shinned hawk	*Accipiter striatus*	0	0	2	2	0	0	0	0	2	2
Buteos		*39*	*39*	*134*	*139*	*73*	*73*	*62*	*63*	*308*	*314*
red-tailed hawk	*Buteo jamaicensis*	21	21	89	94	35	35	27	27	172	177
rough-legged hawk	*Buteo lagopus*	0	0	37	37	37	37	25	25	99	99
unidentified buteo	*Buteo* spp.	4	4	1	1	1	1	2	2	8	8
Swainson's hawk	*Buteo swainsoni*	14	14	7	7	0	0	8	9	29	30
Northern Harrier		*21*	*21*	*116*	*125*	*44*	*45*	*34*	*34*	*215*	*225*
northern harrier	*Circus hudsonius*	21	21	116	125	44	45	34	34	215	225
Eagles		*0*	*0*	*0*	*0*	*4*	*4*	*1*	*1*	*5*	*5*
bald eagle	*Haliaeetus leucocephalus*	0	0	0	0	4	4	1	1	5	5
Falcons		*23*	*23*	*30*	*31*	*19*	*19*	*8*	*8*	*80*	*81*
merlin	*Falco columbarius*	0	0	0	0	1	1	0	0	1	1
prairie falcon	*Falco mexicanus*	2	2	7	7	7	7	3	3	19	19
peregrine falcon	*Falco peregrinus*	0	0	2	2	1	1	0	0	3	3
American kestrel	*Falco sparverius*	21	21	20	21	9	9	5	5	55	56
unidentified falcon	*Falco* spp.	0	0	1	1	1	1	0	0	2	2
Owls		**0**	**0**	**0**	**0**	**1**	**1**	**0**	**0**	**1**	**1**

Appendix A1. Numbers of groups and observations by bird type and species for 60-minute large bird use surveys at the Four Mile Wind Project in Benton County, Washington from June 5, 2018 to May 29, 2019.

		Summer		Fall		Winter		Spring		Total	
Type/Species	Scientific Name	# grps	# obs	# grps	# obs	# grps	# obs	# grps	# obs	# grps	# obs
short-eared owl	*Asio flammeus*	0	0	0	0	1	1	0	0	1	1
Upland Game Birds		**1**	**1**	**4**	**19**	**2**	**10**	**5**	**5**	**12**	**35**
California quail	*Callipepla californica*	0	0	3	11	0	0	3	3	6	14
gray partridge	*Perdix perdix*	0	0	1	8	2	10	0	0	3	18
ring-necked pheasant	*Phasianus colchicus*	1	1	0	0	0	0	2	2	3	3
Doves/Pigeons		**14**	**27**	**6**	**89**	**4**	**56**	**0**	**0**	**24**	**172**
rock pigeon	*Columba livia*	7	20	6	89	4	56	0	0	17	165
mourning dove	*Zenaida macroura*	7	7	0	0	0	0	0	0	7	7
Large Corvids		**30**	**50**	**96**	**276**	**106**	**489**	**87**	**179**	**319**	**994**
common raven	*Corvus corax*	29	49	92	256	105	488	85	177	311	970
black-billed magpie	*Pica hudsonia*	1	1	4	20	1	1	2	2	8	24
Overall		**188**	**917**	**403**	**1,871**	**305**	**11,737**	**237**	**1,756**	**1,133**	**16,281**

Regardless of distance from observer

obs=observations; grps=groups

Appendix A2. Numbers of groups and observations by bird type and species for 10-minute small bird use surveys at the Four Mile Wind Project in Benton County, Washington from June 5, 2018 to May 29, 2019.

		Summer		Fall		Winter		Spring		Total	
Type/Species	Scientific Name	# grps	# obs	# grps	# obs	# grps	# obs	# grps	# obs	# grps	# obs
Passerines		**143**	**282**	**149**	**526**	**97**	**377**	**170**	**445**	**559**	**1,630**
Blackbirds/Orioles		*36*	*41*	*12*	*20*	*7*	*34*	*33*	*129*	*88*	*224*
red-winged blackbird	*Agelaius phoeniceus*	0	0	0	0	0	0	2	3	2	3
western meadowlark	*Sturnella neglecta*	35	40	11	18	6	27	26	27	78	112
European starling	*Sturnus vulgaris*	1	1	1	2	1	7	5	99	8	109
Finches/Crossbills		*1*	*2*	*1*	*25*	*1*	*40*	*0*	*0*	*3*	*67*
house finch	*Haemorhous mexicanus*	0	0	1	25	0	0	0	0	1	25
American goldfinch	*Spinus tristis*	1	2	0	0	1	40	0	0	2	42
Flycatchers		*5*	*6*	*0*	*0*	*0*	*0*	*0*	*0*	*5*	*6*
western kingbird	*Tyrannus verticalis*	5	6	0	0	0	0	0	0	5	6
Grassland/Sparrows		*85*	*143*	*132*	*477*	*89*	*303*	*133*	*298*	*439*	*1,221*
grasshopper sparrow	*Ammodramus savannarum*	8	8	0	0	0	0	6	6	14	14

Appendix A2. Numbers of groups and observations by bird type and species for 10-minute small bird use surveys at the Four Mile Wind Project in Benton County, Washington from June 5, 2018 to May 29, 2019.

Type/Species	Scientific Name	Summer # grps	Summer # obs	Fall # grps	Fall # obs	Winter # grps	Winter # obs	Spring # grps	Spring # obs	Total # grps	Total # obs
American pipit	*Anthus rubescens*	0	0	2	4	0	0	0	0	2	4
lark sparrow	*Chondestes grammacus*	8	12	0	0	0	0	0	0	8	12
horned lark	*Eremophila alpestris*	69	123	102	430	87	292	122	280	380	1,125
dark-eyed junco	*Junco hyemalis*	0	0	1	2	0	0	0	0	1	2
savannah sparrow	*Passerculus sandwichensis*	0	0	19	28	2	11	3	4	24	43
vesper sparrow	*Pooecetes gramineus*	0	0	3	6	0	0	0	0	3	6
white-crowned sparrow	*Zonotrichia leucophrys*	0	0	4	6	0	0	2	8	6	14
unidentified sparrow		0	0	1	1	0	0	0	0	1	1
Mimids		*0*	*0*	*2*	*2*	*0*	*0*	*0*	*0*	*2*	*2*
sage thrasher	*Oreoscoptes montanus*	0	0	2	2	0	0	0	0	2	2
Swallows		*16*	*90*	*0*	*0*	*0*	*0*	*4*	*18*	*20*	*108*
barn swallow	*Hirundo rustica*	1	1	0	0	0	0	0	0	1	1
cliff swallow	*Petrochelidon pyrrhonota*	7	17	0	0	0	0	2	13	9	30
bank swallow	*Riparia riparia*	6	70	0	0	0	0	1	3	7	73
unidentified swallow		2	2	0	0	0	0	1	2	3	4
Thrushes		*0*	*0*	*1*	*1*	*0*	*0*	*0*	*0*	*1*	*1*
hermit thrush	*Catharus guttatus*	0	0	1	1	0	0	0	0	1	1
Wrens		*0*	*0*	*1*	*1*	*0*	*0*	*0*	*0*	*1*	*1*
Bewick's wren	*Thryomanes bewickii*	0	0	1	1	0	0	0	0	1	1
Woodpeckers		**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**
northern flicker	*Colaptes auratus*	1	1	0	0	0	0	0	0	1	1
Unidentified Birds		**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**
unidentified small bird		0	0	0	0	0	0	1	1	1	1
Overall		**144**	**283**	**149**	**526**	**97**	**377**	**171**	**446**	**561**	**1,632**

Regardless of distance from observe

obs=observations; grps=group.

Appendix B. Bird Use, Percent of Use, and Frequency of Occurrence for Large Birds and Small Birds Observed during Avian Use Surveys at the Four Mile Wind Project from June 5, 2018 – to May 29, 2019

Appendix B1. Mean use (number of birds/plot[a]/60-minute survey), percent of use, and frequency of occurrence (%) for each large bird type and species by season during the avian use surveys at the Four Mile Wind Project in Benton County, Washington from June 5, 2018 to May 29, 2019.

	Mean Use				% of Use				% Frequency			
Type/Species	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring
Waterbirds	**9.01**	**4.46**	**0**	**1.55**	**77.0**	**19.3**	**0**	**6.9**	**29.3**	**2.5**	**0**	**10.0**
sandhill crane	0	3.70	0	1.03	0	16.0	0	4.6	0	1.2	0	2.5
American white pelican	9.01	0.75	0	0.52	77.0	3.3	0	2.3	29.3	1.2	0	7.5
Waterfowl	**0**	**10.21**	**150.58**	**16.56**	**0**	**44.2**	**94.1**	**74.0**	**0**	**7.4**	**33.9**	**15.3**
greater white-fronted goose	0	0	0	0.45	0	0	0	2.0	0	0	0	1.3
Canada goose	0	0.15	14.58	5.86	0	0.6	9.1	26.2	0	1.2	18.0	7.6
snow goose	0	10.06	136.00	10.26	0	43.6	85.0	45.8	0	7.4	21.8	9.0
Shorebirds	**0**	**0**	**0.08**	**0.22**	**0**	**0**	**<0.1**	**1.0**	**0**	**0**	**2.1**	**2.6**
killdeer	0	0	0.08	0.22	0	0	<0.1	1.0	0	0	2.1	2.6
Gulls/Terns	**0.64**	**0**	**0**	**0.41**	**5.5**	**0**	**0**	**1.8**	**1.3**	**0**	**0**	**3.8**
ring-billed gull	0	0	0	0.32	0	0	0	1.4	0	0	0	1.3
unidentified gull	0.64	0	0	0.09	5.5	0	0	0.4	1.3	0	0	2.5
Diurnal Raptors	**1.06**	**3.69**	**1.89**	**1.32**	**9.1**	**16.0**	**1.2**	**5.9**	**55.7**	**91.4**	**68.3**	**63.8**
Accipiters	*0.01*	*0.05*	*0*	*0*	*0.1*	*0.2*	*0*	*0*	*1.2*	*4.9*	*0*	*0*
Cooper's hawk	0.01	0	0	0	0.1	0	0	0	1.2	0	0	0
unidentified accipiter	0	0.02	0	0	0	0.1	0	0	0	2.5	0	0
sharp-shinned hawk	0	0.02	0	0	0	0.1	0	0	0	2.5	0	0
Buteos	*0.50*	*1.72*	*0.99*	*0.79*	*4.2*	*7.4*	*0.6*	*3.5*	*33.0*	*67.9*	*57.4*	*47.5*
red-tailed hawk	0.27	1.16	0.47	0.34	2.3	5.0	0.3	1.5	24.1	53.1	30.2	27.5
rough-legged hawk	0	0.46	0.51	0.31	0	2.0	0.3	1.4	0	22.2	40.6	21.4
unidentified buteo	0.05	0.01	0.01	0.02	0.4	<0.1	<0.1	0.1	5.1	1.2	1.2	2.5
Swainson's hawk	0.18	0.09	0	0.11	1.5	0.4	0	0.5	12.7	6.2	0	7.4
Northern Harrier	*0.26*	*1.54*	*0.59*	*0.42*	*2.3*	*6.7*	*0.4*	*1.9*	*15.2*	*58.0*	*38.9*	*27.4*
northern harrier	0.26	1.54	0.59	0.42	2.3	6.7	0.4	1.9	15.2	58.0	38.9	27.4
Eagles	*0*	*0*	*0.05*	*0.01*	*0*	*0*	*<0.1*	*<0.1*	*0*	*0*	*3.8*	*1.3*
bald eagle	0	0	0.05	0.01	0	0	<0.1	<0.1	0	0	3.8	1.3
Falcons	*0.29*	*0.38*	*0.25*	*0.10*	*2.5*	*1.7*	*0.2*	*0.4*	*18.9*	*29.6*	*17.4*	*8.7*
merlin	0	0	0.01	0	0	0	<0.1	0	0	0	1.3	0
prairie falcon	0.03	0.09	0.10	0.04	0.2	0.4	<0.1	0.2	2.6	8.6	9.7	2.5
peregrine falcon	0	0.02	0.01	0	0	0.1	<0.1	0	0	2.5	1.3	0
American kestrel	0.27	0.26	0.12	0.06	2.3	1.1	<0.1	0.3	17.7	19.8	9.0	6.2
unidentified falcon	0	0.01	0.01	0	0	<0.1	<0.1	0	0	1.2	1.3	0
Owls	**0**	**0**	**0.01**	**0**	**0**	**0**	**<0.1**	**0**	**0**	**0**	**1.2**	**0**
short-eared owl	0	0	0.01	0	0	0	<0.1	0	0	0	1.2	0
Upland Game Birds	**0.01**	**0.23**	**0.12**	**0.06**	**0.1**	**1.0**	**<0.1**	**0.3**	**1.3**	**3.7**	**2.5**	**5.0**

Appendix B1. Mean use (number of birds/plot[a]/60-minute survey), percent of use, and frequency of occurrence (%) for each large bird type and species by season during the avian use surveys at the Four Mile Wind Project in Benton County, Washington from June 5, 2018 to May 29, 2019.

	Mean Use				% of Use				% Frequency			
Type/Species	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring
California quail	0	0.14	0	0.04	0	0.6	0	0.2	0	2.5	0	3.8
gray partridge	0	0.10	0.12	0	0	0.4	<0.1	0	0	1.2	2.5	0
ring-necked pheasant	0.01	0	0	0.02	0.1	0	0	0.1	1.3	0	0	2.5
Doves/Pigeons	**0.34**	**1.10**	**0.86**	**0**	**2.9**	**4.8**	**0.5**	**0**	**12.6**	**7.4**	**4.6**	**0**
rock pigeon	0.26	1.10	0.86	0	2.2	4.8	0.5	0	5.1	7.4	4.6	0
mourning dove	0.09	0	0	0	0.8	0	0	0	8.8	0	0	0
Large Corvids	**0.63**	**3.41**	**6.45**	**2.26**	**5.4**	**14.8**	**4.0**	**10.1**	**31.6**	**59.3**	**80.8**	**60.2**
common raven	0.62	3.16	6.44	2.24	5.3	13.7	4.0	10.0	30.3	55.6	80.8	60.2
black-billed magpie	0.01	0.25	0.01	0.03	0.1	1.1	<0.1	0.1	1.3	4.9	1.3	2.5
Overall	**11.71**	**23.10**	**160.00**	**22.38**	**100**	**100**	**100**	**100**				

[a] 800-meter radius plot for large birds

Appendix B2. Mean bird use (number of birds/plot[a]/10-minute survey), percent of use, and frequency of occurrence (%) for each small bird type and species by season during the avian use surveys at the Four Mile Wind Project in Benton County, Washington from June 5, 2018 to May 29, 2019.

	Mean Use				% of Use				% Frequency			
Type/Species	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring
Passerines	**3.59**	**6.49**	**5.81**	**5.55**	**99.6**	**100**	**100**	**99.8**	**66.1**	**60.5**	**52.5**	**78.7**
Blackbirds/Orioles	*0.52*	*0.25*	*0.42*	*1.60*	*14.5*	*3.8*	*7.3*	*28.7*	*29.3*	*13.6*	*8.8*	*29.8*
red-winged blackbird	0	0	0	0.04	0	0	0	0.7	0	0	0	2.5
western meadowlark	0.51	0.22	0.33	0.34	14.2	3.4	5.8	6.0	29.3	12.3	7.5	24.9
European starling	0.01	0.02	0.09	1.22	0.4	0.4	1.5	22.0	1.3	1.2	1.2	5.0
Finches/Crossbills	*0.02*	*0.31*	*0.49*	*0*	*0.7*	*4.8*	*8.5*	*0*	*1.2*	*1.2*	*1.2*	*0*
house finch	0	0.31	0	0	0	4.8	0	0	0	1.2	0	0
American goldfinch	0.02	0	0.49	0	0.7	0	8.5	0	1.2	0	1.2	0
Flycatchers	*0.08*	*0*	*0*	*0*	*2.1*	*0*	*0*	*0*	*5.1*	*0*	*0*	*0*
western kingbird	0.08	0	0	0	2.1	0	0	0	5.1	0	0	0
Grassland/Sparrows	*1.82*	*5.89*	*4.89*	*3.73*	*50.5*	*90.7*	*84.2*	*67.0*	*52.1*	*54.3*	*46.2*	*66.3*
grasshopper sparrow	0.10	0	0	0.07	2.8	0	0	1.3	6.4	0	0	6.2
American pipit	0	0.05	0	0	0	0.8	0	0	0	2.5	0	0
lark sparrow	0.15	0	0	0	4.3	0	0	0	3.8	0	0	0
horned lark	1.56	5.31	4.74	3.50	43.4	81.7	81.6	63.0	44.4	44.4	46.2	62.6

Appendix B2. Mean bird use (number of birds/plot[a]/10-minute survey), percent of use, and frequency of occurrence (%) for each small bird type and species by season during the avian use surveys at the Four Mile Wind Project in Benton County, Washington from June 5, 2018 to May 29, 2019.

	Mean Use				% of Use				% Frequency			
Type/Species	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**
dark-eyed junco	0	0.02	0	0	0	0.4	0	0	0	1.2	0	0
savannah sparrow	0	0.35	0.15	0.05	0	5.3	2.6	0.9	0	9.9	3.3	3.7
vesper sparrow	0	0.07	0	0	0	1.1	0	0	0	2.5	0	0
white-crowned sparrow	0	0.07	0	0.10	0	1.1	0	1.8	0	3.7	0	2.5
unidentified sparrow	0	0.01	0	0	0	0.2	0	0	0	1.2	0	0
Mimids	*0*	*0.02*	*0*	*0*	*0*	*0.4*	*0*	*0*	*0*	*1.2*	*0*	*0*
sage thrasher	0	0.02	0	0	0	0.4	0	0	0	1.2	0	0
Swallows	*1.15*	*0*	*0*	*0.22*	*31.8*	*0*	*0*	*4.0*	*16.5*	*0*	*0*	*4.9*
barn swallow	0.01	0	0	0	0.4	0	0	0	1.3	0	0	0
cliff swallow	0.22	0	0	0.16	6.0	0	0	2.9	7.7	0	0	2.5
bank swallow	0.89	0	0	0.04	24.7	0	0	0.7	5.0	0	0	1.2
unidentified swallow	0.03	0	0	0.02	0.7	0	0	0.4	2.5	0	0	1.2
Thrushes	*0*	*0.01*	*0*	*0*	*0*	*0.2*	*0*	*0*	*0*	*1.2*	*0*	*0*
hermit thrush	0	0.01	0	0	0	0.2	0	0	0	1.2	0	0
Wrens	*0*	*0.01*	*0*	*0*	*0*	*0.2*	*0*	*0*	*0*	*1.2*	*0*	*0*
Bewick's wren	0	0.01	0	0	0	0.2	0	0	0	1.2	0	0
Woodpeckers	**0.01**	**0**	**0**	**0**	**0.4**	**0**	**0**	**0**	**1.3**	**0**	**0**	**0**
northern flicker	0.01	0	0	0	0.4	0	0	0	1.3	0	0	0
Unidentified Birds	**0**	**0**	**0**	**0.01**	**0**	**0**	**0**	**0.2**	**0**	**0**	**0**	**1.2**
unidentified small bird	0	0	0	0.01	0	0	0	0.2	0	0	0	1.2
Overall	**3.60**	**6.49**	**5.81**	**5.56**	**100**	**100**	**100**	**100**				

[a] 100-meter radius plot for small birds.

Appendix C. Mean Use by Point for All Birds, Bird Types, and Diurnal Raptor Subtypes during Avian Use Surveys at the Four Mile Wind Project from June 5, 2018 to May 29, 2019

Appendix C. Mean use (number of large birds/60-minute survey; number of small birds/10-minute survey) by point for large bird types, diurnal raptor subtypes, all large birds, and all small birds at the Four Mile Wind Project, Benton County, Washington from June 5, 2018 to May 29, 2019.

Obs. Pt.	Waterbirds	Waterfowl	Shorebirds	Gulls/Terns	Diurnal Raptors	*Accipiters*	*Buteos*	*Northern Harrier*	*Eagles*	*Falcons*	Owls	Upland Game Birds	Doves/ Pigeons	Large Corvids	All Large Birds	All Small Birds
1	27.27	0	0	0	4.64	*0*	*2.91*	*1.27*	*0.18*	*0.27*	0	0	0	1.64	33.55	7.45
2	0	0	0	0	0.82	*0.09*	*0.18*	*0.55*	*0*	*0*	0	1	0	0.55	2.36	4.27
3	0	3	0	0	2.64	*0*	*1.45*	*0.55*	*0*	*0.64*	0	0	1.73	0.91	8.27	4.45
4	0	0	0	0	1.42	*0*	*0.75*	*0.58*	*0*	*0.08*	0.08	0.67	1.58	2.00	5.75	5.00
5	0.09	11.36	0	0	2.55	*0.09*	*1.27*	*1.18*	*0*	*0*	0	0	0.36	1.82	16.18	1.73
6	0	0	0	0	2.00	*0*	*0.92*	*1.00*	*0*	*0.08*	0	0	4.42	6.58	13.00	6.33
7	0	0	0	0	2.00	*0*	*1.33*	*0.17*	*0*	*0.50*	0	0	0.08	1.75	3.83	2.67
8	0.17	2.83	0	0	0.92	*0*	*0.42*	*0.25*	*0*	*0.25*	0	0	0	2.83	6.75	7.67
9	0	0	0	0	0.75	*0*	*0.33*	*0.33*	*0*	*0.08*	0	0.08	0	7.25	8.08	17.58
10	0	0.73	0	0.36	1.27	*0*	*0.91*	*0.18*	*0*	*0.18*	0	0	0	5.73	8.09	6.64
11	9.73	0	0	0	2.55	*0*	*1.64*	*0.82*	*0*	*0.09*	0	0	0	4.73	17.00	7.09
12	0.08	281.33	0	0	2.58	*0*	*1.00*	*1.25*	*0.08*	*0.25*	0	0	0	0.92	284.92	0.58
13	7.33	82.92	0.08	2.33	1.75	*0*	*0.58*	*0.75*	*0*	*0.42*	0	0	0	0.92	95.33	4.83
14	0	39.50	0	0	2.83	*0.08*	*0.92*	*1.50*	*0.08*	*0.25*	0	0	0.17	5.67	48.17	3.08
15	6.50	25.58	0	0	1.50	*0*	*0.58*	*0.92*	*0*	*0*	0	0.08	0	2.00	35.67	3.08
16	16.50	337.42	0	0	3.08	*0*	*2.00*	*1.00*	*0*	*0.08*	0	0.17	0	6.17	363.33	6.08
17	6.67	80.83	0	0	5.00	*0*	*1.33*	*3.25*	*0*	*0.42*	0	0	0	1.33	93.83	3.67
18	0.83	78.17	0	0	3.33	*0.08*	*2.25*	*0.42*	*0*	*0.58*	0	0	5.92	2.58	90.83	10.33
19	0.18	2.64	0	0	1.27	*0*	*0.55*	*0.45*	*0*	*0.27*	0	0	0	2.91	7.00	8.36
20	9.45	9.45	0	0	1.73	*0.09*	*0.45*	*1.09*	*0*	*0.09*	0	0.09	0	3.18	23.91	3.55
21	2.92	4.25	0	0	1.58	*0*	*0.50*	*0.42*	*0*	*0.67*	0	0	0.08	1.08	9.92	5.08
22	2.42	23.17	0	0	1.17	*0*	*0.75*	*0.17*	*0*	*0.25*	0	0	0.08	3.42	30.25	2.33
23	4.08	67.92	1.67	4.17	2.67	*0*	*1.67*	*0.25*	*0.08*	*0.67*	0	0.75	0	9.08	90.33	4.50
24	0.82	0	0	0	1.09	*0*	*0.64*	*0.09*	*0*	*0.36*	0	0.18	0	3.36	5.45	1.64
25	3.70	53.40	0	0	1.70	*0*	*0.90*	*0.80*	*0*	*0*	0	0	0	0.80	59.6	2.40
26	0	0	0	0	0.90	*0*	*0.70*	*0.10*	*0*	*0.10*	0	0	0	4.00	4.90	7.80
27	6.10	3.50	0	0	0.90	*0*	*0.40*	*0.10*	*0*	*0.40*	0	0	0.10	3.00	13.60	3.90

Appendix D. Fatality Summary Table for the Pacific Northwest Region of North America

Appendix D. Publicly available and comparable all bird and diurnal raptor fatality estimates and habitat types from wind energy facilities in the Pacific Northwest (Oregon and Washington) region of North America.

Project Name	All Bird Fatality Rate (birds/MW/year)	Diurnal Raptor Fatality Rate (raptors/MW/year)	Predominant Habitat Type	Citation
Big Horn, WA (2006-2007)	2.54	0.11	agriculture/grassland	Kronner et al. 2008
Biglow Canyon, OR (Phase I; 2008)	1.76	0.03	agriculture/grassland	Jeffrey et al. 2009b
Biglow Canyon, OR (Phase I; 2009)	2.47	0	agriculture	Enk et al. 2010
Biglow Canyon, OR (Phase II; 2009-2010)	5.53	0.14	grassland/shrub-steppe, agriculture	Enk et al. 2011b
Biglow Canyon, OR (Phase II; 2010-2011)	2.68	0.03	grassland/shrub-steppe, agriculture	Enk et al. 2012a
Biglow Canyon, OR (Phase III; 2010-2011)	2.28	0.05	grassland/shrub-steppe, agriculture	Enk et al. 2012b
Combine Hills, OR (2011)	2.33	0.05	agriculture/grassland	Enz et al. 2012
Combine Hills, OR (Phase I; 2004-2005)	2.56	0	shrub/scrub & agriculture	Young et al. 2006
Elkhorn, OR (2008)	0.64	0.06	shrub/scrub & agriculture	Jeffrey et a. 2009a
Elkhorn, OR (2010)	1.95	0.08	agriculture	Enk et al. 2011a
Goodnoe, WA (2009-2010)	1.4	0.17	agriculture/grassland	URS Corporation (URS) 2010a
Harvest Wind, WA (2010-2012)	2.94	0.23	agriculture/grassland	Downes and Gritski 2012a
Hay Canyon, OR (2009-2010)	2.21	0	grassland/shrub-steppe and agriculture	Gritski and Kronner 2010a
Hopkins Ridge, WA (2006)	1.23	0.14	agriculture/grassland	Young et al. 2007
Hopkins Ridge, WA (2008)	2.99	0.07	agriculture	Young et al. 2009
Kittitas Valley, WA (2011-2012)	1.06	0.09	grassland	Stantec Consulting Services 2012
Klondike II, OR (2005-2006)	3.14	0.06	agriculture/grassland	Northwest Wildlife Consultants (NWC) and WEST 2007
Klondike III (Phase I), OR (2007-2009)	3.02	0.15	agriculture/grassland	Gritski et al. 2010
Klondike IIIa (Phase II), OR (2008-2010)	2.61	0.06	grassland and shrub-steppe	Gritski et al. 2011
Klondike, OR (2002-2003)	0.95	0	grassland/shrub-steppe	Johnson et al. 2003
Leaning Juniper, OR (2006-2008)	6.66	0.16	agriculture/grassland	Gritski et al. 2008
Linden Ranch, WA (2010-2011)	6.65	0.27	agriculture/grassland	Enz and Bay 2011
Marengo I, WA (2009-2010)	0.27	0	sagebrush-steppe, grassland	URS 2010b
Marengo II, WA (2009-2010)	0.16	0.05	grassland/shrub-steppe, agriculture	URS 2010c
Nine Canyon, WA (2002-2003)	2.76	0.03	agriculture	Erickson et al. 2003c
Pebble Springs, OR (2009-2010)	1.93	0.04	agriculture	Gritski and Kronner 2010b
Stateline, OR/WA (2001-2002)	3.17	0.09	agriculture/grassland	Erickson et al. 2004

Appendix D. Publicly available and comparable all bird and diurnal raptor fatality estimates and habitat types from wind energy facilities in the Pacific Northwest (Oregon and Washington) region of North America.

Project Name	All Bird Fatality Rate (birds/MW/year)	Diurnal Raptor Fatality Rate (raptors/MW/year)	Predominant Habitat Type	Citation
Stateline, OR/WA (2003)	2.68	0.09	Cropland, Developed, Grassland, Shrub Steppe, Winter Wheat	Erickson et al. 2004
Stateline, OR/WA (2006)	1.23	0.11	grassland/shrub-steppe, agriculture and forest	Erickson et al. 2007
Tucannon River, WA (2015)	1.5	0.16	Shrub-steppe, grassland	Hallingstad et al. 2016
Tuolumne (Windy Point I), WA (2009-2010)	3.2	0.29	grassland/shrub-steppe, agriculture	Enz and Bay 2010
Vansycle, OR (1999)	0.95	0	grassland	Erickson et al. 2000
Vantage, WA (2010-2011)	1.27	0.29	grassland/shrub-steppe, agriculture	Ventus Environmental Solutions 2012
White Creek, WA (2007-2011)	4.05	0.47	agriculture/grassland	Downes and Gritski 2012b
Wild Horse, WA (2007)	1.55	0.09	agriculture/grassland	Erickson et al. 2008
Windy Flats, WA (2010-2011)	8.45	0.04	agriculture/grassland	Enz et al. 2011

MW = megawatt

Avian Use and Raptor Nest Survey Report for the Horse Heaven Wind Project Benton County, Washington

Year 2 Final Report
July 2018 – June 2019


Shrub-steppe in the southeast portion of the Project

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Revised

Public Draft - For Distribution

EXECUTIVE SUMMARY

Horse Heaven Wind Farm, LLC is developing the proposed Horse Heaven Wind Energy Project (Horse Heaven and/or Project) in Benton County, Washington. Western EcoSystems Technology, Inc. (WEST) was contracted to conduct a two-year avian use study at the proposed Project to evaluate the potential impacts of Project operation on birds. Consistent with survey methods used during the first study year (2017–2018), the second year (2018–2019) focused on large-bodied birds and was designed to comply with recommendations described by the Washington Department of Fish and Wildlife (WDFW) Wind Power Guidelines (WDFW 2009), Tier 3 of the US Fish and Wildlife Service (USFWS) Land-Based Wind Energy Guidelines (USFWS 2012), Stage 2 of the Eagle Conservation Plan Guidance (USFWS 2013) and associated Final Eagle Rule (USFWS 2016). This report presents results from surveys conducted 2018–2019 (Year 2) and briefly compares results from 2017–2018 (Year 1; Jansen and Brown 2018) to Year 2.

The principal objective of the Year 2 survey was to provide site-specific species occurrence and the spatial and temporal patterns of avian use with a particular focus on eagles, other raptors, and non-raptors such as sandhill crane or species of regulatory or management concern (i.e., federal or state-sensitive species). Additionally, surveyors documented observations of rare and sensitive species observed incidental to standardized surveys throughout the course of the study.

The Project is located in the Columbia Plateau Ecoregion located within the Horse Heaven Hills which is an anticline ridge of the Yakima Folds. The Project area is located within 4 miles of Kennewick and the larger tri-cities urban area. Fixed-point bird surveys estimated the seasonal, spatial, and temporal use patterns of birds within the Project. All large birds were recorded within an 800-meter radius plot at 18 fixed-point count stations that were randomly located within the Project area. Surveys for large birds were conducted for 60-minutes at each station once per month (i.e., one visit) for 12 months.

Fourteen visits of large-bird use surveys for a total of 178 surveys were conducted at the Project from July 24, 2018–June 22, 2019. A total of 25 unique bird species were observed during the survey year. Overall large bird mean use ranged from 2.58 observations/plot/survey to 61.40 observations/plot/survey among seasons with the highest use during fall (61.40 observations/plot/survey), followed by spring (6.38 observations/plot/survey), winter (5.68 observations/plot/survey), and summer (2.58 observations/plot/survey).

Five species of federal- or state-protected status were recorded during avian use surveys within the Project area. Of the five species, one state-endangered species, sandhill crane and two state-threatened species, ferruginous hawk and American white pelican were observed during the study. Three bald eagles and three golden eagles were also observed during the study both of which are listed under the Bald and Golden Eagle Protection Act of 1940 and golden eagles are also considered a state species of concern.

Bald eagles were observed during fall, winter, and spring with the highest mean use occurring during winter and spring (0.03 observations/plot/survey), followed by fall (0.02 observations/plot/survey). Golden eagles were observed during fall and had a mean use of 0.06 observations/plot/survey. Collectively, eagles were observed for a total of 30 minutes during the Year 2 study. Of the 30 minutes, 13 minutes were attributed to bald eagles, of which six minutes were flying within the 800 m plot below 200 m above ground level (AGL; eagle exposure minutes). The remaining 17 minutes were from golden eagles, of which eight minutes were considered exposure minutes.

A total of 36 raptor nests were located during aerial surveys that were conducted within 10-mi of the Project boundary. Of the 36 nests documented, 24 nests (66%) were occupied; of the 24 occupied nests, 22 nests had adults incubating or young observed in the nest. Five raptor species were recorded within and 2-miles of the Project and included red-tailed hawk (8 nests) Swainson's hawk (7 nests), great-horned owl (3 nests) and ferruginous hawk (1 nest). Three bald eagle nests were located beyond the 2-mi survey area but within 10 mi of the Project. Territories of two of the three bald eagle nests were occupied and contained nestlings (Nest 37) or eggs (Nest 55). No bald or golden eagle nests were found within the Project area or in the 2-mi Survey Area.

The bird species observed in the Project during the study were typical to those commonly found in agricultural, shrub-steppe and grasslands within the Columbia Plateau. Overall large bird use was significantly higher during spring and fall, likely due to the Project's location in the Pacific Flyway and the stopover habitat available in the surrounding area. Overall, the Project area does not support areas of high concentration or use during the avian breeding season. However, special-status avian species such as eagles, sandhill crane, and American white pelican occur at the Project and pose varying levels of collision risk.

To date, overall fatality rates for birds at wind energy facilities have been consistently low, and the most recent, comprehensive, and robust studies of overall bird fatality rates at wind facilities in the Pacific Northwest have produced fatality rate estimates ranging from 0.03–0.47 birds per MW per year; no Project data suggests the Project would fall outside this range.

STUDY PARTICIPANTS

Erik Jansen	Project Manager, GIS
Samantha Brown	Report Writer
Kori Hutchison	Report Writer, Field Coordinator
Guy DiDonato	Statistician
Julie Bushey	Data Analyst
Carmen Boyd	Project Tracking and Data Manager
Joshua Parrott	Field Biologist

REPORT REFERENCE

Jansen, E. W., S. R. Brown, and K. B. Hutchison. 2019. Avian Use Survey Report for the Horse Heaven Wind Energy Project, Benton County, Washington Draft Report. July 24, 2018 – June 22, 2019. Prepared for Horse Heaven Wind Farm, Boulder Colorado. Prepared by Western EcoSystems Technology, Inc. (WEST), Corvallis, Oregon. August 23, 2019.

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INTRODUCTION

Horse Heaven Wind Farm, LLC is proposing the development of the Horse Heaven Wind Farm project (Horse Heaven and/or Project) in Benton County, Washington (Figure 1). Western EcoSystems Technology, Inc. (WEST) was contracted to conduct a two-year avian use study along with raptor nest surveys for the Project to evaluate the potential impacts of Project wind turbine generator (WTG) construction and operation on birds. Additionally, observations of rare and species of concern[1] were documented incidentally to protocol wildlife surveys. The avian use study was designed to comply with recommendations described by the Washington Department of Fish and Wildlife (WDFW) *Wind Power Guidelines* (WPG; WDFW 2009), the US Fish and Wildlife Service's (USFWS) 2012 *Final Land-Based Wind Energy Guidelines* (WEG), Appendix C(1)(a) of the 2013 USFWS *Eagle Conservation Plan Guidelines* (ECPG), and the USFWS *Revisions to Regulations for Eagle Incidental Take and Take of Eagle Nests* (Final Eagle Rule; 81 FR 91494). This study was initiated August 11, 2017 through July 16, 2018 (Year 1), and continued for the second year from July 24, 2018 through June 22, 2019 (Year 2).

The principal objectives of the study were to 1) provide site-specific species occurrence and the spatial and temporal patterns of avian use with a particular focus on eagles, other raptors, and non-raptors such as sandhill crane or species of regulatory or management concern (i.e., federal or state-sensitive species), and 2) to document raptor nests within the Project and surrounding area.

This report summarizes the methodology and results of the Year 2 avian use surveys and raptor nest surveys at the Project, along with a brief comparison between Years 1 and 2. A comprehensive report of Year 1 results can be found in Jansen and Brown 2018.

PROJECT AREA

The Project encompasses 51,262 acres (80.1 mi^2) in Benton County, Washington located within the Horse Heaven Hills which is an anticline ridge of the Yakima Folds within the larger Columbia Plateau Ecoregion (Clarke and Bryce 1997). The Project area is located within 4 miles of Kennewick and the larger tri-cities urban area. Topography within the Project is composed primarily of rolling to incised hills with a broad northeast-facing rampart along the northern perimeter of the Project boundary (Figure 1). The highly-eroded drainages along the rampart

[1] As defined here, "species of concern" includes any species which 1) is either a) listed as an endangered, threatened or candidate species under the Endangered Species Act, subject to the Migratory Bird Treaty Act, Bald and Golden Eagle Protection Act, or Washington State Environmental Protection Act; b) is designated by federal or state law, regulation, or other formal process for protection and/or management by the relevant agency or other authority; or c) has been shown to be significantly adversely affected by wind energy development, and 2) is determined to be possibly affected by the project (WDFW 2009, USFWS 2012).

create numerous canyons that bisect the Project (Badger Canyon, Coyote Canyon, Taylor Canyon) and expose basalt cliffs and ledges. On the southern side of the rampart, the landscape transitions to relatively rolling topography with shallow, meandering canyons that drain south into the Columbia River.

Land cover within the Project area is a mosaic of dryland and irrigated agriculture, shrub-steppe grasslands, and rural/urban development (Jansen and Brown 2018). Agriculture crop is the dominate land cover throughout the Project and surrounding area. Shrub-steppe are found in topographically steep areas where agriculture was not possible. Lands enrolled in the US Department of Agriculture's Conservation Reserve Program are found in areas throughout the Project. Much of the Project area is privately owned and actively managed for dryland agriculture and livestock grazing. The 63 WTG Nine Canyon Wind Project is located directly to the east of the proposed Project (Figure 1).

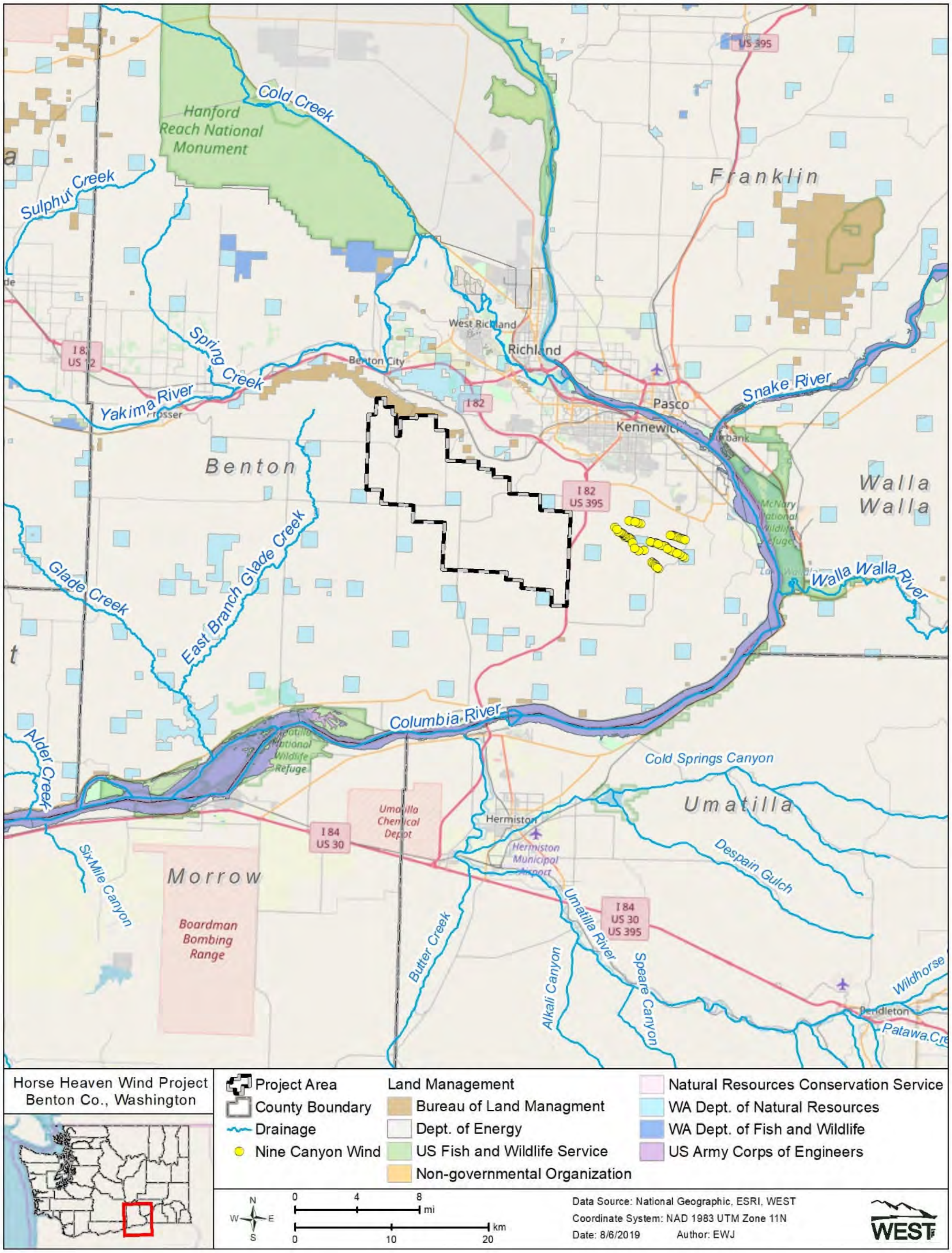

Figure 1. Location of the Horse Heaven Wind Project, Benton County, Washington.

METHODS

The study at the Project consisted of the following: 1) fixed-point avian use surveys, 2) aerial raptor nest surveys, and 3) incidental wildlife observations. The study design and survey methods for birds recorded at the Project primarily follow guidance in the ECPG and the Final Eagle Rule because of the need to collect information on eagles, while also following guidance from the WEG to collect information on other birds, and exceeding standards described in WDFW Wind Power Guidelines (WDFW 2009). Methods described below, therefore, are common for all birds (i.e., large birds, eagles, and other species of concern) except as noted.

Study Design

Fixed-point count stations were established by placing a point nearest to the farthest western proposed WTG location, then picking from a list of randomly-generated numbers that corresponded to a proposed WTG location. Numbers were discarded and redrawn if 800-m radius survey plots substantially overlapped (e.g., >50%). Point placement was microsited (e.g., minor shifts of approximately 100 m) in the field to maximize the surrounding viewshed and were placed on publicly accessible roads.

A total of 13 survey points were established within the proposed Project area to comply with ECPG recommended survey coverage of 30% of the area within one kilometer (km) of WTG's to be covered by 800-m radius observation plot (Figure 2). Surveys were conducted approximately once per month from July 24, 2018 through June 22, 2019 and the order at which points were surveyed was rotated each round to achieve different times of day a point was visited. Due to Project expansion, five additional points (PC14−PC18) were added in April 2019 and were surveyed for 5 visits. These additional points were established and surveyed using the same methodology as the original 13 point counts (Figure 2). Surveys were conducted by one observer; points were not surveyed concurrently to minimize the potential for double counting individuals and are considered independent samples.

Seasons were defined as summer (June 1 to August 12), fall (August 13 to November 30), winter (December 1 to February 28), and spring (March 1 to May 31). Surveys were conducted during daylight hours and survey times at points were randomized to cover all daylight hours during a season. Surveys were conducted under all weather conditions except when visibility was less than 800 m from the observer and 200 m above ground level (AGL).

Survey Methods

Large Birds

At each point, surveys were conducted for 60 minutes (min); all large birds[2] (including eagles) observed or heard within an 800-meter radius from the surveyor were recorded. Biologists recorded the following information for each survey: date, start and end time, and weather (i.e., temperature, wind speed, wind direction, precipitation, and percent cloud cover). Additionally, the following data were recorded for each group of birds observed:

- Observation number
- Species (or best possible identification)
- Number of individuals
- Sex and age class (if possible)
- Distance from survey plot center to the nearest five m interval (first & closest)
- Flight height AGL to the nearest five m interval (first, lowest, and highest)
- Flight direction (first observed)
- Habitat
- Activity (e.g., flying, perched)
- Observation type (visual or aural)
- Flight paths and perch locations of eagles and other species of concern

Eagles

Data were collected if a golden eagle (*Aquila chrysaetos*), bald eagle (*Haliaeetus leucocephalus),* or unidentified eagle were observed during the survey period. Biologists recorded eagle behavior (i.e., flight height, distance from observer, activity) each minute, at the top of the minute, to provide an instantaneous count for every eagle observed, whether or not the eagle was flying below 200 m AGL and within 800 m of the survey location at any time during the minute; and classified the eagle into age class (juvenile [1st year], immature or sub-adult [2nd to 4th year], adult [≥5th year]).

[2] Large birds were defined as waterbirds, waterfowl, shorebirds, gulls/terns, diurnal raptors (i.e., kites, accipiters, *Buteos*, eagles, falcons, northern harrier, and osprey), owls, vultures, upland game birds, doves/pigeons, goatsuckers, and large corvids (e.g., magpies, crows, and ravens).

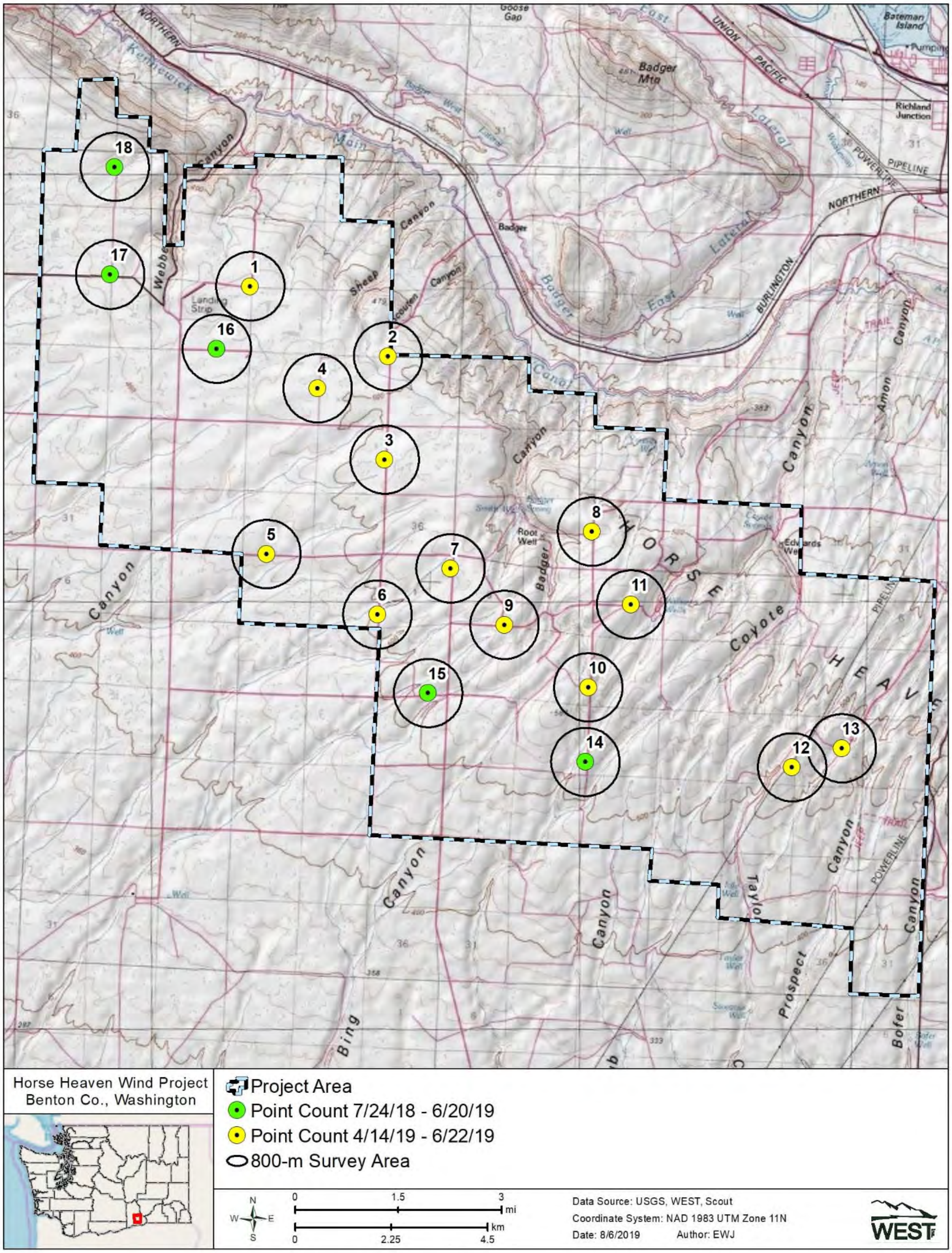

Figure 2. Avian use survey points and plots at the Horse Heaven Wind Project area in Benton County, Washington from July 24, 2018 to June 22, 2019.

Data Management

Quality Assurance and Quality Control

WEST implemented quality assurance and quality control (QA/QC) measures at all stages of the study, including in the field, during data entry and analysis, and report writing. Following surveys, biologists were responsible for inspecting data forms for completeness, accuracy, and legibility. If errors or anomalies were found within the data, follow-up measures were implemented including discussions and review of field data with field technicians and/or Project Managers. WEST traced back any errors, omissions, or problems identified in later stages of analysis to the raw data forms where appropriate changes and measures were implemented, no matter what stage of analysis. Multiple reviews were conducted as QA/QC measures.

Data Compilation and Storage

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

Statistical Analysis

A *visit* was defined as surveying all of the survey plots once within the Project area and could occur across multiple dates but had to be completed in a single season (e.g., spring). If extreme weather conditions prevented all plots from being surveyed during a visit, then a visit might not have constituted a complete survey of all plots. A *survey* was defined as a single 60 min count of birds. In some cases, a count of bird observations may represent repeated observations of the same individual. Only observations within the 800-m survey plot were included for data analysis.

Mean Use, Percent of Use, and Frequency of Occurrence

Mean use is the average number of birds observed per plot per survey for large birds. Large bird use (per 800-m plot per 60-min survey) is calculated by: 1) summing birds per plot per visit, 2) averaging number of birds over plots within a visit, and 3) averaging number of birds across visits within a season. Overall mean use was calculated as a weighted average of seasonal values by the number of days in each season. *Percent of use* was calculated as the percentage of large bird use that was attributable to a particular bird type or species. *Frequency of occurrence* was calculated as the percent of surveys in which a particular bird type or species was observed.

Mean use and frequency of occurrence describe different aspects of relative abundance, in that mean use is based on the number of birds (i.e., large groups can produce high estimates), whereas frequency of occurrence is based on the number of groups (i.e., it is not influenced by group size). Qualitative comparisons were made with these metrics among bird types, seasons, and survey points to help one understand how birds are using the Project area over time and space.

Flight Height

Bird flight heights are important metrics to assess relative potential exposure to WTG blades and were used to calculate the percentage of large birds and eagles observed flying within the rotor-swept height (RSH) of proposed WTG's. A RSH of 25 to 150 m (82 to 492 ft) AGL was assumed for the purpose of the analysis. Flight height recorded during the initial observation was used to calculate the percentage of birds flying within the RSH and mean flight height.

Spatial Use

Mean use was calculated by survey point for large birds and eagles to make spatial comparisons among the survey points. Additionally, flight paths of eagles were mapped during large bird use surveys to qualitatively show flight path location compared to Project area characteristics (e.g., topographic features) to identify if there were areas of concentration or consistent flight patterns within the Project area.

Eagles

Eagle observations during surveys were summarized to provide flight heights (see *Flight Height*) and flight path maps (see *Spatial Use*). Data collected during each minute eagles were observed, were examined to count eagle exposure minutes, defined as the number of minutes an eagle was observed in flight within the risk cylinder (defined as the area within 800 m of the survey point and below 200 m AGL during the 60-min survey periods) and total minutes defined as the amount of time eagles were observed inside and outside the risk cylinder, but still within 800 m of the survey point. The eagle exposure minutes per observation hour were reported by survey plot and month to enable spatial and temporal assessments of eagle exposure minutes recorded in the Project area. Data collected on perched eagles and those outside of survey plots were not considered eagle exposure minutes; however, they were considered in the total eagle minutes. The perch locations and flight paths of all eagles were mapped to qualitatively assess areas of eagle use within the Project area.

Raptor Nest Surveys

Survey Preparation and Consultation

Prior to aerial surveys in 2019, WEST conducted a literature search (Kalasz and Buchanan 2016) and coordinated with Washington Department of Fish and Wildlife (WDFW) biologists to identify previously documented raptor nests in the Survey Area and to review survey protocol. During each survey year, the Project boundary was buffered by 2-miles and 10-miles to create the Survey Area. Compared to 2018, the Project boundary expanded from 25,815 acres to 51,262 acres in 2019. WEST developed a survey plan by plotting previously-identified eagle and non-eagle nests on maps and digital tablets (LG, Seoul, South Korea) with navigational software (Gaia GPS) that was used during aerial surveys.

Aerial Survey Methods

Raptor nest surveys were conducted during two rounds of double-observer (i.e., a primary and secondary observer) aerial surveys. Each survey round were at least 30 days apart and were preformed using a Robinson R-44 Raven II helicopter with bubble windows that provided excellent visibility (Pagel et al. 2010, USFWS 2013). The first survey was conducted during a time period that overlapped the primary early nesting period of eagles in the Pacific Northwest, when breeding pairs are exhibiting courtship, nest-building, and/or egg-laying and incubation behaviors (Isaacs 2018). The second survey was conducted when eagles are actively engaged in mid- to late breeding season reproductive activities (e.g., incubating, brooding, feeding nestlings), and when eagles engaged in ongoing nesting activities would be reliably on or around nests (Watson 2010, Isaacs 2018).

All stick nests that could be constructed by any raptor species were documented within the 2-mi Survey Area, whereas only stick nests constructed by golden eagle or bald eagles were documented within 10 miles of the Project. Surveys utilized an intuitive controlled survey method which focused on areas with the highest potential to support raptor nests including cliffs, rock outcrops, incised drainages and canyons, and large trees. Nests located during the first survey round were revisited during the second survey to evaluate reproductive nesting status. All high-quality nesting habitat was also revisited to search for new nests and later nesting raptor species (e.g., Swainson's hawk [*Buteo swainsoni*]) that may not have been occupied during the first survey round.

During aerial surveys, the helicopter was positioned to allow thorough visual inspection of all appropriate habitat features. In general, the helicopter maintained a distance of no closer than 66 feet (20 m) from cliff faces and nests. When a nest was located, the helicopter reduced speed and adjusted the flight track to allow for a clear view of the nest for documentation and photographing. The amount of time spent circling/searching a particular area or the distance to which a nest was approached was adjusted when raptors, particularly eagles, were present on/near the nest to minimize survey-related disturbance (e.g., flushing). In the event of nestlings, deference was provided and survey of nests directly adjacent to the nestlings (e.g., within 200 m) were aborted.

For each nest or group of nests (e.g., nest site), a Global Positioning System (GPS) location was recorded, a photograph was taken, and nest attribute data were collected. A nest site was defined as two or more nests that occurred on the same shelf, cliff face or tree within close proximity to one another (e.g., approximately 80 ft [25 m]).

WEST categorized basic nesting territories and nest status using definitions originally proposed by Postupalsky (1974) and largely followed today (USFWS 2013). Nests were classified as occupied if any of the following were observed at the nest structure: (1) an adult in an incubating position; (2) eggs; (3) nestlings or fledglings; (4) presence of an adult (sometimes sub-adults); (5) a newly constructed or refurbished stick nest in the area where territorial behavior of a raptor had been observed earlier in the breeding season; or (6) a recently repaired nest with fresh sticks (clean breaks) or fresh boughs on top, and/or droppings and/or molted feathers on its rim or underneath. Occupied nests were further classified as active if an egg or eggs were laid. Nests were classified as inactive if no eggs or chicks were present. Nests not meeting the above criteria for "Occupied" during at least two consecutive surveys were classified as "Unoccupied."

Incidental Observations

Incidental observations were wildlife observed outside of the standardized survey plots but within the Project area and were focused on federal- or state-protected species, unusually large congregations of individuals, species not yet recorded during surveys, unusual or unique birds, mammals, reptiles, amphibians, or eagle attractants (e.g., ground squirrel burrows, areas with concentration of carrion). Data recorded for incidentally observed species were similar to that recorded during scheduled surveys.

RESULTS

Fixed-Point Large Bird Use Surveys

Fourteen visits of large-bird use surveys for a total of 178 surveys were conducted at the Project from July 24, 2018–June 22, 2019. Survey effort varied slightly among seasons with greater survey effort in spring and summer (4 visits), followed by fall and winter (3 visits each) due to weather and accessibility to the Project (Table 1).

Twenty-five species of large birds were observed or heard during the study. Survey results are summarized below, supplemented by the appendices, which present species-level detail on the following: scientific names, number of groups and observations within the survey plot by season (Appendices A), avian use, percent of use, and frequency of occurrence by season (Appendices B), and mean use by survey point (Appendix C).

Table 1. Summary of species richness (species/plot[a]/60-min survey), and sample size by season and overall during the fixed-point bird use surveys at the Horse Heaven Wind Project in Benton County, WA during fixed-point bird use surveys from July 24, 2018 to June 22, 2019.

Season	# Visits	# Surveys Conducted	# Species	Species Richness
				Large Birds
Summer	4	41	10	1.41
Fall	4	52	21	2.38
Winter	3	36	12	1.65
Spring	3	49	15	1.99
Overall	**14**	**178**	**25**	**1.91**

 # Species: Count of bird species observed in the survey plots within and across seasons. Unidentified birds are included in this count ignoring their meta groups.
Species Richness: Average number of species observed within the observer viewshed/plot/visit within seasons.
[a] 800-meter (m) radius plot.

Species of Concern

Eagles

Mean Use

A total of three bald eagles were observed during fall, winter, and spring. Bald eagle mean use relatively consistent among seasons and was highest during winter and spring (0.03 observations/plot/survey), followed by fall (0.02 observations/plot/survey). Overall bald eagle mean use was 0.08 observations/plot/survey. A total of three golden eagles were observed during fall and had a mean use of 0.06 observations/800-m plot/60-min survey.

Eagle Exposure Minutes

A total of 30 eagle minutes were recorded from three bald eagles and three golden eagles during the 178 survey hours. Of the 30 eagle minutes, bald eagles were observed for 13 minutes, of which six minutes were considered exposure minutes where the eagle was observed flying within the risk cylinder (Table 2). Bald eagles occurred during fall, winter, and spring seasons and ranged from 0.02 in spring to 0.058 eagle exposure min/hr in fall (Table 2). Bald eagle exposure minutes per survey hour was highest at survey Point 11 (0.25 eagle exposure min/hr). The remaining 17 eagle minutes were attributed to golden eagles, of which eight minutes were considered exposure minutes (Table 3). Averaged across all seasons, golden eagle exposure minutes per survey hour was 0.045 eagle exposure min/hr with the highest exposure at Point 12 (Table 3).

Eagle Flight Paths

Golden and bald eagle flight paths were mapped at the Project (Figure 3). Eagles were observed flying predominantly south at an average flight height of 66.67 m which is within the 25−150 m likely RSH of a WTG blade. Because of the small number of individuals observed, no discernable patterns emerged from the flight path data; however, three eagles (two golden eagles and one bald eagle) were observed in the southeastern corner of the Project at Point 12 and Point 13. Topography in the area of Points 12 and 13 consists of dissected to rolling hills.

Table 2. The bald eagle minutes and observations recorded during avian use surveys in the Horse Heaven Wind Energy Project area in Benton County, Washington from July 24, 2018 to June 22, 2019.

	Eagle Minutes		Eagle Observations			
Season	Within Risk Cylinder[1]	Total[2]	Within Risk Cylinder[1]	Total[2]	Survey Hours	Eagle Exposure Mins/Survey Hr
Summer	0	0	0	0	41	0.0000
Fall	3	7	1	1	52	0.0577
Winter	2	3	1	1	36	0.0556
Spring	1	3	1	1	49	0.0204
Total	**6**	**13**	**3**	**3**	**178**	**0.0337**[3]

[1] Minutes or observations inside the risk cylinder (within 800 m of observer, below 200 m AGL); minutes inside risk cylinder = eagle exposure minutes.

[2] Total = minutes or observations inside and outside the risk cylinder, but still within 800 m of the survey point.

[3] Seasonal average

Table 3. The golden eagle minutes and observations recorded during avian use surveys in the Horse Heaven Wind Energy Project area in Benton County, Washington from July 24, 2018 to June 22, 2019.

Season	Eagle Minutes		Eagle Observations		Survey Hours	Eagle Exposure Mins/Survey Hr
	Within Risk Cylinder[1]	Total[2]	Within Risk Cylinder[1]	Total[2]		
Summer	0	0	0	0	41	0.0000
Fall	8	17	3	3	52	0.1538
Winter	0	0	0	0	36	0.0000
Spring	0	0	0	0	49	0.0000
Total	**8**	**17**	**3**	**3**	**178**	**0.0449**

[1] In = minutes or observations inside the risk cylinder (within 800 m of observer, below 200 m AGL); minutes inside risk cylinder = eagle exposure minutes.

[2] Total = minutes or observations inside and outside the risk cylinder, but still within 800 m of the survey point.

[3] Seasonal average

Federal- and state-protected species

Five species of federal- or state-protected status were recorded during avian use surveys within the Project area (Table 4). One state-endangered species, sandhill crane, was observed during the study. Sixteen groups comprising 2,924 individuals were observed with nearly half (52%) of the observations occurring outside of point count surveys. Two state-threatened species, one ferruginous hawk and five groups of 65 American white pelicans were observed during avian use surveys. Three bald eagles and three golden eagles were observed during the year-long study. Both species are listed under the Bald and Golden Eagle Protection Act of 1940 and golden eagles are also considered a state species of concern. A permitting process is available that authorizes the incidental take of an eagle that result from but is not the purpose of an otherwise lawful activity (USFWS 2016).

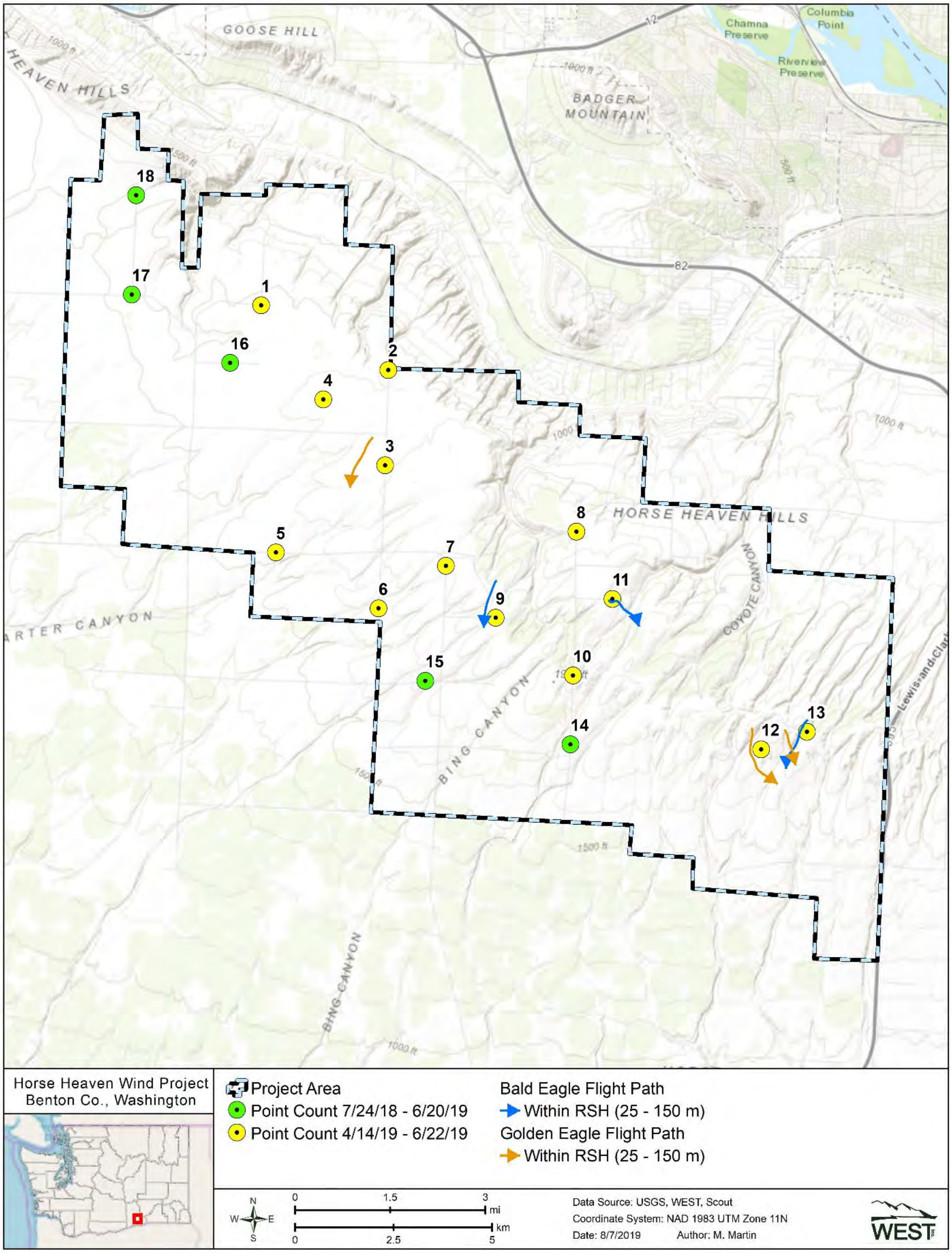

Figure 3. Bald and golden eagle flight path at the Horse Heaven Project area in Benton County, Washington.

Table 4. Groups and observations of federal- and state-protected species recorded during avian use surveys or as incidental wildlife observations at the Horse Heaven Wind Project area in Benton County, Washington from July 24, 2018 to June 22, 2019.

			Point Count		Incidental		Total	
Species	**Scientific Name**	**Status**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
sandhill crane	*Antigone canadensis*	WA-E	9	1,400	7	1,524	16	2,924
golden eagle	*Aquila chrysaetos*	BGEPA; SCS	3	3	0	0	3	3
ferruginous hawk	*Buteo regalis*	WA-T	1	1	0	0	1	1
bald eagle	*Haliaeetus leucocephalus*	BGEPA	3	3	0	0	3	3
American white pelican	*Pelecanus erythrorhynchos*	WA-T	5	65	0	0	5	65
Total	***5 species***		**21**	**1,472**	**7**	**1524**	**28**	**2,996**

WA-E = State Endangered
WA-T = State Threatened
SCS = State Candidate Species
BGEPA = Bald and Golden Eagle Protection Act

Large Birds

Twenty-four species of large birds were observed or heard over the 178 hours of surveys during Year 2. Four unidentified bird groups (individuals that could not be identified to species) were observed during surveys. Each unidentified bird group represented a small proportion of the species observed within the group. Unidentified geese represented approximately 9% of all waterfowl observed. Within the raptor group, unidentified *Buteo* (1.2%), unidentified accipiter (<1%), and unidentified falcon (<1%) rarely occurred.

Mean Use, Percent of Use, and Frequency of Occurrence

Mean use, percent of use, and frequency of occurrence were calculated by season for large bird types (Figures 4a, 4b, 4c) and species (Appendix B). Large bird mean use ranged from 2.58 observations/plot/survey to 61.40 observations/plot/survey among seasons and was highest during fall (61.40 observations/plot/survey), followed by spring (6.38 observations/plot/survey), winter (5.68 observations/plot/survey), and summer (2.58 observations/plot/survey; Figure 4a). Species composition of avian use varied by season. Waterbirds and waterfowl comprised the majority of use during fall (27.88 observations/plot/survey and 25.65 observations/plot/survey, respectively), whereas diurnal raptors had the highest use during summer (1.28 observations/plot/survey) and doves/pigeons had the highest use in winter (2.23 observations/plot/survey) and spring (1.95 observations/plot/survey; Figure 4a).

Similarly, waterbirds and waterfowl comprised the majority of observations during fall (87.2% total), while diurnal raptors did so during summer (49.8%) and doves/pigeons during spring (30.5%; Figure 4b). Diurnal raptor frequency of occurrence was highest among seasons, ranging from 55.1 to 80.8%, followed by large corvids (26.6 to 61.3%; Figure 4c).

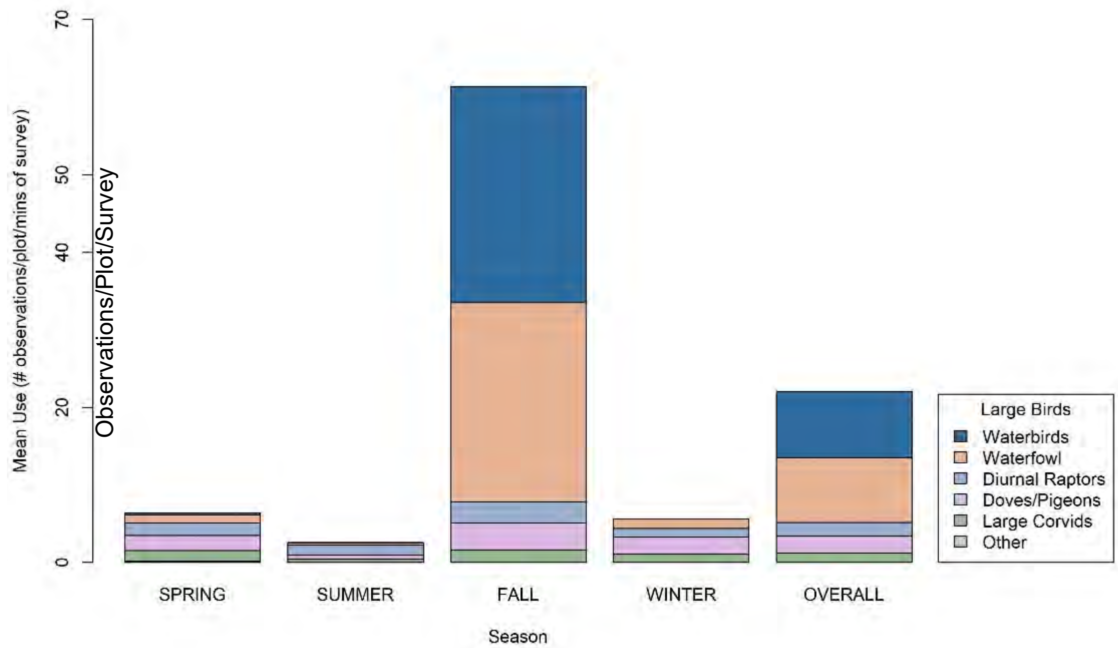

Figure 4a. Large bird mean use by season and bird type at the Horse Heaven Wind Project area in Benton County, Washington from July 24, 2018 to June 22, 2019.

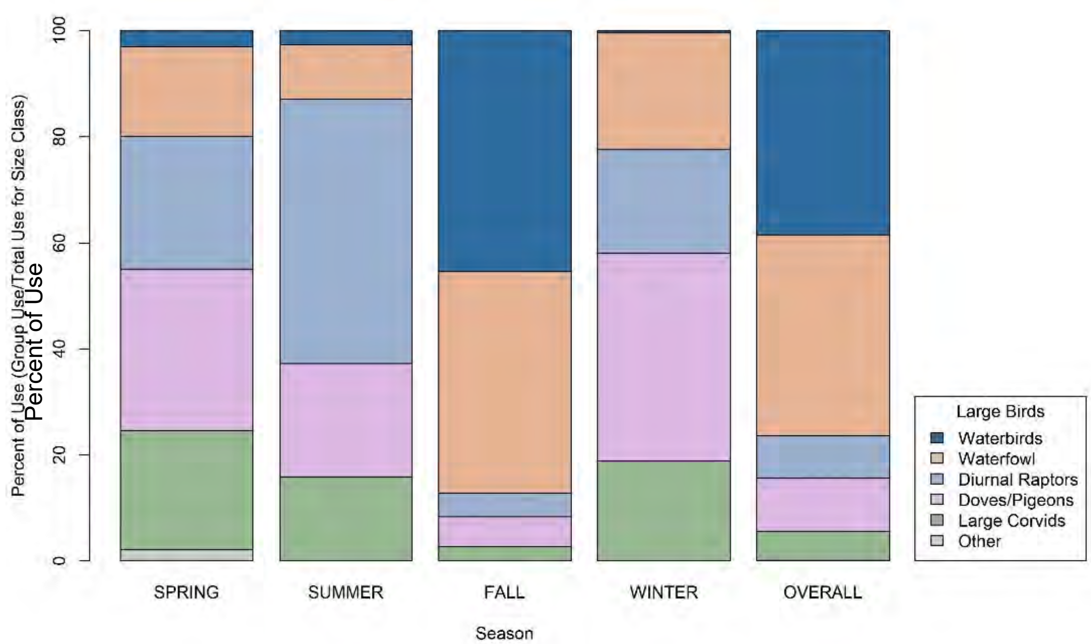

Figure 4b. Large bird percent of use by season and bird type at the Horse Heaven Wind Project area in Benton County, Washington from July 24, 2018 to June 22, 2019.

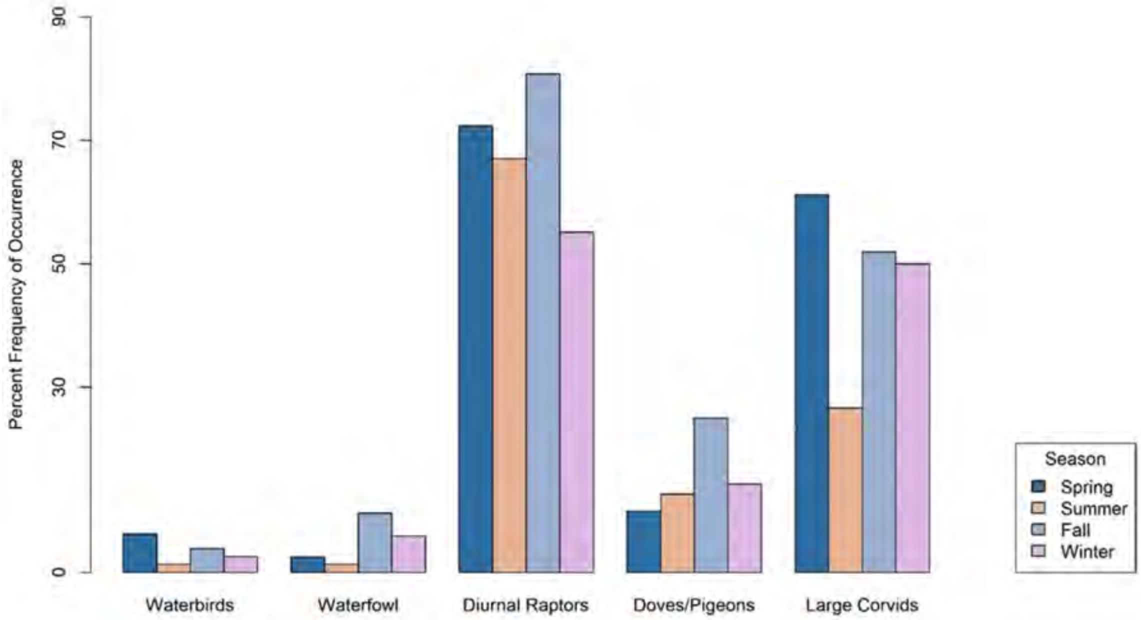

Figure 4c. Large bird frequency of occurrence by season and bird type at the Horse Heaven Wind Project area in Benton County, Washington from July 24, 2018 to June 22, 2019.

Bird Flight Height

Mean large bird flight heights ranged from 3.00 m (9.84 ft) for owls to 309.67 m (1,015.98 ft) for waterbirds. Shorebirds (100%) and waterfowl (90.8%) were recorded most frequently within RSH (25 to 150 m AGL; Table 5). Owl flight heights were within 0 to 25 m (85 ft) 100% of the time, and waterbirds flew >150 m most (99.6%) of the time (Table 5). Within the diurnal raptor group, the species with the highest mean use (*Buteos*) were observed within the RSH the majority (83%) of the time. As discussed, all six eagle observations were within the RSH. Frequently observed during surveys, northern harrier was rarely observed within the RSH and flew below 25 m AGL 92.5%.

Table 5. Flight height characteristics by large bird type and raptor subtype during 60-minute use surveys at the Horse Heaven Wind Project in Benton County, Washington from July 24, 2018 to June 22, 2019.

Bird Type	# Groups Flying	# Obs Flying	Mean Flight Height (m)	% Obs Flying	% within Flight height Categories		
					0 - <25 m	25 - 150 *m*[b]	> 150 m
Waterbirds	**15**	**1,466**	**309.67**	**100**	**0**	**0.4**	**99.6**
Waterfowl	**15**	**1,436**	**100.87**	**100**	**9.2**	**90.8**	**0**
Shorebirds	**1**	**4**	**25.00**	**80.0**	**0**	**100**	**0**
Diurnal Raptors	**273**	**278**	**38.19**	**87.7**	**49.6**	**49.3**	**1.1**
Accipiters	*2*	*2*	*25.00*	*100*	*50.0*	*50.0*	*0*
Buteos	*137*	*141*	*62.42*	*83.9*	*14.9*	*83.0*	*2.1*
Northern Harrier	*106*	*106*	*9.34*	*100*	*92.5*	*7.5*	*0*
Eagles	*6*	*6*	*66.67*	*100*	*0*	*100*	*0*
Falcons	*22*	*23*	*19.73*	*65.7*	*78.3*	*21.7*	*0*
Owls	**1**	**1**	**3.00**	**100**	**100**	**0**	**0**
Doves/Pigeons	**31**	**363**	**21.35**	**93.8**	**56.7**	**43.3**	**0**
Large Corvids	**125**	**205**	**32.26**	**96.2**	**48.8**	**42.9**	**8.3**
Large Birds Overall	**461**	**3,753**	**46.22**	**98.1**	**15.4**	**45.2**	**39.4**

[a] 800-meter (m) radius plot for large birds.
[b] The likely RSH for potential collision with a WTG blade, or 25 to 150 m (85 to 492 ft) above ground level.
[c] Zeroes and NA values indicate that the species was observed but was not flying.

Spatial Variation

Mean Use by Point

Large bird use ranged from 1.60 observations/plot/survey to 120.33 observations/plot/survey across points and was concentrated on Points 11 and 1 (Figure 6a). High avian use at these points was influenced by large groups of waterbirds at Point 11 and waterfowl at Point 1 (Figures 6a, 6b, 6c; Appendix C).

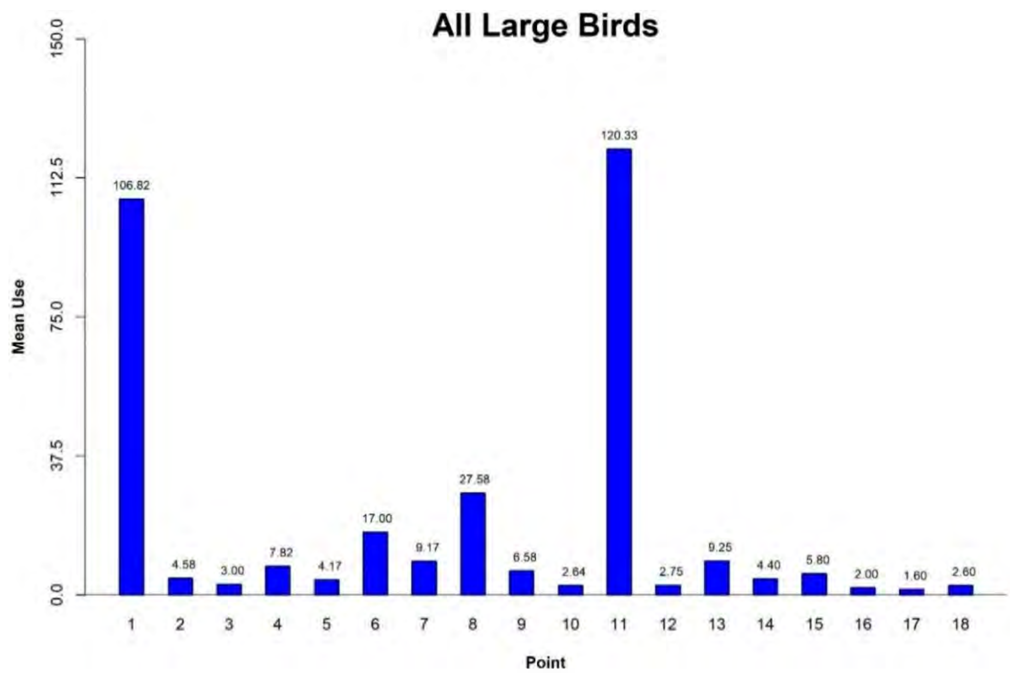

Figure 5a. Large Bird Mean Use by Point by bird type at the Horse Heaven Wind Project area in Benton County, Washington from July 24, 2018 to June 22, 2019.

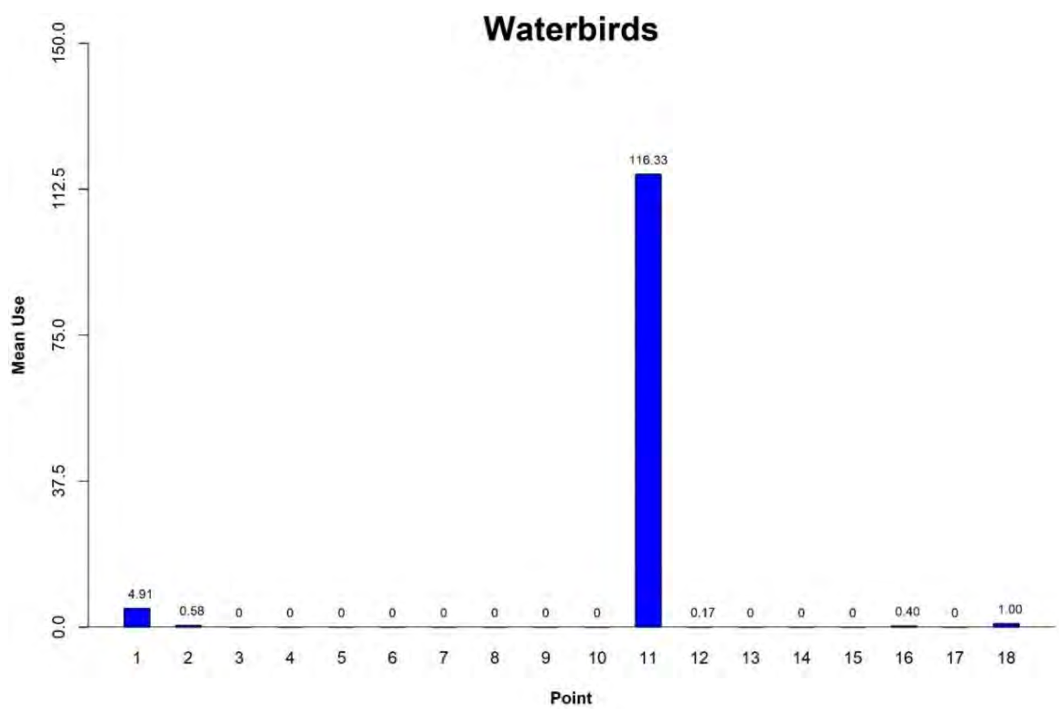

Figure 5b. Waterbird Mean Use by Point at the Horse Heaven Wind Project area in Benton County, Washington from July 24, 2018 to June 22, 2019.

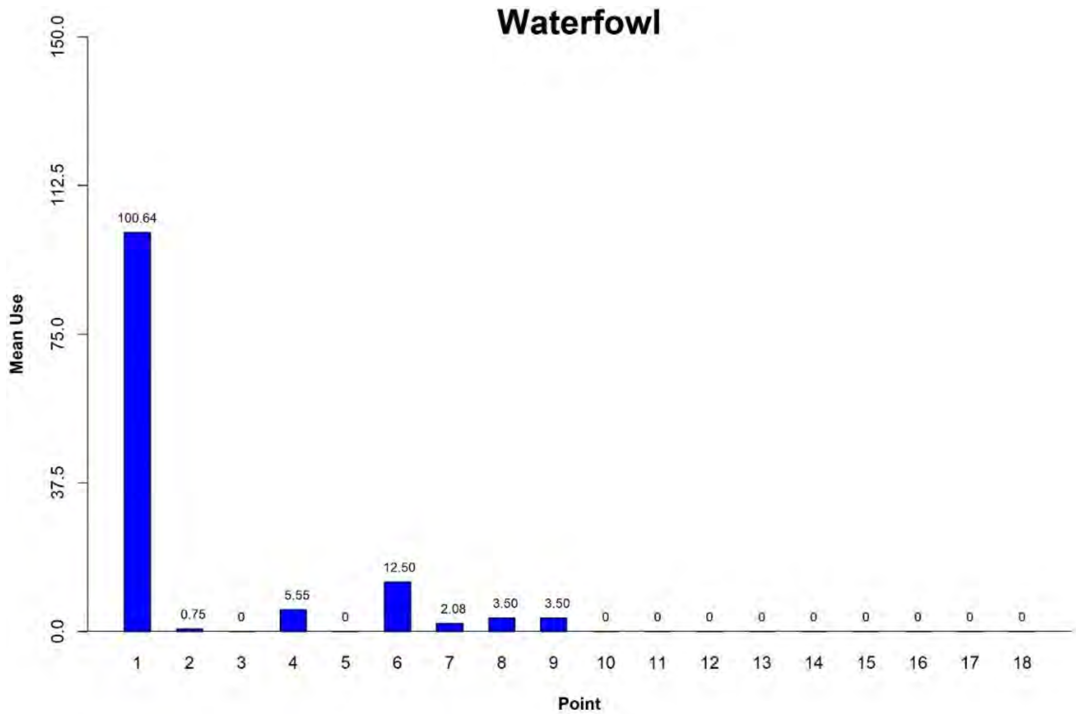

Figure 5c. Waterfowl Mean Use by Point at the Horse Heaven Wind Project area in Benton County, Washington from July 24, 2018 to June 22, 2019.

<u>Flight Paths</u>

Flight paths of sandhill crane were mapped at the Project. Nine groups of 1,400 individuals were observed flying over the Project area during fall. Groups were observed flying in a predominant southerly flight direction. All groups observed were flying above RSH. The average flight height was 364 m AGL (range 200−500 m AGL).

Flight paths of five groups of 65 American white pelican were mapped at the Project. Groups were observed during summer, fall and spring. Groups occurred throughout the Project area and did not appear to follow a particular flight pattern. Of the five groups observed, one group of five individuals were observed during summer flying in the RSH at approximately 125 m AGL. The average flight height was 260 m AGL (range 125−400 m AGL).

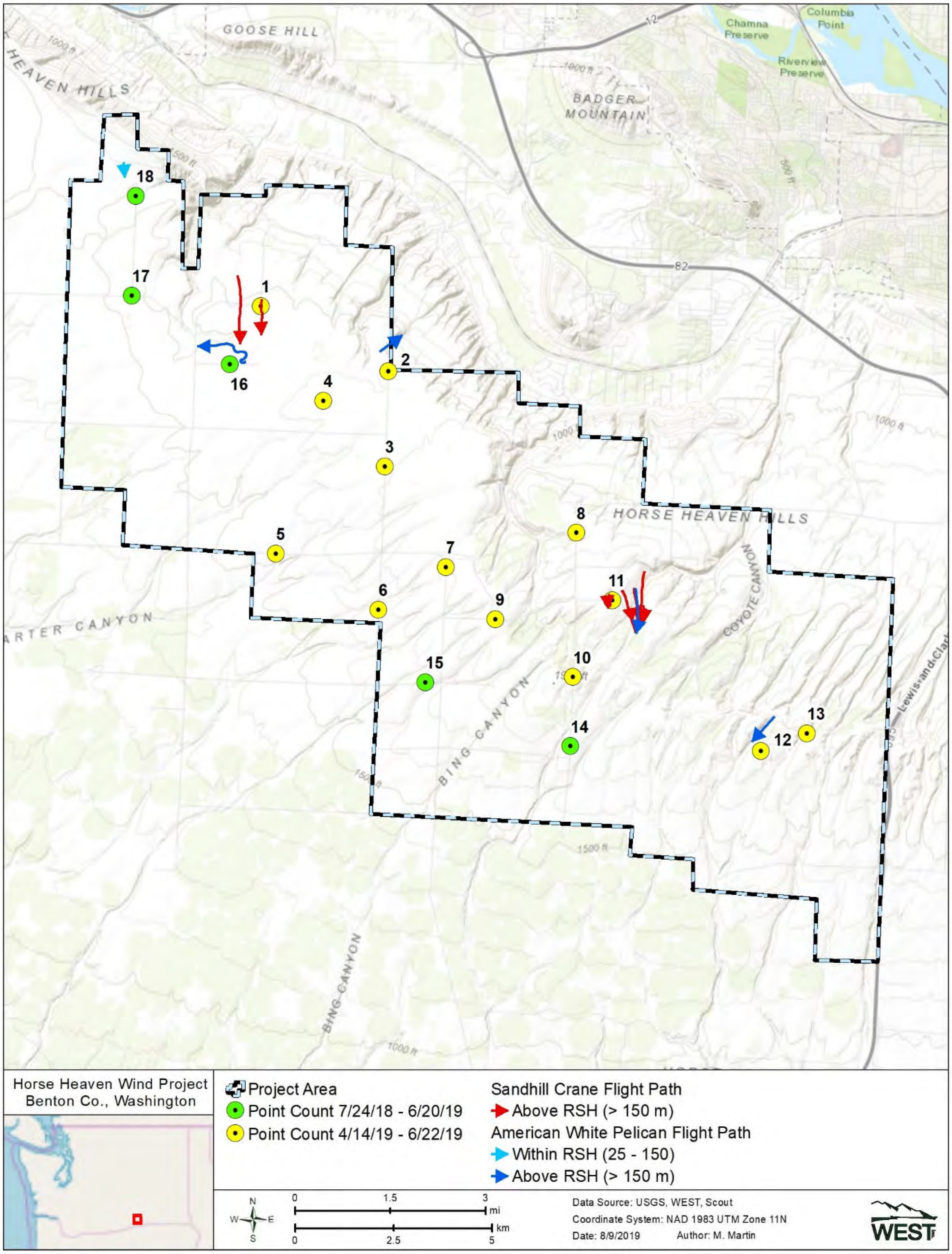

Figure 6. Sandhill crane flight paths at the Horse Heaven Wind Project, Benton County Washington from July 24, 2018 to June 22, 2019.

Raptor Nest Surveys

A total of 36 raptor nests were located during aerial surveys that were conducted at the Project on March 5 and May 16, 2019. Of the 36 nests documented, 24 nests (66%) were occupied; of the 24 occupied nests, 22 nests had adults incubating or young observed in the nest (Appendix D1). Of the occupied nests, six raptor species were recorded within 10-miles of the Project and included red-tailed hawk (8 nests) Swainson's hawk (7 nests), great-horned owl (3 nests), bald eagle (3 nests), and ferruginous hawk (1 nest). Although not considered a raptor, two common raven nests were documented during surveys.

Three bald eagle territories were located within the 10-mile Survey Area: Yakima River Mouth, Port of Pasco, and Sand Station[3]. The Yakima River Mouth territory (Nest 18) was located at the [redacted] (Figure 7 and 8). During the second survey, one adult was present at the nest which contained new nest material, but no eggs or young were observed; thus, the breeding status of the nest was considered inactive. The Port of Pasco territory (Nest 37), [redacted]. During the second survey, the nest was occupied by two adults and contained two nestlings approximately 21 to 30 days old (Appendix D2). The Sand Station territory (Nest 55) was located [redacted] During the second survey, two adults were present at the nest which contained two eggs (Appendix D3). No bald or golden eagle nests were found within the Project area or in the 2-mi Survey Area.

One ferruginous hawk nest (Nest 03) was located in a deciduous tree within the Project area and contained one adult in an incubating posture (Appendix D4). Eight additional unoccupied nests characteristic of nests built by ferruginous hawk were documented within two miles of the Project. These unoccupied nests were all located in the northwestern portion of the Project within the [redacted] 13 (Figure 9). All nests were located on the ground and had the size and form typical of ferruginous hawk construction (Photo D5). Seven of the nests were in poor condition, indicating no recent maintenance or nesting activities had occurred and were most likely old territories.

Eight red-tailed hawk nests were observed within two miles of the Project. Of the eight nests, seven were occupied and active with four of the nests containing young approximately 14–30 days old during the second survey (Nest 09, 20, 26, and 27; Figure 8; Appendix D). Nest 26 contained four nestlings at the time of the second survey (Photo D6). The remaining nest (Nest 14) was occupied inactive with an adult present during both surveys but no sign indicative of nesting was observed.

Seven occupied Swainson's hawk nests were located two miles from the Project and contained adults on the nest in an incubating posture. Six of the seven nests were located within the Project area and another nest (Nest 43) was located approximate 2 mi southeast of the Project (Table 8,

[3] WEST-defined territory names

Figure 8). In Washington, Swainson's hawks typically arrive later in the season to nest compared to other species, thus adults tending the nests were still incubating during the time of the second survey.

Three great-horned owls were observed nesting within two miles of the Project (Figure 8). All three nests were documented as occupied and active, two of which had owlets present. Located within the Project area, Nest 01 had two owlets standing adjacent to the nest during the second survey and Nest 41 had a juvenile flush from the nest but no adults were present. Located within the 2-mi Study Area, Nest 07 had a red-tailed hawk at the nest during the first survey but by the second survey the nest was occupied by an adult great-horned owl that was incubating (Photo D7).

While not a raptor per se, two common raven (*Corvus corax*) nests (Nest 19 and 33) were documented because ravens and raptors are known to use similar-sized nests. The nests were located within the Project area, one on a cliff with two adults and four chicks present while the other one was in a deciduous tree with one adult present.

The 12 unoccupied inactive nests were located two miles from the Project. Several of the nests were highly dilapidated, of which two (Nests 12 and 13) nest were no longer considered viable nests without substantial rebuilding. Eight nests were characteristic of a ferruginous hawk placement and construction possibly occupied by ferruginous hawks prior to 2017 when surveys at the Project began.

2017–2019 Nest Survey Comparison

Although the number of nests located within the 2-mile Study Area of the Project increased from 2017 to 2019, nest density decreased because the Survey Area was over twice as large in 2019 (Table 6). In addition to a larger Study Area, the increase in the number of nests between years was due to the construction of *Buteo* nests; red-tailed hawks in deciduous trees along an old railroad grade located north of the Project and Swainson's hawks in isolated trees scattered throughout the Project. The number of occupied red-tailed hawk, Swainson's hawk, and ferruginous hawk nests among survey years contributing to the majority of the raptor nest use in 2017 (64%), 2018 (73%), and 2019 (67%; Table 6).

Overall, nest density in 2019 was relatively consistent with densities observed 2018 although lower compared to 2017. Although nest density decreased in 2019 compared to 2017, the proportion of occupied nests (67%) in 2019 was higher than in 2017 when nearly half of the nests were unoccupied (52%; Table 6).

Seven nests were occupied consecutively during all three survey years (Nests 2, 3, 7, 9, 14, 18, and 19). Of the seven nests occupied in successive years, three (43%) contained the same species. The Yakima River Mouth bald eagle territory (Nest 18) was occupied and contained nestlings during 2017 and 2018 survey years but did not show sign of nesting or attempted nesting during 2019. Nest 3 contained a ferruginous hawk that was observed incubating during each survey year. Nest 9 was occupied by a red-tailed hawk and contained at least one nestling each survey year. Occupied nests with a different species among years typically had a great-horned owl, Swainson's hawk, or a common raven during one of the three survey years.

Table 6. Raptor nest results within 2-miles of the proposed Horse Heaven Wind Project, Washington. Aerial surveys conducted March 31 and May 10 2017, March 05 and May 10 2018, and March 5 and May 16 2019. Supplemental ground surveys were conducted during summer 2018.

Species Obs. On Nest	2017		2018		2019	
	# Nests	Nest Density (#/mi²)[a]	# Nests	Nest Density (#/mi²)[a]	# Nests	Nest Density (#/mi²)[a]
Ferruginous Hawk	2	0.027	1	0.007	1	0.005
Swainson's Hawk	1	0.013	6	0.039	7	0.037
Red-tailed Hawk	4	0.054	8	0.052	8	0.043
Great-horned Owl	2	0.027	2	0.013	3	0.016
Common Raven	1	0.013	1	0.007	2	0.011
Unoccupied	10	0.134	14	0.092	12	0.064
Sum	20	0.268	32	0.210	33	0.176

[a] Nest Density = # Nests within 2-mi of Project / (Project Area + 2-mi All Raptor Survey Area): 2017 = 74.66 mi^2; 2018 = 152.60 mi^2 ; 2019 = 187.14 mi^2

[b] Located outside the two-mile Survey Area.

[REDACTED DUE TO SENSITIVE INFORMATION]

Figure 7. Aerial orthophotograph of 2019 raptor nests within 10-miles of the Horse Heaven Wind Project area in Benton County, Washington.

[REDACTED DUE TO SENSITIVE INFORMATION]

Figure 8. Topographic map with 2019 raptor nests within 10-miles of the Horse Heaven Wind Project area in Benton County, Washington.

[REDACTED DUE TO SENSITIVE INFORMATION]

Figure 9. Topographic map of 2019 raptor nests within 2-miles of the Horse Heaven Wind Project area in Benton County, Washington.

Incidental Observations

Four avian species and one mammal species not identified during surveys were observed during the study period (Table 7). Of the four species observed, two species were listed as special status including sandhill crane (state endangered) and sage thrasher (state candidate species for listing). Of additional note, two pronghorn antelope were observed in May during the aerial raptor nest surveys. Two adult males were observed separately running through agricultural fields. While not considered a listed or sensitive species, pronghorn population numbers in Washington are very low (e.g., < 300 individuals) and reintroduction efforts are currently underway (WDFW 2018)

Table 7. Incidental wildlife observed at the Horse Heaven Wind Project area in Benton County, Washington from July 24, 2018 to June 22, 2019.

Species	Scientific Name	# grps	# obs
sandhill crane[1]	*Antigone canadensis*	7	1,524
snowy owl	*Bubo scandiacus*	1	1
Bullock's oriole	*Icterus bullockii*	1	7
sage thrasher[2]	*Oreoscoptes montanus*	1	1
Pronghorn antelope	*Antilocapra americana*	2	2
Total	***5 species***	**12**	**1,535**

[1] State Endangered

[2] State Candidate Species

DISCUSSION

The principal objectives of the study were to 1) provide site-specific species occurrence and spatial and temporal patterns of avian use with a particular focus on eagles, other raptors, and non-raptors such as sandhill crane or species of regulatory or management concern (i.e., federal or state-sensitive species), and 2) document raptor nests within the Project and surrounding area. Additionally, surveyors documented observations of rare and sensitive species observed incidental to standardized surveys throughout the course of the study.

The bird species observed in the Project during the study were typical to those commonly found in agricultural, shrub-steppe and grasslands within the Columbia Plateau. Bird use was highest for species common and widespread in the region and the bird community observed coincided with the assemblage expected based on habitat in the Project and surrounding area. For example, waterbirds and waterfowl were primarily observed during spring and fall when individuals were likely moving between their summer and winter ranges.

Overall large bird use was significantly higher during spring and fall, likely due to the Project's location in the Pacific Flyway and the stopover habitat available in the surrounding area. Sandhill crane and snow goose had the highest mean use of all birds in Year 2 due to the large flock numbers that flew over the Project. The region surrounding the Project contains various agricultural and crop lands that could provide valuable stopover locations for migrating cranes and geese; however based on high flight heights and patterns it is likely these species are predominantly passing over the Project area rather than utilizing resources in the area. Certain areas within the Project (primarily in ravines and small sections of non-cultivated lands) provided some suitable nesting habitat for raptors (e.g., cliff, escarpments or trees). Overall diurnal raptor use was generally consistent across the Project area with overall large bird use concentrated at Points 1 and 11. Several large bird groups of interest for the Project are discussed separately, below.

Waterbirds

The waterbird group accounted for the highest mean use but contained only three species, two of which are of conservation interest; American white pelican (state threatened) and sandhill crane (state endangered).

American white pelican mean use was relatively low when compared to other waterbirds and waterfowl. Of a total of five groups of 65 American white pelicans observed during spring, summer, and fall, only 7.7% were flying within the RSH. In comparison, the Year 1 study observed only one individual American white pelican during the summer flying within the RSH. In Washington, the largest breeding colony of American white pelicans is on Badger Island, located 12 miles northeast of the Project near Kennewick (Stinson 2016). No large bodies of water that provide suitable pelican foraging habitat is present within the Project; however, considering an increasing population (approximate 86% increase on Badger Island since 2009, n = 3,267 individuals total), occasional use of the Project area may continue. No behavioral patterns or areas of concentration were observed during the either survey year.

Sandhill crane comprised the majority of large bird observations at the Project in both survey years and had the highest use during spring and fall. Higher crane use was at the center of the Project in both Year 1 and 2 (Point 7 and Point 11, respectively), but there does not appear to be a strong association for observed sandhill crane use at either survey point or the surrounding areas. This suggests individuals observed during surveys were likely passing over the Project. Despite the pattern of high use at the Project, sandhill cranes do not seem especially vulnerable to WTG collisions. This is based primarily on observed flight heights above the RSH in both Year 1 and 2 (90% and 100%, respectively). This flight behavior is supported by studies that have shown sandhill cranes are likely to avoid WTG's (Nagy et al. 2013, Derby et al. 2012, Pearse et al. 2016). In addition, researchers at WEST monitored use by migrating sandhill cranes at five wind energy facilities in North and South Dakota from 2009 – 2013 for three years at each site. Concurrently, they searched underneath all WTG's daily for fatalities of cranes. Cumulatively, observers spent 13,182 hours recording crane use over 1,305 days, and even though 42,727 sandhill crane observations were recorded, no fatalities of cranes were found beneath WTG's (Derby et al. 2018). A crane monitoring study was conducted at the Forward Energy Center, a wind energy facility in southern Wisconsin located within 3.2 km (2.0 mi) of a large wetland used by sandhill cranes. No crane fatalities were found during the crane monitoring study in the fall of 2008, or during regular bird fatality monitoring studies conducted in the fall of 2008, spring and fall of 2009, and in the spring of 2010, even though sandhill cranes were observed in the study area (Grodsky et al. 2013).

Due to the observed numbers of cranes, continued use of the Project during spring and fall is anticipated. However, the absence of suitable breeding and stopover habitat within the Project area, average flight heights above the RSH, and the available data regarding these species' interactions with WTG's, impacts to sandhill crane resulting from Project development and operation are anticipated to be low.

Waterfowl

Two species comprised the waterfowl group: Canada goose and snow goose. Mean use was highest in fall which was attributed to large groups of each species migrating through the Project. Waterfowl do not seem especially vulnerable to WTG collisions. In an analysis of 116 studies of bird mortality at over 70 operating wind facilities, waterfowl composed 2.7% of 4,975 fatalities found (Erickson et al. 2014). Wheat fields within the Project area may become inundated with water in the spring or fall and provide suitable foraging habitat. Waterfowl that enter or exit agricultural fields while foraging for grain crops may be at greater risk of WTG collision.

Diurnal Raptors

Diurnal raptor use was highest during the fall when northern harrier, red-tailed hawks, Swainson's hawks and rough-legged hawk use increased. Fall coincides with migration when large-scale movement of many raptor species to more southern latitudes occurs. The increased use of raptors in fall followed by the subsequent decrease of most raptor species in winter suggests a limited number of raptor species overwinter in the Project area.

Observations of red-tailed hawks and northern harriers increased during fall migration; Swainson's hawk use peaked in summer post nesting but is considered a highly migratory species. Based on the higher relative use of *Buteos* and harriers during fall and flight behavior that is often within the RSH, there is higher potential for *Buteos* fatalities compared to other raptor species. Fatalities of all three raptor species (Swainson's hawk, red-tailed hawk, and northern harrier) have been documented at operating wind projects.

Ferruginous hawks, a state listed threatened species, was observed during large bird surveys and during raptor nest surveys. Observed during fall, overall use was low when compared to other diurnal raptor use in the area. The number of unoccupied nests whose construction was indicative of ferruginous hawk suggests higher nest occupancy in the Horse Heaven Hills prior to 2017 nest surveys; however, one nest has consistently been occupied by ferruginous hawk during the 2017-2019 raptor nest surveys. A 2010 survey of 192 ferruginous hawk territories in Washington resulted in the lowest number of occupied territories (19%) over a 14-year period, which indicates a persistent population decline in Washington (WDFW 2013).

<u>Bald and Golden Eagles</u>

Three adult bald eagles were observed during large bird use surveys for a total of six eagle minutes. Observations of bald eagles within the Project may be associated with the occupied bald eagle nests along the Columbia River that was documented during 2017−2019 raptor nest surveys. Eagle observations occurred in fall, winter, and spring when individuals typically range widely to migrate or in search of food (Kalasz and Buchanan 2016). Occurrence in the Project was consistent with seasonal occurrence observed in 2017-2018. No open water or typical bald eagle foraging habitat is found in the Project; the nearest being the Columbia River, located approximately 7-miles northwest. In eastern Washington, the risk of bald eagle collision with WTG's may be lower compared to other regions due to lower population densities (Kalasz and Buchanan 2016). Although there are no bald eagle nests within approximately 7 miles of the Project and there are no concentrated prey items within the Project, low use at the Project during the multi-year survey suggests that bald eagles will continue to occur at the Project.

Three golden eagles were observed in fall during Year 2 large bird use surveys for a total of eight eagle minutes. Due to the limited sample size, no patterns of spatial use were observed; although two observations were in the southeast corner of the Project where topography is more complex. Using a nine-year study of 17 golden eagles within the Columbia Plateau that found golden eagle use correlated with the proximity to nests, terrain complexity, and prey abundance researchers were able to create conservative estimates to caution wind development within 8 miles of an active golden eagle nest (Watson et al. 2014). No golden eagle nests were observed within 10 miles of the Project during aerial nest surveys conducted spring 2017−2019. Although no golden eagle year nests were located within 10 miles of the Project and there were no concentrated prey items within the Project, consistent use over several survey years suggests use at the Project by golden eagles will continue to occur.

CONCLUSIONS

Tier 3 studies are used to address questions regarding impacts that could not be sufficiently addressed using available literature (i.e., during Tier 1 and 2 desktop analyses; USFWS 2012). These studies provide additional data that, when combined with available literature reviewed in previous tiers, allow for a better-informed assessment of the risk to species of concern at the project area. Overall, the Project area does not support high use during the avian breeding season, overall avian use may fluctuate annually, and large bird use is typically characterized by seasonally abundant and common species such as geese, ravens, doves, pigeons, and raptors. However, special-status avian species such as eagles, sandhill crane, and American white pelican occur at the Project and pose varying levels of collision risk.

Differences suggest seasonal and annual variability in species composition and use are likely to occur at the Project. Based on data from other publicly available wind projects in Oregon and Washington, diurnal raptor fatality rates are expected to be within the range of fatality rates observed at other facilities. To date, overall fatality rates for birds at wind energy facilities have been consistently low, and the most recent, comprehensive, and robust studies of overall bird fatality rates at wind facilities in the Pacific Northwest have produced fatality rate estimates ranging from 0.03–0.47 birds per MW per year; no Project data suggests the Project would fall outside this range.

This study also was designed to document use of bald and golden eagles, following the ECPG survey recommendations and the Final Rule (USFWS 2013, 2016). During the two-year large bird survey at Horse Heaven conducted 2017-2019, the total bald eagle risk minutes was 12 min

(2017−2018 = 6 min; 2018−2019 = 6 min) and golden eagle was 43 min (2017−2018 = 35 min; 2018−2019 = 8 min). The combined two-year survey effort resulted in 500 hours of large bird use surveys (2017−2018 = 322 hrs; 2018−2019 = 178 hrs). Eagle use varied by season although no observations occurred during summer. Suitable bald and golden eagle nesting, roosting and other areas of concentration were absent within the Project area.

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Appendix A. All Bird Types and Species Observed at the Horse Heaven Wind Project during Avian Use Surveys, July 24, 2018 to June 22, 2019.

Appendix A. Numbers of groups and observations by bird type and species for 60-minute large bird use surveys at the Horse Heaven Wind Project from July 24, 2018 to June 22, 2019.

		Summer		Fall		Winter		Spring		Total	
Type / Species	Scientific Name	# grps	# obs	# grps	# obs	# grps	# obs	# grps	# obs	# grps	# obs
Waterbirds		**1**	**5**	**10**	**1,450**	**1**	**1**	**3**	**10**	**15**	**1,466**
sandhill crane	*Antigone canadensis*	0	0	9	1,400	0	0	0	0	9	1,400
great blue heron	*Ardea herodias*	0	0	0	0	1	1	0	0	1	1
American white pelican	*Pelecanus erythrorhynchos*	1	5	1	50	0	0	3	10	5	65
Waterfowl		**1**	**19**	**11**	**1,334**	**2**	**41**	**1**	**42**	**15**	**1,436**
Canada goose	*Branta canadensis*	1	19	3	218	1	16	1	42	6	295
snow goose	*Chen caerulescens*	0	0	5	987	1	25	0	0	6	1,012
unidentified goose		0	0	3	129	0	0	0	0	3	129
Shorebirds		**0**	**0**	**0**	**0**	**0**	**0**	**2**	**5**	**2**	**5**
killdeer	*Charadrius vociferus*	0	0	0	0	0	0	1	4	1	4
long-billed curlew	*Numenius americanus*	0	0	0	0	0	0	1	1	1	1
Diurnal Raptors		**54**	**54**	**142**	**142**	**40**	**41**	**75**	**80**	**311**	**317**
Accipiters		*0*	*0*	*2*	*2*	*0*	*0*	*0*	*0*	*2*	*2*
unidentified accipiter	*Accipiter* spp.	0	0	1	1	0	0	0	0	1	1
sharp-shinned hawk	*Accipiter striatus*	0	0	1	1	0	0	0	0	1	1
Buteos		*31*	*31*	*70*	*70*	*15*	*15*	*47*	*52*	*163*	*168*
red-tailed hawk	*Buteo jamaicensis*	10	10	23	23	1	1	11	11	45	45
rough-legged hawk	*Buteo lagopus*	0	0	33	33	14	14	11	11	58	58
ferruginous hawk	*Buteo regalis*	0	0	1	1	0	0	0	0	1	1
unidentified *Buteo*	*Buteo* spp.	0	0	1	1	0	0	3	3	4	4
Swainson's hawk	*Buteo swainsoni*	21	21	12	12	0	0	22	27	55	60
Northern Harrier		*19*	*19*	*51*	*51*	*13*	*13*	*23*	*23*	*106*	*106*
northern harrier	*Circus hudsonius*	19	19	51	51	13	13	23	23	106	106
Eagles		*0*	*0*	*4*	*4*	*1*	*1*	*1*	*1*	*6*	*6*
golden eagle	*Aquila chrysaetos*	0	0	3	3	0	0	0	0	3	3
bald eagle	*Haliaeetus leucocephalus*	0	0	1	1	1	1	1	1	3	3
Falcons		*4*	*4*	*15*	*15*	*11*	*12*	*4*	*4*	*34*	*35*
prairie falcon	*Falco mexicanus*	1	1	2	2	1	1	1	1	5	5
American kestrel	*Falco sparverius*	3	3	12	12	10	11	3	3	28	29
unidentified falcon	*Falco* spp.	0	0	1	1	0	0	0	0	1	1

Appendix A. Numbers of groups and observations by bird type and species for 60-minute large bird use surveys at the Horse Heaven Wind Project from July 24, 2018 to June 22, 2019.

		Summer		Fall		Winter		Spring		Total	
Type / Species	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Owls		**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**
short-eared owl	*Asio flammeus*	0	0	0	0	0	0	1	1	1	1
Doves/Pigeons		**7**	**19**	**19**	**180**	**6**	**84**	**5**	**104**	**37**	**387**
rock pigeon	*Columba livia*	4	16	18	179	5	79	5	104	32	378
mourning dove	*Zenaida macroura*	3	3	1	1	1	5	0	0	5	9
Large Corvids		**14**	**18**	**40**	**87**	**28**	**39**	**50**	**69**	**132**	**213**
common raven	*Corvus corax*	14	18	40	87	28	39	50	69	132	213
Overall		**77**	**115**	**222**	**3,193**	**77**	**206**	**137**	**311**	**513**	**3,825**

Appendix B. Bird Use, Percent of Use, and Frequency of Occurrence for Large Birds Observed during Avian Use Surveys at the Horse Heaven Wind Project Area from July 24, 2018 to June 22, 2019.

Appendix B. Mean large birds use (number of large birds/plot[a]/60-minute survey), percent of total use (%), and frequency of occurrence (%) for each large bird type and species by season during the fixed-point bird use surveys at the Horse Heaven Wind Project during fixed-point bird use surveys from July 24, 2018 to June 22, 2019.

	Mean Use				% of Use				% Frequency			
Type / Species	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring
Waterbirds	**0.07**	**27.88**	**0.03**	**0.19**	**2.7**	**45.4**	**0.5**	**3.0**	**1.4**	**3.8**	**2.6**	**6.3**
sandhill crane	0	26.92	0	0	0	43.8	0	0	0	3.8	0	0
great blue heron	0	0	0.03	0	0	0	0.5	0	0	0	2.6	0
American white pelican	0.07	0.96	0	0.19	2.7	1.6	0	3.0	1.4	1.9	0	6.3
Waterfowl	**0.26**	**25.65**	**1.24**	**1.08**	**10.2**	**41.8**	**21.9**	**16.9**	**1.4**	**9.6**	**5.9**	**2.6**
Canada goose	0.26	4.19	0.41	1.08	10.2	6.8	7.2	16.9	1.4	5.8	2.6	2.6
snow goose	0	18.98	0.83	0	0	30.9	14.7	0	0	1.9	3.3	0
unidentified goose	0	2.48	0	0	0	4.0	0	0	0	3.8	0	0
Shorebirds	**0**	**0**	**0**	**0.12**	**0**	**0**	**0**	**1.9**	**0**	**0**	**0**	**4.4**
killdeer	0	0	0	0.10	0	0	0	1.6	0	0	0	2.6
long-billed curlew	0	0	0	0.02	0	0	0	0.3	0	0	0	1.9
Diurnal Raptors	**1.28**	**2.73**	**1.11**	**1.60**	**49.8**	**4.4**	**19.6**	**25.0**	**67.1**	**80.8**	**55.1**	**72.4**
Accipiters	*0*	*0.04*	*0*	*0*	*0*	*<0.1*	*0*	*0*	*0*	*3.8*	*0*	*0*
unidentified accipiter	0	0.02	0	0	0	<0.1	0	0	0	1.9	0	0
sharp-shinned hawk	0	0.02	0	0	0	<0.1	0	0	0	1.9	0	0
Buteos	*0.84*	*1.35*	*0.42*	*1.02*	*32.4*	*2.2*	*7.4*	*16.0*	*51.8*	*48.1*	*33.8*	*46.6*
red-tailed hawk	0.30	0.44	0.03	0.20	11.6	0.7	0.5	3.2	21.6	23.1	2.6	14.8
rough-legged hawk	0	0.63	0.40	0.26	0	1.0	7.0	4.1	0	25.0	31.3	13.2
ferruginous hawk	0	0.02	0	0	0	<0.1	0	0	0	1.9	0	0
unidentified buteo	0	0.02	0	0.06	0	<0.1	0	0.9	0	1.9	0	5.6
Swainson's hawk	0.54	0.23	0	0.50	20.8	0.4	0	7.8	39.0	13.5	0	25.9
Northern Harrier	*0.35*	*0.98*	*0.34*	*0.48*	*13.4*	*1.6*	*6.0*	*7.5*	*25.8*	*42.3*	*29.0*	*43.2*
northern harrier	0.35	0.98	0.34	0.48	13.4	1.6	6.0	7.5	25.8	42.3	29.0	43.2
Eagles	*0*	*0.08*	*0.03*	*0.03*	*0*	*0.1*	*0.5*	*0.4*	*0*	*5.8*	*2.6*	*2.6*
golden eagle	0	0.06	0	0	0	<0.1	0	0	0	3.8	0	0
bald eagle	0	0.02	0.03	0.03	0	<0.1	0.5	0.4	0	1.9	2.6	2.6
Falcons	*0.10*	*0.29*	*0.32*	*0.07*	*4.0*	*0.5*	*5.7*	*1.2*	*10.2*	*26.9*	*27.2*	*7.4*
prairie falcon	0.02	0.04	0.03	0.02	0.7	<0.1	0.6	0.3	1.9	3.8	3.3	1.9
American kestrel	0.08	0.23	0.29	0.06	3.2	0.4	5.1	0.9	8.3	21.2	23.8	5.6
unidentified falcon	0	0.02	0	0	0	<0.1	0	0	0	1.9	0	0
Owls	**0**	**0**	**0**	**0.02**	**0**	**0**	**0**	**0.3**	**0**	**0**	**0**	**1.9**

Appendix B. Mean large birds use (number of large birds/plot[a]/60-minute survey), percent of total use (%), and frequency of occurrence (%) for each large bird type and species by season during the fixed-point bird use surveys at the Horse Heaven Wind Project during fixed-point bird use surveys from July 24, 2018 to June 22, 2019.

	Mean Use				% of Use				% Frequency			
Type / Species	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**
short-eared owl	0	0	0	0.02	0	0	0	0.3	0	0	0	1.9
Doves/Pigeons	**0.55**	**3.46**	**2.23**	**1.95**	**21.3**	**5.6**	**39.3**	**30.5**	**12.7**	**25.0**	**14.4**	**10.0**
rock pigeon	0.49	3.44	2.06	1.95	19.1	5.6	36.3	30.5	10.8	23.1	11.0	10.0
mourning dove	0.06	0.02	0.17	0	2.2	<0.1	2.9	0	3.8	1.9	3.3	0
Large Corvids	**0.41**	**1.67**	**1.07**	**1.43**	**15.9**	**2.7**	**18.8**	**22.4**	**26.6**	**51.9**	**50.0**	**61.3**
common raven	0.41	1.67	1.07	1.43	15.9	2.7	18.8	22.4	26.6	51.9	50.0	61.3
Overall	**2.58**	**61.40**	**5.68**	**6.38**	**100**	**100**	**100**	**100**				

Appendix C. Mean Use by Point for All Birds, Bird Types, and Diurnal Raptor Subtypes during Avian Use Surveys at the Horse Heaven Wind Project Area from July 24, 2018 to June 22, 2019.

Appendix C. Mean use (number of birds/60-minute survey) by point for all birds[a], major bird types, and diurnal raptor subtypes observed at the Horse Heaven Wind Project during fixed-point large bird use surveys from July 24, 2018 to June 22, 2019.

	Survey Point																	
Bird Type	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
Waterbirds	**4.91**	**0.58**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**116.33**	**0.17**	**0**	**0**	**0**	**0.40**	**0**	**1.00**
Waterfowl	**100.64**	**0.75**	**0**	**5.55**	**0**	**12.50**	**2.08**	**3.50**	**3.50**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Shorebirds	**0**	**0**	**0**	**0**	**0.33**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.20**	**0**	**0**	**0**	**0**
Diurnal Raptors	**0.82**	**1.33**	**1.17**	**1.36**	**2.58**	**2.92**	**1.75**	**1.83**	**1.58**	**1.45**	**2.00**	**1.83**	**3.33**	**1.80**	**1.80**	**0.60**	**1.60**	**0.80**
Accipiters	*0*	*0.08*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0.08*	*0*	*0*	*0*	*0*	*0*
Buteos	*0.09*	*0.67*	*0.42*	*0.73*	*1.25*	*2.17*	*0.67*	*1.25*	*0.83*	*0.82*	*1.17*	*0.83*	*1.42*	*1.20*	*1.40*	*0.40*	*1.20*	*0.20*
Northern Harrier	*0.45*	*0.25*	*0.67*	*0.64*	*1.00*	*0.42*	*0.92*	*0.08*	*0.58*	*0.55*	*0.42*	*0.83*	*1.50*	*0.60*	*0.20*	*0.20*	*0.40*	*0.20*
Eagles	*0*	*0*	*0.08*	*0*	*0*	*0*	*0*	*0*	*0.08*	*0*	*0.08*	*0.17*	*0.08*	*0*	*0*	*0*	*0*	*0*
Falcons	*0.27*	*0.33*	*0*	*0*	*0.33*	*0.33*	*0.17*	*0.50*	*0.08*	*0.09*	*0.33*	*0*	*0.25*	*0*	*0.20*	*0*	*0*	*0.40*
Owls	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.20**	**0**	**0**
Doves/Pigeons	**0**	**0**	**0**	**0**	**0**	**1.25**	**4.75**	**21.08**	**0**	**0**	**0.25**	**0.25**	**3.92**	**0**	**1.80**	**0**	**0**	**0**
Large Corvids	**0.45**	**1.92**	**1.83**	**0.91**	**1.25**	**0.33**	**0.58**	**1.17**	**1.50**	**1.18**	**1.75**	**0.50**	**2.00**	**2.40**	**2.20**	**0.80**	**0**	**0.80**
All Large Birds	**106.82**	**4.58**	**3.00**	**7.82**	**4.17**	**17.00**	**9.17**	**27.58**	**6.58**	**2.64**	**120.33**	**2.75**	**9.25**	**4.40**	**5.80**	**2.00**	**1.60**	**2.60**

[a] 800-meter (m) radius plot for large birds.

Appendix D. 2019 Raptor Nest Survey Results within 10 miles of the Horse Heaven Wind Project, Benton County, Washington.

Appendix D1. 2019 Raptor Nest Survey Results within 10 miles of the Horse Heaven Wind Project, Benton County, Washington.

Nest ID	Species[1]	Status	Nest Substrate	Comments
01	GHOW	Occupied / Active	Deciduous	2 nestlings standing adjacent to nest
02	SWHA	Occupied / Active	Deciduous	1 adult incubating on nest by roadside
03	FEHA	Occupied / Active	Deciduous	1 adult incubating; nest occupied active in 2018 as well
04	UNRA	Unoccupied / Inactive	Ground	Fair condition - characteristic FEHA
07	GHOW	Occupied / Active	Deciduous	1 adult incubating; Nest 07 duplicate
08	UNRA	Unoccupied / Inactive	Ground	Good condition - characteristic FEHA
09	RTHA	Occupied / Active	Deciduous	Adult present, 2 nestlings approximately 4 weeks old
10	UNRA	Unoccupied / Inactive	Ground	Poor condition - characteristic FEHA
11	UNRA	Unoccupied / Inactive	Ground	Poor condition - characteristic FEHA
12	UNRA	GONE	Cliff	Nest mostly gone, sticks on ground very poor condition
13	UNRA	Unoccupied / Inactive	Ground	Nest dilapidated and very poor condition
14	RTHA	Occupied / Inactive	Deciduous	One adult present at nest
15	UNRA	Unoccupied / Inactive	Ground	Poor condition- characteristic FEHA
16	UNRA	Unoccupied / Inactive	Ground	Poor condition - characteristic FEHA
17	UNRA	Unoccupied / Inactive	Ground	Poor condition - characteristic FEHA
18	BAEA	Occupied / Inactive	Deciduous	Yakima River Mouth Territory. One adult flushed from nest, greenery, no eggshells
19	CORA	Occupied / Active	Deciduous	1 adult incubating
20	RTHA	Occupied / Active	Deciduous	2 adults present; 1 nestling 1-2 weeks old, 2 additional nests in tree to the north of RTHA nest
22	UNRA	Unoccupied / Inactive	Ground	Poor condition - characteristic FEHA
23	RTHA	Occupied / Active	Deciduous	1 adult incubating/tending on nest
24	RTHA	Occupied / Active	Deciduous	1 adult incubating/tending on nest
25	UNRA	Unoccupied / Inactive	Deciduous	No sign of nesting
26	RTHA	Occupied / Active	Deciduous	1 adult tending nest with 4 nestlings approximately 1-2 weeks old
27	RTHA	Occupied / Active	Deciduous	2 adults present; one nestling in nest

Appendix D1. 2019 Raptor Nest Survey Results within 10 miles of the Horse Heaven Wind Project, Benton County, Washington.

Nest ID	Species[1]	Status	Nest Substrate	Comments
28	SWHA	Occupied / Active	Deciduous	1 adult incubating; flushed, 4 eggs, nest in low shrubbery
30	UNRA	Unoccupied / Inactive	Ground	Poor condition - characteristic FEHA
31	SWHA	Occupied / Active	Deciduous	1 adult incubating on nest, near old farmhouse
32	SWHA	Occupied / Active	Conifer	1 adult incubating on nest; next to commercial building
33	CORA	Occupied / Active	Cliff	2 adults present, 4 nestlings approximately 1-2 weeks old
35	SWHA	Occupied / Active	Conifer	1 adult in incubating posture; nest adjacent to house/road
37	BAEA	Occupied / Active	Deciduous	Port of Pasco Territory. 2 adults present 2 nestlings approximately 3-4 weeks
40	RTHA	Occupied / Active	Deciduous	2 adults present; one adult on nest incubating/tending
41	GHOW	Occupied / Active	Deciduous	1 juvenile flushed from the nest; no adults present
42	SWHA	Occupied / Active	Deciduous	1 adult incubating, 1 adult perched on adjacent power pole
43	SWHA	Occupied / Active	Deciduous	2 nests side-by-side; 1 SWHA adult incubating in one and other with 4 CORA nestlings
55	BAEA	Occupied / Active	Deciduous	Sand Station Territory. 2 adults present, 2 eggs 2nd round

[1] BAEA – Bald Eagle, FEHA – Ferruginous Hawk, SWHA – Swainson's Hawk, RTHA – Red-tailed Hawk, GHOW – Great-horned Owl, CORA – Common Raven, UNRA – Unidentified Raptor

[REDACTED DUE TO SENSITIVE INFORMATION]

Appendix D2. Nest 37 with two fully gray feathered bald eagle nestlings approximately 21-30 days old. A red prey item can be seen between the two nestlings. Photo taken 05/16/2019.

[REDACTED DUE TO SENSITIVE INFORMATION]

Appendix D3. Nest 55 with an adult bald eagle tending to the nest with two eggs. Photo taken 05/16/2019

[REDACTED DUE TO SENSITIVE INFORMATION]

Appendix D4. Adult ferruginous hawk at Nest 3, incubating. Photo taken 05/16/2019.

[REDACTED DUE TO SENSITIVE INFORMATION]

Appendix D5. Characteristics ferruginous hawk (Nest 8) ground nest in good condition. Nest occupied inactive 2017 and was unoccupied in 2018−2019 surveys. Majority of ground nests along the rampart were in poor condition. Photo taken 05/16/2019.

[REDACTED DUE TO SENSITIVE INFORMATION]

Appendix D6. Red-tailed hawk Nest 08 with four nestlings observed during the second aerial survey. Photo taken 05/16/2019.

[REDACTED DUE TO SENSITIVE INFORMATION]

Appendix D7. An adult great-horned owl incubating at Nest 07 which was occupied by a red-tailed hawk during the first survey. Photo taken 05/16/2019.

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TECHNICAL MEMORANDUM

DATE: July 12, 2019 *Public Draft - For Distribution*

TO: Jeffrey Wagner and Micah Engum, wpd Wind Projects Inc.

FROM: Andrea Chatfield, Troy Rintz, and Erik Jansen, WEST, Inc.

RE: Results of the 2019 Raptor Nest Survey for the Four Mile Wind Project, Benton County, Washington.

INTRODUCTION

Four Mile MW LLC (Four Mile) is proposing to develop the Four Mile Wind Project (Project) in Benton County, Washington. Four Mile contracted Western EcoSystems Technology, Inc. (WEST) to conduct aerial raptor nest surveys within the proposed Project and surrounding area, as recommended by the US Fish and Wildlife Service (USFWS; 2012, 2013) and the Washington Department of Fish and Wildlife (WDFW; 2009). Surveys for nests of all raptor species were conducted within a 2-mile (mi; 3.2-kilometer [km]) buffer of the Project, while surveys specifically for bald eagle (*Haliaeetus leucocephalus*) and golden eagle (*Aquila chrysaetos*) nests were conducted within a 10-mi (16-km) buffer of the Project (Survey Area). The initial aerial survey was conducted in early March, 2019, with a follow-up aerial survey completed in mid-May, 2019. This memorandum summarizes the characteristics of the Survey Area, survey methodology, and results of the 2019 aerial raptor nest survey at the Project.

PROJECT AND SURVEY AREA

WEST developed the raptor nest Survey Area by buffering the proposed Project boundary by 2 mi and 10 mi in a Geographic Information System (GIS). The Survey Area consisted of the Project and surrounding buffers, which included portions of Benton, Franklin, and Walla Walla counties, Washington and Umatilla County, Oregon (Figure 1). The Project is located near the eastern extent of the Horse Heaven Hills which is an anticline ridge of the Yakima Folds within the larger Columbia Plateau Ecoregion (Clarke and Bryce 1997). Topography within the Project is composed primarily of rolling hills bisected by meandering canyons that drain primarily to the south into the Columbia River. The Columbia River runs throughout the central portion of the Survey Area, bending around the eastern boundary of the Project. The Yakima River, Snake River, and Walla Walla River all drain into the Columbia River to the north, northeast, and east of the Project, respectively (Figure 1). Areas along these river corridors contain trees and cliffs suitable for nesting raptors.

Land cover within the Survey Area is a mosaic of dryland and irrigated agriculture, shrub-steppe grasslands, and rural/urban development (Figure 2). Agricultural cropland is the dominate land cover throughout the Project and Survey Areas. Shrub-steppe grasslands are found in topographically steep areas where agriculture was not possible. About a quarter of the Survey Area contains rural/urban development including portions of the tri-cities metro area (Richmond, Kennewick, and Pasco), Benton City and unincorporated rural areas. Much of the Survey Area is privately owned and actively managed for agriculture and livestock grazing. A few, scattered trees, primarily associated with farms, residences, or parks and preserves along the Columbia, Snake, and Walla Walla rivers, are scattered throughout the Survey Area. The 96-megawatt (MW) Nine Canyon wind energy facility is located immediately to the north of the proposed Project, and the 300-MW Stateline wind energy facility is located approximately four mi (6.4 km) to the southeast.

METHODS

Prior to conducting the nest surveys, WEST reviewed eagle nest information available from the WDFW (Hayes 2013, Kalasz and Buchanan 2016), as well raptor nest data collected by WEST during previous survey efforts in the region. Pre-flight planning included a review of topographic maps and aerial imagery, and the creation of field maps and GIS files for conducting the surveys. The 2019 aerial surveys were conducted by two qualified WEST biologists from a Bell Jet Ranger helicopter with bubble windows that provided excellent visibility (Pagel et al. 2010, USFWS 2013). The first aerial survey was conducted on March 7, and a follow-up aerial survey was conducted on May 16.

The initial survey in March was conducted during a time period that overlapped the primary early nesting period of bald and golden eagles in Washington, when breeding pairs are exhibiting courtship, nest-building, and/or incubation behaviors. This initial survey utilized an intuitive controlled survey method that focused on identifying and searching specific habitat features within the Survey Area that held the highest potential to support the target species. Within the 2-mi buffer, efforts focused on habitat features typically used by raptors that use large, conspicuous stick nests (e.g., eagles, red-tailed hawk [*Buteo jamaicensis*], Swainson hawk [*B. Swainsoni*], ferruginous hawk [*B. regalis*], and great horned owl [*Bubo virginianus*]). In addition to raptor nests, nests of common ravens (*Corvus corax*) were also documented as raptors and ravens are known to use similar-sized nests. Search efforts beyond the 2-mi buffer out to 10 mi focused on eagle nests specifically. Key habitat features within the Survey Area included cliffs, rock outcrops, incised drainages and canyons, powerline structures, and large/dominant trees.

The second aerial survey, conducted in mid-May, was performed at a time when eagles and other raptors are actively engaged in mid- to late-breeding season reproductive activities (e.g., incubating, brooding, feeding nestlings), and when raptors engaged in ongoing nesting activities would be reliably on or around nests. The second survey was conducted as described above for areas within the 2-mi buffer (i.e., an intuitive controlled search of key habitat features throughout the area), while surveys beyond the 2-mi buffer primarily focused on confirming the status of previously documented eagle nests. However, some additional effort was spent searching for eagle nests in a few specific areas identified during the initial survey as being most suitable for supporting eagle nests (e.g., cliffs and river corridors).

During each aerial survey, the helicopter was positioned to allow thorough visual inspection of all appropriate habitat features. In some cases, multiple passes were required to thoroughly cover nesting habitat. In general, the helicopter remained within a zone 100 feet (ft; 31 meters [m]) to 500 ft (152 m) above ground level and moved at a relative air speed of approximately 50 mi per hour (80.5 km per hour), with the helicopter maintaining a distance of at least 65 ft (20 m) from cliff faces and nests (Pagel et al. 2010). When nests were located, the helicopter reduced speed and adjusted flight to allow for a clear view of the nest for documentation and photographing. For each nest found, a Global Positioning System location was recorded and nest attribute data were collected, including species (if known), nest type, size, substrate, and condition, along with any comments useful in determining the nest status.

Nesting status for the 2019 nesting season was categorized using definitions originally proposed by Postupalsky (1974) and largely followed today (USFWS 2013). Nests were classified as occupied if any of the following were observed at the nest structure: (1) an adult in an incubating position; (2) eggs; (3) nestlings or fledglings; (4) presence of an adult (sometimes sub-adults); (5) a newly constructed or refurbished stick nest in the area where territorial behavior or a raptor had been observed earlier in the breeding season; or (6) a recently repaired nest with fresh sticks (clean breaks) or fresh boughs on top, and/or droppings and/or molted feathers on its rim or underneath. Occupied nests were further classified as active if an egg or eggs were laid. Nests were classified as inactive if no eggs or chicks were present. Nests not meeting the above criteria for “Occupied” during at least two consecutive surveys were classified as “Unoccupied”. A status of “unknown” was assigned to nests that could not be effectively monitored and therefore did not meet the criteria of occupied or unoccupied as described above.

RESULTS

During the spring 2019 nest surveys, six occupied bald eagle nests (nests 18, 37, 48, 53, 54, and 55), located within five separate nesting territories, were documented within the 10-mi Survey Area (Figure 1; Table 1). Of these occupied nests, four (nests 37, 53, 54, and 55) were determined to be active in 2019 (i.e., contained eggs or young; Table 1). The closest nest to the Project boundary, Nest 53 (“Peavine Island” territory) is located approximately 2.5 mi (4.0 km) northeast of the Project along the Columbia River (Figure 1). This nest contained two nestlings estimated to be three weeks old on the May 16 survey (Photo 1). Nest 48, located in a nearby tree in the same nesting territory, is a likely alternate nest to Nest 53 (Figure 1; Table 1). Nest 37 (“Port of Pasco” territory) and Nest 55 (“Sand Station” territory) are also located along the Columbia River, approximately 6.0 mi (9.7 km) north of the Project and 8.0 mi (12.9 km) south of the Project, respectively (Figure 1). Nest 37 contained two nestlings estimated to be 3-4 weeks old and Nest 55 contained an incubating adult and two eggs (Table 1; Photos 2 and 3). The fourth active bald eagle nest (Nest 54) was located in the McNary National Wildlife Refuge (NWR) along the Walla Walla River, approximately 6.3 mi (10.1 km) east of the Project (“McNary NWR” territory; Figure 1). Two adult eagles and two nestlings, estimated to be three week old, were observed at the nest during the May survey (Table 1; Photo 4). Nest 18 is a historical bald eagle nest located about 10.0 mi north of the Project [redacted] (Yakima River Mouth territory; Figure 1; Photo 5). This nest was found to contain greenery (i.e., fresh boughs) and an adult eagle was flushed from the nest in May; however, no evidence of eggs or young were observed during either survey and the nest was, therefore, recorded as occupied but inactive (Table 1). No occupied golden eagle nests were documented during the survey; however, an unoccupied stick nest (Nest 36) located on a cliff above the Columbia River, approximately 2.8 mi (4.5 km) southeast of the Project, was recorded during the May survey (Figure 1; Table 1; Photo 6). While this nest was unoccupied and observed to be in poor to fair condition, it does share characteristics typical of golden eagle nests and should be monitored during any future aerial survey efforts in the region.

Within the 2-mi Survey Area, a total of 13 raptor or common raven nests were documented during surveys (Figure 1; Table 1). Of these, 11 nests were determined to be occupied/active as of the second survey in May including five red-tailed hawk nests, two Swainson's hawk nests, two common raven nests, and one ferruginous hawk nest. Only three of the 13 identified nests (two common raven nests and one Swainson's hawk nest) were located within the proposed Project boundary (Figure 1). The single ferruginous hawk nest (Nest 03) identified during surveys was located in a tree about [redacted] 13 of the Project boundary (Figure 1; Photo 7). During the May survey, an adult was observed in incubating position on this nest (Table 1; Photo 7).

In Washington, the bald eagle is considered a federal species of concern (USFWS 2008, WDFW 2019) and the golden eagle is a state candidate for listing (WDFW 2013, 2019). Both bald and golden eagles are protected by the federal Bald and Golden Eagle Protection Act (BGEPA; 1940) and Migratory Bird Treaty Act (MBTA; 1918). The ferruginous hawk is considered a federal species of concern (USFWS 2008) but is also listed as state threatened due to population declines (WDFW 2013, 2019). Ferruginous hawk, red-tailed hawk, Swainson's hawk, and common raven are species protected under the MBTA.

[REDACTED DUE TO SENSITIVE INFORMATION]

Figure 1. Raptor nest locations documented during aerial surveys for the Four Mile Wind Project, March 7 and May 16, 2019.

Table 1. Results of 2019 raptor nest surveys conducted on March 7 and May 16 for the Four Mile Wind Project, Benton County, Washington.

Nest ID	Species	2019 Nest Status[1]	Substrate	Comments
03	Ferruginous hawk	Occupied/Active	Deciduous tree	Adult incubating in May
18	Bald eagle	Occupied/Inactive	Deciduous tree	"Yakima River Mouth" territory. Greenery present in nest; adult flushed from nest in May, no eggs or young present
31	Swainson's hawk	Occupied/Active	Deciduous tree	Adult incubating on nest, near old farmhouse
36	Unknown Raptor	Unoccupied	Cliff	"Port Kelley" territory. Poor-fair condition, small to medium-sized nest, abundant whitewash; characteristic of golden eagle nest
37	Bald eagle	Occupied/Active	Deciduous tree	"Port of Pasco" territory. Two adults present, 2 nestlings approximately 3-4 weeks old
43	Swainson's hawk	Occupied/Active	Deciduous tree	Two nests side-by-side; Swainson's hawk adult incubating next to nest with four common raven nestlings
44	Common raven	Occupied/Active	Deciduous tree	Adult in nest with 4 nestlings
45	Red-tailed hawk	Occupied/Active	Deciduous tree	Adult nearby, 2 nestlings in nest about 1 week old
46	Common raven	Occupied/Active	Deciduous tree	One nestling in nest; cluster of three nests in single tree
47	Unknown raptor	Unoccupied	Deciduous tree	Small nest in poor condition, adjacent to cropland
48	Bald eagle	Occupied/Inactive	Deciduous tree	"Peavine Island" territory. Alternate nest to Nest 53 which was Occupied/Active in 2019, nest in good condition
49	Unknown raptor	Unoccupied	Deciduous tree	Large nest in good condition, located in [redacted] 13
50	Red-tailed hawk	Occupied/Active	Deciduous tree	Adult incubating; 2 nests at location; 2nd nest good condition
51	Red-tailed hawk	Occupied/Active	Deciduous tree	Adult brooding; at least 1 nestling observed, approximately 1-2 weeks old
52	Red-tailed hawk	Occupied/Active	Deciduous tree	One nestling in nest
53	Bald eagle	Occupied/Active	Deciduous tree	"Peavine Island" territory. Alternate to Nest 48; 2 adults present, 2 nestlings approximately 3 weeks old.
54	Bald eagle	Occupied/Active	Deciduous tree	"McNary NWR" territory. Two adults present; 2 nestlings approximately 3 weeks old
55	Bald eagle	Occupied/Active	Deciduous tree	"Sand Station" Territory. Two adults present, 2 eggs during second survey. Potential re-nesting attempt
56	Red-tailed hawk	Occupied/Active	Deciduous tree	Adult brooding; 1 chick approximately 1 week old in nest
57	Red-tailed hawk	Occupied/Unknown	Deciduous tree	Did not locate nest during second survey. Tree with heavy leaf-out; no adults in area

[1]Highest level of reproductive status determined for the current breeding season: **Occupied** = contained eggs, young, or an incubating eagle, or had a pair of eagles on or near it, or had been recently repaired or decorated. **Active** = an occupied nest in which eggs were laid, as evidenced by the presence of an incubating bird, eggs, young, or any other indication that eggs had been laid in the current year. **Inactive** = no eggs or chicks present. **Unoccupied** = no sign of nesting or territory occupancy in the current nesting season, based on at least two visits. **Unknown** = nest was not located or status as occupied/unoccupied could not be confirmed as defined herein.

[REDACTED DUE TO SENSITIVE INFORMATION]

Photo 1. Two bald eagle chicks in Nest 53 ("Peavine Island" territory) located along the Columbia River near the mouth of the Snake River. Photo taken May 16, 2019.

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Photo 2. Two bald eagle chicks in Nest 37 ("Port of Pasco" territory) located along the Columbia River. Photo taken May 16, 2019.

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Photo 3. Adult bald eagle and two eggs in Nest 55 ("Sand Station" territory) located along the Columbia River. Photo taken May 16, 2019.

[REDACTED DUE TO SENSITIVE INFORMATION]

Photo 4. Two bald eagle chicks in Nest 54 (McNary NWR" territory) located in the McNary Wildlife Refuge along the Walla Walla River. Photo taken May 16, 2019.

[REDACTED DUE TO SENSITIVE INFORMATION]

Photo 5. Nest 18 ("Yakima River Mouth" territory): Occupied/inactive bald eagle nest located near the confluence of the Yakima and Columbia rivers. Photo taken March 7, 2019.

[REDACTED DUE TO SENSITIVE INFORMATION]

Photo 6. Nest 36: Unoccupied/inactive raptor nest located along Columbia River. Photo taken May 16, 2019.

[REDACTED DUE TO SENSITIVE INFORMATION]

Photo 7. Adult ferruginous hawk in incubating position on Nest 03. Photo taken May 16, 2019.

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TECHNICAL MEMORANDUM

DATE: July 12, 2019 *Public Draft - For Distribution*

TO: Jeffrey Wagner and Micah Engum, wpd Wind Projects Inc.

FROM: Andrea Chatfield, Troy Rintz, and Erik Jansen, WEST, Inc.

RE: Results of the 2019 Raptor Nest Survey for the Badger Canyon Wind Project, Benton County, Washington.

INTRODUCTION

Badger Canyon MW LLC (Badger Canyon) is proposing to develop the Badger Canyon Wind Project (Project) in Benton County, Washington. Badger Canyon contracted Western EcoSystems Technology, Inc. (WEST) to conduct aerial raptor nest surveys within the proposed Project and surrounding area, as recommended by the US Fish and Wildlife Service (USFWS; 2012, 2013) and the Washington Department of Fish and Wildlife (WDFW; 2009). Surveys for nests of all raptor species were conducted within a 2-mile (mi; 3.2-kilometer [km]) buffer of the Project, while surveys specifically for bald eagle (*Haliaeetus leucocephalus*) and golden eagle (*Aquila chrysaetos*) nests were conducted within a 10-mi (16-km) buffer of the Project (Survey Area). The initial aerial survey was conducted in early March, 2019, with a follow-up aerial survey completed in mid-May, 2019. This memorandum summarizes the characteristics of the Survey Area, survey methodology, and results of the 2019 aerial raptor nest surveys at the Project.

PROJECT AND SURVEY AREA

WEST developed the raptor nest Survey Area by buffering the proposed Project boundary by 2 mi and 10 mi in a Geographic Information System (GIS). The Survey Area consisted of the Project and surrounding buffers, which included portions of Benton and Franklin counties, Washington and Umatilla County, Oregon (Figure 1). The Project is located within the Horse Heaven Hills which is an anticline ridge of the Yakima Folds within the larger Columbia Plateau Ecoregion (Clarke and Bryce 1997). Topography within the Project is composed primarily of rolling to incised hills with a broad northeast-facing rampart along the northern perimeter of the Project boundary (Figure 1). The highly-eroded drainages along the rampart expose basalt cliffs and ledges that are suitable for nesting raptors. Isolated trees and small tree stands found along drainage bottoms also provide nesting habitat. On the southern side of the rampart, the landscape transitions to relatively rolling topography with shallow, meandering canyons that drain south into the Columbia River. The Yakima River runs through the northern portion of the

Survey Area and small segments of the Columbia River are located along the northeastern and southern edge of the Survey Area. These river corridors contain areas with trees and cliffs suitable for nesting raptors.

Land cover within the Survey Area is a mosaic of dryland and irrigated agriculture, shrub-steppe grasslands, and rural/urban development (Figure 1). Agricultural cropland is the dominate land cover throughout the Project and Survey Areas. Shrub-steppe grasslands are found in topographically steep areas where agriculture is not possible. About a fifth of the Survey Area contains rural/urban development including portions of the tri-cities metro area (Richmond and Kennewick), Benton City and unincorporated rural areas. Much of the Survey Area is privately owned and actively managed for agriculture and livestock grazing. A few, scattered trees, primarily associated with farms, residences, or parks and preserves along the Columbia and Yakima Rivers, are scattered throughout the Survey Area. The 96-megawatt Nine Canyon wind energy facility is located approximately nine mi (14.5 km) east of the proposed Project.

METHODS

Prior to conducting the nest surveys, WEST reviewed eagle nest information available from the WDFW (Hayes 2013, Kalasz and Buchanan 2016), as well raptor nest data collected by WEST during previous survey efforts in the region. Pre-flight planning included a review of topographic maps and aerial imagery, and the creation of field maps and GIS files for conducting the surveys. The 2019 aerial surveys were conducted by two qualified WEST biologists from a Bell Jet Ranger helicopter with bubble windows that provided excellent visibility (Pagel et al. 2010, USFWS 2013). The first aerial survey was conducted on March 7, and a follow-up aerial survey was conducted on May 16.

The initial survey in March was conducted during a time period that overlapped the primary early nesting period of bald and golden eagles in Washington, when breeding pairs are exhibiting courtship, nest-building, and/or incubation behaviors. This initial survey utilized an intuitive controlled survey method that focused on identifying and searching specific habitat features within the Survey Area that held the highest potential to support the target species. Within the 2-mi buffer, efforts focused on habitat features typically used by raptors that use large, conspicuous stick nests (e.g., eagles, red-tailed hawk [*Buteo jamaicensis*], Swainson hawk [*B. Swainsoni*], ferruginous hawk [*B. regalis*], and great horned owl [*Bubo virginianus*]). In addition to raptor nests, nests of common ravens (*Corvus corax*) were also documented as raptors and ravens are known to use similar-sized nests. Search efforts beyond the 2-mi buffer out to 10 mi focused on eagle nests specifically. Key habitat features within the Survey Area included cliffs, rock outcrops, incised drainages and canyons, powerline structures, and large/dominant trees.

The second aerial survey, conducted in mid-May, was performed at a time when eagles and other raptors are actively engaged in mid- to late-breeding season reproductive activities (e.g., incubating, brooding, feeding nestlings), and when raptors engaged in ongoing nesting activities would be reliably on or around nests. The second survey was conducted as described above for areas within the 2-mi buffer (i.e., an intuitive controlled search of key habitat features throughout the area), while surveys beyond the 2-mi buffer primarily focused on confirming the status of previously documented eagle nests. However, some additional effort was spent searching for eagle nests in a few specific areas identified during the initial survey as being most suitable for supporting eagle nests (e.g., cliffs, large trees, and river corridors).

During each aerial survey, the helicopter was positioned to allow thorough visual inspection of all appropriate habitat features. In some cases, multiple passes were required to thoroughly cover nesting habitat. In general, the helicopter remained within a zone 100 feet (ft; 31 meters [m]) to 500 ft (152 m) above ground level and moved at a relative air speed of approximately 50 mi per hour (80.5 km per hour), with the helicopter maintaining a distance of at least 65 ft (20 m) from cliff faces and nests (Pagel et al. 2010). When nests were located, the helicopter reduced speed and adjusted flight to allow for a clear view of the nest for documentation and photographing. For each nest found, a Global Positioning System location was recorded and nest attribute data were collected, including species (if known), nest type, size, substrate, and condition, along with any comments useful in determining the nest status.

Nesting status for the 2019 nesting season was categorized using definitions originally proposed by Postupalsky (1974) and largely followed today (USFWS 2013). Nests were classified as occupied if any of the following were observed at the nest structure: (1) an adult in an incubating position; (2) eggs; (3) nestlings or fledglings; (4) presence of an adult (sometimes sub-adults); (5) a newly constructed or refurbished stick nest in the area where territorial behavior or a raptor had been observed earlier in the breeding season; or (6) a recently repaired nest with fresh sticks (clean breaks) or fresh boughs on top, and/or droppings and/or molted feathers on its rim or underneath. Occupied nests were further classified as active if an egg or eggs were laid. Nests were classified as inactive if no eggs or chicks were present. Nests not meeting the above criteria for “Occupied” during at least two consecutive surveys were classified as “Unoccupied”.

RESULTS

During the spring 2019 nest surveys, two occupied bald eagle nests (nests 58 and 18) were documented within the 10-mi Survey Area (Figure 1; Table 1). Of these two occupied nests, only Nest 58 had evidence of active nesting. Nest 58 (“Prosser” territory), located along the Yakima River approximately 7.4 mi (11.9 km) west of the Project (Figure 1), contained an adult bald eagle and 2-3 chicks estimated to be about four weeks old during the second survey in May (Table 1; Photo 1). Nest 18 (“Yakima River Mouth” territory) is a historical bald eagle nest located about 8.2 mi (13.2 km) northeast of the Project [redacted] (Figure 1). Greenery (i.e., fresh boughs) was observed in this nest during both the March and May surveys, and an adult eagle was flushed from the nest in May; however, no evidence of eggs or young were observed during either survey. Nest 18 was, therefore, recorded as occupied but inactive (Table 1; Photo 2). No golden eagle nests or nests characteristic of golden eagle nests were documented during the surveys.

Within the 2-mi Survey Area, a total of 19 raptor or common raven nests were documented (Figure 1; Table 1). Of these, 13 nests were determined to be occupied as of the second survey in May including five Swainson's hawk nests, three red-tailed hawk nests, three common raven nests, and two great horned owl nests (Figure 1; Table 1). Four of the 13 occupied nests (three Swainson's hawk nests and one great horned owl nest) were located within the proposed Project boundary (Figure 1). The majority of occupied nests were in trees, with one nest located on a cliff face and one along a transmission line (both common raven nests; Table 1). Six of the raptor/raven nests identified during surveys were determined to be unoccupied. This included five nests that were located on the ground and characteristic of ferruginous hawk nests; however, each of these five nests was observed to be in poor condition with no sign of occupancy (Figure 1; Table 1).

The bald eagle is considered a federal species of concern (USFWS 2008, WDFW 2019) and is protected under both the Migratory Bird Treaty Act (MBTA; 1918) and the Bald and Golden Eagle Protection Act (BGEPA; 1940). The ferruginous hawk is considered a federal species of concern (USFWS 2008) but is also listed as state threatened due to population declines (WDFW 2013, 2019). Ferruginous hawk, red-tailed hawk, Swainson's hawk, great horned owl, and common raven are species protected under the MBTA.

[REDACTED DUE TO SENSITIVE INFORMATION]

Figure 1. Raptor nest locations documented during aerial surveys for the Badger Canyon Wind Project, March 7 and May 16, 2019.

Table 1. Results of 2019 raptor nest surveys conducted on March 7 and May 16 for the Badger Canyon Wind Project, Benton County, Washington.

Nest ID	Species	2019 Nest Status[1]	Substrate	Comments
02	Swainson's hawk	Occupied/Active	Deciduous tree	Adult incubating on nest by roadside
07	Great horned owl	Occupied/Active	Deciduous tree	Adult sitting on nest
08	Unknown raptor	Unoccupied	Ground	Poor condition; characteristic of ferruginous hawk nest
09	Red-tailed hawk	Occupied/Active	Deciduous tree	Adult present, 2 chicks approximately 4 weeks old
10	Unknown raptor	Unoccupied	Ground	Poor condition; characteristic of ferruginous hawk nest
11	Unknown raptor	Unoccupied	Ground	Poor condition; characteristic of ferruginous hawk nest
16	Unknown raptor	Unoccupied	Ground	Poor condition; characteristic of ferruginous hawk nest
18	Bald eagle	Occupied/Inactive	Deciduous tree	"Yakima River Mouth" territory. Greenery present in nest; adult flushed from nest in May, no eggs or young present
19	Common raven	Occupied/Active	Deciduous tree	Adult incubating in nest
28	Swainson's hawk	Occupied/Active	Deciduous tree	Adult incubating; flushed, 4 eggs, nest in low shrubbery
30	Unknown raptor	Unoccupied	Ground	Poor condition; characteristic of ferruginous hawk nest
32	Swainson's hawk	Occupied/Active	Conifer tree	Adult incubating on nest; next to commercial building
33	Common raven	Occupied/Active	Cliff	Two adults present, 4 chicks approximately 1-2 weeks old
34	Unknown raptor	Unoccupied	Cliff	Large nest, good condition
35	Swainson's hawk	Occupied/Active	Conifer tree	Adult in incubating posture; nest adjacent to house/road
38	Common raven	Occupied/Active	Transmission line	Adult present, 2 chicks in nest
39	Red-tailed hawk	Occupied/Active	Deciduous tree	Adult brooding 1 chick approximately 2 weeks old
40	Red-tailed hawk	Occupied/Active	Deciduous tree	Two adults present; one on nest incubating/tending
41	Great horned owl	Occupied/Active	Deciduous tree	One juvenile flushed from the nest; no adults present
42	Swainson's hawk	Occupied/Active	Deciduous tree	Adult incubating, one adult perched on adjacent power pole
58	Bald eagle	Occupied/Active	Deciduous tree	"Prosser" territory; one adult and 2-3 chicks approximately 4 weeks old at nest

[1]Highest level of reproductive status determined for the current breeding season: **Occupied** = contained eggs, young, or an incubating eagle, or had a pair of eagles on or near it, or had been recently repaired or decorated. **Active** = an occupied nest in which eggs were laid, as evidenced by the presence of an incubating bird, eggs, young, or any other indication that eggs had been laid in the current year. **Inactive** = no eggs or chicks present. **Unoccupied** = no sign of nesting or territory occupancy in the current nesting season, based on at least two visits.

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Photo 1. Bald eagle chicks in Nest 58 ("Prosser" nesting territory) along the Yakima River. Photo taken May 16, 2019.

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Photo 2. Occupied/Inactive bald eagle nest (Nest 18; "Yakima River Mouth" nesting territory) near the confluence of the Yakima and Columbia rivers. Photo taken March 7, 2019.

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Large Bird Avian Use Report for the Horse Heaven Wind Farm (East) Benton County, Washington

October 2019 – September 2020
Final Report

Shrub-steppe in the southeast portion of the Project

Prepared for:

Horse Heaven Wind Farm, LLC
5775 Flatiron Parkway, Suite 120
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Prepared by:

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January 2021

WEST Inc.

Public Draft - For Distribution

EXECUTIVE SUMMARY

The Horse Heaven Wind Farm, LLC is developing the proposed eastern portion of their wind energy project (Horse Heaven [East] and/or Project) in Benton County, Washington. Western EcoSystems Technology, Inc. (WEST) was contracted to conduct an avian use study to evaluate the potential impacts of the proposed Project on large-sized birds. Survey methods were consistent with protocols used during other past avian studies conducted in the Horse Heaven Hills which were designed to comply with recommendations described by the Washington Department of Fish and Wildlife (WDFW) Wind Power Guidelines (WDFW 2009), Tier 3 of the US Fish and Wildlife Service (USFWS) Land-Based Wind Energy Guidelines (USFWS 2012), Stage 2 of the Eagle Conservation Plan Guidance (USFWS 2013) and associated Final Eagle Rule (USFWS 2016).

The principal objective of the study was to provide site-specific species occurrence and the spatial and temporal patterns of avian use with a particular focus on eagles, other raptors, and non-raptors such as American white pelican or species of regulatory or management concern (i.e., federal or state-sensitive species). This report summarizes the methodology and results of the year-long avian use survey.

The Project is located in the Columbia Plateau Ecoregion located within the Horse Heaven Hills which is an anticline ridge of the Yakima Folds within 4 miles of Kennewick and the larger tri-cities urban area. Fixed-point bird surveys estimated the seasonal, spatial, and temporal use patterns of birds within the Project. All large birds were recorded within an 800-meter radius plot at the same eight fixed-point count stations and protocols used by Chatfield et al. (2019a). Surveys for large birds were conducted for 60-minutes at each point once per month (i.e., one visit) for 12 months.

Twelve visits of large-bird use surveys for a total of 96 surveys were conducted at the Project from October 23, 2019–September 20, 2020. A total of 18 unique bird species and one unidentified accipiter were observed during the survey year. Overall large bird mean use ranged from 2.13 observations/plot/survey to 152.63 observations/plot/survey among seasons and was:

- highest during winter (152.63 observations/plot/survey),
- followed by fall (22.38 observations/plot/survey), and
- then spring (3.33 observations/plot/survey), and summer (2.13 observations/plot/survey).

Three species of federal- or state-protected status were recorded during avian use surveys within the Project area. Of the three species, one state-threatened species, the American white pelican was observed during the study. Observations of five bald eagles and one golden eagle were recorded during the study, both of which are listed under the Bald and Golden Eagle Protection Act of 1940 and golden eagles are also considered a state species of concern.

Bald eagles were observed during fall, winter, and spring with equal mean use in winter and spring (0.08 observations/plot/survey). The bald eagle observed in fall was outside the survey pot and not used in mean use calculations. The single golden eagle observed during fall had a mean use of 0.04 observations/plot/survey. Collectively, eagles were observed for a total of 30 minutes during the Year 2 study. Of the 47 minutes, 21 minutes were attributed to bald eagles, of which eight minutes were flying within the 800 m plot below 200 m above ground level (eagle exposure minutes). The remaining 26 minutes were from a golden eagles of which 15 minutes were considered exposure minutes.

The bird species observed in the Project during the study were typical to those commonly found in agricultural, shrub-steppe and grasslands within the Columbia Plateau. Overall large bird use was significantly higher during winter due to the Project's location in the Pacific Flyway and high number of snow geese that were observed flying over the Project. Although land cover within the Project does not provide relatively unique nesting or foraging habitat for high concentrations of large birds compared to the surrounding landscape; the Projects location within the Pacific Flyway and proximity to the Columbia River will result in continued use of the area by large birds. Relatively more observations of waterfowl and waterbirds were recorded at survey points closer to the Columbia River than further away. Seasonal and spatial differences in bird species composition, flight behavior, and use occur at the Project and potential impacts to birds from turbine collision of other impacts such as displacement will likely reflect these patterns.

STUDY PARTICIPANTS

Erik Jansen	Project Manager, GIS
Diem Pham	Statistician
Pallavi Sirajuddin	Data Analyst
Ashleigh Boyd	Data Coordinator
Joshua Parrott	Field Biologist

REPORT REFERENCE

Jansen, E. W. 2021. Large Bird Avian Use Survey Report for the Horse Heaven Wind Farm (East), Benton County, Washington Final Report. October 2019 – September 2020. Prepared for Horse Heaven Wind Farm, LLC, Boulder, Colorado. Prepared by Western EcoSystems Technology, Inc. (WEST), Corvallis, Oregon. January 18, 2021. 24 pages + appendices.

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INTRODUCTION

The Horse Heaven Wind Farm, LLC is proposing the development of the Eastern portion of their project (Horse Heaven [East] and/or Project) in Benton County, Washington (Figure 1). Western EcoSystems Technology, Inc. (WEST) was contracted to conduct a one-year avian use study at the Project to evaluate the potential impacts of Project wind turbine generator construction and operation on birds. Additionally, observations of rare and species of concern[1] were documented incidental to protocol avian use surveys. The avian use study was designed to comply with recommendations described by the Washington Department of Fish and Wildlife (WDFW) *Wind Power Guidelines* (WPG; WDFW 2009), the US Fish and Wildlife Service's (USFWS) 2012 *Final Land-Based Wind Energy Guidelines* (WEG), Appendix C(1)(a) of the 2013 USFWS *Eagle Conservation Plan Guidelines* (ECPG), and the USFWS *Revisions to Regulations for Eagle Incidental Take and Take of Eagle Nests* (Final Eagle Rule; 81 FR 91494). In order to comply with the two-year survey criteria as specified in the Final Rule, this avian use study was conducted in the same geographic area at a subset of survey points sampled by Chatfield et al. (2019a; Figure 1). This study was conducted October 23, 2019 through September 20, 2020.

The principal objective of the study was to provide site-specific species occurrence and the spatial and temporal patterns of avian use with a particular focus on eagles, other raptors, and non-raptors such as American white pelican (*Pelecanus erythrorhynchos*), sandhill crane (*Antigone canadensis*) or other species of regulatory or management concern (i.e., federal or state-sensitive species). This report summarizes the methodology and results of the year-long avian use survey.

PROJECT AREA

The Study Area encompasses 5,480 hectares (13,542 acres) of privately owned land within Benton County in southeastern Washington, approximately 6.4 kilometers (km; 4.0 miles [mi]) south of the city of Kennewick (Figure 1). Topography within the Study Area generally consists of rolling hills bisected by meandering canyons that drain primarily to the south and east into the Columbia River. Elevations range from approximately 192 meters (m; 630 feet [ft]) along the northeastern boundary of the Study Area to 613 m (2,010 ft) in the northwest. The 96-megawatt (MW) Nine Canyon Wind Project (Nine Canyon) is located immediately to the north of the Study Area and the 300-MW Stateline Wind Energy Facility (Stateline) is located approximately 6.4 km (4.0 mi) to the southeast (Figure 1).

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[1] As defined here, "species of concern" includes any species which 1) is either a) listed as an endangered, threatened or candidate species under the Endangered Species Act, subject to the Migratory Bird Treaty Act, Bald and Golden Eagle Protection Act, or Washington State Environmental Protection Act; b) is designated by federal or state law, regulation, or other formal process for protection and/or management by the relevant agency or other authority; or c) has been shown to be significantly adversely affected by wind energy development, and 2) is determined to be possibly affected by the project (WDFW 2009, USFWS 2012).

Habitat types per WDFW (2009) classification includes croplands that consisted of tilled dry-land agriculture (primarily wheat) with smaller areas of uncultivated grassland, the majority of which is managed as part of the US Department of Agriculture Farm Service Agency's Conservation Reserve Program. There are smaller areas of remnant shrub-steppe, typically in topographically steeper areas that were unsuitable for croplands, such as drainages. Developed areas, that included individual structures, residences, and farms, were scattered throughout the area. Although the areas containing shrub-steppe are relatively small, shrub-steppe is considered an important habitat type for avian species, providing critical nesting and foraging opportunities (WDFW 2009). Trees are generally absent from the Study Area and limited to the farms and residences that are scattered throughout the Study Area.

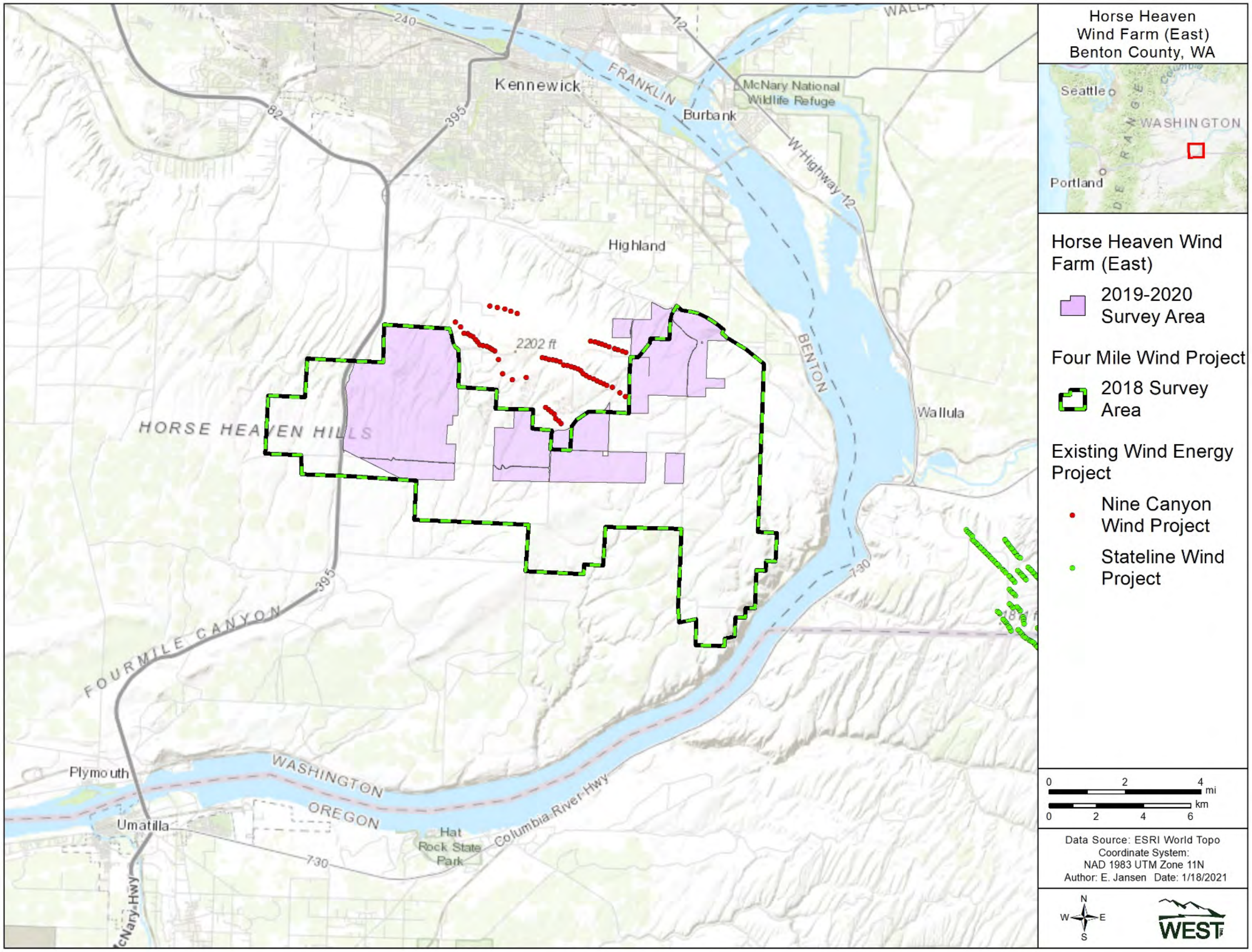

Figure 1. Location of the Horse Heaven Wind Farm (East), Benton County, Washington.

METHODS

The study consisted of the following: 1) fixed-point avian use surveys and 2) incidental wildlife observations. The study design and survey methods followed guidance in the ECPG and the Final Eagle Rule because of the need to collect information on eagles, while also following guidance from the WEG to collect information on other birds, and exceeding standards described in WDFW Wind Power Guidelines (WDFW 2009). Methods described below, therefore, are common for all birds (i.e., large birds, eagles, and other species of concern) except as noted.

Study Design

To maintain consistency between study years, fixed-point count stations were selected from a sample of established points that were surveyed during 2018−2019 (Chatfield et al. 2019a). A total of eight survey points were established within the proposed Project area to comply with Final Rule recommended survey coverage of approximately 30% of the project footprint[2] at the time survey points were designed. Points were surveyed over two days each month to account for varying weather conditions and the order at which points were surveyed rotated each round to achieve different times of day a point was visited. Surveys were conducted by one observer; points were not surveyed concurrently to minimize the potential for double counting individuals and are considered independent samples.

Seasons were defined as fall (August 16 to November 30), winter (December 1 to February 28), spring (March 1 to May 31), and summer (June 1 to August 15). Surveys were conducted during daylight hours and survey times at points were randomized to cover all daylight hours during a season. Surveys were conducted under all weather conditions except when visibility was less than 800 m from the observer and 200 m above ground level (agl).

Survey Methods

Large Birds

At each point, surveys were conducted for 60 minutes (min); all large birds[3] observed or heard within an 800 meter radius from the surveyor were recorded. Biologists recorded the following information for each survey: date, start and end time, and weather (i.e., temperature, wind speed, wind direction, precipitation, and percent cloud cover). Additionally, the following data were recorded for each group of birds observed:

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[2] The project footprint is the minimum-convex polygon that encompassed the wind-project area inclusive of the hazardous area around all turbines.

[3] Large birds were defined as waterbirds, waterfowl, shorebirds, gulls/terns, diurnal raptors (i.e., kites, accipiters, *Buteos*, eagles, falcons, northern harrier, and osprey), owls, vultures, upland game birds, doves/pigeons, goatsuckers, and large corvids (e.g., magpies, crows, and ravens).

- Observation number
- Species (or best possible identification)
- Number of individuals
- Sex and age class (if possible)
- Distance from survey plot center to the nearest five m interval (first & closest)
- Flight height AGL to the nearest five m interval (first, lowest, and highest)
- Flight direction (first observed)
- Habitat
- Activity (e.g., flying, perched)
- Observation type (visual or aural)
- Flight paths and perch locations of eagles and other species of concern

Eagles

Data were collected if a golden eagle (*Aquila chrysaetos*), bald eagle (*Haliaeetus leucocephalus),* or unidentified eagle were observed during the survey period. Biologists recorded eagle behavior (i.e., flight height, distance from observer, activity) each minute, at the top of the minute, to provide an instantaneous count for every eagle observed, whether or not the eagle was flying below 200 m agl and within 800 m of the survey location at any time during the minute; and classified the eagle into age class (juvenile [1st year], immature or sub-adult [2nd to 4th year], adult [≥5th year]).

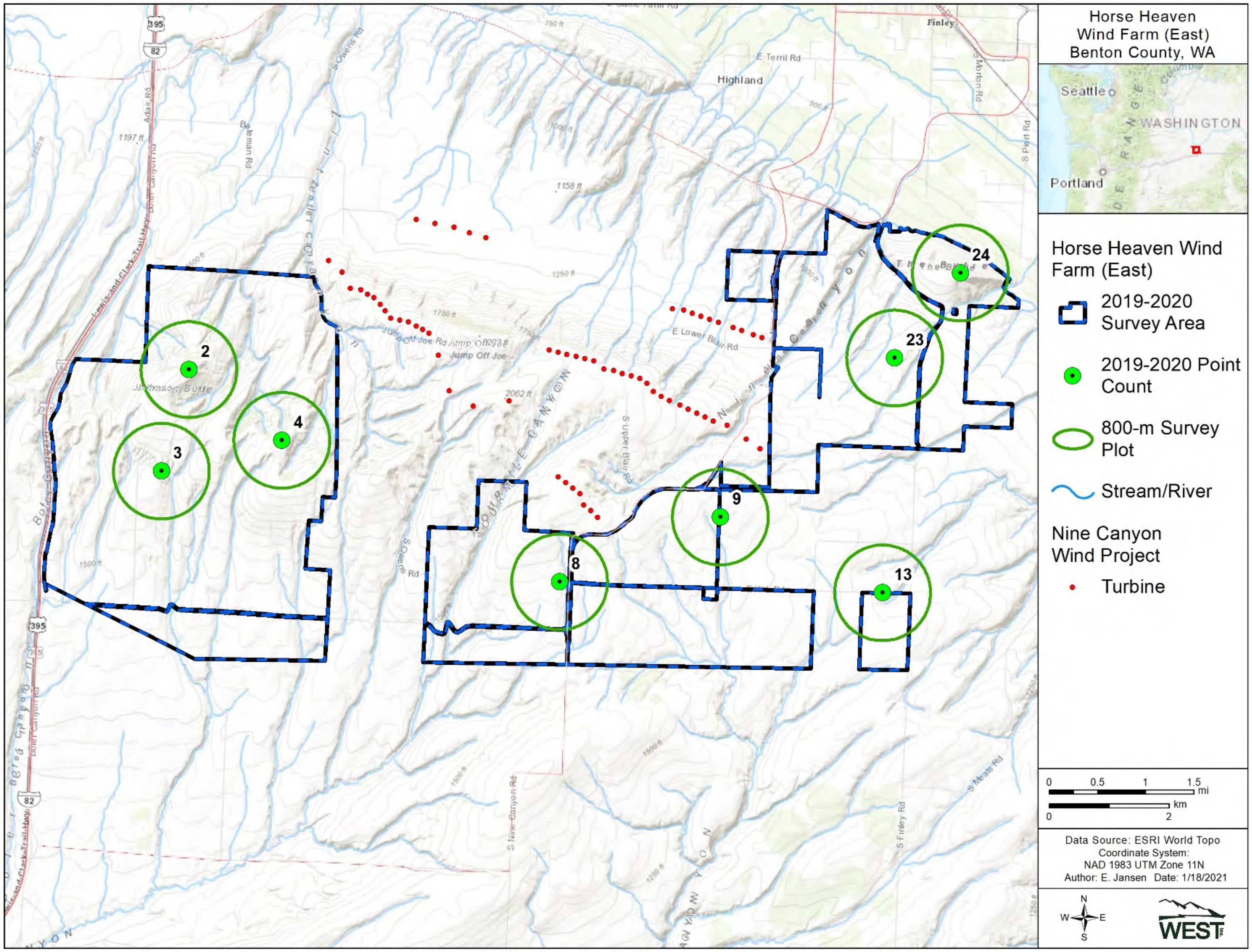

Figure 2. Avian use survey points and plots at the Horse Heaven Wind Farm (East) in Benton County, Washington from October 23, 2019 to September 20, 2020.

Data Management

Quality Assurance and Quality Control

WEST implemented industry standard quality assurance and quality control (QA/QC) measures at all stages of the study, including in the field, during data entry and analysis, and report writing. Following surveys, biologists were responsible for inspecting data forms for completeness, accuracy, and legibility. If errors or anomalies were found within the data, follow-up measures were implemented including discussions and review of field data with field technicians and/or Project Managers. WEST traced back any errors, omissions, or problems identified in later stages of analysis to the raw data forms where appropriate changes and measures were implemented, no matter what stage of analysis. Multiple reviews were conducted as QA/QC measures.

Data Compilation and Storage

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

Statistical Analysis

A *visit* was defined as surveying all of the survey plots once within the Project area and could occur across multiple dates but had to be completed in a single season (e.g., spring). If extreme weather conditions prevented all plots from being surveyed during a visit, then a visit might not have constituted a complete survey of all plots. A *survey* was defined as a single 60 min count of birds. In some cases, a count of bird observations may represent repeated observations of the same individual. Only observations within the 800 m survey plot were included for data analysis.

Mean Use, Percent of Use, and Frequency of Occurrence

Mean use is the average number of birds observed per plot per survey for large birds. Large bird use (per 800 m plot per 60 min survey) is calculated by: 1) summing birds per plot per visit, 2) averaging number of birds over plots within a visit, and 3) averaging number of birds across visits within a season. Overall mean use was calculated as a weighted average of seasonal values by the number of days in each season. *Percent of use* was calculated as the percentage of large bird use that was attributable to a particular bird type or species. *Frequency of occurrence* was calculated as the percent of surveys in which a particular bird type or species was observed.

Mean use and frequency of occurrence describe different aspects of relative abundance, in that mean use is based on the number of birds (i.e., large groups can produce high estimates), whereas frequency of occurrence is based on the number of groups (i.e., it is not influenced by group size). Qualitative comparisons were made with these metrics among bird types, seasons, and survey points to help one understand how birds are using the Project area over time and space.

Flight Height and Behavior

Bird flight heights are important metrics to assess relative potential exposure to turbine blades and were used to calculate the percentage of large birds and eagles observed flying within the rotor-swept height (RSH) of proposed turbines. A RSH of 10 to 155 m (82 to 492 ft) agl was assumed for the purpose of the analysis. Flight height recorded during the initial observation was used to calculate the percentage of birds flying within the RSH and mean flight height.

The bird exposure index is used as a relative measure of species-specific risk of turbine collision and the species most likely to occur as fatalities at the wind energy facility. A relative index of bird exposure (*R*) was calculated for bird species observed during the surveys using the following formula:

$$R = A \times P_f \times P_t$$

Where *A* equals mean relative use for species i (large bird observations within 800 m of the observer) 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 RSH. The exposure index does not account for other possible collision risk factors, such as foraging or courtship behavior. The first flight height was selected because of the concern that the observer could bias the flight height of the bird. The thought was the first flight height would be the most independent measurement if bias from the observer exists.

Spatial Use

Mean use was calculated by survey point for large birds and eagles to make spatial comparisons among the survey points. Additionally, flight paths of eagles were mapped during large bird use surveys to qualitatively show flight path location compared to Project area characteristics (e.g., topographic features) to identify if there were areas of concentration or consistent flight patterns within the Project area.

Eagles

Eagle observations during surveys were summarized to provide flight heights (see *Flight Height*) and flight path maps (see *Spatial Use*). Data collected during each minute eagles were observed were examined to count eagle exposure minutes, defined as the number of minutes an eagle was observed in flight within the risk cylinder (defined as the area within 800 m of the survey point and below 200 m AGL during the 60 min survey periods) and total minutes defined as the amount of time eagles were observed inside and outside the risk cylinder, but still within 800 m of the survey point. The eagle exposure minutes per observation hour were reported by survey plot and month to enable spatial and temporal assessments of eagle exposure minutes recorded in the Project area. Data collected on perched eagles and those outside of survey plots were not considered eagle exposure minutes; however, they were considered in the total eagle minutes. The perch locations and flight paths of all eagles were mapped to qualitatively assess areas of eagle use within the Project area.

Incidental Observations

Incidental observations were wildlife observed outside of the standardized survey plots but within the Project area and were focused on federal- or state-protected species, unusually large congregations of individuals, species not yet recorded during surveys, unusual or unique birds, mammals, reptiles, amphibians, or eagle attractants (e.g., ground squirrel burrows, areas with concentration of carrion). Data recorded for incidentally observed species were similar to that recorded during scheduled surveys.

RESULTS

Fixed-Point Large Bird Use Surveys

Twelve visits of large-bird use surveys for a total of 96 surveys were conducted at the Project from October 23, 2019–September 20, 2020. Survey effort was equal among seasons (Table 1).

Eighteen species of large birds and one unidentified bird type (unidentified accipiter) were observed or heard during the study. The index to species richness was highest during summer and lowest in spring. Survey results are summarized below, supplemented by the appendices, which present species-level detail on the following: scientific names, number of groups and observations within the survey plot by season (Appendices A), avian use, percent of use, and frequency of occurrence by season (Appendices B), relative exposure index (Appendix C), and mean use by survey point (Appendix D).

Table 1. Summary of species richness (species/plot[a]/60-min survey), and sample size by season and overall during the fixed-point bird use surveys at the Horse Heaven Wind Farm (East) in Benton County, WA during fixed-point bird use surveys from October 23, 2019 to September 20, 2020.

Season	# Visits	# Surveys Conducted	Species Richness	Index to Species Richness Large Birds
Summer	3	24	13	2.63
Fall	3	24	12	2.29
Winter	3	24	10	1.75
Spring	3	24	8	1.04
Overall	**12**	**96**	**18**	**1.99**

Species Richness: The total number of unique species observed within survey plots during avian use surveys.
Index to Species Richness: Average number of species observed within the observer survey plot/plot/visit within seasons.
[a] 800-meter (m) radius plot.

Species of Concern

Eagles

<u>Mean Use</u>

A total of five bald eagles were observed during fall, winter, and spring. One adult and one juvenile were observed in both winter and spring, with a seasonal mean use of 0.08 observations/plot/survey. The eagle observation in fall was flying beyond the 800 m survey plot and not calculated in the mean use estimate. Overall bald eagle mean use was 0.04 observations/plot/survey. One adult golden eagle was observed during fall and had a mean use of 0.04 observations/plot/survey.

Eagle Exposure Minutes

A total of 47 eagle minutes were recorded from five bald eagles and one golden eagle during the 96 survey hours. Of the 47 eagle minutes, bald eagles were observed for 21 minutes, of which eight minutes were considered exposure minutes where the eagle was observed flying within the risk cylinder (Table 2). Bald eagles occurred during fall, winter, and spring seasons; however, winter and spring observations were within the survey plot and resulted in 0.1667 seasonal eagle exposure min/hr, respectively (Table 2). Monthly bald eagle exposure was highest during May (0.5 eagle exposure min/hr) followed by February (0.375 eagle exposure min/hr), and January (0.125 eagle exposure min/hr). The remaining 26 eagle minutes were attributed to golden eagles, of which 15 minutes were considered exposure minutes (Table 3). Averaged across all seasons, golden eagle exposure minutes per survey hour was 0.156 eagle exposure min/hr with the only golden eagle observation recorded during fall (0.625 eagle exposure min/hr; Table 3).

Eagle Flight Paths

Golden and bald eagle flight paths were mapped at the Project (Figure 3). Eagles were observed flying at an average flight height of 103 m agl when first observed which is within the 10−155 m RSH of a turbine blade. Because of the small number of individuals observed, no discernable patterns emerged from the flight path data; however, three eagles (one golden eagles and two bald eagle) were observed in the northeastern corner of the Project at Point 24. Point 24 is on top of a predominant hill called The Butte with relatively steep topography compared to the surrounding area with an elevation difference of approximately 630 m within the 800 m survey plot.

Table 2. The bald eagle minutes and observations recorded during avian use surveys in the Horse Heaven Wind Farm (East) in Benton County, WA during fixed-point bird use surveys from October 23, 2019 to September 20, 2020.

	Eagle Minutes		Eagle Observations			
Season	**Within Risk Cylinder[1]**	**Total[2]**	**Within Risk Cylinder[1]**	**Total[2]**	**Survey Hours**	**Eagle Exposure Mins/Survey Hr**
Fall	0	3	0	1	24	0.0000
Winter	4	8	2	2	24	0.1667
Spring	4	10	2	2	24	0.1667
Summer	0	0	0	0	24	0.0000
Total	**8**	**21**	**4**	**5**	**96**	**0.0833[3]**

[1] Minutes or observations inside the risk cylinder (within 800 m of observer, below 200 m agl); minutes inside risk cylinder = eagle exposure minutes.

[2] Total = minutes or observations inside and outside the risk cylinder, but still within 800 m of the survey point.

[3] Seasonal average

Table 3. The golden eagle minutes and observations recorded during avian use surveys in the Horse Heaven Wind Farm (East) in Benton County, WA during fixed-point bird use surveys from October 23, 2019 to September 20, 2020.

Season	Eagle Minutes		Eagle Observations		Survey Hours	Eagle Exposure Mins/Survey Hr
	Within Risk Cylinder[1]	Total[2]	Within Risk Cylinder[1]	Total[2]		
Fall	15	26	1	1	24	0.6250
Winter	0	0	0	0	24	0.0000
Spring	0	0	0	0	24	0.0000
Summer	0	0	0	0	24	0.0000
Total	**15**	**26**	**1**	**1**	**96**	**0.1562**

[1] Minutes or observations inside the risk cylinder (within 800 m of observer, below 200 m agl); minutes inside risk cylinder = eagle exposure minutes.

[2] Total = minutes or observations inside and outside the risk cylinder, but still within 800 m of the survey point.

[3] Seasonal average

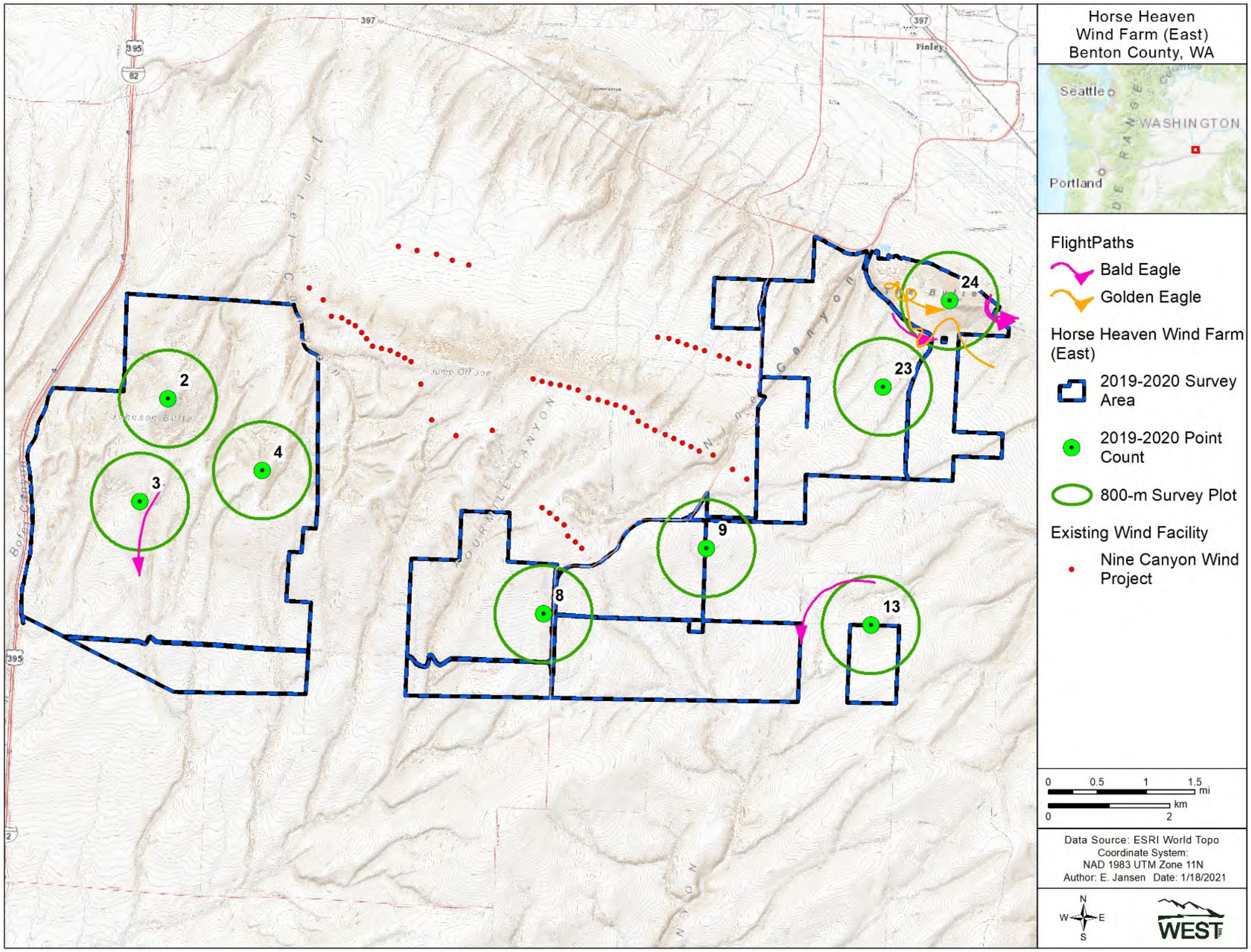

Figure 3. Bald and golden eagle flight path at the Horse Heaven Wind Farm (East) in Benton County, Washington, October 23, 2019 to September 20, 2020.

Federal- and state-protected species

Three species of federal- or state-protected status were recorded during avian use surveys within the Project area (Table 4). One state-threatened species, American white pelican, was observed during the study. Eight groups comprising 39 observations were recorded during point count surveys. American white pelican were observed at five of the eight survey points on the eastern half of the Project with the highest mean use at point 24 which is located on a prominent hill called The Butte (1.33 observations/plot/survey; Appendix D). Five bald eagles and one golden eagle were observed during the year-long study. Both species are listed under the Bald and Golden Eagle Protection Act of 1940 and golden eagle are considered a state species of concern. A permitting process is available that authorizes the incidental take of an eagle that result from but is not the purpose of an otherwise lawful activity (USFWS 2016).

Table 4. Groups and observations of federal- and state-protected species recorded during avian use surveys or as incidental wildlife observations at the Horse Heaven Wind Farm (East) in Benton County, Washington from October 23, 2019 to September 20, 2020.

			Point Count		Incidental		Total	
Species	**Scientific Name**	**Status**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
golden eagle	*Aquila chrysaetos*	SC; BGEPA	1	1	0	0	1	1
bald eagle	*Haliaeetus leucocephalus*	BGEPA	5	5	0	0	5	5
American white pelican	*Pelecanus erythrorhynchos*	WA-T	8	39	0	0	8	39
Total	**3 species**		**14**	**45**	**0**	**0**	**14**	**45**

WA-T = State Threatened
SC = State Candidate Species
BGEPA = Bald and Golden Eagle Protection Act

Large Birds

Eighteen species of large birds were observed or heard during 96 survey hours for a total of 4,332 observations of 258 groups (Appendix A). One unidentified accipiter (observation that could not be identified to species) was recorded during surveys.

Mean Use, Percent of Use, and Frequency of Occurrence

Mean use, percent of use, and frequency of occurrence were calculated by season for large bird types (Figures 4a-c) and species (Appendix B). Large bird mean use ranged from 2.13 observations/plot/survey to 152.63 observations/plot/survey among seasons and was highest during winter (152.63 observations/plot/survey), followed by fall (22.38 observations/plot/survey), spring (3.33 observations/plot/survey), and summer (2.13 observations/plot/survey; Figure 4a). Species composition of avian use varied by season and showed distinct patters for several groups. Waterfowl (i.e., snow goose [*Anser caerulescens*], Canada goose [*Branta canadensis*]) comprised nearly all avian use during winter (98%; 149.79 observations/plot/survey) yet none were observed during spring and summer (Appendix B). Diurnal raptors were observed during all seasons but typically had the highest use during fall when proportionately more *Buteos* and northern harrier were observed compared to other seasons (Appendix B). Seasonally, large corvids had the highest use during fall and spring (2.88 observations/plot/survey and 1.38 observations/plot/survey, respectively). Although waterbirds comprised the majority of mean use and percent of mean use during fall and winter, species within the group were observed comparatively less frequently than diurnal raptors and large corvids that were recorded during more than half of all surveys in fall, winter, and spring (Figures 4b-c, Appendix B).

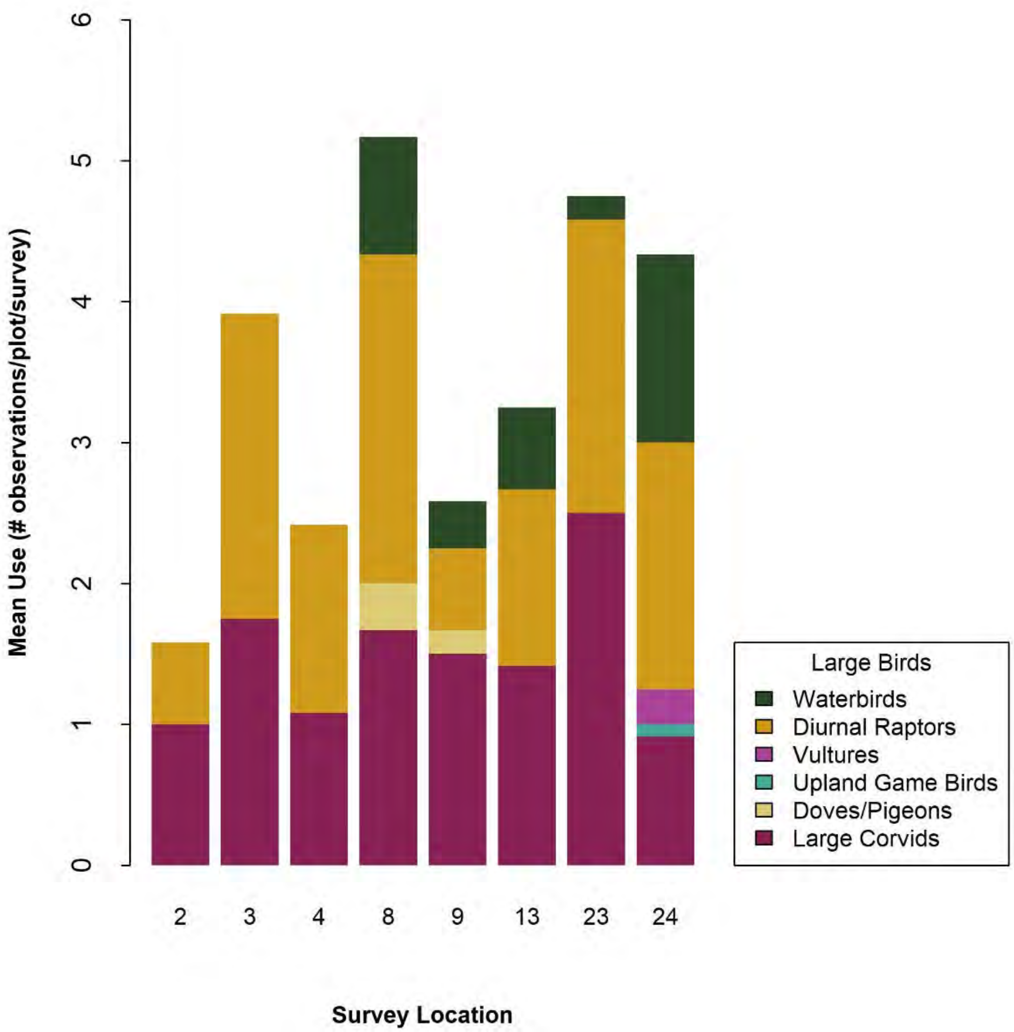

Figure 4a. Large bird mean use by season and bird type at the Horse Heaven Wind Farm (East) in Benton County, Washington from October 23, 2019 to September 20, 2020.

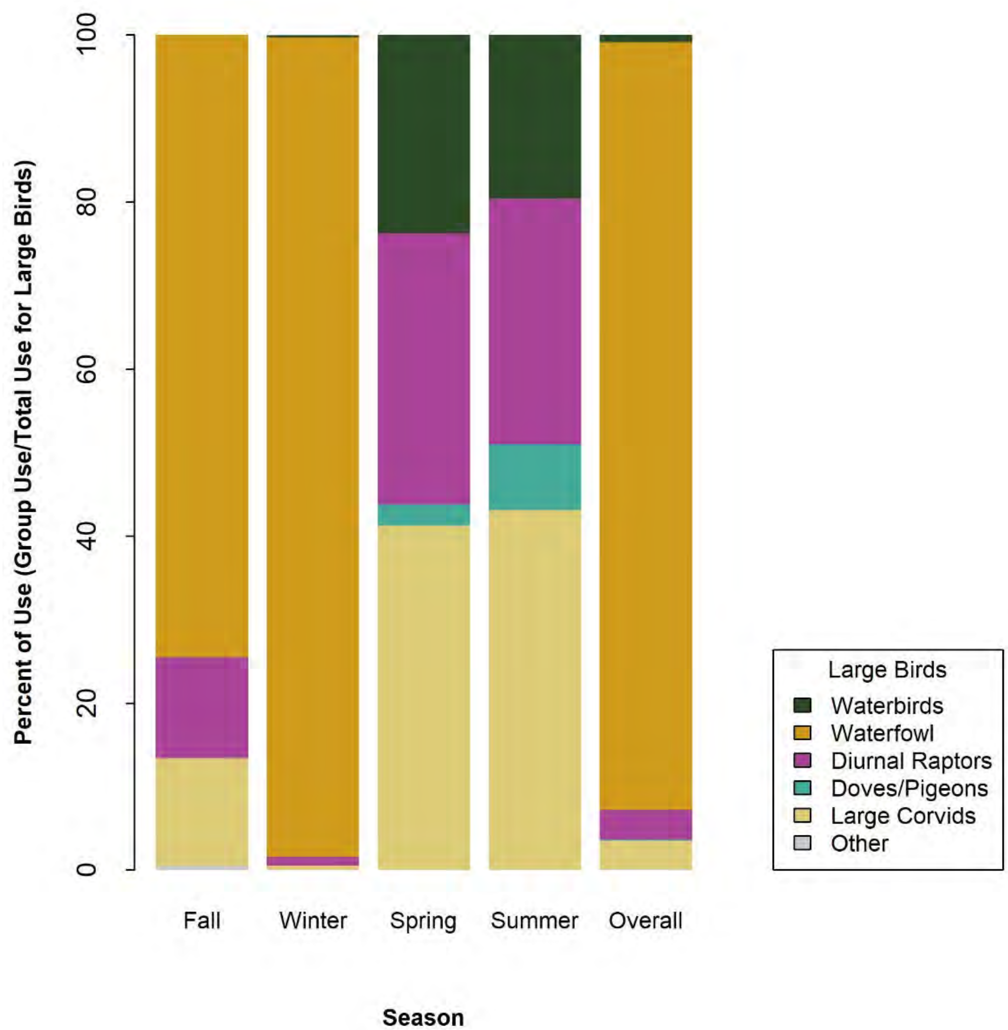

Figure 4b. Large bird percent of use by season and bird type at the Horse Heaven Wind Farm (East) in Benton County, Washington from October 23, 2019 to September 20, 2020.

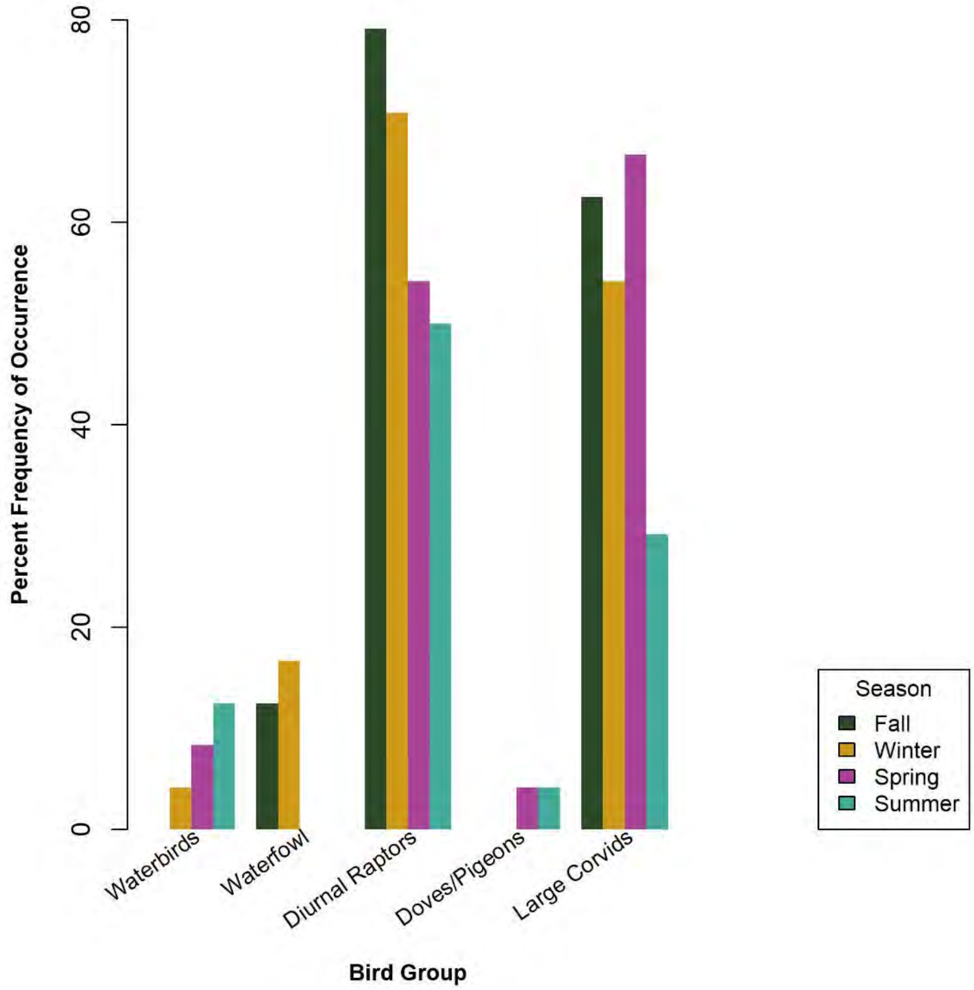

Figure 4c. Large bird frequency of occurrence by season and bird type at the Horse Heaven Wind Farm (East) in Benton County, Washington from October 23, 2019 to September 20, 2020.

Bird Flight Height

There was large variability in flight heights among species and species groups that ranged from an average of 20 m for northern harrier to 130 m for American white pelican. Waterfowl, the species type with highest mean use, flew within the RSH approximately 82% of the groups recorded and had the highest relative exposure index (33.31; Table 5; Appendix C). Overall mean use was a primary contributing factor in the exposure index as illustrated by the difference between snow goose (33.28) and the species with the second highest mean use, Canada goose (1.89). Within the diurnal raptor type, the group with the highest mean use (*Buteos*) were observed within the RSH the majority (89%) of the time followed by northern harrier, which typically flew low to the ground and within the RSH approximately 40% of the time (Table 5). For this analysis, the maximum RSH of 155 m agl was used; if a taller turbine technology were considered, the percent and species composition of birds flying with RSH would shift but likely be proportionately similar.

Four of the five eagle recorded within the 800 m survey plot were within the RSH when first observed which resulted in an average of 126 m (Table 5) but all eagles flew within the RSH during the course of the observation but had a relatively low exposure index because of low mean use (Appendix C).

Table 5. Flight height characteristics by large bird type and raptor subtype during 60-minute use surveys at the Horse Heaven Wind Farm (East) in Benton County, Washington from October 23, 2019 to September 20, 2020.

Bird Type	# Groups Flying	# Obs Flying	% Obs Flying	Mean Flight Height (m)	% within Flight height Categories <10 m	10 - 155 *m*[b]	> 155 m
Waterbirds	**8**	**39**	**100**	**130**	**0**	**82.1**	**17.9**
Waterfowl	**16**	**3,665**	**91.7**	**114**	**0**	**91.7**	**8.3**
Diurnal Raptors	**112**	**112**	**77.2**	**50**	**21.4**	**74.1**	**4.5**
Accipiters	*3*	*3*	*100*	*65*	*0*	*100*	*0*
Buteos	*56*	*56*	*71.8*	*65*	*5.4*	*89.3*	*5.4*
Northern Harrier	*32*	*32*	*100*	*20*	*59.4*	*40.6*	*0*
Eagles	*5*	*5*	*100*	*126*	*0*	*60.0*	*40.0*
Falcons	*15*	*15*	*57.7*	*24*	*13.3*	*86.7*	*0*
Osprey	*1*	*1*	*100*	*85*	*0*	*100*	*0*
Vultures	**3**	**3**	**100**	**77**	**0**	**100**	**0**
Upland Game Birds	**0**	**0**	**0**	**NA**	**NA**	**NA**	**NA**
Doves/Pigeons	**2**	**6**	**100**	**43**	**0**	**100**	**0**
Large Corvids	**73**	**131**	**92.3**	**33**	**19.8**	**80.2**	**0**
Large Birds Overall	**214**	**3,956**	**91.3**	**52**	**1.3**	**90.7**	**8.0**

[a] 800-meter (m) radius plot for large birds.
[b] The likely RSH for potential collision with a turbine blade, or 10 to 155 m (33 to 508 ft) above ground level.
[c] Zeroes and NA values indicate that the species was observed but was not flying.

Spatial Variation

Mean Use by Point

The spatial variation of large bird use ranged widely across the Project from a mean use of 1.58 observations/plot/survey to 319.33 observations/plot/survey across points. Mean use was highest at Point 13 in the southeastern corner of the Project and lowest at Point 2 located in the western edge of the Project (Figure 5a). High avian use at survey point 13 was influenced by large groups of waterfowl, specifically snow goose during fall and winter (Figure 5a; Appendix B). Mean use by point of the diurnal raptor type was variable throughout the Project and reflected the same spatial pattern observed in the *Buteo* sub-type. Observations of American white pelican, osprey [*Pandion haliaetus*], snow goose and Canada goose were recorded primarily at survey points (i.e., points 8−24) located in the eastern half of the Project, closer to the Columbia River.

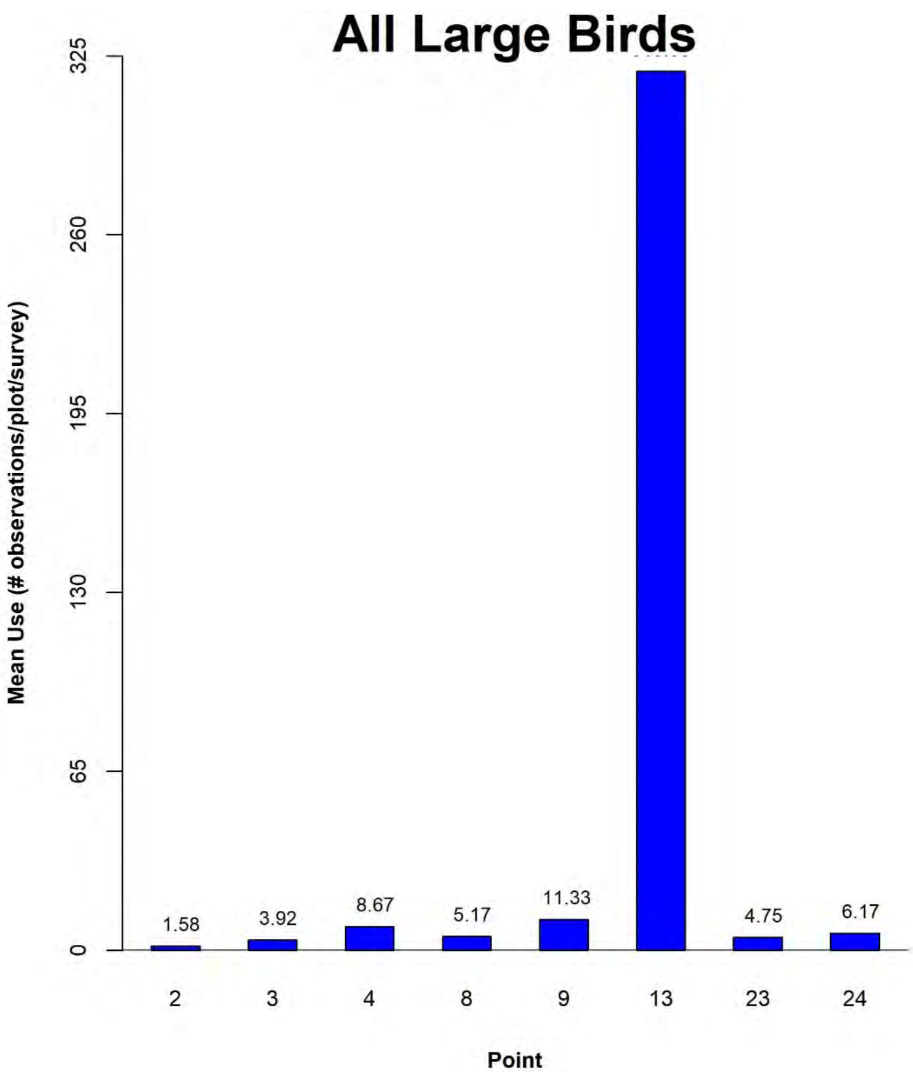

Figure 5a. Overall large bird mean use by survey point at the Horse Heaven Wind Farm (East) in Benton County, Washington from October 23, 2019 to September 20, 2020.

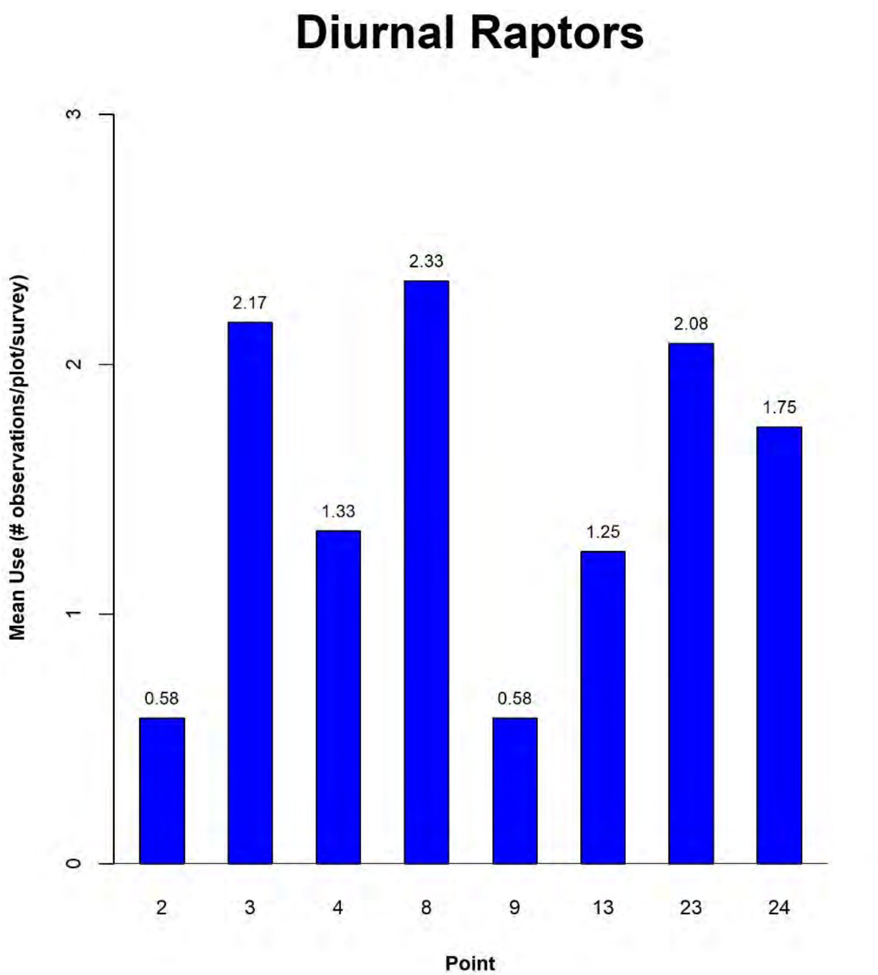

Figure 5b. Diurnal raptor mean use by survey point at the Horse Heaven Wind Farm (East) in Benton County, Washington from October 23, 2019 to September 20, 2020.

<u>Flight Paths</u>

Flight paths of eight groups of 39 American white pelican were mapped at the Project. Groups were observed during winter, spring, and summer and ranged between 1-10 observations (mean = 5 observations). Groups occurred at survey points located throughout the Project area and flight patterns were typically parallel to drainages as recorded at points 8, 9, 13, 23 or traversing a north-facing slope adjacent to point 24 (Figure 6). The overall mean flight height when first observed was 130 m agl (range 65−300 m agl).

Flight paths of 13 groups of 3,782 snow goose were mapped at the Project. Records of groups were limited to fall and winter and ranged between 9−1,500 observations (mean = 290 observations). Groups occurred primarily at survey point 13 and flight patterns were typically oriented in a straight north or south direction (Figure 6). Of the 11 groups with flight heights recorded, the overall mean flight height when first observed was 119 m agl (range 35−200 m agl).

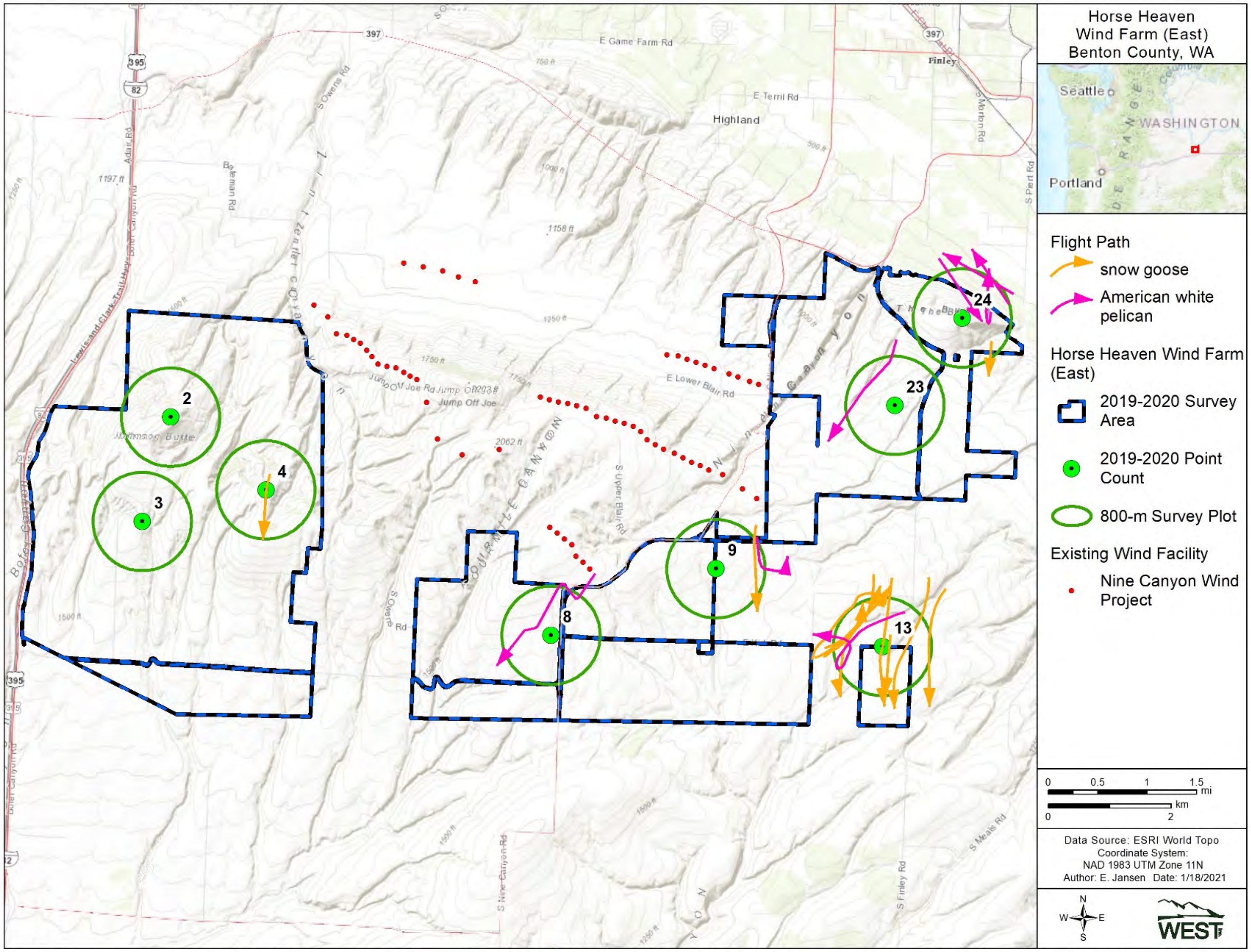

Figure 6. American white pelican and snow goose flight paths at the Horse Heaven Wind Farm (East), Benton County Washington from October 23, 2019 to September 20, 2020.

Incidental Observations

Four avian species were recorded incidental to point count surveys during the study period (Table 6). None of the species were listed as special status species but were recorded because of the substantial group size or a species of note that was not recorded during point count surveys.

Table 6. Incidental wildlife observed at the Horse Heaven Wind Farm (East) in Benton County, Washington from October 23, 2019 to September 20, 2020.

Species	Scientific Name	# grps	# obs
snow goose	*Anser caerulescens*	3	4,650
rough-legged hawk	*Buteo lagopus*	1	1
osprey	*Pandion haliaetus*	2	4
varied thrush	*Ixoreus naevius*	1	1
Total	***4 species***	**7**	**4,656**

DISCUSSION

The principal objective of the study was to provide site-specific species occurrence and the spatial and temporal patterns of avian use with a particular focus on eagles, other raptors, and non-raptors such as American white pelican or species of regulatory or management concern (i.e., federal or state-sensitive species). Additionally, surveyors documented observations of rare and sensitive species observed incidental to standardized surveys throughout the course of the study.

The bird species observed in the Project during the study were typical to those commonly found in agricultural, shrub-steppe and grasslands within the Columbia Plateau. Bird use was highest for species common and widespread in the region and the bird community observed coincided with the assemblage expected based on the time of year and habitat in the Project and surrounding area. For example, snow goose were primarily observed during fall and winter when individuals were likely moving between their summer and winter ranges. Certain raptor species such as Swainson's hawk [*Buteo swainsoni*] were observed during spring and summer when the species migrates from southern latitudes to nest in southeastern Washington.

Overall large bird use was significantly higher during fall and winter, likely due to the Project's location in the Pacific Flyway and the stopover habitat available in the surrounding area. Patterns of high waterfowl use during fall and winter are consistent with patterns observed during other avian studies conducted in the Horse Heaven Hills by Chatfield et al. (2019a, 2019b) and Jansen et al. (2019). Several large bird groups of interest for the Project are discussed separately, below.

Waterbirds

A species of conservation interest, American white pelican (state threatened), comprised the waterbird group. Year-round use of American white pelican within the Horse Heaven Hills has been documented in previous studies and use has fluctuated seasonally (Jansen and Brown 2018, Chatfield et al. 2019a, Chatfield et al. 2019b, and Jansen et al. 2019). Chatfield et al. (2019a) documented high use during summer (9.01 observations/plot/survey) whereas Jansen et al. (2019) documented relatively higher use during fall (0.96 observations/plot/survey). Spatial use tends to be relatively higher at points located further east, in proximity to the Columbia River. In the Great Basin[4], of the 43 wind facilities with publically available post-construction fatality data, no American white pelican fatalities have been documented (WEST 2019, 2020). In Washington, the largest breeding colony of American white pelicans is on Badger Island, located approximately 3.5 miles east of the Project in the Columbia River (Stinson 2016). No large bodies of water provide suitable pelican foraging habitat within the Project; however, considering an increasing population (approximate 86% increase on Badger Island since 2009, *n* = 3,267 individuals total; Stinson 2016), occasional use of the Project area may continue. However, based on the absence of the American white pelicans at a large number of wind facilities within the migration and breeding range of the pelican, potential collisions with wind turbines appears to be low.

Waterfowl

Snow goose had the highest mean use of all large birds due to the large groups that flew over the Project. The Project and surrounding region contains various agricultural and croplands that could provide valuable stopover habitat for migrating geese. Wheat fields within the Project area may become inundated with water in the spring or fall and provide suitable foraging habitat. Waterfowl that enter or exit agricultural fields while foraging for grain crops may be at greater risk of turbine collision. However, waterfowl do not seem especially vulnerable to turbine collisions. In an analysis of 116 studies of bird mortality at over 70 operating wind facilities, waterfowl composed 2.7% of 4,975 fatalities found (Erickson et al. 2014). No waterfowl fatalities have been reported at the adjacent Nine Canyon Wind Project since carcass monitoring began in 2002 (Erickson et al. 2003, Energy Northwest 2020). Based on flight behavior and seasonality of observations, it is likely snow geese are predominantly passing over the Project area rather than utilizing resources in the area.

Diurnal Raptors

Diurnal raptor comprised a comparatively large proportion of avian use at the Project. Despite their relatively low fatality rates at wind facilities compared to passerines, raptors are are a group of concern due to flight behavior that increases risk of collisions with turbines combined with the their low reproductive rates. Diurnal raptor use was highest during the fall and spring when red-tailed hawk [*Buteo jamaicensis*], Swainson's hawk and rough-legged hawk [*Buteo lagopus*] use increased. Fall and spring coincide with migration when large-scale movement of many raptor species from their nesting or overwintering occurs, respectively. Conversely, use of some species such as American kestrel [*Falco sparverius*] increased in winter. A golden eagle was observed during fall whereas bald eagles were observed more often during fall, winter, and spring, which is consistent with the seasonal patterns recorded during previous studies in the Horse Heaven Hills (Jansen and Brown 2018, Chatfield et al. 2019a, Chatfield et al. 2019b, and Jansen et al. 2019). Five raptor species (American kestrel, red-tailed hawk, Swainson's hawk, rough-legged hawk, and golden eagle) that comprise the majority of raptor fatalities in the Pacific Region[5] had

[4] USFWS Bird Conservation Region 9, Great Basin (BCR 9; USFWS 2008)
[5] USFWS Pacific Region (Idaho, Oregon, and Washington; USFWS 2020); WEST 2019

relatively higher use compared to other raptor species at the Project which suggests turbine collision probability will likely be species- and seasonally-specific.

CONCLUSIONS

Tier 3 studies are used to address questions regarding impacts that could not be sufficiently addressed using available literature (i.e., during Tier 1 and 2 desktop analyses; USFWS 2012) and designed to document use of bald and golden eagles, following the ECPG survey recommendations and the Final Rule (USFWS 2013, 2016). Overall, the Project area does not support high use during the avian breeding season or large water bodies or other habitats that attract concentrations of birds. Overall avian use fluctuated seasonally and large bird use was typically characterized by seasonally abundant and common species such as geese, raptors, and ravens. However, special-status avian species such as American white pelican, golden eagle and bald eagle occurred at the Project and pose varying levels of likelihood to collide with operational turbines. Seasonal differences in species composition and use occur at the Project and potential impacts to birds will likely reflect these patterns.

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Appendix A. All Bird Types and Species Observed during Avian Use Surveys at the Horse Heaven Wind Farm (East), Benton County, Washington from October 23, 2019 to September 20, 2020.

Appendix A. Summary of all groups and individual observations, regardless of distance from observer, by bird type and species during avian bird surveys at the Horse Heaven Wind Farm (East)in Benton County, Washington from October 23, 2019 to September 20, 2020.

Type/Species	Scientific Name	Fall		Winter		Spring		Summer		Total	
		# grps	# obs	# grps	# obs	# grps	# obs	# grps	# obs	# grps	# obs
Waterbirds		**0**	**0**	**1**	**10**	**4**	**19**	**3**	**10**	**8**	**39**
American white pelican	*Pelecanus erythrorhynchos*	0	0	1	10	4	19	3	10	8	39
Waterfowl		**6**	**400**	**12**	**3,595**	**0**	**0**	**0**	**0**	**18**	**3,995**
snow goose	*Anser caerulescens*	5	365	8	3,417	0	0	0	0	13	3,782
Canada goose	*Branta canadensis*	1	35	4	178	0	0	0	0	5	213
Diurnal Raptors		**66**	**66**	**39**	**39**	**26**	**26**	**15**	**15**	**146**	**146**
Accipiters		*2*	*2*	*0*	*0*	*1*	*1*	*0*	*0*	*3*	*3*
Cooper's hawk	*Accipiter cooperii*	1	1	0	0	1	1	0	0	2	2
unidentified accipiter		1	1	0	0	0	0	0	0	1	1
Buteos		*33*	*33*	*16*	*16*	*18*	*18*	*11*	*11*	*78*	*78*
red-tailed hawk	*Buteo jamaicensis*	19	19	8	8	12	12	6	6	45	45
rough-legged hawk	*Buteo lagopus*	14	14	8	8	3	3	0	0	25	25
Swainson's hawk	*Buteo swainsoni*	0	0	0	0	3	3	5	5	8	8
Northern Harrier		*20*	*20*	*9*	*9*	*2*	*2*	*1*	*1*	*32*	*32*
northern harrier	*Circus hudsonius*	20	20	9	9	2	2	1	1	32	32
Eagles		*2*	*2*	*2*	*2*	*2*	*2*	*0*	*0*	*6*	*6*
golden eagle	*Aquila chrysaetos*	1	1	0	0	0	0	0	0	1	1
bald eagle	*Haliaeetus leucocephalus*	1	1	2	2	2	2	0	0	5	5
Falcons		*8*	*8*	*12*	*12*	*3*	*3*	*3*	*3*	*26*	*26*
prairie falcon	*Falco mexicanus*	2	2	1	1	0	0	0	0	3	3
American kestrel	*Falco sparverius*	6	6	11	11	3	3	3	3	23	23
Osprey		*1*	*1*	*0*	*0*	*0*	*0*	*0*	*0*	*1*	*1*
osprey	*Pandion haliaetus*	1	1	0	0	0	0	0	0	1	1
Vultures		**3**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**3**
turkey vulture	*Cathartes aura*	3	3	0	0	0	0	0	0	3	3
Upland Game Birds		**0**	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**1**	**1**
California quail	*Callipepla californica*	0	0	1	1	0	0	0	0	1	1
Doves/Pigeons		**0**	**0**	**0**	**0**	**1**	**2**	**1**	**4**	**2**	**6**
rock pigeon	*Columba livia*	0	0	0	0	1	2	1	4	2	6
Large Corvids		**27**	**69**	**16**	**18**	**25**	**33**	**12**	**22**	**80**	**142**

Appendix A. Summary of all groups and individual observations, regardless of distance from observer, by bird type and species during avian bird surveys at the Horse Heaven Wind Farm (East)in Benton County, Washington from October 23, 2019 to September 20, 2020.

		Fall		Winter		Spring		Summer		Total	
Type/Species	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
common raven	*Corvus corax*	25	67	15	17	25	33	11	20	76	137
black-billed magpie	*Pica hudsonia*	2	2	1	1	0	0	1	2	4	5
Overall		**102**	**538**	**69**	**3,663**	**56**	**80**	**31**	**51**	**258**	**4,332**

[a] grps = groups; obs = observations.

Appendix B. Bird Use, Percent of Use, and Frequency of Occurrence for Large Birds Observed during Avian Use Surveys at the Horse Heaven Wind Farm (East) from October 23, 2019 to September 20, 2020.

Appendix B. Mean large birds use (number of large birds/plot[a]/60 minute survey), percent of total use (%), and frequency of occurrence (%) for each large bird type and species by season during avian bird use surveys at the Horse Heaven Wind Farm (East) in Benton County, Washington from October 23, 2019 to September 20, 2020.

Type/Species	Mean Use				% of Use				% Frequency			
	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer
Waterbirds	**0**	**0.42**	**0.79**	**0.42**	**0**	**0.3**	**23.8**	**19.6**	**0**	**4.2**	**8.3**	**12.5**
American white pelican	0	0.42	0.79	0.42	0	0.3	23.8	19.6	0	4.2	8.3	12.5
Waterfowl	**16.67**	**149.79**	**0**	**0**	**74.5**	**98.1**	**0**	**0**	**12.5**	**16.7**	**0**	**0**
snow goose	15.21	142.38	0	0	68.0	93.3	0	0	12.5	12.5	0	0
Canada goose	1.46	7.42	0	0	6.5	4.9	0	0	4.2	12.5	0	0
Diurnal Raptors	**2.71**	**1.63**	**1.08**	**0.63**	**12.1**	**1.1**	**32.5**	**29.4**	**79.2**	**70.8**	**54.2**	**50.0**
Accipiters	*0.08*	*0*	*0.04*	*0*	*0.4*	*0*	*1.3*	*0*	*4.2*	*0*	*4.2*	*0*
Cooper's hawk	0.04	0	0.04	0	0.2	0	1.3	0	4.2	0	4.2	0
unidentified accipiter	0.04	0	0	0	0.2	0	0	0	4.2	0	0	0
Buteos	*1.38*	*0.67*	*0.75*	*0.46*	*6.1*	*0.4*	*22.5*	*21.6*	*58.3*	*50.0*	*50.0*	*37.5*
red-tailed hawk	0.79	0.33	0.50	0.25	3.5	0.2	15.0	11.8	45.8	25.0	45.8	20.8
rough-legged hawk	0.58	0.33	0.13	0	2.6	0.2	3.8	0	25.0	29.2	12.5	0
Swainson's hawk	0	0	0.13	0.21	0	0	3.8	9.8	0	0	8.3	20.8
Northern Harrier	*0.83*	*0.38*	*0.08*	*0.04*	*3.7*	*0.2*	*2.5*	*2.0*	*62.5*	*37.5*	*8.3*	*4.2*
northern harrier	0.83	0.38	0.08	0.04	3.7	0.2	2.5	2.0	62.5	37.5	8.3	4.2
Eagles	*0.04*	*0.08*	*0.08*	*0*	*0.2*	*0.1*	*2.5*	*0*	*4.2*	*8.3*	*4.2*	*0*
golden eagle	0.04	0	0	0	0.2	0	0	0	4.2	0	0	0
bald eagle	0	0.08	0.08	0	0	0.1	2.5	0	0	8.3	4.2	0
Falcons	*0.33*	*0.50*	*0.13*	*0.13*	*1.5*	*0.3*	*3.8*	*5.9*	*25.0*	*37.5*	*12.5*	*12.5*
prairie falcon	0.08	0.04	0	0	0.4	<0.1	0	0	8.3	4.2	0	0
American kestrel	0.25	0.46	0.13	0.13	1.1	0.3	3.8	5.9	20.8	37.5	12.5	12.5
Osprey	*0.04*	*0*	*0*	*0*	*0.2*	*0*	*0*	*0*	*4.2*	*0*	*0*	*0*
osprey	0.04	0	0	0	0.2	0	0	0	4.2	0	0	0
Vultures	**0.13**	**0**	**0**	**0**	**0.6**	**0**	**0**	**0**	**4.2**	**0**	**0**	**0**
turkey vulture	0.13	0	0	0	0.6	0	0	0	4.2	0	0	0
Upland Game Birds	**0**	**0.04**	**0**	**0**	**0**	**<0.1**	**0**	**0**	**0**	**4.2**	**0**	**0**
California quail	0	0.04	0	0	0	<0.1	0	0	0	4.2	0	0
Doves/Pigeons	**0**	**0**	**0.08**	**0.17**	**0**	**0**	**2.5**	**7.8**	**0**	**0**	**4.2**	**4.2**
rock pigeon	0	0	0.08	0.17	0	0	2.5	7.8	0	0	4.2	4.2
Large Corvids	**2.88**	**0.75**	**1.38**	**0.92**	**12.8**	**0.5**	**41.3**	**43.1**	**62.5**	**54.2**	**66.7**	**29.2**

Appendix B. Mean large birds use (number of large birds/plot[a]/60 minute survey), percent of total use (%), and frequency of occurrence (%) for each large bird type and species by season during avian bird use surveys at the Horse Heaven Wind Farm (East) in Benton County, Washington from October 23, 2019 to September 20, 2020.

	Mean Use				% of Use				% Frequency			
Type/Species	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**
common raven	2.79	0.71	1.38	0.83	12.5	0.5	41.3	39.2	58.3	50.0	66.7	25.0
black-billed magpie	0.08	0.04	0	0.08	0.4	<0.1	0	3.9	8.3	4.2	0	4.2
Overall	**22.38**	**152.63**	**3.33**	**2.13**	**100**	**100**	**100**	**100**				

[a] 800-meter (2,625 foot) radius plot for large birds

Sums of values may not equal totals shown due to rounding.

Appendix C. **Relative exposure index and flight characteristics for bird species during avian bird use surveys at the Horse Heaven Wind Farm (East) in Benton County, Washington from October 23, 2019 to September 20, 2020.**

Appendix C. Relative exposure index and flight characteristics for bird species[a] during avian bird use surveys at the Horse Heaven Wind Farm (East) in Benton County, Washington from October 23, 2019 to September 20, 2020.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within RSH based on initial obs	Exposure Index	% Within RSH at anytime
snow goose	11	39.56	91.3	92.1	33.28	92.4
Canada goose	5	2.26	100	83.6	1.89	100
common raven	70	1.51	92.7	80.3	1.13	94.5
American white pelican	8	0.39	100	82.1	0.32	87.2
red-tailed hawk	30	0.49	66.7	80.0	0.26	90.0
rough-legged hawk	22	0.28	88.0	100	0.25	100
northern harrier	32	0.37	100	40.6	0.15	65.6
American kestrel	13	0.24	56.5	84.6	0.12	100
rock pigeon	2	0.06	100	100	0.06	100
Swainson's hawk	4	0.07	50.0	100	0.04	100
turkey vulture	3	0.04	100	100	0.04	100
black-billed magpie	3	0.05	80.0	75.0	0.03	100
prairie falcon	2	0.03	66.7	100	0.02	100
Cooper's hawk	2	0.02	100	100	0.02	100
bald eagle	4	0.04	100	50.0	0.02	100
osprey	1	0.01	100	100	0.01	100
golden eagle	1	0.01	100	100	0.01	100
unidentified accipiter	1	0.01	100	100	0.01	100

[a] Only includes species with actual exposure index values; California quail was not observed flying.

[b] The assumed "rotor-swept height" for potential collision with a turbine blade, or 10 to 155 m (33 to 509 ft) above ground level.

[c] 800 meter (2,625 foot) radius plot for large birds.

[d] obs = observations

Appendix D. Mean Use by Point for All Birds, Bird Types, and Diurnal Raptor Subtypes during Avian Use Surveys at the Horse Heaven Wind Farm (East) from October 23, 2019 to September 20, 2020.

Appendix D. Mean use (number of birds/60 minute survey) by point for all large bird[a] types observed during avian bird use surveys at the Horse Heaven Wind Farm (East) in Benton County, Washington from October 23, 2019 to September 20, 2020.

	Survey Point							
Bird Type	**2**	**3**	**4**	**8**	**9**	**13**	**23**	**24**
Waterbirds	**0**	**0**	**0**	**0.83**	**0.33**	**0.58**	**0.17**	**1.33**
Waterfowl	**0**	**0**	**6.25**	**0**	**8.75**	**316.08**	**0**	**1.83**
Diurnal Raptors	**0.58**	**2.17**	**1.33**	**2.33**	**0.58**	**1.25**	**2.08**	**1.75**
Accipiters	*0*	*0*	*0*	*0*	*0*	*0.08*	*0*	*0.17*
Buteos	*0.33*	*1.42*	*0.83*	*1.17*	*0.33*	*0.50*	*1.00*	*0.92*
Northern Harrier	*0.25*	*0.42*	*0.33*	*0.67*	*0.17*	*0.25*	*0.50*	*0.08*
Eagles	*0*	*0.08*	*0*	*0*	*0*	*0.08*	*0*	*0.25*
Falcons	*0*	*0.25*	*0.17*	*0.50*	*0.08*	*0.33*	*0.50*	*0.33*
Osprey	*0*	*0*	*0*	*0*	*0*	*0*	*0.08*	*0*
Vultures	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.25**
Upland Game Birds	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.08**
Doves/Pigeons	**0**	**0**	**0**	**0.33**	**0.17**	**0**	**0**	**0**
Large Corvids	**1.00**	**1.75**	**1.08**	**1.67**	**1.50**	**1.42**	**2.50**	**0.92**
All Large Birds	**1.58**	**3.92**	**8.67**	**5.17**	**11.33**	**319.33**	**4.75**	**6.17**

[a] 800 meter (2,625 foot) radius plot for large birds.

Sums of values may not equal totals shown due to rounding.

Botany and Habitat Survey Report for Horse Heaven Wind Farm

Benton County, Washington

Prepared for

Horse Heaven Wind Farm, LLC

Prepared by

TETRA TECH

19803 North Creek Parkway

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January 2021

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ACRONYMS AND ABBREVIATIONS

GPS	Global Positioning System
NLCD	National Land Cover Database
Project	Horse Heaven Wind Farm Project
Tetra Tech	Tetra Tech, Inc.
Turbine	wind generator turbine
USFWS	U.S. Fish and Wildlife Service
WNHP	Washington Natural Heritage Program

1 INTRODUCTION

This report presents the methods and results for botanical and habitat surveys conducted by Tetra Tech, Inc. (Tetra Tech) for the Horse Heaven Wind Farm (Project). The Project is located within Benton County, approximately 2.5 miles south of Benton City and 6 miles south of Kennewick, Washington (Figure 1). The purpose of the botanical and habitat surveys was to document the presence of special status vascular plant and noxious weed species and verify, map, and characterize habitat at 44 proposed wind turbine generator (Turbine) locations preliminarily identified as occurring within native habitat, in support of permitting for the Project.

2 METHODS

2.1 Survey Area

Tetra Tech conducted botanical and habitat surveys at 44 proposed Turbine locations (based on the Project Turbine layout dated April 15, 2020) sited in areas mapped as native habitat (i.e., shrub-steppe, eastside [interior] grassland, herbaceous, shrub/scrub and/or grassland) based on National Land Cover Database (NLCD) data and information collected during previous reconnaissance-level surveys (Chatfield and Brown 2018a, 2018b; Chatfield and Thompson 2018a, 2018b; Jansen and Brown 2018). The survey area included a minimum 200 foot buffer around these Turbine locations as well as areas that were traversed on foot or vehicle between the 44 Turbine locations (Figure 2). The survey area generally coincided with the portions of the Micrositing Corridor[1] around and in between these 44 Turbine locations, but habitat was also mapped beyond the Micrositing Corridor where the surveyor was able to visually scan the surrounding area and determine the habitat type with the assistance of aerial imagery.

2.2 Background Review

2.2.1 Special Status Plant Species

Prior to conducting field surveys, Tetra Tech conducted a pre-field review of existing information on special status plant species with the potential to occur within the survey area. For purposes of this report, the term "special status plant" includes federally or state-listed endangered, threatened, or candidate vascular plant species and state-listed sensitive vascular plant species as defined by the Washington Natural Heritage Program (WNHP). Specific sources of information that were reviewed prior to conducting field surveys include the following:

- U.S. Fish and Wildlife Service (USFWS) species lists for Benton County (USFWS 2020a);
- List of Known Occurrences of Rare Plants in Washington by County (WNHP 2019a);
- Washington Vascular Plant Species of Special Concern (WNHP 2019b); and
- Field Guide to the Rare Plants of Washington (WNHP 2020a)

Based on review of the above sources, Tetra Tech compiled a list of special status plant species known to occur or with the potential to occur in the survey area (Attachment A). No federally listed plant species

[1] The Project's Micrositing Corridor (dated July 15, 2020) consists of the area in which facilities would be sited during the final design. The Micrositing Corridor is larger than the Project's final footprint to allow minor rerouting to optimize the design and to avoid resources that may be discovered during the final design and pre-construction process.

are suspected or known to occur within the survey area; therefore, the target species list was limited to species listed as threatened, endangered, or sensitive in Washington by the WNHP.

In addition to the sources listed above, the WNHP database of known occurrences of special status plant species was reviewed to determine plant element occurrence records located within 5 miles of the Project Lease Boundary (WNHP 2019c). Two state threatened plant species, woven-spore lichen (*Texosporium sancti-jacobi*) and grey cryptantha (*Cryptantha leucophaea*), have been documented within 5 miles of the Project Lease Boundary. Woven spore-lichen has been documented at four separate locations within approximately 3 miles of the Project Lease Boundary, with the closest occurrence approximately 0.4 mile to the north. One occurrence of grey cryptantha has been documented approximately 5 miles from the eastern border of the Project Lease Boundary; however, this occurrence is across the Columbia River from the Project Lease Boundary.

Each of the 30 species identified as potentially occurring within the survey area was assigned a "likelihood of occurrence" (i.e., unlikely, low, moderate, high) based on the proximity of known occurrences and the likelihood of suitable habitat occurring within the survey area. Tetra Tech also reviewed aerial imagery of the survey area to identify potential habitat for special status plant species within the survey area.

Prior to conducting field surveys, Tetra Tech reviewed existing literature, herbarium records, and other sources to generate fact sheets or "field guides" for each special status plant species with the potential to occur within the survey area. These fact sheets were used by surveyors in the field and included:

- Photographs of each species and its habitat;
- Information detailing habitat associations;
- Range and flowering period;
- Identifying features; and
- Characteristics distinguishing the target species from similar species within its range.

2.2.2 Noxious Weeds

Prior to field surveys, Tetra Tech reviewed lists of species designated as noxious weeds in Washington State and Benton County (BCNWCB 2020; WSNWCB 2020). Additionally, existing literature and other sources were reviewed to familiarize surveyors with identification of designated noxious weeds that would potentially be encountered within the survey area.

2.2.3 Habitat

Prior to conducting field surveys, Tetra Tech conducted a desktop review to identify habitat types mapped within the survey area. Sources reviewed included the following:

- NLCD data (Homer et al. 2020);
- Site Characterization Study Report, Badger Canyon Wind Project (Chatfield and Thompson 2018a);
- Site Characterization Study Report, Four Mile Wind Project (Chatfield and Thompson 2018b);
- Results of the 2018 vegetation and land cover mapping for the Badger Canyon Wind Project (Chatfield and Brown 2018a);

- Results of the 2018 vegetation and land cover mapping for the Four Mile Wind Project (Chatfield and Brown 2018b);
- Wildlife Survey Report for the Horse Heaven Wind Project (Jansen and Brown 2018);
- Washington Department of Fish and Wildlife priority species and habitat database (WDFW 2020);
- WNHP element occurrence of rare and imperiled species and plant communities (WDNR 2018);
- USFWS National Wetland Inventory database (USFWS 2020b); and
- U.S. Geological Survey National Hydrography Database (USGS 2020).

2.3 Field Surveys

Field surveys were conducted June 1-5, 2020. The survey dates were chosen as they coincide with the identification period for the majority of special status plant species with the potential to occur within the survey area.

2.3.1 Special Status Plant Survey Methods

Special status plant field surveys were conducted using the Intuitive Controlled survey method, a standard and commonly accepted survey protocol (USFS and BLM 1998). This method incorporates meandering transects that traverse the survey area, and that target the full array of major vegetation types, aspects, topographical features, habitats, and substrate types. While en route, the surveyors searched for special status plant species, and when the surveyors arrive at an area of high potential habitat, they conducted a complete survey for the special status species. Complete surveys include an examination of 100 percent of the habitat.

Standard Tetra Tech survey methods would include recording the Global Positioning System (GPS) location of any special status plant species encountered with a tablet using ArcGIS Collector software. Additionally, for any special status plant species observations, methods would include completing a WNHP siting form for each population and taking photos to serve as digital specimen vouchers to illustrate identifying characteristics, plant habits, and habitat. Data collected for each special status plant population would include the following:

- Species phenology;
- Number of plants observed;
- Age class;
- Habitat information and associated species; and
- Visible threats.

During surveys, Tetra Tech maintained a running list of vascular plant species encountered within the survey area and made informal collections of unknown species for later identification. In addition to noting plants observed within each of the 44 surveyed Turbine locations, vascular plant species encountered while the surveyor traversed on foot between the turbine locations were also documented. Identification was verified by the use of appropriate plant keys, in particular, *Flora of the Pacific Northwest* (Hitchcock and Cronquist 2018). The final vascular plant species list for the survey area is included as Attachment B in this report.

2.3.2 Noxious Weeds

Noxious weed surveys were conducted concurrently with special status plant and habitat surveys. Tetra Tech recorded observations of state- and county-designated noxious weeds. When a noxious weed was encountered in the survey area, the location was recorded with a GPS point and the species, estimated size of the infestation, and relative abundance was recorded. In addition to documenting noxious weeds at each of the 44 surveyed Turbine locations, noxious weeds were also documented while the surveyor travelled between survey locations.

2.3.3 Habitat

Tetra Tech conducted habitat verification, mapping, and characterization surveys concurrently with special status and noxious weed surveys. Habitats were characterized by recording the dominant plant species and general condition of the habitat. In addition to characterizing and mapping habitat within the 44 surveyed Turbine locations, the surveyor also characterized and mapped habitats encountered while traversing or travelling between Turbine locations on foot or vehicle, and mapped habitat out beyond these areas where the habitat type could be determined from a distance in conjunction with aerial imagery. In general, habitat types were adapted from habitat descriptions in the *Washington Department of Fish and Wildlife Wind Power Guidelines* (WDFW 2009) and *Wildlife-habitat Relationships in Oregon and Washington* (Johnson and O'Neil 2001). However, two of the habitat types observed during field surveys (i.e., rabbitbrush shrubland and non-native grassland) were not readily classified following either of those sources. Descriptions of these habitat types, as well as all habitat types observed during field surveys are provided in Section 3.3.

3 RESULTS

3.1 Special Status Plants

No special status plant species were observed within the survey area (i.e., within each of the 44 surveyed Turbine locations or in areas traversed between Turbine locations). In addition, very little suitable habitat for special status plant species was observed.

3.2 Noxious Weeds

Tetra Tech recorded six state- and county-designated noxious weed species during field surveys. In addition, the location, estimated extent, and estimated abundance of noxious weeds observed was documented. Table 1 lists the noxious weed species observed, their noxious weed designation, and the frequency of observations. Figure 3 shows the locations of noxious weeds observed during field surveys.

Table 1. Noxious Weeds Observed During Botanical Field Surveys

Scientific Name	Common Name	State and County Status[1]	Frequency
Bassia (Kochia) scoparia	kochia	B	Observed in several locations scattered throughout survey area.
Centaurea sp.[2]	knapweed	B	Frequently observed in central portion of survey area.
Centaurea solstitialis	yellow starthistle	B	Observed in two locations in central portion of survey area.
Chondrilla juncea	rush skeletonweed	B	Abundant. Frequently observed throughout survey area.
Onopordum acanthium	Scotch thistle	B	Observed in two locations in south-central portion of survey area.
Secale cereale	Cereal rye	C	Abundant. Frequently observed throughout survey area.

Notes:
[1] **"Class B" weeds:** Non-native species presently limited to portions of the state. Species are designated for required control in regions where they are not yet widespread. Preventing new infestations in these areas is a high priority. In regions where a Class B species is already abundant, control is decided at the local level, with containment as the primary goal. **"Class C" weeds:** Noxious weeds that are typically widespread in the state or are of special interest to the state's agricultural industry. The Class C status allows county weed boards to require control if locally desired, or they may choose to provide education or technical consultation (WSNWCB 2020).
[2] Individuals observed were not flowering at the time of surveys; therefore, positive identification was not possible. Based on observations of rosettes and leaves, individuals and populations are believed to be either diffuse knapweed or spotted knapweed which are both designated "Class B" weeds.

Three noxious weed species were abundant throughout the survey area: knapweed (*Centaurea* sp.), rush skeletonweed (*Chondrilla juncea*), and cereal rye (*Secale cereale*). Knapweed was primarily observed in the central portion of the survey area. Patches ranged from small (<0.1 acre) to large (1-5 acres) patches that consisted of sparse, scattered individuals to areas with a high cover of knapweed. The knapweed individuals were not flowering at the time of the field surveys; however, based on the rosettes and leaf characteristics, it is assumed that individuals observed where either diffuse knapweed (*Centaurea diffusa*) or spotted knapweed (*Centaurea stoebe*). Tetra Tech documented rush skeletonweed throughout all but the northwest corner of the survey area. Although most patches of rush skeletonweed were either small (<0.1 acre) or medium (0.1-1 acre) in size, several larger infestations (1-5 acres) were observed scattered throughout the central portion of the survey area. Typically, observations of rush skeletonweed consisted of small patches or individuals scattered throughout the area, instead of occurring in dense populations. Large (greater than 1 acre), dense patches of cereal rye were frequently observed throughout the survey area. This noxious weed was often observed on hillslopes or adjacent to drainages, and cereal rye formed almost a complete monoculture in many of the locations where it was observed.

Kochia (*Bassia* [*Kochia*] *scoparia*) was primarily observed alongside Nicoson Road in the center of the survey area, where it was commonly observed in sparse to dense patches. Kochia was also observed along roadsides in the western and eastern portions of the survey area. Yellow starthistle (*Centaurea solstitialis*) and Scotch thistle (*Onopordum acanthium*) were each observed in only two locations in the survey area. All observations of yellow starthistle and Scotch thistle were located in the south-central portion of the survey area (Figure 3). One observation of yellow starthistle was a small (<0.1 acre) patch consisting of just a few individuals, while the other observation was larger (0.1-1 acre) and relatively dense (high cover). Both observations of Scotch thistle were small (<0.1 acre) patches. One of these observations consisted of just a few individuals, while the other observations consisted of a dense patch of Scotch thistle.

Cereal rye is a Class C noxious weed, indicating that it is either widespread in the state or is of interest to the state's agricultural industry. The other five noxious weed species observed are "Class B" noxious weeds, meaning that they are designated for required control in regions where they are not yet widespread and preventing new infestations in these areas is a high priority. In regions where these species are already abundant, control is decided at the local level, with containment as the primary goal (WSNWCB 2020).

3.3 Habitat

In general, vegetation within the majority of the survey area has been heavily modified due to historic and current agriculture and grazing activity. Non-native invasive grasses and forbs are prevalent throughout the survey area due to historic and current farming and grazing activity.

The following seven habitat types were field verified and/or mapped within the survey area:

- Agricultural land
- Developed/disturbed
- Dwarf shrub-steppe
- Non-native grassland
- Planted grassland
- Rabbitbrush shrubland
- Sagebrush shrub-steppe

Each of these habitat types is discussed briefly below. Locations of habitat types field-verified and/or mapped during field surveys are presented in Figure 4. Representative photos of habitat types observed during field surveys are provided in Attachment C.

3.3.1 Agricultural Land

Areas mapped as agricultural land within the survey area consisted of active wheat fields and fallow wheat fields (i.e., fields in active rotation but not planted during the current season). Areas mapped as agricultural land primarily include areas that during the background review had been mapped as native habitat (e.g., eastside [interior] grassland, sagebrush shrub-steppe), but which during field surveys were determined to be cultivated agricultural land, primarily active or fallow wheat fields.

3.3.2 Developed/Disturbed

Two areas, both in the northeastern portion of the survey area, were field-verified as developed/disturbed. One of these areas is associated with a gravel pit and the other includes buildings and structures associated with ranching and farming activities.

3.3.3 Dwarf Shrub-steppe

One small area of dwarf shrub-steppe was mapped within the survey area (Figure 4a). This area is located on a ridgetop in the northwest corner of the Project boundary and occurs on lithosol soils. Lithosols are shallow soils with poorly defined layers that consist mainly of partially weathered rock fragments (Azerrad et al. 2011). Dominant species observed within this habitat type include the native sub-shrub/dwarf shrub rock buckwheat (*Eriogonum sphaerocephalum*), the native perennial grasses bluebunch wheatgrass (*Pseudoroegneria spicata*) and Sandberg bluebrass (*Poa secunda*), and the non-native annual grasses cheatgrass (*Bromus tectorum*) and cereal rye (*Secale cereale*). Forbs and sub-shrubs commonly observed in this habitat type include common yarrow (*Achillea millefolium*), rosy balsamroot (*Balsamorhiza rosea*), hoary aster (*Dieteria canescens*), Douglas' dustymaidens (*Chaenactis douglasii*), cushion fleabane (*Erigeron poliospermus*), narrowleaf goldenweed (*Nestotus stenophyllus*), tall tumblemustard (*Sisymbrium altissimum*), and yellow salsify (*Tragopogon dubius*). Scattered shrubs, including rubber rabbitbrush (*Ericameria nauseosa*), green rabbitbrush (*Chrysothamnus viscidiflorus*) and big sagebrush (*Artemisia tridentata*), were also observed in areas mapped as the dwarf shrub-steppe habitat type; however, cover of these shrub species did not exceed 5 percent cover. This habitat type matches the description of the rock buckwheat/Sandberg bluegrass dwarf-shrub herbaceous vegetation type, which is listed by the WNHP as a rare and/or high-quality plant community (WNHP 2020b). Representative photos of this habitat type are presented in Attachment C, Photo 2.

3.3.4 Non-native Grassland

Non-native grassland habitat was commonly observed in the survey area. This habitat type was often observed on hillslopes and adjacent draws; however, it was also found adjacent to agricultural fields or in other flat areas where formerly planted and/or native grassland is now dominated by non-native grass and forb species. Dominant species observed in this habitat type include cereal rye, cheatgrass, prickly lettuce (*Lactuca serriola*), tall tumblemustard, and yellow salsify. Although native forbs including common yarrow, hoary-aster, and slender hareleaf (*Lagophylla ramosissima*) were occasionally observed in this habitat type, they typically represented only a small percent cover of the overall vegetative cover. Several areas mapped as non-native grassland habitat consisted of vast areas dominated by dense cover of cereal rye (Attachment C, Photos 3 and 6). As noted in Section 3.2, cereal rye is listed as a Class C noxious weed in Washington State and Benton County.

3.3.5 Planted Grassland

The planted grassland habitat type was the most prevalent habitat type mapped within the survey area. This habitat type consists of former agricultural lands that have been planted with non-native grasses, native grasses, and/or native shrubs. These areas may have been or may currently be enrolled in the Conservation Reserve Program (CRP) but their current legal status is unknown.

Areas mapped as planted grassland include areas planted with the non-native perennial grass crested wheatgrass (*Agropyron cristatum*), as well as areas planted primarily with the native perennial grasses bluebunch wheatgrass and big bluegrass (*Poa ampla;* a cultivar of *P. secunda*). Rabbitbrush, primarily rubber rabbitbrush, was also commonly observed in this habitat type. Areas mapped as planted grassland typically contained less than approximately five percent cover of rabbitbrush. However, small (less than 1 acre) dense patches of rabbitbrush occur in this habitat type. Areas where high cover of rabbitbrush was observed were mapped as the rabbitbrush shrubland habitat type (see Section 3.3.5).

The quality of planted grassland habitat type within the survey area varied, with some areas of planted grassland habitat containing a higher predominance of native species such as bluebunch wheatgrass, big bluegrass, common yarrow, and large-flowered agoseris (*Agoseris grandiflora*) and lower cover of non-native invasive species. Other areas of planted grassland habitat contain a high predominance of non-native species including the planted perennial grass crested wheatgrass, as well as higher cover of non-native invasive species such as cheatgrass, cereal rye, prickly lettuce, and yellow salsify. In general, planted grassland habitat contained a low diversity of forb species.

3.3.6 Rabbitbrush Shrubland

Rabbitbrush shrubland habitat was the second most common habitat type mapped within the survey area. Similar to the planted grassland habitat type, this habitat type was often observed in former agricultural lands that have been planted with native grasses, native shrubs, and/or non-native grasses. These areas may have been or may currently be enrolled in CRP, but their current status is unknown. Shrub cover in the rabbitbrush shrubland habitat type ranged between approximately 10 to 80 percent cover, but was typically greater than 50 percent. Rubber rabbitbrush was the dominant shrub species observed, although green rabbitbrush was occasionally observed in this habitat type as well. It is unknown whether rubber and green rabbitbrush were planted in these areas or have established naturally.

Other common species observed in rabbitbrush shrubland habitat include the native grasses big bluegrass and the non-native grasses crested wheatgrass, cheatgrass, and cereal rye. Common forbs observed included the native common yarrow and hoary-aster and the non-native prickly lettuce, tall tumblemustard, and yellow salsify.

3.3.7 Sagebrush Shrub-steppe

Sagebrush shrub-steppe habitat was primarily mapped in the north-central and northeastern portions of the survey area. In addition, a small patch of remnant sagebrush shrub-steppe habitat was mapped in the northwestern portion of the survey area (Figure 4).

Shrub cover in sagebrush shrub-steppe habitat type ranged between approximately 10 to 75 percent cover, but was typically less than 50 percent and included areas of grassland habitat in between patches of shrubs. The dominant shrub species in this habitat type was big sagebrush. Other shrub species commonly observed include spineless horsebrush (*Tetradymia canescens*), rubber rabbitbrush, and green rabbitbrush. Cover and diversity of grasses and forbs was variable within this habitat type; however, cover of the non-native cheatgrass was typically high. Other grasses and forbs observed in sagebrush shrub-steppe habitat include the native grasses and forbs: bluebunch wheatgrass, Sandberg bluegrass, Carey's balsamroot (*Balsamorhiza careyana*), common yarrow, long-leaf phlox (*Phlox longifolia*), low pussytoes (*Antennaria dimorpha*), shaggy fleabane (*Erigeron pumilus*), woolly plantain (*Plantago patagonica*), woollypod milkvetch (*Astragalus purshii*), and the non-native forbs: redstem stork's bill (*Erodium cicutarium*), prickly lettuce, and yellow salsify.

4 CONCLUSIONS

Botanical surveys conducted in 2020 did not document any special status plant species within the survey area. Six noxious weed species were documented during field surveys conducted within 44 proposed Turbine locations, several of which were abundant within the survey area. Seven habitat types were mapped and characterized within the survey area. The most abundant habitat type observed in the survey area (corresponding to the 44 proposed Turbine locations) was planted grassland, followed by rabbitbrush shrubland. However, as noted in Sections 1 and 2, surveys were only conducted within 44 proposed Turbine locations preliminarily mapped as occurring in native habitat; therefore, these results only reflect observations within the areas surveyed and are not indicative of the overall Project Lease Boundary. Habitat within the majority of the Project Lease Boundary consists of agricultural lands.

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FIGURES

Horse Heaven Wind Farm

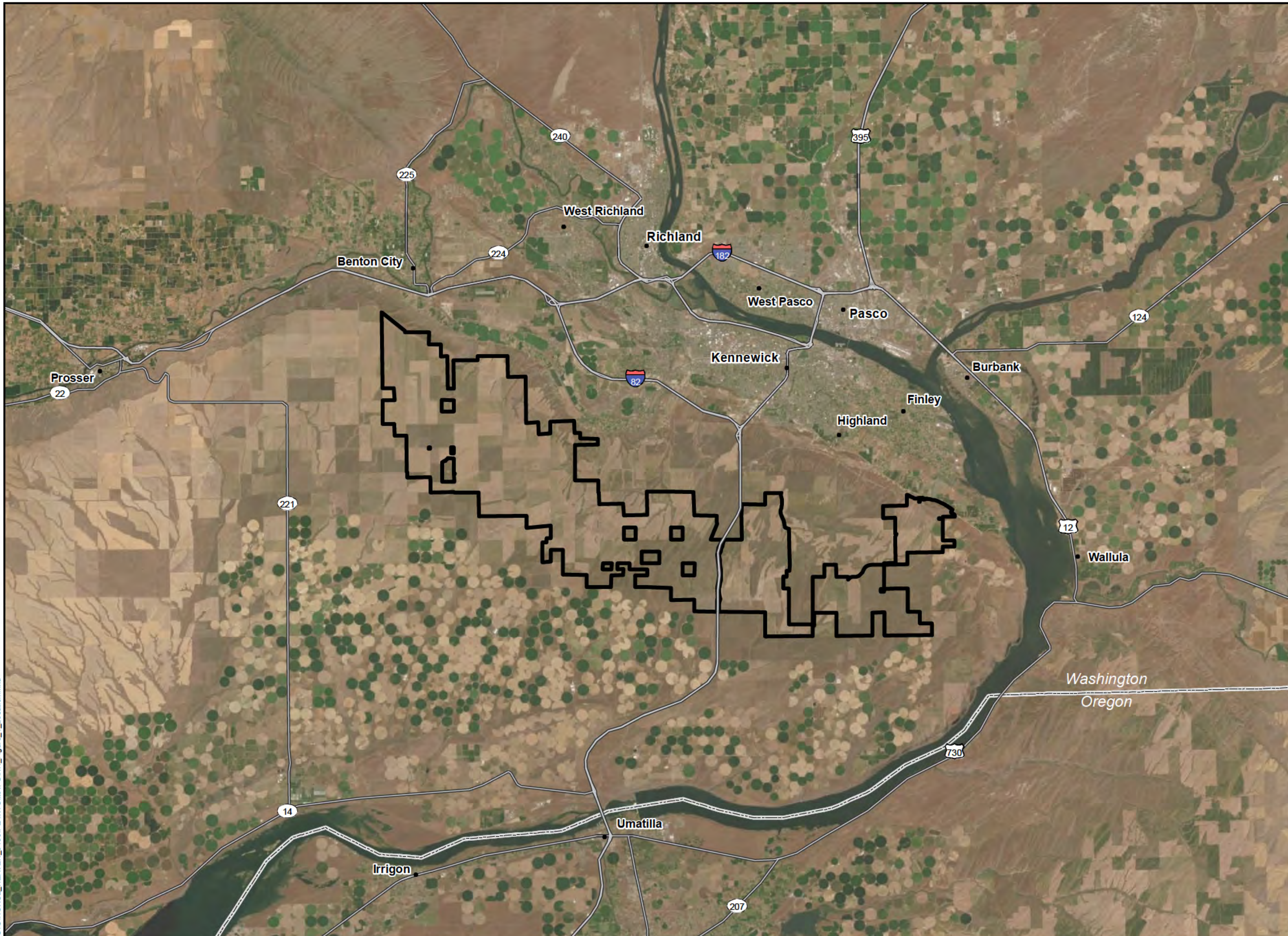
SCOUT CLEAN ENERGY

Figure 1
Project Location

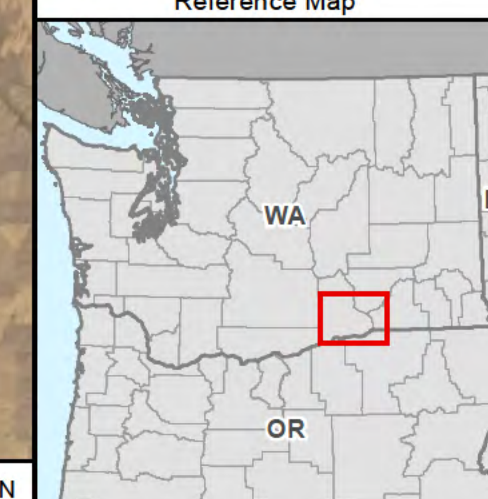
BENTON COUNTY, WA

Project Boundary (4/17/20)

TETRA TECH



Reference Map



1:250,000 NAD 1983 StatePlane Washington South FIPS 4602 Feet

0 2.5 5 10 Miles

NOT FOR CONSTRUCTION

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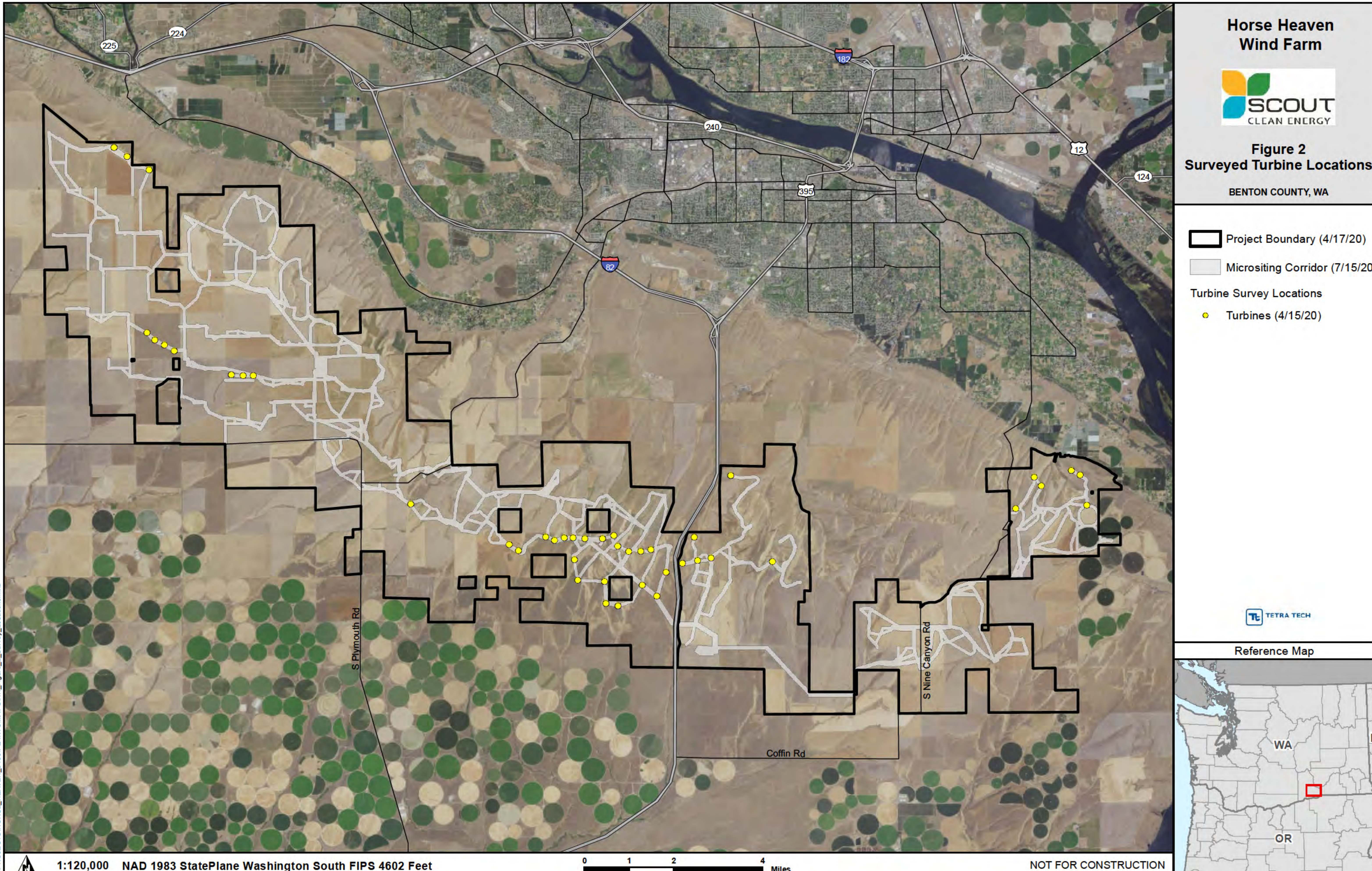
Horse Heaven Wind Farm

SCOUT CLEAN ENERGY

Figure 2
Surveyed Turbine Locations

BENTON COUNTY, WA



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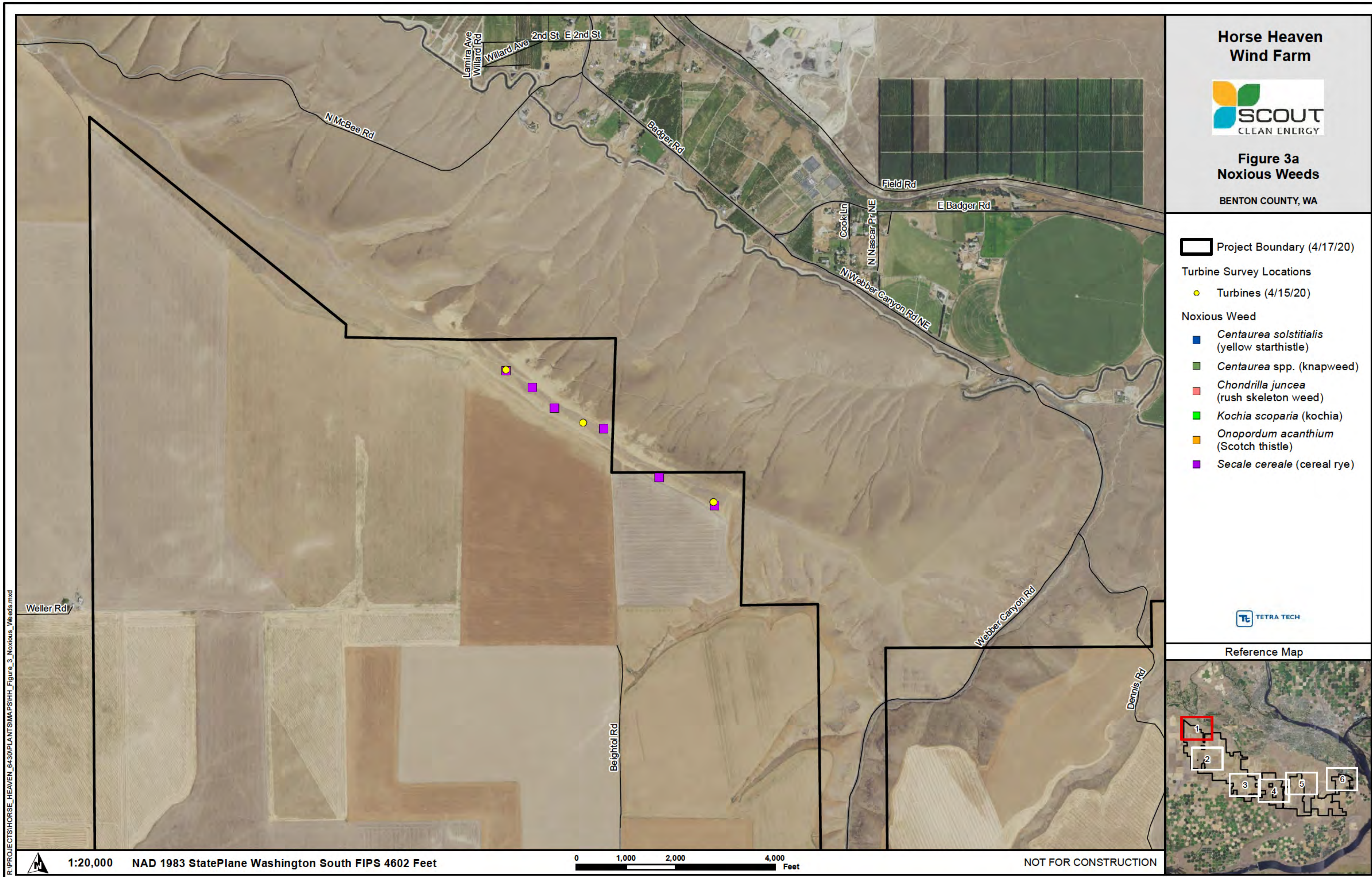

Horse Heaven Wind Farm
SCOUT CLEAN ENERGY
Figure 3a
Noxious Weeds
BENTON COUNTY, WA
Project Boundary (4/17/20)
Turbine Survey Locations
Turbines (4/15/20)
Noxious Weed
Centaurea solstitialis (yellow starthistle)
Centaurea spp. (knapweed)
Chondrilla juncea (rush skeleton weed)
Kochia scoparia (kochia)
Onopordum acanthium (Scotch thistle)
Secale cereale (cereal rye)
TETRA TECH
Reference Map
N McBee Rd
Badger Rd
Field Rd
E Badger Rd
Cook Ln
N Nascar Pr NE
N Webber Canyon Rd NE
Webber Canyon Rd
Dennis Rd
Beightol Rd
Weller Rd
Lamira Ave
Willard Rd
Willard Ave
2nd St
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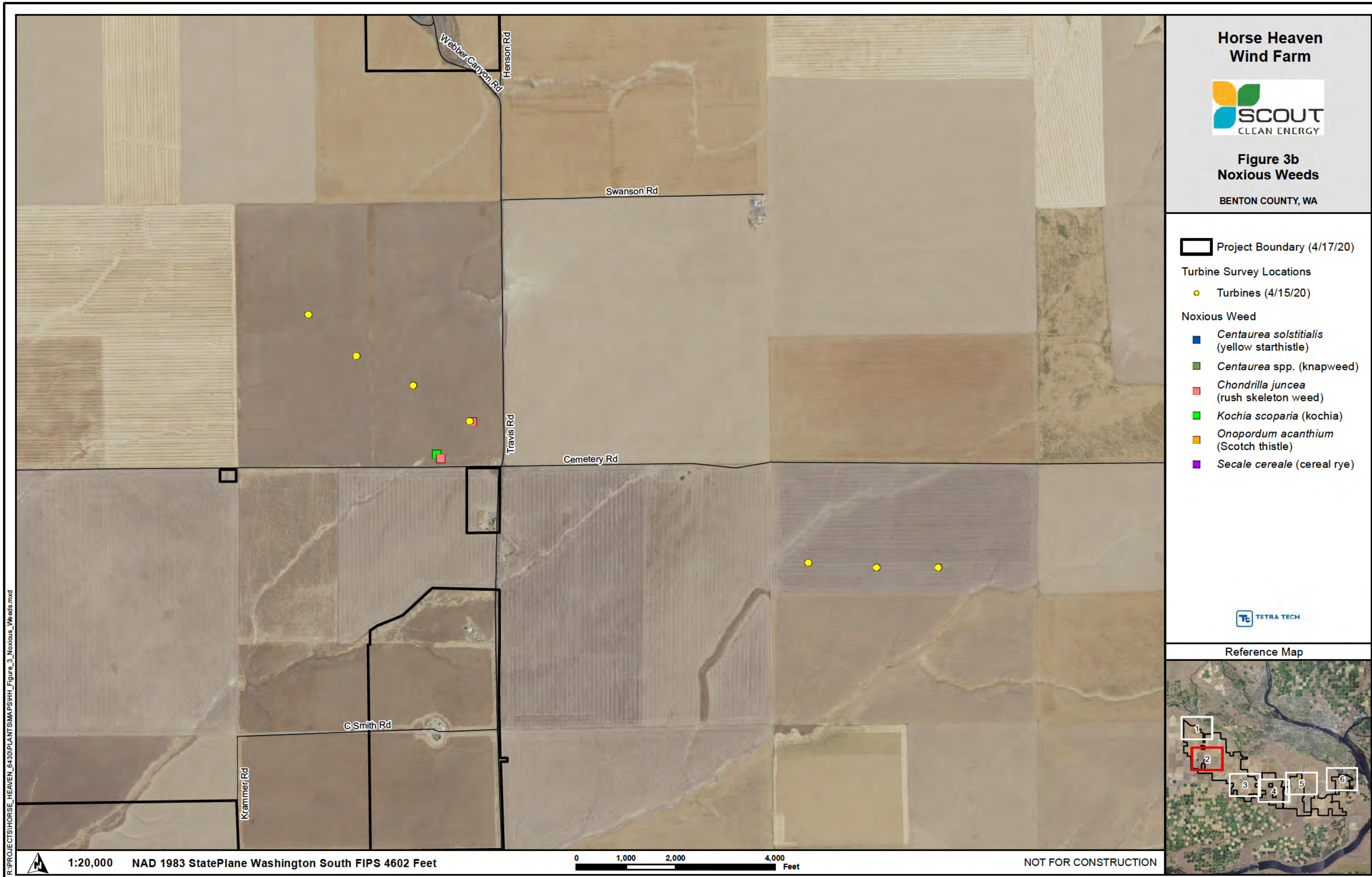
Webber Canyon Rd
Henson Rd
Swanson Rd
Travis Rd
Cemetery Rd
C Smith Rd
Krammer Rd
Horse Heaven Wind Farm
SCOUT CLEAN ENERGY
Figure 3b
Noxious Weeds
BENTON COUNTY, WA
Project Boundary (4/17/20)
Turbine Survey Locations
Turbines (4/15/20)
Noxious Weed
Centaurea solstitialis (yellow starthistle)
Centaurea spp. (knapweed)
Chondrilla juncea (rush skeleton weed)
Kochia scoparia (kochia)
Onopordum acanthium (Scotch thistle)
Secale cereale (cereal rye)
TETRA TECH
Reference Map
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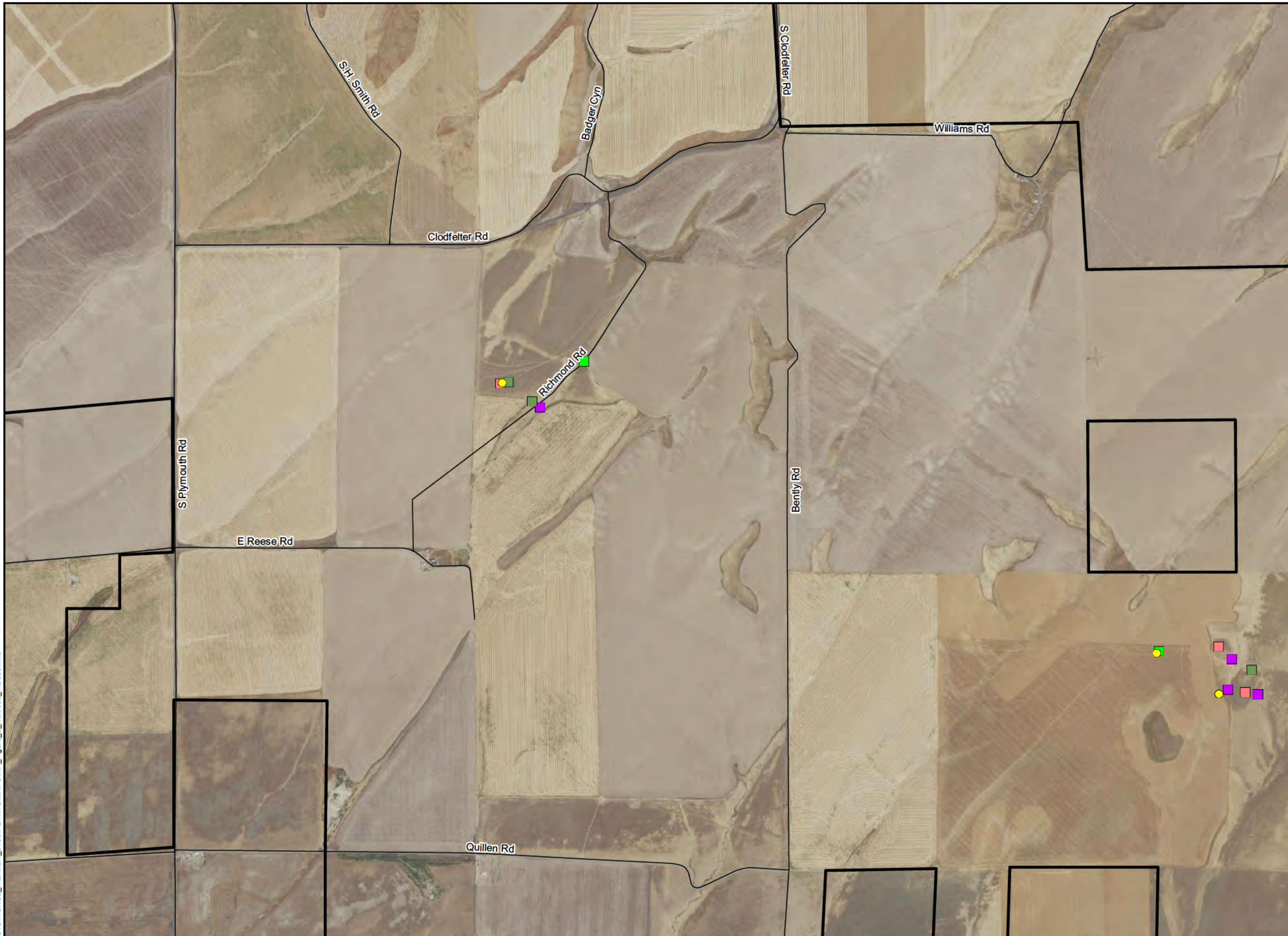
Horse Heaven Wind Farm

SCOUT CLEAN ENERGY

Figure 3c
Noxious Weeds

BENTON COUNTY, WA



Project Boundary (4/17/20)

Turbine Survey Locations

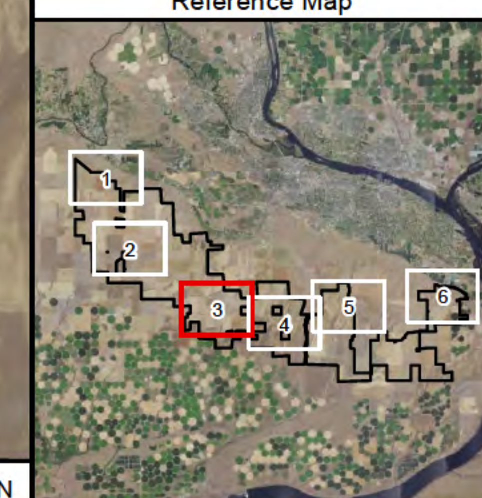
- Turbines (4/15/20)

Noxious Weed

- *Centaurea solstitialis* (yellow starthistle)
- *Centaurea* spp. (knapweed)
- *Chondrilla juncea* (rush skeleton weed)
- *Kochia scoparia* (kochia)
- *Onopordum acanthium* (Scotch thistle)
- *Secale cereale* (cereal rye)

TETRA TECH

Reference Map



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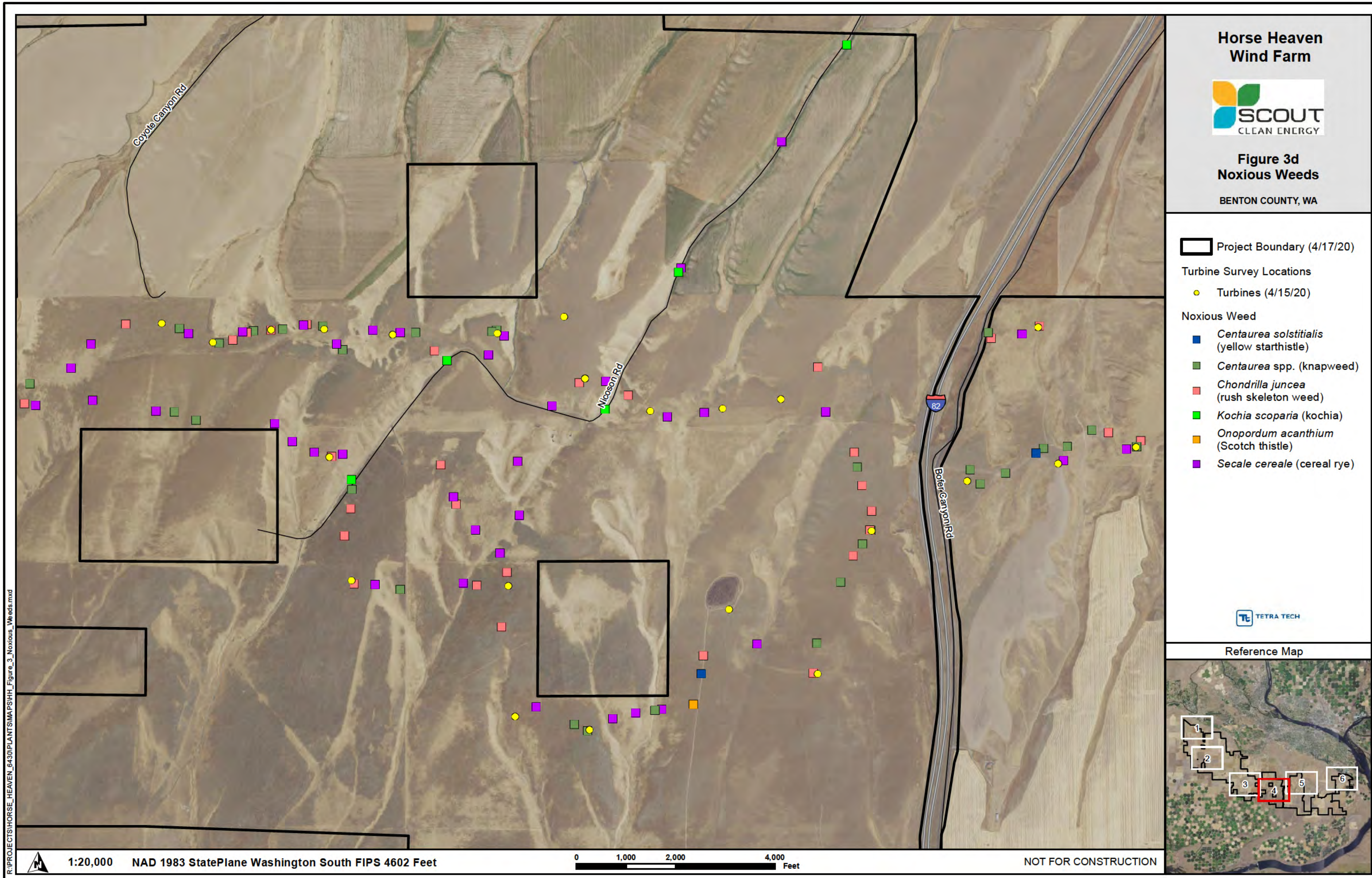

Horse Heaven Wind Farm
SCOUT CLEAN ENERGY
Figure 3d
Noxious Weeds
BENTON COUNTY, WA
Project Boundary (4/17/20)
Turbine Survey Locations
Turbines (4/15/20)
Noxious Weed
Centaurea solstitialis (yellow starthistle)
Centaurea spp. (knapweed)
Chondrilla juncea (rush skeleton weed)
Kochia scoparia (kochia)
Onopordum acanthium (Scotch thistle)
Secale cereale (cereal rye)
TETRA TECH
Reference Map
Coyote Canyon Rd
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Bofer Canyon Rd
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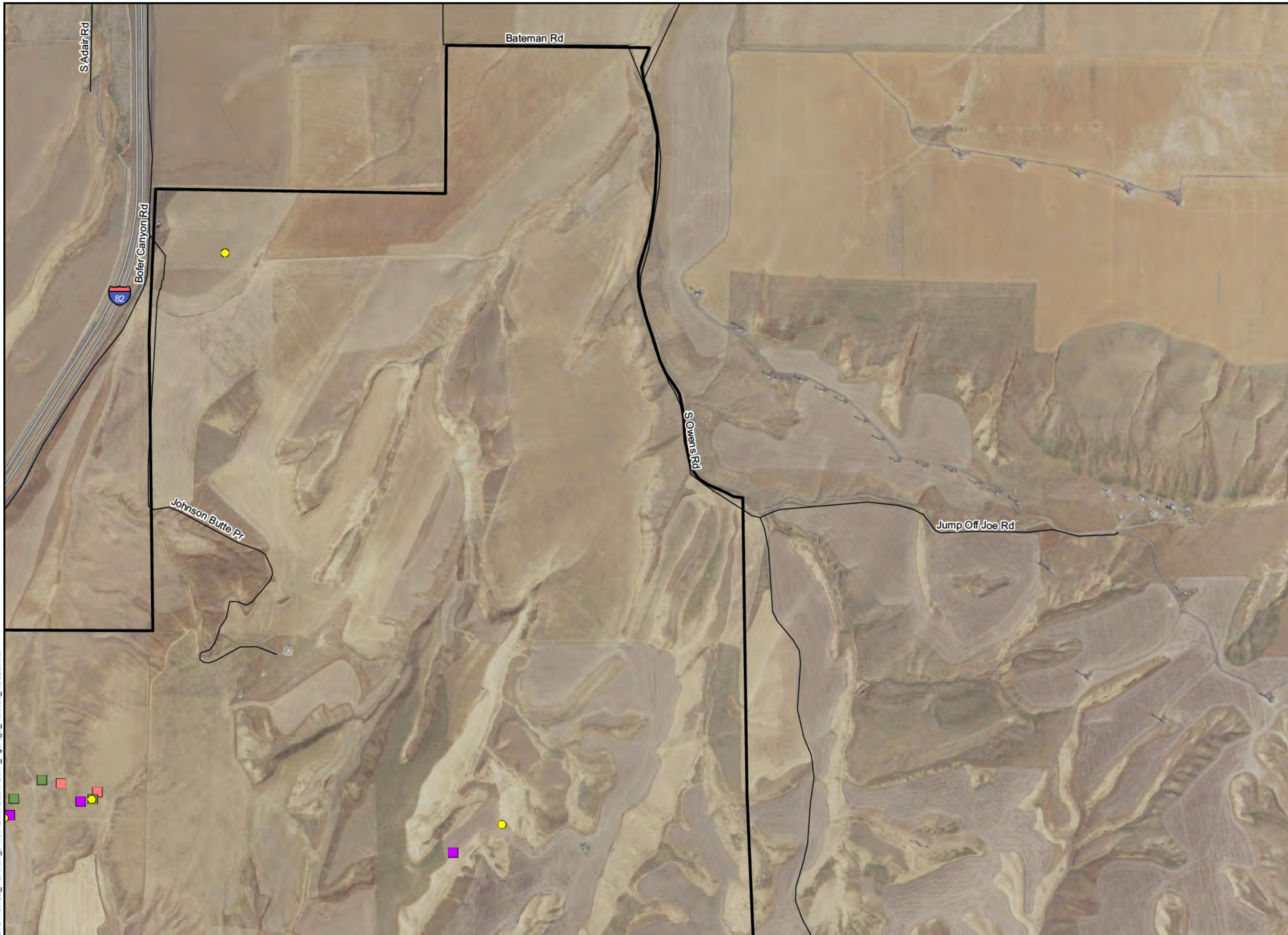


Horse Heaven Wind Farm

SCOUT CLEAN ENERGY

Figure 3e Noxious Weeds

BENTON COUNTY, WA

Project Boundary (4/17/20)

Turbine Survey Locations

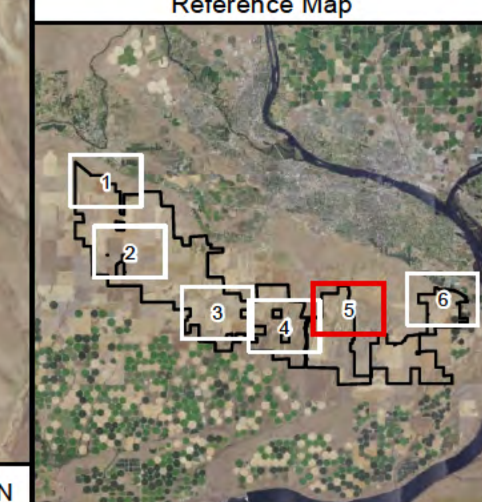
- Turbines (4/15/20)

Noxious Weed

- *Centaurea solstitialis* (yellow starthistle)
- *Centaurea* spp. (knapweed)
- *Chondrilla juncea* (rush skeleton weed)
- *Kochia scoparia* (kochia)
- *Onopordum acanthium* (Scotch thistle)
- *Secale cereale* (cereal rye)

TETRA TECH

Reference Map



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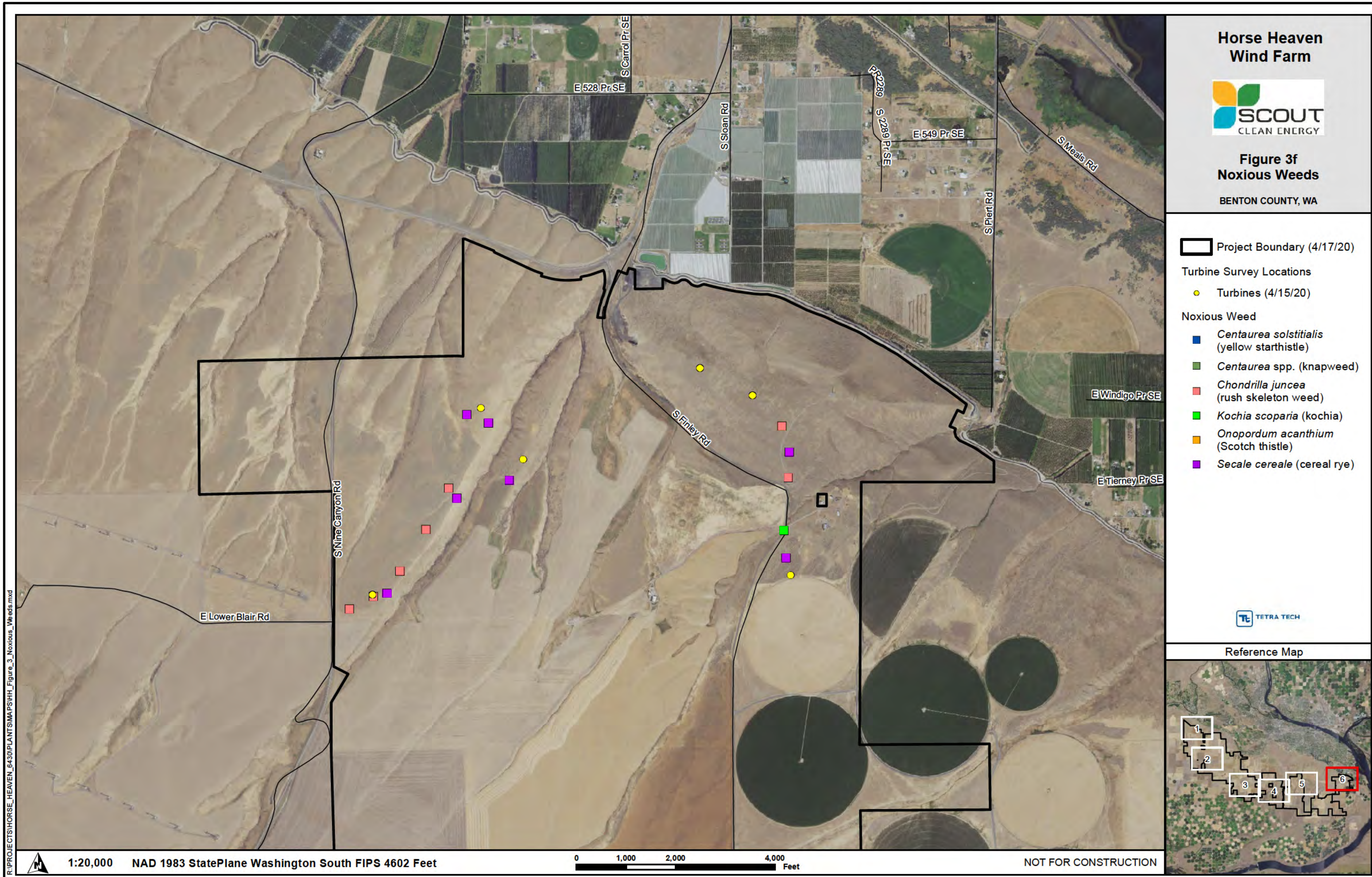

Horse Heaven Wind Farm
SCOUT CLEAN ENERGY
Figure 3f
Noxious Weeds
BENTON COUNTY, WA
Project Boundary (4/17/20)
Turbine Survey Locations
Turbines (4/15/20)
Noxious Weed
Centaurea solstitialis (yellow starthistle)
Centaurea spp. (knapweed)
Chondrilla juncea (rush skeleton weed)
Kochia scoparia (kochia)
Onopordum acanthium (Scotch thistle)
Secale cereale (cereal rye)
TETRA TECH
Reference Map
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S Carroll Pr SE
E 528 Pr SE
S Sloan Rd
PR 2289
S 2289 Pr SE
E 549 Pr SE
S Meals Rd
S Piert Rd
E Windigo Pr SE
E Tierney Pr SE
S Finley Rd
S Nine Canyon Rd
E Lower Blair Rd
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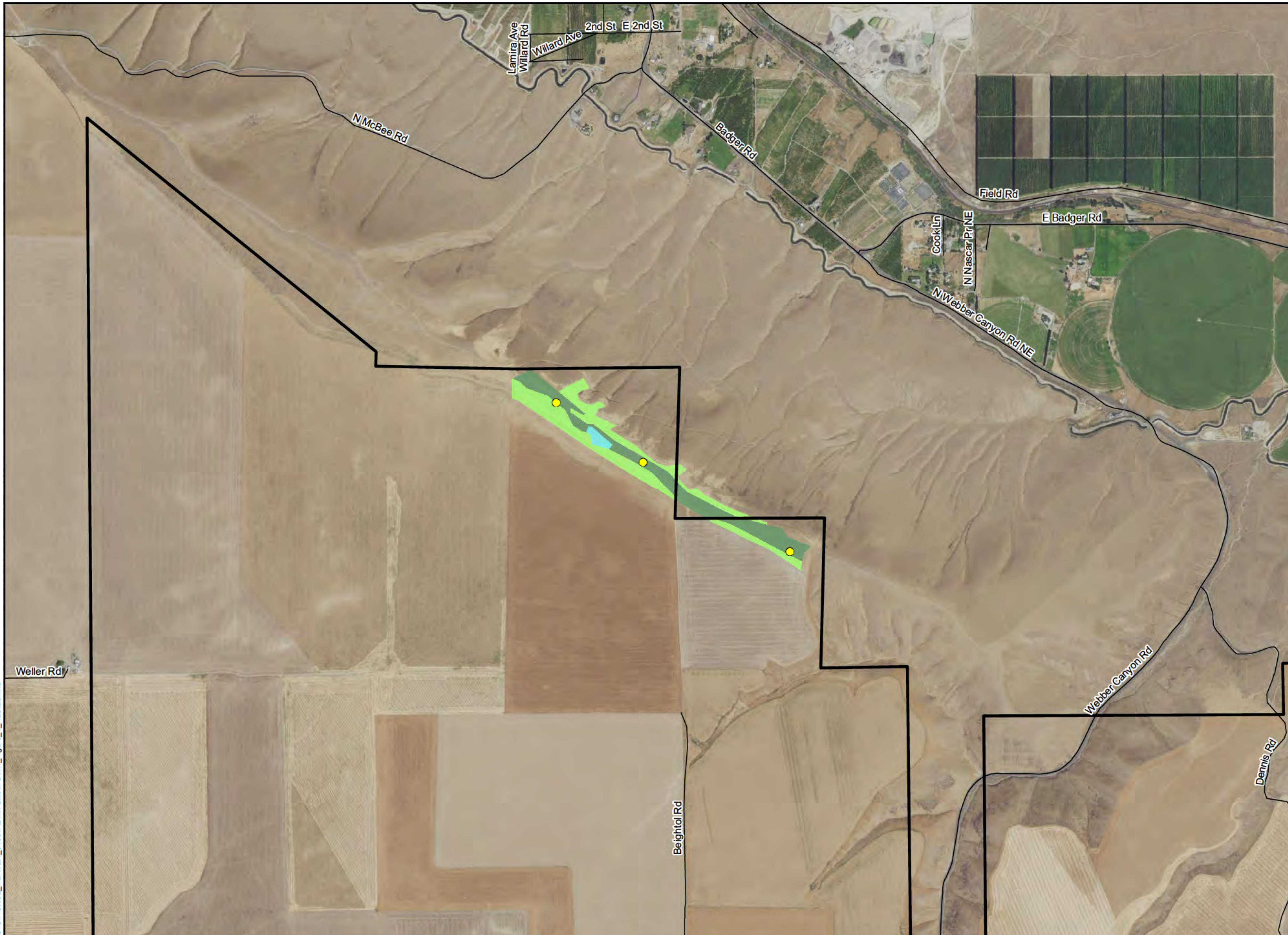
Horse Heaven Wind Farm

SCOUT CLEAN ENERGY

Figure 4a
Habitat Mapping

BENTON COUNTY, WA



Project Boundary (4/17/20)

Turbine Survey Locations

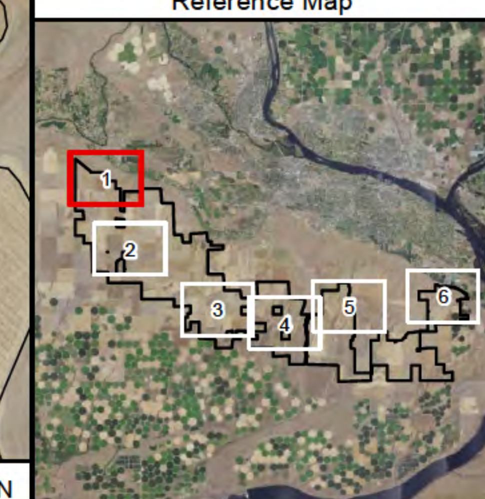
Turbines (4/15/20)

Habitat Type

- Agricultural land
- Developed/disturbed
- Dwarf shrub-steppe
- Non-native grassland
- Planted grassland
- Rabbitbrush shrubland
- Sagebrush shrub-steppe

TETRA TECH

Reference Map



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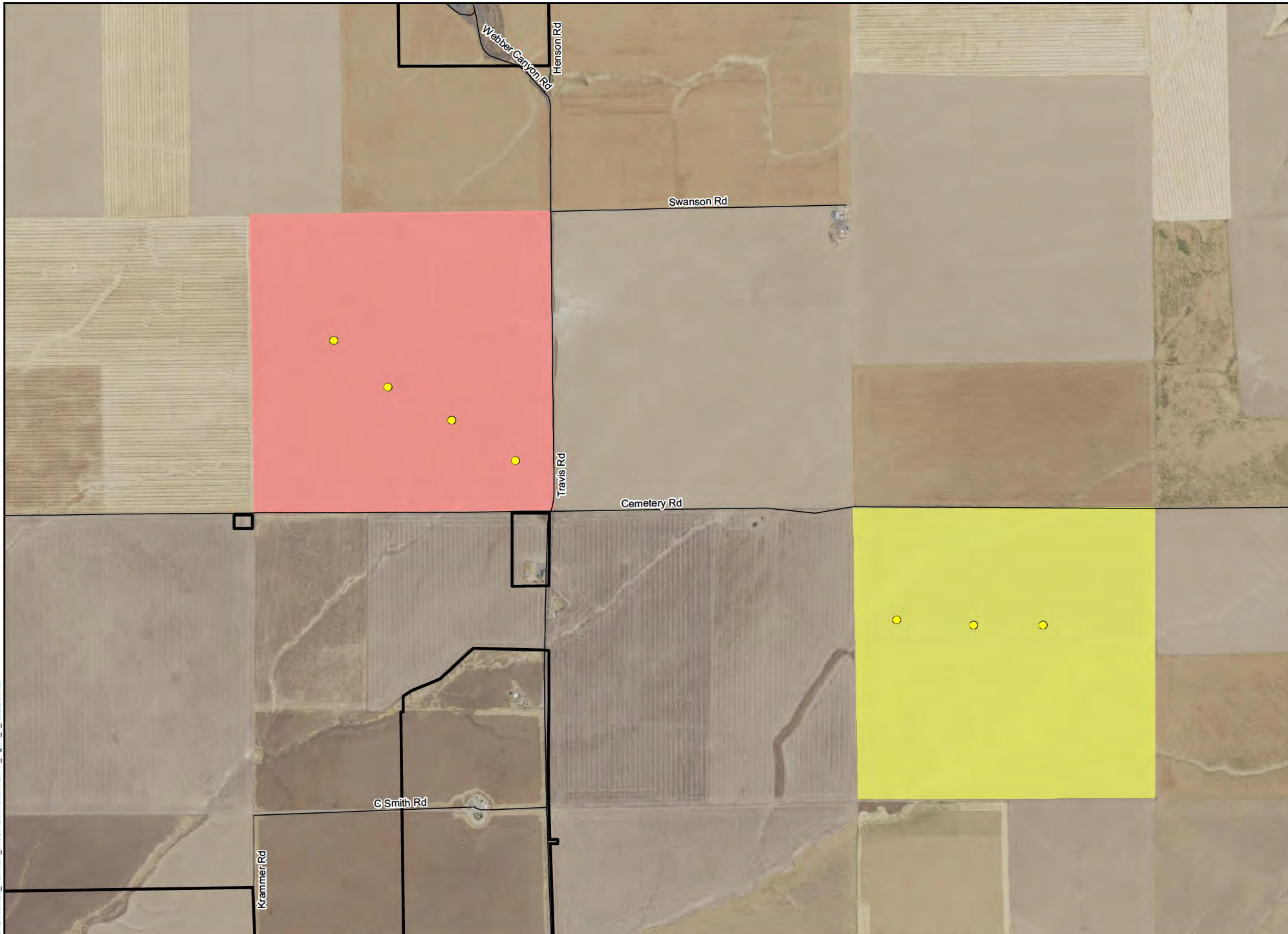
Horse Heaven Wind Farm

SCOUT CLEAN ENERGY

Figure 4b
Habitat Mapping

BENTON COUNTY, WA



- Project Boundary (4/17/20)

Turbine Survey Locations

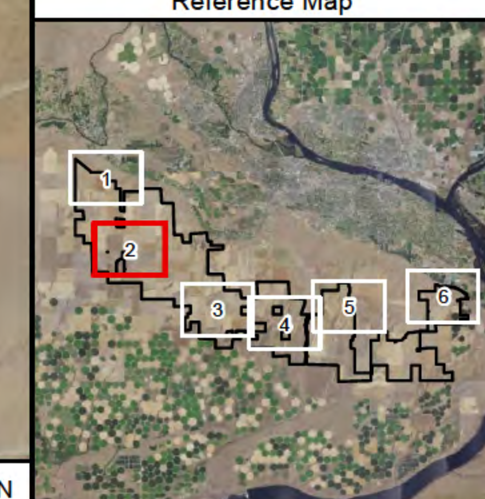
- Turbines (4/15/20)

Habitat Type

- Agricultural land
- Developed/disturbed
- Dwarf shrub-steppe
- Non-native grassland
- Planted grassland
- Rabbitbrush shrubland
- Sagebrush shrub-steppe

TETRA TECH

Reference Map



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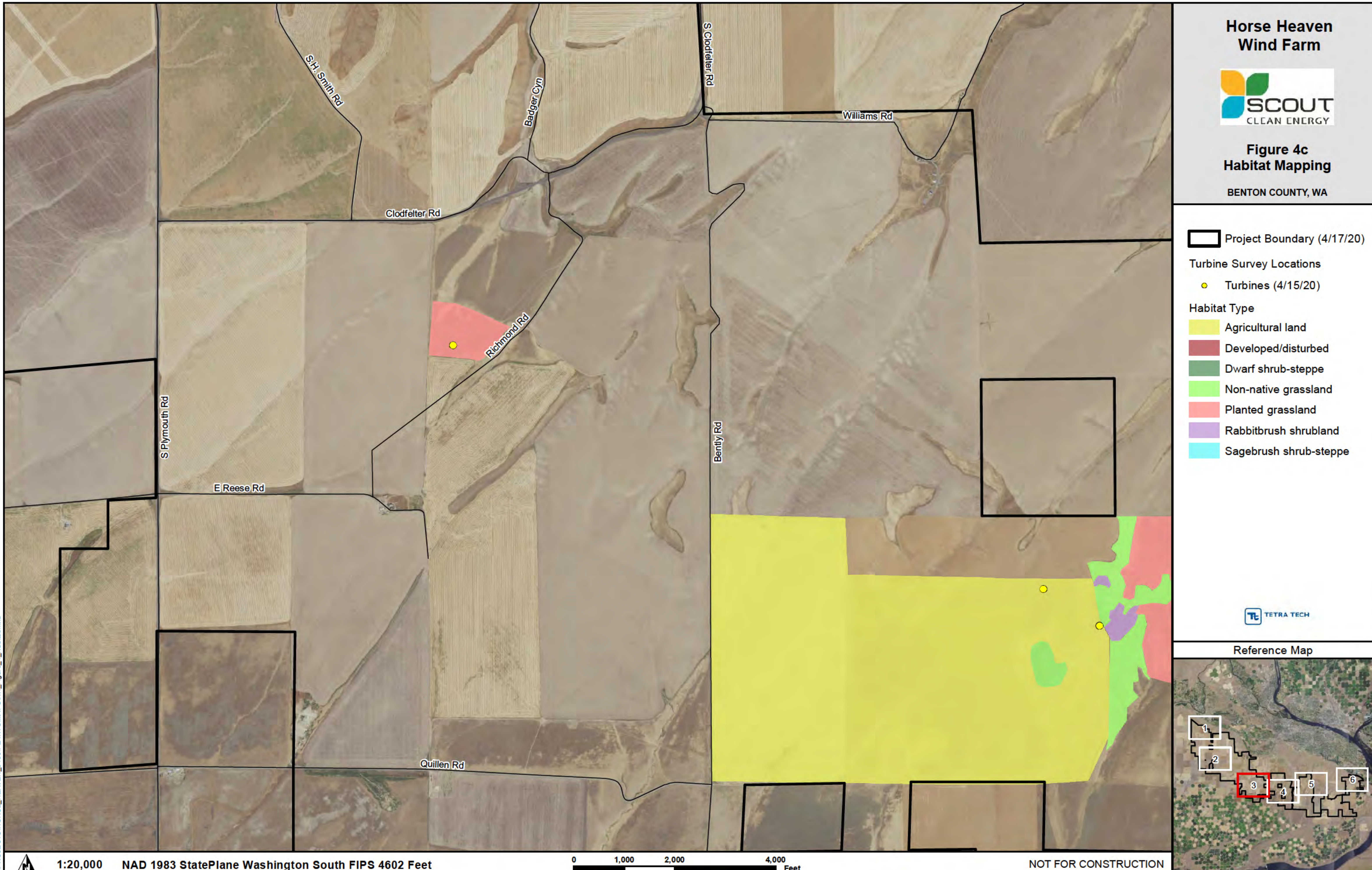

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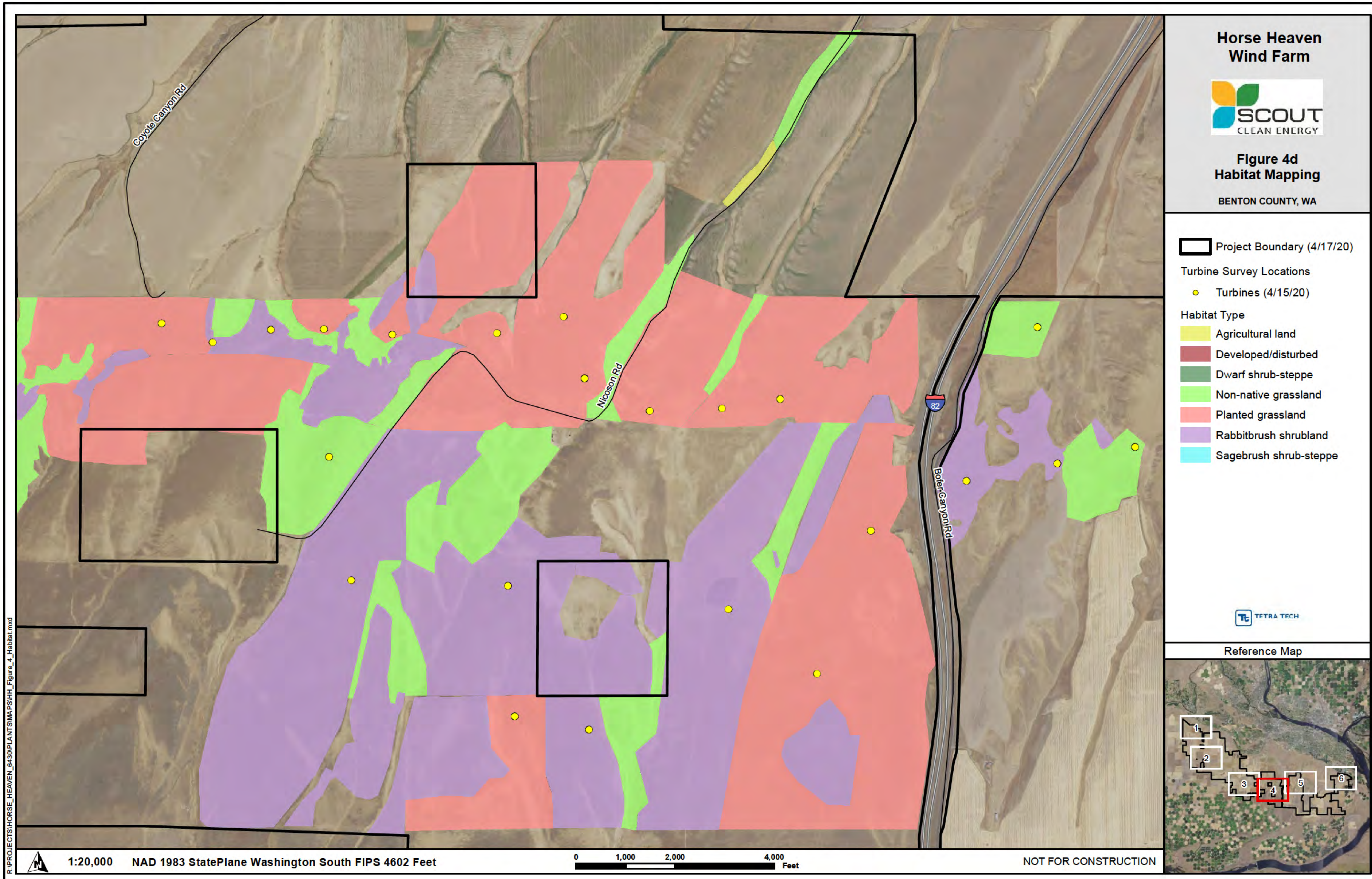

Horse Heaven
Wind Farm
SCOUT
CLEAN ENERGY
Figure 4d
Habitat Mapping
BENTON COUNTY, WA
Project Boundary (4/17/20)
Turbine Survey Locations
Turbines (4/15/20)
Habitat Type
Agricultural land
Developed/disturbed
Dwarf shrub-steppe
Non-native grassland
Planted grassland
Rabbitbrush shrubland
Sagebrush shrub-steppe
TETRA TECH
Reference Map
Coyote Canyon Rd
Nicoson Rd
Bofer Canyon Rd
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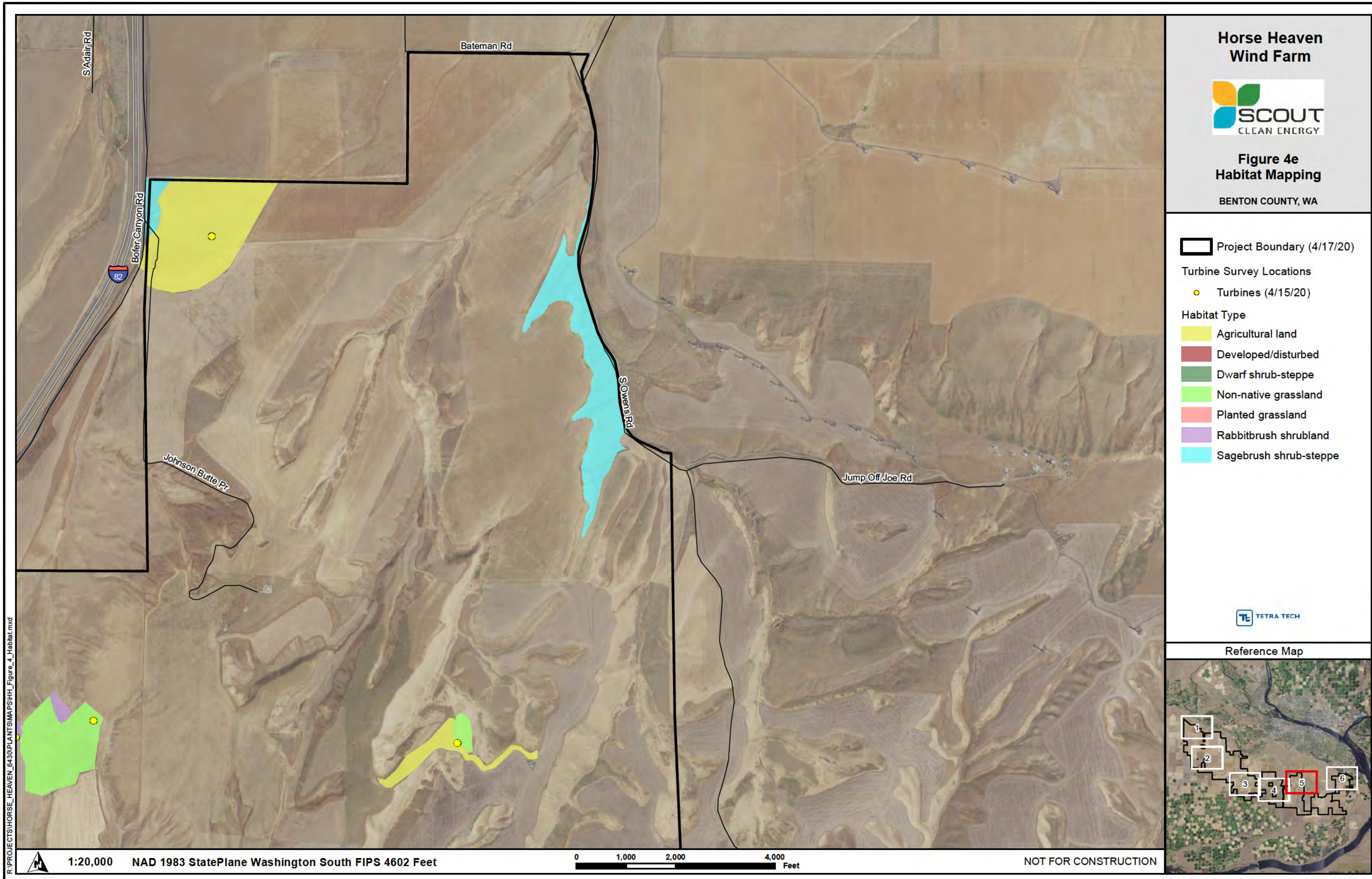

Bateman Rd
S Adair Rd
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S Owens Rd
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Jump Off Joe Rd
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Horse Heaven Wind Farm
SCOUT CLEAN ENERGY
Figure 4e
Habitat Mapping
BENTON COUNTY, WA
Project Boundary (4/17/20)
Turbine Survey Locations
Turbines (4/15/20)
Habitat Type
Agricultural land
Developed/disturbed
Dwarf shrub-steppe
Non-native grassland
Planted grassland
Rabbitbrush shrubland
Sagebrush shrub-steppe
TETRA TECH
Reference Map
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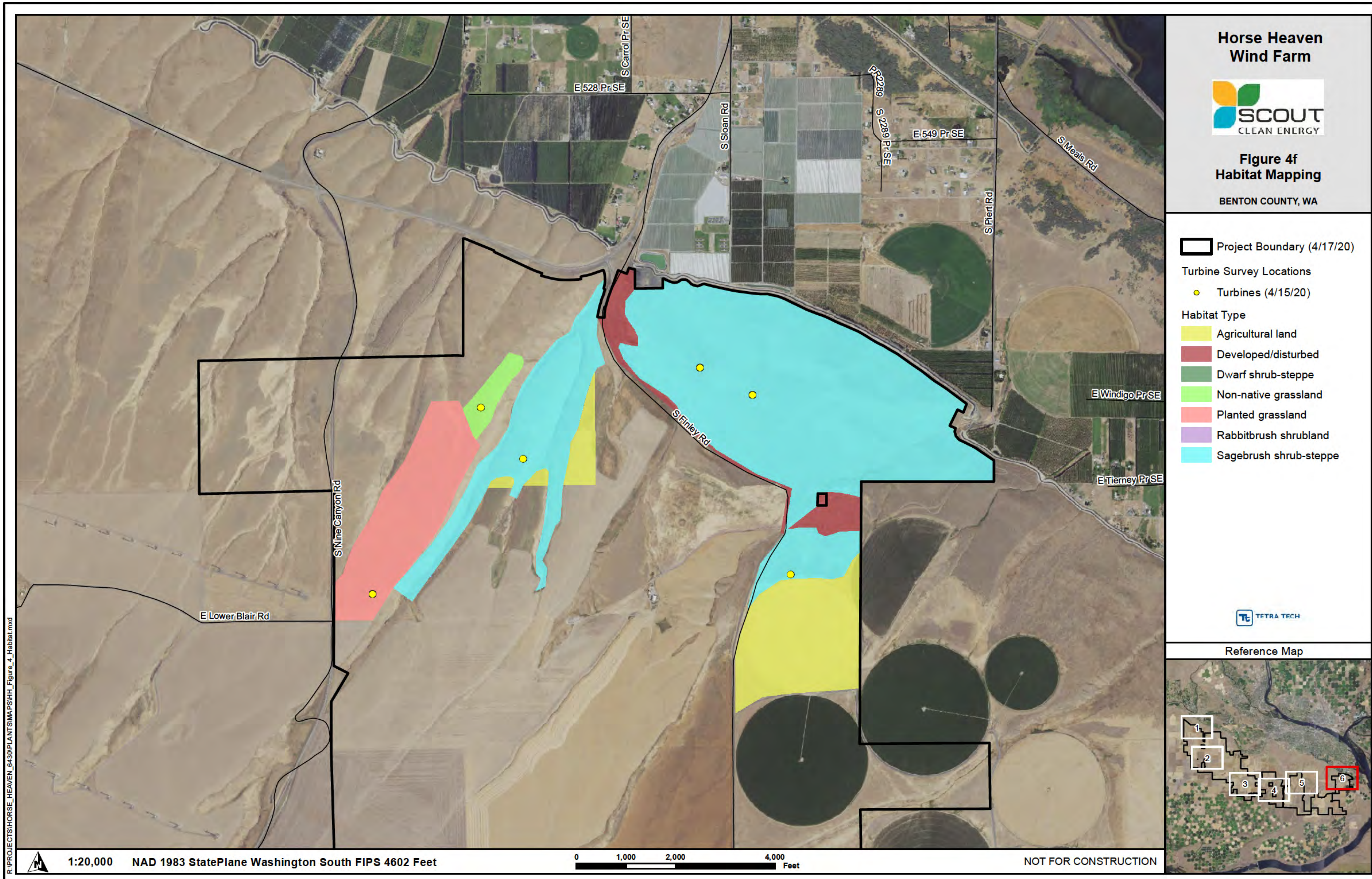

Horse Heaven Wind Farm
SCOUT CLEAN ENERGY
Figure 4f Habitat Mapping
BENTON COUNTY, WA
Project Boundary (4/17/20)
Turbine Survey Locations
Turbines (4/15/20)
Habitat Type
Agricultural land
Developed/disturbed
Dwarf shrub-steppe
Non-native grassland
Planted grassland
Rabbitbrush shrubland
Sagebrush shrub-steppe
TETRA TECH
Reference Map
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S Carrol Pr SE
E 528 Pr SE
S Sloan Rd
PR 2289
S 2289 Pr SE
E 549 Pr SE
S Meals Rd
S Piert Rd
E Windigo Pr SE
E Tierney Pr SE
S Finley Rd
S Nine Canyon Rd
E Lower Blair Rd
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ATTACHMENT A
SPECIAL-STATUS PLANT SPECIES WITH POTENTIAL TO OCCUR WITHIN THE SURVEY AREA

Table A-1. Special-Status Plant Species with Potential to Occur within the Survey Area

Scientific name (Common Name)	State Status[1/]	Habitat Characteristics/ Identifying Features[2/]	Potential to Occur in Survey Area	Survey Period
Aliciella leptomeria (Great Basin gilia)	T	Open habitats in semiarid regions, on dry bluffs or in sandy swales. Substrates are often hard, gravelly or sandy, fine reddish to blackish basalt soils, or fine nonbasalt gravel with caliche fragments. Associated species include: *Artemisia tridentata, Grayia spinosa*, and *Gilia sinuata*. Elev. 470 - 1,140 feet.	Low; limited suitable likely present in survey area.	May
Ammania robusta (grand redstem)	T	Shoreline and islands along the Columbia River, in riparian mudflats dominated by annual species. Also known from lakeshores in the channeled scablands. Sites are inundated until midsummer and periodically throughout the growing season, depending on upstream management of the river. Associated species include *Rotala ramosior, Eleocharis acicularis, Cyperus* spp., *Limosella aquatica, Lindernia dubia*, and occasionally *Rorippa columbiae*.	Unlikely; suitable habitat unlikely to occur within survey area.	May - June
Artemisia campestris var. *wormskioldii* (Wormskiold's northern wormwood)	E	Known from 2 occurrences in the Columbia River floodplain on basalt, compacted cobble, and sand in shrub-steppe vegetation. Associated species include: *Phacelia hastata, Rumex venosus, Artemisia campestris* var. *scouleriana, Lupinus polyphyllus, Eriogonum compositum, Sisymbrium altissimum, Penstemon acuminatus*, and *Centaurea diffusa*.	Unlikely; only known from 2 disjunct sites along the Columbia River.	April - May
Astragalus columbianus (Columbia milkvetch)	S	Shrub-steppe habitats on sandy or gravelly loams, silts, rocky silt loams, and lithosols. Associated species include: *Artemisa tridentata, A. rigida, Pseudoroegneria spicata, Astragalus caricinus, A. purshii, A. speirocarpus*, and *A. succumbens*. Elev. 420 - 2,320 feet.	Low to moderate; suitable habitat potentially present in survey area.	Mid-April – mid-June
Astragalus kentrophyta var. *douglasii* (thistle milkvetch)	X	On sandy ground, dunes, or eroded riverbanks at low elevations. Not seen since 1883; this taxon is likely extinct.	Unlikely; species is believed to be extirpated in Washington.	June
Astragalus misellus var. *pauper* (pauper milk-vetch)	S	Open ridgetops and upper slopes, rarely middle and lower slopes, along western margin of the Columbia Basin province. In Artemisia tridentata/ Pseudoroegneria spicata community. Associated species include: *Artemisia rigida, A. tridentata, Crepis atribarba, C. occidentalis, Eriogonum sphaerocephalum, Pseudoroegneria spicata, Poa secunda, Astragalus purshii., Erigeron linearis, Lomatium macrocarpum, Phlox longifolia*, and *P. hoodii*. Elev. 500 to 3,280 feet.	Unlikely; known occurrences in Benton County are historical occurrences.	April – mid-May
Calyptridium roseum (rosy pussypaws)	T	Sagebrush desert to arid montane forest, in sandy to gravelly soils. In Washington, grows in very dry shrub-steppe, in low swales in dark sandy soil. In spring, the swale microsites may be moister than the surrounding habitat. Associated species include: *Artemisia tridentata, Bromus tectorum, Poa secunda, Cryptantha circumscissa, Holosteum umbellatum, Draba verna, Erythranthe suksdorfii, Microsteris gracilis, Loeflingia squarrosa* subsp. *squarrosa*, and *Gilia leptomeria*. Elev: 525 feet.	Low to moderate; suitable habitat potentially present in survey area.	May - June

Scientific name (Common Name)	State Status[1/]	Habitat Characteristics/ Identifying Features[2/]	Potential to Occur in Survey Area	Survey Period
Cryptantha leucophaea (gray cryptantha)	T	Sandy substrates, especially sand dunes that have not been completely stabilized. Appears to be restricted to areas where there is still some wind-derived movement of open sand. Associated species include: *Purshia tridentata, Artemisia tridentata, Hesperostipa comata, Achnatherum hymenoides, Poa secunda, Oenothera pallida, Eriogonum niveum, Penstemon attenuates,* and *Astragalus succumbens*. Elev. 300-2,500 feet.	Low; limited suitable habitat likely present in survey area.	May - June
Cryptantha scoparia (desert cryptantha)	S	Dry areas with full sun and little competing vegetation. In Washington, grows on south-facing slopes and ridges between small canyons with fine, dry silt and talus. Sites may be a little more alkaline than surrounding areas. Associated species include: *Artemisia tridentata, Krascheninnikovia lanata, Eriogonum niveum, Eriophyllum lanatum, Epilobium minutum, Bromus hordeaceus, Bromus tectorum*, and *Pseudoroegneria spicata*. Elev. 1,200 - 2,100 feet.	Low; limited suitable habitat likely present in survey area.	April - June
Cryptantha spiculifera (Snake River cryptantha)	S	Sandy knolls and badlands and talus at low elevations; dry, open, flat or sloping areas in stable or stony soils. Associated species include: *Artemisia rigida, A. tridentata, Ericameria nauseosa, Eriogonum sphaerocephalum, Salvia dorrii, Lupinus sericeus, Pseudoroegneria spicata*, and *Poa secunda*. Elev. 450 to 3,500 feet.	Low; limited suitable habitat likely present in survey area.	May - July
Cuscuta denticulata (desert dodder)	T	Parasitic on a variety of native shrubs in desert areas, including sagebrush (Artemisia spp.), rabbitbrush (Chrysothamnus/Ericameria spp.). Associated species include: *Artemisia tridntata, Poa secunda, Achnatherum hymenoides, Bromus tectorum, Astragalus caricinus, Erigeron poliospermus, Cymoperus terebinthinus*, and *Helianthus cusickii*. Elev. 880 - 1,089 feet.	Unlikely; known occurrences in Benton County are historical occurrences.	July - August
Eleocharis coloradoensis (dwarf spike-rush)	X	Fresh to brackish bare wet soil, inland. Fresh or brackish drying lake and pond margins, stream beds, flood plains, vernal pools, irrigation ditches, tidal wetlands. Elev: 0 - 6,900 feet.	Unlikely; species is believed to be extirpated in Washington.	Spring – fall
Eremogone franklinii var. *thompsonii* (Thompson's sandwort)	S	Sand dunes, scabland, and sagebrush slopes. Associated species include: Purshia tridentata, Poa canbyi and other bunchgrasses.	Low; limited suitable habitat likely present in survey area.	May - June
Eremothera minor (small-flower evening-primrose)	S	Gravelly basalt slopes, sandy and alkaline soils, and dry rocky hillsides; often with considerable cover of bare soil. Associated species include: *Artemisia tridentata, Ericameria nauseosa, Purshia tridentata, Bromus tectorum*, and *Poa secunda*. Elev. 460 - 1,140 feet.	Low; limited suitable habitat likely present within survey area.	May – early June
Eremothera pygmaea (dwarf evening-primrose)	S	Sagebrush steppe, on unstable soil or gravel in steep talus, dry washes, banks, and roadcuts. Associated species include: *Artemisia tridentata, Bromus tectorum, Eriogonum* spp., *Gilia minutiflora, Mentzelia* spp., *Cryptantha* spp., *Salsola tragus*, and *Neoholmgrenia* (*Camissonia*) *andina*. Elev. 450 - 2,050 feet.	Low; limited suitable habitat likely present within survey area.	June - August

Scientific name (Common Name)	State Status[1/]	Habitat Characteristics/ Identifying Features[2/]	Potential to Occur in Survey Area	Survey Period
Erythranthe suksdorfii (Suksdorf's monkeyflower)	S	Open, moist, or rather dry places, from the valleys and foothills to moderate or occasionally high elevations in the mountains. Occurs in seasonally moist swales, drainages, or vernal pools in shrub-steppe vegetation. Microhabitats are often disturbed by small erosive events (i.e., slumps, slides, bioturbidity, and frost boils). Associated species include: *Juniperus communis. Philadelphus lewisii, Artemisia tridentata, Eriogonum* sp., *Bromus tectorum, Poa secunda, Camissonia hilgardii, Collomia linearis, Draba verna, Erythranthe floribunda, E. breviflora, Plectritis macrocera, Cryptantha ambigua, Microsteris gracilis*, and *Ranunculus testiculatus*. Elev. 430 to 7,100 feet.	Unlikely; suitable habitat unlikely to occur within survey area.	mid-April – approx. June
Hypericum majus (Canadian St. John's-wort)	S	Along ponds, lakesides, riparian habitats, or other low, wet places (FACW species). In Washington, it occurs in habitats that are completely submerged during portions of the growing season or periodically inundated from water controlled by hydroelectric dams. Associated species include: *Equisetum* spp., *Juncus bufonius, J. tenuis, J. articulatus*, and *Carex* spp. Elev. 50 - 2,340 feet.	Unlikely; suitable habitat unlikely to occur within survey area.	July - September
Leymus flavescens (yellow wildrye)	S	Occurs in sandy soils throughout its range. In Montana it is found in sand-deposition areas of sand dunes, where it is associated with *Hesperostipa comata* and *Elymus caninus*. The species has also been found on sandy roadsides.	Unlikely; known occurrence in Benton County is a historical occurrence.	June - July
Lipocarpha aristulata (awned halfchaff sedge)	T	Wet soil and mud, often comprised of fine sand and silt, in bottomlands, sandbars, beaches, shorelines, stream banks, ponds, and ditches. In WA, grows along shorelines and islands below high water at elevations up to 500 feet. Associated species include: *Eleocharis* spp., *Juncus* spp., *Ammannia robusta, Rotala ramoior, Cyperus* spp., *Limosella* spp., *Lindernia dubia*, and *Rorippa columbiae*.	Unlikely; suitable habitat unlikely to occur within survey area.	Late-summer – early-fall
Loeflingia squarrosa (spreading pygmyleaf)	T	Low swales and shallow vernal pools in sandy and silty areas. The Washington populations were found during an unusually wet year in swales and vernally wet areas with a great diversity of annuals in an otherwise arid environment. Associated species include: *Artemisia tridentata, Poa secuda, Greeneocharis circumscissa, Erythranthe suksdorfi, Holosteum umbellatum, Microsteris gracilis, Gnaphalium palustre, Epilobium minutum, Gilia sinuata*, and *Juncus bufonius*. Elev. 430 - 580 feet.	Unlikely; suitable habitat unlikely to occur within survey area.	May
Lomatium tuberosum (Hoover's desert-parsley)	S	Loose basalt talus in sagebrush steppe, typically on east- to north-facing slopes. Sometimes in channels of open ridgetops and talus on south- to southwest-facing slopes in the western portion of its distribution. Associated species include: *Artemisia rigida, Poa secunda, Pseudoroegneria spicata*, and *Delphinium nuttalianum*. Elev. 460 - 4,000 feet.	Low; limited suitable habitat likely present within survey area.	Early-March – mid-April

Scientific name (Common Name)	State Status[1/]	Habitat Characteristics/ Identifying Features[2/]	Potential to Occur in Survey Area	Survey Period
Micromonolepis pusilla (red poverty-weed)	T	Desert regions, in saline or alkaline clay soils, salt-encrusted soils, or edges of alkaline ponds. This species is adapted to extreme conditions. In some sites it is limited to growing directly beneath greasewood shrubs, due to cattle trampling and soil compaction between the shrubs. Associated species include: *Sarcobatus vermiculatus, Suaeda depressa, Bromus tectorum*, and *Phacelia tetramera*. Elev. 1,950 - 2,210 feet.	Unlikely; suitable habitat unlikely to occur within survey area and known occurrence in Benton County is historical occurrence.	April - June
Mimetanthe pilosa (false monkeyflower)	S	Moist, sandy or gravelly soils, especially by small streams, seeps, springs, and disturbed areas. Elev. 1,000-4,500 feet.	Unlikely; known occurrence in Benton County is a historical occurrence.	April - August
Myosurus alopecuroides (foxtail mousetail)	T	Obligate vernal pool species; found on hard, bare, desiccated clay in sparsely vegetated areas of shallow pools. Associated species include: *Deschampsia danthonioides, Myosurus minimus, Navarretia leucocephala, Plagiobothrys* spp., and *Polygonum polygaloides* ssp. *confertiflorum*. Elev. 250 to 2,500 feet.	Unlikely; suitable habitat unlikely to occur within survey area.	May - June
Nicotiana attenuata (coyote tobacco)	S	Dry, sandy bottom lands, dry rocky washes, and in other dry open places; Elev. 320 to 2,640 feet. Associated species: *Artemisia tridentata, Ericameria* spp., *Bromus tectorum, Leymus cinereus, Centaurea diffusa, Verbascum thapsus, Solanum triflorum, Achillea millefolium*, and *Mentzelia laevicaulis*.	Low to moderate; suitable habitat is potentially present in survey area.	June - September
Oenothera cespitosa ssp. *cespitosa* (cespitose evening-primrose)	S	Open sagebrush desert; on loose talus slopes, steep, sandy or gravelly slopes, road cuts, and dry hills; as well as along the flat river terrace of the Columbia River. It occurs within general areas dominated by Artemisia tridentata or Artemisia rigida. Other associated species include: *Ericameria nauseosa, Eriogonum douglasii* and *E. niveum, Poa secunda, Achnatherum thurberianum, A. hymenoides, Hesperostipa comata, Koeleria macrantha, Astragalus purshii, A. succumbens, Balsamorhiza careyana, Phacelia hastata*, and *Pteryxia terebinthina*. Elev. 410 to 1,800 feet.	Moderate; suitable habitat potentially present in survey area.	Late-April – mid-June
Rorippa columbiae (Columbia yellowcress)	T	Riverbanks, permanent lakes, snow-fed lakes, and streams, internally-drained lakes with extended periods of dryness, wet meadows, and ditches. All known sites are inundated for at least part of the year. Soil types include clay, sand, gravel, sandy silt, cobblestones, and rocks. All sites in Washington occur along the Columbia River, in the lowest vegetated riparian zone.	Unlikely; suitable habitat unlikely to occur within survey area.	April - October
Rotala ramosior (lowland toothcup)	S	Damp areas in fine sand and silt, wet, swampy places, mudflats, lakes and pond margins, and along free-flowing river reaches. Found in riparian wetlands growing below high water, often in a community of small emergent annuals. Elev. 200 to 2,260 feet. Associated species include: *Salix exigua, Ammannia robusta, Juncus* spp., *Eleocharis acicularis, Limosella acaulis, Lindneria dubia*, and *Cyperus acuminatus*. Elev. 200 to 2,259 feet.	Unlikely; suitable habitat unlikely to occur within survey area.	June - August

Scientific name (Common Name)	State Status[1/]	Habitat Characteristics/ Identifying Features[2/]	Potential to Occur in Survey Area	Survey Period
Sabulina nuttallii var. *fragilis* (Nuttall's sandwort)	T	Open, gravelly benches, dry rocky areas, or limestone talus from open sagebrush hills to alpine slopes. In Washington this taxon has been found on desert ridges of raised basalt, talus, outcrops, and in rocky to gravelly or sandy soil. Associated species include: *Purshia tridentata, Grayia spinosa, Salvia dorrii, Pseudoroegneria spicata, Ericameria nauseosa, Eriogonum microthecum, Balsamorhiza careyana*, and *Lomatium macrocarpum*.	Unlikely; suitable habitat unlikely to occur within survey area.	May - August
Texosporium sancti-jacobi (woven-spore lichen)	T	Arid to semi-arid shrub steppe, grassland or savannah communities up to 3,300 feet in elevation. On flat to gentle north-facing slopes. Soils are non-saline and noncalcareous. Most common on decomposing bunchgrass clumps that are impregnated with soil, but elevated above the surrounding surface. Also found on old, decaying mammal scat. Associated species: *Artemisia tridentata, Purshia tridentata, Poa secunda, Festuca idahoensis, Pseudoroegneria spicata*, the lichens *Megaspora verrucosa, Trapeliopsis* spp., *Cladonia* spp., and the moss *Encalypta rhaptocarpa*.	Low to moderate; suitable habitat potentially occurs within survey area.	April - June

Notes:

1/ State Status: WNHP (2019) provides the following explanation of state status:

E = Endangered, in danger of becoming extinct or extirpated from Washington
T = Threatened, likely to become Endangered in Washington
S = Sensitive, vulnerable or declining and could become Endangered or Threatened in Washington
X = Possibly extinct or extirpated from Washington State (includes state historical species).

No federally listed species have the potential to occur in survey area.

2/ Sources: Burke Museum of Natural History and Culture 2020; Camp and Gamon 2011; Hitchcock and Cronquist 2018; WNHP 2019, 2020.

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ATTACHMENT B
VASCULAR PLANTS OBSERVED WITHIN THE SURVEY AREA

Scientific Name	Common Name	Family	Type	Non-native	Noxious Weed Class Benton County / Washington State	Synonyms / Notes
Achillea millefolium	common yarrow	Asteraceae	forb			
Agoseris grandiflora	bigflower agoseris	Asteraceae	forb			
Agoseris heterophylla	annual agoseris	Asteraceae	forb			
Agropyron cristatum	crested wheatgrass	Poaceae	grass	x		
Allium acuminatum	tapertip onion	Amaryllidaceae	forb			
Ambrosia acanthicarpa	bur ragweed	Asteraceae	forb			
Amsinckia lycopsoides	tarweed fiddleneck, bugloss fiddleneck	Boraginaceae	forb			
Amsinckia tessellata	bristly fiddleneck, tessellate fiddleneck	Boraginaceae	forb			
Antennaria dimorpha	low pussytoes	Asteraceae	forb			
Artemisia tridentata	big sagebrush	Asteraceae	shrub			
Astragalus caricinus	buckwheat milkvetch	Fabaceae	forb			
Astragalus purshii	woollypod milkvetch, rabbit eggs milk-vetch	Fabaceae	forb			
Astragalus spaldingii	Spalding's milkvetch	Fabaceae	forb			
Astragalus succumbens	crouching milkvetch, Columbia milkvetch	Fabaceae	forb			
Balsamorhiza careyana	Carey's balsamroot	Asteraceae	forb			
Balsamorhiza rosea	rosy balsamroot	Asteraceae	forb			
Bassia scoparia	red belvedere, mock cypress, kochia	Amaranthaceae	forb	x	Class B / Class B	*Kochia scoparia*
Bromus arvensis	field brome/Japanese brome	Poaceae	grass	x		*Bromus japonicus*
Bromus hordeaceus	soft brome	Poaceae	grass	x		*Bromus mollis*
Bromus tectorum	cheatgrass	Poaceae	grass	x		
Calochortus macrocarpus var. *macrocarpus*	sagebrush mariposa lily	Liliaceae	forb			
Centaurea solstitialis	yellow starthistle	Asteraceae	forb	x	Class B / Class B	
Centaurea sp.	knapweed	Asteraceae	forb	x	Class B / Class B	likely diffuse knapweed
Ceratocephala testiculata	burr buttercup	Ranunculaceae	forb	x		
Chaenactis douglasii	Douglas' dustymaiden, dusty maidens	Asteraceae	forb			
Chondrilla juncea	rush skeletonweed	Asteraceae	forb	x	Class B / Class B	
Chorispora tenella	crossflower, blue mustard	Brassicaceae	forb	x		
Chrysothamnus viscidiflorus	yellow rabbitbrush, green rabbitbrush	Asteraceae	shrub			
Comandra umbellata	bastard toadflax	Santalaceae	forb			
Conyza canadensis	horseweed, Canadian fleabane	Asteraceae	forb			
Crepis atribarba	slender hawksbeard	Asteraceae	forb			
Crepis intermedia	intermediate hawksbeard, limestone hawksbeard	Asteraceae	forb			
Cymopterus terebinthinus	turpentine spring parsley, turpentine wavewing	Apiaceae	forb			*Pteryxia terebinthina*
Descurainia pinnata	western tansymustard	Brassicaceae	forb			
Dieteria canescens	hoary-aster	Asteraceae	forb			*Machaeranthera canescens*
Draba verna	spring whitlow-grass	Brassicaceae	forb	x		
Elymus elymoides	squirreltail	Poaceae	grass			
Epilobium brachycarpum	tall annual willowherb	Onagraceae	forb			
Ericameria nauseosa	rubber rabbitbrush, gray rabbitbrush	Asteraceae	shrub			
Erigeron filifolius	threadleaf fleabane	Asteraceae	forb			
Erigeron poliospermus	cushion fleabane, hairy-seeded daisy fleabane	Asteraceae	forb			
Erigeron pumilus	shaggy fleabane	Asteraceae	forb			
Eriogonum niveum	snow buckwheat	Polygonaceae	forb			
Eriogonum sphaerocephalum var. sphaerocephalum	rock buckwheat	Polygonaceae	forb			
Eriophyllum lanatum var. *integrifolium*	Oregon sunshine	Asteraceae	forb			
Erodium cicutarium	redstem stork's bill, crane's-bill	Geraniaceae	forb	x		
Hesperostipa comata	needle-and-thread grass	Poaceae	grass			
Holosteum umbellatum	jagged chickweed	Caryophyllaceae	forb	x		
Hordeum murinum	mouse barley	Poaceae	grass	x		
Lactuca serriola	prickly lettuce	Asteraceae	forb	x		
Lagophylla ramosissima	slender hareleaf, branched lagophylla	Asteraceae	forb			
Leymus cinereus	basin wildrye	Poaceae	grass			*Elymus cinereus*
Linum lewisii var. *lewisii*	wild blue flax, prairie flax	Linaceae	forb			
Lithospermum ruderale	western gromwell, western stoneseed	Boraginaceae	forb			

Scientific Name	Common Name	Family	Type	Non-native	Noxious Weed Class Benton County / Washington State	Synonyms / Notes
Lomatium sp.	desert-parsley, biscuit-root	Apiaceae	forb			
Lupinus leucophyllus	velvet lupine	Fabaceae	forb			
Lupinus sulphureus var. *subsaccatus*	sulphur lupine, Bingen lupine	Fabaceae	forb			
Madia sp.	tarweed	Asteraceae	forb			
Nestotus stenophyllus	narrowleaf goldenweed	Asteraceae	forb/sub-shrub			*Haplopappus stenophyllus*
Onopordum acanthium	Scotch thistle	Asteraceae	forb	x	Class B / Class B	
Phlox longifolia	long-leaf phlox	Polemoniaceae	forb			
Phlox sp.	phlox	Polemoniaceae	forb			
Plantago patagonica	woolly plantain, indianwheat plantain	Plantaginaceae	forb			
Poa ampla	big bluegrass	Poaceae	grass			cultivar of *Poa secunda*
Poa bulbosa	bulbous bluegrass	Poaceae	grass	x		
Poa secunda	Sandberg bluegrass	Poaceae	grass			
Polygonum aviculare	prostrate knotweed	Polygonaceae	forb	x		
Pseudognaphalium sp.	cudweed	Asteraceae	forb			
Pseudoroegneria spicata	bluebunch wheatgrass	Poaceae	grass			
Salsola tragus	prickly Russian thistle	Chenopodiaceae	forb	x		*Salsola kali*
Secale cereale	cereal rye	Poaceae	grass	x	Class C / Class C	
Sisymbrium altissimum	tall tumblemustard	Brassicaceae	forb	x		
Stephanomeria tenuifolia	wire lettuce, narrowleaf wirelettuce	Asteraceae	forb			
Taraxacum officinale	common dandelion	Asteraceae	forb	x		
Tetradymia canescens	gray horsebrush, spineless horsebrush	Asteraceae	shrub			
Tragopogon dubius	yellow salsify	Asteraceae	forb	x		
Triticum aestivum	wheat	Poaceae	grass	x		
Vulpia microstachys	small fescue	Poaceae	grass			

ATTACHMENT C
REPRESENTATIVE HABITAT PHOTOGRAPHS

Photo 1. Active wheat field within area previously mapped as eastside (interior) grassland

Photo 2. Dwarf-shrub steppe habitat dominated by rock buckwheat (*Eriogonum sphaerocephalum*) and Sandberg bluegrass (*Poa secunda*) in northwestern corner of survey area

Photo 3. Non-native grassland dominated by cereal rye (*Secale cereale*)

Photo 4. Planted grassland with bluebunch wheatgrass (*Pseudoroegneria spicata*), crested wheatgrass (*Agropyron cristatum*), and abundant cheatgrass (*Bromus tectorum*)

Photo 5. Planted grassland dominated by big bluegrass (*Poa ampla*) and bluebunch wheatgrass

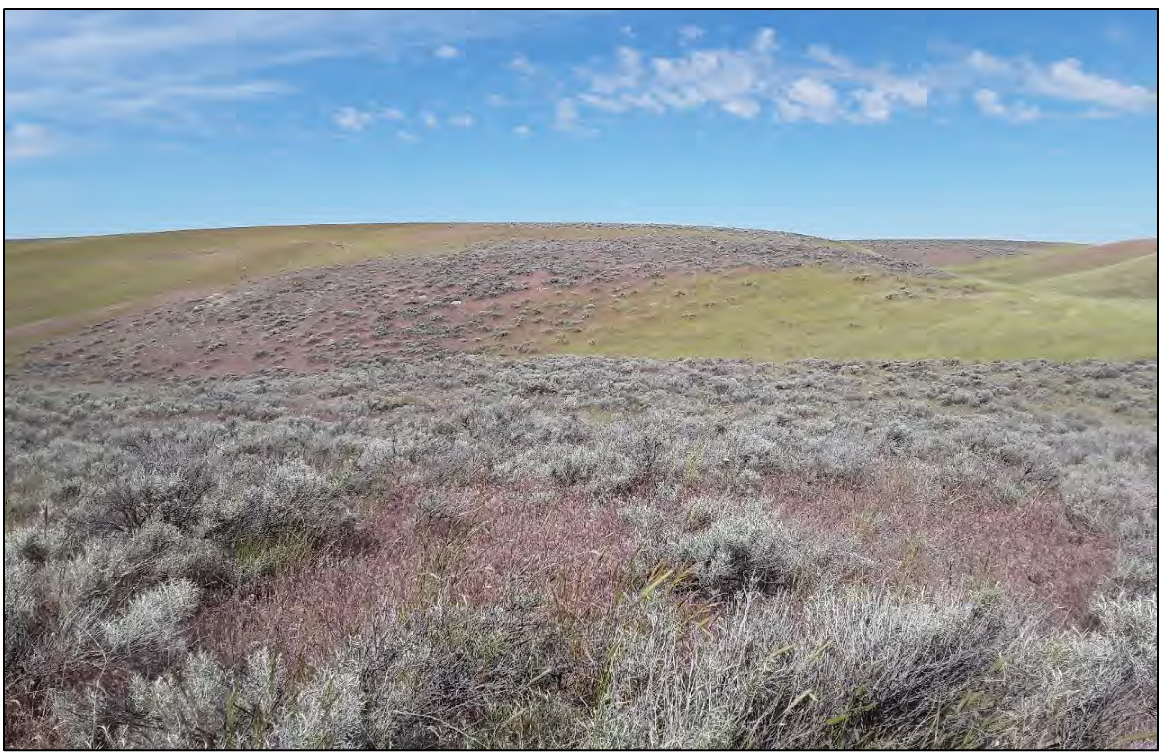
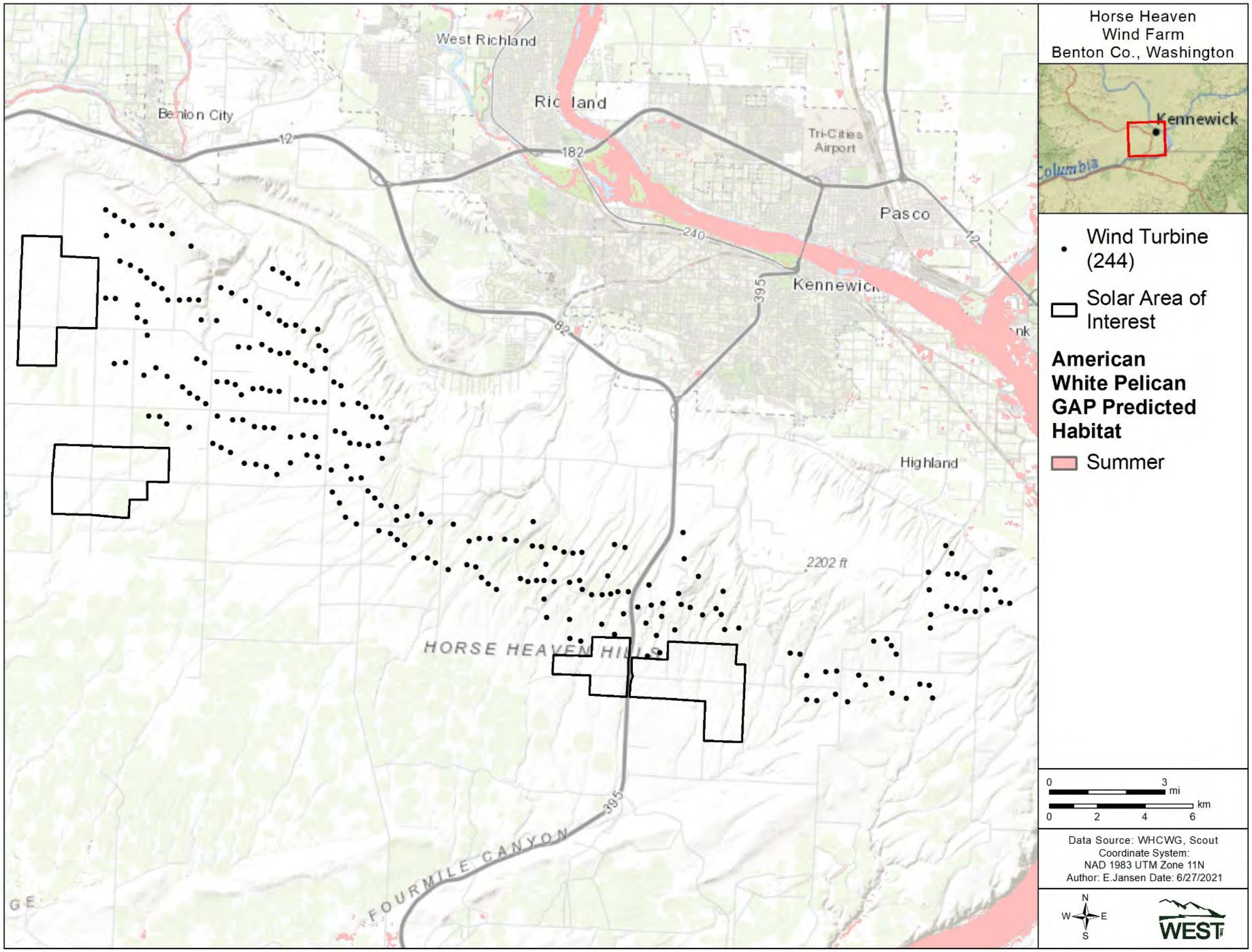


Photo 6. Rabbitbrush shrubland with high cover of rubber rabbitbrush (*Ericameria nauseosa*) and non-native grassland habitat dominated by cereal rye

Photo 7. Sagebrush shrub-steppe habitat with high cover of cheatgrass and yellow salsify (*Tragopogon dubius*) in understory

Photo 8. Sagebrush shrub-steppe habitat with big sagebrush (*Artemisia tridentata*), bluebunch wheatgrass, Sandberg bluegrass, and cheatgrass

Wildlife GAP Predicted Habitat Maps (6/29/2021)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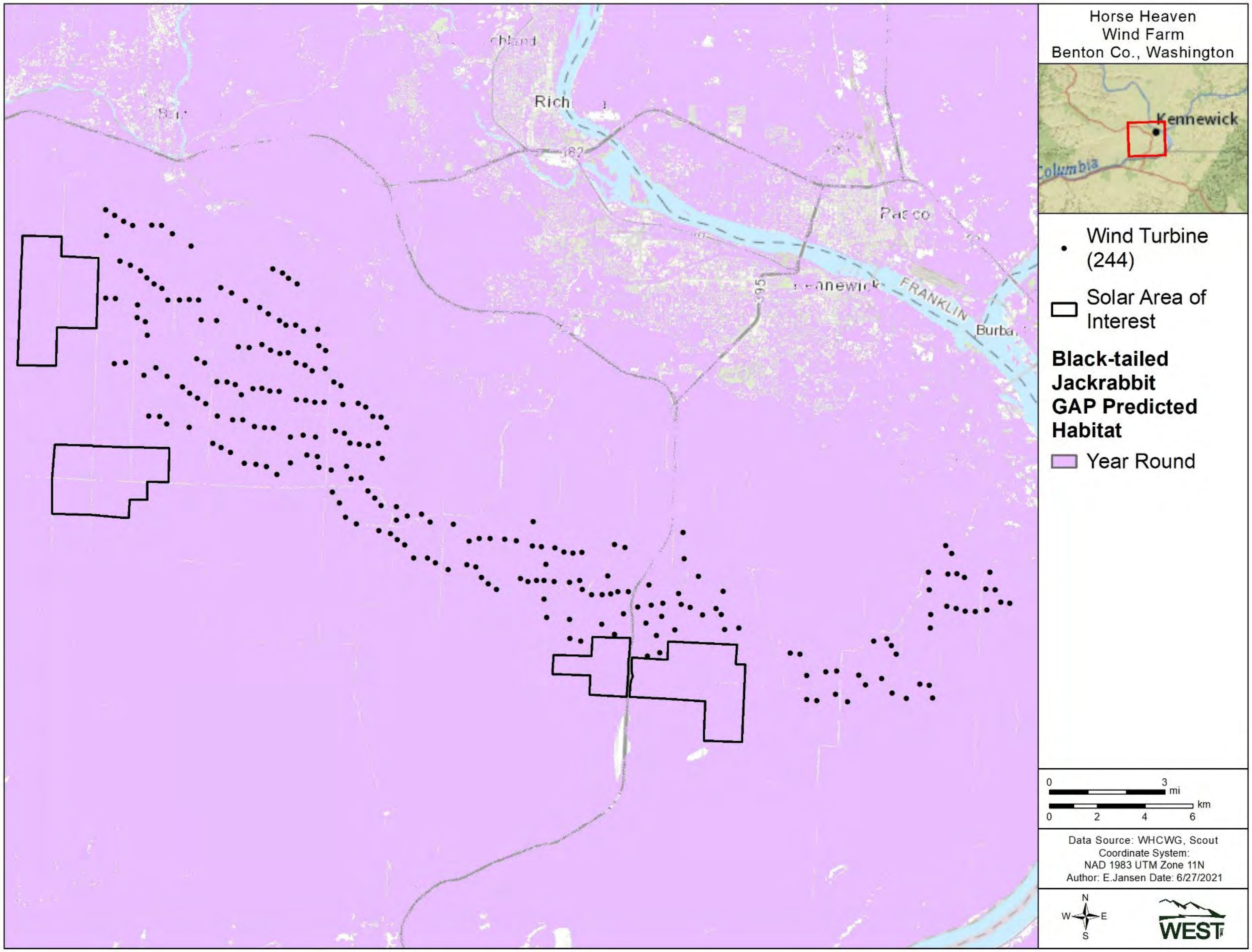
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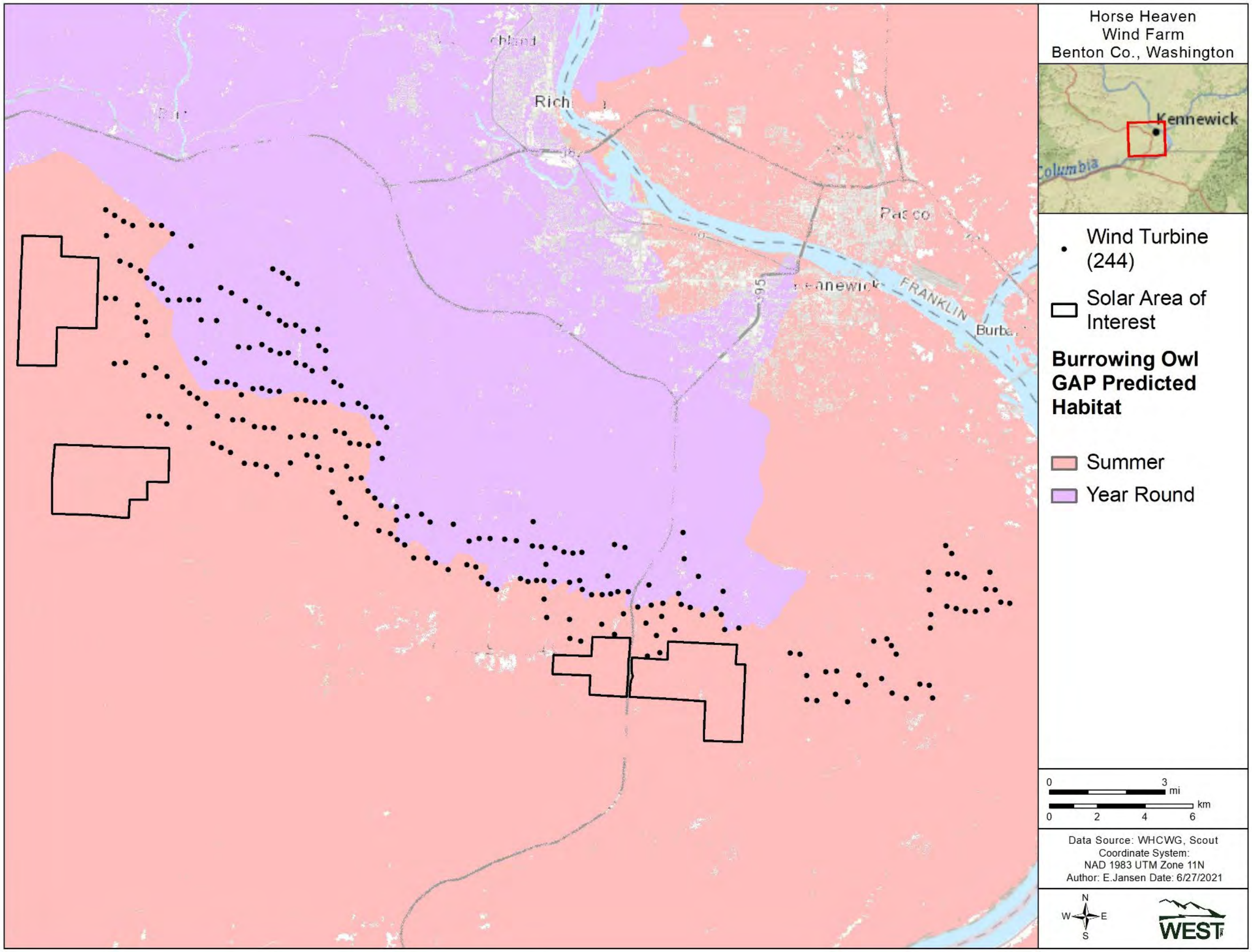
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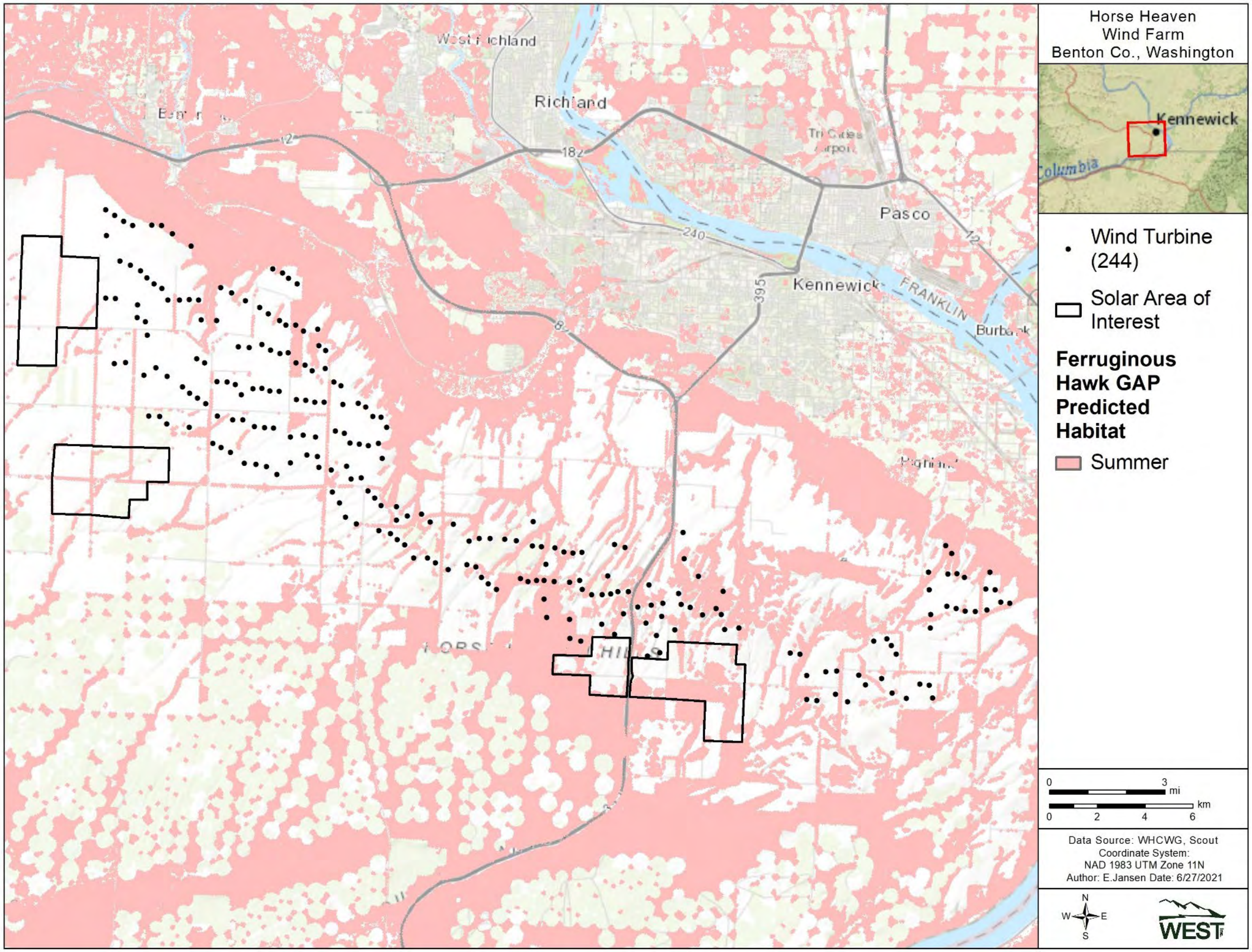
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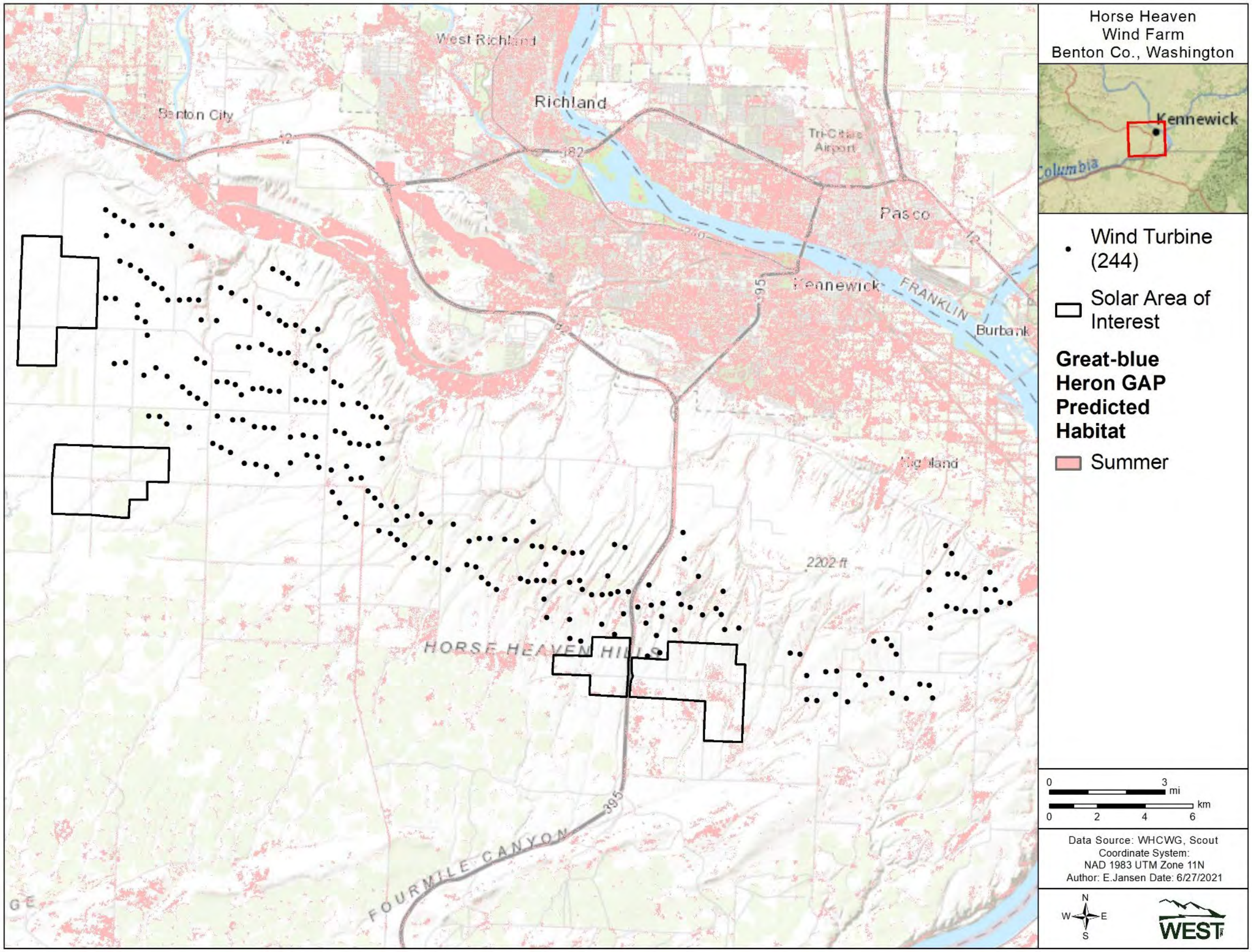
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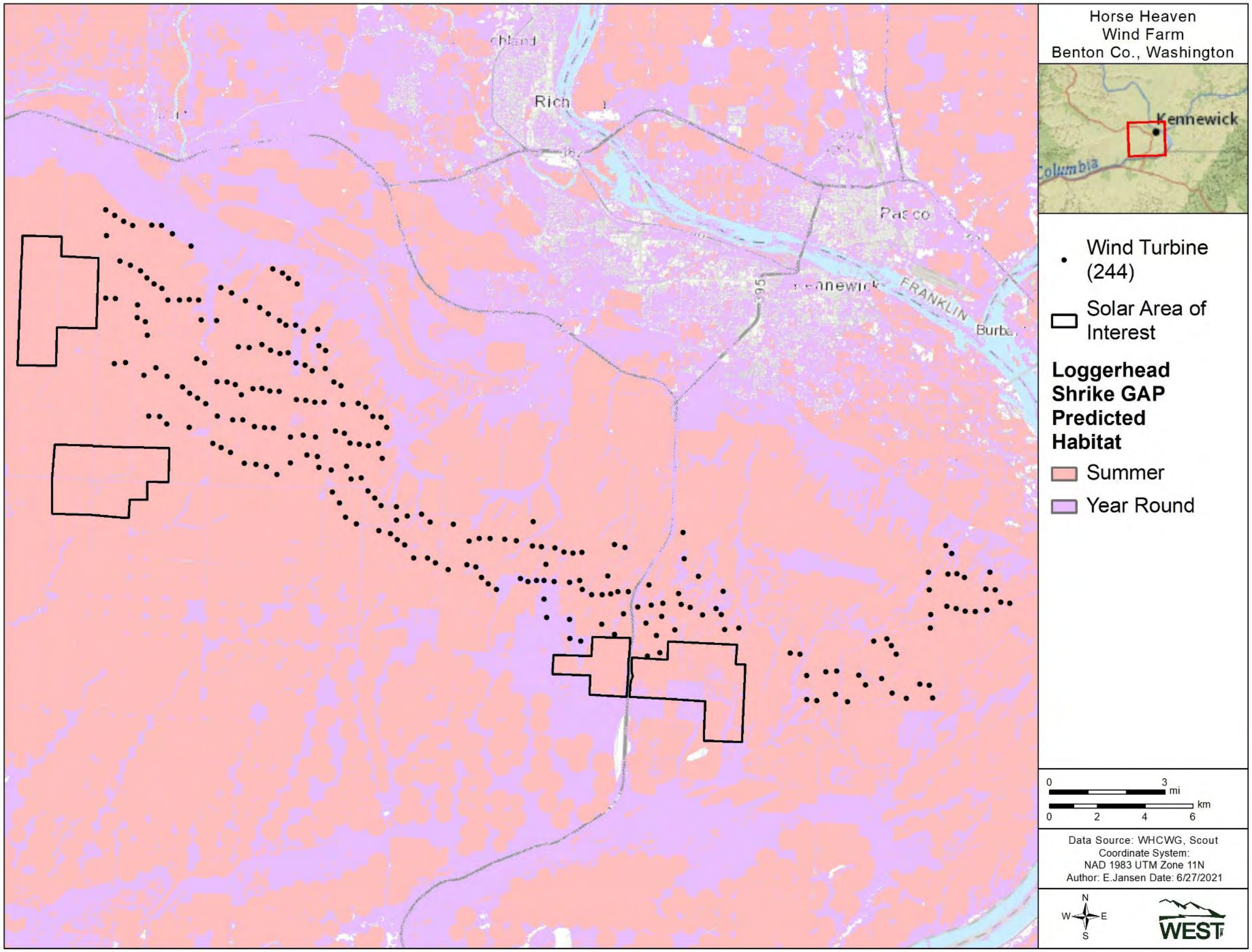

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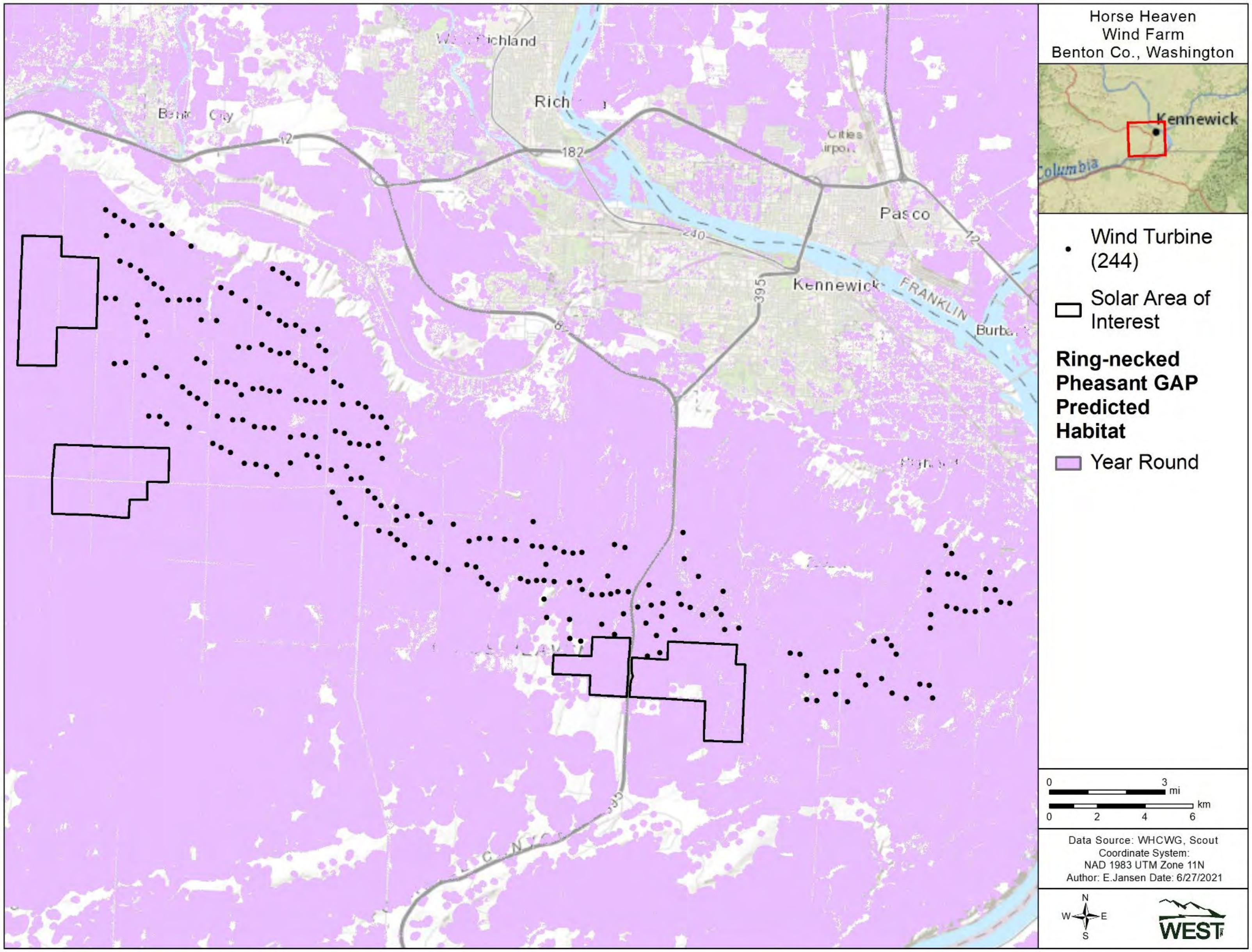
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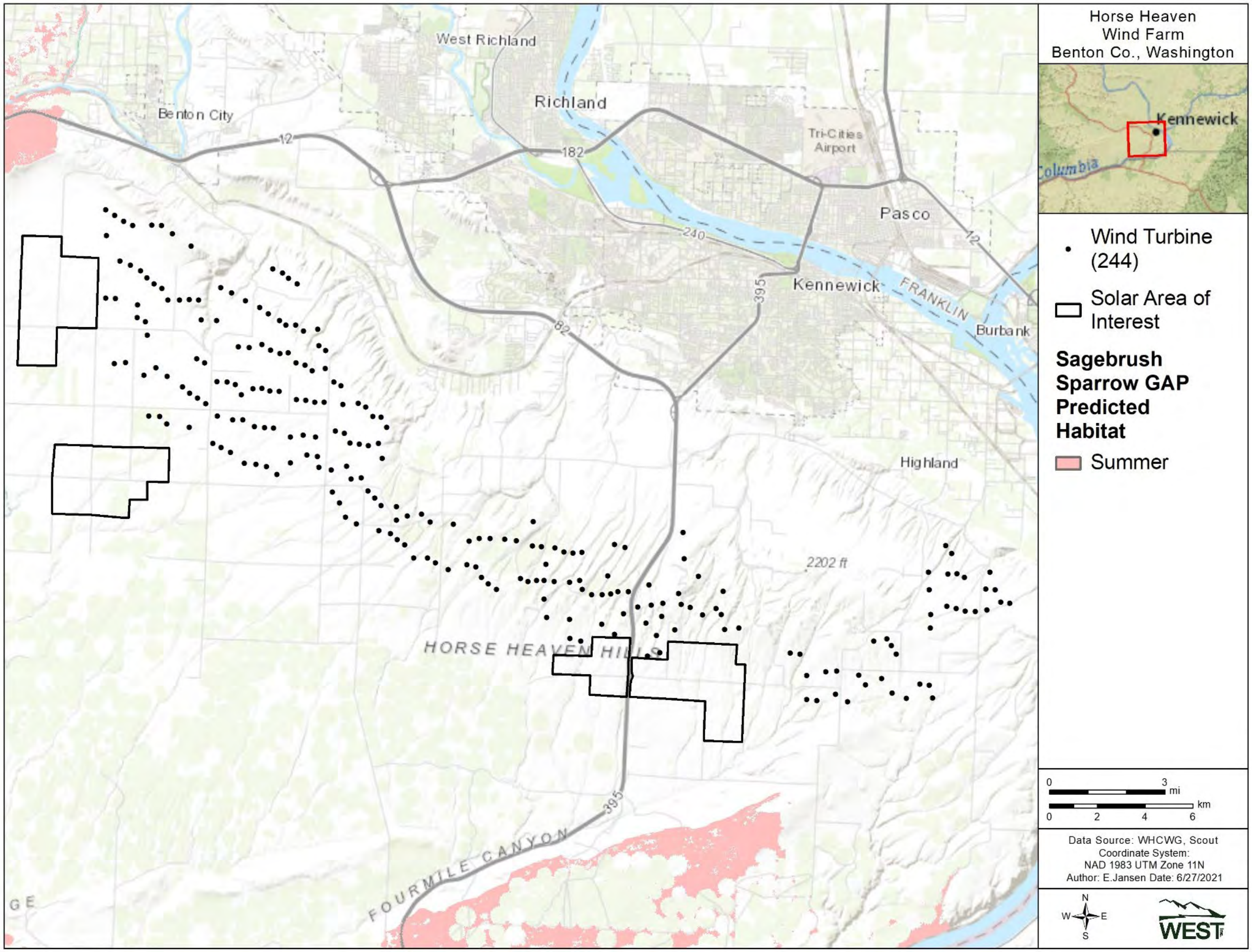
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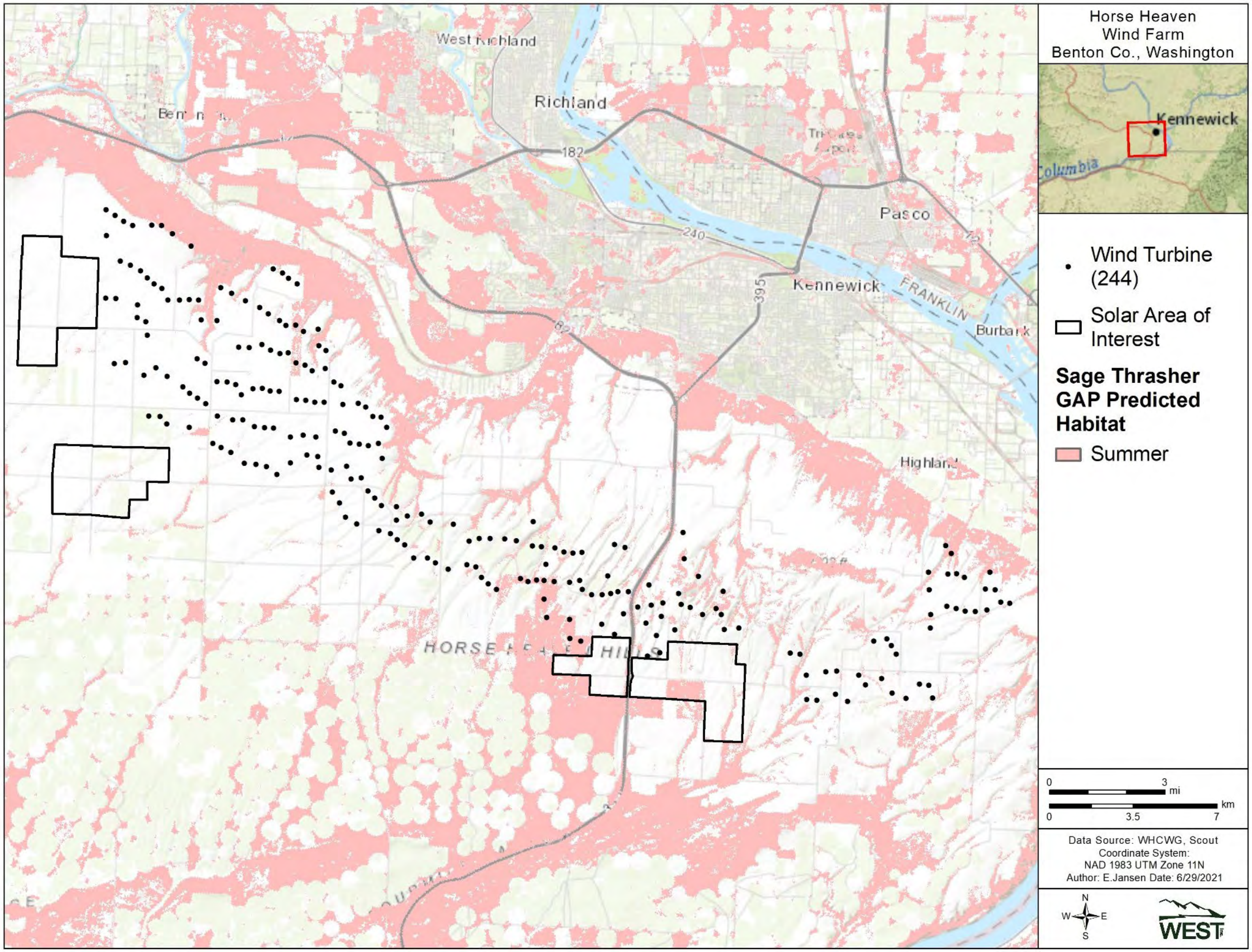

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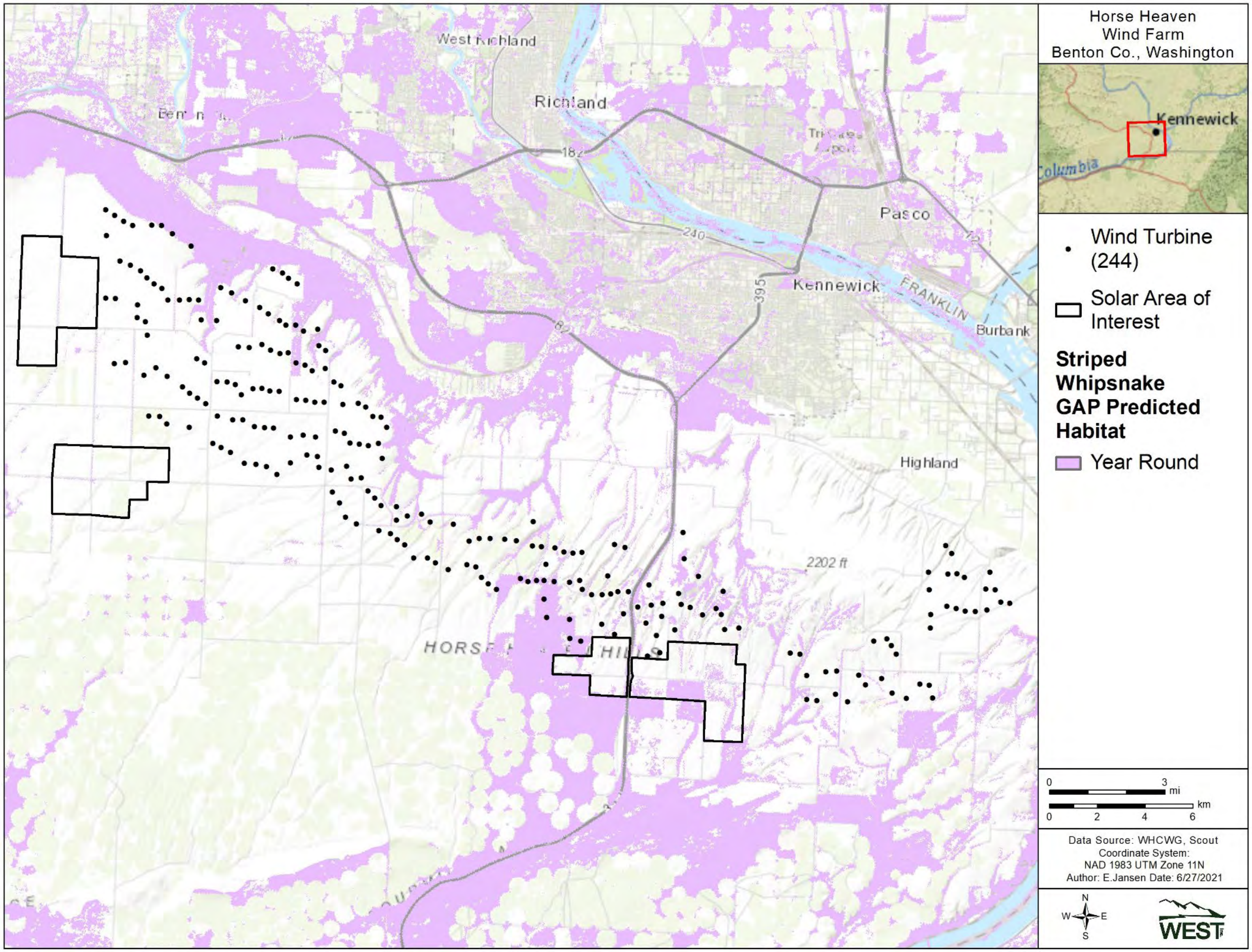
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Solar Area of Interest
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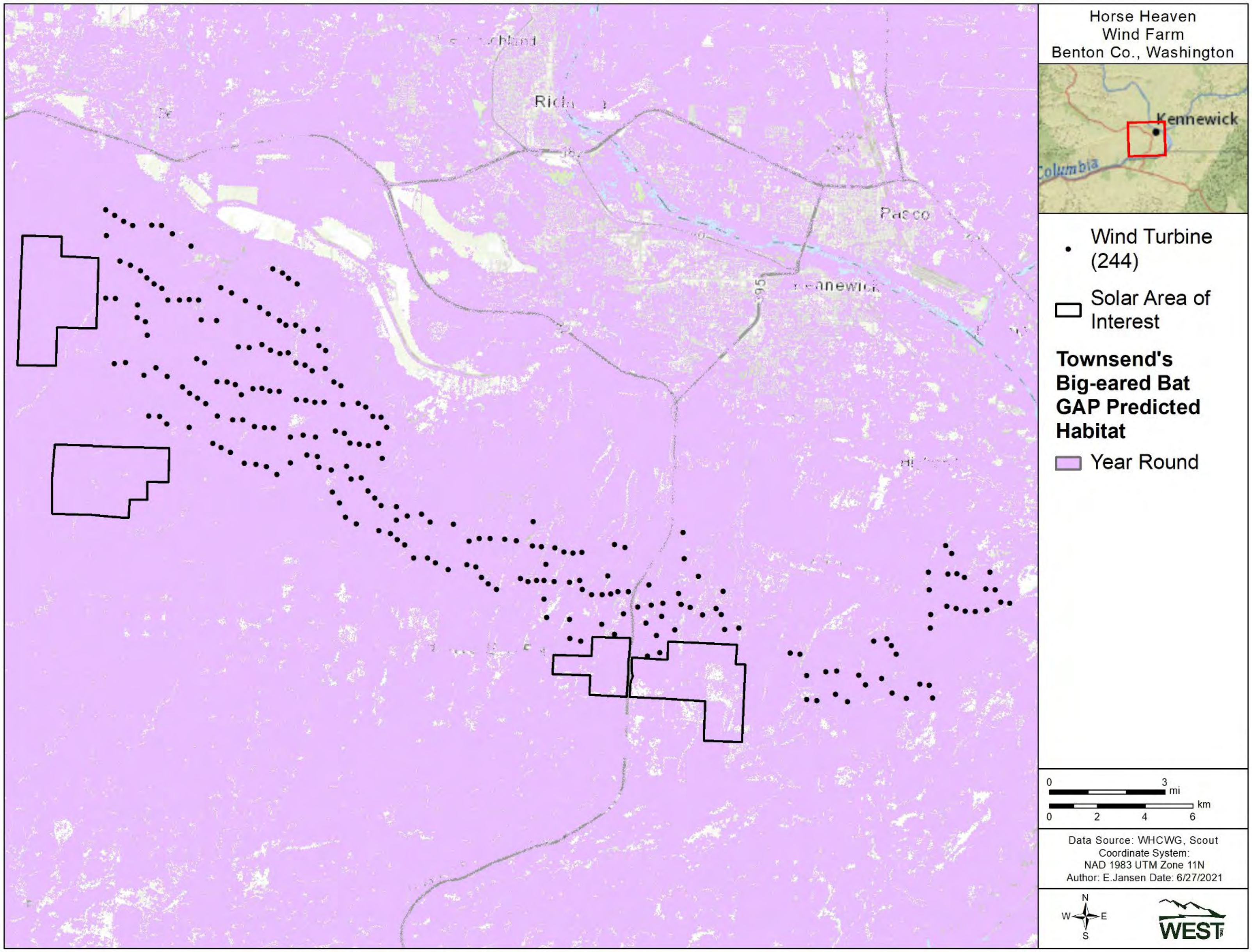
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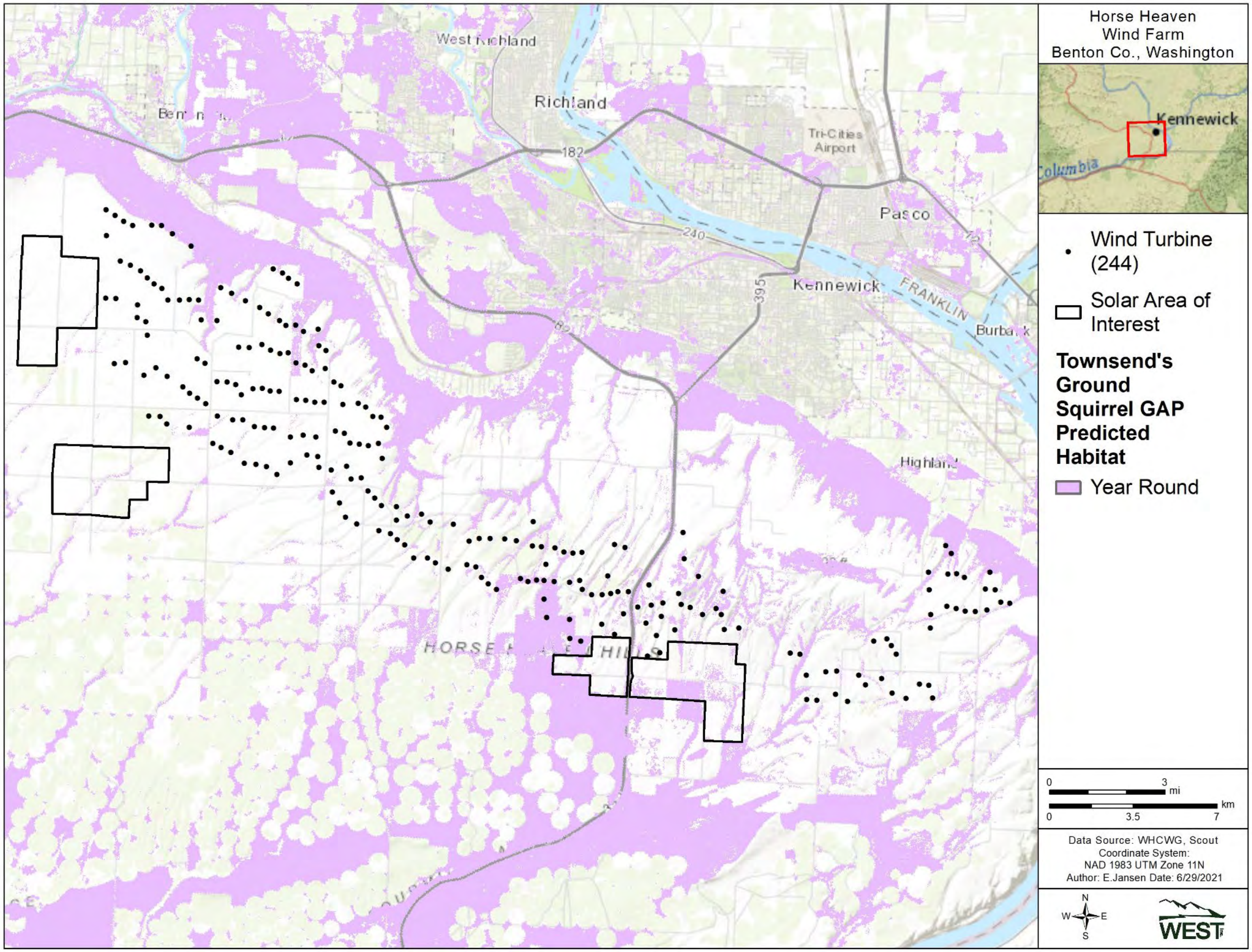
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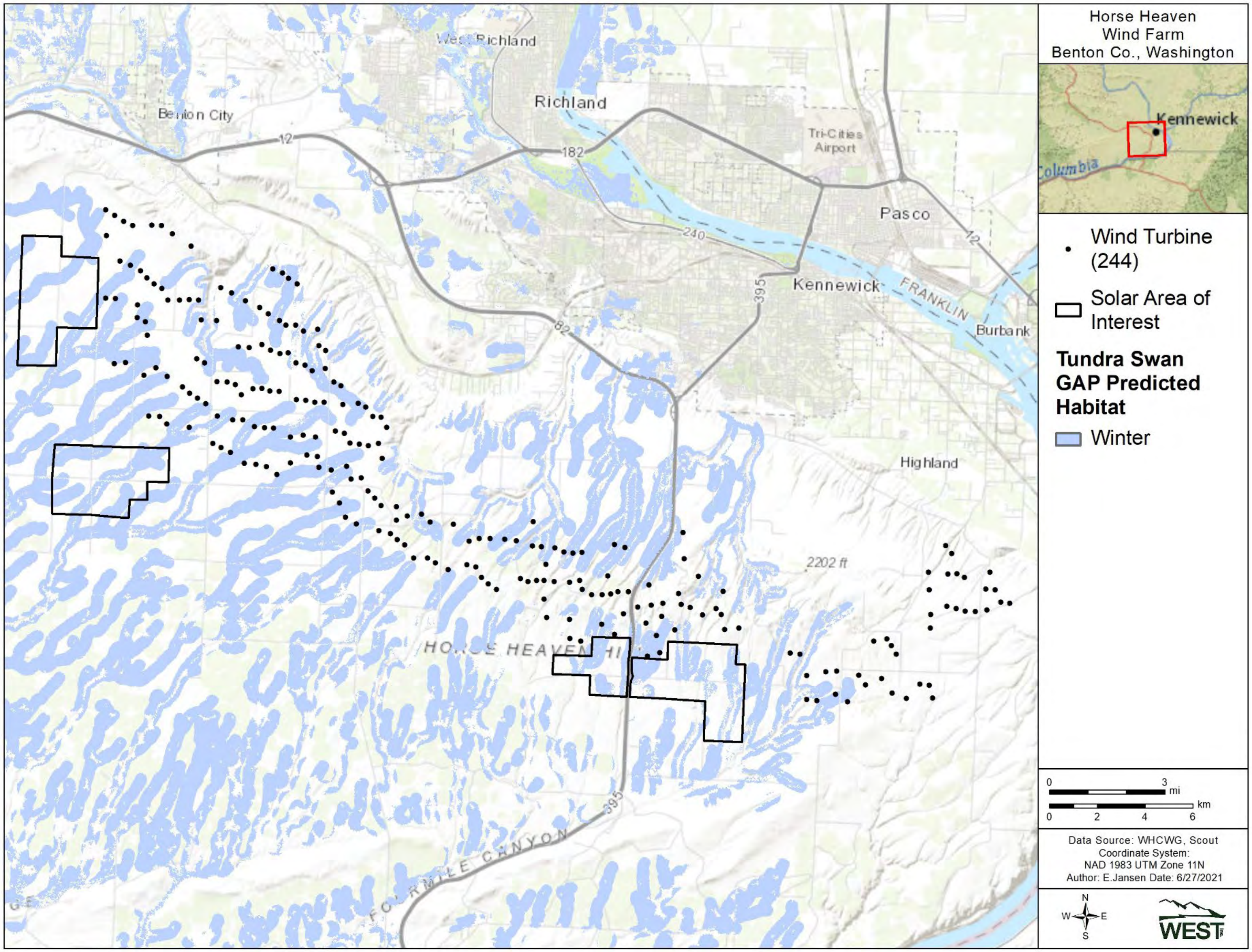
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Habitat
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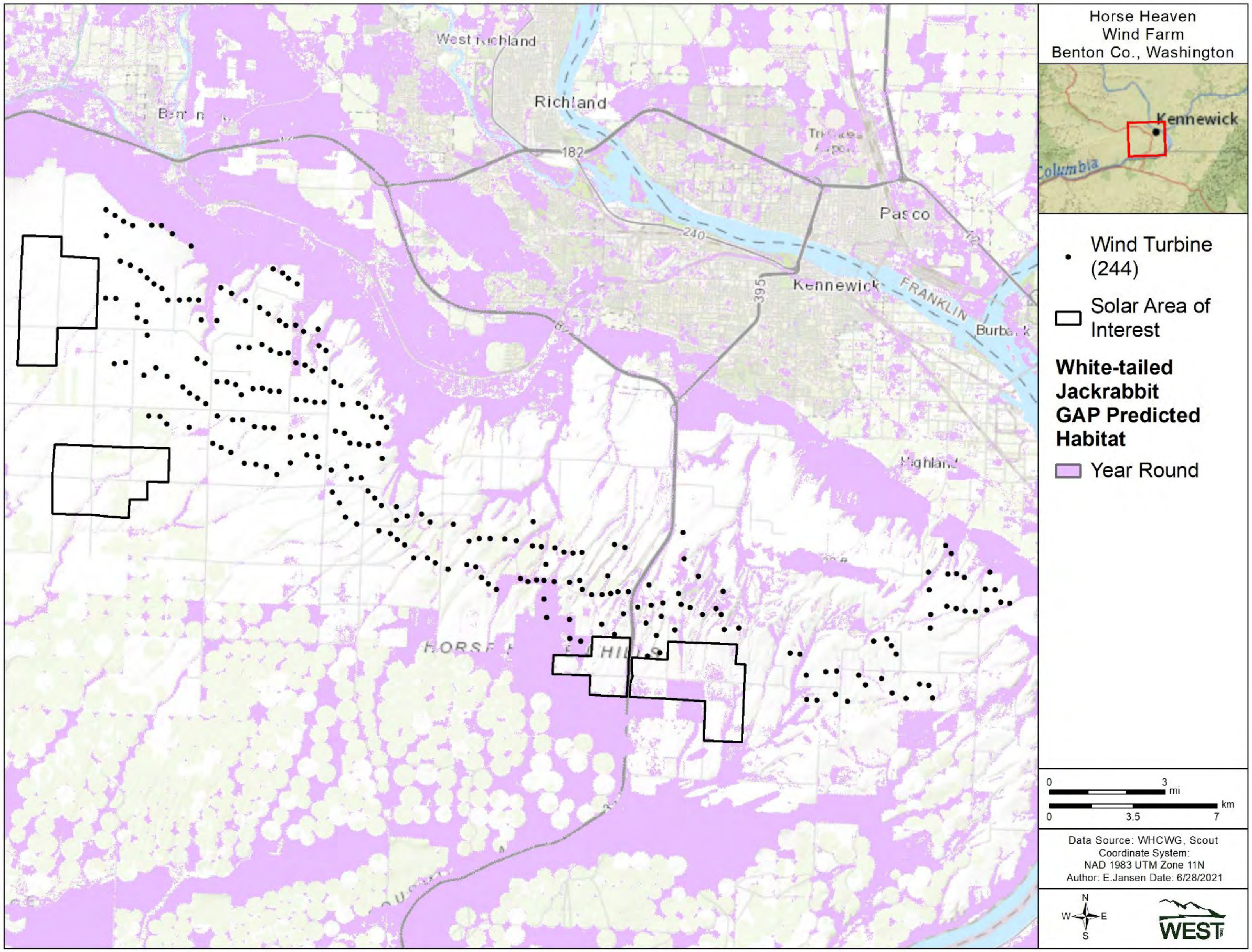
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Solar Area of Interest
White-tailed Jackrabbit GAP Predicted Habitat
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Coordinate System:
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Author: E.Jansen Date: 6/28/2021
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2021 Botany and Habitat Survey Report for Horse Heaven Wind Farm

Benton County, Washington

Prepared for

Horse Heaven Wind Farm, LLC

Prepared by

TETRA TECH

19803 North Creek Parkway

Bothell, WA 98011

August 2021

TABLE OF CONTENTS

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LIST OF ATTACHMENTS

ACRONYMS AND ABBREVIATIONS

CRP	Conservation Reserve Program
GPS	Global Positioning System
IPaC	Information for Planning and Consultation
NHD	National Hydrography Dataset
NWI	National Wetlands Inventory
PHS	Priority Habitat and Species
Project	Horse Heaven Wind Farm
Tetra Tech	Tetra Tech, Inc.
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WDFW	Washington Department of Fish and Wildlife
WNHP	Washington Natural Heritage Program

1 INTRODUCTION

This report presents the methods and results for the 2021 botanical and habitat surveys conducted by Tetra Tech, Inc. (Tetra Tech) for the Horse Heaven Wind Farm (Project). The Project is located within Benton County, approximately 2.5 miles south of Benton City and 6 miles south of Kennewick, Washington (Figure 1). In 2020, Tetra Tech conducted botanical and habitat surveys in locations associated with 44 proposed wind turbine generators preliminarily identified as occurring within native habitat (Tetra Tech 2021). The purpose of the 2021 botanical and habitat surveys was to document the presence of special status vascular plant and noxious weed species and verify, map, and characterize habitat within portions of the Project Wind Energy Micrositing Corridor and Solar Siting Areas not completed in 2020 (Figure 2).

2 METHODS

2.1 Survey Area

The 2021 Survey Area consisted of portions of the Project Wind Energy Micrositing Corridor and Solar Siting Areas that were not surveyed in 2020 (Figure 2). At the time of the surveys, access was not permitted to two parcels totaling 604 acres within the southwestern Solar Siting Area. With the exception of these two parcels, all portions of the Wind Energy Micrositing Corridor and Solar Siting Areas not completed in 2020 were surveyed in 2021. The 2021 Survey Area consisted of 18,338 acres. Although the parcels where access was not permitted were not traversed on foot during surveys (or considered part of the 2021 Survey Area), they were viewed from public roads and adjacent accessible parcels to the extent possible.

2.2 Background Review

2.2.1 Special Status Plant Species

Prior to conducting field surveys, Tetra Tech conducted a pre-field review of existing information on special status plant species with the potential to occur in Benton County and within the 2021 Survey Area. For purposes of this report, the term “special status plant” includes federally-listed endangered, threatened, or candidate vascular plant species and state endangered, threatened, and sensitive vascular plant species as defined by the Washington Natural Heritage Program (WNHP). Specific sources of information that were reviewed prior to conducting field surveys include the following:

- U.S. Fish and Wildlife Service (USFWS) Information for Planning and Consultation (IPaC) query for Benton County (USFWS 2021a);
- Washington Natural Heritage Rare Vascular and Nonvascular Species, County Lists (WNHP 2021a);
- Washington Vascular Plant Species of Special Concern (WNHP 2019);
- WNHP Element Occurrence database of rare and imperiled species and plant communities (WNHP 2021b);
- Online Field Guide to the Rare Plants of Washington (WNHP 2021c);
- USFWS National Wetlands Inventory (NWI; USFWS 2021b); and
- U.S. Geological Survey (USGS) National Hydrography Dataset (NHD; USGS 2021)

Based on review of the above sources, Tetra Tech compiled a list of special status vascular plant species known to occur or with the potential to occur in the 2021 Survey Area (Attachment A). Each of the species identified as potentially occurring within the 2021 Survey Area was assigned a “likelihood of occurrence” (i.e., highly unlikely, low, moderate) based on the proximity of known occurrences, whether the known occurrence is a historical occurrence, and the likelihood of suitable habitat occurring within the 2021 Survey Area (Attachment A). Tetra Tech also reviewed aerial imagery of the 2021 Survey Area to identify potential habitat for special status plant species within the 2021 Survey Area.

Prior to conducting field surveys, Tetra Tech reviewed existing literature, herbarium records, and other sources to generate fact sheets or “field guides” for each special status plant species with the potential to occur within the 2021 Survey Area. These fact sheets were used by surveyors in the field and included:

- Photographs of each species and its habitat;
- Information detailing habitat associations;
- Range and flowering period;
- Identifying features; and
- Characteristics distinguishing the target species from similar species within its range.

2.2.2 Noxious Weeds

Prior to field surveys, Tetra Tech reviewed lists of species designated as noxious weeds in Washington State and Benton County (BCNWCB 2020; WSNWCB 2021). Additionally, existing literature and other sources were reviewed to familiarize surveyors with identification of designated noxious weeds that would potentially be encountered within the 2021 Survey Area.

2.2.3 Habitat

Prior to conducting field surveys, Tetra Tech conducted a desktop review to preliminarily identify habitat types within the 2021 Survey Area. Sources reviewed for the preliminary habitat classification included the following:

- National Land Cover Database land cover data (Homer et al. 2020);
- Site Characterization Study Report, Badger Canyon Wind Project (Chatfield and Thompson 2018a);
- Site Characterization Study Report, Four Mile Wind Project (Chatfield and Thompson 2018b);
- Results of the 2018 vegetation and land cover mapping for the Badger Canyon Wind Project (Chatfield and Brown 2018a);
- Results of the 2018 vegetation and land cover mapping for the Four Mile Wind Project (Chatfield and Brown 2018b);
- Wildlife Survey Report for the Horse Heaven Wind Project (Jansen and Brown 2018);
- Washington Department of Fish and Wildlife (WDFW) Priority Habitat and Species (PHS) database (WDFW 2021);
- USFWS NWI (USFWS 2021b);
- USGS NHD (USGS 2021);
- Management recommendations for Washington’s priority habitats (Azerrad et al. 2011);
- Washington Large Fires 1973-2020 (DNR 2021); and
- SAGEMAP Sagebrush Habitat (USGS 2011).

Based on review of the above sources, preliminary habitat boundaries within the 2021 Survey Area were delineated. These preliminary habitat boundaries were uploaded to Samsung Galaxy tablets using ArcGIS Collector mapping software for field verification of habitat types during field surveys.

2.3 Field Surveys

Field surveys were conducted May 31–June 4, 2021. The survey dates were chosen as they coincide with the identification period for the majority of special status plant species with the potential to occur within the 2021 Survey Area.

2.3.1 Special Status Plant Survey Methods

Special status vascular plant field surveys were conducted using the focused intuitive controlled survey method, a standard and commonly accepted survey protocol (USFS and BLM 1998). This method incorporates meandering transects that traverse the survey area and that target the full array of major vegetation types (with the exception of agricultural fields as they do not support special status plant species), aspects, topographical features, habitats, and substrate types. The distribution of survey effort is based on habitat conditions observed in the field and surveyor experience and knowledge of rare plant species and their habitats. Areas that provide marginal potential habitat for rare plant species (e.g., areas dominated by non-native species) are surveyed with less intensity than areas of high-potential habitat for special status plant species (e.g., intact shrub-steppe habitat). While traversing the 2021 Survey Area, the surveyors searched for special status vascular plant species, and when the surveyors arrived at an area of high-potential habitat for special status species, they conducted a complete survey for the special status species. Complete surveys include an examination of 100 percent of the habitat.

During surveys, Tetra Tech maintained a running list of vascular plant species encountered within the 2021 Survey Area and made informal collections of unknown species for later identification. Identification was verified by the use of appropriate plant keys, in particular, *Flora of the Pacific Northwest* (Hitchcock and Cronquist 2018).

2.3.2 Noxious Weeds

Noxious weed surveys were conducted concurrently with special status plant and habitat surveys. Tetra Tech recorded observations of state- and county-designated noxious weeds. When a noxious weed was encountered in the 2021 Survey Area, the location was recorded with a global positioning system (GPS) point and the species, estimated size of the infestation (<0.1 acre; 0.1–1.0 acre; 1.0–5.0 acres), and relative abundance (sparse; common; high cover) was recorded.

2.3.3 Habitat

Tetra Tech conducted habitat surveys concurrently with special status and noxious weed surveys. Surveys consisted of a combination of roadside and pedestrian (i.e., walking) surveys. Where accessible by roads, agricultural and disturbed/developed lands were typically documented from the roadside, and the type of agriculture (e.g., wheat) or disturbance (e.g., cell tower) and status of each agricultural field (e.g., fallow, active) were noted. For non-agricultural lands and vegetated portions of disturbed or developed lands, biologists conducted pedestrian surveys that consisted of walking meandering transects throughout the area. Field surveys were conducted by a team of two biologists familiar with eastern Washington Columbia Plateau Ecoregion habitats, WDFW priority habitats (WDFW 2008), and the WDFW Wind Power Guidelines habitat categories[1] (WDFW 2009).

[1] The WDFW Wind Power Guidelines (WDFW 2009) provide specific management recommendations, alternatives for site assessment, and mitigation options and construction alternatives for avoiding impacts to Washington’s wildlife resources and habitat for proposed wind power projects. Currently, there are no similar guidelines for solar power projects.

During field surveys, habitat types within the 2021 Survey Area were documented, mapped, and characterized. In general, habitat types were adapted from habitat descriptions in the WDFW Wind Power Guidelines (WDFW 2009) and *Wildlife-habitat Relationships in Oregon and Washington* (Johnson and O'Neil 2001). Preliminary habitat classifications identified during the desktop review (see Section 2.2.3) were revised either by modifying habitat boundaries in the field utilizing the tablets and ArcGIS Collector mapping software and/or drawing revised boundaries (based on field data collection and observations described below) in Google Earth that were then digitized following the field surveys.

To help characterize and map habitat types, biologists collected GPS habitat points. Information collected at these habitat points included the percent cover, using Daubenmire cover classes (NRCS and BLM 1996), of the following:

- Total vegetation cover
- Total tree and shrub cover
- Total cover of native and non-native grasses
- Total cover of non-native species
- Total cover of annual and perennial forbs
- Cover of standing dead shrubs or trees
- Cover of litter, rock, and bare ground
- Percent cover of dominant tree, shrub, and grass species

In addition, a list of dominant forbs, as well as observed disturbances (e.g., grazing), and a general assessment of habitat quality (e.g., poor, moderate, high) were also recorded at each habitat point and a photo of the habitat was taken. In addition to walking meandering transects, the biologists scanned the adjacent landscape from vantage points that allowed views across the landscape to help map habitat boundaries.

3 RESULTS

3.1 Background Review

3.1.1 Special Status Plants

Based on the background review, one federally listed threatened vascular plant species, the Umtanum desert buckwheat (*Eriogonum codium*), is known to occur within Benton County (USFWS 2021a). However, this species has a highly restricted distribution, and the entire known population occurs in a 1.9-acre area on the eastern end of Umtanum Ridge within the Hanford Reach National Monument, which is more than 25 miles north of the Project Lease Boundary (USFWS 2019). Additionally, the approximately 5 acres of designated critical habitat for Umtanum desert buckwheat is restricted to this region along Umtanum Ridge (i.e., outside the Project Lease Boundary).

Including Umtanum desert buckwheat, which in addition to being federally listed as threatened is also considered a state endangered species, 29 state endangered, threatened, or sensitive vascular plant species are known or have the potential to occur in Benton County (WNHP 2021a). Attachment A provides the list of the 29 special status plant species known or potentially occurring in Benton County, as well as their state and federal status, preferred habitat, likelihood of occurring in the 2021 Survey Area, and recommended survey period. As noted in Attachment A, one state threatened vascular plant species, grey cryptantha (*Cryptantha leucophaea*), has been documented within 5 miles of the eastern border of the Project Lease Boundary (WNHP 2021b); however, this occurrence is across the Columbia River from the Project Lease Boundary.

During the background review, one special status lichen species, woven-spore lichen (*Texosporium sancti-jacobi*), was also identified as having the potential to occur in the 2021 Survey Area (WNHP 2021a). This species is listed as threatened in the state by the WNHP. Woven spore-lichen has been documented at four separate locations within approximately 3 miles of the Project Lease Boundary, with the closest occurrence approximately 0.4 mile to the north (WNHP 2021b).

3.1.2 Noxious Weeds

Based on the background review, 155 species are currently designated as noxious weeds in Washington State, and 124 species are currently designated as noxious weeds in Benton County (BCNWCB 2020; WSNWCB 2021). Per the WSNWCB (2021), the following are the definitions for each class of noxious weed:

- **Class A Weeds**: Non-native species whose distribution in Washington is still limited. Preventing new infestations and eradicating existing infestations are the highest priority. Eradication of all Class A plants is required by law.
- **Class B Weeds**: Non-native species presently limited to portions of the State. Species are designated for required control in regions where they are not yet widespread. Preventing new infestations in these areas is a high priority. In regions where a Class B species is already abundant, control is decided at the local level, with containment as the primary goal.
- **Class C Weeds**: Noxious weeds that are typically widespread in Washington or are of special interest to the state's agricultural industry. The Class C status allows county weed boards to require control if locally desired, or they may choose to provide education or technical consultation.

3.1.3 Habitat

Existing habitat conditions within the Survey Area are influenced by existing and past land uses, as well as historic fires that have affected the region. Therefore, a background review was conducted to determine the known extent of existing habitat conditions and historic fires within the area that have been recorded in public databases.

The WDFW PHS query identified one priority habitat, shrub-steppe, within and adjacent to much of the northern edge of the Project Lease Boundary and within portions of the 2021 Survey Area. SAGEMAP data identified sagebrush habitat as present scattered throughout the 2021 Survey Area (USGS 2011). The NHD maps 40.4 miles of intermittent streams within the 2021 Survey Area (USGS 2021). Desktop review of NWI data identified 0.25 acre of freshwater emergent wetlands and 96.3 acres of riverine wetlands within the 2021 Survey Area (USFWS 2021b). Nine fires were identified as overlapping the Project Lease Boundary between 1973 and 2020, eight of which overlap a portion of the 2021 Survey Area (Figure 3; DNR 2021).

3.2 Field Surveys

3.2.1 *Special Status Plants*

No special status vascular plant species were observed within the 2021 Survey Area during surveys conducted in 2021. In addition, very little suitable habitat for special status vascular plant species was observed (Attachment A). The list of vascular plant species observed within the 2021 Survey Area is provided as Attachment B.

Although field surveys in 2020 and 2021 were focused on special status vascular plants, a habitat suitability assessment for woven-spore lichen was conducted to identify potential suitable habitat at the Project for this species. The habitat suitability assessment is provided in Attachment C. Based on this assessment, approximately 18.9 acres within the Wind Energy Micrositing Corridor and Solar Siting Areas may provide suitable habitat for woven-spore lichen.

3.2.2 *Noxious Weeds*

Tetra Tech recorded six state- and county-designated noxious weed species during field surveys. Table 1 lists the noxious weed species observed, their noxious weed designation, and the frequency of observations. Figure 4 shows the locations of noxious weeds observed during field surveys.

Table 1. Noxious Weeds Observed During 2021 Botanical Field Surveys

Scientific Name	Common Name	State and County Class[1]	Frequency
Bassia (Kochia) scoparia	kochia	B	Abundant. Frequently observed throughout the 2021 Survey Area.
Centaurea sp.[2]	knapweed	B	Commonly observed in central portion of 2021 Survey Area. Also observed in several locations in eastern and western portion of 2021 Survey Area.
Chondrilla juncea	rush skeletonweed	B	Commonly observed throughout 2021 Survey Area.
Convolvulus arvensis	field bindweed	C	Observed in two locations in eastern portion of 2021 Survey Area.
Onopordum acanthium	Scotch thistle	B	Observed in five locations in central-eastern portion of 2021 Survey Area.
Secale cereale	cereal rye	C	Abundant. Frequently observed throughout 2021 Survey Area.

Notes:
[1] Definitions for weed classes are provided in Section 3.1.2.
[2] Individuals observed were not flowering at the time of surveys. Based on observations of rosettes and leaves, individuals and populations are believed to be either diffuse knapweed (*Centaurea diffusa*) or spotted knapweed (*Centaurea stoebe*) which are both designated Class B weeds.

Two noxious weed species were abundant throughout the 2021 Survey Area: kochia and cereal rye. Kochia was frequently observed along roadsides and along the edges of agricultural fields throughout the 2021 Survey Area. Although a few small (<0.1 acre) infestations of kochia were observed, most infestations were larger than 0.1 acre and many were larger than 1 acre. Large (greater than 1 acre), dense patches of cereal rye were frequently observed throughout the 2021 Survey Area. This noxious weed was often observed on hillslopes adjacent to agricultural fields or drainages and formed almost a complete monoculture in many the locations where it was observed.

Both knapweed and rush skeletonweed were commonly observed in the 2021 Survey Area. Knapweed was primarily observed in the central portion of the 2021 Survey Area. Patches ranged from small (<0.1 acre) to large (1-5 acres) patches that consisted of sparse, scattered individuals to areas with a high cover of knapweed. The knapweed individuals were not flowering at the time of the field surveys; however, based on the rosettes and leaf characteristics, it is assumed that individuals observed were either diffuse knapweed or spotted knapweed. Tetra Tech documented rush skeletonweed in scattered locations throughout much of the 2021 Survey Area, with the exception of the northwest portion (Figure 4). Although most patches of rush skeletonweed were either small (<0.1 acre) or medium (0.1-1 acre) in size, several larger infestations (1-5 acres) were observed scattered throughout the central portion of the 2021 Survey Area. Typically, observations of rush skeletonweed consisted of small patches or individuals scattered throughout the area, instead of occurring in dense populations.

Scotch thistle was observed in five locations in the 2021 Survey Area: all in the central-eastern portion of the 2021 Survey Area (Figure 4). Three of the five infestations were between approximately 0.1 and 1 acre in size with many Scotch thistle plants, while two infestations were small (<0.1 acre) and consisted of just a few plants. Two small (<0.1 acre) infestations of field bindweed were observed: one in the northeastern portion and one in the central-eastern portion of the 2021 Survey Area (Figure 4).

Cereal rye is a Class C noxious weed, indicating that it is either widespread in the state or is of interest to the state's agricultural industry. The other four species observed are Class B noxious weeds, meaning that they are designated for required control in regions where they are not yet widespread and preventing new infestations in these areas is a high priority. In regions where these species are already abundant, control is decided at the local level, with containment as the primary goal (WSNWCB 2021).

3.2.3 Habitat

The following seven habitat types were field mapped within the 2021 Survey Area:

- Agricultural land
- Developed/disturbed
- Eastside (interior) grassland
- Non-native grassland
- Planted grassland
- Rabbitbrush shrubland
- Sagebrush shrub-steppe

Table 2 lists the acres of each habitat type found within the 2021 Survey Area, and Figure 5 displays the locations of habitat types mapped within the 2021 Survey Area. Each of these habitat types is briefly described below. Representative photos of habitat types observed during field surveys are provided in Attachment D. As noted in Section 2.1, access to two parcels totaling 604 acres within the southwestern Solar Siting Area was not permitted during the 2021 surveys. While these areas were not traversed on foot or considered part of the 2021 Survey Area, they were viewed from adjacent accessible parcels and public roads to the extent possible. Of these 604 acres, it was determined that approximately 595 acres (99 percent) consisted of cultivated agricultural land. Based on a desktop review of the areas that were not able to be viewed from adjacent parcels or public roads, the remaining approximately 9 acres (1 percent) was determined to potentially consist of non-native grassland (6 acres) and sagebrush shrub-steppe (3 acres).

In general, vegetation within the majority of the 2021 Survey Area has been heavily modified due to historic and current agriculture and grazing activity. Non-native invasive grasses and forbs, such as bulbous bluegrass, cereal rye, cheatgrass, prickly lettuce, Russian thistle, tall tumblemustard, and yellow salsify, are prevalent throughout the 2021 Survey Area.

Table 2. Habitat Types Mapped within the 2021 Survey Area

Habitat Type	Acres in Survey Area (Percent of Survey Area)	Common Plant Species Observed[1]
Agricultural land	15,273 (83%)	Wheat or fallow wheat fields. In addition to wheat, several non-native grasses and forbs were observed in agricultural fields, including: Grasses: **cereal rye (*Secale cereale*), cheatgrass (*Bromus tectorum*)** Forbs: **kochia (*Bassia* [*Kochia*] *scoparia*), prickly lettuce (*Lactuca serriola*), Russian thistle (*Salsola tragus*)**
Developed/disturbed	221 (1%)	No to limited vegetation observed. Where vegetation exists, species are similar to those listed under the non-native grassland habitat type.
Eastside (interior) grassland[2]	174 (1%)	Shrubs: green rabbitbrush (*Chrysothamnus viscidiflorus*), rubber rabbitbrush (*Ericameria nauseosa*) Grasses: bluebunch wheatgrass (*Pseudoroegneria spicata*), **bulbous bluegrass (*Poa bulbosa*), cheatgrass, cereal rye,** Great Basin wildrye (*Leymus cinereus*), needle-and-thread (*Hesperostipa comata*), Sandberg bluegrass (*Poa secunda* ssp. *secunda*) Forbs: Carey's balsamroot (*Balsamorhiza* careyana), **common stork's bill** (*Erodium cicutarium*), fiddleneck (*Amsinckia* spp.), lupine (*Lupinus* spp.), **prickly lettuce,** shaggy fleabane (*Erigeron pumilus*), Spalding's milkvetch (*Astragalus spaldingii*), **tall tumblemustard,** triternate biscuit-root (*Lomatium triternatum*), wild blue flax (*Linum lewisii* var. *lewisii*), woolly plantain (*Plantago patagonica*), woollypod milkvetch (*Astragalus purshii*), yarrow (*Achillea millefolium*), **yellow salsify (*Tragopogon dubius*)**
Non-native grassland	929 (5%)	Shrubs: rubber rabbitbrush (only occasionally observed, and when observed was very sparse) Grasses: **bulbous bluegrass, cereal rye, cheatgrass** Forbs: fiddleneck, **kochia, prickly lettuce, Russian thistle, tall tumblemustard,** yarrow, **yellow salsify**
Planted grassland	602 (3%)	Shrubs: rubber rabbitbrush Grasses: big bluegrass (*Poa secunda* ssp. *juncifolia*), bluebunch wheatgrass, **cereal rye, cheatgrass, crested wheatgrass (*Agropyron cristatum*)** Forbs: bigflower agoseris (*Agoseris grandiflora*), yarrow, hawksbeard (*Crepis* spp.), hoary-aster (*Dieteria canescens*), shaggy fleabane, **prickly lettuce, tall tumblemustard, yellow salsify**
Rabbitbrush shrubland	980 (5%)	Shrubs: green rabbitbrush, rubber rabbitbrush Grasses: big bluegrass, bluebunch wheatgrass, **bulbous bluegrass, cereal rye, cheatgrass, crested wheatgrass,** Idaho fescue (*Festuca idahoensis*), needle-and-thread Forbs: Carey's balsamroot, fiddleneck, hoary-aster, lupine, **knapweed , prickly lettuce,** shaggy fleabane, **tall tumblemustard,** threadleaf fleabane (*Erigeron filifolius*), woolly plantain, yarrow, **yellow salsify**
Sagebrush shrub-steppe[2]	161 (1%)	Shrubs: big sagebrush (*Artemisia tridentata*), green rabbitbrush, rubber rabbitbrush Grasses: bluebunch wheatgrass, **bulbous bluegrass, cereal rye, cheatgrass,** needle-and-thread, Sandberg bluegrass, Forbs: Carey's balsamroot, **common stork's bill,** desert parsley (*Lomatium* sp.), fiddleneck, hoary-aster, long-leaf phlox (*Phlox longifolia*), low pussytoes (*Antennaria dimorpha*), lupine, milkvetch (*Astragalus purshii, A. spaldingii*), **prickly lettuce, Russian thistle,** sagebrush mariposa lily (*Calochortus macrocarpus* var. *macrocarpus*), shaggy fleabane, **tall tumblemustard,** wild blue flax, woolly plantain, yarrow, **yellow salsify**
Total	**18,338 (100%)**[3, 4]	

Notes:
[1] Species in **bold** are non-native.
[2] Listed as a priority habitat by the WDFW (WDFW 2008).
[3] Totals may not sum exactly due to rounding.
[4] Total does not include the 604 acres of the western solar siting areas where access was not permitted during 2021 surveys.

3.2.3.1 Agricultural Land

Areas mapped as agricultural land within the 2021 Survey Area consisted of active wheat fields and fallow wheat fields (i.e., fields in active rotation but not planted during the current season). The vast majority of the 2021 Survey Area was mapped as agricultural land (Table 2; Figure 5).

3.2.3.2 Developed/Disturbed

Developed/disturbed areas mapped within the 2021 Survey Area primarily included roads, structures and other disturbed areas associated with agricultural production, gravel piles for road repair and construction, and cell towers. The majority of the areas mapped as developed/disturbed were unvegetated or sparsely vegetated. Where present, vegetation within developed/disturbed areas was dominated by non-native invasive species such as cereal rye, cheatgrass, kochia, and prickly lettuce.

3.2.3.3 Eastside (Interior) Grassland

Eastside (interior) grassland habitat was mapped in three locations within the 2021 Survey Area. The largest of these locations was associated with the Solar Siting Area in the southeastern portion of the 2021 Survey Area. Dominant species observed in this location included the native grass needle-and-thread and the native forbs yarrow, shaggy fleabane, and lupine, as well as the non-native grasses and forbs: bulbous bluegrass, cereal rye, cheatgrass, prickly lettuce, yellow salsify, and common stork's-bill. Although rubber rabbitbrush and green rabbitbrush were observed in this area, the cover of these species was less than 5 percent. This area of eastside (interior) grassland is degraded due to the high cover of non-native species and heavy cattle grazing.

The other two locations were mapped in the central portion of the 2021 Survey Area. One of these locations consisted of a small area dominated by Great Basin wildrye along an ephemeral drainage (Attachment D, Photo 6). This area was also highly degraded due to the high cover of non-native species including cereal rye, cheatgrass, and tall tumblemustard. The third location was located on steep hillslopes along Badger Canyon. The 2018 Locust Grove Fire was mapped as overlapping a portion of this area (Figure 3; DNR 2021). Dominant species observed in this area included the native grasses and forbs: bluebunch wheatgrass and Sandberg bluegrass, Carey's balsamroot, lupine, yarrow, and Spalding's milkvetch and the non-native grasses and forbs: cheatgrass and tall tumblemustard. Although traces of rabbitbrush were observed in this area, no shrubs or seedlings of sagebrush (*Artemisia* spp.), including burned or dead sagebrush, were observed in this area (Attachment D, Photo 7). The habitat quality on the east side of Badger Canyon was higher (lower cover of non-native species, less signs of cattle grazing) than on the west side of the canyon.

3.2.3.4 Non-native Grassland

Non-native grassland habitat was commonly observed in the 2021 Survey Area. This habitat type was often observed on hillslopes and adjacent draws; however, it was also found adjacent to agricultural fields or in other flat areas where formerly planted and/or native grassland is now dominated by non-native grass and forb species. The majority of areas mapped as non-native grassland habitat consisted of vast areas dominated by dense cover of cereal rye (Attachment D, Photos 2, 3, and 8). As noted in Section 3.2.2, cereal rye is listed as a Class C noxious weed in Washington State and Benton County. Other common species observed in this habitat type include cheatgrass, prickly lettuce, tall tumblemustard, and yellow salsify. Although native forbs including yarrow, hoary-aster, and slender hareleaf (*Lagophylla ramosissima*) were occasionally observed in this habitat type, they typically represented only a small percent cover of the overall vegetative cover.

3.2.3.5 Planted Grassland

Within the 2021 Survey Area, the planted grassland habitat type consists of former agricultural lands or other disturbed areas (e.g., disturbed from wildfire) that have been planted with non-native grasses, native grasses and/or native shrubs. These areas may have been or may currently be enrolled in the Conservation Reserve Program (CRP) but their current legal status is unknown.

Areas mapped as planted grassland include areas planted with the non-native perennial grass crested wheatgrass , as well as areas planted primarily with the native perennial grasses bluebunch wheatgrass and big bluegrass. Rabbitbrush, primarily rubber rabbitbrush, was also commonly observed in this habitat type. Areas mapped as planted grassland typically contained less than approximately 10 percent cover of rabbitbrush. However, small (less than 1 acre) dense patches of rabbitbrush occur in this habitat type. Areas where high cover of rabbitbrush was observed were mapped as the rabbitbrush shrubland habitat type (see Section 3.2.3.6).

The quality of planted grassland habitat type within the 2021 Survey Area varied, with some areas of planted grassland habitat containing a higher predominance of native species such as bluebunch wheatgrass, big bluegrass, yarrow, and large-flowered agoseris and lower cover of non-native invasive species (Attachment D, Photo 10). Other areas of planted grassland habitat contain a high predominance of non-native species including the planted perennial grass crested wheatgrass and/or higher cover of non-native invasive species such as cheatgrass, cereal rye, prickly lettuce, and yellow salsify (Attachment D, Photo 11). In the western portion of the Survey Area, several areas mapped as planted grassland habitat consisted of dead and dying planted grasses (Attachment D, Photo 12). In general, planted grassland habitat contained a low diversity of forb species.

3.2.3.6 Rabbitbrush Shrubland

Rabbitbrush shrubland habitat was primarily mapped in the central and eastern portions of the 2021 Survey Area (Figure 5). Similar to the planted grassland habitat type, this habitat type was often observed in former agricultural lands or other disturbed areas (e.g., disturbed from wildfire) that appear to have been planted with non-native grasses, native grasses, and/or native shrubs (Attachment D, Photo 13). These areas may have been or may currently be enrolled in the CRP, but their current status is unknown. It is unknown whether rabbitbrush was planted in these areas or has established naturally. Rubber rabbitbrush is an early seral species that readily colonizes disturbed sites, such as areas disturbed by overgrazing or fire or abandoned agricultural lands (Faber-Langendoen et al. 2013; Tirmenstein 1999; USDA 2017). Within the 2021 Survey Area, rabbitbrush shrubland was also observed on hillslopes that are too steep for agricultural cultivation (Attachment D, Photos 14 and 15). Rabbitbrush may have colonized some of these hillslopes following past wildfires.

Shrub cover in the rabbitbrush shrubland habitat type ranged between approximately 10 to 80 percent cover, but was typically greater than 25 percent. Rubber rabbitbrush was the dominant shrub species observed, although green rabbitbrush and occasionally spineless horsebrush was also observed in this habitat type. Other common species observed in rabbitbrush shrubland habitat included the native grasses big bluegrass and bluebunch wheatgrass and the non-native grasses crested wheatgrass, cheatgrass, and cereal rye. Common forbs observed included the native forbs hoary-aster (*Dieteria canescens*), shaggy fleabane, and yarrow and the non-native forbs prickly lettuce, tall tumblemustard, and yellow salsify.

3.2.3.7 Sagebrush Shrub-steppe

Sagebrush shrub-steppe habitat was mapped in scattered locations within the 2021 Survey Area; however, it was most prevalent in the eastern portion of the survey area (Figure 5). In general, sagebrush shrub-steppe habitat within the 2021 Survey Area was restricted to hillslopes and drainages that are too steep for agricultural production (Attachment D, Photo 16). The vast majority of sagebrush shrub-steppe habitat within the 2021 Survey Area was fragmented and highly degraded due to high cover of non-native grass and forb species and/or grazing (Attachment D, Photo 17). In a few areas mapped as sagebrush shrub-steppe, evidence of past wildfires was noted by the presence of dead shrubs (Attachment D, Photo 18).

Shrub cover in sagebrush shrub-steppe habitat type ranged between approximately 5 and 75 percent cover, but was typically less than 40 percent. The dominant shrub species in this habitat type was big sagebrush. Other shrub species commonly observed include rubber rabbitbrush and green rabbitbrush; and spineless horsebrush (*Tetradymia canescens*) and threetip sagebrush (*Artemisia tripartita*) were also observed in a few locations. Cover and diversity of grasses and forbs was variable within this habitat type; however, cover of non-native grasses including cereal rye, cheatgrass, and bulbous bluegrass was typically high. Other grasses and forbs commonly observed in sagebrush shrub-steppe habitat include the native grasses and forbs: bluebunch wheatgrass, needle-and-thread, Sandberg bluegrass, Carey's balsamroot, yarrow, long-leaf phlox, lupine, shaggy fleabane, woolly plantain , and Spalding's milkvetch, and the non-native forbs: redstem stork's bill, prickly lettuce, Russian thistle, tall tumblemustard, and yellow salsify.

4 CONCLUSIONS

Tetra Tech did not document any special status plant species within the 2021 Survey Area. Five noxious weed species were documented, several of which were abundant within the 2021 Survey Area.

Seven habitat types were mapped and characterized within the 2021 Survey Area. The vast majority (approximately 83 percent) of the 2021 Survey Area was found to consist of agricultural land. Developed/disturbed and non-native grassland accounted for approximately 6 percent of the 2021 Survey Area and eastside (interior) grassland, planted grassland, rabbitbrush shrubland, and sagebrush shrub-steppe accounted for the remaining approximately 10 percent of the 2021 Survey Area. As noted in Sections 2.1 and 3.2.3, access to two parcels totaling 604 acres within the southwestern Solar Siting Area was not permitted during the 2021 surveys. While these areas were not traversed on foot during surveys or considered part of the 2021 Survey Area, they were viewed from adjacent accessible parcels and public roads to the extent possible. Of these 604 acres, it was determined that approximately 99 percent (595 acres) of this area consists of agricultural land. In general, habitat in the vast majority of the 2021 Survey Area has been heavily modified and degraded due to historic and current agriculture and grazing activity, wildfires, and the presence of non-native, invasive plant species.

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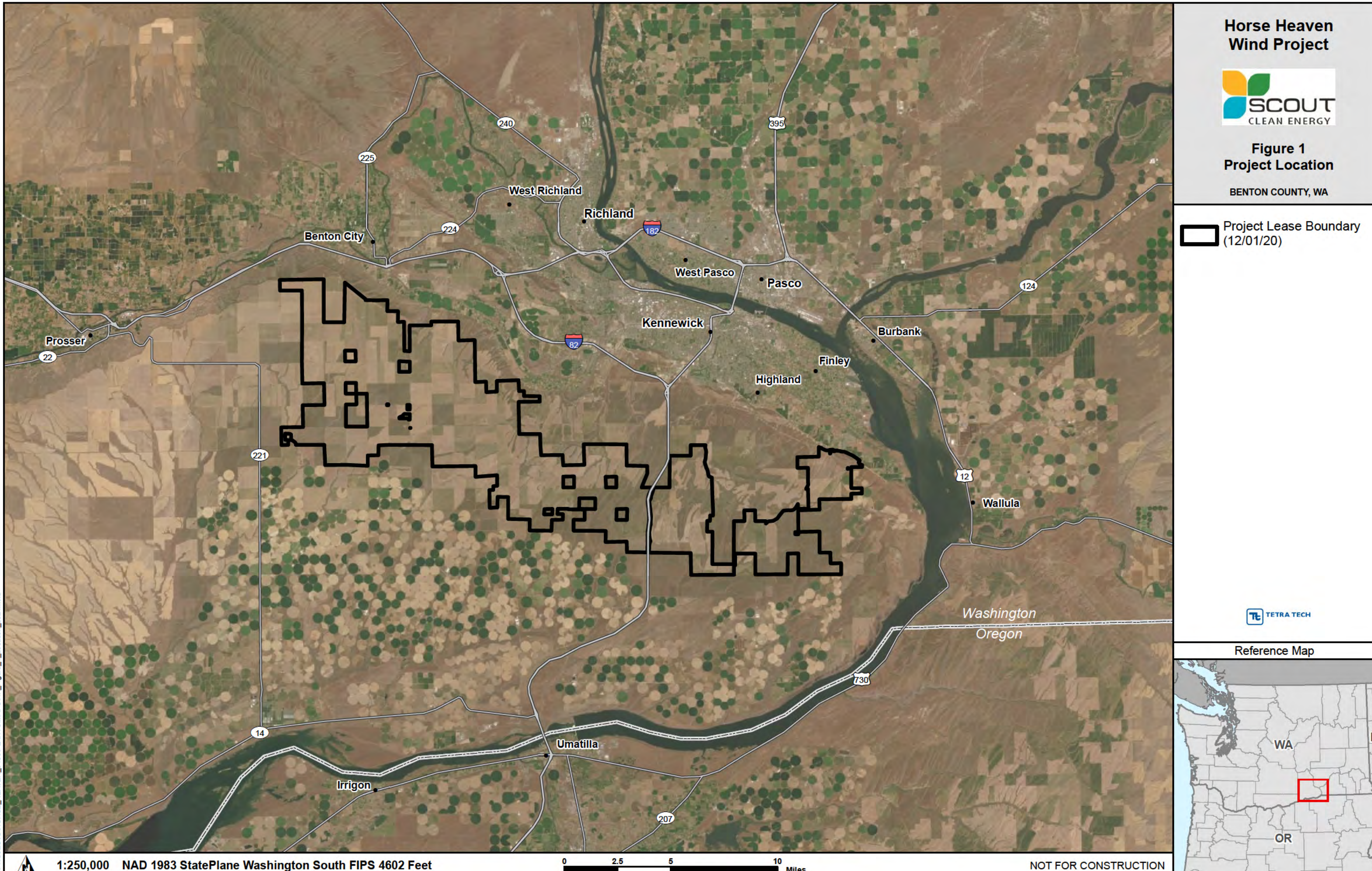
FIGURES

Horse Heaven Wind Project

SCOUT CLEAN ENERGY

Figure 1
Project Location

BENTON COUNTY, WA



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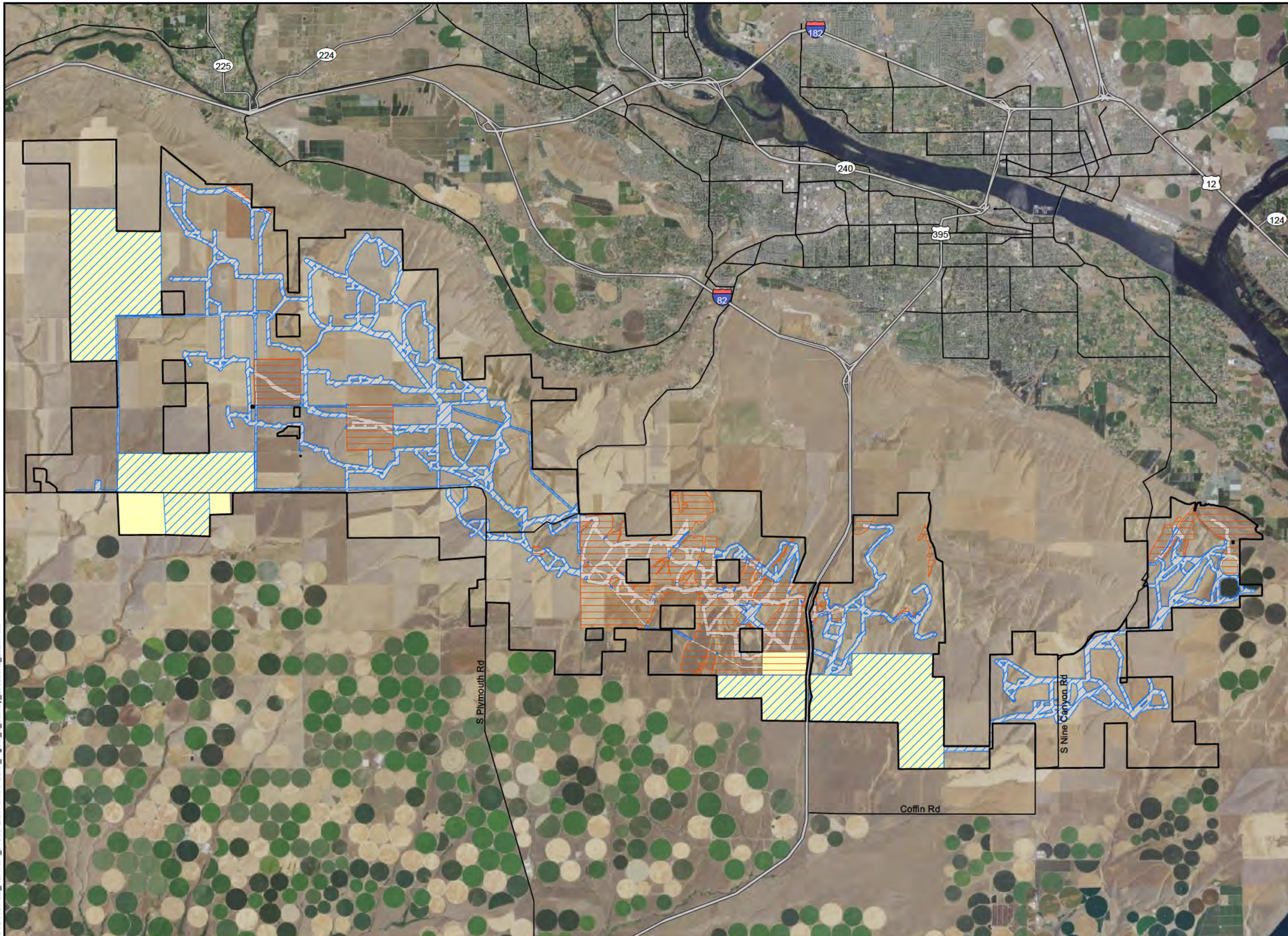
Horse Heaven Wind Project

SCOUT CLEAN ENERGY

Figure 2
2020 and 2021 Survey Area

BENTON COUNTY, WA



- Project Lease Boundary (12/01/20)
- 2021 Survey Area
- 2020 Survey Area (Tetra Tech 2021)
- Wind Energy Micrositing Corridor (12/03/20)
- Solar Siting Area

TETRA TECH

Reference Map

1:130,000 NAD 1983 StatePlane Washington South FIPS 4602 Feet

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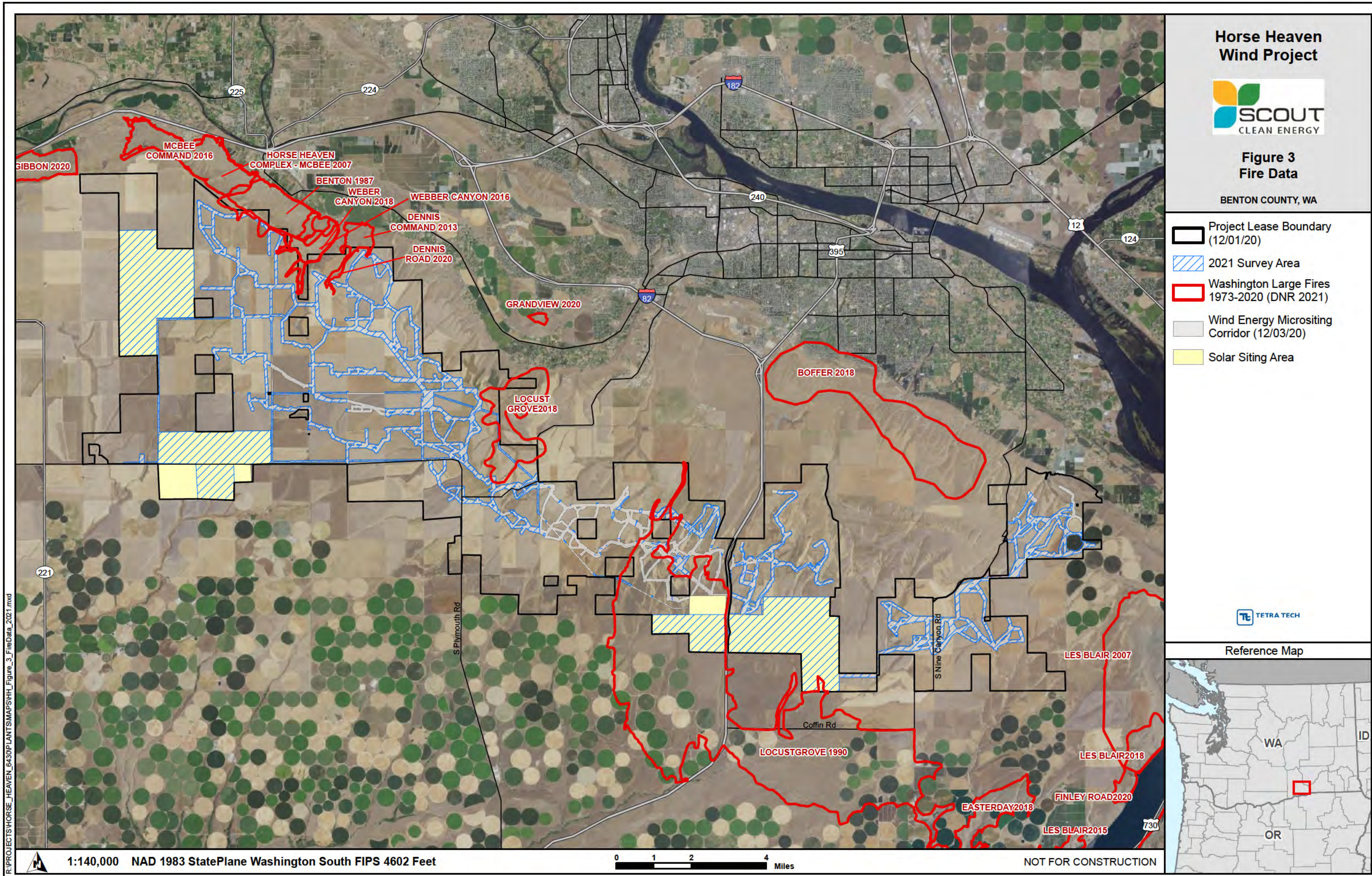

Horse Heaven Wind Project
SCOUT CLEAN ENERGY
Figure 3
Fire Data
BENTON COUNTY, WA
Project Lease Boundary (12/01/20)
2021 Survey Area
Washington Large Fires 1973-2020 (DNR 2021)
Wind Energy Micrositing Corridor (12/03/20)
Solar Siting Area
TETRA TECH
Reference Map
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OR
MCBEE COMMAND 2016
HORSE HEAVEN COMPLEX - MCBEE 2007
GIBBON 2020
BENTON 1987
WEBER CANYON 2018
WEBBER CANYON 2016
DENNIS COMMAND 2013
DENNIS ROAD 2020
GRANDVIEW 2020
LOCUST GROVE2018
BOFFER 2018
LES BLAIR 2007
LES BLAIR2018
FINLEY ROAD2020
EASTERDAY2018
LES BLAIR2015
LOCUSTGROVE 1990
Coffin Rd
S Plymouth Rd
S Nine Canyon Rd
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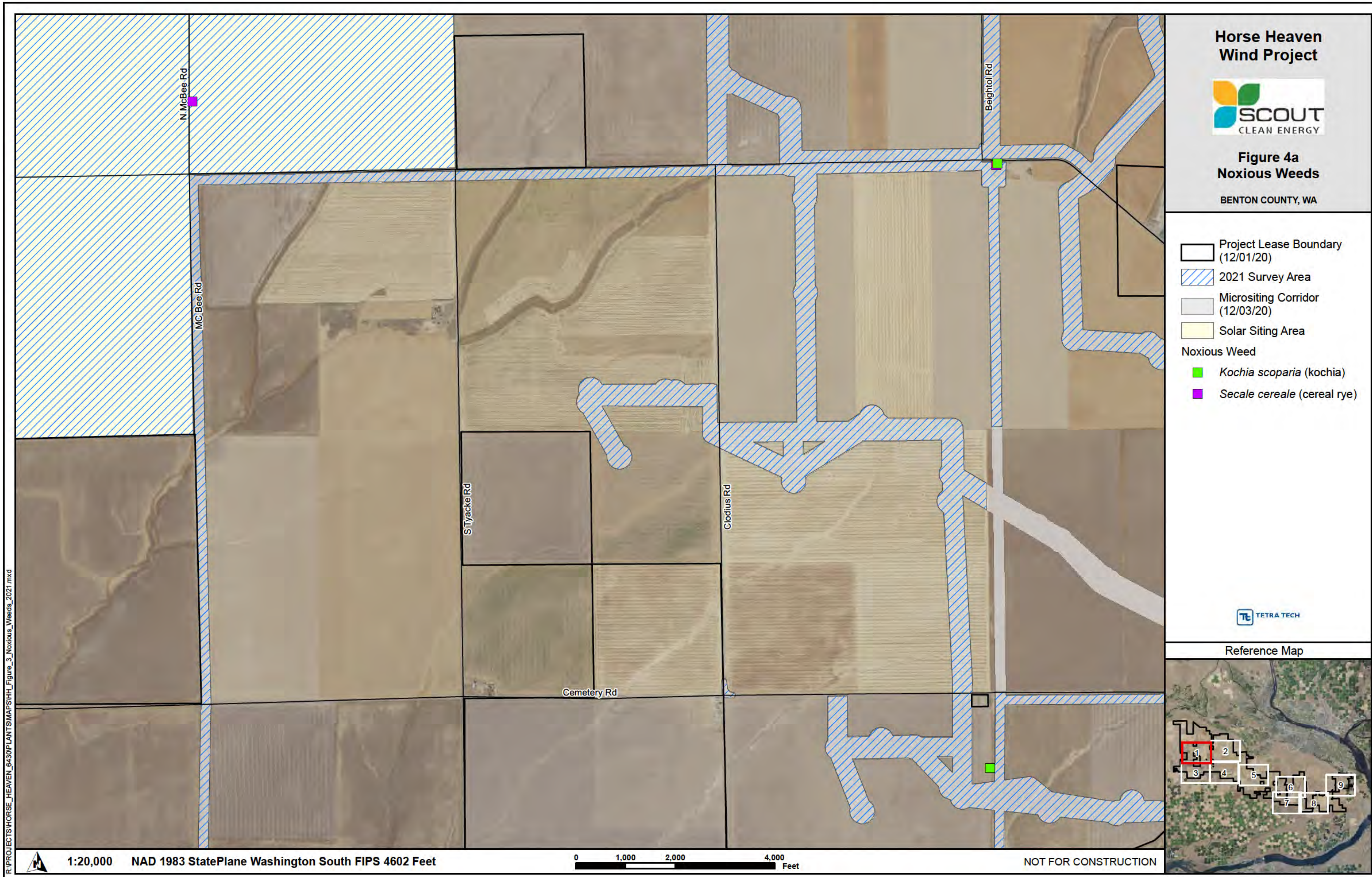

Horse Heaven Wind Project
SCOUT CLEAN ENERGY
Figure 4a
Noxious Weeds
BENTON COUNTY, WA
Project Lease Boundary (12/01/20)
2021 Survey Area
Micrositing Corridor (12/03/20)
Solar Siting Area
Noxious Weed
Kochia scoparia (kochia)
Secale cereale (cereal rye)
TETRA TECH
Reference Map
N McBee Rd
MC Bee Rd
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S Tyacke Rd
Clodius Rd
Cemetery Rd
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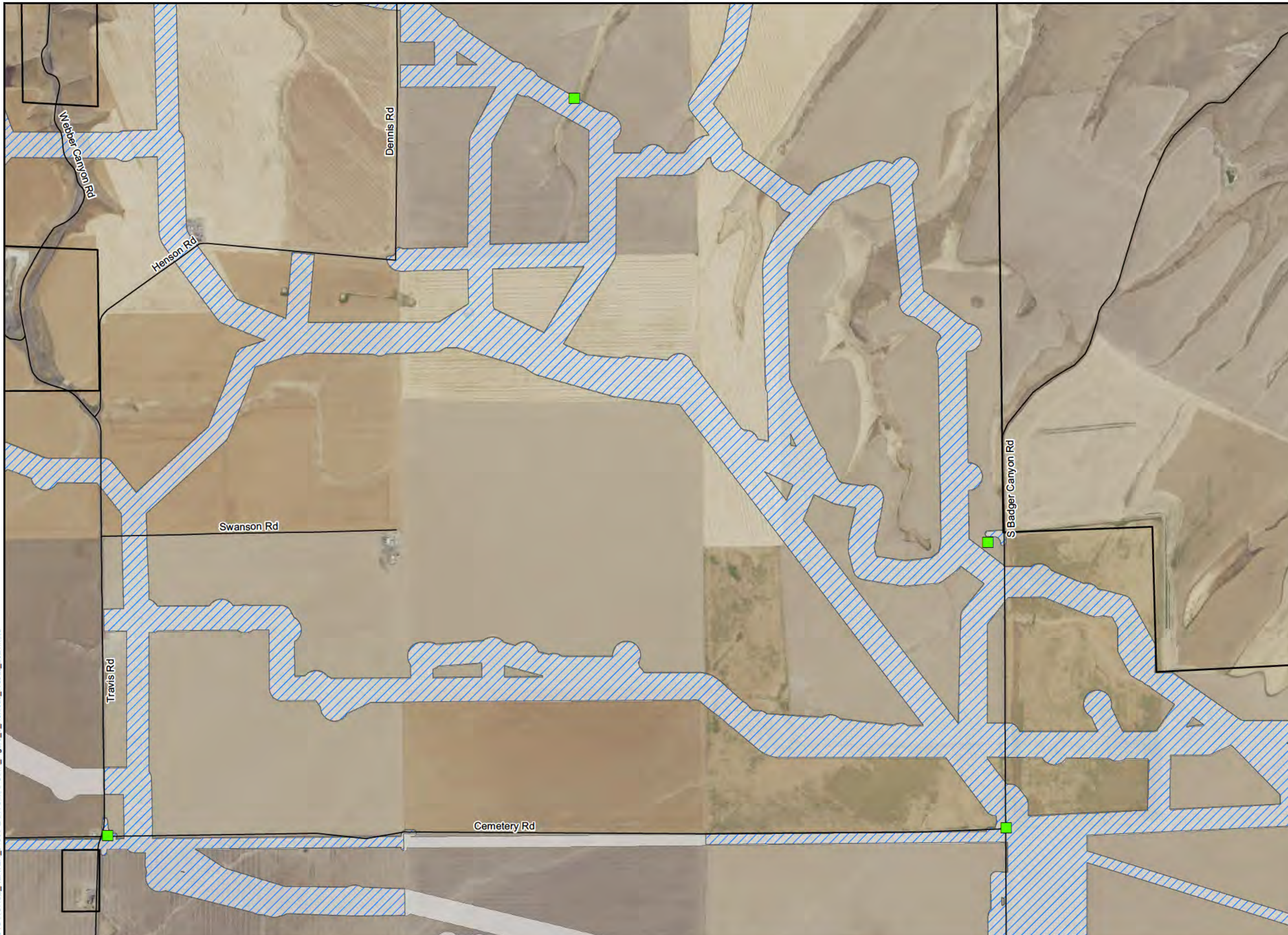
Horse Heaven Wind Project

SCOUT CLEAN ENERGY

Figure 4b
Noxious Weeds

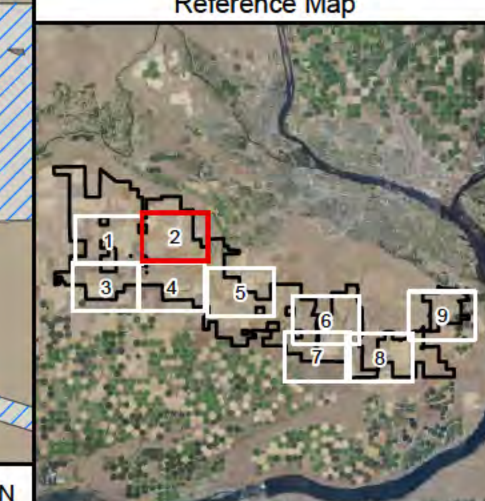
BENTON COUNTY, WA



Project Lease Boundary (12/01/20)
2021 Survey Area
Micrositing Corridor (12/03/20)
Solar Siting Area
Noxious Weed
Kochia scoparia (kochia)

TETRA TECH

Reference Map



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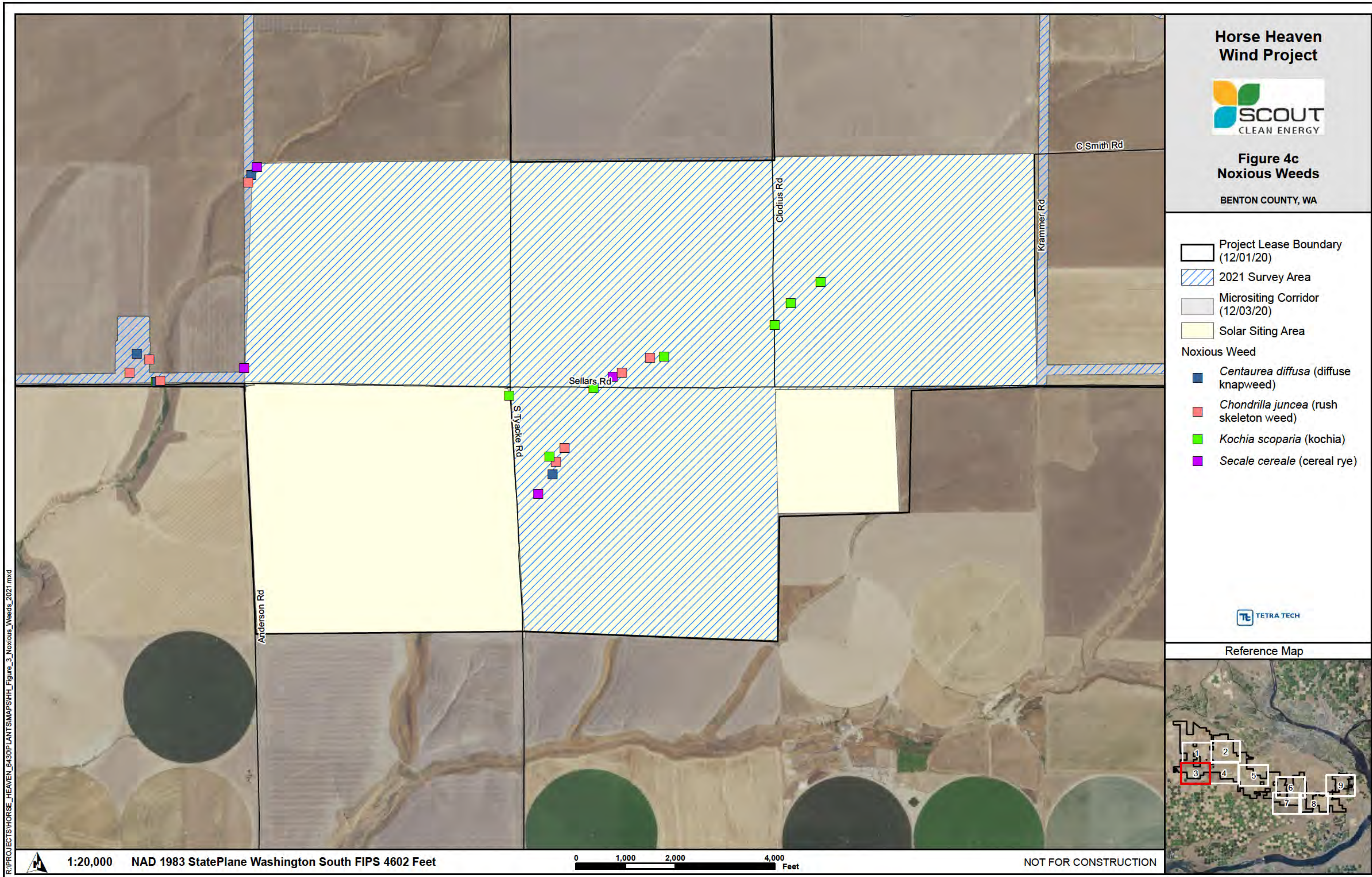
Horse Heaven Wind Project
SCOUT CLEAN ENERGY
Figure 4c Noxious Weeds
BENTON COUNTY, WA
Project Lease Boundary (12/01/20)
2021 Survey Area
Micrositing Corridor (12/03/20)
Solar Siting Area
Noxious Weed
Centaurea diffusa (diffuse knapweed)
Chondrilla juncea (rush skeleton weed)
Kochia scoparia (kochia)
Secale cereale (cereal rye)
TETRA TECH
Reference Map
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C Smith Rd
Clodius Rd
Krammer Rd
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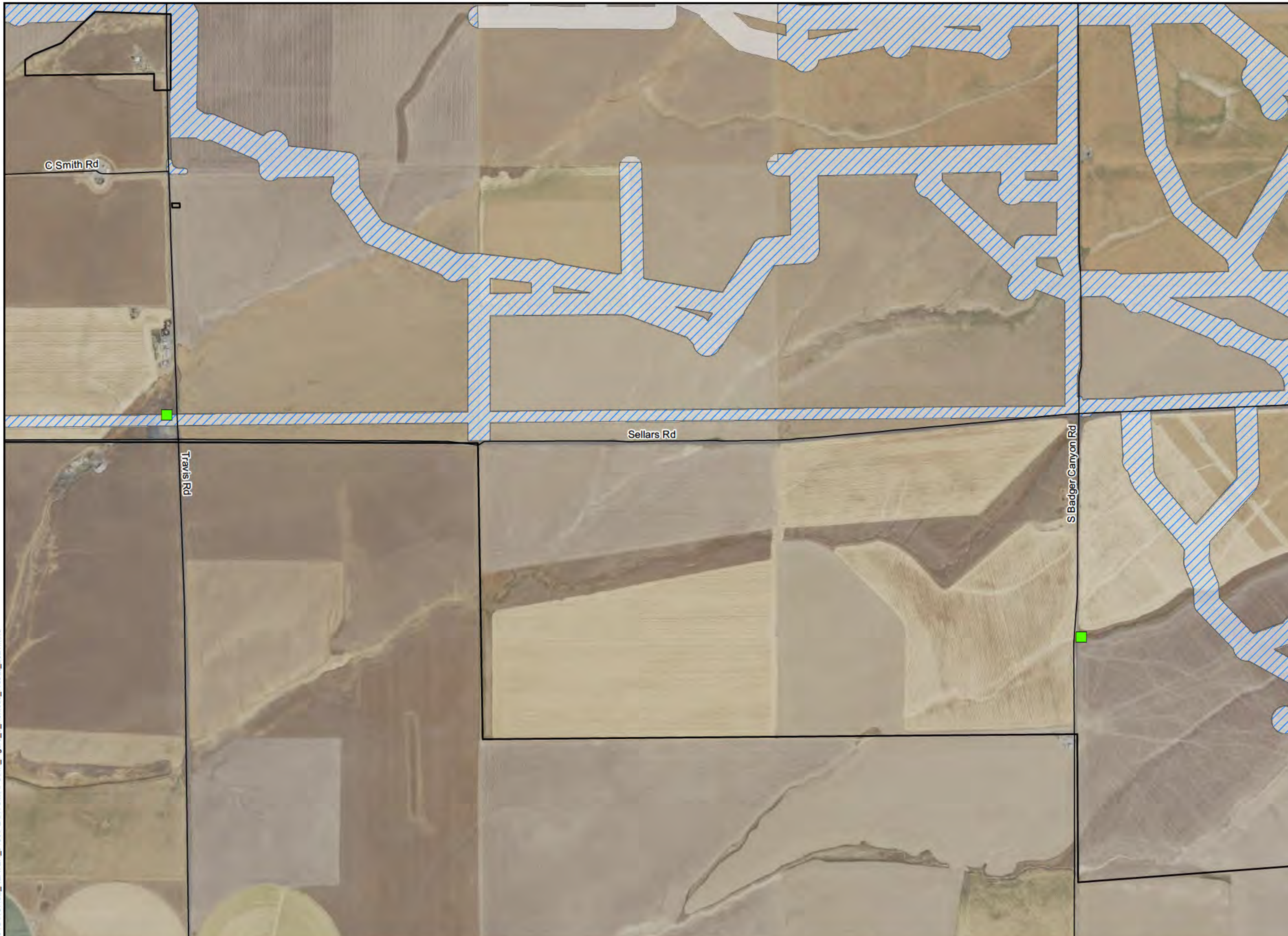


Horse Heaven Wind Project

SCOUT CLEAN ENERGY

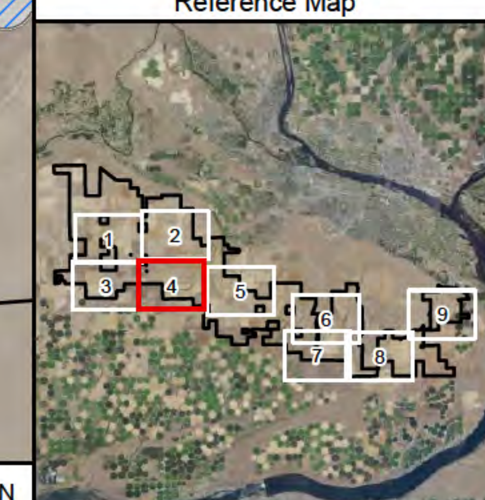
Figure 4d Noxious Weeds

BENTON COUNTY, WA

Project Lease Boundary (12/01/20)
2021 Survey Area
Micrositing Corridor (12/03/20)
Solar Siting Area
Noxious Weed
Kochia scoparia (kochia)

TETRA TECH

Reference Map



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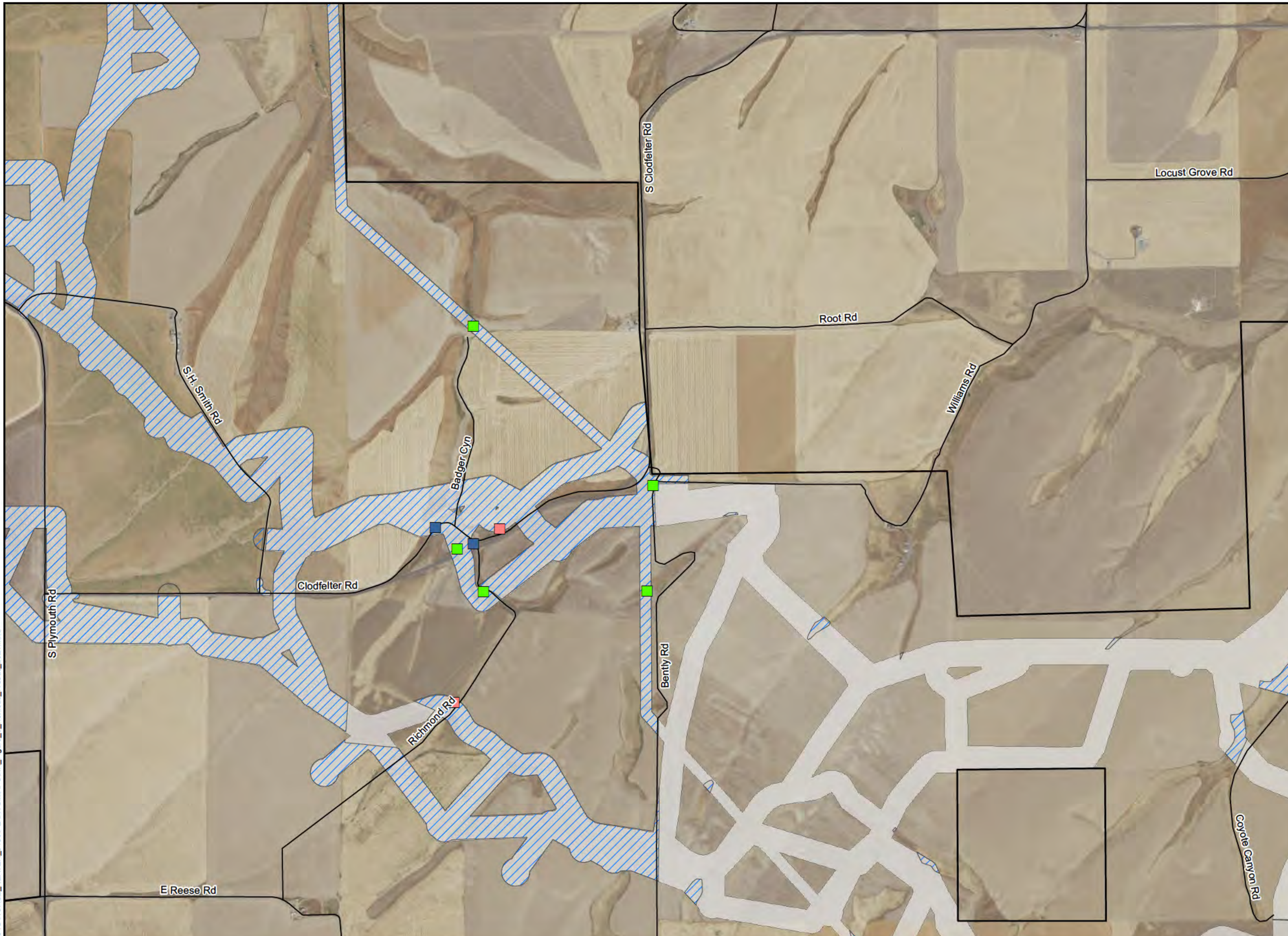

Horse Heaven Wind Project

SCOUT CLEAN ENERGY

Figure 4e Noxious Weeds

BENTON COUNTY, WA

Project Lease Boundary (12/01/20)
2021 Survey Area
Micrositing Corridor (12/03/20)
Solar Siting Area
Noxious Weed
Centaurea diffusa (diffuse knapweed)
Chondrilla juncea (rush skeleton weed)
Kochia scoparia (kochia)

TETRA TECH

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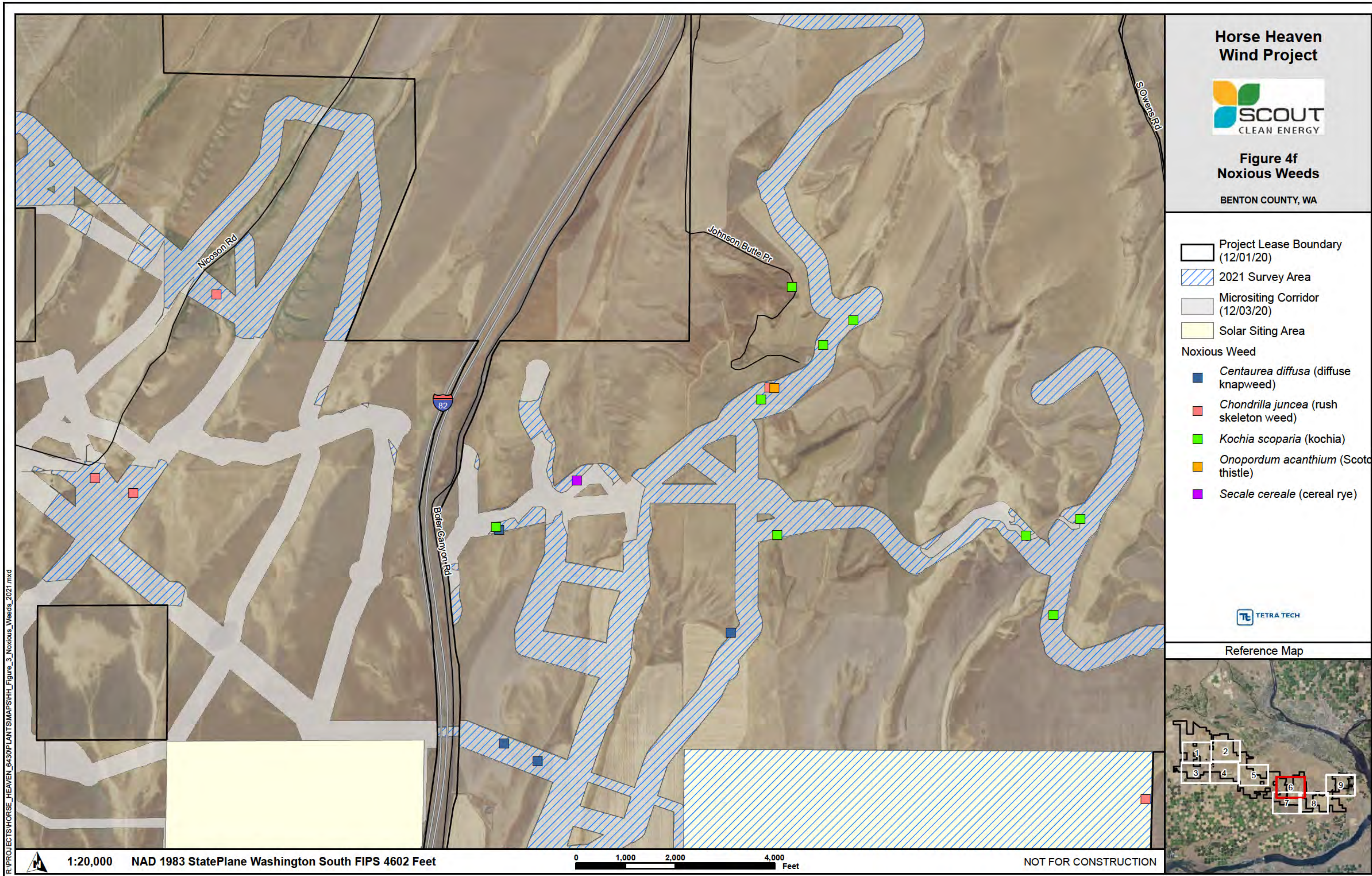

Horse Heaven Wind Project
SCOUT CLEAN ENERGY
Figure 4f
Noxious Weeds
BENTON COUNTY, WA
Project Lease Boundary (12/01/20)
2021 Survey Area
Micrositing Corridor (12/03/20)
Solar Siting Area
Noxious Weed
Centaurea diffusa (diffuse knapweed)
Chondrilla juncea (rush skeleton weed)
Kochia scoparia (kochia)
Onopordum acanthium (Scotch thistle)
Secale cereale (cereal rye)
TETRA TECH
Reference Map
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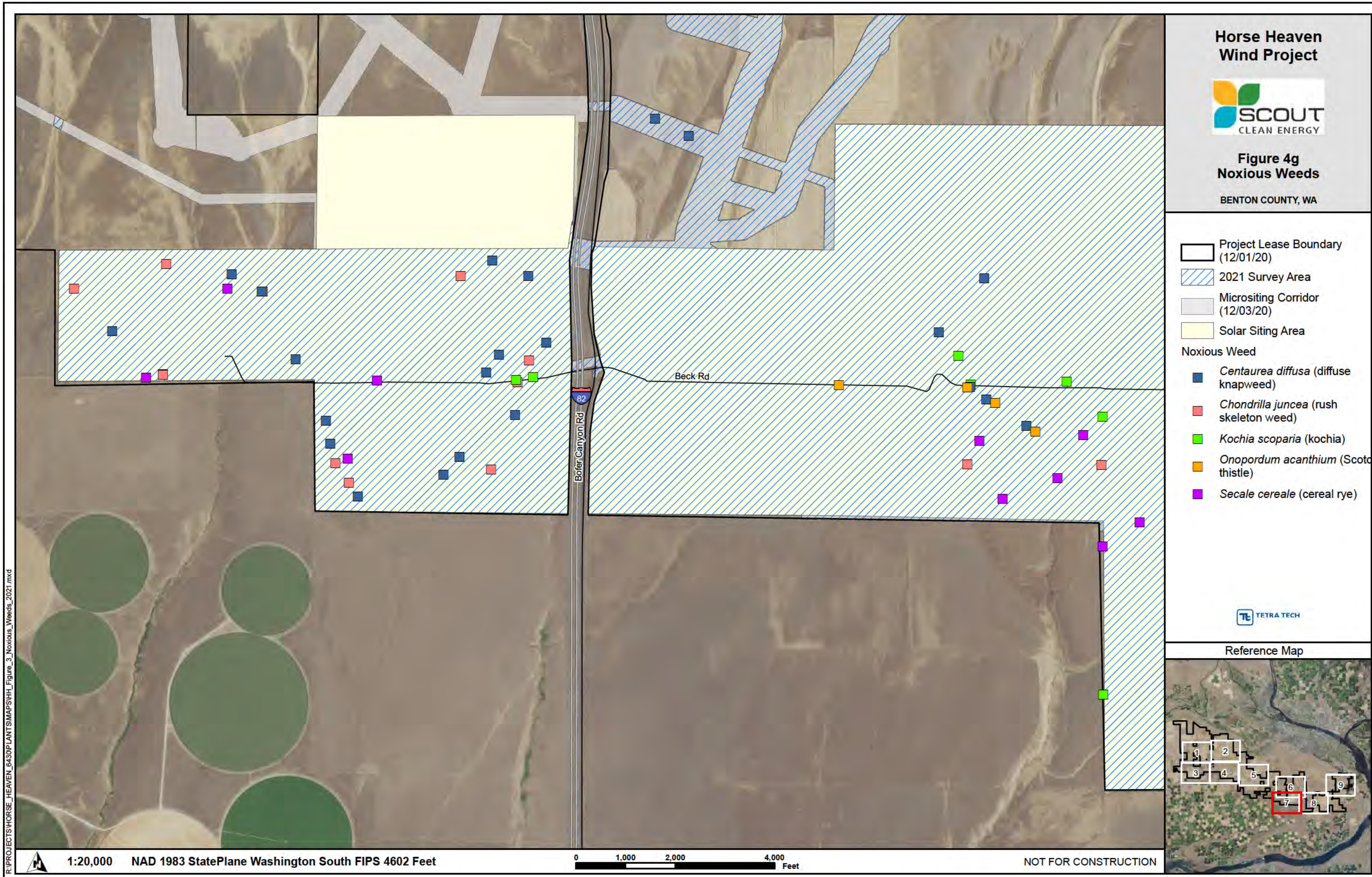

Horse Heaven Wind Project
SCOUT CLEAN ENERGY
Figure 4g
Noxious Weeds
BENTON COUNTY, WA
Project Lease Boundary (12/01/20)
2021 Survey Area
Micrositing Corridor (12/03/20)
Solar Siting Area
Noxious Weed
Centaurea diffusa (diffuse knapweed)
Chondrilla juncea (rush skeleton weed)
Kochia scoparia (kochia)
Onopordum acanthium (Scotch thistle)
Secale cereale (cereal rye)
TETRA TECH
Reference Map
Beck Rd
Bofer Canyon Rd
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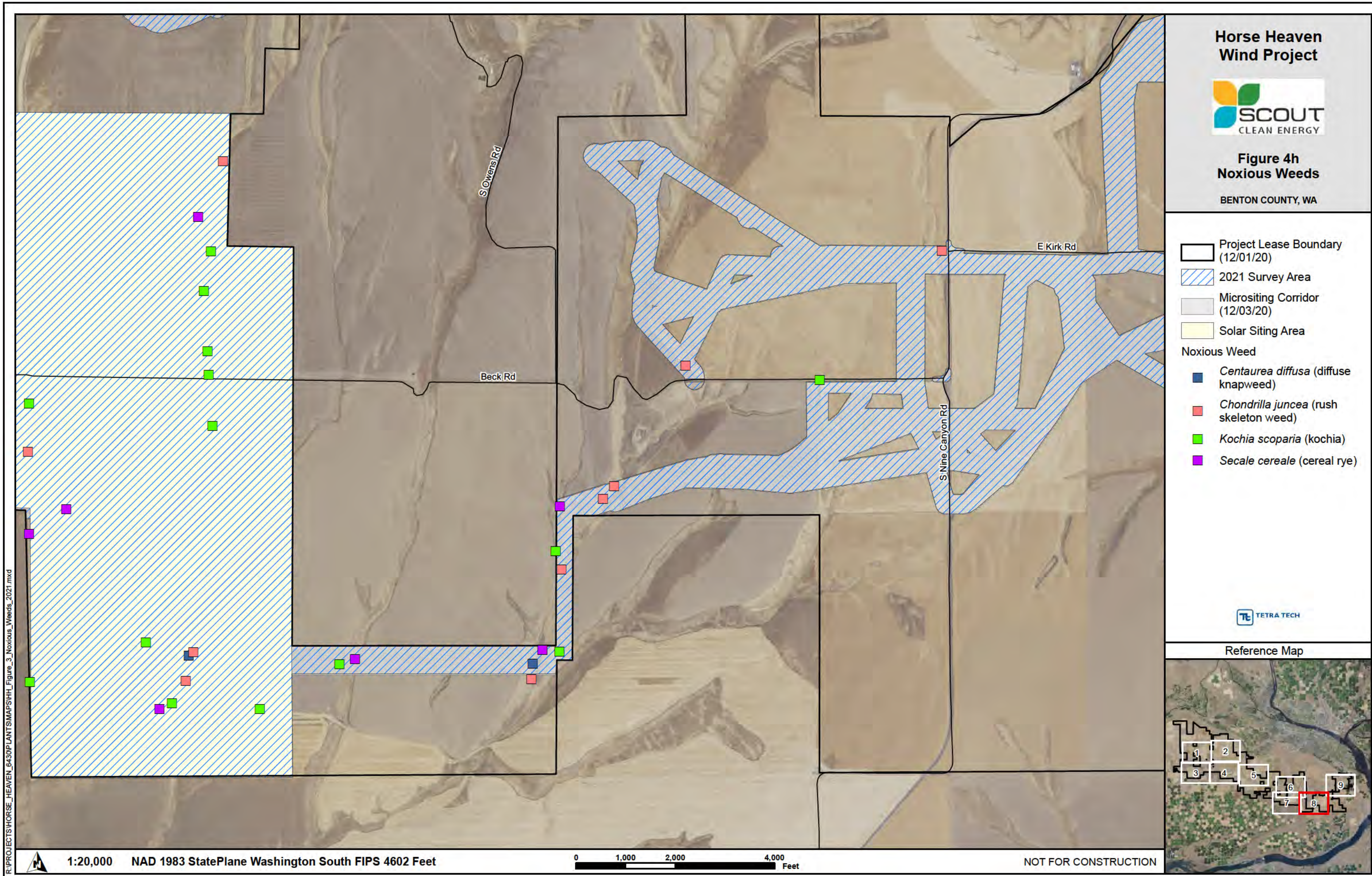

Horse Heaven Wind Project
SCOUT CLEAN ENERGY
Figure 4h
Noxious Weeds
BENTON COUNTY, WA
Project Lease Boundary (12/01/20)
2021 Survey Area
Micrositing Corridor (12/03/20)
Solar Siting Area
Noxious Weed
Centaurea diffusa (diffuse knapweed)
Chondrilla juncea (rush skeleton weed)
Kochia scoparia (kochia)
Secale cereale (cereal rye)
TETRA TECH
Reference Map
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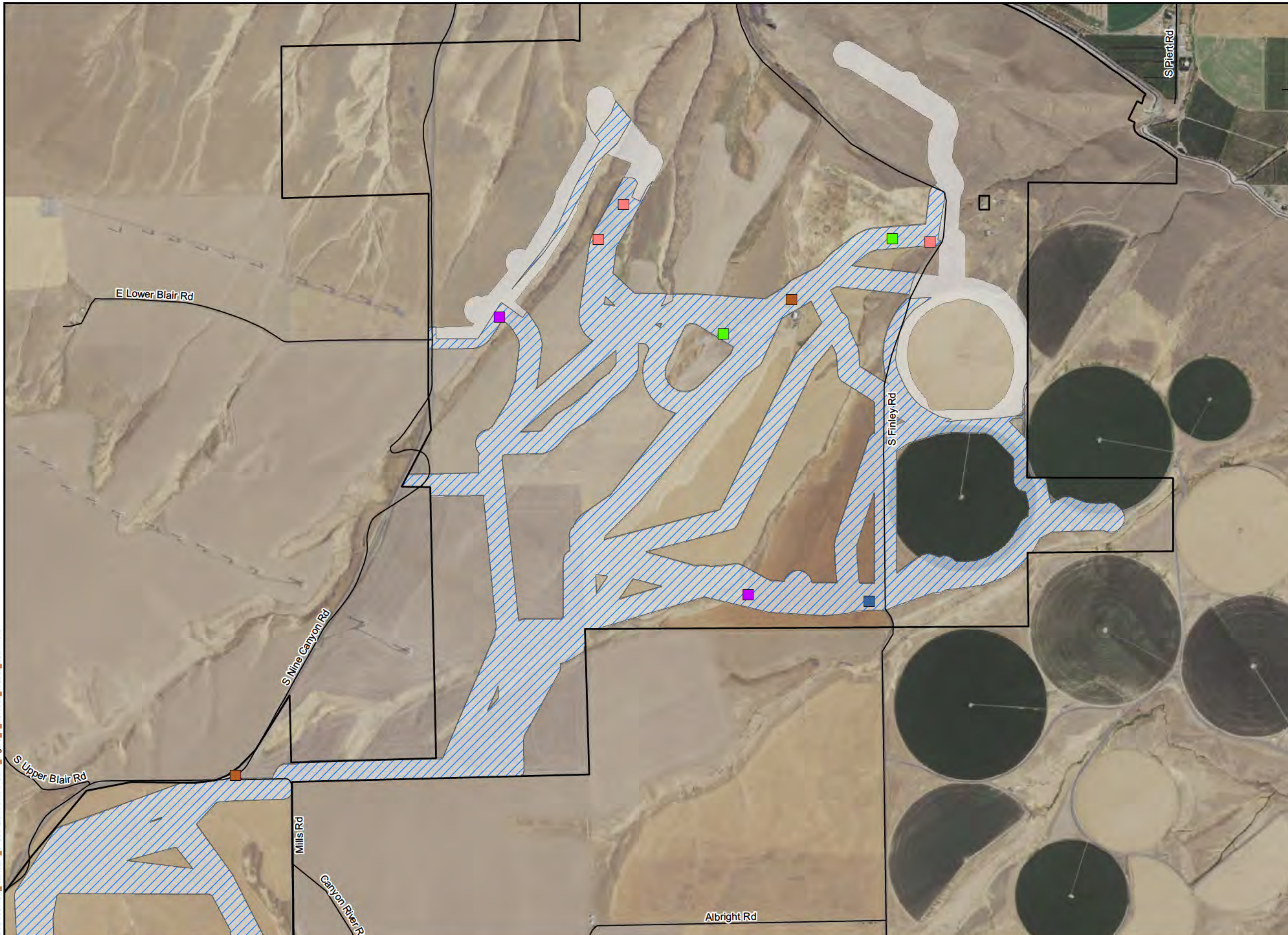
Horse Heaven Wind Project

SCOUT CLEAN ENERGY

Figure 4i
Noxious Weeds

BENTON COUNTY, WA



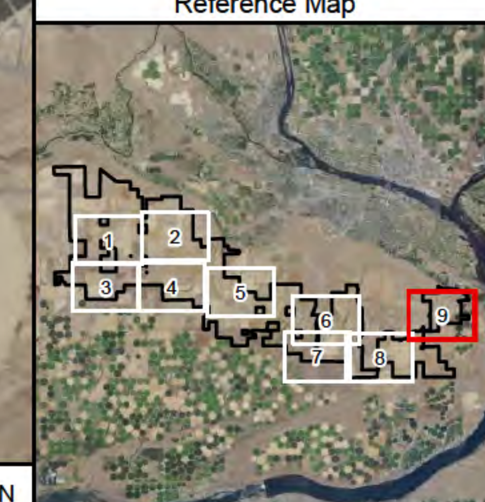
Project Lease Boundary (12/01/20)
2021 Survey Area
Micrositing Corridor (12/03/20)
Solar Siting Area

Noxious Weed

- *Centaurea diffusa* (diffuse knapweed)
- *Chondrilla juncea* (rush skeleton weed)
- *Convolvulus arvensis* (field bindweed)
- *Kochia scoparia* (kochia)
- *Secale cereale* (cereal rye)

TETRA TECH

Reference Map



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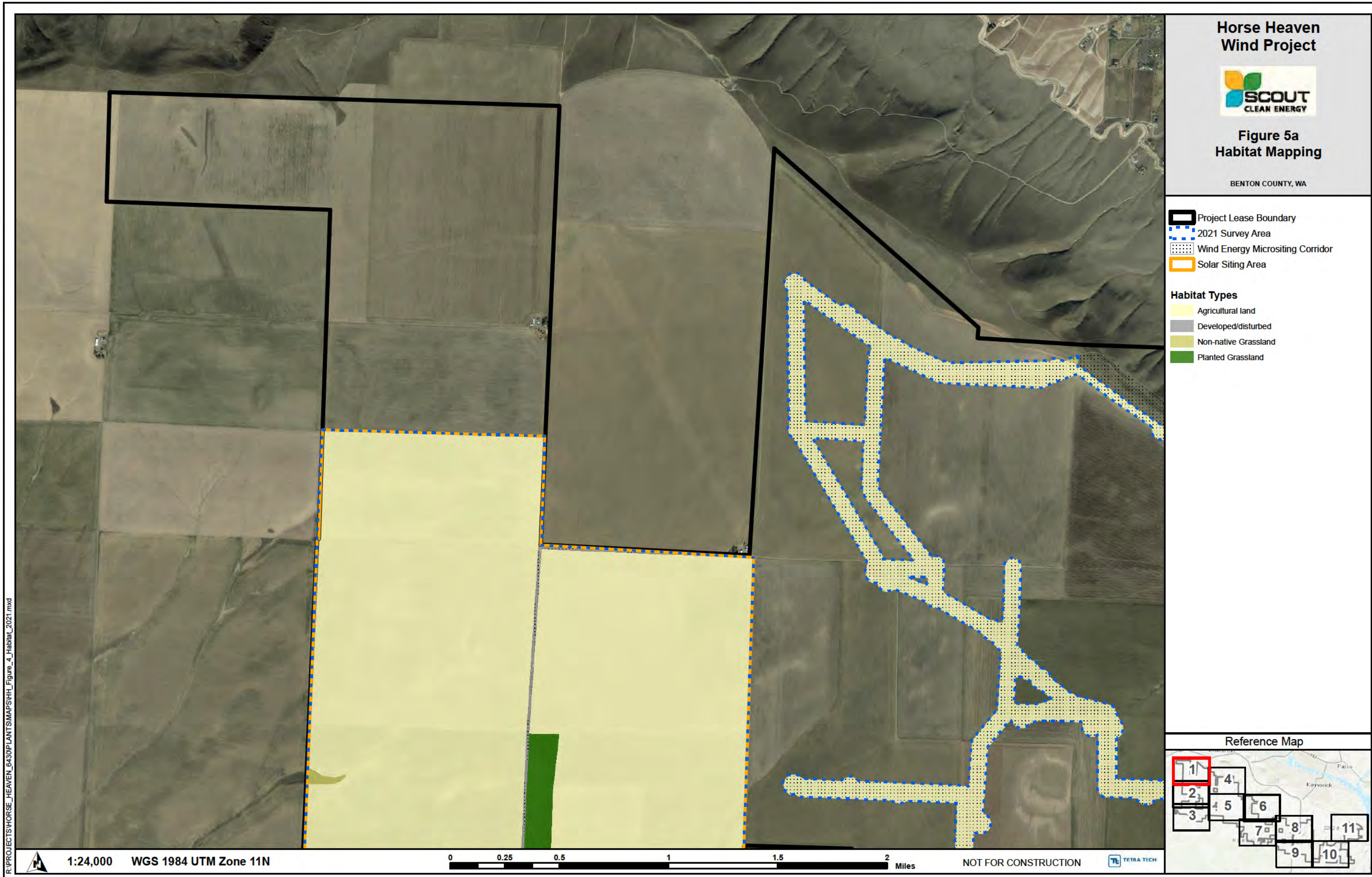
Horse Heaven Wind Project
SCOUT CLEAN ENERGY
Figure 5a
Habitat Mapping
BENTON COUNTY, WA
Project Lease Boundary
2021 Survey Area
Wind Energy Micrositing Corridor
Solar Siting Area
Habitat Types
Agricultural land
Developed/disturbed
Non-native Grassland
Planted Grassland
Reference Map
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WGS 1984 UTM Zone 11N
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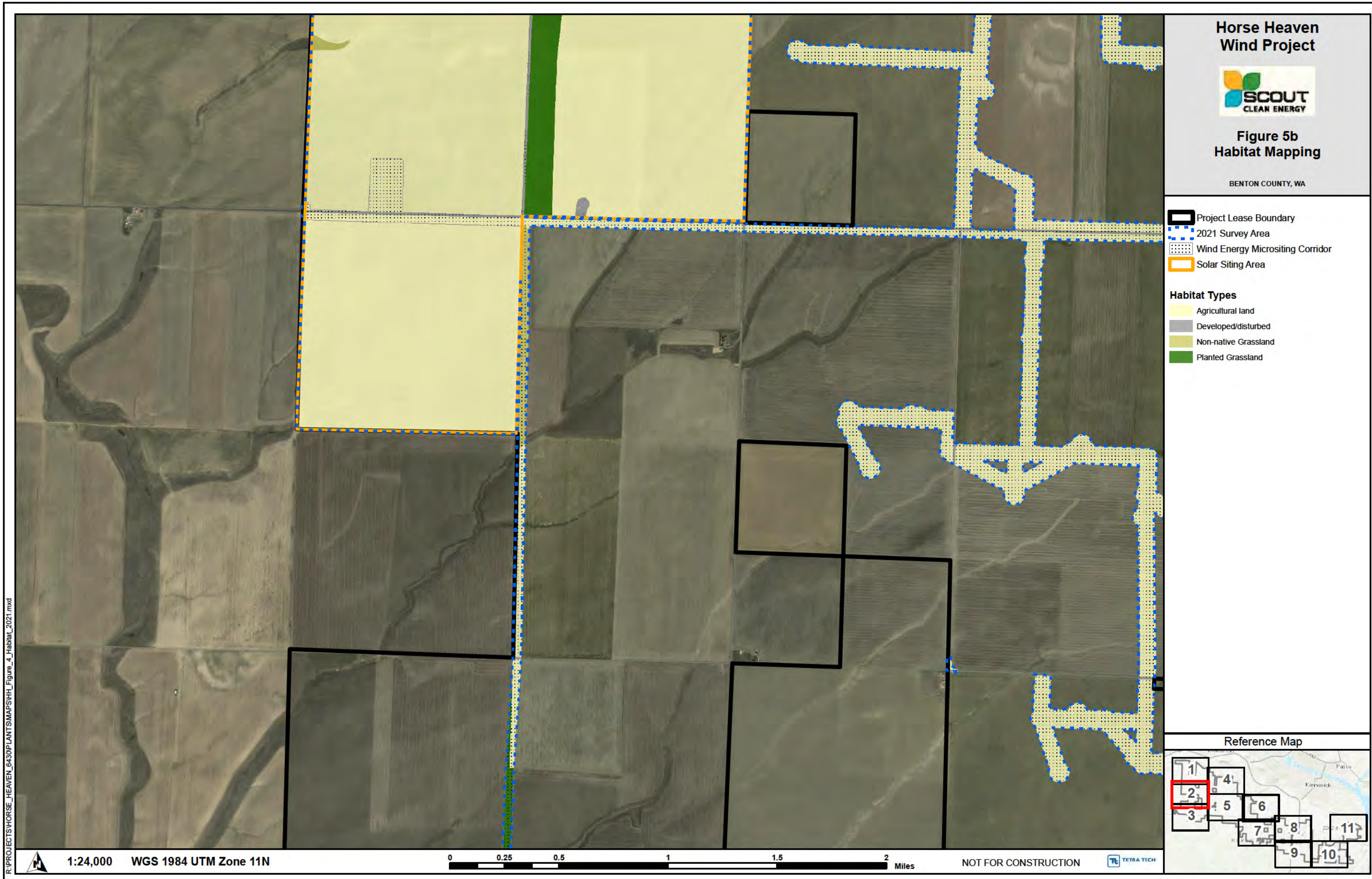
Horse Heaven
Wind Project
SCOUT
CLEAN ENERGY
Figure 5b
Habitat Mapping
BENTON COUNTY, WA
Project Lease Boundary
2021 Survey Area
Wind Energy Micrositing Corridor
Solar Siting Area
Habitat Types
Agricultural land
Developed/disturbed
Non-native Grassland
Planted Grassland
Reference Map
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WGS 1984 UTM Zone 11N
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Miles
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TETRA TECH
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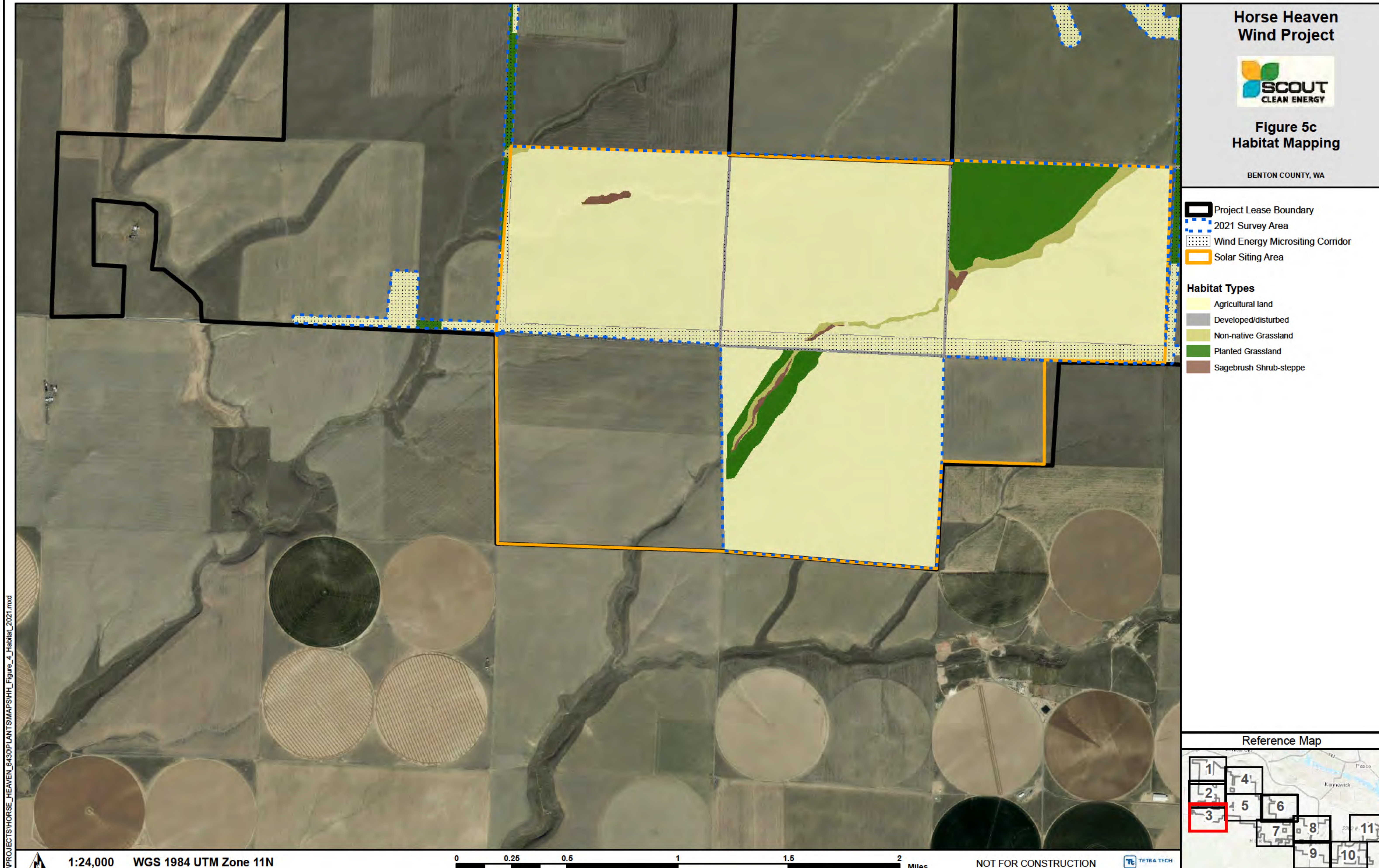
Horse Heaven Wind Project
SCOUT CLEAN ENERGY
Figure 5c
Habitat Mapping
BENTON COUNTY, WA
Project Lease Boundary
2021 Survey Area
Wind Energy Micrositing Corridor
Solar Siting Area
Habitat Types
Agricultural land
Developed/disturbed
Non-native Grassland
Planted Grassland
Sagebrush Shrub-steppe
Reference Map
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1:24,000
WGS 1984 UTM Zone 11N
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Miles
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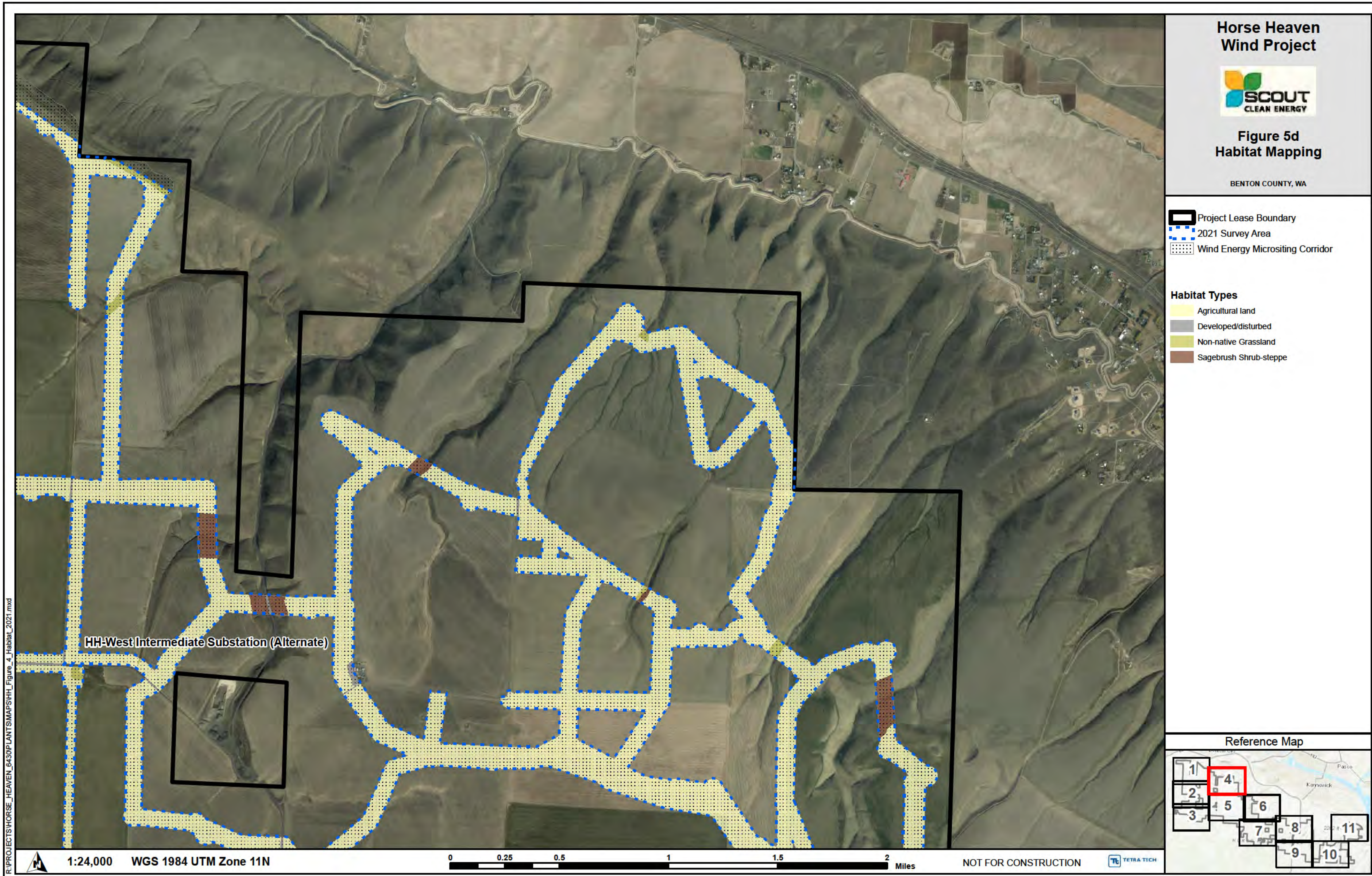

Horse Heaven
Wind Project
SCOUT CLEAN ENERGY
Figure 5d
Habitat Mapping
BENTON COUNTY, WA
Project Lease Boundary
2021 Survey Area
Wind Energy Micrositing Corridor
Habitat Types
Agricultural land
Developed/disturbed
Non-native Grassland
Sagebrush Shrub-steppe
HH-West Intermediate Substation (Alternate)
Reference Map
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Horse Heaven Wind Project
SCOUT CLEAN ENERGY
Figure 5e
Habitat Mapping
BENTON COUNTY, WA
Project Lease Boundary
2021 Survey Area
Wind Energy Micrositing Corridor
Solar Siting Area
Habitat Types
Agricultural land
Developed/disturbed
Non-native Grassland
Planted Grassland
Sagebrush Shrub-steppe
HH-West Intermediate Substation (Primary)
Reference Map
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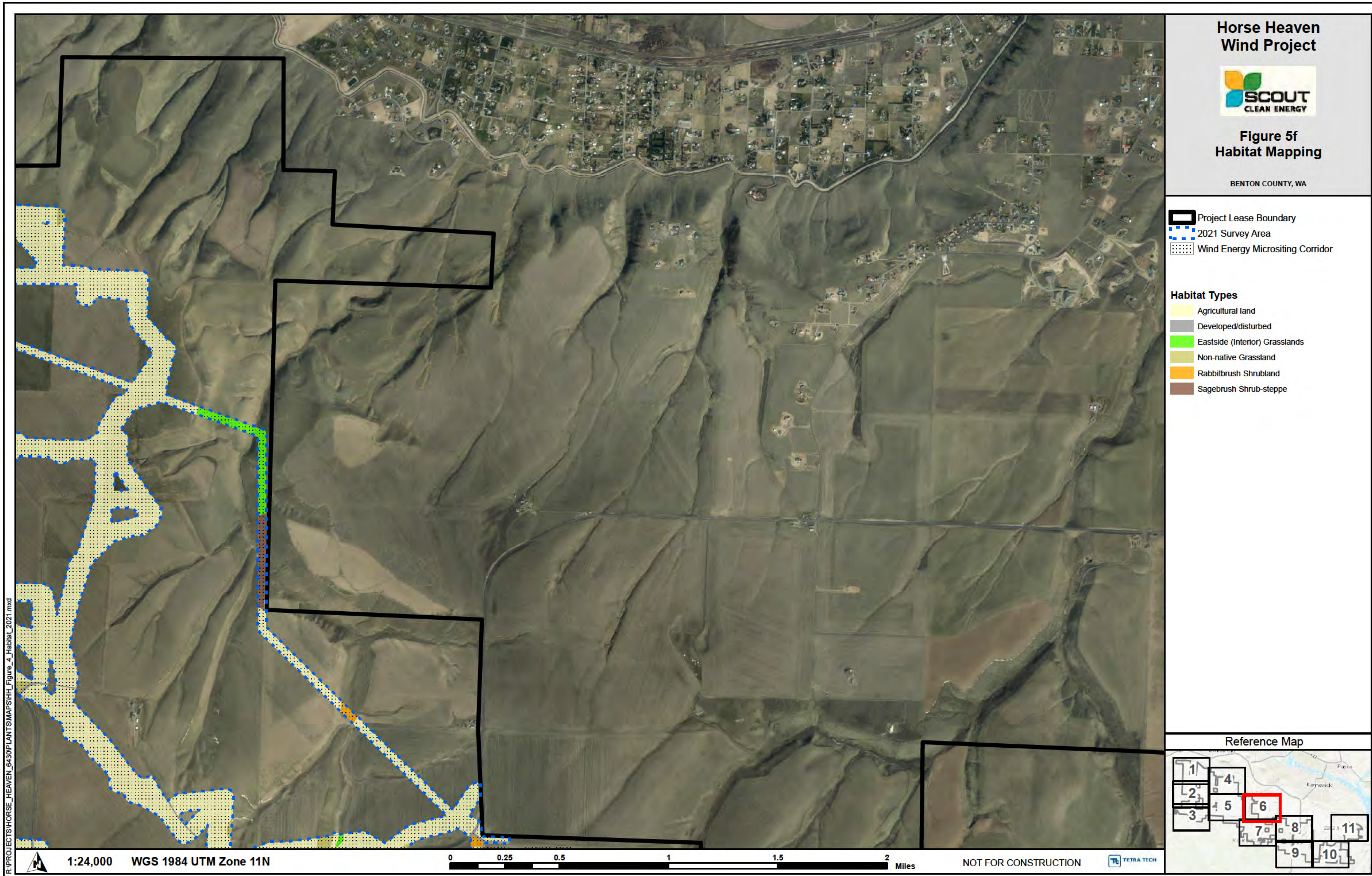

Horse Heaven
Wind Project
SCOUT
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Figure 5f
Habitat Mapping
BENTON COUNTY, WA
Project Lease Boundary
2021 Survey Area
Wind Energy Micrositing Corridor
Habitat Types
Agricultural land
Developed/disturbed
Eastside (Interior) Grasslands
Non-native Grassland
Rabbitbrush Shrubland
Sagebrush Shrub-steppe
Reference Map
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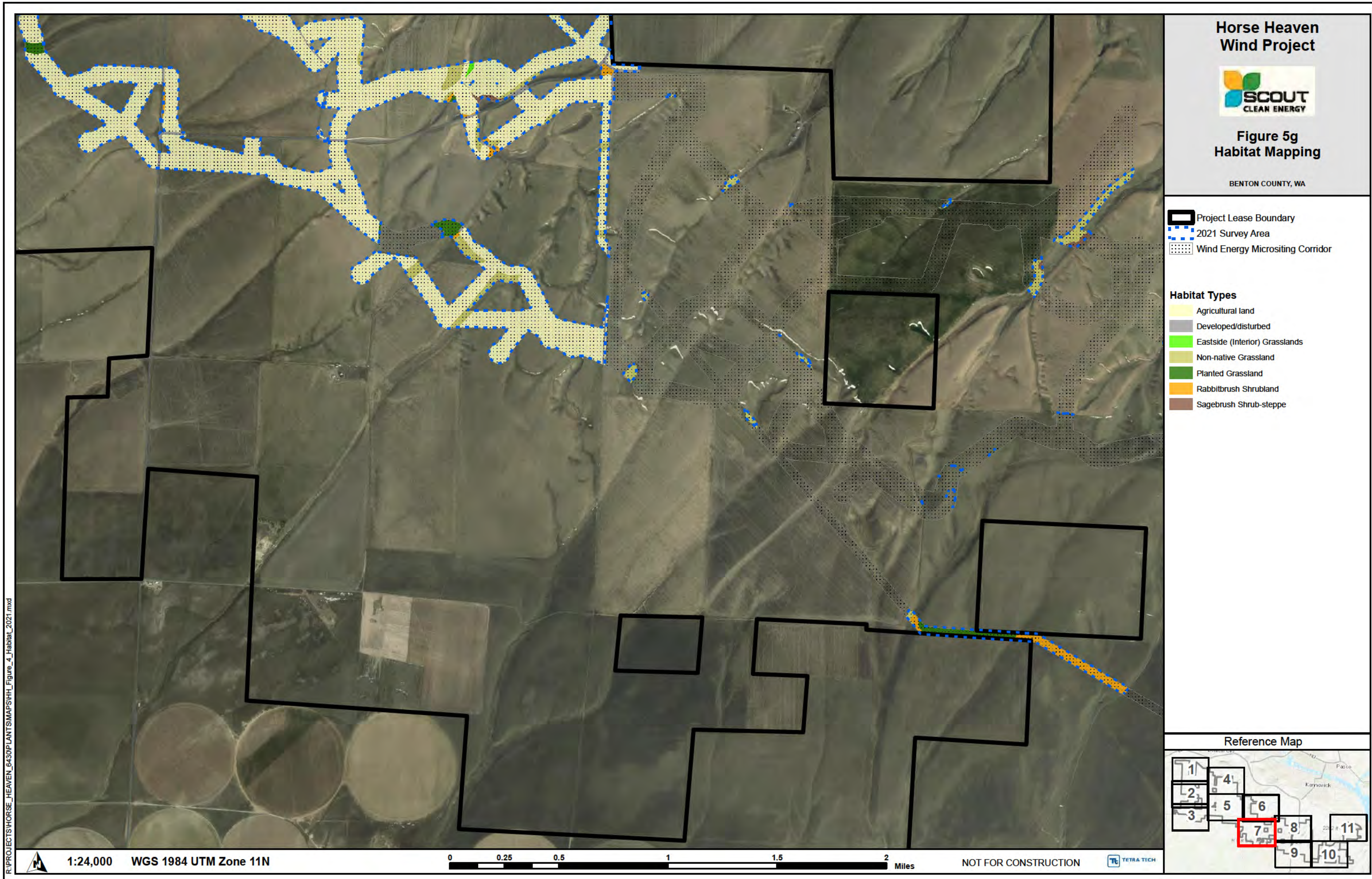
Horse Heaven Wind Project
SCOUT CLEAN ENERGY
Figure 5g
Habitat Mapping
BENTON COUNTY, WA
Project Lease Boundary
2021 Survey Area
Wind Energy Micrositing Corridor
Habitat Types
Agricultural land
Developed/disturbed
Eastside (Interior) Grasslands
Non-native Grassland
Planted Grassland
Rabbitbrush Shrubland
Sagebrush Shrub-steppe
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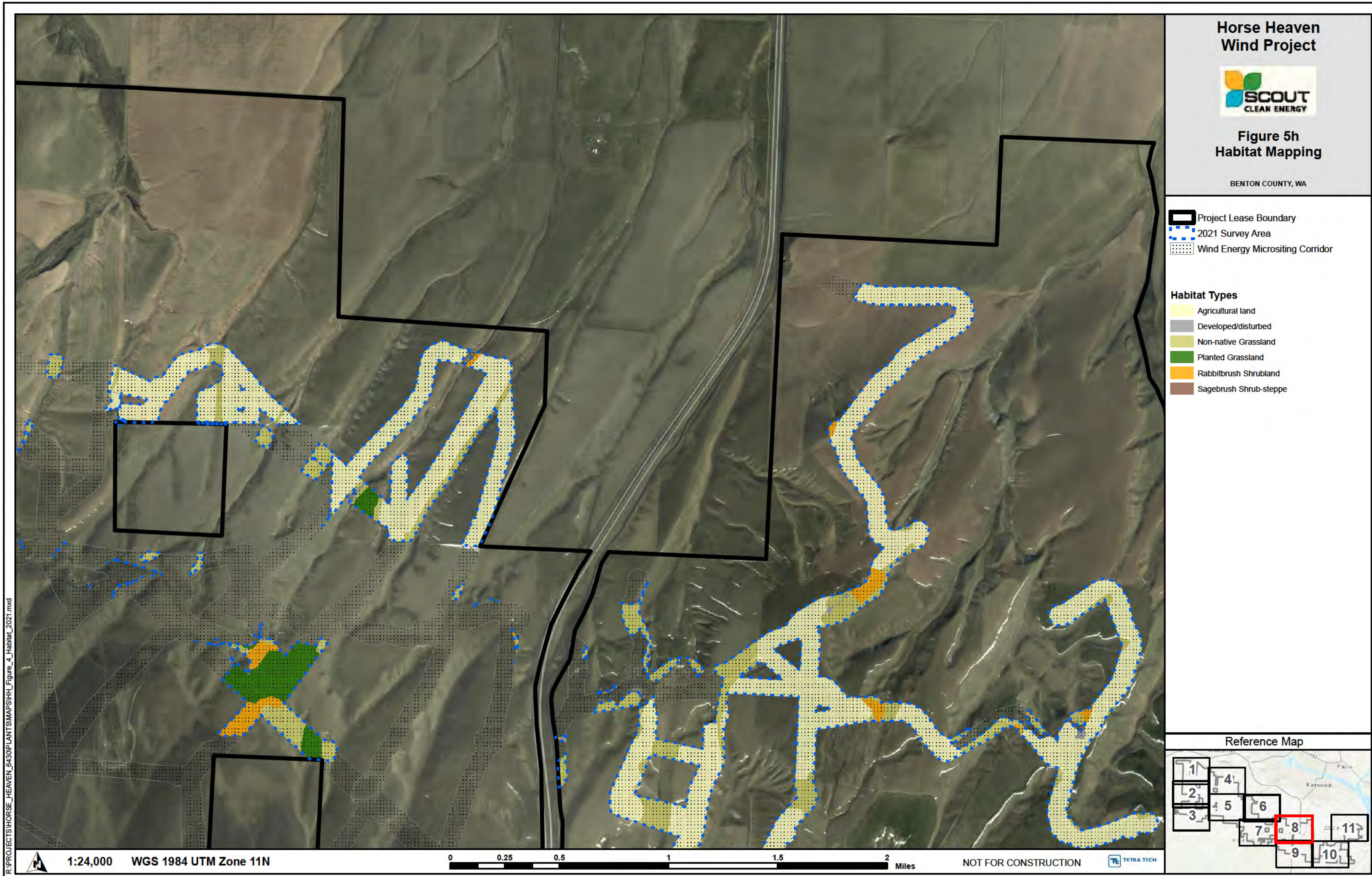
Horse Heaven Wind Project
SCOUT CLEAN ENERGY
Figure 5h
Habitat Mapping
BENTON COUNTY, WA
Project Lease Boundary
2021 Survey Area
Wind Energy Micrositing Corridor
Habitat Types
Agricultural land
Developed/disturbed
Non-native Grassland
Planted Grassland
Rabbitbrush Shrubland
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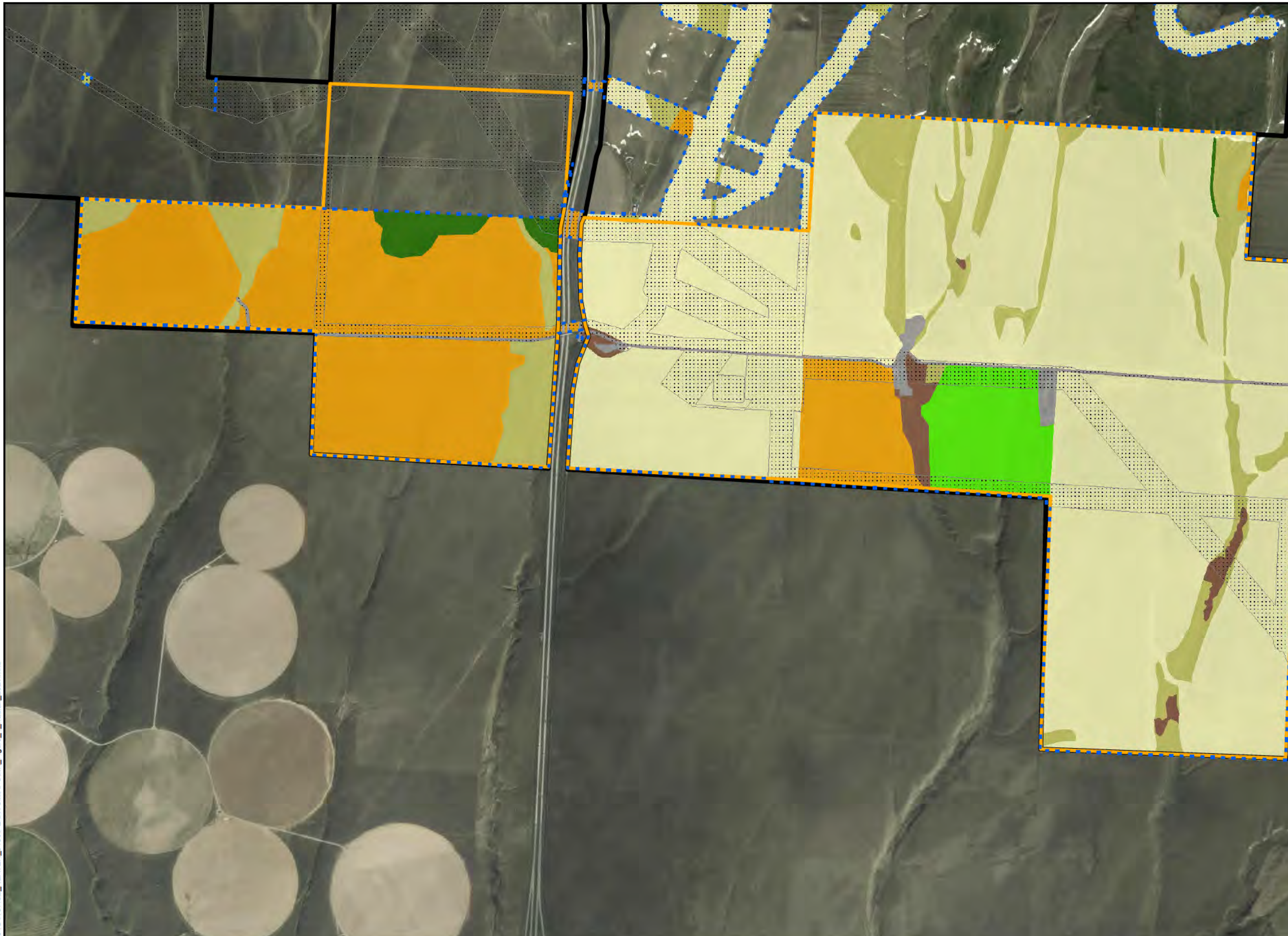
Horse Heaven Wind Project

Figure 5i
Habitat Mapping

BENTON COUNTY, WA



- Project Lease Boundary
- 2021 Survey Area
- Wind Energy Micrositing Corridor
- Solar Siting Area

Habitat Types

- Agricultural land
- Developed/disturbed
- Eastside (Interior) Grasslands
- Non-native Grassland
- Planted Grassland
- Rabbitbrush Shrubland
- Sagebrush Shrub-steppe

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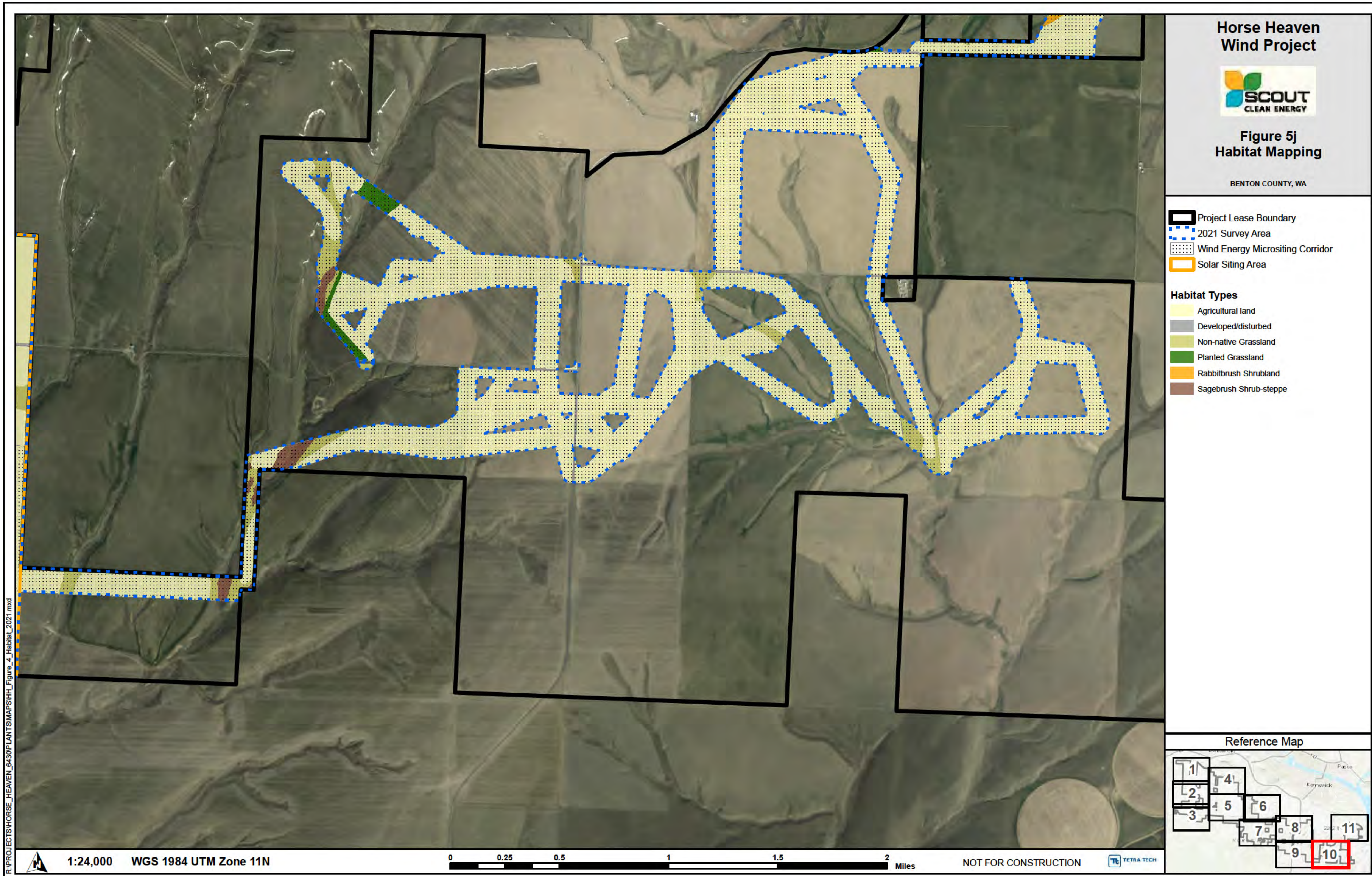
Horse Heaven
Wind Project
SCOUT
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Figure 5j
Habitat Mapping
BENTON COUNTY, WA
Project Lease Boundary
2021 Survey Area
Wind Energy Micrositing Corridor
Solar Siting Area
Habitat Types
Agricultural land
Developed/disturbed
Non-native Grassland
Planted Grassland
Rabbitbrush Shrubland
Sagebrush Shrub-steppe
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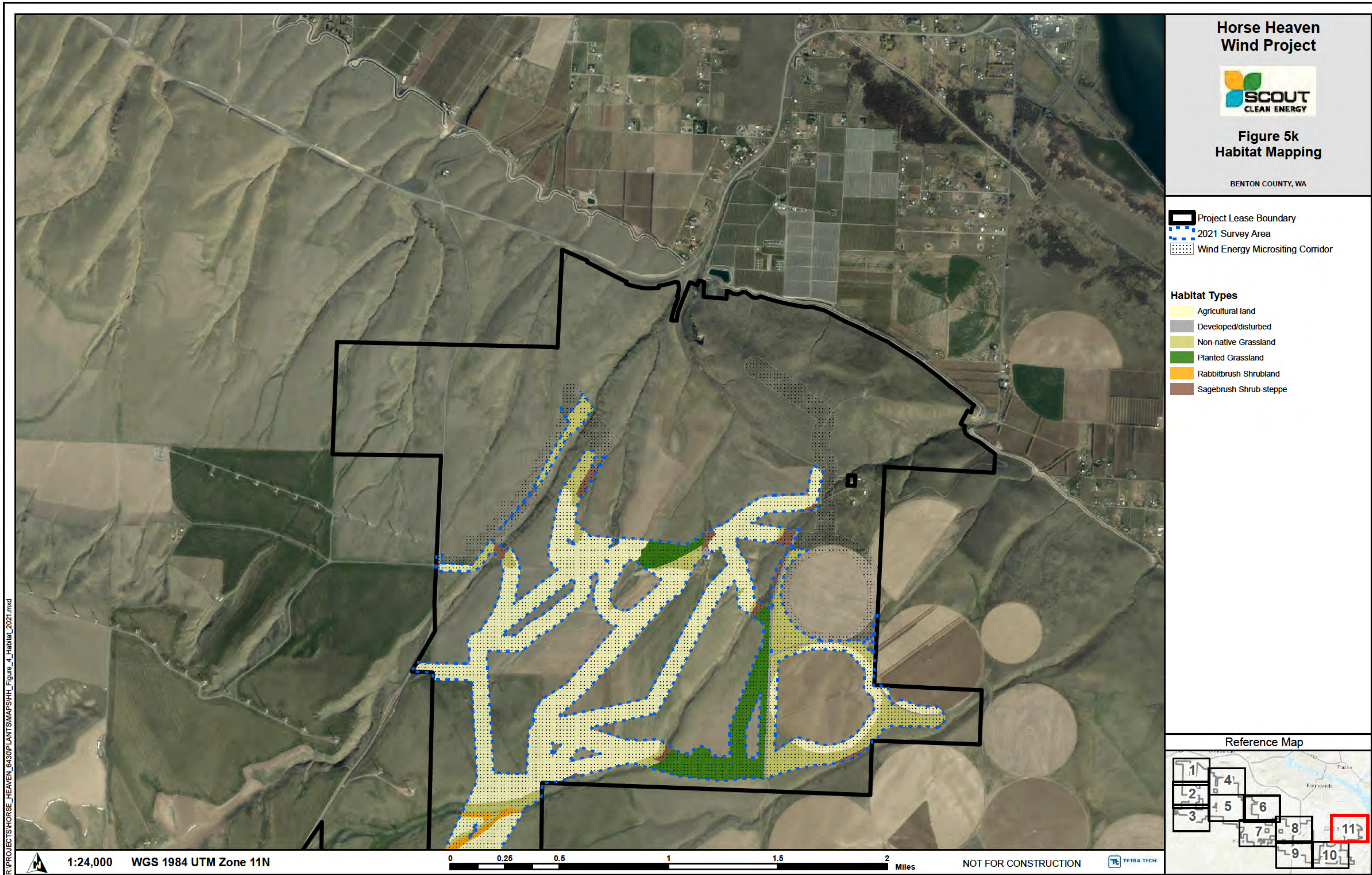

Horse Heaven
Wind Project
SCOUT CLEAN ENERGY
Figure 5k
Habitat Mapping
BENTON COUNTY, WA
Project Lease Boundary
2021 Survey Area
Wind Energy Micrositing Corridor
Habitat Types
Agricultural land
Developed/disturbed
Non-native Grassland
Planted Grassland
Rabbitbrush Shrubland
Sagebrush Shrub-steppe
Reference Map
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ATTACHMENT A
SPECIAL STATUS PLANT SPECIES WITH POTENTIAL TO OCCUR WITHIN THE 2021 SURVEY AREA

Table A-1. Special Status Plant Species with Potential to Occur within the 2021 Survey Area[1]

Scientific name (Common Name)	State Status / Federal Status[2]	Habitat Characteristics/ Identifying Features[3]	Survey Period[4]	Likelihood of Occurrence Based on Background Review	Suitable Habitat Present Based on Field Surveys
Aliciella leptomeria (Great Basin gilia)	T / --	Open habitats in semiarid regions, on dry bluffs or in sandy swales. Substrates are often hard, gravelly or sandy, fine reddish to blackish basalt soils, or fine non-basalt gravel with caliche fragments. Associated species include: *Artemisia tridentata*, *Grayia spinosa*, and *Gilia sinuata*. Elev. 470–1,140 feet.	April–June	Low; limited suitable habitat likely present in 2021 Survey Area.	Limited suitable habitat present
Ammania robusta (grand redstem)	T / --	Shoreline and islands along the Columbia River, in riparian mudflats dominated by annual species. Also known from lakeshores in the channeled scablands. Sites are inundated until midsummer and periodically throughout the growing season, depending on upstream management of the river. Associated species include *Rotala ramosior, Eleocharis acicularis, Cyperus* spp., *Limosella aquatica, Lindernia dubia*, and occasionally *Rorippa columbiae*.	May–June	Highly unlikely; suitable habitat unlikely to occur within 2021 Survey Area.	No suitable habitat present
Astragalus columbianus (Columbian milkvetch)	S / --	Shrub-steppe habitats on sandy or gravelly loams, silts, rocky silt loams, and lithosols. Associated species include: *Artemisia tridentata, A. rigida, Pseudoroegneria spicata, Astragalus caricinus, A. purshii, A. speirocarpus*, and *A. succumbens*. Elev. 420–2,320 feet.	Mid-April–mid-June	Low to moderate; suitable habitat potentially present in 2021 Survey Area.	Limited suitable habitat present
Astragalus kentrophyta var. *douglasii* (thistle milkvetch)	X / --	On sandy ground, dunes, or eroded riverbanks at low elevations. Not seen since 1883; this taxon is likely extinct.	June	Highly unlikely; species is believed to be extirpated in Washington.	No suitable habitat present
Astragalus misellus var. *pauper* (pauper milk-vetch)	S / --	Open ridgetops and upper slopes, rarely middle and lower slopes, along western margin of the Columbia Basin province. In *Artemisia tridentata/ Pseudoroegneria spicata* vegetation community. Associated species include: *Artemisia rigida, A. tridentata, Crepis atribarba, C. occidentalis, Eriogonum sphaerocephalum, Pseudoroegneria spicata, Poa secunda, Astragalus purshii., Erigeron linearis, Lomatium macrocarpum, Phlox longifolia*, and *P. hoodii*. Elev. 500–3,280 feet.	April–June	Highly unlikely; known occurrences in Benton County are historical occurrences.[5]	Very limited suitable habitat present

Scientific name (Common Name)	State Status / Federal Status[2]	Habitat Characteristics/ Identifying Features[3]	Survey Period[4]	Likelihood of Occurrence Based on Background Review	Suitable Habitat Present Based on Field Surveys
Calyptridium roseum (rosy pussypaws)	T / --	Sagebrush desert to arid montane forest, in sandy to gravelly soils. In Washington, grows in very dry shrub-steppe, in low swales in dark sandy soil. In spring, the swale microsites may be moister than the surrounding habitat. Associated species include: *Artemisia tridentata, Bromus tectorum, Poa secunda, Greeneocharis circumscissa, Holosteum umbellatum, Draba verna, Erythranthe suksdorfii, Microsteris gracilis, Loeflingia squarrosa* subsp. *squarrosa*, and *Gilia leptomeria*. Elev. 525 feet.	May–June	Low to moderate; suitable habitat potentially present in 2021 Survey Area.	Limited suitable habitat present
Cryptantha leucophaea (gray cryptantha)	T / --	Sandy substrates, especially sand dunes that have not been completely stabilized. Appears to be restricted to areas where there is still some wind-derived movement of open sand. Associated species include: *Purshia tridentata, Artemisia tridentata, Hesperostipa comata, Achnatherum hymenoides, Poa secunda, Oenothera pallida, Eriogonum niveum, Penstemon attenuatus*, and *Astragalus succumbens*. Elev. 300–2,500 feet.	May–June	Low; limited suitable habitat likely present in 2021 Survey Area.	Very limited suitable habitat present
Cryptantha scoparia (desert cryptantha)	S / --	Dry areas with full sun and little competing vegetation. In Washington, grows on south-facing slopes and ridges between small canyons with fine, dry silt and talus. Sites may be a little more alkaline than surrounding areas. Associated species include: *Artemisia tridentata, Krascheninnikovia lanata, Eriogonum niveum, Eriophyllum lanatum, Epilobium minutum, Bromus hordeaceus, Bromus tectorum*, and *Pseudoroegneria spicata*. Elev. 1,200–2,100 feet.	April–June	Low; limited suitable habitat likely present in 2021 Survey Area.	No suitable habitat present
Cryptantha spiculifera (Snake River cryptantha)	S / --	Sandy knolls and badlands and talus at low elevations; dry, open, flat or sloping areas in stable or stony soils. Associated species include: *Artemisia rigida, A. tridentata, Ericameria nauseosa, Eriogonum sphaerocephalum, Salvia dorrii, Lupinus sericeus, Pseudoroegneria spicata*, and *Poa secunda*. Elev. 450–3,500 feet.	May–July	Low; limited suitable habitat likely present in 2021 Survey Area.	Very limited suitable habitat present
Cuscuta denticulata (desert dodder)	T / --	Parasitic on a variety of native shrubs in desert areas, including sagebrush (Artemisia spp.), rabbitbrush (Chrysothamnus/Ericameria spp.). Associated species include: *Artemisia tridentata, Poa secunda, Achnatherum hymenoides, Bromus tectorum, Astragalus caricinus, Erigeron poliospermus, Cymopterus terebinthinus*, and *Helianthus cusickii*. Elev. 880–1,089 feet.	July–August	Highly unlikely; known occurrences in Benton County are historical occurrences[5].	Limited suitable habitat present

Scientific name (Common Name)	State Status / Federal Status[2]	Habitat Characteristics/ Identifying Features[3]	Survey Period[4]	Likelihood of Occurrence Based on Background Review	Suitable Habitat Present Based on Field Surveys
Eleocharis coloradoensis (dwarf spike-rush)	X / --	Fresh to brackish bare wet soil, inland. Fresh or brackish drying lake and pond margins, stream beds, flood plains, vernal pools, irrigation ditches, tidal wetlands. Elev. 0–6,900 feet.	Spring–fall	Highly unlikely; species is believed to be extirpated in Washington.	No suitable habitat present
Eremogone franklinii var. *thompsonii* (Thompson's sandwort)	S / --	Sand dunes, scabland, and sagebrush slopes. Associated species include: *Purshia tridentata, Poa canbyi* and other bunchgrasses.	May–June	Low; limited suitable habitat likely present in 2021 Survey Area.	Very limited suitable habitat present
Eremothera minor (small-flower evening-primrose)	S / --	Gravelly basalt slopes, sandy and alkaline soils, and dry rocky hillsides; often with considerable cover of bare soil. Associated species include: *Artemisia tridentata, Ericameria nauseosa, Purshia tridentata, Bromus tectorum*, and *Poa secunda*. Elev. 460–1,140 feet.	May–early June	Low; limited suitable habitat likely present within 2021 Survey Area.	Very limited suitable habitat present
Eremothera pygmaea (dwarf evening-primrose)	S / --	Sagebrush steppe, on unstable soil or gravel in steep talus, dry washes, banks, and roadcuts. Associated species include: *Artemisia tridentata, Bromus tectorum, Eriogonum* spp., *Gilia minutiflora, Mentzelia* spp., *Cryptantha* spp., *Salsola tragus*, and *Neoholmgrenia* (*Camissonia*) *andina*. Elev. 450–2,050 feet.	Flowers April–June; Fruits June –August	Low; limited suitable habitat likely present within 2021 Survey Area.	Very limited suitable habitat present
Eriogonum codium (Umtanum desert buckwheat)	E / T	Known from one population on flat to gently sloping microsistes near the top of a steep, north-facing basalt ridge overlooking the Columbia River. Overall vegetation cover is low. Associated species include: *Grayia spinosa, Salvia dorrii, Bromus tectorum, Camissonia minor, Cryptantha pterocarya, and Phacelia linearis.* Elev. 1,120–1,300 feet.	May–August	Highly unlikely, only known population is located more than 25 miles north of 2021 Survey Area.	No suitable habitat present
Erythranthe suksdorfii (Suksdorf's monkeyflower)	S / --	Open, moist, or rather dry places, from the valleys and foothills to moderate or occasionally high elevations in the mountains. Occurs in seasonally moist swales, drainages, or vernal pools in shrub-steppe vegetation. Microhabitats are often disturbed by small erosive events (i.e., slumps, slides, bioturbidity, and frost boils). Associated species include: *Juniperus communis. Philadelphus lewisii, Artemisia tridentata, Eriogonum* sp., *Bromus tectorum, Poa secunda, Camissonia hilgardii, Collomia linearis, Draba verna, Erythranthe floribunda, E. breviflora, Plectritis macrocera, Cryptantha ambigua, Microsteris gracilis*, and *Ranunculus testiculatus*. Elev. 430–7,100 feet.	mid-April–approx. June	Low; limited suitable habitat likely to occur within 2021 Survey Area.	No suitable habitat present

Scientific name (Common Name)	State Status / Federal Status[2]	Habitat Characteristics/ Identifying Features[3]	Survey Period[4]	Likelihood of Occurrence Based on Background Review	Suitable Habitat Present Based on Field Surveys
Hypericum majus (Canadian St. John's-wort)	S / --	Along ponds, lakesides, riparian habitats, or other low, wet places (FACW species). In Washington, it occurs in habitats that are completely submerged during portions of the growing season or periodically inundated from water controlled by hydroelectric dams. Associated species include: *Equisetum* spp., *Juncus bufonius, J. tenuis, J. articulatus,* and *Carex* spp. Elev. 50–2,340 feet.	July–September	Highly unlikely; suitable habitat unlikely to occur within 2021 Survey Area.	No suitable habitat present
Leymus flavescens (yellow wildrye)	S / --	Occurs in sandy soils throughout its range. In Montana it is found in sand-deposition areas of sand dunes, where it is associated with *Hesperostipa comata* and *Elymus caninus*. The species has also been found on sandy roadsides.	June–July	Highly unlikely; known occurrence in Benton County is a historical occurrence[5].	No suitable habitat present
Lipocarpha aristulata (awned halfchaff sedge)	T / --	Wet soil and mud, often comprised of fine sand and silt, in bottomlands, sandbars, beaches, shorelines, stream banks, ponds, and ditches. In WA, grows along shorelines and islands below high water at elevations up to 500 feet. Associated species include: *Eleocharis* spp., *Juncus* spp., *Ammannia robusta*, *Rotala ramosior*, *Cyperus* spp., *Limosella* spp., *Lindernia dubia*, and *Rorippa columbiae*.	June–August	Highly unlikely; suitable habitat unlikely to occur within 2021 Survey Area.	No suitable habitat present
Loeflingia squarrosa (spreading pygmyleaf)	T / --	Low swales and shallow vernal pools in sandy and silty areas. The Washington populations were found during an unusually wet year in swales and vernally wet areas with a great diversity of annuals in an otherwise arid environment. Associated species include: *Artemisia tridentata, Poa secuda, Greeneocharis circumscissa, Erythranthe suksdorfii, Holosteum umbellatum, Microsteris gracilis, Gnaphalium palustre, Epilobium minutum, Gilia sinuata*, and *Juncus bufonius*. Elev. 430–580 feet.	May	Highly unlikely; suitable habitat unlikely to occur within 2021 Survey Area.	No suitable habitat present
Lomatium tuberosum (Hoover's desert-parsley)	S / --	Loose basalt talus in sagebrush steppe, typically on east- to north-facing slopes. Sometimes in channels of open ridgetops and talus on south- to southwest-facing slopes in the western portion of its distribution. Associated species include: *Artemisia rigida, Poa secunda, Pseudoroegneria spicata*, and *Delphinium nuttalianum*. Elev. 460–4,000 feet.	Early March–mid-April	Low; limited suitable habitat likely present within 2021 Survey Area.	No suitable habitat present

Scientific name (Common Name)	State Status / Federal Status[2]	Habitat Characteristics/ Identifying Features[3]	Survey Period[4]	Likelihood of Occurrence Based on Background Review	Suitable Habitat Present Based on Field Surveys
Micromonolepis pusilla (red poverty-weed)	T / --	Desert regions, in saline or alkaline clay soils, salt-encrusted soils, or edges of alkaline ponds. This species is adapted to extreme conditions. In some sites it is limited to growing directly beneath greasewood shrubs, due to cattle trampling and soil compaction between the shrubs. Associated species include: *Sarcobatus vermiculatus, Suaeda depressa, Bromus tectorum*, and *Phacelia tetramera*. Elev. 1,950–2,210 feet.	April–June	Highly unlikely; suitable habitat unlikely to occur within survey area and known occurrence in Benton County is historical occurrence[5].	No suitable habitat present
Mimetanthe pilosa (false monkeyflower)	S / --	Moist, sandy or gravelly soils, especially by small streams, seeps, springs, and disturbed areas. Elev. 1,000–4,500 feet.	May–July	Highly unlikely; known occurrence in Benton County is a historical occurrence[5].	No suitable habitat present
Myosurus alopecuroides (foxtail mousetail)	T / --	Obligate vernal pool species; found on hard, bare, desiccated clay in sparsely vegetated areas of shallow pools. Associated species include: *Deschampsia danthonioides, Myosurus minimus, Navarretia leucocephala, Plagiobothrys* spp., and *Polygonum polygaloides* ssp. *confertiflorum*. Elev. 250–2,500 feet.	March–June	Highly unlikely; suitable habitat unlikely to occur within 2021 Survey Area.	No suitable habitat present
Nicotiana attenuata (coyote tobacco)	S / --	Dry, sandy bottom lands, dry rocky washes, and in other dry open places; Elev. 320 to 2,640 feet. Associated species: *Artemisia tridentata, Ericameria* spp., *Bromus tectorum, Leymus cinereus, Centaurea diffusa, Verbascum thapsus, Solanum triflorum, Achillea millefolium*, and *Mentzelia laevicaulis*.	June–September	Low; limited suitable habitat likely to occur in 2021 Survey Area.	Very limited suitable habitat present
Oenothera cespitosa ssp. *cespitosa* (cespitose evening-primrose)	S / --	Open sagebrush desert; on loose talus slopes, steep, sandy or gravelly slopes, road cuts, and dry hills; as well as along the flat river terrace of the Columbia River. It occurs within general areas dominated by *Artemisia tridentata* or *Artemisia rigida*. Other associated species include: *Ericameria nauseosa, Eriogonum douglasii* and *E. niveum, Poa secunda, Achnatherum thurberianum, A. hymenoides, Hesperostipa comata, Koeleria macrantha, Astragalus purshii, A. succumbens, Balsamorhiza careyana, Phacelia hastata*, and *Cymopterus terebinthina*. Elev. 410–1,800 feet.	Late-April–mid-June	Moderate; suitable habitat potentially present in 2021 Survey Area.	Limited suitable habitat present

Scientific name (Common Name)	State Status / Federal Status[2]	Habitat Characteristics/ Identifying Features[3]	Survey Period[4]	Likelihood of Occurrence Based on Background Review	Suitable Habitat Present Based on Field Surveys
Rorippa columbiae (Columbia yellowcress)	T / --	Riverbanks, permanent lakes, snow-fed lakes, and streams, internally-drained lakes with extended periods of dryness, wet meadows, and ditches. All known sites are inundated for at least part of the year. Soil types include clay, sand, gravel, sandy silt, cobblestones, and rocks. All sites in Washington occur along the Columbia River, in the lowest vegetated riparian zone.	April–October	Highly unlikely; suitable habitat unlikely to occur within 2021 Survey Area.	No suitable habitat present
Rotala ramosior (lowland toothcup)	S / --	Damp areas in fine sand and silt, wet, swampy places, mudflats, lakes and pond margins, and along free-flowing river reaches. Found in riparian wetlands growing below high water, often in a community of small emergent annuals. Elev. 200 to 2,260 feet. Associated species include: *Salix exigua*, *Ammannia robusta*, *Juncus* spp., *Eleocharis acicularis*, *Limosella acaulis*, *Lindernia dubia*, and *Cyperus acuminatus*. Elev. 200–2,259 feet.	June–August	Highly unlikely; suitable habitat unlikely to occur within 2021 Survey Area.	No suitable habitat present
Sabulina nuttallii var. *fragilis* (Nuttall's sandwort)	T / --	Open, gravelly benches, dry rocky areas, or limestone talus from open sagebrush hills to alpine slopes. In Washington this taxon has been found on desert ridges of raised basalt, talus, outcrops, and in rocky to gravelly or sandy soil. Associated species include: *Purshia tridentata*, *Grayia spinosa*, *Salvia dorrii*, *Pseudoroegneria spicata*, *Ericameria nauseosa*, *Eriogonum microthecum*, *Balsamorhiza careyana*, and *Lomatium macrocarpum*.	May–August	Highly unlikely; suitable habitat unlikely to occur within 2021 Survey Area.	No suitable habitat present

Notes:

[1] Table based on the WNHP's Rare Vascular and Nonvascular Species List for Benton County (WNHP 2021a)

[2] State Status: WNHP (2019) provides the following explanation of state status:

E = Endangered, in danger of becoming extinct or extirpated from Washington
T = Threatened, likely to become Endangered in Washington
S = Sensitive, vulnerable or declining and could become Endangered or Threatened in Washington
X = Possibly extinct or extirpated from Washington State (includes state historical species).

Federal status: T = Listed threatened.

[3] Sources: Burke Museum of Natural History and Culture 2021; Hitchcock and Cronquist 2018; WNHP 2019, 2021b.

[4] Sources: Burke Museum of Natural History and Culture 2021; WNHP 2021b.

[5] Historical occurrence is one that has not been reconfirmed for 40 or more years, or the species is extirpated from the county (WNHP 2021a).

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ATTACHMENT B
VASCULAR PLANTS OBSERVED WITHIN THE 2021 SURVEY AREA

Scientific Name	Common Name	Family	Type	Non-native	Noxious Weed Class Benton County / Washington State	Synonyms / Notes
Achillea millefolium	common yarrow	Asteraceae	forb			
Achnatherum hymenoides	Indian rice grass	Poaceae	grass			
Agoseris grandiflora	bigflower agoseris	Asteraceae	forb			
Agoseris heterophylla	annual agoseris	Asteraceae	forb			
Agropyron cristatum	crested wheatgrass	Poaceae	grass	x		
Allium acuminatum	tapertip onion	Amaryllidaceae	forb			
Amaranthus blitoides	matweed, prostrate pigweed	Amaranthaceae	forb	x		
Ambrosia acanthicarpa	bur ragweed	Asteraceae	forb			
Amsinckia lycopsoides	tarweed fiddleneck, bugloss fiddleneck	Boraginaceae	forb			
Amsinckia tessellata	bristly fiddleneck, tessellate fiddleneck	Boraginaceae	forb			
Antennaria dimorpha	low pussytoes	Asteraceae	forb			
Artemisia dracunculus	dragon sagewort, tarragon, dragon wormwood	Asteraceae	forb			
Artemisia tridentata	big sagebrush	Asteraceae	shrub			
Artemisia tripartita	threetip sagebrush	Asteraceae	shrub			
Astragalus purshii	woollypod milkvetch, Pursh's milk-vetch	Fabaceae	forb			
Astragalus spaldingii	Spalding's milkvetch	Fabaceae	forb			
Balsamorhiza careyana	Carey's balsamroot	Asteraceae	forb			
Bassia scoparia	red belvedere, mock cypress, kochia	Amaranthaceae	forb	x	Class B / Class B	*Kochia scoparia*
Bromus arvensis	field brome/Japanese brome	Poaceae	grass	x		*Bromus japonicus*
Bromus hordeaceus	soft brome	Poaceae	grass	x		*Bromus mollis*
Bromus tectorum	cheatgrass	Poaceae	grass	x		
Calochortus macrocarpus var. *macrocarpus*	sagebrush mariposa lily	Liliaceae	forb			
Centaurea sp.	knapweed	Asteraceae	forb	x	Class B / Class B	likely diffuse knapweed
Ceratocephala testiculata	burr buttercup	Ranunculaceae	forb	x		
Chaenactis douglasii	Douglas' dustymaiden, dusty maidens	Asteraceae	forb			
Chenopodium leptophyllum	narrowleaf goosefoot	Amaranthaceae	forb			
Chondrilla juncea	rush skeletonweed	Asteraceae	forb	x	Class B / Class B	
Chorispora tenella	crossflower, blue mustard	Brassicaceae	forb	x		
Chrysothamnus viscidiflorus	yellow rabbitbrush, green rabbitbrush	Asteraceae	shrub			
Convolvulus arvensis	field bindweed	Convolvulaceae	forb	x	Class C / Class C	
Conyza canadensis	horseweed, Canadian fleabane	Asteraceae	forb			
Crepis atribarba	slender hawksbeard	Asteraceae	forb			
Crepis intermedia	intermediate hawksbeard, limestone hawksbeard	Asteraceae	forb			
Cymopterus terebinthinus	turpentine spring parsley, turpentine wavewing	Apiaceae	forb			*Pteryxia terebinthina*
Descurainia pinnata	western tansymustard	Brassicaceae	forb			
Descurainia sophia	flixweed	Brassicaceae	forb	x		
Dieteria canescens	hoary-aster	Asteraceae	forb			*Machaeranthera canescens*
Draba verna	spring whitlow-grass	Brassicaceae	forb	x		
Elymus elymoides	squirreltail	Poaceae	grass			
Epilobium brachycarpum	tall annual willowherb	Onagraceae	forb			
Ericameria nauseosa	rubber rabbitbrush, gray rabbitbrush	Asteraceae	shrub			
Erigeron filifolius	threadleaf fleabane	Asteraceae	forb			
Erigeron linearis	desert yellow daisy, lineleaf fleabane	Asteraceae	forb			
Erigeron pumilus	shaggy fleabane	Asteraceae	forb			
Eriophyllum lanatum var. *integrifolium*	Oregon sunshine	Asteraceae	forb			
Erodium cicutarium	redstem, common stork's bill, crane's-bill	Geraniaceae	forb	x		
Grayia spinosa	spiny hopsage	Amaranthaceae	shrub			
Hesperostipa comata	needle-and-thread grass	Poaceae	grass			
Heterotheca villosa	hairy goldaster	Asteraceae	forb			
Holosteum umbellatum	jagged chickweed	Caryophyllaceae	forb	x		
Hordeum murinum	mouse barley	Poaceae	grass	x		
Lactuca serriola	prickly lettuce	Asteraceae	forb	x		
Lagophylla ramosissima	slender hareleaf, branched lagophylla	Asteraceae	forb			
Lappula longispina	long-spined stickseed	Boraginaceae	forb	x		

Scientific Name	Common Name	Family	Type	Non-native	Noxious Weed Class Benton County / Washington State	Synonyms / Notes
Leymus cinereus	basin wildrye	Poaceae	grass			*Elymus cinereus*
Linum lewisii var. *lewisii*	wild blue flax, prairie flax	Linaceae	forb			
Lithospermum ruderale	western gromwell, western stoneseed	Boraginaceae	forb			
Lomatium macrocarpum	large-fruit desert-parsley, bigseed lomatium	Apiaceae	forb			
Lomatium papilioniferum	butterbly bearing biscuit-root	Apiaceae	forb			*Lomatium grayi*
Lomatium triternatum	triternate biscuit-root	Apiaceae	forb			
Lupinus leucophyllus	velvet lupine	Fabaceae	forb			
Lupinus sulphureus var. *subsaccatus*	sulphur lupine, Bingen lupine	Fabaceae	forb			
Madia sp.	tarweed	Asteraceae	forb			
Mentzelia albicaulis	white-stem blazingstar	Loasaceae	forb			
Onopordum acanthium	Scotch thistle	Asteraceae	forb	x	Class B / Class B	
Phacelia linearis	thread-leaf phacelia, thread-leaf scorpion-weed	Hydrophyllaceae	forb			
Phlox longifolia	long-leaf phlox	Polemoniaceae	forb			
Phlox sp.	phlox	Polemoniaceae	forb			
Plantago patagonica	woolly plantain, indianwheat plantain	Plantaginaceae	forb			
Poa bulbosa	bulbous bluegrass	Poaceae	grass	x		
Poa secunda ssp. *juncifolia*	big bluegrass, Nevada bluegrass, alkali bluegrass	Poaceae	grass			*Poa ampla*
Poa secunda ssp. *secunda*	Sandberg bluegrass, curly bluegrass	Poaceae	grass			
Polygonum aviculare	prostrate knotweed	Polygonaceae	forb	x		
Polypogon monspeliensis	annual rabbit's-foot grass	Poaceae	grass	x		
Pseudoroegneria spicata	bluebunch wheatgrass	Poaceae	grass			
Robinia pseudoacacia	black locust	Fabaceae	tree	x		
Salsola tragus	prickly Russian thistle	Chenopodiaceae	forb	x		*Salsola kali*
Secale cereale	cereal rye	Poaceae	grass	x	Class C / Class C	
Sisymbrium altissimum	tall tumblemustard	Brassicaceae	forb	x		
Stephanomeria tenuifolia	wire lettuce, narrowleaf wirelettuce	Asteraceae	forb			
Taraxacum officinale	common dandelion	Asteraceae	forb	x		
Tetradymia canescens	gray horsebrush, spineless horsebrush	Asteraceae	shrub			
Tragopogon dubius	yellow salsify	Asteraceae	forb	x		
Triticum aestivum	wheat	Poaceae	grass	x		
Verbena bracteata	carpet vervain	Verbenaceae	forb			
Vulpia bromoides	brome fescue	Poaceae	grass	x		
Vulpia microstachys	small fescue	Poaceae	grass			

ATTACHMENT C
WOVEN-SPORE LICHEN HABITAT SUITABILITY ASSESSMENT

1 INTRODUCTION

Based on review of the Washington Natural Heritage Program (WNHP) data (WNHP 2021a, 2021b), one special status non-vascular species, woven-spore lichen (*Texosporium sancti-jacobi*), was identified as occurring in Benton County and potentially within the Project Lease Boundary. In Washington, this species has been assigned the rank of threatened by the WNHP (WNHP 2021a). Woven spore-lichen has been documented at four separate locations within approximately 3 miles of the Project Lease Boundary, with the closest occurrence approximately 0.4 mile to the north. Field surveys for woven-spore lichen have not been conducted for the Project. In lieu of field surveys, this habitat suitability assessment was conducted to identify potentially suitable habitat at the Project for this species.

2 BACKGROUND

Woven spore lichen is a crustose lichen in the Caliciaceae (pin lichen) family of the Fungi Kingdom. It is identified by its whitish-margined apothecia (spore-bearing structure or fruiting body) and dark olive, loose spore mass (WNHP 2021c). In Washington, this species is currently known from Benton, Klickitat, Lincoln, and Yakima counties (Stone et al. 2018).

Habitat for this species includes arid to semiarid shrub-steppe, grassland, biscuit scabland, or savannah communities up to 3,300 feet in elevation (WNHP 2021c). Woven-spore lichen is typically found in areas of non-saline and noncalcerous soils on flat to gentle slopes, although it has also been found on slopes of up to 15 percent (Root and McCune 2012; Stone et al. 2018; WNHP 2021c). Most sites where it is found are relatively undisturbed and dominated by native plants, including sagebrush (*Artemisia tridentata*), bitterbrush (*Purshia tridentata)*, Idaho fescue (*Festuca idahoensis*), and bluebunch wheatgrass (*Pseudoroegneria spicata*) and are influenced by moisture from a river or lake (Root and McCune 2012; Stone et al. 2018; WNHP 2021c). It is often found on decomposing bunchgrass clumps that are impregnated with soil but elevated above the surrounding surface, on well-developed pinnacles of soil, or on old, decaying mammal scat (Stone et al. 2018; WNHP 2021c).

In 2018, surveys for woven-spore lichen were conducted for the Bureau of Land Management (BLM) in various locations on BLM-managed land in Lincoln, Grant, Yakima, and Benton counties (Stone et al. 2018). These surveys included BLM-managed land in the Horse Heaven Hills. During these surveys, woven-spore lichen was found in the Horse Heaven Hills in areas dominated by native bunchgrasses including bluebunch wheatgrass (*Pseudoroegneria spicata*) and Sandberg bluegrass (*Poa secunda* ssp. *secunda*) and lacking a shrub component (Stone et al. 2018). Although the areas where woven-spore lichen was most observed to be most abundant during these surveys had high cover of native plants, some areas had significant cover of invasive annual *Bromus* species and other non-native species (Stone et al. 2018). However, the ability to tolerate invasive grasses may be restricted to relatively moist habitats, such as those in proximity to rivers (Root and McCune 2012; Stone et al 2018).

Woven-spore lichen appears to be intolerant of disturbance such as livestock grazing, and fire generally eliminates the species (McCune and Rosentreter 1992; Stone et al. 2018; WNHP 2021c). Vegetation communities where this species is typically found are considered late-successional due to the lack of disturbance for 20 years or more (McCune and Rosentreter 1992).

3 METHODS – HABITAT SUITABILITY ASSESSMENT

Based on the habitat requirements noted above and the results of habitat and botanical field surveys conducted in 2020 (Tetra Tech 2021) and 2021 (this report), Tetra Tech performed a habitat suitability assessment to determine whether potential suitable habitat for woven-spore lichen may occur within the Project Wind Energy Micrositing Corridor and Solar Siting Areas and, therefore, whether this species could potentially be impacted by the Project.

During field surveys in 2020 and 2021, Tetra Tech mapped eight habitat types within the Wind Energy Micrositing Corridor and Solar Siting Areas. Of these eight, five habitat types were removed from consideration as potential habitat for woven-spore lichen: agricultural land, developed/disturbed, non-native grassland, planted grassland, and rabbitbrush shrubland. Agricultural land, developed/disturbed, and non-native grassland habitat types were removed from consideration because these habitat types undergo continual disturbance and are dominated by non-native plant species. Although in some areas within the Wind Energy Micrositing Corridor and Solar Siting Areas, the planted grassland and rabbitbrush shrubland habitat types contained relatively high cover of native species, these two habitat types were excluded from the assessment because 1) they are not considered late-successional vegetation communities and 2) they have undergone repeated disturbance (e.g., agricultural production, planting of grasses and/or shrubs) in the past 20 years. Planted grasslands, and often rabbitbrush shrubland, within the Micrositing Corridor and Solar Siting Areas are generally located on former agricultural lands or other disturbed areas (e.g., areas disturbed by wildfire) that have been planted with non-native and/or native grasses. As discussed in Section 3.2.3.6 of this report, rabbitbrush shrubland was also mapped on hillslopes unlikely to have been previously cultivated for agriculture. These areas were also removed from consideration as these areas occur on slopes greater than 15 percent or contained high cover of non-native invasive grasses and forbs.

The remaining three habitat types—dwarf shrub-steppe, sagebrush shrub-steppe, and eastside (interior) grassland—were evaluated for their potential to provide suitable habitat for woven-spore lichen. To determine suitability, the following habitat factors, per McCune and Rosentreter (1992), Root and McCune (2012), Stone et al. (2018), and WNHP (2021c), were considered:

- Dominance of native species
- Presence of disturbance – i.e., past wildfires, heavy livestock grazing, presence of invasive species
- Percent slope – i.e., slopes greater than 15 percent were removed from analysis
- Proximity to a waterbody (e.g., river or drainage)

Table C-1 provides the habitat suitability criteria that was used to determine areas of dwarf shrub-steppe, sagebrush shrub-steppe, and eastside (interior) grassland mapped within the Wind Energy Micrositing Corridor and Solar Siting Areas that may provide suitable habitat for woven-spore lichen.

Table C-1. Habitat Suitability Criteria

Habitat Factor	Suitability Criteria
Dominance of native species	Area dominated by native species and with relatively low cover (less than approximately 50 percent cover) of non-native grasses and forbs
Presence of disturbance – livestock grazing	Areas where livestock grazing was not noted or where livestock grazing appeared to be light to moderate (some grazing and/or presence of cow sign noted)
Presence of disturbance – wildfire	No documented fires in area in the past 20 years (DNR 2021)
Percent slope	Slopes less than 15 percent
Proximity to a waterbody (e.g., river or drainage)	Drainages or other waterbodies are present within vicinity.[1]

[1] The literature does not define a distance to a waterbody to help determine habitat suitability for woven-spore lichen; therefore, this habitat suitability criterion was not used to eliminate any areas of potentially suitable habitat.

4 RESULTS

Based on the factors listed in Table C-1, approximately 18.9 acres of habitat was considered potentially suitable for woven-spore lichen (Figure C-1). This includes approximately 10.9 acres of dwarf shrub-steppe and 8.0 acres of sagebrush shrub-steppe habitat. All areas mapped as eastside (interior) grassland within the Micrositing Corridor and Solar Siting Areas were determined not to contain suitable habitat for woven-spore lichen based on at least one of the factors listed in Table C-1.

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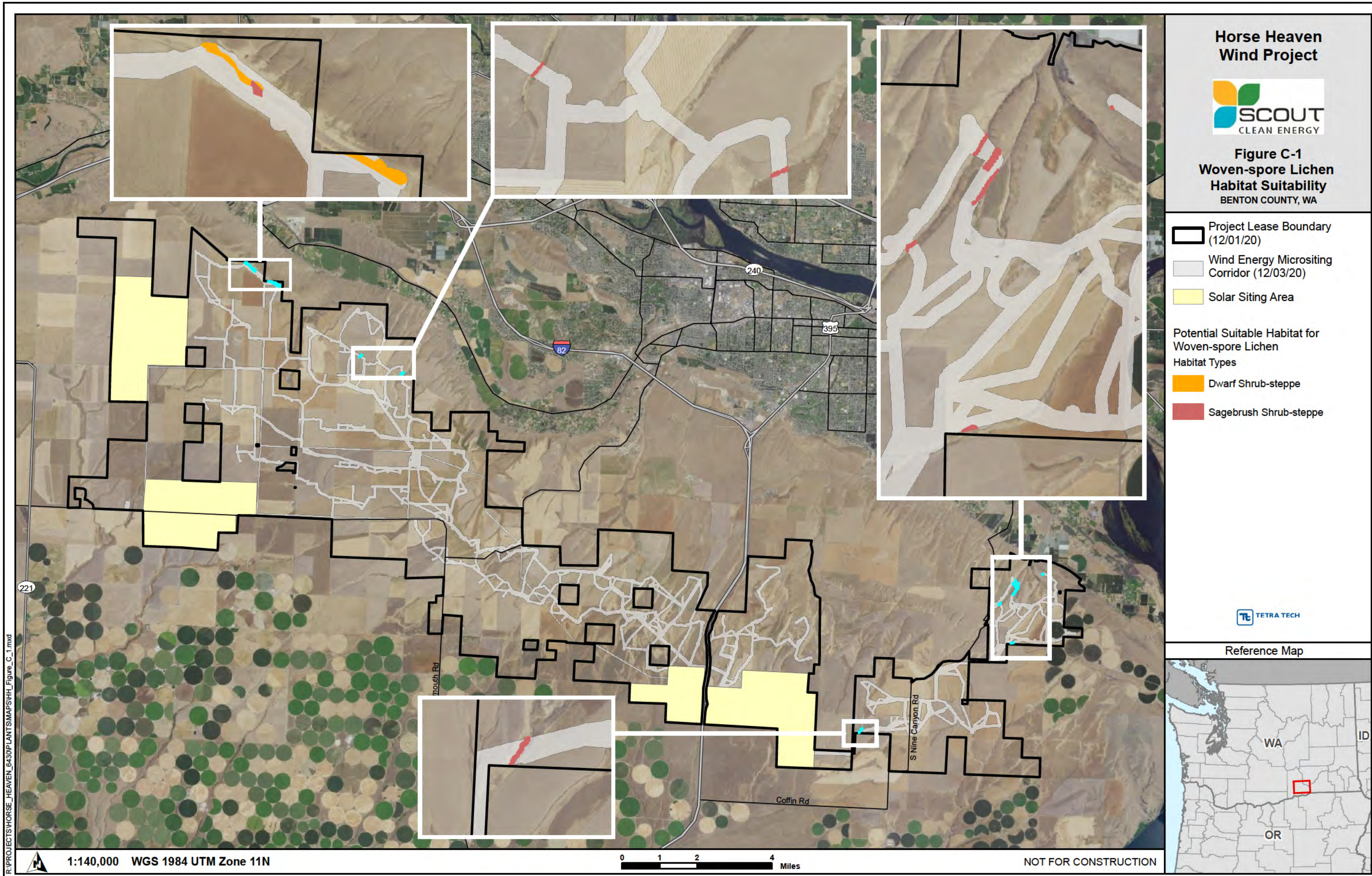
FIGURE



Horse Heaven Wind Project
SCOUT CLEAN ENERGY
Figure C-1
Woven-spore Lichen Habitat Suitability
BENTON COUNTY, WA
Project Lease Boundary (12/01/20)
Wind Energy Micrositing Corridor (12/03/20)
Solar Siting Area
Potential Suitable Habitat for Woven-spore Lichen
Habitat Types
Dwarf Shrub-steppe
Sagebrush Shrub-steppe
TETRA TECH
Reference Map
WA
ID
OR
240
395
82
221
Coffin Rd
S Nine Canyon Rd
mouth Rd
1:140,000 WGS 1984 UTM Zone 11N
0 1 2 4 Miles
NOT FOR CONSTRUCTION
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ATTACHMENT D
REPRESENTATIVE HABITAT PHOTOGRAPHS

Photo 1. Active wheat field within northeastern portion of the 2021 Survey Area.

Photo 2. Fallow wheat field (foreground) adjacent to non-native grassland (left background) dominated by cereal rye (*Secale cereale*).

Photo 3. Fallow wheat field (left), active wheat field (background), and non-native grassland dominated by cereal rye (foreground) in central portion of 2021 Survey Area.

Photo 4. Developed/disturbed habitat: gravel pile for road repair and construction.

Photo 5. Eastside (interior) grassland dominated by needle-and-thread (*Hesperostipa comata*), cheatgrass (*Bromus tectorum*), and cereal rye in southeastern portion of 2021 Survey Area.

Photo 6. Eastside (interior) grassland dominated by Great Basin wildrye (*Leymus cinereus*). Non-native grassland dominated by cereal rye in background.

Photo 7. Eastside (interior) grassland habitat along Badger Canyon.

Photo 8. Non-native grassland dominated by cheatgrass (*Bromus tectorum*) and cereal rye. Active wheat field and remnant sagebrush shrub-steppe (located outside 2021 Survey Area) observable in background.

Photo 9. Non-native grassland dominated by cheatgrass, prickly lettuce (*Lactuca serriola*), and yellow salsify (*Tragopogon dubius*) in northeast portion of 2021 Survey Area.

Photo 10. Higher-quality planted grassland dominated by big bluegrass (*Poa secunda* ssp. *juncifolia*) and bluebunch wheatgrass (*Pseudoroegneria spicata*) in northeast portion of 2021 Survey Area.

Photo 11. High cover of cheatgrass and yellow salsify in lower-quality planted grassland in southeast portion of 2021 Survey Area.

Photo 12. Dead grasses in planted grassland habitat in southwest portion of 2021 Survey Area.

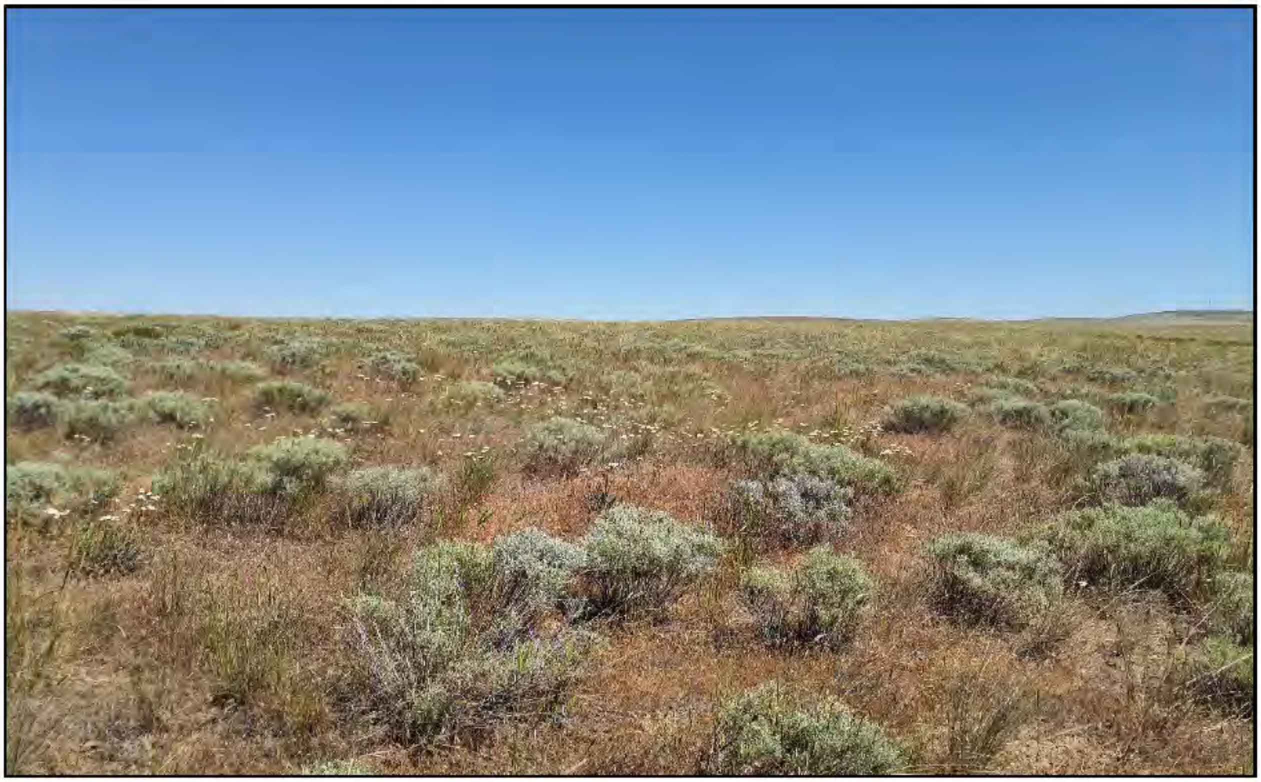

Photo 13. Rabbitbrush shrubland in area burned during the Locust Grove Fire in 1990.

Photo 14. Rabbitbrush shrubland on hillslopes along I-82 in area burned during the Locust Grove Fire in 1990.

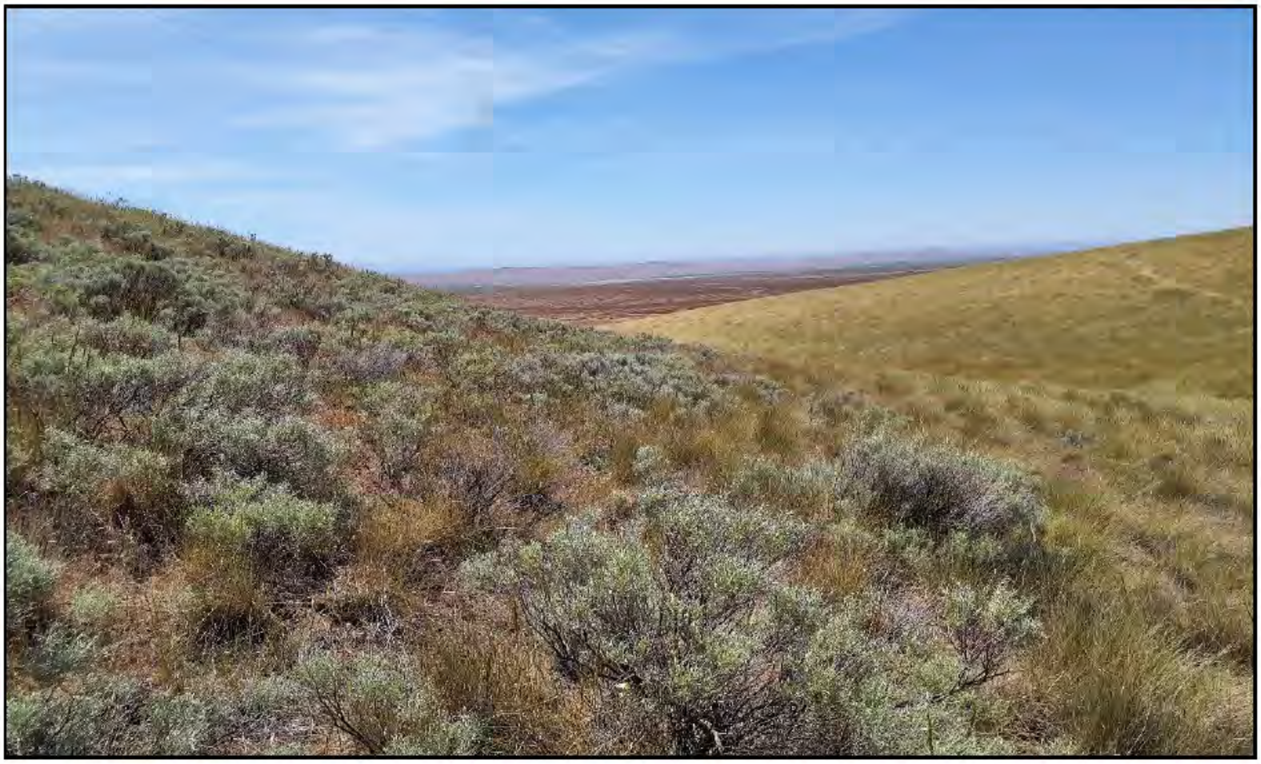

Photo 15. Rabbitbrush shrubland on hillslopes in central-eastern portion of 2021 Survey Area.

Photo 16. Patches of sagebrush shrub-steppe interspersed with non-native grassland on hillslopes and in drainage in southeastern portion of the 2021 Survey Area. Sagebrush shrub-steppe in background is located outside the 2021 Survey Area.

Photo 17. Sagebrush shrub-steppe habitat degraded by heavy grazing and high cover of cheatgrass.

Photo 18. Dead big sagebrush shrub (*Artemisia tridentata*) in area of sagebrush shrub-steppe habitat burned during the Dennis Road fire in 2020.

Modeled Townsend's Ground Squirrel Habitat Concentration Area Maps Prepared in Response to Data Request 2 submitted on August 6, 2021 (ALI 2021)

Attachment Wildlife-20

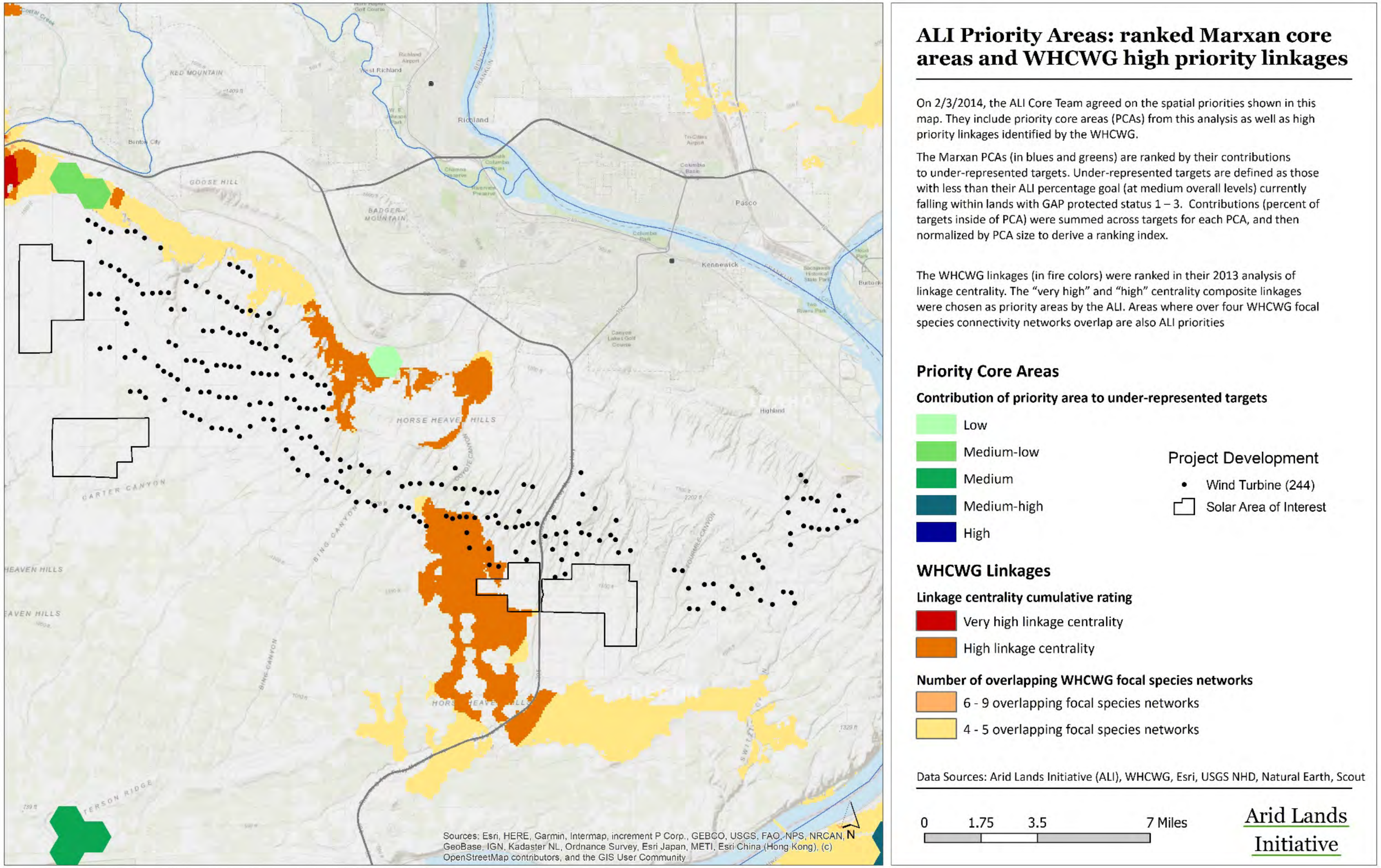

Figure 1. ALI Shared Priority Area Model Results and Horse Heaven Wind Farm Infrastructure

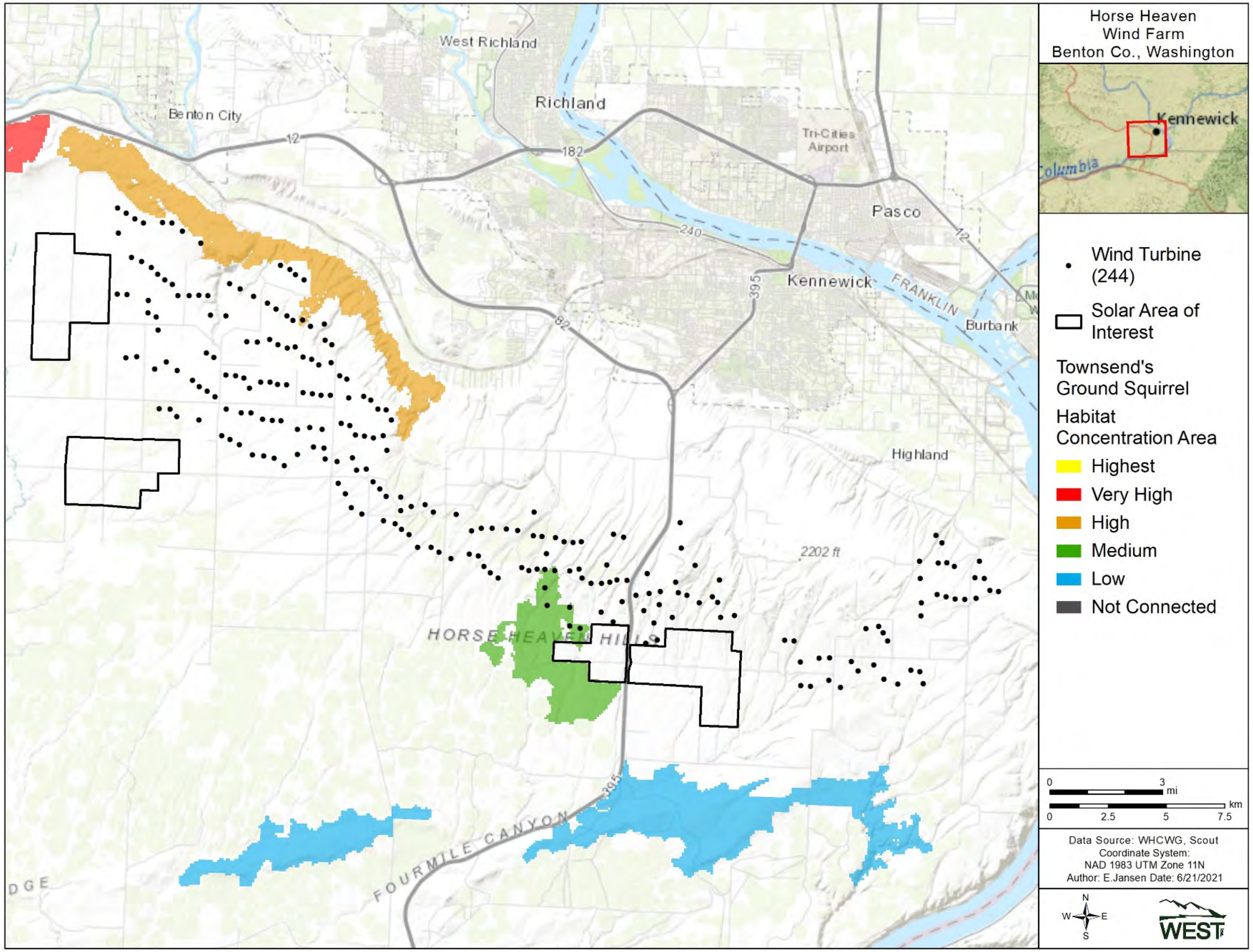

Figure 2. Townsend's Ground Squirrel Habitat Concentration Areas in the Horse Heaven Hills as Modeled by the WHCWG

Ferruginous Hawk Supplemental Information Provided in Response to Data Request 2 submitted on September 10, 2021 (WEST 2021)

Attachment Wildlife-1

Additional Project-specific information is being provided in light of the recent up listing of the ferruginous hawk (*Buteo regalis*) by the Washington Fish and Wildlife Commission on August 27, 2021. This information supplements responses to Wildlife-1, Wildlife-2, Wildlife-4, Wildlife-5, and Wildlife-21.

Ferruginous hawk use and nesting at the Project was characterized as low during pre-construction surveys conducted 2017−2020. Four ferruginous hawk observations in four groups were recorded over 1,232 hours of avian use surveys conducted 2017−2020 at 94 point counts stations distributed throughout the Horse Heaven Hills. The average flight height when first observed was approximately 48 meters above ground level (range of 5−120 m agl). Of the four hawk observations, three were during spring, one during fall, and all were within the western Survey Area during 2018. Observations occurred at three point counts nearest to an active nest that was located approximately two miles away. Observations of ferruginous hawks exclusively at point counts nearest to an active nest suggests increased use was associated with an occupied nesting territory. Although the majority of historic ferruginous hawk nests in the Survey Area were located on [redacted] 13 of the Project Area, all nests were available for breeding birds but inactive during the three years of aerial surveys conducted 2017−2019 within and two miles surrounding the Project. Accordingly, ferruginous hawk nesting was considered low during 2017 (1 inactive nest and 1 active nest out of 20 nests surveyed), 2018 (1 active nest out of 32 nests surveyed) and 2019 (1 active nest out of 44 nests surveyed). Low use and nesting activity during the course of the studies suggest that the likelihood for collisions with Turbines is comparatively low.

Ferruginous hawk are wide-ranging species that face a number of different threats to their survival. Individuals that over winter in California and nest in the Pacific Northwest can summer as far east as North Dakota, with many in southern Saskatchewan, Canada. Along the way, habitat loss from conversion to croplands and urbanization removes vital prey sources that are already prone to fluctuate annually (Hayes and Watson 2020). The use of pesticides and other chemicals to control prey populations throughout their range, particularly in the Central Valley of California, results in year-round pressure on migratory individuals. Other anthropogenic sources of mortality include wind energy, solar energy, oil and gas development, and power transmission which are all associated with infrastructure and human activity; however, the level of severity of these sources in context with the threats mentioned previously is poorly understood.

In the Pacific Region, five hawk fatalities have been attributed with Turbine collisions over a 10 year period (2003-2012; Hayes and Watson 2020) which is comparatively lower than other raptor species reported during post-construction monitoring (AWWI 2019, WEST 2019). To date, no ferruginous hawk fatalities have been reported at Nine Canyon Wind Project, located adjacent to the Horse Heaven Clean Energy Center (HHCEC) site, since the beginning of operations in 2003 (Energy Northwest 2020). Ng et al. (2020) report a similar low fatality estimate from studies conducted at the Altamont Pass Wind Resource Area in California and other studies the investigated mortality from transmission and distribution lines. The issue of climate change has been cited as an additional threat to ferruginous hawk survival (Hayes and Watson 2020, Ng 2020). While predicting how climate change will affect ferruginous hawk is uncertain, the reduction in fossil fuel use and purpose of the HHCEC is one measure that can be taken to assist in the effects of climate change.

Of the five ferruginous hawk fatalities recorded in the Pacific Region, four have been documented at three different wind facilities in Washington. Exposure to Turbine collision risk present primarily during the breeding season and migration, when the species occurs in the region. Use of the Project Area by ferruginous hawk will likely continue following construction. Exposure to Turbine collision risk likely increases at Turbines in proximity to occupied territories, particularly if the nest is active during the nesting period (Kolar 2013). Due to past nesting activity in the Horse Heaven Hills and the overall relatively low territory occupancy in the region, impacts to ferruginous hawk can result in abandonment of the nest territories located closer to Project facilities, particularly because of the tendency of the species to avoid human development and activity (Richardson 1996).

Project operations can further reduce territory occupancy and nest success of ferruginous hawk within the Horse Heaven Hills. To avoid and minimize potential impacts to ferruginous hawk, HHCEC will implement spatial and seasonal restrictions on ground disturbing activities, per WDFW recommendations. Compensatory habitat mitigation as directed by WDFW (2009) will be implemented to offset permanent and temporary impacts. Additional measures will be taken to minimize impacts to habitat and wildlife through Best Management Practices described in Appendix L to the Application for Site Certificate. These measures are the subject of ongoing discussions with WDFW and may be revised based on requests and input from this agency.

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Memo

To:	Dave Kobus, Senior Project Manager, Scout Clean Energy
From:	Matt Cambier, Wildlife Biologist, Tetra Tech and Erik Jansen, Wildlife Biologist, Western EcoSystems Technology, Inc.
Date:	December 21, 2021
Subject:	**WDFW Data Request Regarding Potential Impacts to Pronghorn from Wind and Solar Energy Development at the Horse Heaven Clean Energy Center, Benton County, Washington.**

INTRODUCTION

The purpose of this assessment was to evaluate the population status and distribution of pronghorn antelope (pronghorn; *Antilocapra americana*) in Washington, assess potential effects from the development of wind and solar energy development, and summarize measures the Horse Heaven Wind Farm (Project) has implemented to avoid and minimize potential impacts to pronghorn during construction and operation of the Project.

POPULATION STATUS AND DISTRIBUTION

Pronghorn were extirpated from Washington state by the start of the early twentieth century (Oyster et al. 2015). Currently, there is no open hunting season and the species is not listed as a Priority Species in the Washington Priority Habitat and Species program. After three failed reintroduction attempts between 1938–1968, the Confederated Tribes and Bands of the Yakama Nation (Yakama Tribe) successfully reintroduced 97 individuals in 2011 on the Yakama Reservation (Tsukamoto 2006; Oyster et al. 2015). In 2015, the Yakama Nation Wildlife Program (YNWP) and Washington Department of Fish and Wildlife (WDFW) began biennial aerial and ground surveys to obtain minimum population estimates (Oyster et al. 2015, 2017; Fidorra et al. 2019, Fidorra and Peterson 2021). Surveys were conducted in winter, and the survey area included portions of Klickitat, Yakima, and Benton Counties, Washington (Appendix A). The far eastern portion of the survey area included portions of the western portion of the Project. Each survey year, the survey area was generally replicated; however, it excluded irrigated agricultural fields in 2019 and 2021, which Yoakum (1980) and Tsukamoto (2006) classified as poor pronghorn habitat. This exclusion allowed survey crews to focus efforts in native land cover types (Fidorra et al. 2019).

Since 2011, minimum population estimates have increased from 97 to 250 individuals, (Figure 1; Fidorra and Peterson 2021). This includes supplemental reintroduction efforts in 2018–2019 that added 99 individuals to the population(Figure 1; Fidorra and Peterson 2021). Following the survey in 2019 a severe mortality event occurred resulting in the loss of approximately 40 of the recently introduced individuals. The fact that minimum population estimates remained relatively stable between 2019 and 2021, despite this severe mortality event, suggests that natural recruitment is likely playing a substantial role in sustaining the population. That recruitment is assumed to be the result of reproduction as the population is considered a closed population with no known movements across the Columbia River to the south where populations reside in Oregon, or east to populations re-introduced in north-central Washington by the Colville Tribe (Fidorra and Peterson 2021)..

Geographic coordinates of observations during surveys are not available; however, descriptions from Oyster et al. (2015, 2017) and coarse location information from Fidorra et al. (2019) and Fidorra and Peterson (2021) suggest winter use of the eastern Horse Heaven Hills by pronghorn (Figure 2). Pronghorn were observed within the Project boundary in 2021 (Figure 2; Fidorra and Peterson 2021). Additional observations of pronghorn in the survey area were documented during avian use surveys conducted in the Project in May 2017 and September 2018 when a solitary pronghorn of unknown sex was observed, incidental to avian surveys, walking in a grassland west of Highway 395 (Jansen and Brown 2018).

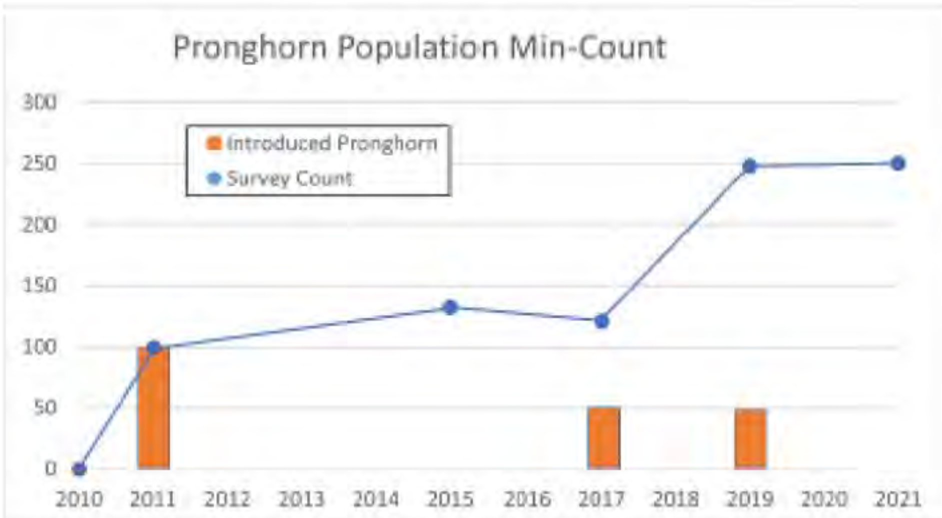

Figure 1. South-Central Washington Pronghorn Minimum Population Estimates Based on Counts from Survey Compared to the Total Number of Introduced Individuals (Fidorra and Peterson 2021)

Table 1. Summary Statistics of Minimum Pronghorn Population Counts during Surveys Conducted 2015-2021, Starting with Reintroduction in 2011

Year	Total Count	# Groups	Ave. Group Size[1]	Count On Reservation	Count Off Reservation	Comment
2011	97	1	97	97	0	Reintroduction starts
2015	132	15	8.8	49	57	One group of four individuals south of Kennewick, exact location unknown
2017	121	19	6.4	44	72	Off Reservation were located south and southeast of Reservation, west of the Project
2019	248	8	31.0	178	70	Off Reservation were located in Benton County, west of the Project

2021	250	34	7.4	124	126	Off Reservation were located in Yakima, Klickitat, and Benton County

[1] Average group size = Total Count / # groups

[redacted]

Figure 2. Pronghorn Group Locations Observed During 2021 Aerial Surveys (Fidorra and Peterson 2021) Relative to the Approximate Location of the Project. Location data from 2015 and 2017 surveys were unavailable.

HABITAT USE, SEASONAL MOVEMENT, AND THREATS TO SURVIVAL

Habitat Use

Traditionally considered a prairie obligate species that uses grassland, savanna, and shrub-steppe, pronghorn may use annual or perennial croplands, particularly in altered areas where native habitat have been lost (Torbit et al. 1993; Jones et al. 2015). Pronghorn have been documented to use dryland agricultural areas, like winter wheat fields, as sources of forage when nutrition of native forage is low during the winter (Torbit et al. 1993). Of the 34 total groups documented during 2015 and 2017 aerial surveys, most groups were observed in rangeland (25 groups, 74 percent), followed by cropland (8 groups, 24 percent), and land enrolled in the Conservation Reserve Program (1 group, 3 percent). Habitat use data from 2019 and 2021 surveys were unavailable. The majority of groups located outside of the

Reservation in 2015 and 2017 were described as south and southeast of the Reservation, which correspond to landscapes primarily composed of grasslands (herbaceous), shrub-steppe (shrub/scrub), and agriculture (cultivated crop; Figure 3; Oyster et al. 2015, 2017). In 2019 and 2021 surveys, more groups were located farther east of the Reservation in landscapes primarily composed of agriculture (Oyster et al. 2015, 2017; Fidorra et al. 2019; Fidorra and Peterson 2021; Figures 2 and 3).

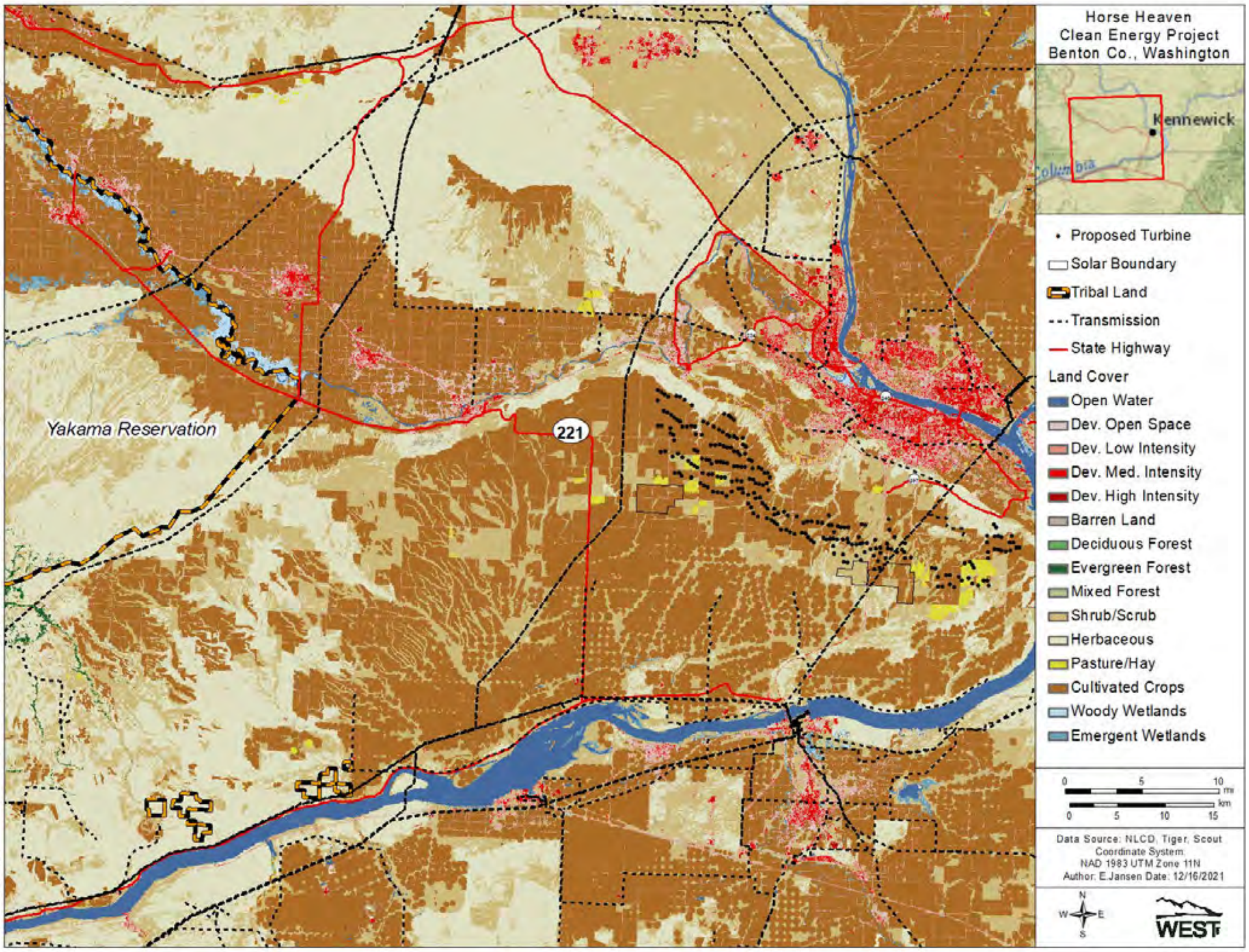

Figure 3. Land Cover Characteristics Between the Yakama Reservation and the Project

Seasonal Movement

Depending on winter severity, snow depth, and access to forage, pronghorn may exhibit distinct seasonal movements between their summer and winter ranges (Sawyer et al. 2002). Winter range provides the species with forage and thermal cover whereas summer range provides cooler temperatures, lush vegetation, and a place to have and raise their young. Winter range includes lower-elevation shrub-steppe habitat and agricultural fields (Sawyer et al. 2002). Migration is influenced by natural features and the juxtaposition of forage and cover resources on the landscape. Data from 2015-2021 YNWP/WDFW aerial surveys show approximately half the pronghorn established in the Yakama Reservation leave during the winter, with some migrating to surrounding lower-elevation rangelands and dryland agriculture areas of

Klickitat, Yakima, and Benton counties. Based on the location of individuals during winter, the Yakama pronghorn population can be considered partially migratory with a portion of the population remaining on the Reservation through the duration of winter, with others diffusing up to 30 miles outside of the Reservation into the surrounding counties. Based on the data available, there does not appear to be high directionality in seasonal movement, and no distinct migratory corridors have been identified. Data on summer use for this population are unavailable but it is suspected that the majority of the population may relocate onto Reservation lands where shrub cover, forage, and human disturbance are relatively less than the regions surrounding the Reservation and more conducive for rearing young (Christie et al. 2017).

Threats to Survival

A myriad of factors influence the survival of individuals and, more importantly, population viability, as is the situation of the small population of the reintroduced Yakama pronghorn population. Primary factors that influence survival of small populations include winter severity, habitat fragmentation, predation, and genetic isolation. An 8-year study of 175 collared females in the northern sagebrush-steppe ecosystem of southern Alberta and Saskatchewan, Canada, and northern Montana, USA, found winter severity as the primary factor that influenced survival of a partially migratory population (Jones et al. 2020). The relationship between survival and severe wind weather corresponds to survival patterns from other pronghorn studies in the northern portion of the species' range (O'Gara and Yoakum 2004; Reinking et al. 2018; Jakes et al. 2020).

Evolved as an open prairie obligate, pronghorn have mixed responses to habitat fragmentation that results from conversion to incompatible land cover types, fence construction for livestock management, transportation systems, and energy development (Gates et al. 2011; Hebblewhite 2011; Reinking et al. 2018). Direct impacts to survival include mortality resulting from vehicle collisions or entanglement with three-strand barbed wire fences. Indirect impacts to survival may result from conversion to incompatible land cover types or energy development (Sawyer et al. 2002; Xu et al. 2021; Zeller et al. 2021). Although wind and solar energy development does not pose a direct mortality risk, avoidance behavior that deters individuals from access to essential foraging or parturition habitat may lead to reduced fecundity, particularly when those habitat types are limiting on the landscape (Gates et al. 2012; Yoakum et al. 2014). WDFW has not established essential foraging, parturition, or any other seasonal habitat designations for pronghorn in Washington state.

Predation is another important factor affecting pronghorn populations. Coyotes (*Canis latrans*) account for upwards of 75 percent of predation-caused mortality on fawns (Berger and Conner 2008; Berger et al. 2008; White et al. 2009; Painting et al. 2021). Specific to the Yakama population, YNWP/WDFW identified coyote as a potential limiting factor in individual and population persistence (Oyster et al. 2015, 2017). Anecdotal observations from aerial surveys conducted in 2017 through 2019 in a 10-mile radius from the Project correspond with high numbers of coyote observed throughout the Horse Heaven Hills (E. Jansen, unpublished data).

Small population sizes, as observed in the Yakama population, result in reduced genetic variation that may lead to genetic bottlenecks where inbreeding depression can affect population viability (Stephen et al. 2005; Dunn and Beyers 2008). Supportive breeding, or additional reintroductions into the population assist in diversifying the genetic variability in small populations which are more resilient to stochastic environmental events such as severe weather (Dunn and Beyers 2008; Cancino et al. 2010). Supplemental reintroduction of 98 individuals into the Yakama population in 2018 and 2019 helped diversify the genetic variability, increasing the resilience of the herd.

PRONGHORN RESPONSE TO RENEWABLE ENERGY DEVELOPMENT

All of the few publicly available studies on pronghorn response to wind or solar energy development have been conducted in Wyoming, where nearly half of the entire U.S. pronghorn population resides (Kobilinsky 2020; Smith et al. 2020; Sawyer et al. 2022). According to U.S. Geological Survey research assistant Meghan Milligan (Kobilinsky 2020), because research on the effects of energy development has mostly focused on oil and gas, it is unknown whether the negative effects on big game species from these studies can be inferred for wind or solar development. Extractive energy development creates different sources and intensity of disturbance on the landscape than renewable energy development. For instance, oil and gas development includes more human presence throughout construction and operation, while the increase in human activity during wind and solar development is more temporary and associated with construction (Kobilinsky 2020). High densities of oil and natural gas wells create a complex network of wells, roads, tank batteries, electrical systems, and other infrastructure that can effectively eliminate hundreds of areas of pronghorn habitat whereas wind is more dispersed over the landscape and solar is highly concentrated in a comparatively smaller area, resulting in high land-use efficiency (Hernandez et al. 2015). Wind energy development remains unfenced and permeable for pronghorn use whereas security fencing surrounding solar development excludes pronghorn and other large ungulates (Sawyer et al. 2013). For both wind and solar, once construction is complete, there is a lower level of human presence, including vehicle traffic, in and around the facilities during operations, reducing exposure to large mammals, when compared to oil and gas facilities (Sawyer et al. 2022).

Research in the Shirley Basin of south-central Wyoming during the winters of 2010 to 2012, and again from 2018 to 2020, focused on wind energy development and pronghorn behavior (Kobilinsky 2020). This area is designated crucial winter range for the Medicine Bow pronghorn herd (Kobilinksy 2020; USGS 2021). Findings of the study were inconsistent and variable. During the summer and winter months, the effects of wind energy on pronghorn were inconsistent; some years the pronghorn selected habitat closer to wind turbine generators (Turbines) and other years chose habitat farther away. Pronghorn selected habitat within proximity to Turbines because no other reasonable alternative was available considering the Turbines were placed in high-quality pronghorn habitat (Kobilinsky 2020). The study also found that pronghorn home range size was not influenced by Turbines. Finally, the study found that individual pronghorn in close range of the Turbines (30 to 40 miles) did not respond to them during the construction phase, but tended to avoid them during the post-construction phase.

At the Dunlap Ranch in south-central Wyoming, Smith et al. (2020) evaluated the potential impacts of wind energy infrastructure on pronghorn winter habitat selection. While the authors indicate that continued research is needed, they found that pronghorn avoided Turbines within their winter home ranges after development was complete. This general observation is consistent with findings from oil and gas developments that has found evidence that pronghorn response to energy development involves avoidance of infrastructure (Sawyer et al. 2019).

In another study at the Dunlap Ranch in Wyoming, the mortality risk for pronghorn on crucial winter range that included wind energy development was examined (Taylor et al. 2016). The study found that exposure to wind energy infrastructure was not an informative predictor of pronghorn mortality risk on winter range, suggesting that adult pronghorn tolerate wind development. However, results also suggest that other factors such as environmental and non-wind anthropogenic effects (e.g., distance to major roads) may have influenced the vulnerability of pronghorn to wind energy infrastructure.

In the only study of pronghorn response to solar development, Sawyer et al. (2022) investigated the effects of a 568-acre, 80-megawatt project located in the middle of a high-use migratory corridor in southwest Wyoming. Although 30 radio-collared pronghorn continued to travel directly adjacent to the fence, use declined 40 percent within 1.2 miles from the project and 34 percent within 1.8 miles. Located adjacent to a state highway, barrier effects from the project inadvertently diverted animals onto a state highway, causing safety issues for animals and humans alike. Although the Wyoming herd comprises thousands of individuals that migrate 19 to 140 miles between summer and winter ranges, Sawyer et al. (2022), reiterated the importance of siting solar projects in previously disturbed areas or agricultural lands where environmental impacts are largely avoided (Cameron et al. 2012; Hernandez et al. 2015).

DISCUSSION

Based on four years of systematic aerial surveys by YNWP/WDFW, a portion of the pronghorn population have been observed using the agricultural areas of the Horse Heaven Hills during the winter. Pronghorn were observed further east in 2021 than in previous survey efforts, including some observations in the Project area. Areas south and southeast of the Reservation and west and outside of the Project, where the majority of groups were observed in 2015 and 2017, consist of more grasslands and shrub-steppe compared to the predominantly agricultural area of the eastern Horse Heaven Hills, which includes the Project. The Yakama Reservation is approximately 23 linear miles from the nearest proposed Turbine. Land ownership is primarily private with scattered parcels of trust lands managed by the Washington Department of Natural Resources. The south-facing, primarily flat grassland slopes south and east of the Reservation (outside of the Project area) offer suitable winter range for pronghorn; however, existing barriers throughout the landscape including countless three-stand barbed wire fences, roads, and highways pose a substantial impediment to pronghorn movement (Figure 3).

It is anticipated that pronghorn would avoid Project construction activities, with wintering individuals being the most likely to be exposed to these activities. Construction and operation of wind facilities would result in small areas of disturbance distributed over the larger Micrositing Corridor. While research on the effect of operational Turbines on pronghorn use of winter habitat varies, some studies indicate that animals avoid Turbines to varying degrees. Fenced solar arrays would permanently remove potential foraging habitat for pronghorn; however, removal of the primarily agricultural fields where solar development is proposed should not be limiting, considering the amount of similar habitat on the landscape (Figure 3). Survey data do not indicate the area of the proposed Project is along a primary migration corridor, as evidenced by the number of unaggregated winter observations; therefore, potential barriers to seasonal movement from solar development as observed by Sawyer et al. (2022) are not expected. To our knowledge, the Project would not be an impediment to pronghorn (or other big game) access to water features that are crucial for pronghorn during all seasons (Yoakum et al. 2014). Indirect impacts to pronghorn from avoidance of Project infrastructure is anticipated to some degree; however, because of the seasonal use of the Project area and availability of suitable winter habitat across the landscape, avoidance should not result in significantly adverse effect to individuals or the population.

PROJECT PRONGHORN AVOIDANCE AND MINIMIZATION MEASURES

The following avoidance and minimization measures were implemented in the Project design and planned for operations to reduce impacts to terrestrial wildlife, including pronghorn. As summarized in Section 1.10.1 of the Project's Application for Site Certification (ASC) as well as in related responses to data requests submitted to the Energy Facility Site Evaluation Council (EFSEC), these measures include the following:

Design Measures

- Project facilities were sited on previously disturbed (e.g., cultivated cropland) areas to the extent feasible to avoid impacts to native habitats and associated wildlife species.
- The Applicant will use industry standard BMPs to minimize impacts on vegetation, waters, and wildlife.
- Collection lines were co-located along existing roads and proposed access roads to reduce habitat disturbance.
- Sagebrush shrub-steppe habitat would be avoided to the extent possible. If avoidance is not possible, mitigation for impacts to sagebrush shrub-steppe habitat would be developed in consultation with the applicable agencies.
- The Applicant will limit construction disturbance by flagging any sensitive areas and will conduct ongoing environmental monitoring during construction to ensure flagged areas are avoided.

Operational Measures

- Following construction, temporarily disturbed areas will be revegetated with native or non-invasive, non-persistent non-native plant species as described in the Revegetation and Noxious Weed Management Plan (see Appendix N of the ASC).
- Traffic speeds on unpaved roads will be limited to 25 miles per hour to minimize vehicle collisions with wildlife.
- Construction of new 3-strand barbed wire fencing is not anticipated.
- Various measures will be implemented that reduce or eliminate the potential the risk of wildfire.
- The Applicant does not anticipate using pesticides during Project construction or operation; if unforeseen circumstances arise that require the use of pesticides, the Applicant would consult with WDFW and EFSEC.
- A Wildlife Handling and Incidental Reporting System (WHIRS) will be implemented at Project, which will facilitate a system where all wildlife fatalities and species of management interest will be reported through a mandatory reporting system. The WHIRS will be independent of the standardized 2-year post-construction fatality bird and bat monitoring program.

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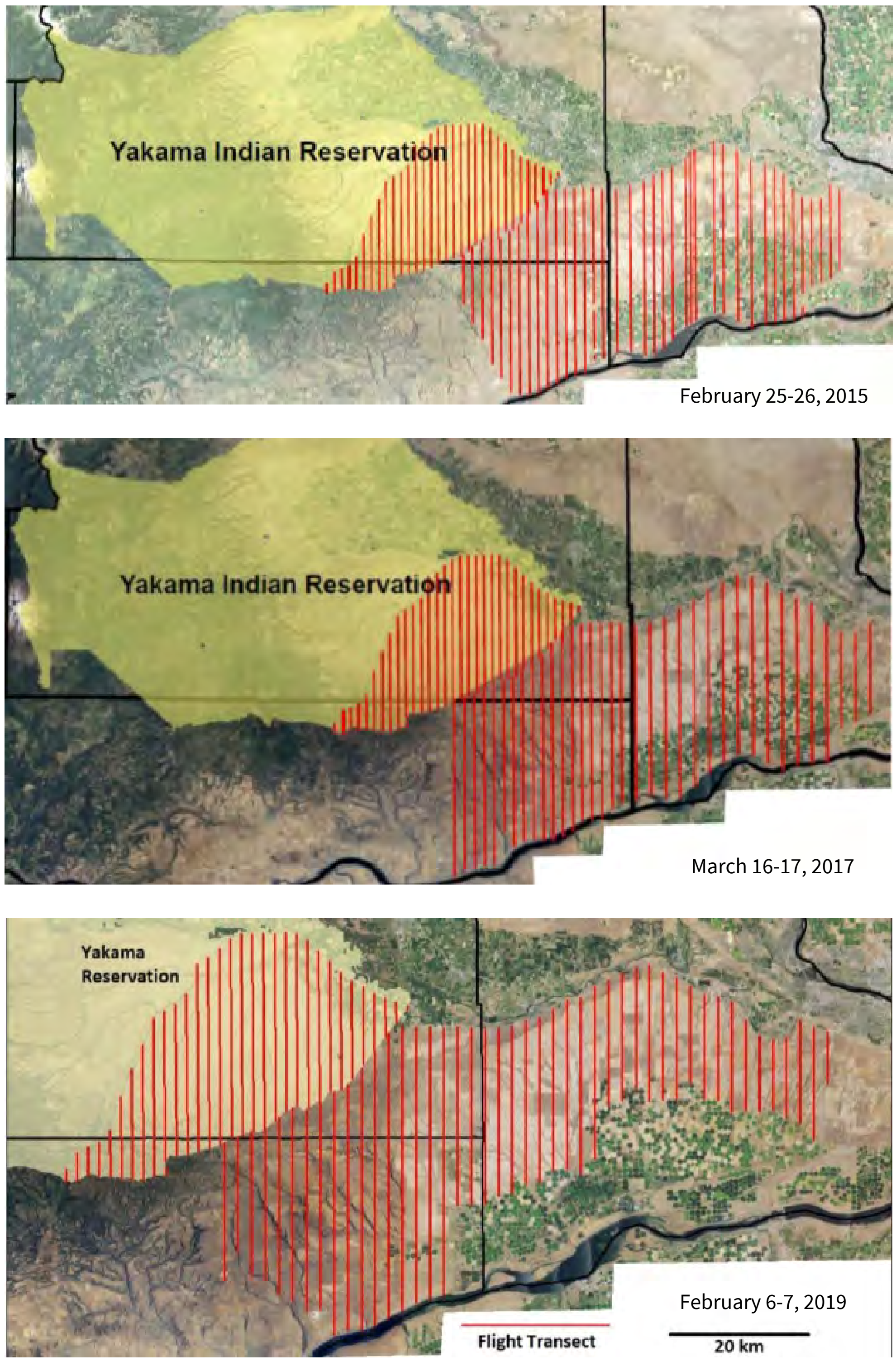
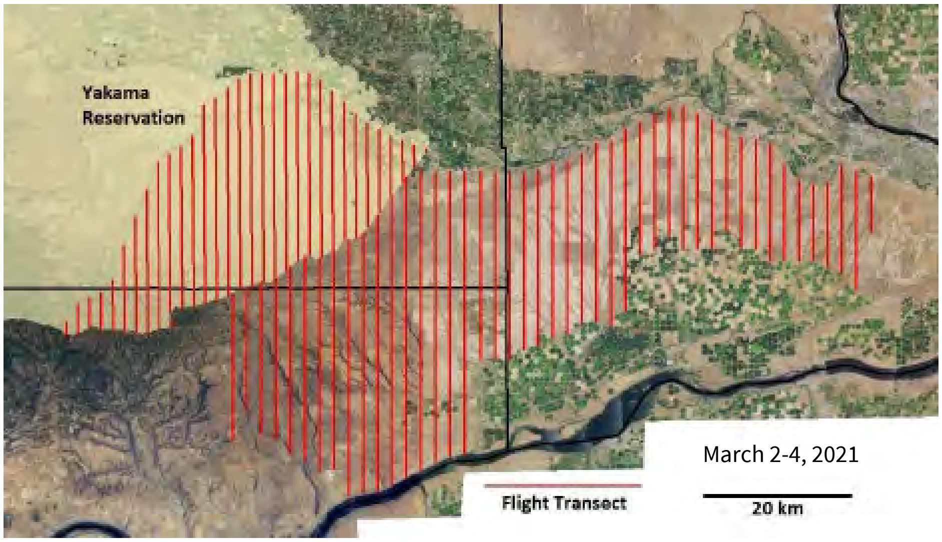
Appendix A

Appendix A. Flight Transects within the Pronghorn Population Survey Area Conducted 2015–2019 (Oyster et al. 2015, 2017, Fidorra et al. 2019, Fidorra and Peterson 2021)




Yakama
Reservation
March 2-4, 2021
Flight Transect
20 km

Patterns of Ferruginous Hawk (*Buteo regalis*) Nesting in the Horse Heaven Hills, Benton County, Washington, 2017−2019, 2022

REDACTED DUE TO SENSITIVE INFORMATION

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June 5, 2022

WEST Inc.

EXECUTIVE SUMMARY

Horse Heaven Wind Farm, LLC is proposing the development of the Horse Heaven Clean Energy Center (Horse Heaven and/or Project) in Benton County, Washington. As part of Project development, Western EcoSystems Technology, Inc. (WEST) was contracted to conduct raptor nest surveys throughout the Horse Heaven Hills during the 2017-2019 and 2022 nesting periods. Raptor nest surveys comply with guidelines described by the Washington Department of Fish and Wildlife (WDFW) and recommendations from the US Fish and Wildlife Service (USFWS).

Ferruginous hawk (*Buteo regalis*) was recently uplisted to endangered by the Washington Fish and Wildlife Commission in August 2021 (WDFW 2021). Based on the location of the Project relative to a core breeding area within the state and a desire to better understand ferruginous hawk nesting in the Horse Heaven Hills, the principal objectives of this study were to 1) survey and photo document all historic nests maintained in the WDFW Priority Habitat and Species (PHS) database within two miles (3.2 kilometers) of the proposed Project in 2022 to evaluate nest status and condition; 2) summarize nest status and condition for each survey year; and 3) contribute data to WDFW/PHS on ferruginous hawk nesting to facilitate understanding of nest occupancy and population trends within Washington. Primary conclusions from the assessment include:

- In 2022, over half of the 58 historic nests (30 nests, 52%) listed in the WDFW database were classified as Gone, 22 nests (38%) were classified as Inactive, and six nests (10%) were classified as Occupied by common raven (*Corvus corax*) or raptor species other than ferruginous hawk.
- During 2017-2019 and 2022, a total of four nesting attempts were made at two nests located in the [redacted] territories. The [redacted] territory was occupied and active for three consecutive years while the nesting attempt in [redacted] was abandoned or failed.
- During 2017−2019 and 2022, the number of occupied ferruginous hawk territories and nests declined even as the number of surveyed territories and nests increased each year.
- The overall four-year average of nest and territory occupancy was 6% and 7%, respectively. Historic nests were more likely to be occupied by other species. Nests not occupied by ferruginous hawk had an overall occupancy rate of 16%.
- Nest occupancy at Horse Heaven was lower than the average percent of occupied nests documented in Washington. Between 1978−2016, the estimated average state-wide occupancy rate was 41% (range 18−88%), with nest occupancy declining significantly in recent years (18% in 2016).
- Low nest occupancy at Horse Heaven during the survey period reflected a declining trend in occupancy state-wide. However, existing stressors on the landscape, including land conversion from expanding residential and intensive agricultural development, drought resulting in depressed prey populations, and predation, will likely continue to affect nest occupancy in the Horse Heaven Hills.

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Unit Conversions

Imperial	Metric
1 foot	0.3048 meter
3.28 feet	1 meter
1 mile	1.61 kilometer
0.621 mile	1 kilometer
1 acre	0.40 hectare
2.47 acre	1 hectare
Common Conversions	
Imperial	**Metric**
0.5 miles	800 meters
0.12 miles	200 meters
0.5 miles	0.8 kilometers
10 miles	16.1 kilometers

REPORT REFERENCE

Jansen, E. W. 2022. Patterns of Ferruginous Hawk Nesting in the Horse Heaven Hills, Benton County, Washington. Prepared for Horse Heaven Wind Farm, LLC., Boulder Colorado. Prepared by Western EcoSystems Technology, Inc. (WEST), Corvallis, Oregon. June 5, 2022. 17 pages + appendices.

INTRODUCTION

Horse Heaven Wind Farm, LLC is proposing the development of the Horse Heaven Clean Energy Center (Horse Heaven and/or Project) in Benton County, Washington. As part of Project development, Western EcoSystems Technology, Inc. (WEST) was contracted to conduct raptor nest surveys throughout the Horse Heaven Hills during the 2017-2019 and 2022 nesting periods. Raptor nest surveys complied with recommendations described by the Washington Department of Fish and Wildlife (WDFW) *Wind Power Guidelines* (WPG; WDFW 2009), the US Fish and Wildlife Service's (USFWS) 2012 *Final Land-Based Wind Energy Guidelines* (WEG), Appendix C(1)(a) of the 2013 USFWS *Eagle Conservation Plan Guidelines* (ECPG), and the USFWS *Revisions to Regulations for Eagle Incidental Take and Take of Eagle Nests* (Final Eagle Rule; 81 FR 91494).

Ferruginous hawk (hawk, *Buteo regalis*) was removed from the list of threatened species and uplisted to endangered by the Washington Fish and Wildlife Commission in August 2021 (WDFW 2021). Primary reasons for uplisting included the continued conversion of native habitats to cropland, urbanization, and reductions in prey populations, which resulted in significant declines in nesting territory occupancy, nest success, and productivity between 1974−2016 (Hayes and Watson 2021). Habitat degradation, alteration, and depressed prey populations prevalent outside Washington contribute to stressors on the species during the fall migration and winter non-breeding period (WDFW 2021). Although not summarized as a primary threat in the listing decision, collisions with wind turbine generators (WTG) are an issue of conservation concern that may affect individual hawks as well as nest occupancy and productivity (Hayes and Watson 2021, Watson et al. 2021). To date, no hawk fatalities have been reported at the 63-WTG Nine Canyon Wind Project during standardized post-construction fatality monitoring and operational monitoring, 2003-2021 (Erickson et al. 2003, Energy Northwest). However, publically available data from 43 operating wind energy facilities within the Columbia Plateau Ecoregion reported eight hawk fatalities from collisions with wind turbines, 1999−2020 (WEST 2020).

Located in Benton County, the Project is considered part of the South Zone historical ferruginous hawk nesting territory as designated in the Recovery Plan (WDFW 1996). Based on historic nest location data, Benton and Franklin counties are considered the core ferruginous hawk breeding range within the state (WDFW 1996, Watson et al. 2018, Hayes and Watson 2021). State-wide nest surveys inform population status and trends and were last conducted by WDFW in 2016 when 56 of 66 historic nests in the Horse Heaven Hills were surveyed. This assessment provides a summary of the status and condition of ferruginous hawk nests from surveys conducted from 2017−2019 and 2022.

The principal objectives of this study were to 1) survey and photo document all historic ferruginous hawk nests maintained in the WDFW Priority Habitat and Species (PHS) database within two miles of the proposed Project in 2022 to evaluate the nest status and condition; 2) summarize ferruginous hawk nest status and condition within the area surveyed each survey year; and 3) contribute data to WDFW/PHS on ferruginous hawk nesting to facilitate understanding of nest occupancy and population trends within Washington.

SURVEY AREA

Raptor nest surveys occurred within the eastern portion of the Horse Heaven Hills, located in southeastern Benton County, Washington. The size of the Survey Area varied annually and ranged between approximately 74−329 square miles (mi^2), depending on the size of the Project Area under consideration (Appendix A). The Survey Areas were located adjacent to the Tri-cities urban areas of Kennewick, Richland, and Pasco, and included portions of exurban communities associated with Benton City and Highland.

A prominent topographic feature in the Survey Area was a broad, northeast-facing anticline ridge along the northern perimeter, consisting of numerous highly-eroded drainages and cliff-lined canyons (Badger Canyon, Coyote Canyon, Taylor Canyon, Webber Canyon; Figure 1). South of the ridge, toward the interior of the Survey Area, the landscape transitions to relatively rolling topography with shallow, meandering canyons that drain south into the Columbia River. Elevation within the Survey Area was lowest toward the Columbia River to the east (approximately 350 feet [ft]), rising to above 2,000 ft at prominent features including Jump Off Joe (2,200 ft), Johnson Butte (2,043 ft), and Chandler Butte (2,046 ft) which all have radio and telecommunication facilities installed (Figure 1).

Land cover within the Survey Area is a mosaic of dryland and irrigated cropland, shrub-steppe grasslands, and rural/urban development (Horse Heaven Wind Farm, LLC 2021). Cropland is the dominate land cover throughout the Project and surrounding area (>80%; *see* Horse Heaven Wind Farm, LLC. 2020). Shrub-steppe is found in topographically steep areas and drainage bottoms where conversion to cropland was not possible. Lands within the Project vicinity are also enrolled in the US Department of Agriculture's Conservation Reserve Program.

Land use in the Survey Area consists predominantly of actively-managed dryland winter wheat (*Triticum aestivum*) and the associated infrastructure including silos and warehouses. Abandoned and working farmsteads are scattered in low density throughout the landscape, reflecting historic land use of the area; while new residential development encroaches into the foothills and on top of the Horse Heaven Hills ridge, indicative of the growing Tri-cities area population. Several rock quarries are actively used for on-going road and other construction projects. Electrical systems include radio and telecommunication towers, several high-voltage (115-500 kV) Bonneville Power Administration transmission lines bisecting the Survey Area, and numerous low-voltage (34.5 kV) distribution lines servicing business and residential buildings. Portions of Nine Canyon Wind Project was located within or adjacent to the Survey Area, depending on the survey year (Figure 1). Nine Canyon Wind Project consists of 63 WTG that range between 61−80 meters (m) tall with 30−45 m radius rotor blades.

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Figure 1. Landscape features within the Survey Area and WDFW historic ferruginous hawk nests surveyed in 2022 for the Horse Heaven Clean Energy Project, Benton County, Washington.

METHODS

Raptor nest surveys were initiated February 22, 2017 and continued yearly to May 5, 2022 with interruptions in 2020 and 2021 due to health and safety restrictions related to the COVID-19 pandemic. The study design and survey methods incorporated guidance described in the WDFW *Wind Power Guidelines* (WDFW 2009), and the WEG (USFWS 2012), with specific measures adapted for bald eagles (*Haliaeetus leucocephalus*) and golden eagles (*Aquila chrysaetos*) as described by the USFWS (Pagel et al. 2010, USFWS 2013, 81 FR 91494). Methods and results described here are specific to ferruginous hawk; for non-ferruginous hawk nest information, please see references listed in Table 1.

Survey Preparation and Consultation

Prior to aerial surveys in 2017, WEST conducted a literature search to identify nest locations in the area (WDFW 2016). Following the 2017 survey, results were presented to WDFW to review survey protocols and solicit feedback. Data from each survey was incorporated into subsequent survey efforts to develop a comprehensive database of nests in the in the area. In fall 2021, WEST obtained records of all historic ferruginous hawk nests from the WDFW PHS database. Depending on the survey year, the Project Area and/or proposed infrastructure was buffered by 2 miles in ArcMap (ESRI, Redlands, California) to create the Survey Area, and historical nests were imported into the respective Survey Area (Figure 2; Appendix A). In 2022, a group of historic hawk nests just outside the 2-mi buffer was included due to its proximity to the buffer and potential use by hawks as alternative nest locations. WEST developed a survey plan by plotting previously identified nests on maps and digital tablets (LG, Seoul, South Korea) with navigational software (Gaia GPS) that was used during aerial surveys.

Aerial Survey Methods

Each survey year, raptor nest surveys were conducted during two rounds of double-observer (i.e., a primary and secondary observer) aerial surveys. Each survey round was at least 30 days apart and preformed using a Robinson R-44 Raven II helicopter with bubble windows that provided excellent visibility (Pagel et al. 2010, USFWS 2013). Adult hawks begin to arrive in Washington mid-February and egg-laying may begin mid-March (WDFW 2016), thus the first survey was conducted to overlap the early nesting period of hawks in Washington when breeding pairs are exhibiting courtship, nest-building, and/or egg-laying and incubation behaviors (WDFW 2016). The second survey was conducted in May when, historically, more than 90% of 162 nests monitored by WDFW hatched by May 14, and hawks engaged in ongoing nesting activities would reliably be found on or around nests (WDFW 2016).

Using all WDFW historic ferruginous hawk nests in the region and three years of intensive WEST survey data, 2022 surveys focused on visiting each historic location twice (March and May) to check previously documented nests and searching for new nest locations. Emphasis was placed on locating and documenting the status of historic nests by repeating standard survey protocols used during previous survey years that entailed a cautious approach including circular or stationary hover and multiple sweeps, if needed, until sufficient confidence was established regarding nest disposition.

During all survey years (2017−2019 and 2022), all stick nests that could be constructed by any raptor species or common ravens (*Corvus corax*) were documented within the Survey Area. Common raven nests were documented in addition to nests definitively constructed by raptors because of the potential for species to interchangeably use nest locations. Surveys utilized an intuitive controlled survey method that focused on areas with the highest potential to support raptor nests, including rock outcrops and cliffs, basalt talus and scree slopes along incised drainages and canyons, transmission towers, distribution poles, windmills, and trees. Nests located during the first survey round were revisited during the second survey to evaluate reproductive nesting status while also searching for new nests constructed by breeding pairs who may have arrived after the first survey round was completed.

During aerial surveys, the helicopter was positioned to allow thorough visual inspection of all appropriate habitat features. In general, the helicopter maintained a distance of no closer than 66 ft (20 m) from cliff faces and nests. When a nest was located, the helicopter reduced speed and adjusted the flight track to allow for a clear view of the nest for documentation and photographing. The amount of time spent circling/searching a particular area or the distance to which a nest was approached was adjusted when birds were present on or near the nest to minimize survey-related disturbance (e.g., flushing). In the event of eggs/nestlings, deference was provided and nests located directly adjacent to the eggs/nestlings (e.g., within 200 m) were not surveyed.

For each nest or group of nests (e.g., nest site), Global Positioning System (GPS) coordinates were recorded, photographs were taken from a distance using a Nikon digital single lens reflex camera with 55−200 mm telephoto lens to reduce nest disturbance, and nest attribute data were collected. A nest site was defined as two or more nests that occurred on the same shelf, cliff face, or tree within close proximity to one another (e.g., approximately 80 ft [25 m]). Data collected at each nest included the nesting species, status and physical attributes that included condition, substrate, size, and signs of recent nest tending that included fresh sticks, greenery, or whitewash. The following definitions were used to characterize nests:

<u>Nest Status:</u>

- Occupied Active (OA) = evidence of nest tending, with eggs/fragments, nestlings, and/or an adult in incubating/brooding position present at the time of the survey;
- Occupied Inactive (OI) = evidence of recent tending of the nest or presence of an adult, but no eggs, nestlings or an adult in incubating/brooding position observed;
- Inactive (I) = no evidence of nest tending and no eggs, nestlings or adults present;
- Unoccupied (U): nest was classified as inactive for at least two consecutive surveys;

- Gone (G) = nest determined to be completely missing or so degraded that only remnant material (scattered, loose sticks) were present that would need complete reconstruction in order to be used;
- Did Not Survey (DNS) = Nest was outside the survey area for that particular survey year.
- Did Not Locate (DNL) = Nest was not located during survey; typical of historic nests in Remnant condition;
- Unknown (UNK) = nest likely present, but status cannot be determined. Scenario typically arises when cryptic nests were obscured by tree leaves, survey was aborted due to young on a neighboring nest, or disturbance issues related to horses or other human factors limited survey effort.

<u>Nest Condition:</u>

Nest condition is a strong indicator of nest status; nests that are in better condition reflect the likelihood that the nest is currently in use of has been in use recently. However, longevity of the nest on the landscape is also affected by the stability of the nest construction, exposure of the nest to weather, wildfire, or human removal (WDFW 1996).

- Good = in excellent condition with very well-defined bowl, no sagging, may contain fresh material; possible to use immediately or currently in use;
- Fair = in generally Good condition with fairly well-defined bowl, minor sagging of material but lacks substantive damage; may require some repair or addition to use immediately;
- Poor = material sloughing or sagging that would require reconstruction of the nest bowl in order to be used; most likely not being used during the current nesting season and possibly multiple nesting seasons, depending on nest exposure and other factors;
- Remnant = only loose or scattered material remains at the nest site which would require complete reconstruction of the nest base, body, and bowl to be usable;
- Unknown = condition is unknown due to either nest status being Gone (G) or Unknown (UNK).

<u>Nest Size:</u>

Nest size may be correlated with nest status or nest condition, but can be another useful indicator of nesting activity if tracked over time. Ferruginous hawks typically construct stout nests that can measure equally tall as the nest is wide and persist on the landscape over long periods of time. Encompassing the range of nest sizes reported by WDFW (2016) and Hayes and Watson (2021), hawk nests can range between 24–51 inches diameter by 11-19 inches tall with exceptionally-sized nests measuring 74 inches diameter by 70 inches tall. We defined nest size as:

- Giant = greater than 36 inches in diameter; typically shaped as a stack, mound, platter or conical with noticeably more volume and substantial nesting material; can reflect periods of consistent annual use by *Buteo* or eagle species;

- Large = approximately 24−36 inches in diameter; typically shaped as a stack, mound, platter or conical; consistent with *Buteo* and eagle construction;
- Medium = approximately 12−24 inches in diameter; typically shaped as a bowl, platter or comparatively smaller mound; can reflect inactivity if originally constructed by ferruginous hawk;
- Small = Remnant to approximately 12 inches in diameter, typically shaped as a bowl or scattered material; can reflect prolonged periods of inactivity if originally constructed by ferruginous hawk.
- Unknown = size is unknown due to either nest status being Gone (G) or Unknown (UNK).

After each survey round, high-resolution aerial imagery, topographic maps, and flight tracks were used in ArcMap to georectify GPS coordinates recorded in the field to accurately correspond with the nest structure (tree, cliff face, rock outcrop, etc.) where the nest was observed. Nest photos were downloaded and labeled and a geodatabase was developed that tracked the status of each nest over the survey period. Annual and overall occupancy was calculated as the proportion of territories or nests that were occupied over the four-year survey period where the status could be conclusively determined (occupancy = total # years a nest was occupied / total # survey years a nest was observed). Conclusively determined was defined as historic territory or nest found during surveys and available for nesting with a nest condition of Remnant or better. Nests that were not located or not within the Survey Area were excluded from the calculation of nest occupancy.

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Figure 2. WDFW historic ferruginous hawk territories surveyed in 2022 for the Horse Heaven Clean Energy Project, Benton County, Washington.

RESULTS

The size of the Survey Area varied annually and ranged from 74−329 mi^2, depending on the size of the Project Area under consideration (Table 1; Appendix A). Survey coverage of suitable habitat within the Survey Area was typically accomplished within one day, with larger areas taking multiple days or longer flight times (8−9 hours per day).

Table 1. Aerial raptor nest survey dates and survey area for the Horse Heaven Clean Energy Project, Benton County, Washington, 2017-2019, 2022.

Year	Survey Date[1]		Survey Area (mi^2)[2]	Reference
	Round 1	Round 2		
2017	March 31	May 10	74.7	Jansen 2017
2018	March 05	May 10	152.6	Jansen and Brown 2018
2019	March 05, 07	May 16	328.8	Chatfield et al. 2019a,b; Jansen et al. 2019
2022	March 23	May 05	245.5	Jansen 2022

[1] During 2017−2019, in addition to aerial surveys, ground-based surveys to document new nests and follow-up surveys were conducted for certain nests during year-round avian point count surveys.

[2] Survey Area 2017 = Generalized, conceptual area + 2-mi buffer
Survey Area 2018−2019 = Leased lands + 2-mi buffer
Survey Area 2022 = Proposed turbines and solar areas + 2-mi buffer

During 2022, WEST biologists surveyed 56 historic ferruginous hawk nests comprised of 18 territories within and directly adjacent to the 2-mi Survey Area (Figure 2). One previously documented nest unassociated with a historic WDFW nest and one additional new nest found during the 2022 effort were surveyed for a total of 58 nests (Table 2). Of the 58 nests, 28 nest sites were documented in 16 territories (Appendix B). [redacted] Of the 58 nests, 30 nests (52%) were classified as Gone, 22 nests (38%) were classified as Inactive, and six nests (10%) were occupied by a raptor species or common raven. Occupied nests consisted of three common raven nests, two Swainson's hawk (*Buteo swainsoni*) nests, and one great horned owl (*Bubo virginianus*) nest (Figures 3−6). No historic nests were occupied by ferruginous hawk during 2022 surveys.

The majority of 2022 nests were in Remnant to Poor condition (15 nests; 54%), followed by Fair condition (6 nests; 21%), and 7 nests (25%) were in Good condition. Nests in good condition were either being used by a common raven or other raptor or likely had recent nesting activity, as was the case for [redacted] Of the 13 historic nests included in the 2022 Survey Area that were not surveyed or located during previous survey years, 7 nests (54%) were in Remnant to Poor condition, three nests (23%) were in Fair condition, and three nests were in Good condition and occupied by common [redacted] great horned owl [redacted] and a Swainson's hawk in the [redacted] built a new nest in an isolated tree surrounded by cropland (Appendix B).

Ferruginous hawk nesting was infrequently observed during the eight survey rounds conducted over four survey years. Over four survey years, four nesting attempts were made at two nests located [redacted] Of 12 historic ferruginous hawk nests surveyed three or more years [redacted] was Occupied Active (OA) during three consecutive survey years (2017−2019); however, a pair of Swainson's hawk were observed perched on the nest tree in 2022 during the second survey round. Although a third follow-up visit to the nest was not conducted to determine nesting status, it is assumed Swainson's hawk attempted nesting [redacted] In 2017, [redacted] was classified as Occupied Inactive (OI) with a single adult ferruginous hawk observed perched above the nest during the first survey round and no sign of nesting was observed during the second survey round. The absence of sign (e.g., egg shells or young in the nest) suggests the nesting attempt was abandoned or failed. [redacted] remained in Good condition during the 2018-2019 surveys but the nest was Gone during 2022 surveys with sticks scattered throughout the area of the canyon where the nest was once located.

During 2017−2019 and 2022, the number of occupied ferruginous hawk territories and nests declined even as the number of surveyed territories and nests increased each year (Table 2). Annual territory and nest occupancy was highest in 2017 at approximately 20% and declined to no nesting activity observed in 2022. The overall four-year average of nest and territory occupancy was 6% and 7%, respectively. Historic nests were occupied by other raptor species and common raven more frequency than ferruginous hawk. Over four survey years, nine historic nests were occupied 10 times by species other than ferruginous hawk; the majority by common raven (five occurrences), Swainson's hawk (three occurrences), great horned owl (one occurrence), or red-tailed hawk (*Buteo jamaicensis,* one occurrence). Historic nests not occupied by ferruginous hawk had an overall occupancy rate of 16%.

Table 2. Annual and overall ferruginous hawk territory and nest occupancy rates.

		Territories		Nests		
Survey Year	# Occupied	# Surveyed	% Occ.[1]	# Available	% Occ.[1]	Comment[2]
2017	2	9	22%	10	20%	[redacted]
2018	1	10	10%	12	8%	
2019	1	17	6%	16	6%	
2022	0	18	0%	28	0%	
Overall	4	54	7%	66	6%	

[1] % occupied = # occupied divided by the # territories surveyed or the number of nests recorded in a survey year
[2] OA = Occupied Active, OI = Occupied Inactive, SWHA = Swainson's hawk

DISCUSSION

Ferruginous hawk nest occupancy in the Horse Heaven Hills was low based on four years of aerial raptor nest surveys. Four nesting attempts in two territories were documented during 66 nest years (6% nest occupancy) was lower than the average percent occupied nests previously documented across the species' range in Washington. Between 1978−2016, Watson et al. (2021) estimated an average of 41% occupancy rate (range 18−88%) during years when more than 70% of known nesting territories were surveyed (average = 54 territories, range 30−78); however, occupancy rates significantly declined range-wide in recent years. Despite the comparatively smaller sample size reported here than used in range-wide assessments of territory occupancy, occupancy at Horse Heaven appears on the low end of the range compared to other areas in Washington that may have more favorable conditions (larger areas of native habitat and prey populations and less human disturbance). The dilapidated condition of a majority of nests at Horse Heaven further indicated consistent low nest occupancy as tended nests can typically be used with limited maintenance. Over time, Inactive nests slowly deteriorate due to exposure to the elements, which appears to be case [redacted] slowly deteriorated in subsequent years. All historic nests classified in 2022 as Fair or Good condition were either previously or currently occupied by another bird species. Inactive nests in Fair condition, as are [redacted] 73), and the Good condition [redacted] may be a function of a microclimate protected from the elements or nest occupancy in the intervening years when surveys did not occur (2020−2021).

Low nest occupancy during 2017-2019 was reflected in the low use of ferruginous hawk documented during 1,232 hours of point count surveys conducted year-round throughout the Horse Heaven Hills from August 2017-September 2020 (Horse Heaven Wind Farm, LLC. 2020). During this time, four total observations at three point counts located nearest to Nest 03 were documented in March (two observations), April (one observation), and October (one observation). Low avian use indicates the species had low abundance and was not widely distributed when point count surveys occurred.

Surveys were scheduled to consider broader survey objectives, including surveying species other than ferruginous hawk (eagles, other hawks, falcons, and owls), prior to tree leaf out to increase nest detection, and to account for asynchronous nesting chronology of various raptor species (e.g., early owls and later *Buteos*). Surveys conducted in March and May were prior to the time when ferruginous hawk nest success can be typically be determined as young generally fledge from the nest in June and July. However, the primary survey objective was to determine nest status (nest occupancy) and not nest success (# young successfully fledged). Nevertheless, there was high confidence each survey year that nest surveys coincided with the return of ferruginous hawks from wintering grounds in California due to observations reported from ground-based avian point count and other raptor nest surveys that were conducted throughout eastern Washington and Oregon during 2017-2019 and 2022.

Primary threats to nesting in the Horse Heaven Hills currently include agricultural activities which may affect availability of native habitat that support small mammal prey populations; similarly, encroachment of residential and exurban development into the foothills [redacted] and along the escarpment reduces the suitability of nesting and foraging shrub-steppe habitat. Predation at ground nests may also be a factor influencing nest occupancy and success. Although anecdotal, each aerial survey noted coyotes (*Canis latrans*) throughout the Survey Area and concentrated along [redacted] of the escarpment where historic ferruginous hawk nests were located (Photo 1). Interestingly, the most consistent nesting attempts by ferruginous hawks were in a [redacted]

[redacted] The use of trees for nesting may represent a shift away from ground nests where predators have easier access to young (Ng et al. 2020).

Photo 1. Numerous coyotes were observed along the escarpment and interior agricultural fields of the Horse Heaven Hills during each survey round. Ground predators reduce the suitability of ground nests.

Historic nest data from the WDFW PHS database did not note nest occupancy in 2016 at nests in the Horse Heaven Hills when the last comprehensive range-wide survey effort was made. Based on historic data from WDFW and contemporary survey results, many ferruginous hawk nests have disappeared from the landscape or have been unoccupied for ≥ 5 years. The highly modified and changing landscape continues to present challenges to ferruginous hawk nest occupancy and nesting success in the Horse Heaven Hills. Existing stressors on the landscape, including land conversion from expanding residential and agricultural development, depressed prey populations, and predation are primary factors that affect hawks (WDFW 1996, Hayes and Watson 2021), and will likely continue to affect nest occupancy in the Horse Heaven Hills. Comparatively low nest occupancy relative to state-wide averages suggest populations in the Horse Heaven Hills have sustained low occupancy rates for nearly half a decade, although ferruginous hawk have exhibited a declining population trend in Washington since state-wide counts began in the late 1970's (Hayes and Watson 2021).

Table 3. Historic ferruginous hawk nest status and condition during surveys conducted 2017-2019, 2022 in the Horse Heaven Hills, Benton County, Washington. Territories listed in alphabetical order.

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Figure 3. 2022 nesting status of historic WDFW ferruginous hawk territories [redacted]

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Figure 4. 2022 nesting status of historic WDFW ferruginous hawk territories [redacted]

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Figure 5. 2022 nesting status of historic WDFW ferruginous hawk territories [redacted]

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Figure 6. 2022 nesting status of historic WDFW ferruginous hawk territories [redacted]

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Appendix A. Survey Areas for raptor nest surveys conducted 2017-2019 and 2022 for the Horse Heaven Clean Energy Center, Benton County, Washington.

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Appendix A. Survey Areas for raptor nest surveys conducted 2017-2019 and 2022 for the Horse Heaven Clean Energy Center, Benton County, Washington.

Appendix B. Photographic guide and description of ferruginous hawk nests and territories for the Horse Heaven Clean Energy Project, Benton County, Washington, 2017−2019, 2022.

Note: Territories are names assigned by WDFW and summarized here as they occur on the landscape, from west to east as shown in Figure 2. Nest ID numbers are unique to WEST survey efforts, PHS ID numbers (PHS ####) are unique to the WDFW PHS Program, represent the OccurPoint field in the database, and provided here for reference. The nests surveyed in a particular year reflect the geometry of the 2-mile Survey Area. The most comprehensive survey effort was 2022, when the location of historic hawk nests were obtained from the PHS Program. Current threats to a territory are noted as they were perceived in the field and do not include an exhaustive list common to all territories and associated nests (e.g., climate change, wildfire, loss of native habitat, reduction in prey populations and the synergistic affects between them).

REDACTED DUE TO SENSITIVE INFORMATION

Population Viability Analysis of Ferruginous Hawk (*Buteo regalis*) in Eastern Washington

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EXECUTIVE SUMMARY

Horse Heaven Wind Farm, LLC (Horse Heaven) is proposing development of the Horse Heaven Clean Energy Center (Project) in Benton County, Washington. The breeding range of the state-endangered ferruginous hawk (*Buteo regalis*) overlaps the Project. Although the Washington nesting population size has historically been low compared to populations in surrounding states, the decline in the Washington breeding population over the past half century was a factor considered in the recent decision to uplist the species to state endangered. Due to the species vulnerability to the effects of wind energy development, Western EcoSystems Technology, Inc. (WEST) analyzed how ferruginous hawk populations might be impacted by hypothetical impact scenarios and how the population might respond to potential mitigation measures.

We used a population viability analysis (PVA) to model projected outcomes and sensitivities to various levels of impacts from wind energy development and proposed mitigation measures. Our study objectives were to: 1) use a stochastic growth model to generate a baseline population growth rate based on published vital rates, 2) simulate how biologically realistic levels of direct and indirect effects influence nesting population trends, 3) identify sensitive life-history stages to guide future conservation management actions, and 4) simulate how conservation efforts from the construction and use of artificial nest platforms (nest platforms) might affect population trends.

Using a range of scenarios, ferruginous hawk PVA simulations resulted in the following key points:

- Declining baseline population growth rates (λ) of 0.97 reduced the number of occupied nesting territories (territory) by 49% from 47 to 24 nesting territories over a 30-year period.
- The low levels of direct effects simulating loss of six adults over 30 years due to wind energy reduced the number of nesting territories by 50% over a 30-year period; however, indirect effects from the loss of one territory resulted in a 57% a reduction in nesting territories. Thus, population trajectories showed a comparatively greater response to the loss of nesting territories than collisions (the loss of individual birds). Combined, these scenarios magnified the effects on population trend, depending on the intensity of the effect.
- The average number of nesting territories were largely unaffected by variable survival rates of adults and juveniles.
- Construction of artificial nest platforms in suitable areas lacking natural nest substrates can effectively maintain or increase nesting territory occupancy. Assuming an average annual occupancy rate of 36%, increases of three to 10 nesting territories can positively affect ferruginous hawk population trends.

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1 INTRODUCTION

Horse Heaven Wind Farm, LLC (Horse Heaven) is proposing development of the Horse Heaven Clean Energy Center (Project) in Benton County, Washington. The breeding range of the state-endangered ferruginous hawk (*Buteo regalis*) overlaps the Project and historical nests are located within 2.0 miles (mi; 3.2 kilometers [km]) of Project facilities. Decline in the Washington breeding population over the past half-century was a factor considered in the recent decision to uplist the species to state endangered. Mortality from turbine collisions and reduced territory occupancy resulting from wind energy development both have the potential to affect population trends, particularly in populations with few individuals (Squires et al. 2020, Diffendorfer et al. 2021, Watson et al. 2021). Due to the species vulnerability to the effects of wind energy development, Western EcoSystems Technology, Inc. (WEST) analyzed how ferruginous hawk populations might be impacted by hypothetical impact scenarios and how the population might respond to potential mitigation measures.

We used a population viability analysis (PVA) that incorporated ferruginous hawk population demographics to model projected outcomes and sensitivities to various levels of Project impacts and proposed mitigation measures (Reed et al. 2002, Saeher and Engen 2002). PVA models have been used in a wide variety of applications to model extinction probabilities, identify sensitivities in demographic or genetic parameters, or simulate the outcome of different management scenarios (Beissinger and McCullough 2002). Specifically for ferruginous hawk, PVA models have been used to examine how changes in demographic vital rate parameters affect population growth in US Forest Service Region 2 (Collins and Reynolds 2005), and to simulate how collisions with wind turbines could affect population growth rates throughout the species' range in the US (Diffendorfer et al. 2021). In this study, our overall objective was to compare effects of management actions and vital rate sensitivities following Reed et al. (2002), who provided guidance on the application of demographic matrix models. This study does not attempt to predict the probability of extinction due to the small population size (e.g., < 200 individuals) and uncertainty of survival rates and long-term territory occupancy in Washington. To our knowledge, this is the first PVA of ferruginous hawk in Washington applied to a proposed wind energy development scenario.

We considered a range of model scenarios to account for uncertainty in demographic vital rates, direct and indirect effects, conservation efforts, and how Project impacts could affect the population. We used vital rate parameters (e.g., survival, nesting success) typically used in population modeling to determine how direct effects (wind turbine mortality), indirect effects (nest occupancy), and conservation effects (artificial nest platforms) influenced population trends. Specifically, our study objectives were to: 1) use a stochastic growth model to generate a baseline population growth rate based on published vital rates, 2) simulate how biologically realistic levels of direct and indirect effects influence nesting population trends, 3) identify sensitive life-history stages to guide future conservation management actions, and 4) simulate how conservation efforts from the construction and use of artificial nest platforms affected nesting population trends.

2 ANALYSIS AREA

The Analysis Area consisted of two areas. We considered a Study Area that included the entire breeding range of the ferruginous hawk in Washington; and a comparatively smaller Project Area where wind energy development is proposed and potential Project impacts to the population were evaluated.

2.1 Study Area

The Study Area occurs in the Level III Columbia Plateau Ecoregion (CPE) in eastern Washington (Clarke and Bryce 1997). The CPE includes the shrub-steppe and grassland nesting habitat that encompasses the northwestern extent of ferruginous hawk nesting in the US. As part of the larger Great Basin Bird Conservation Region (BCR 9), approximately 74% of the CPE is located within Washington (Bird Studies Canada and US North American Bird Conservation Initiative 2014). We used the CPE in Washington as the Study Area because its inclusion of suitable nesting habitat, including all publicly available records of ferruginous hawk nests in Washington, as well as it being a focal area for renewable energy development in the region (Hayes and Watson 2021, Washington Department of Fish and Wildlife [WDFW] 2021, Renewable Northwest 2022).

Using Breeding Bird Survey (BBS) data collected from 2006−2015, Partners in Flight (2020) estimated 130 ferruginous hawk (95% confidence intervals [CI]: 0–370) within the Washington portion of the Great Basin BCR. Population trends corresponded with -1.59% annual change (97.5% CI: -7.01−3.66) in Washington based on BBS data, 1999−2019 (Sauer et al. 2019). The last WDFW statewide-population surveys conducted in 2016 documented 32 breeding pairs and 47 occupied nests at 263 known territories (Hayes and Watson 2021).

2.2 Project Area

The Project Area consisted of a 113 mi^2 (293 km^2) Project Lease Boundary, of which approximately 35 mi^2 (91 km^2; 31%) consists of micrositing corridors[1] where 244 wind turbines, three areas of solar array and related infrastructure are proposed in a maximum build scenario (Horse Heaven Wind Farm, LLC 2021). The Project Area is located adjacent to the Tri-cities urban areas of Kennewick, Richland, and Pasco. The majority of native land cover (e.g., shrub-steppe and grassland) within and surrounding the Project Area has been converted to dryland and irrigated wheat (*Triticum aestivum*) cropland (Horse Heaven Wind Farm, LLC 2021). Portions of the 63-wind turbine generator Nine Canyon Wind Project were located within or adjacent to the Project Area.

Historical ferruginous hawk nest sites occurred within 2.0 mi of the proposed infrastructure, primarily at a relatively broad ridge along the northern perimeter of the Project Area. Four years of surveys during the nesting season resulted in low historical nest occupancy[2]. Nest surveys conducted for the Project during 2017–2019 and 2022 resulted in two occupied nests, one of

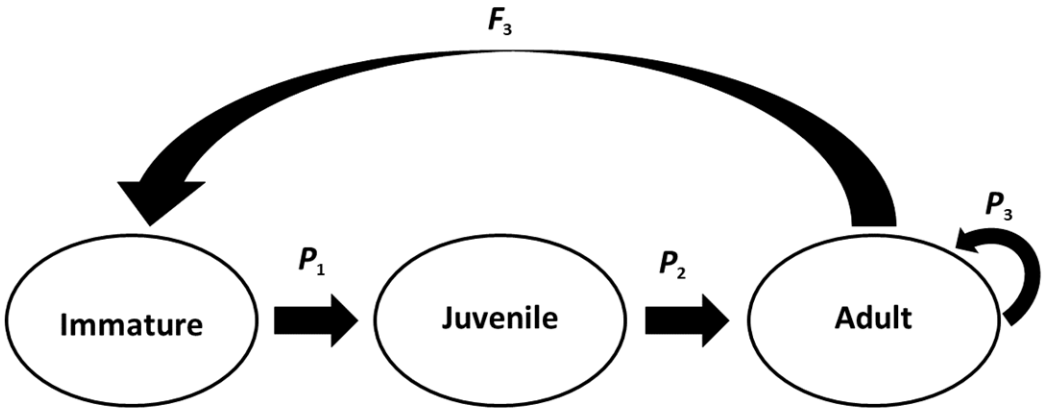
[1] Micositing corridors consisted of an 18.5 mi^2 (47.9 km^2) Wind Energy Micrositing Corridor and 16.8 mi^2 (43.5 km^2) of a Solar Siting Area (Horse Heaven Wind Farm, LLC 2021).

[2] As defined by Steenhof and Newton 2007 and USFWS 2013

which had an adult incubating during the 2017−2019 nesting seasons and the other nesting attempt was abandoned in 2017, and then was gone in subsequent nesting seasons (Jansen 2022).

3 METHODS

In this study, we used a 3-stage population projection matrix with three life history stages to estimate population growth rate (λ) and simulate population trends under potential model scenarios (Figure 1). The three life history stages followed Lande (1988) and incorporated a 1-year projection interval.



$$\begin{pmatrix} 0 & 0 & F_3 \\ P_1 & 0 & 0 \\ 0 & P_2 & P_3 \end{pmatrix}$$

Figure 1. Life cycle diagram and corresponding structure of the 3×3 projection matrix used in the ferruginous hawk population trend analysis in Washington. The probability (*P*) of survival from each stage to the next stage is represented by the subscript value. Fecundity (*F*) demonstrates biological productivity from adults back into the immature stage.

The first stage, immature, included individuals that survived from fledgling to dispersal, the second stage represented non-reproductive juveniles, and the third stage represented reproductively mature adults (Lande et al. 1988). Ferruginous hawk reach reproductive maturity between the ages of two and three (Wheeler 2003, Ng et al. 2020); thus, the projection matrix assumed reproduction after year two and continues indefinitely as birds age. Natural mortality due to age was implicit in the adult survival parameter. We selected vital rates for each parameter from published literature (Table 1). Because of the geographically constrained breeding population in southeast Washington, we attempted to keep all parameter values as local as possible to avoid introducing regional or national vital rates that may not reflect the condition of the breeding population.

Baseline adult fecundity estimates were based on 38 years (1978−2016) of nesting and reproductive success data in Washington (Table 2; Hayes and Watson 2021). The adult fecundity parameter (*F*) was calculated by taking the average number of successful nestlings per pair (2.4) and multiplying it by the average proportion of known successful nests (0.81), the proportion of breeding pairs contributing to the breeding pool (0.68), and 0.5 to account for sex ratios in the adult breeding population (Table 1). Baseline survival estimates were taken from the literature directly for immature (Watson et al. 2019), juvenile (Collins and Reynolds 2005), and adult life stages (Table 1; Watson and Pierce 2003). We assumed 47 initial occupied nesting territories (nesting territories or territories) based on the 2016 reporting (Hayes and Watson 2021).

Table 1. Baseline vital rate parameter values for ferruginous hawk in Washington.

Life Stage	Parameter	Value	Source(s)
Immature	Fecundity	0.00	Wheeler 2003, Ng et al. 2020
	Survival	0.62[a]	Watson et al. 2019[b]
Juvenile	Fecundity	0.00	Wheeler 2003, Ng et al. 2020
	Survival (Dispersal to Year 2)	0.43	Collins and Reynolds 2005
Adult	Average Number of Nestlings	2.40	Hayes and Watson 2021
	Average Nest Success Rate	0.81	Hayes and Watson 2021
	Occupied Nesting Territories	0.68	Hayes and Watson 2021
	Fecundity	0.66[c]	Hayes and Watson 2021
	Survival	0.76	Watson and Pierce 2003
	Baseline # Occupied Nests (2016)	47	Hayes and Watson 2021
	Baseline # Breeding Pairs (2016)	32	Hayes and Watson 2021
	Average # Breeding Pairs (1978–2016)	54	Hayes and Watson 2021

[a] Range-wide estimate was used as it is more conservative than the Montana survival estimate of 0.86 (Zelenak et al. 1997)

[b] As reported in Hayes and Watson 2021

[c] Calculated from table 2 from Hayes and Watson 2021 (2.4 nestlings per nest × 0.81 success rate × 0.68 proportion breeding × 0.5 females)

We generated a 3×3 projection matrix from vital rate parameters to calculate baseline values for growth rate (λ) using eigenanalysis to identify the dominant eigenvalue following Caswell (2001) and Stevens (2009). Additionally, the stable stage distribution (Table 2), elasticity, and sensitivity (Table 3) were calculated following Stevens (2009). We used the proportions from the stable stage distribution to calculate the initial abundance for each age class based on the 47 nesting territories observed in 2016 (Hayes and Watson 2021). We calculated sensitivity and elasticity of the projection matrices to determine how λ varied by the transitions between life stages. Sensitivity represented the effect a small change to the projection matrix would have on λ for each transition stage (i.e. immature to juvenile, juvenile to adult, adult mortality, or births). Elasticity represented the relative magnitude of effect that each transition has on λ.

Table 2. Proportions and initial abundances of ferruginous hawk based on the stable-stage distribution calculated from the projection matrix, according to Caswell (2001).

Parameter	Immature	Juvenile	Adult
Proportion	0.32	0.21	0.47
Initial Abundance[a]	32	21	47

[a] adult column represents the number of occupied nesting territories

Table 3. Sensitivity and elasticity during life-stage transitions from eigenanalysis of the projection matrix.

Parameter	Immature to Juvenile	Juvenile to Adult	Adult Mortality	Births
Sensitivity	0.27	0.39	0.67	0.17
Elasticity	0.12	0.12	0.36	0.12

3.1 Population Growth Model

This PVA incorporated demographic stochasticity to reflect the variation in vital rates caused by dynamics inherent to small populations, such as ferruginous hawk in Washington. Demographic stochasticity can have large impacts on population size estimates and are important to model for reliable population projections (Saeher and Engen 2002). Demographic stochasticity incorporated the fluctuating random probabilities that affect nest productivity, which included nest success, nest occupancy, and number of nestlings. To incorporate demographic stochasticity, we allowed all vital rates in the baseline projection matrix to vary from year to year. Vital rate variation was based on random sampling from a normal distribution based on the mean (μ) and standard deviation (σ). The σ for average nest success ($\mu = 0.81$, $\sigma = 0.138$) and average number of nestlings ($\mu = 2.4$, $\sigma = 0.446$) were calculated from Hayes and Watson (2021). Nest occupancy and survival rates lacked published σ, therefore, a σ of 0.1 was used for these parameters to reflect a high level of uncertainty. Vital rates from the normal distribution were restricted so reasonable biological levels (within σ) were not exceeded. The model assumes that the net influence of immigration or emigration was zero.

Although we do not explicitly incorporate environmental stochasticity into the PVA, we acknowledge the effect of extrinsic environmental factors on ferruginous hawk nesting populations. Annual fluctuations in climate (e.g., temperature, precipitation), habitat quality (e.g., prey availability), and catastrophic events (e.g., wildfire, disease) can all affect ferruginous hawk populations and the underlying vital rates (Wallace et al. 2016a, Shoemaker et al. 2019, Squires et al. 2021). For example, annual fluctuations in the spatial and temporal variability of prey abundance affects age-specific survival rates (Collins and Reynolds 2005, Hayes and Watson 2021). Environmental stochasticity was not directly modeled in this effort; however, the variation in occupancy and nestling counts from Hayes and Watson (2021) from 1978–2016 enabled us to vary fecundity in our model in a way that likely reflects the inherent environmental fluctuations that could impact this population.

3.2 Model Scenarios

Population models were simulated over 30 years based on the anticipated life expectancy of the Project. The average population sizes and λ were calculated across 10,000 model iterations for each model scenario. First, we modeled a baseline population trend for all model scenarios using the vital rates in the projection matrix, no annual take, and the initial abundance established from the stable stage distribution (Figure 2). To compare the mean baseline population trend with historical occupancy data, we graphed historical counts of occupied territories, occupied territories with known breeding outcomes, and successful territories reported in Hayes and Watson (2021) against the predicted territory occupancy trend (Figure 3). Historical occupancy data were unadjusted for inter-annual survey effort and survey areas, which were unavailable. The mean λ and final population sizes from the 10,000 iterations are reported with 90% CIs (Appendix A).

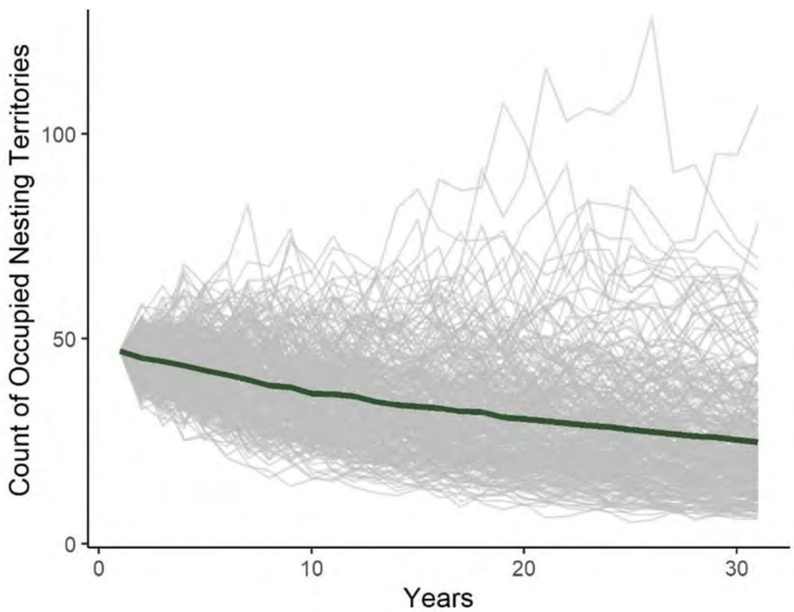


Figure 2. Baseline 30-year predicted trend for occupied nesting territories based on the projection matrix values derived from the literature. Each grey line represents one of the first 300 of 10,000 iterations to visualize variability.

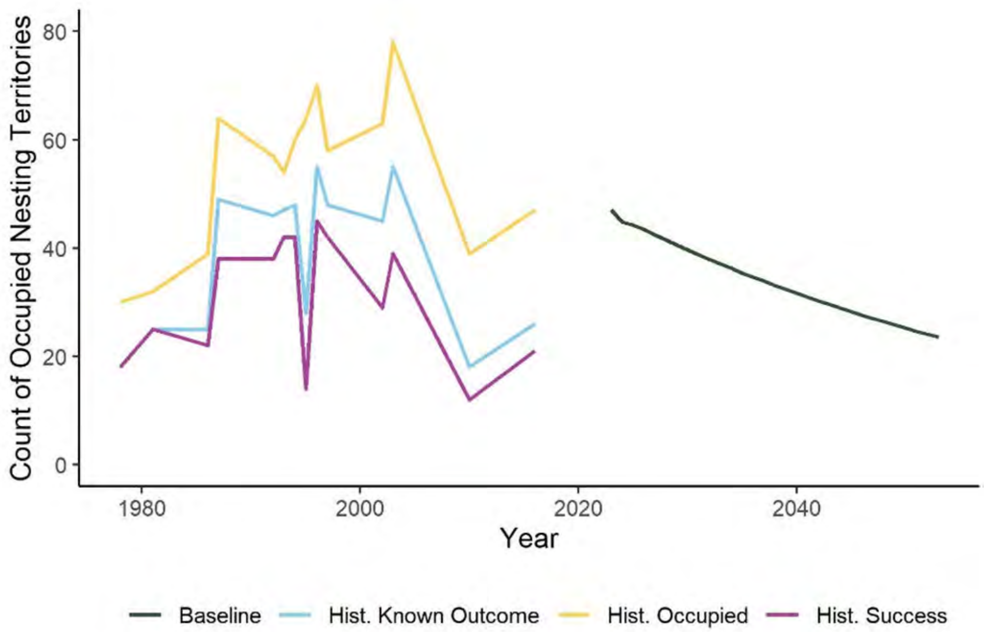


Figure 3. Comparison of historical occupied nesting territories, with the mean baseline predicted trend of occupied nesting territories from 10,000 iterations.

Direct and indirect effects were modeled separately and together to illustrate the relative effect on the population. We report decimals of territories instead of whole numbers to better illustrate the variation in the model results. Population benefits resulting from the construction and use of artificial nest platforms used the combined effects to simulate the biological response of increased nesting success. To simulate the effects on population trends from Project impacts and conservation efforts, we modeled the following scenarios:

- Direct effect from wind turbine collision considering low-, medium-, and high-effect scenarios (defined below);
- Indirect effect from loss of available nesting territories considering removal of one, two, or three territories;
- Direct and indirect effects from Project operations considering a combination of effects; and
- Artificial nest platform construction and use considering variable occupancy levels.

3.2.1 Direct Effect Scenario

We simulated population trends that reflected variable levels of mortality from turbine collision to provide a range of possible population effects. We used fatality counts from publicly available post-construction fatality monitoring (PCFM) studies at multiple spatial scales to develop a biologically realistic range of mortality scenarios. Count data was used because many of the fatalities were found outside of standardized PCFM when the estimation process was not possible, species-specific fatality estimates were unavailable, or study designs lacked rigor in one or more areas. Because of the discrepancies, count data provided a larger sample size of studies conducted within a particular region and was used to standardize the enumeration of ferruginous hawk fatalities across regions. Fatality count data were unadjusted for searcher efficiency or carcass persistence; thus, the range of fatalities should be considered a conservative estimate within each region. We quantified the number of fatalities documented during PCFM in the US, the CPE, and Washington (Table 4).

- Within the US, there were 40 ferruginous hawk fatalities reported from 20 operational wind facilities, 1996−2021 (WEST 2022).
- Within the CPE, there were eight ferruginous hawk fatalities reported from six operational wind facilities, 1999−2020 (WEST 2022).
- Within Washington, there were four ferruginous hawk fatalities reported from two operational wind facilities, 1999−2020 (WEST 2022).

Table 4. Regional ferruginous hawk fatalities recorded during post-construction fatality monitoring studies at operational wind energy facilities, 1996−2021.

		Fatality Age Group			Total	Fatality
Region	# Years	Adult	Juvenile	Unknown	Fatalities	Rate[a]
United States	25	9	6	25	40	1.60
Columbia Plateau Ecoregion	21	5	1	2	8	0.38
Washington	21	3	1	0	4	0.19

[a] calculated as Total Fatalities ÷ # Years

To derive a range of fatality rates used to estimate direct effects, we used region-specific ferruginous hawk PCFM data divided by the total number of years of PCFM data available in the region to calculate a fatality rate, multiplied by 30 years, and rounded up to the nearest whole bird. The range of direct effect estimates were classified into three levels: low, intermediate and high. We used fatality rates from the CPE and Washington to calculate a high (12 fatalities/30 years) and low (six fatalities/30 years) level, respectively, and split the difference between estimates for the intermediate (nine fatalities/30 years) level. The US fatality rate was not used because it would exceed the entire size of the CPE breeding population.

Direct effects on ferruginous hawk populations were predicted by varying age specific survival in the projection matrix for low, intermediate, and high levels of fatalities. Because Hayes and Watson (2021) suggested a bottleneck exists for earlier life history stages, we implemented direct effects in age specific patterns. In one set of models, predicted fatalities were applied to just adults, whereas in another set of models, fatalities were split evenly between adult and juvenile age classes.

3.2.2 Indirect Effect Scenario

Indirect effect scenarios were evaluated by varying the fecundity parameter in the projection matrix to reflect biologically realistic reductions of nesting territories. The three scenarios reflect a permanent removal of one, two, or three nesting territories across the 30-year period. Removal of a nesting territory may result from the permanent abandonment due to disturbance or displacement or from land conversion to unsuitable habitat types that may cause territory loss.

3.2.3 Combined Direct and Indirect Effects Scenario

We simulated the combined impacts of direct and indirect effects by incorporating both into the models.

3.2.4 Artificial Nest Platform Scenario

Artificial nest platforms have been demonstrated as an effective mitigation and habitat-enhancement tool that provide supplemental nesting substrates in areas where nests have been destroyed or substrates were not available (Tigner et al. 1996, Wallace et al. 2016b). Artificial nest platform scenarios were incorporated into the modeling to determine population responses from the use of artificial nest platforms. These scenarios assume that direct and indirect effects occur as described above, but incorporate an increase in fecundity from artificial nest platform use and resulting nesting success. For an artificial nest platform to be successful in this scenario, it must be additive to the breeding population and increase breeding success, and not result in relocation of a presumably successful breeding pair to an artificial nest platform.

To determine anticipated platform occupancy for each scenario, we calculated the average annual artificial nest platform occupancy from a review of nine studies over 53 study years in the US and Canada, 1976−2019 (Table 5). Nest occupancy varied widely in the studies that cumulatively surveyed 1,155 nests with an average annual occupancy of 36% ± 24% (Table 5). We used this average annual occupancy value to model possible effects from the addition of three, seven, and 10 artificial nest platforms within the CPE.

Table 5. Annual ferruginous hawk nest occupancy of artificial nest platforms (ANP)

Survey Year	# ANP	# ANP Occupied	% Occupied	Location	Reference
1976-2004[a]	105	64	61	Wyoming, US	Neal 2007
1976	97	2	2	Alberta, Canada	Schmutz et al. 1984
1977	98	4	4	Alberta, Canada	Schmutz et al. 1984
1981	81	11	14	Alberta, Canada	Schmutz et al. 1984
1982	81	12	15	Alberta, Canada	Schmutz et al. 1984
1983	78	11	14	Alberta, Canada	Schmutz et al. 1984
1988	25	11	44	Wyoming, US	Tigner et al. 1996
1989	54	34	63	Wyoming, US	Tigner et al. 1996
1990	61	33	54	Wyoming, US	Tigner et al. 1996
1991	65	41	63	Wyoming, US	Tigner et al. 1996
1992	71	37	52	Wyoming, US	Tigner et al. 1996
1993	71	29	41	Wyoming, US	Tigner et al. 1996
2009	130	45	35	Alberta, Canada	Migaj et al. 2011
2013[b]	27	18	67	Wyoming, US	Wallace et al. 2016
2016	2	1	50	Alberta, Canada	Kemper et al. 2020
2017	3	2	67	Alberta, Canada	Kemper et al. 2020
2017-2018[c]	57	5	9	Utah, US	Hopkins 2019
2018	2	0	0	Alberta, Canada	Kemper et al. 2020
2019	2	1	50	Alberta, Canada	Kemper et al. 2020
2019	16	6	38	Alberta, Canada	Parayko et al. 2021
2019[d]	29	2	7	Washington, US	Hayes and Watson 2021
Total	**1155**	**369**	**32[e]**		
Mean	**55**	**18**	**36**		
St.Dev.	**38**	**18**	**24**		

[a] Annual occupancy ranged from 52.1–69.7% - median (60.9%) calculated for simplicity
[b] Re-occupancy = 0.66 (95% confidence interval = 0.10–0.97)
[c] 32 ANP in low predicted nesting likelihood, 25 ANP in medium to high
[d] Undetermined level of survey effort, construction and survey occurred same year
[e] Total # ANP occupied ÷ Total # ANP surveyed: 369 ÷ 1,155 = 32% overall

4 RESULTS

Based on eigenanalysis of the projection matrix, adult mortality was affected disproportionally more than other life stages by small shifts in vital rates with a value of 0.67 (Table 3). Fecundity or births demonstrated the lowest sensitivity (0.12) compared to other life stages; however, our effect scenarios did not reflect this pattern which showed more stable patterns when vital rates varied between age classes and fecundity.

The baseline scenario revealed that occupied nest outcomes can vary widely (Figure 2), likely due to the small population size and uncertainty in vital rates. However, even with this uncertainty the 90% CI for the average λ of 0.9776 (90% CI: 0.9774−0.9779) and the mean number of nesting territories after 30-years, 23.52 (90% CI: 23.31−23.74) resulted in narrow CI across all 10,000 iterations (Appendix A). Mean λ for the baseline scenario was an annual population decline of 2.2% (Appendix A).Effect scenarios are discussed in further detail, below.

4.1 Direct Effect Scenario

The low direct effect scenario simulating six adults over 30 years resulted in 52% fewer nesting territories (22.71; 90% CI: 22.5−22.93), than the starting number of territories (47). The difference in nesting territories between the low direct effect scenario and the baseline was 3.5% (difference of one nest), indicating a similar outcome after 30 years. Mean λ for the low direct effect scenario was 0.9764 (90% CI: 0.9761−0.9767), resulting in an average 2.4% annual population decline.

Low juvenile survival that reduced the number of birds reaching reproductive age has been suggested as a mortality bottleneck affecting population growth (Hayes and Watson 2021). However, our simulations did not result in a more rapid population decline when mortality rates were split evenly between adults and juveniles (Figure 4). Direct effect models focusing on only adult fatalities resulted in a range of 19.05−22.71 nesting territories after 30 years, whereas models that split fatalities between adult and juvenile age classes resulted in approximately one fewer nesting territories after 30 years (18.26−21.41 territories; Appendix A).

4.2 Indirect Effect Scenario

The removal of nesting territories resulted in more substantial declines in nesting territories (Figure 5) compared to variability in adult or juvenile survival (Figure 4). Reduction of one to three territories resulted in 19.34 to 12.73 (of 47) nesting territories remaining after 30 years, whereas low to high fatality rates (direct effects) resulted in 22.71 to 19.05 nesting territories. Compared to the baseline, removing one nesting territory across all years resulted in a 59% decline (from 47 to 19.34 territories [90% CI: 19.16−19.51]) in nesting territories after 30 years, and λ of 0.9708 (90% CI: 0.9705−0.971; Appendix A). Removal of three nesting territories decreased the predicted number of nesting territories nearly 73% from a starting baseline of 47 nesting territories to 12.73 territories after 30 years.

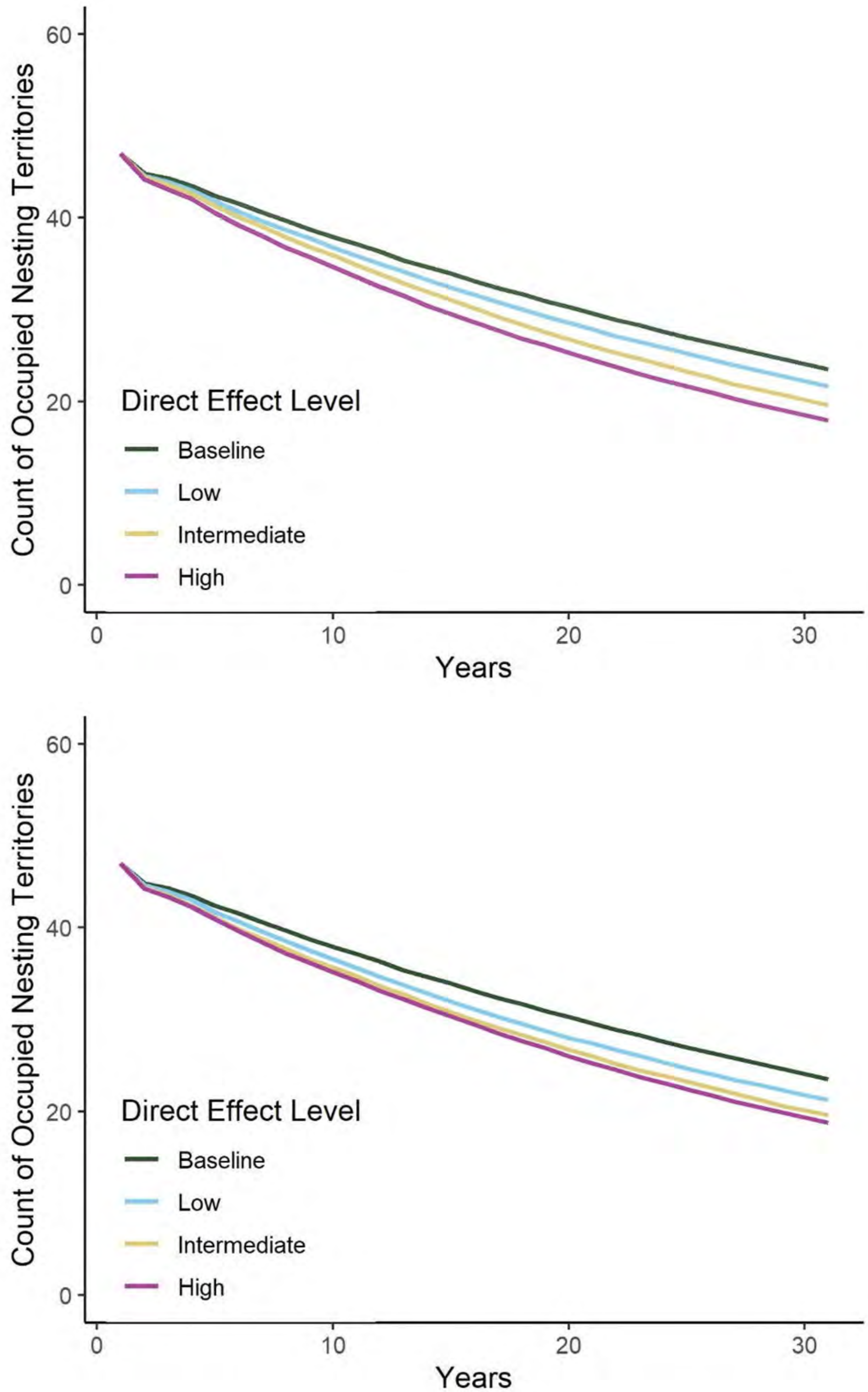


Figure 4. Predicted trend of occupied nesting territories accounting for direct effects to adults (top) and split evenly amongst adults and juveniles (bottom).

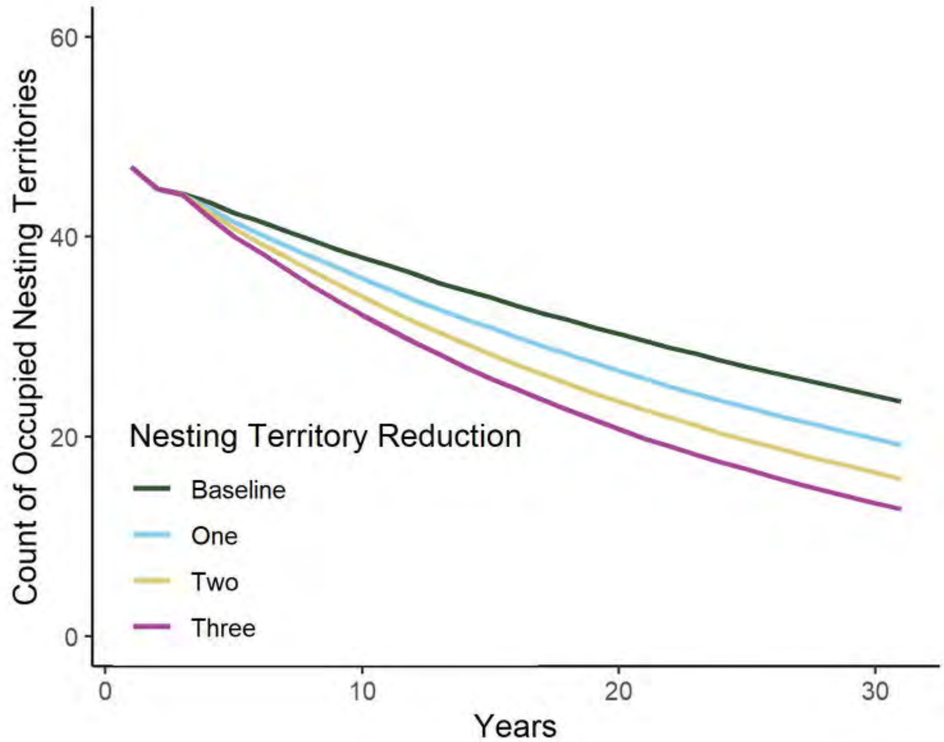


Figure 5. Predicted trend of occupied nesting territories accounting for indirect effects of nesting territory reduction.

4.3 Combined Direct and Indirect Effects Scenario

Population trends declined more substantially when the scenarios of reduced survival and declining territory occupancy were combined. Low direct effects and reduction of one nesting territory predicted 18.27 nesting territories remaining after 30 years, whereas high direct effects and reduction of three nesting territories predicted 10.12 territories after 30 years (Figure 6).

The difference in the magnitude of the effect is seen when compared with the baseline (Figure 6). The combined scenario of low fatality rates and reduction of one nesting territory resulted in a reduction of five nesting territories when compared to the baseline, and λ of 0.9694 (90% CI: 0.9691−0.9696; Figure 6; Appendix A). High direct effect levels and three removed territories resulted in 2.5 times fewer territories compared to baseline, and λ of 0.9495 (90% CI: 0.9492−0.9498; Figure 6; Appendix A). The corresponding average population decline was 2.2% for the baseline scenario compared with a 5.1% average annual decline for the combined high direct and indirect effect scenarios.

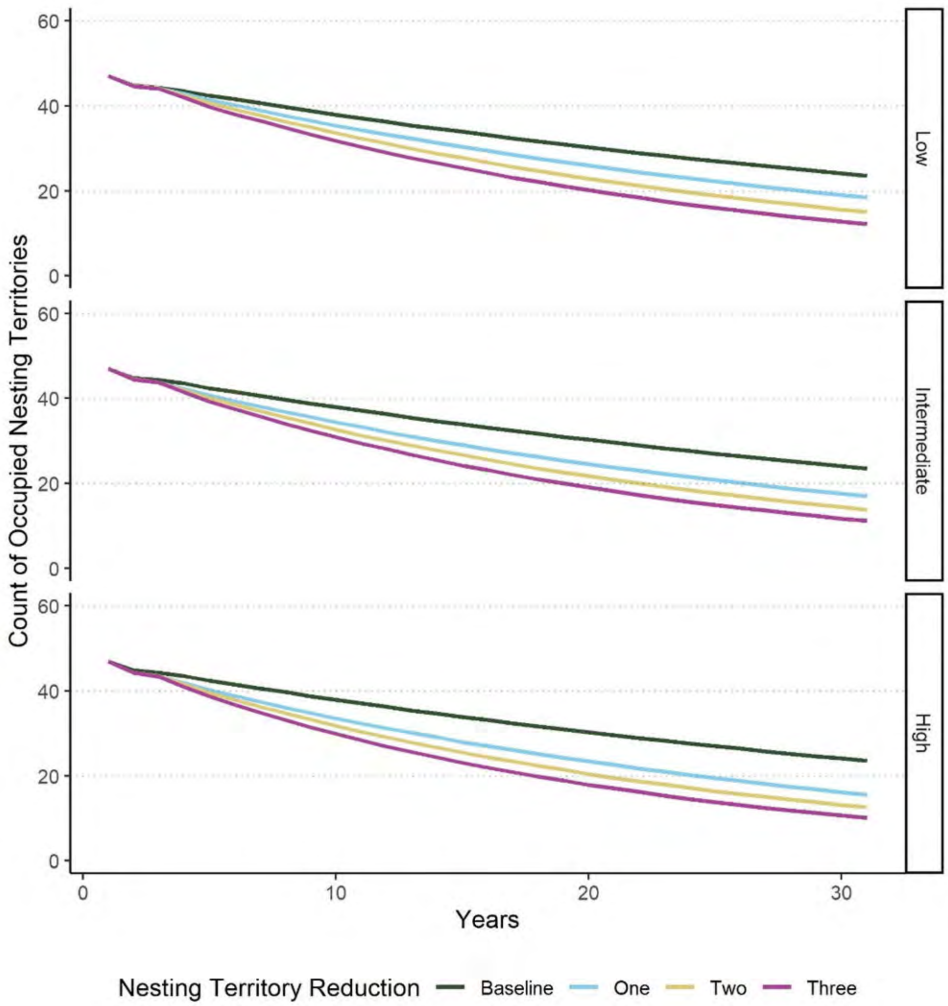


Figure 6. Predicted trend of occupied nesting territories accounting for direct effects (low, intermediate, and high) and indirect effects (reduction of one, two, or three nesting territories).

4.4 Artificial Nest Platform Scenario

Predicted λ for baseline, direct effect, indirect effect, and combined effects was always below 1.00, resulting in declining population trends across all scenarios (Appendix A). However, simulations incorporating artificial nest platforms resulted in a positive values of λ corresponding with an increase in successful breeding pairs in the population due to the construction and use of artificial nest platforms (Figure 7). Offsetting the effects of low or intermediate direct effects and the reduction of one occupied territory would require three artificial platforms to be constructed with an average annual occupancy of 36% (Appendix A). If high levels of direct effects occur, then seven artificial platforms are needed to return the number of nesting territories above baseline. Across all three levels of directs effects, 10 new territories are necessary to achieve a positive trend in nesting territories (Figure 7).

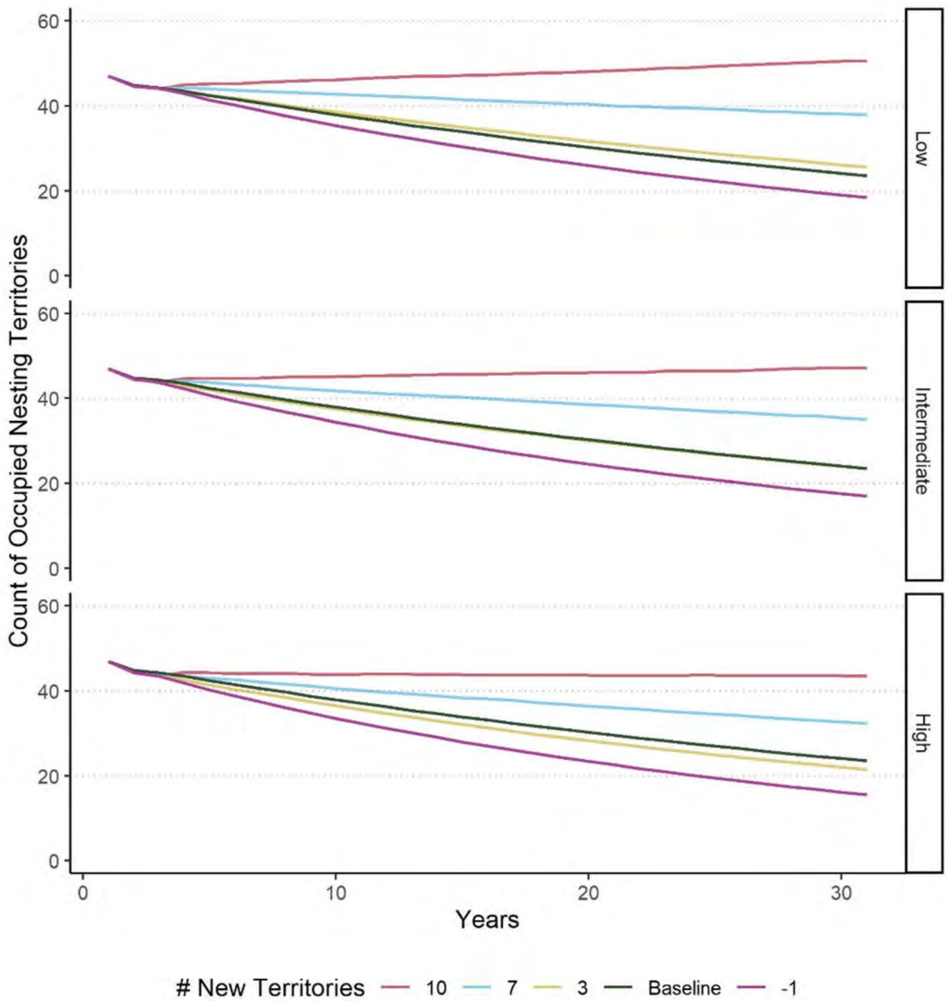


Figure 7. Predicted trend of occupied nesting territories accounting for direct effects (low, intermediate, high), indirect effects (reduction of one nesting territory), and construction of three, seven, and ten artificial nest platforms, assuming 36% occupancy.

5 DISCUSSION

Based on published vital rates and population estimates, our baseline model simulated a ferruginous hawk population with an annual average decline of approximately 2.4% over the next 30 years. By adjusting the simulated levels of turbine-related mortality and permanent loss of nesting territories, population trajectories showed a comparatively greater response to the loss of nesting territories than collisions (the loss of individual birds). Population trends did not respond to disproportionate effects to adult or juvenile age classes, suggesting age structure of turbine-related mortality has less of an affect than loss of a nesting territory or the removal of an individual from the population. When the effects of the scenarios were combined, the resulting influence to the population trends were magnified more than the influence of one effect alone. Our models simulated how the construction and use of artificial nest platforms, a common mitigation measure, could be used to mitigate the effects of Project operation.

As described above, simulations of the baseline population without the additive effects of increased mortality or loss of territories resulted in declining population trends for ferruginous hawk in Washington. Trend results corresponded with a -1.59% annual change (97.5% CI: -7.01−3.66) in Washington based on BBS data, from 1999−2019 (Sauer et al. 2019). Although statistically insignificant with credible intervals that included zero, BBS trend data in Washington reflected the patterns of declining nest occupancy, productivity, and nesting pairs observed over the last four decades (Hayes and Watson 2021). Despite the observed stability of ferruginous hawk populations across the US, Diffendorfer et al. (2021) modeled the vulnerability in maintaining a stable or positive λ from current (106 gigawatt [GW]) and future (241 GW) installed wind energy generation scenarios and found ferruginous hawk was comparatively more susceptible to changes in λ from turbine-related mortality compared to other species. In our study, localized effects on a small, declining population exposed to a myriad of existing environmental stressors unrelated to wind energy resulted in increased sensitivity to changes in demographic vital rates and λ.

In our PVA, there was no substantial change in population trends when the age structure of the survival parameter varied between adult and juvenile. Previous raptor research has shown adult survival can influence population viability (see Newton et al. 2016); however, the effect of low juvenile survival has been noted as a constraining factor in Washington populations of ferruginous hawks (Hayes and Watson 2021). The relatively equal effect of age class on population trends over a 30-year period perhaps underscores the demographic importance of all age classes, particularly for small populations. The reduced influence of adult survival on population trends compared to territory loss may suggest emigration of individuals into the breeding population during the non-breeding season or non-breeding “floaters” that replace breeding adults when densities decrease and breeding space becomes available (Watson and Keren 2019, Parayko et al. 2021).

Our scenarios show that the indirect loss of a nesting territory can have a greater affect than the direct loss of an individual and when combined, can substantially influence λ. Although nesting territories were not identified as a limiting factor in the Recovery Plan or status report

(Richardson 1996, Hayes and Watson 2021), loss of historical nesting territories and surrounding foraging habitat resulting from agricultural conversion, wildfire, reduced prey availability, urbanization and other anthropogenic sources have decreased or eliminated the suitability of nest sites over the ferruginous hawk breeding range in Washington. Efforts to increase availability of nesting territories through construction of artificial nest platforms in otherwise suitable areas lacking natural substrates can increase the number of nesting sites in a territory. Assuming an average annual occupancy rate of 36%, increases of three nesting territories may return the population trend to baseline conditions while 10 nesting territories may result in positive ferruginous hawk population trends.

Future PVAs could be refined to consider a range of probable fatalities based on annual fatality estimates from PCFM studies that adjust for searcher efficiency and carcass persistence. Count data excludes biases associated with carcass detection probabilities inherent with PCFM and thus is a coarse approximation we used to define a range of potential fatalities across spatial scales and not the biological reality that may occur. Despite the use of count data, we believe the relative magnitude in the effect of each scenario is representative of the biological response provided the same vital rates are considered. We want to acknowledge that the confidence intervals in Appendix A are narrower than we might expect for simulated ecological data suggesting that the data inputs are more precise than we might observe during the 30-year analysis period.

Our analysis scenarios demonstrate that reduced survival and territory occupancy can have synergistic effects on ferruginous hawk populations. Depending on the magnitude of the effects, the cumulative result of direct and indirect effects on small populations can substantially affect viability. The decrement in population growth from the loss of territories or individuals is not biologically restricted to wind energy development. As discussed in WDFW's Recovery Plan and Periodic Assessment, conversion and fragmentation of native habitats to agriculture and urbanization and the use of rodenticides and pesticides result in an increasingly human-disturbed landscape that affect ferruginous hawk populations (Richardson 1996, Hayes and Watson 2021). In addition to the installation of nesting platforms, WDFW discussed a range of conservation efforts including more comprehensive monitoring and research, increased funding and emphasis placed on habitat management and enhancement programs[3], reduced application of industrial chemicals, and strategic conservation planning that minimizes encroachment into unfragmented native habitats can result in incremental benefits (Richardson 1996, Hayes and Watson 2021). Mitigation of stressors that affect population trends should continue across the broad range of factors that impact ferruginous hawk nesting and foraging habitat in order to maintain viability of local populations over time.

[3] Examples of habitat management or enhancement programs include, but are not limited to, the US Department of Agriculture, Farm Service Agency's Conservation Reserve Program (CRP), Conservation Reserve Enhancement Program (CREP), State Acres for Wildlife Enhancement (SAFE), or the Washington Wildlife and Recreation Program (WWRP)

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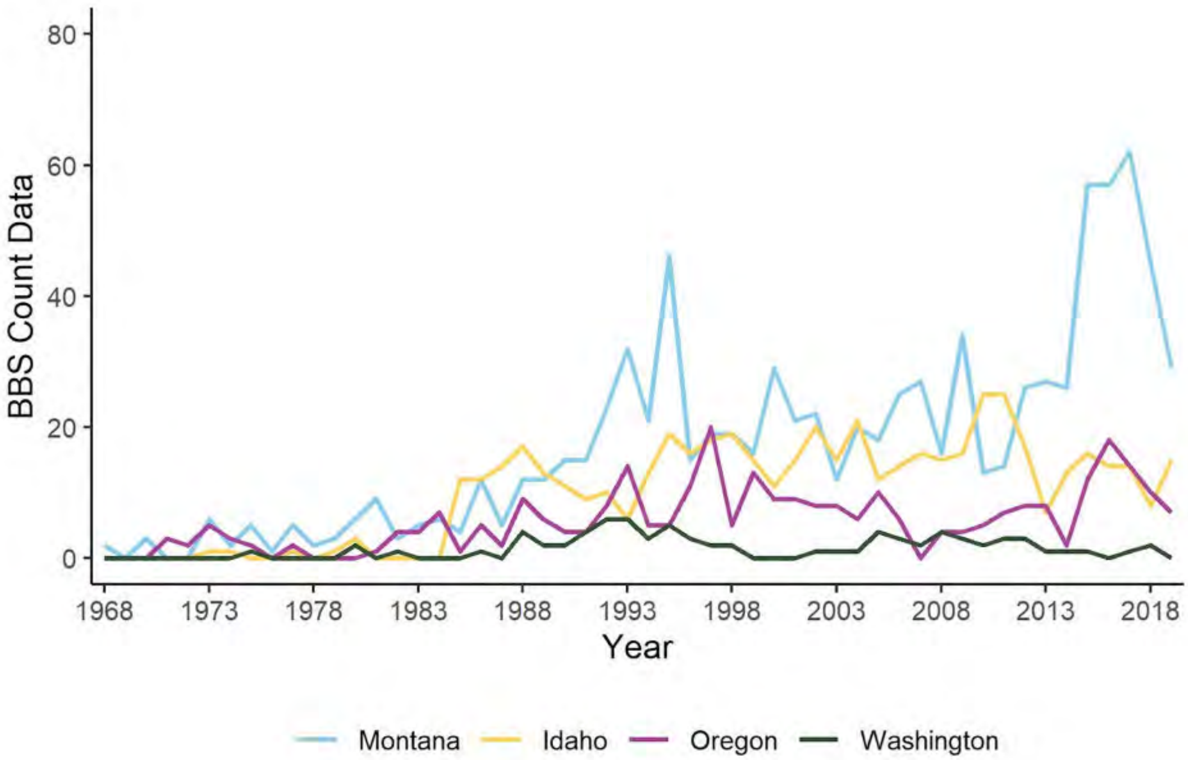
Appendix A1. Predicted λ and occupied nesting territories for each scenario after 30-years.

Scenario	Direct Effect Level	Indirect Effect Level	Added Nesting Territories	λ	λ 90% CI	# Territories	Territories 90% CI
Baseline	-	-	-	0.9776	0.9774−0.9779	23.52	23.31−23.74
Direct Effects	Low	-	-	0.9764	0.9761−0.9767	22.71	22.5−22.93
Direct Effects	Intermediate	-	-	0.9736	0.9733−0.9739	20.78	20.58−20.97
Direct Effects	High	-	-	0.9708	0.9705−0.971	19.05	18.87−19.23
Direct Effects (Adults and Juveniles)	Low	-	-	0.9746	0.9744−0.9749	21.41	21.22−21.61
Direct Effects (Adults and Juveniles)	Intermediate	-	-	0.9736	0.9734−0.9739	20.87	20.68−21.07
Direct Effects (Adults and Juveniles)	High	-	-	0.9694	0.9691−0.9696	18.26	18.09−18.43
Indirect Effects	-	1	-	0.9708	0.9705−0.9711	19.34	19.16−19.51
Indirect Effects	-	2	-	0.9639	0.9636−0.9641	15.68	15.54−15.83
Indirect Effects	-	3	-	0.9566	0.9564−0.9569	12.73	12.61−12.85
Combined Effects	Low	1	-	0.9694	0.9691−0.9696	18.44	18.27−18.6
Combined Effects	Intermediate	1	-	0.9667	0.9664−0.967	16.96	16.8−17.12
Combined Effects	High	1	-	0.964	0.9638−0.9643	15.6	15.46−15.75
Combined Effects	Low	2	-	0.9624	0.9621−0.9627	15.05	14.91−15.19
Combined Effects	Intermediate	2	-	0.9597	0.9595−0.96	13.79	13.66−13.92
Combined Effects	High	2	-	0.9569	0.9566−0.9571	12.6	12.48−12.71
Combined Effects	Low	3	-	0.9552	0.9549−0.9555	12.14	12.03−12.25
Combined Effects	Intermediate	3	-	0.9525	0.9522−0.9528	11.15	11.04−11.25
Combined Effects	High	3	-	0.9495	0.9492−0.9498	10.12	10.03−10.22
Artificial Nest Platform Credit	Low	1	3	0.9807	0.9804−0.9809	25.61	25.38−25.85
Artificial Nest Platform Credit	Low	1	7	0.994	0.9937−0.9943	37.87	37.51−38.22
Artificial Nest Platform Credit	Low	1	10	1.0044	1.0041−1.0046	50.68	50.22−51.15
Artificial Nest Platform Credit	Intermediate	1	3	0.9779	0.9776−0.9782	23.52	23.3−23.74
Artificial Nest Platform Credit	Intermediate	1	7	0.9917	0.9914−0.992	35.02	34.7−35.34
Artificial Nest Platform Credit	Intermediate	1	10	1.002	1.0017−1.0022	47.15	46.71−47.6
Artificial Nest Platform Credit	High	1	3	0.9749	0.9747−0.9752	21.48	21.28−21.68
Artificial Nest Platform Credit	High	1	7	0.989	0.9887−0.9893	32.35	32.04−32.65
Artificial Nest Platform Credit	High	1	10	0.9991	0.9989−0.9994	43.44	43.03−43.86

CI = confidence interval



Appendix A2. Breeding Bird Survey count data by state for the northwestern United States. Washington historically has had low numbers relative to other states. Interannual and interdecadal counts appears high, although differences were not quantified. The number of routes surveyed increased until the early 1990s before remaining relatively consistent. Therefore, any perceived population growth from 1968 through 1993 is likely the result of survey effort.

Multi-scale Resource Selection of Ferruginous Hawk (*Buteo regalis*) Nesting in Eastern Washington and at the Horse Heaven Clean Energy Center, Benton County, Washington

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September 23, 2022

WEST

EXECUTIVE SUMMARY

Horse Heaven Wind Farm, LLC is proposing development of the Horse Heaven Clean Energy Center (Horse Heaven and/or Project) in Benton County, Washington. Horse Heaven contracted Western EcoSystems Technology, Inc. (WEST) to analyze factors that influence nest site selection for the ferruginous hawk (*Buteo regalis*), an endangered species in Washington. We used two decades of nest occupancy data and suite of environmental and anthropogenic covariates to create resource selection functions (RSF) modeling nesting probability across the hawk's nesting range in eastern Washington. Nest selection was modeled on the landscape (population) scale to identify characteristics hawks consider as important criteria within their home range and at a smaller nesting (individual) scale to identify characteristics in the species core range. Smaller scales of resource selection were applied at the Project to predict areas where hawks may nest in the future so avoidance and minimization measures could be strategically considered prior to project operation.

On a population scale, the strongest predictive covariates influencing relative nest site selection included increased habitat heterogeneity in land cover, higher quality prey habitat, flatter terrain with pronounced areas of topographic relief, and less disturbance indicated by the avoidance of various intensities of development.

On an individual scale, occupied nest sites were characterized by relatively higher-quality prey habitat of Washington ground squirrel (*Urocitellus washingtoni*) and black-tailed jackrabbit (*Lepus californicus*). Correspondingly, springtime vegetative productivity was selected, further indicating the close relationship between vegetative browse and prey abundance surrounding the nest site.

The highest probability of nest use was along the northern escarpment bordering the Project. Areas identified within this study in combination with other avoidance, minimization, and mitigation measures described by the Project (Horse Heaven Wind Farm, LLC 2021), can be implemented in the construction and operational phases of the Project to strategically reduce indirect and direct impacts to ferruginous hawk.

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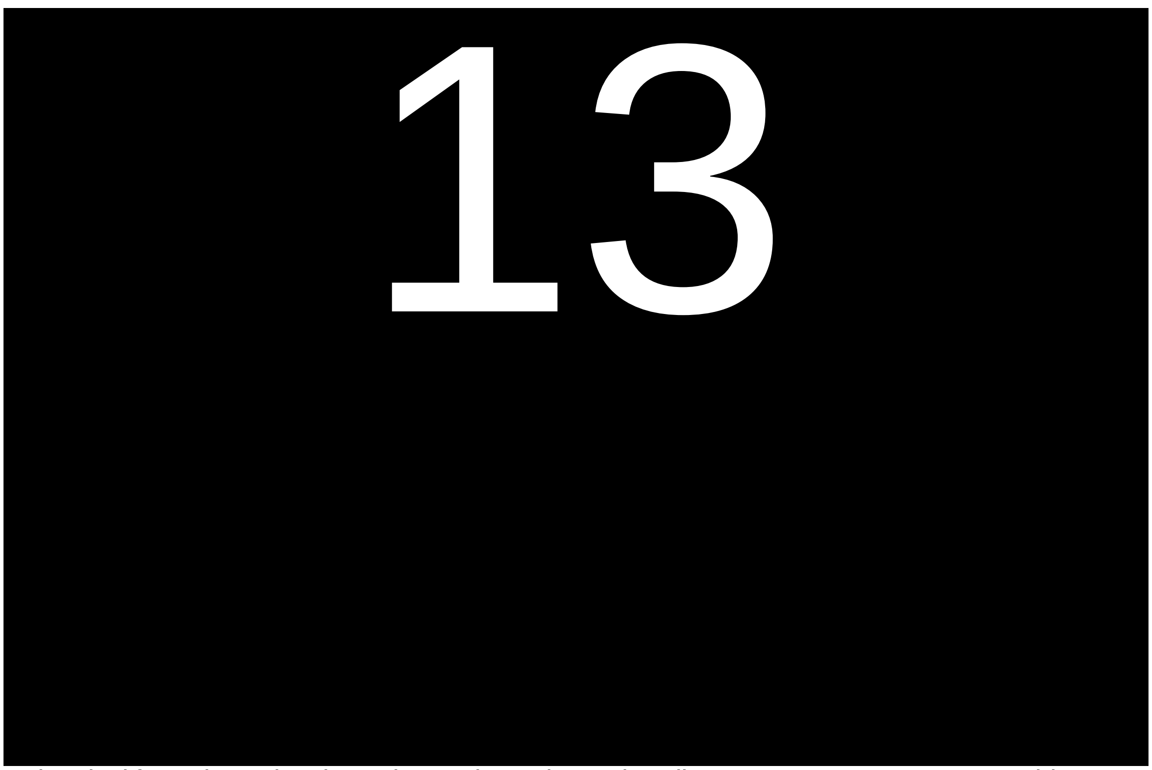

Historical ferruginous hawk nesting territory along Chandler Butte, Benton County, Washington.

Cover Page: Expanding urbanization into historical hawk nesting territories of the Horse Heaven Hills, May 2022; incubating ferruginous hawk in a locust (*Robinia* spp.) tree, Benton County, May 2018. All photos: E. Jansen.

STUDY PARTICIPANTS

Erik Jansen	PM and Reporting
Kurt Smith	Statistician and Reporting
Faith Kuzler	Statistician
Karl Kosciuch	Report Review and Reporting
David Kline	Report Editing

REPORT REFERENCE

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Unit Conversions*

Imperial	Metric
1 foot	0.3048 meter
3.28 feet	1 meter
1 mile	1.61 kilometer
0.621 mile	1 kilometer
1 acre	0.40 hectare
2.47 acre	1 hectare

Common Conversions

Imperial	Metric
0.5 miles	800 meters
0.12 miles	200 meters
0.5 miles	0.8 kilometers
10 miles	16.1 kilometers

* units are used interchangeably and conversions are provided here for reference

1 INTRODUCTION

Horse Heaven Wind Farm, LLC (Horse Heaven) is proposing development of the Horse Heaven Clean Energy Center (HHCEC and/or Project) in Benton County, Washington. The breeding range of the state-endangered ferruginous hawk (*Buteo regalis*) overlaps the Project, and historical nests are located within 3.2 kilometers (km) of Project facilities. Horse Heaven contracted Western EcoSystems Technology, Inc. (WEST) to analyze nest site selection criteria to predict areas where ferruginous hawks might nest in the future so that minimization measures can be strategically considered prior to Project operation.

Identifying hotspots of spatial use by raptors within a wind project area is an important component of the risk-assessment process (US Fish and Wildlife Service 2013). Ferruginous hawk use across a landscape can be influenced by a variety of environmental characteristics (e.g., land cover, prey resources, terrain and disturbances; Collins and Reynolds 2005) and resource selection functions (RSF) have been identified as a powerful tool to predict how potential wind energy development may spatially relate to predicted ferruginous hawk nest selection and inform conservation planning (Squires et al. 2020).

In this study, we used an RSF framework to model biologically relevant covariates associated with occupied ferruginous hawk nests in eastern Washington from 2000–2022. Temporal and spatially explicit covariates included environmental and anthropogenic variables that were previously identified as important for nesting ferruginous hawks (Squires et al. 2020). We used the best performing covariates to model multi-scale nest site selection; at the nest site level and within the entire breeding range of ferruginous hawks in eastern Washington. Model results were applied to the Project to evaluate proposed wind development in relation to areas of predicted nest site selection. To our knowledge, this is the first landscape-scale assessment of ferruginous hawk nest site selection in Washington applied to a proposed wind energy project.

We used biologically relevant attributes from a similar study in Wyoming to identify factors influencing nest selection in Washington. Although landscape conditions differ between the two states, with a more robust population and comparatively unfragmented landscape in Wyoming, use of similar covariates can help differentiate factors that influence nest site selection in two geographically separated populations. Because of the highly modified landscape present throughout the breeding range in Washington we assumed ferruginous hawks would be more flexible in their selection of nest sites. We predicted that ferruginous hawk would: 1) not strongly avoid human development (e.g., roads, urbanization and energy) because of its uniform distribution across the landscape (Washington Wildlife Habitat Connectivity Working Group [WHCWG] 2012); 2) not strongly avoid agricultural areas considering the rate of land conversion over the past century and relationship between nest sites and agriculture in previous research (Leary et al. 1998; Sleeter 2012) and; 3) strongly select prey sources at all spatial scales considering the importance of food resources to nest success (Collins and Reynolds 2005, Hayes and Watson 2021).

2 ANALYSIS AREA

Our analysis extent consisted of two areas. We considered the Study Area where ferruginous hawk nest data and nesting habitat characteristics could be modeled on a landscape-scale and included the entire breeding range of the ferruginous hawk (Figure 1). Second, we considered a comparatively smaller Project Area that functioned as a model validation area where renewable energy development is proposed and where the relative probability of nest site selection could be compared with contemporary nest survey results.

2.1 Study Area

The Study Area included the shrub-steppe and grasslands of eastern Washington, which encompass the northwestern extent of ferruginous hawk nesting range in the United States. The Study Area comprised 23,790 square miles (mi^2) in eastern Washington within the geographic boundary of the Columbia Plateau Ecoregion (CPE) Level III Ecosystem (Omernik 1987; Figure 1 and 2). Part of the larger Great Basin Bird Conservation Region, approximately 74% of the CPE is located within Washington (Bird Studies Canada and U.S. North American Bird Conservation Initiative [NABCI] 2014). We used the CPE as the Study Area because it included suitable nesting habitat, all publicly available records of ferruginous hawk nests in Washington, and it is a focal area for renewable energy development in the region (Hayes and Watson 2021, Renewables Northwest 2022, Washington Department of Fish and Wildlife [WDFW] 2015).

The CPE is located in the northwestern extent of ferruginous hawk nesting in the United States. In general, the Washington breeding population arrives from the California Central Valley in late February to early March where adults start occupying nesting territories (Watson et al. 2018). Fidelity to previously occupied sites is high among breeding adults even when prey sources are scare due to drought conditions, suggesting that other factors are also important for nest site selection (Watson and Keren 2019).

The CPE is bound in all directions by comparatively more mountainous ecoregions in surrounding ecoregions (Figure 2). Rising approximately 4,500 feet (ft) above sea level, topography in the CPE is characterized by broad, flat plateaus, rolling hills with lakes and potholes, channeled scablands and bisected by steep canyons and river systems and reservoirs (Cleland et al. 2007). Annual precipitation averages 7 to 18 inches. Soils are derived from parent material resulting from erosion and re-deposition by great floods and strong winds across the relatively level lava plateau (Cleland et al. 2007). Windblown sediment (loess) covers most of the CPE providing deep fertile soil optimal for agriculture. Fertile soils in the CPE have resulted in approximately 80% of historical shrub-steppe habitat lost or degraded to cropland or other land uses (WDFW 2015). The rolling, mostly cropland-dominated topography of the CPE is interrupted by the geologic mayhem of the Missoula Floods that created areas of flood-scoured, channeled scablands, potholes, buttes and steep topography that provides suitable nesting habitat for ferruginous hawk (Alt 2001).

Grasslands and shrub-steppe form a mosaic of native vegetation that comprise the dominant habitat types within the CPE. Clinal variation in vegetation communities range from grasslands and shrub-steppe in lower elevations transitioning to landscapes dominated by trees in higher elevations (Figure 2). Introduced from Eurasia and the Mediterranean, cheatgrass (downy brome, *Bromus tectorum*) continues to be a major threat to biodiversity, functionally eliminating native plant species in areas, modifying wildlife populations and increasing the risk of wildfire, which burned approximately 800,000 acres of shrub-steppe habitat and affected five ferruginous hawk territories in 2020 (National Interagency Fire Center 2021, Pilliod et al. 2021).

2.2 Project Area

The Project Area consists of a 3.1-mile (mi) radius buffer surrounding a 113 mi^2 Project lease boundary, of which approximately 35 mi^2 (31%) includes micrositing corridors[1] where wind turbines, solar array and related infrastructure are proposed in a maximum build scenario (Horse Heaven Wind Farm, LLC 2021). The Project Area is located adjacent to the Tri-cities urban areas of Kennewick, Richland, and Pasco and included portions of exurban communities associated with Benton City and Highland.

A prominent topographic feature important to ferruginous hawk nesting is a broad, northeast-facing anticline ridge along the northern perimeter of the Project Area. The ridge consists of numerous highly eroded drainages and cliff-lined canyons (Badger Canyon, Coyote Canyon, Webber Canyon, Nine Canyon) where historical nests have been documented. South of the ridge, toward the interior of the Project, the landscape transitions to relatively rolling topography with shallow, meandering canyons that drain south into the Columbia River. Elevation within the Project Area was lowest toward the Columbia River to the east (approximately 350 ft), rising to above 2,000 ft at prominent features including Jump Off Joe (2,200 ft), Johnson Butte (2,043 ft), and Chandler Butte (2,046 ft), which all have radio and telecommunication facilities installed.

Land cover within the Project Area is a mosaic of dryland and irrigated cropland, shrub-steppe grasslands, and rural/urban development (Horse Heaven Wind Farm, LLC 2021). Cropland is the dominate land cover throughout the Project and surrounding area (>80%; Horse Heaven Wind Farm, LLC. 2020). Shrub-steppe is found in topographically steep areas and drainage bottoms where conversion to cropland was not possible. Portions of lands within the Project Area are enrolled in the US Department of Agriculture's Conservation Reserve Program.

Land use in the Project Area consists predominantly of actively managed dryland winter wheat (*Triticum aestivum*) and associated infrastructure including silos and warehouses. Historic land use is reflected in abandoned and working farmsteads scattered in low density throughout the landscape. New residential development encroaches into the foothills and on top of the Horse Heaven Hills ridge, indicative of a growing Tri-cities area population. Several rock quarries in the Project Area are actively used for on-going road and other construction projects. Electrical systems include radio and telecommunication towers, several high-voltage (115-500 kV) Bonneville Power Administration transmission lines bisecting the Project Area, and numerous low-voltage (34.5 kV) distribution lines servicing business and residential buildings. Portions of the 63 Turbine Nine Canyon Wind Project were located within or adjacent to the Project Area.

[1] Micositing corridors consisted of an 18.5 mi^2 Wind Energy Micrositing Corridor and 16.8 mi^2 of Solar Siting Area (Horse Heaven Wind Farm, LLC 2021).

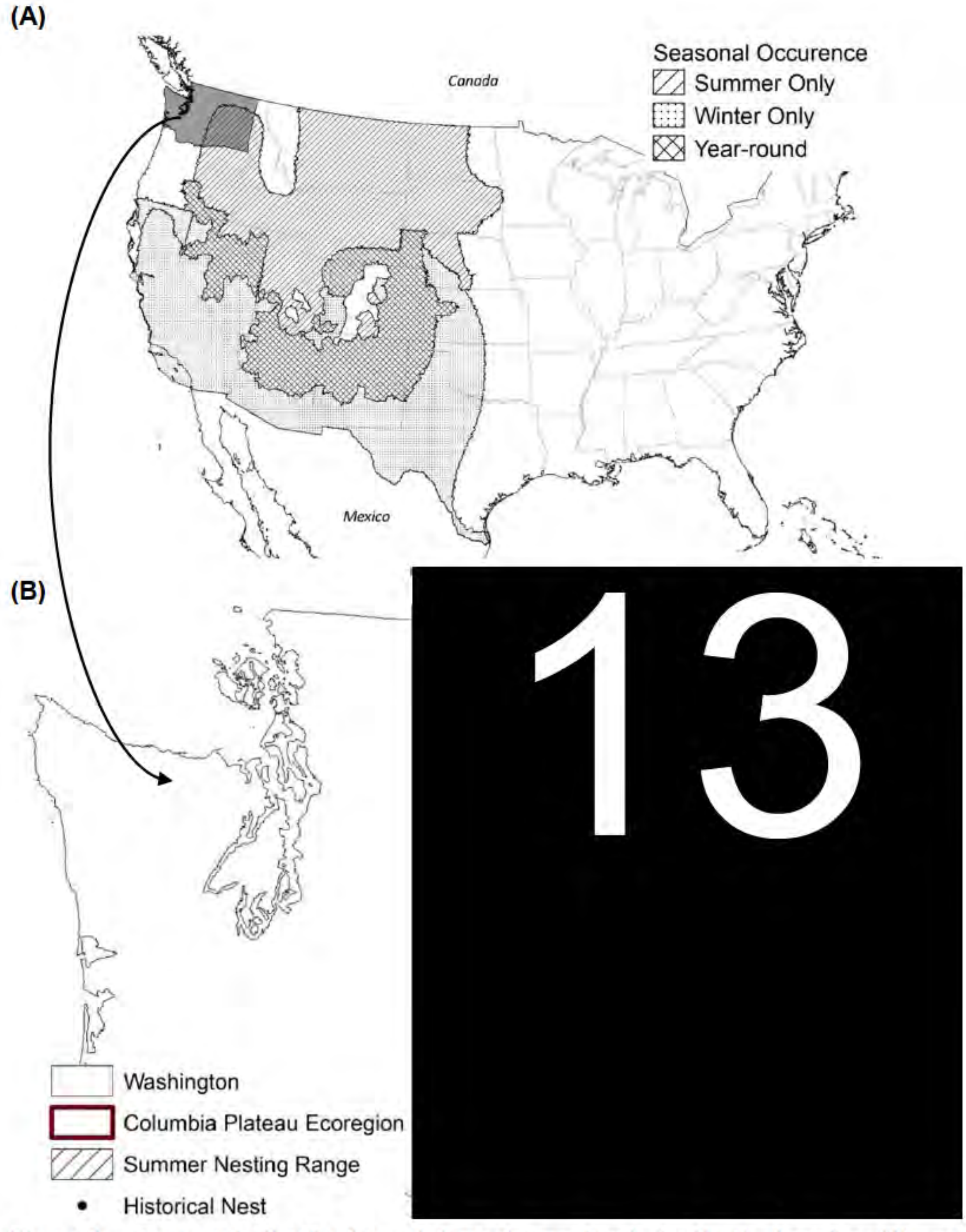

Figure 1. Seasonal distribution of ferruginous hawk in North America (A), and distribution of 677 historical ferruginous hawk nests within the Columbia Plateau Ecoregion (Study Area) in eastern Washington 1974−2020 (B).

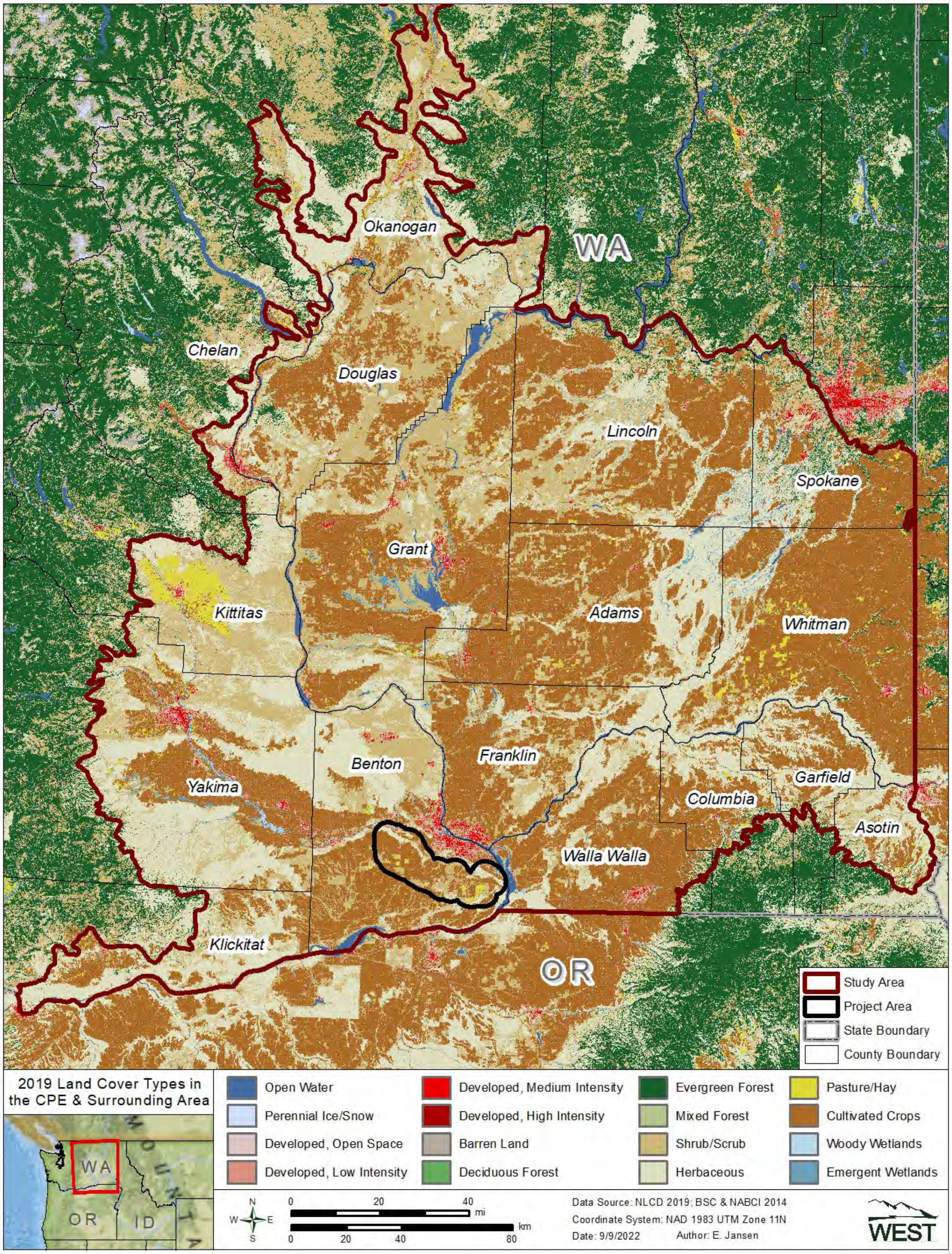

Figure 2. Land cover types within the Columbia Plateau Ecoregion.

3 METHODS

We use an RSF framework, a common and statistically rigorous method, to estimate ferruginous hawk nest site selection as a function of environmental and anthropogenic characteristics (Manly et al. 2002), to take a data-driven approach to predict the likelihood of ferruginous hawk nesting within the Study Area and Project Area. The following sections describe how nest occupancy combined with spatially explicit covariates informed relative nest site selection at various spatial scales.

3.1 Nest Data

We used historical ferruginous hawk nest data documented throughout the CPE as a basis to model landscape scale variables to predict the relative probability of site selection. WDFW collected the majority of nest data as part of their state-wide monitoring survey effort intended to assess the status of all nesting territories systematically, but were <100% due to access limitation, limited staff capacity, weather factors, or other conditions (Hayes and Watson 2021). Greater survey effort (≥ 70% of nesting territories surveyed) occurred in 1978, 1981, 1986, 1987, 1992−1997, 2002−2003, 2010, and 2016 (Hayes and Watson 2021). Annual WDFW nest surveys were not randomized but based on preselected nesting territories and areas that had a higher likelihood of documenting new territories in order to more effectively document the nesting distribution of a species with a small population size. Nest survey methodology is described by Hayes and Watson (2021). The nest database received from WDFW in fall 2021 contained 677 nests from 289 territories documented 1974−2020[2]. To align the nest status with the year when model covariates were derived (described below), we used nests documented as occupied during at least one visit within a survey year from 2000−2020.

3.2 Predictor Variables

We developed a suite of publicly available environmental and anthropogenic predictor variables based on natural history characteristics and previously identified as important for nesting ferruginous hawk (Table 1; Squires et al. 2020). Four groups of environmental covariates consisted of a combination of data representing vegetation, prey, climatic and topographic characteristics. Anthropogenic covariates consisted of one group of variables that characterized human disturbances across the landscape. All covariate datasets covered the entire Study Area (Appendix A). We conducted data processing, analyses, and visualization of spatially explicit covariates in ArcMap 10.7.1 (ESRI, Redlands, California) and R (R Core Team 2020).

3.2.1 Environmental Covariates

In Washington, ferruginous hawk nest in open, arid shrub-steppe grasslands with rock outcrop, cliffs, and isolated trees that provide suitable nest sites and abundant prey resources (Hayes and Watson 2021). Conversion of over half of Washington’s shrub-steppe habitat to agriculture has contributed to the loss of nesting and foraging habitat (Hayes and Watson 2021). Traditionally,

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[2] Territory defined as an area that contains, or historically contained, one or more nests within the home range of a pair of mated birds (Postupalsky 1974). Unique WDFW territory defined by SiteName. A single territory can be comprised of many nests. Territories in the WDFW database consisted of 1−8 nests.

ferruginous hawk required large areas of native land cover for nesting and foraging but as availability of unfragmented native areas diminishes in Washington, hawks have been documented using agricultural landscapes as well (Berry et al. 1998, Leary et al. 1998, Watson et al. 2018). A 30 × 30-m land cover raster was used to characterize the land cover surrounding each nest by calculating the proportion of sagebrush, agriculture and bare ground (NLCD 2016, 2019). Shrub height was used as a metric of habitat quality and defined as all shrub species discriminated by the presence of woody stems and < 6 m in height (NLCD 2016). Taller shrub heights are indicative of more intact stands that receive relatively less grazing pressure and provide prey species for ferruginous hawk with protective cover and forage. We quantified the heterogeneity (expressed as standard deviation of the mean) associated with the proportion of agriculture, sagebrush, bare ground and shrub height. Integrated Normalized Difference Vegetation Index provided a metric of vegetative productivity during the growing season (Pettorelli et al. 2005, 2011). The index reflects the density of green growing vegetation and was calculated using package *MODIStsp* in R to obtain 16-day composite rasters at 250 m resolution (Busetto and Ranghetti 2016, Didan 2015).

Prey availability is an essential component of nest site selection and abundance can affect the ranging behavior as well as nesting success and productivity (Ng et al. 2020). In Washington, small to medium-sized mammals comprise the majority of prey items and include ground squirrel (*Urocitellus* spp.), hare (*Lepus* spp.), rabbit (*Sylvilagus* spp.), and northern pocket gopher (*Thomomys talpoides*). We used habitat value models of four common prey species in the CPE as covariates to inform nest site selection. Species included Townsend's ground squirrel (*U. townsendii*), Washington ground squirrel (*U. washingtoni*), black-tailed jackrabbit (*L. californicus*), and white-tailed jackrabbit (*L. townsendii*). Habitat value was modeled as an index ranging from 0 (non-habitat) to 1 (the best possible habitat) and were selected based on peer-reviewed literature, and expert opinion (WHCWG 2012).

Ferruginous hawk are sensitive to weather conditions during the nesting period (Wallace et al. 2016). Temperatures within the CPE have increased over the past half century and projected to continue over the next 30 years (Snyder et al. 2019). Changing climate conditions will undoubtedly affect vegetation, prey availability, and wildfire frequencies, which in turn, could affect hawks directly and indirectly (Shank and Bayne 2015). Typically considered a species that nests in arid, warm-weather climates, we considered mean spring temperature and precipitation to evaluate how nest-site selection was affected by relatively warmer and wetter regions throughout the CPE (Wallace et al. 2016). We used two decades of annual precipitation and temperature data from 2000–2021 at a 4-km scale to model the influence of climate on nest site selection.

Ferruginous hawk nest sites are often characterized by rugged terrain composed of prominent basalt rock outcrops, cliffs, cinder cones, spires or steep slopes that preclude access by ground predators and provide unobstructed vantages. Complementary to vegetation and climatic covariates, we characterized the physical terrain in the CPE. We used five indices of terrain to characterize potential nesting habitat including topographic position index, topographic roughness, slope, elevation and ruggedness that were derived from 90-m digital elevation models (DEM). We calculated roughness as the mean difference in minimum and maximum elevation between a cell and eight surrounding cells (or neighborhood; Wilson et al. 2007). We used the native rate of elevation change in a DEM to calculate percent slope. We used topographic indices of position and ruggedness to quantify topographic heterogeneity and identify terrain features that may be selected by nesting ferruginous hawk (Riley et al. 1999).

3.2.2 Anthropogenic Covariates

Anthropogenic stressors can influence the likelihood of nest site selection and ultimately result in population-level effects by affecting nesting success and productivity (Olendorff 1993, Kolar 2013, White and Thurow 1985; Keeley and Bechard 2011, Wallace et al. 2021, Collins and Reynolds 2005). Population growth and the underlying land management decisions to accommodate an expanding population are inextricably linked with changes in land cover, renewable energy development, and impacts to ferruginous hawk populations. We modeled the effect of human development as the proportion of land cover classified as low-, medium-, or high-intensity developed in NLCD to reflect the footprint of residential, commercial, and industrial development (i.e., urbanization) within the CPE. Transportation networks fragment habitat but may also have a positive effect by creating perches and open, foraging habitat (Watson 2020). We considered county, secondary and primary roads to model the effect of roads on nest site selection. County roads were defined as paved or unpaved (e.g., rock aggregate), publicly-accessible roads (WSDOT 2022). County roads typically receive lower volume traffic compared to secondary and primary roads. Secondary roads were defined as main paved arteries, usually in the U.S. Highway, State Highway, and/or County Highway system. Primary roads were defined as large, limited-access highways within the interstate highway system or under State management, and are distinguished by the presence of interchanges (Tiger 2021).

The rate of renewable wind energy development has steadily increased within the CPE since 2000 with substantial growth in 2010. Growth of wind energy development is anticipated to continue in the CPE as mandated by Senate Bill 5116, which directs electricity supply free of greenhouse emissions by 2045[3]. Despite the environmental benefits, wind energy may effect ferruginous hawk; Kolar (2013) found that the daily survival rate of ferruginous hawk nests decreased as the number of wind turbines within the home range increased. We used the USGS turbine database to model the effect of wind turbine density and distance to turbines (km) on nest site selection (Hoen et al. 2022).

[3] Washington Senate Bill 5116

Table 1. Covariates used to model ferruginous hawk nest site selection in the Columbia Plateau Ecoregion, Washington, USA, 2000–2021.

Covariate	Description	Reference
Vegetation		
Agriculture (*PropAg*)[a, b]	Proportion of cells containing agriculture. Included Hay/Pasture and Cultivated Crop classes	NLCD 2019
Bare ground (*Bare, BareSD*)[a]	Mean % and standard deviation of bare ground	NLCD 2016
Integrated Normalized Difference Vegetation Index (*INDVI*)[a, b]	Sum of INDVI annual values between March and May	Pettorelli et al. 2005, 2011
Prey[a]	Index of habitat quality (0-1) modeled for four common prey species: black-tailed jackrabbit, white-tailed jackrabbit, Townsend's ground squirrel, Washington ground squirrel	WHCWG 2012
Sagebrush (*Sage, SageSD*)[a, b]	Mean % and standard deviation of sagebrush cover	NLCD 2016
Shrub Height (*ShrubH, ShrubHSD*)[a, b]	Mean and standard deviation of shrub height (cm)	NLCD 2016
Climate		
Precipitation[a, b]	Cumulative monthly precipitation (mm) March−May each year	PRISM Climate Group 2022
Temperature[a, b]	Mean monthly temperature (°C) March−May each year	PRISM Climate Group 2022
Terrain		
Roughness[a]	Mean difference between maximum and minimum elevation of each raster cell and 8 surrounding cells	Wilson et al. 2007 Leu et al. 2008
Slope[a]	Average % slope	Leu et al. 2008
Topographic Position Index (*TPI*)[a]	Mean elevation of each raster cell compared to the mean elevation of the 8 surrounding cells	Guisan et al. 1999
Topographic Ruggedness Index (*TRI*)[a]	Mean of the absolute difference between elevation at each raster cell and 8 surrounding cells	Leu et al. 2008 Wilson et al. 2007
Anthropogenic		
Developed (*PropDev*)[a, b]	Proportion of cells containing development. Included Developed Low, Medium and High Intensity classes	NLCD 2019
Distance to Roads (*WSRoadDist, TIRoadDist*)[b]	Euclidean distance to county roads open to the public (*WSRoadDist*) and primary and secondary roads.	Tiger 2021 WSDOT 2022
Density of Roads (*WSRoadDens, TIRoadDens*)[a, b]	Density of (proportion of raster cells containing road) county roads open to the public (*WSRoadDist*;) and primary and secondary roads	Tiger 2021 WSDOT 2022
Wind Turbine Density (*TurbCount*)[a, b]	Count of operational wind energy turbines	Hoen et al. 2022
Distance to Wind Turbines (*TurbDist*)[b]	Euclidean distance to operational wind energy turbines (km).	Hoen et al. 2022

[a] Non-Euclidean distance covariates were estimated with 0.25-, 0.5-, 1.0-, 1.5-, 5.0-, and 10.0-km moving windows.

[b] Covariate data available for multiple years. Data appended to nests and available locations were time stamped to the nearest year of available data to accurately reflect conditions when nests were present.

3.3 Model Framework and Spatial Predictions

We assessed all non-distance based covariates across six moving windows: 0.25-km, 0.50-km, 1.0-km, 1.5-km, 5.0-km, and 10-km radii. Covariates were assessed across multiple windows to best represent spatial scales at which ferruginous hawk selected nest sites as described by Squires et al. (2020). We assumed smaller scales (0.25−1 km) were indicative of post-fledging areas as observed in other raptors (Kennedy et al. 1994). The smallest landscape scale (5-km radius) was based on a conservative estimate of a core area surrounding a nest site and the 10-km radius represented the average home range surrounding a nest site, based on telemetry data from studies in Oregon and Washington (J. Watson, WDFW, unpub. data). When covariate spatial data were available for multiple years (e.g., NLCD, precipitation, temperature, turbine), we appended data to occupied nests based on the nearest years represented in the spatial data to ensure that data accurately reflected conditions when nests were occupied.

We estimated ferruginous hawk nest site resource selection at population (second-order) and individual levels (third-order) with RSFs (Johnson 1980). Johnson's ecological framework described wildlife habitat selection along a gradient that begins on a broad geographical scale of a species (first-order) and transcends into finer preferences of habitat selection (fourth-order). Here, we consider nest site section of the breeding population in Washington (second-order) and surrounding conditions of an individual nest (third-order). We restricted nests that were identified on or after 2000 to best align with available covariate data. We also excluded nests that were located within 5 km of the Project to be used for independent model validation (described below). For each order of selection, we generated available nesting locations at a rate of 50 times the number of nest (use) locations. For the population level analysis, available nesting locations were generated within the CPE. At the individual level, available nesting locations were restricted to a 10-km buffer surrounding each nest location. The 10-km buffer represented the average home range during the nesting season (J. Watson, WDFW, unpub. data). To estimate each RSF, we used binomial generalized models with R statistical software. The RSFs took the following form:

$$w(x) = exp\left(\beta_1 x_1 + \beta_2 x2 + \ldots + \beta_n x_n\right)$$

where w(x) was proportional to the relative probability of selection, and $\beta_{n's}$ were coefficient estimates for each covariate. We used second-order Akaike's Information Criterion (AIC_c) to assess model support for all models (Burnham and Anderson 2002). Prior to model development, we performed initial variable screening procedures. Variables were centered and Z-transformed (Becker et al. 1988). We first ran univariate models and selected the variable scale that had the lowest AIC_c score for variables assessed across multiple moving windows and only retained variables when AIC_c scores indicated better model fit than intercept only models. We explored all variable combinations of covariates that were retained following initial screening, but did not allow variables in the same model when |r| >0.6. Model selection criteria used to rank and select the most informative model considered a combination of the lowest AIC_c score, highest model weight (w_i), and most parsimonious (Burnham and Anderson 2002). Models were limited to 10 covariates to reduce the potential for model overfitting (Burnham and Anderson 2002). Models were fitted with package *MuMIn* in R (Barton 2020).

3.4 Model Validation

We used 5-fold cross validations to evaluate the most informative population and individual level RSFs. We estimated predictions based on four of the five groups (training data) and compared them to the withheld group, and repeated this until the five withheld groups were evaluated (Johnson et al. 2006). We binned predictions into five equal-area (quartile) intervals (Wiens et al. 2008). Validations were performed by running simple linear regression models on the number of observed locations from the test group compared to expected locations generated from each RSF bin (Johnson et al. 2006). We considered models to be good predictors when linear regression models had high coefficients of determination ($r^2 > 0.9$) and 95% confidence intervals (CI) of slope estimates excluded zero and included 1 (Howlin et al. 2004). In addition, we evaluated model fit with nests located within 5 km of the Project that were excluded from RSF models. We calculated the proportion of nest locations that were in each RSF bin. If the model performed well, the bins corresponding to higher probability of nest site selection would contain more nest locations than the lower-probability bins. We used the best-supported RSF models to create spatially explicit maps of across the Study Area by using coefficients from the top models and distributed predictions into five equal area bins corresponding with increasing relative probability of selection (low, low-medium, medium, medium-high, high). Population level predictive maps were used to visualize patterns of relative nest site selection on the landscape scale, while individual level predictive maps were used to compare the patterns of nest selection to the locations of proposed wind and solar development within the Project Area.

4 RESULTS

4.1 Nest Data

Of the 677 nests in the WDFW database, we identified 194 (28%) occupied nests documented 2000−2020 with a known nesting year to model nest site selection across the range of ferruginous hawk in eastern Washington (Appendix B). Eighteen of the 194 nests (9%) documented as occupied and active were located within 5 km of the Project used for an independent model validation (Section 3.4).

4.2 Population Level RSF (Second-Order)

The most informative population level (second-order) model included 10 covariates, excluding the intercept (Table 2, Figure 3-5, Appendix C). At this order, models suggested that ferruginous hawk selected an array of vegetation, topographic, climactic, and anthropogenic characteristics. Ferruginous hawk selected nest sites with greater variability in bare ground (β = 0.47, 95% CI = 0.22 to 0.72) and less agriculture (β = -1.12, 95% CI = -1.46 to -0.81) within 0.25-km, and less variability in shrub height (β = -1.48, 95% CI = -1.86 to -1.13) within 10.0-km. Ferruginous hawk also select nest sites with higher habitat value for black-tailed jackrabbit within 1.5 km (β = 1.31, 95% CI = 1.03 to 1.61), greater precipitation within 10.0 km (β = 0.43, 95% CI = 0.13 to 0.73), and in areas demarcated by lower topographic ruggedness (β = -1.18, 95% CI = -1.65 to -0.74), but greater topographic position (β = 0.32, 95% CI = 0.08 to 0.55) within 10.0-km. Ferruginous hawk avoided development within 1.0 km (β = -0.70, 95% CI = -1.66 to -0.09), but selected nest locations closer to publicly accessible roads (β = -0.27, 95% CI = -0.48 to -0.06) and turbines (β = -0.47, 95% CI = -0.83 to -0.14; (Figure 4).

The spatial prediction of the population level RSF was a strong predictor of ferruginous hawk nest site selection (Figure 3; Appendix C). When we partitioned validation testing and training groups by nest, average r^2 = 0.99 (± < 0.001 standard error [SE]), and confidence intervals of slope estimates included one, with none excluded in four of the five folds. In addition, the percent of ferruginous hawk nest locations within 5 km of the Project that occurred in the two highest predicted relative probability of selection bins was 94.4%, indicating good model fit (Appendix D).

4.3 Individual Level RSF (Third-Order)

The most informative individual level (third-order) model included five covariates (Table 2; Figure 3, 4 and 6; Appendix C). At this order, models suggested that ferruginous hawk selected for vegetation and topographic characteristics. Ferruginous hawk selected nest sites with greater bare ground within 0.25 km (β = 0.45, 95% CI = 0.27 to 0.62), greater INDVI within 5.0 km (β = 0.20, 95% CI = 0.02 to 0.38), and greater habitat value for black-tailed jackrabbit (β = 0.37, 95% CI = 0.19 to 0.56) and Washington ground squirrel (β = 0.18, 95% CI = 0.00 to 0.37) within 1.0 km. Ferruginous hawk also selected nest sites with greater slope (β = 0.32, 95% CI = 0.26 to 0.38) at the local 0.25-km radii (Figure 4).

The overall spatial prediction of the individual level RSF was a strong predictor of ferruginous hawk nest site selection (Figure 3; Appendix C). When we partitioned validation testing and training groups by nest, average r^2 = 0.95 (± 0.01 SE), and confidence intervals of slope estimates included one in four of the five folds. The percent of nest locations within 5.0-km of the Project that occurred in the two highest predicted relative probability of selection bins was 72.2%, indicating good model fit near the Project (Appendix D).

4.4 Project Level RSF Assessment

Visual inspection of the third-order RSF at the Project identified a range of relative probabilities for nest site selection that was closely associate with terrain attributes and habitat quality for prey species. The highest probability of selection occurred along the ridge north of the proposed wind turbine (Turbine) array (Figure 7). Of the 244 proposed Turbines, the majority (162 Turbines, 66%) were located within low to low-medium RSF bins followed by medium (58 Turbines, 24%), medium-high (18 Turbines, 7%) and high (6 Turbines; 2%; Figure 8). The location of Turbines in relatively higher RSF bins were along the northern ridgeline (Figure 7). Narrow fingers of high probability extended south from the ridge following incised canyons and drainages that contained a greater proportion of native habitat. In general, areas further away from the ridgeline, interior to the Project, had relatively lower probabilities of nest site selection. Interior areas of higher probability south of the Project in the vicinity of a solar array reflected relatively higher quality habitat for Townsend's ground squirrel.

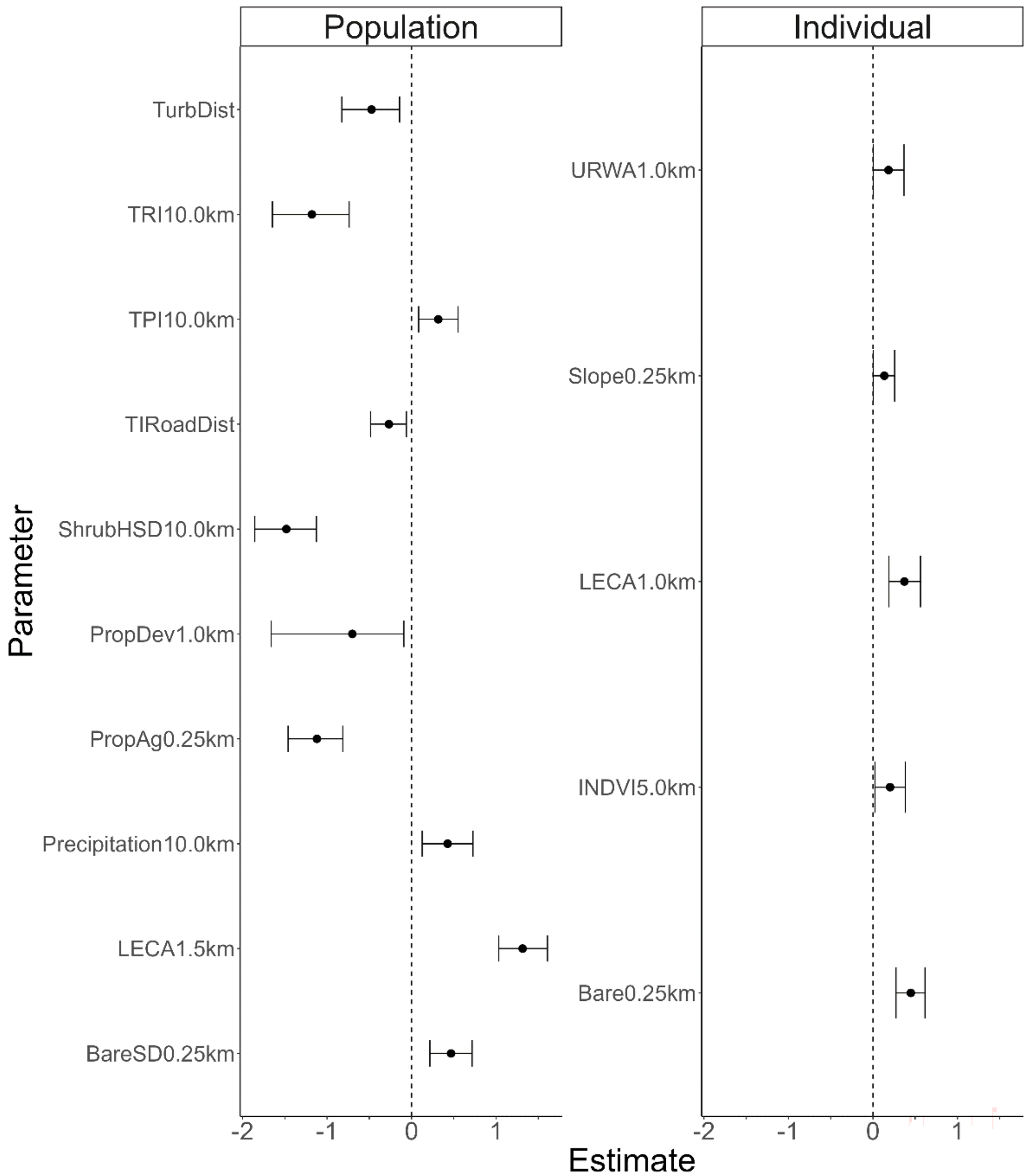
Two historical territories ([redacted] Road and [redacted] Road) were located in an area proposed for solar development (Figure 7). Both territories have a history of disturbance, inconsistent occupancy, and were unoccupied during Project nest surveys (Jansen 2022). The [redacted] Road

Territory was comprised of two nests sites, one of which was occupied in 1987 and removed by residential development in the early 1990's. A second [redacted] Road nest was located [redacted], with the last ferruginous hawk nestlings documented in 2013, and was refurbished in 2016 but the nest outcome was unknown. The nest was occupied in 2019 by common raven (*Corvus corax*) and Swainson's hawk (*B. swainsonii*) and unoccupied in 2022 (Jansen 2022). The [redacted] Road Territory also comprised of two nests sites; one of which two adults were observed perching on in 2007 and destroyed the same year and a second nest that contained nestlings in 2006 was destroyed the following year and rebuilt and occupied by common ravens 2010−2016. WEST 2022 surveys documented a collapsed, inactive nest that did not show sign of recent activity.

Table 2. Coefficient estimates and 95% confidence intervals (CI) for variables in the most parsimonious models describing ferruginous hawk nest site selection at the population (second-order) and individual (third-order) levels within the Columbian Plateau Ecoregion. An asterisk (*) denoted covariates that were significant at the 95% confidence level.

		95 % CI	
Parameter[a]	**Estimate**	**Lower**	**Upper**
Population level selection (second-order)			
$BareSD_{0.25km}$	0.47*	0.22	0.72
$PropAg_{0.25km}$	-1.12*	-1.46	-0.81
$ShrubHSD_{10.0km}$	-1.48*	-1.86	-1.13
$LECA_{1.5km}$	1.31*	1.03	1.61
$Precipitation_{10.0km}$	0.43*	0.13	0.73
$TPI_{10.0km}$	0.32*	0.08	0.55
$TRI_{10.0km}$	-1.18*	-1.65	-0.74
$PropDev_{1.0km}$	-0.70*	-1.66	-0.09
TIRoadDist	-0.27*	-0.48	-0.06
TurbDist	-0.47*	-0.83	-0.14
Individual level selection (third-order)			
$Bare_{0.25km}$	0.45*	0.27	0.62
$INDVI_{5.0km}$	0.20*	0.02	0.38
$LECA_{1.0km}$	0.37*	0.19	0.56
$URWA_{1.0km}$	0.18*	0.00	0.37
$Slope_{0.25km}$	0.13*	0.00	0.26

[a] See Table 1 for description of model covariates. Prey covariates included: LECA = back-tailed jackrabbit, URWA = Washington ground squirrel



* Description of Parameters are provided in Section 3.2 and Table 1

Figure 3. Parameter estimates and 95% confidence intervals (CI) for predictor variables describing nest site selection of ferruginous hawk at population and individual levels of selection within the Columbian Plateau Ecoregion, Washington.

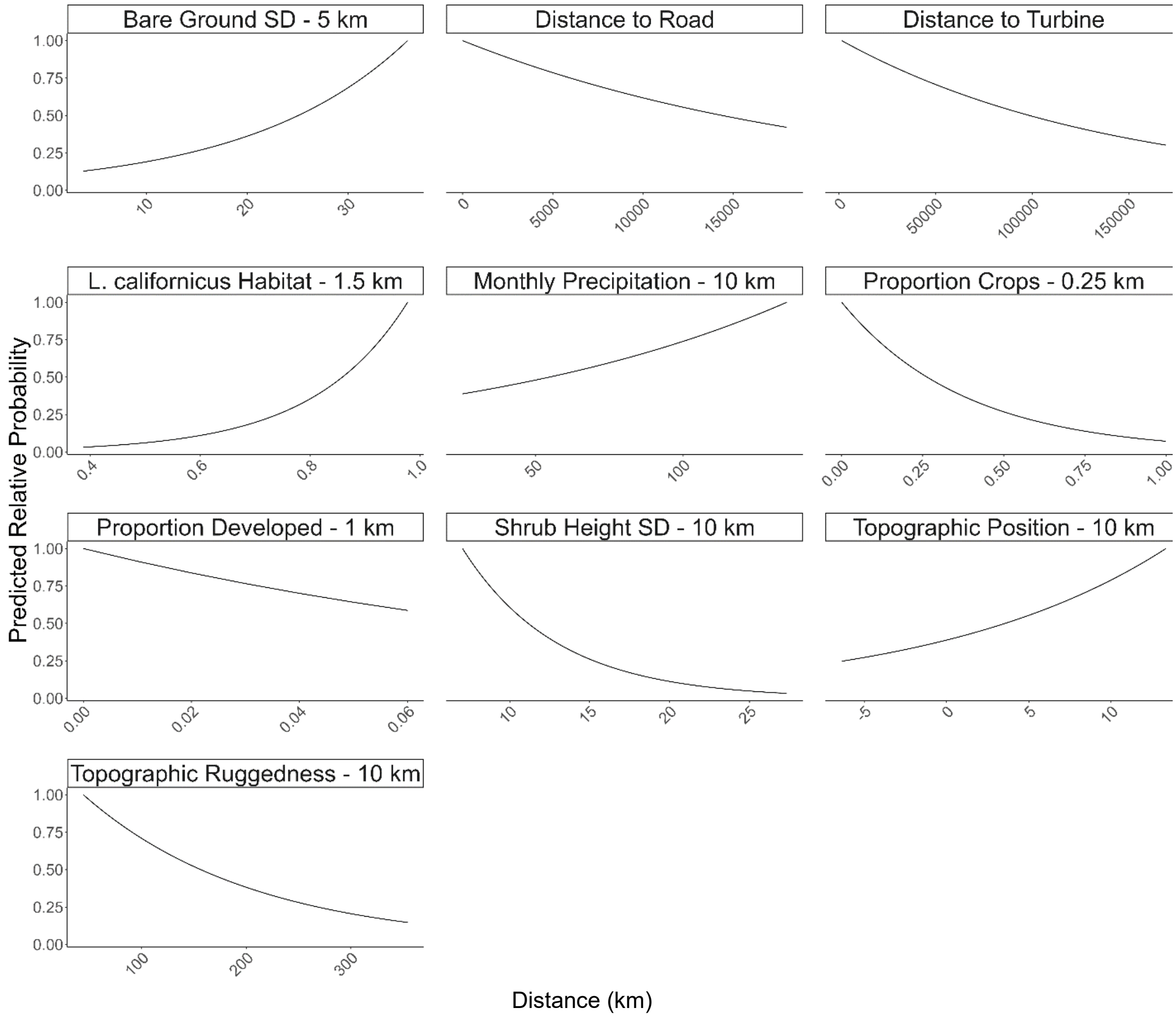


Figure 4. Marginal response curves of each population level (second-order) covariate in the most informative model of relative nest site selection within the Columbia Plateau Ecoregion, Washington. See Table 1 for a description of model covariates.

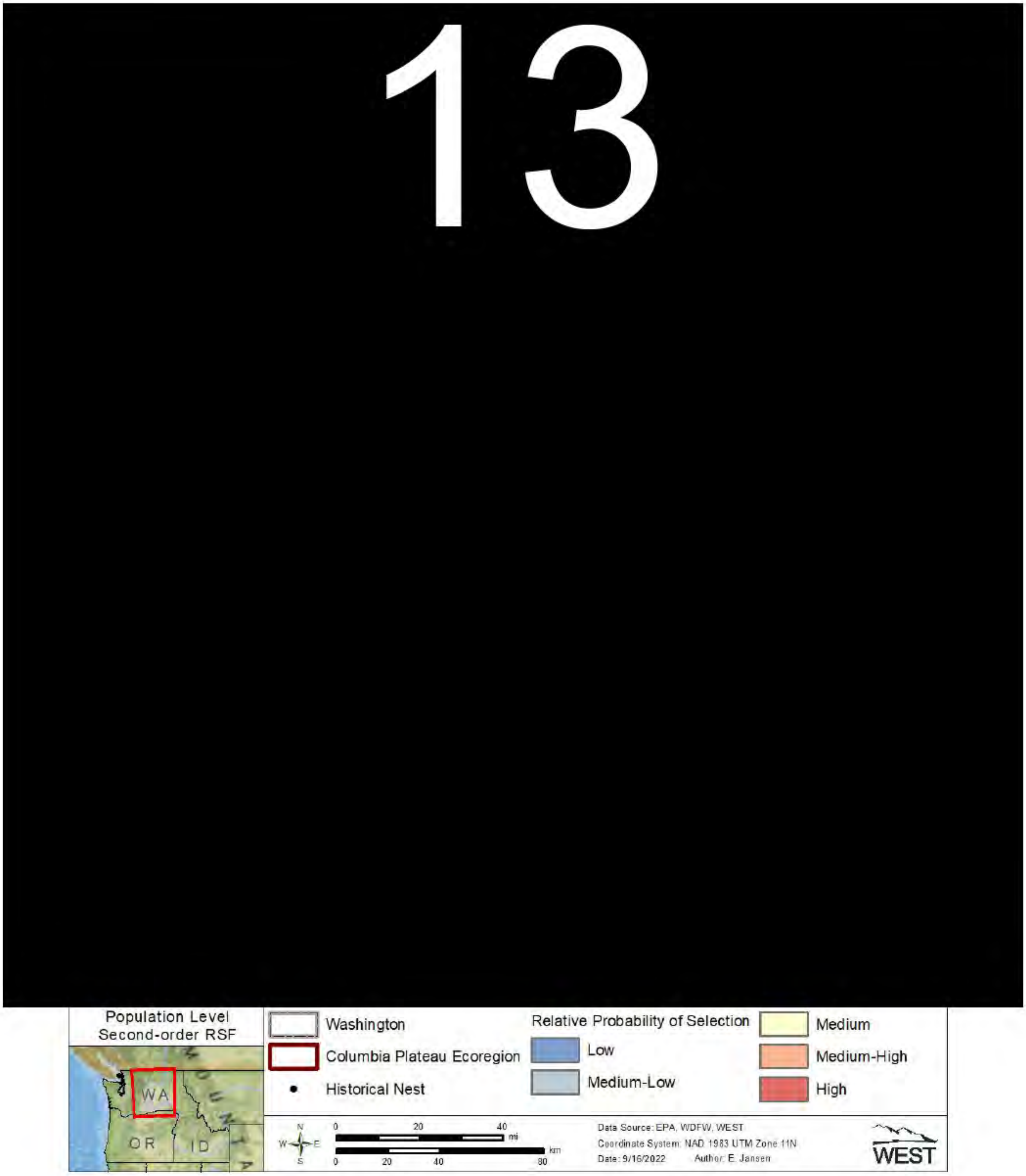


Figure 5. Predicted population level (second-order) ferruginous hawk nest site selection within the Columbian Plateau Ecoregion, Washington.

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[redacted]

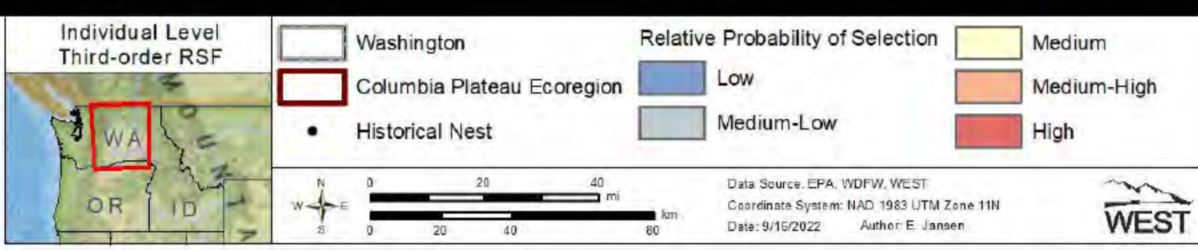

Figure 6. Predicted individual level (third-order) ferruginous hawk nest site selection within the Columbian Plateau Ecoregion, Washington.

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Figure 7. Predicted individual level (third-order) ferruginous hawk nest site selection within the Horse Heaven Clean Energy Center, Benton County, Washington.

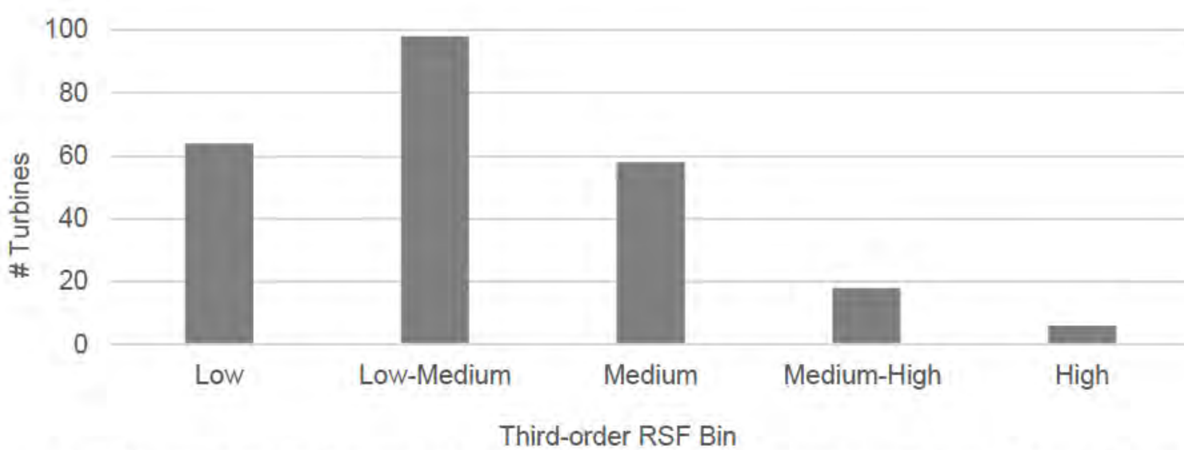

Figure 8. Distribution of Turbines in third-order RSF bins at the Horse Heaven Clean Energy Center, Benton County, Washington.

5 DISCUSSION

We evaluated factors influencing ferruginous hawk nest site selection in a declining population located at the edge of the species' range in the United States. Nest site selection by ferruginous hawk was explained by different variables at the population and individual level, and we found support for our predictions varied when we considered the level of analysis.

We found mixed support for our first prediction that ferruginous hawk would strongly avoid human disturbance at the population level, because nest sites were selected away from development but closer to publicly accessible roads and Turbines. We did not find support for this prediction at the individual level, as all variables in the best model were environmental.

We did not find support for our second prediction that ferruginous hawk would not strongly avoid agriculture at the population level, as the best model suggested that ferruginous hawk selected nest sites with less agriculture. We found no influence of agriculture on nest site selection on the individual level.

Finally, we found support for our third prediction at the population and individual levels that nest site selection would be associated with prey resources as nest sites were associated with a higher habitat value for black-tailed jackrabbits. Patterns of resource selection at both population and individual levels were effectively modeled with remotely sensed covariates based on the high confirmation in the model validation process.

Overall, results support evidence of a hierarchal decision-making process where nest site selection occurs over a broad perception of factors across a landscape and then finer-scale discrimination to include factors essential to nesting success (Mayor et al. 2009).

5.1 Vegetation

Vegetation characteristics influenced nest site selection at multiple scales. At the population scale, ferruginous hawk selected areas with lower heterogeneity in shrub height within 10 km, increased heterogeneity in bare ground within 0.25 km, and lower percent agricultural cover within 0.25 km of the nest. In addition, higher habitat quality for black-tailed jackrabbit within 1.5 km was a strong predictor of nest site selection. We interpret the dichotomous relationship between uniform shrub height and bare ground as an indicator of habitat patchiness or matrix that is characteristic to shrub-steppe grassland habitats (Azerrad et al. 2011). Increased habitat heterogeneity reduces shrub cover, which provide ferruginous hawk, a wait and ambush predator, with greater access to prey (Olson et al. 2017, Watson 2020). However, increased patchiness and loss of shrub cover can negatively affect black-tailed jackrabbit populations and coincides with a comparable decline with habitat during our 21-year study period (Ferguson and Atamain 2012, Sato 2012, Hayes and Watson 2021).

The proportion of agriculture at the population scale was avoided but at a smaller moving window than we expected (0.25 km, Table 1). As a shrub-steppe grassland species, we anticipated a stronger avoidance of agriculture because of the loss of land cover characteristics typical of ferruginous hawk nesting and foraging habitat (Schmutz 1987, Wiggen et al. 2014, Watson 2020). However, at the Hanford Nuclear Site in Benton and Franklin counties, hawks foraged at greater distances from the nest to exploit northern pocket gophers (*Thomomys talpoides*) in agricultural fields, which represents a scenario where agricultural fields were utilized and a shift from prey species considered in our modeling (Leary et al. 1998). Nevertheless, the importance of prey availability and nest selection in areas of higher-quality prey habitat was reflected in the individual models that included black-tailed jackrabbit and Washington ground squirrel (Table 2, Figure 3, Appendix C).

5.2 Climate

Although the range of ferruginous hawk in Washington is within the rain shadow of the Cascade Mountains, the amount of precipitation at a 10 km population scale was a single climate covariate in the final model. Precipitation increases along a gradient the further the distance from the Cascades but is comparatively low (<12−30 inches annually) and defined as arid (PRISM Group 2022). Although not statistically correlated with other covariates in our analysis, precipitation likely influences NDVI, which reflected vegetative productivity. Ferruginous hawk selected for intermediate levels of spring precipitation in Wyoming that also included prey covariates (Squires et al. 2020). A RSF study of two Arctic raptor species in Canada (rough-legged hawk [*B. lagopus*], and Arctic peregrine falcon [*Falco peregrinus tundrius*]) found strong signals for nest selection in models including NDVI at a population and individual scale. Climate projections for 2020 – 2050 in the CPE indicate that temperatures will continue to rise and precipitation levels will decrease (Snyder et al. 2019, Northwest Power and Conservation Council 2021). The effects of climate change on ferruginous hawk are unknown but patterns are anticipated to affect prey populations and availability, drought intensity and wildfire frequency. Frequent drought and fires can result in a shift from native shrub-steppe to invasive annual grasses that reduces prey availability and degrades ferruginous hawk nesting habitat (Smith and Johnson 1985, Van Horne et al. 1997, Van Horne et al. 1998, Yensen and Quinney 1992, Yensen et al. 1992).

5.3 Terrain

At a population level, ferruginous hawk showed weak selection for nest sites that were comparatively higher than their surrounding elevation within 10 km. Weiss (2011) suggested weak positive TPI values indicated a slope position of open cliff to cliff edge, which corresponds to 2017−2022 survey data and verified in the WDFW database where 54% of the 194 nests were located on a cliff or rock outcrop (Jansen 2022, WDFW 2021). We observed a stronger avoidance with rugged terrain, which indicates a selection for flatter topography at a landscape scale. Nest selection for elevated areas surrounded by a comparatively flatter landscape reflects topography in the CPE where deeply incised canyons and drainages are flanked by flat plateau or rolling valley bottoms that provide suitable foraging habitat. Our results were consistent with Squires et al. (2020) where nest selection sharply declined as topographic roughness increased and terrain became more jagged within 5 km.

5.4 Anthropogenic

5.4.1 Development

Ferruginous hawk avoided areas with a higher proportion of low, medium, and high intensity development within 1 km of a nest. However, the proportion of the developed area around the nest was highly variable, as seen in the wide 95% CI of the coefficient (Appendix C). High variability in the proportion of development could be due, in part, to the pooled intensity levels in the model. Throughout the species' range and Washington, urbanization has resulted in habitat loss, fragmentation, and degradation by increasing artificial food subsidies to nest predators (Hayes and Watson, 2021, Keeley et al. 2016, Watson et al. 2021).

Nesting success can be affected by nest disturbance and varies by the intensity and duration of the disturbance (Gaines 1985, Nordell et al. 2017). White and Thurow (1985) recommended limiting driving and walking within 0.25 km around nests to minimize desertion in ≤ 90% of the population, Nordell et al. (2017) observed nest disturbance nearly 1 km (mean = 130 m) from the nest, and Gaines (1985) documented lower reproductive success at nests within 2.5 km of residences. From 2020−2030, annual population growth within the CPE is projected to increase approximately 1% per year to approximately 1.9 million individuals, or 10.3% increase by 2030 (Washington Office of Financial Management 2018). Corresponding development to accommodate human population growth will likely add further stressors to the population, particularly in expanding exurban areas located on the fringes of growth management boundaries, where the intersection between historical nesting sites and human will meet (Gaines 1985, Ng 2019). Examples of encroachment into historical nesting sites have been documented proximate to the Project along the Horse Heaven Hills in Benton County (Jansen 2022), surrounding the Juniper Dunes Wilderness and along the Washtucna Coulee in Franklin County, and foothills of the Rattlesnake Hills in Yakima County (WDFW 1996, WDFW 2021).

5.4.2 Roads

Nest sites were located closer to county, secondary, and primary roads than expected; however, there are several potential explanations for this relationship. With the exception of several large roadless areas under state or federal ownership (e.g., Yakima Training Center, Hanford Reach/Nuclear, Lower Crab Wildlife Area), roads are located throughout the CPE. Convenience sampling along roads may increase detection of perched and breeding pairs of ferruginous hawk, thereby increasing the likelihood of detecting nests in the surrounding are (Anderson 2007). In Wyoming, ferruginous hawk nests were located closer to roads but were associated with oil and gas development and observed a preferential response to the associated power poles for perching (Squires et al. 2020). Similarly, in Colorado, nests were associated with areas closer to roads (Aagaard et al. 2021). Roads and fences may have a positive effect on habitat quality by creating perches and open foraging habitat, and ferruginous hawk may habituate to low levels of vehicular traffic, particularly on gravel roads which are prevalent in more rural areas of the CPE where historical nests are located (Nordell et al. 2017, Watson 2020).

5.4.3 Wind Turbines

At the population level, ferruginous hawk selected nest sites closer to operating Turbines, but did not select landscapes based on Turbine density. The finding that ferruginous hawk selected nest sites in areas nearer to Turbines than available locations was likely due to generating availability across the entire extent of the CPE, representing a more course analysis that does not infer selection for areas nearer to Turbines at finer scales. In support, the majority of ferruginous hawk nests were approximately 50 km from an operating Turbine (Figure 9). As of 2021, there are approximately 1,780 operating Turbines at 27 projects[4] in the CPE (Hoen et al. 2022). Turbine density was highest along the periphery of the CPE, adjacent to the Columbia River Gorge in Klickitat County and along the Snake River Breaks in Columbia and Garfield counties. Historically, ferruginous hawk nested at lower densities in these areas compared to the nesting stronghold in Franklin County, located toward the interior of the CPE. Despite this inconsistency, a decrease in nest occupancy and increase distance (i.e., displacement) of occupied nests from Turbines has been documented. In a regional study of 18 wind projects in the CPE of Oregon and Washington, ferruginous hawk nest occupancy declined approximately 68% during surveys conducted > 10 years post-construction (Watson et al. 2021). There was a proportional and statistically significant decrease in occupied nesting at a control area; thus, the causal mechanism affecting nest occupancy could not be separated from other regional trends that included an overall declining population trend, increasing common raven population or local factors including persistent drought that decreases prey availability. Spatial displacement of ferruginous hawk nests within 3.2 km of wind facilities increased approximately 43% post-construction (mean = 2.16 km 95%CI 0.81−3.5 km) but the difference of the distance was not statistically significant (Watson et al. 2021). Nevertheless, declines in the nesting population during the study period and regionally over the past half century, should indicate the covariates affecting nest site selection should be considered holistically during management and land use planning decisions.

5.5 Project Level Assessment

The majority of the proposed Project is located in areas modeled as low to low-moderate probability of nest site selection. Highest probability of nest site selection was along the northern escarpment bordering the Project. Historic nest sites, native land cover, terrain, and modeled prey habitat highlight areas where nest selection was relatively higher. Jansen (2022) provided an overview of nesting patterns of ferruginous hawk in the Horse Heaven Hills documented during surveys conducted 2017−2019 and 2022. Survey results indicted low and inconsistent nest occupancy with the majority of historic nests in poor condition, gone, or occupied by another raptor species/common raven (Jansen 2022). Despite an agriculturally dominated landscape bisected by transportation/electrical systems, and encroaching exurban development within 100 m of some historical nests, ferruginous hawk have nested within 3.2 km of the Project in recent years.

[4] Total number of projects includes individual phases despite similar project names (e.g., Big Horn I, Bird Horn II)

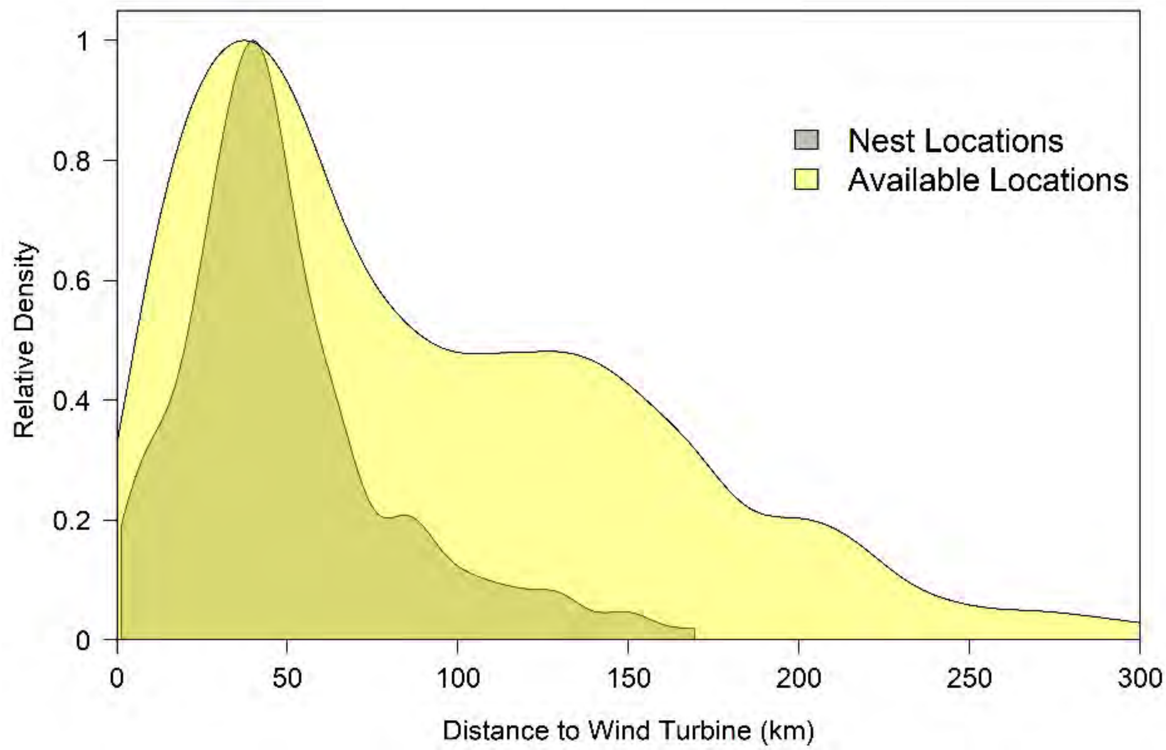

Figure 9. Density of nest locations used by ferruginous hawk (grey) and available locations across the CPE (yellow) relative to distance to Turbines. Density plots were relativized by dividing values by their maximum.

6 CONCLUSION

Nest site selection at the population level was influenced by a suite of biotic and abiotic factors and included expected relationships (e.g., positive association with prey habitat quality) and unexpected relationships (positive association with Turbines).

Nest site selection at the individual level was influenced by biotic factors, and our best model did not contain anthropogenic covariates found in the population level model including the proportion of agriculture, distance to roads, or distance to Turbines. We interpret the change in covariates between the levels to represent settlement decisions by the population of ferruginous hawk on the landscape to first select nest sites that contains anthropogenic features then for individuals to select nest sites that maximize reproductive potential. Our population level modeling results should not be interpreted that agriculture, roads, or Turbines benefit ferruginous hawk, or that the development of these features will create nesting habitat. In fact, our individual level analysis show that anthropogenic features were not included in the top model.

Overall, our model provides valuable information at the individual level for high probability nest sites that could be considered during renewable energy development siting. Methods used to identify areas of higher nest site selection identified within this study in combination with avoidance and minimization measures can be implemented during Project development phases to strategically reduce direct and indirect impacts to ferruginous hawk.

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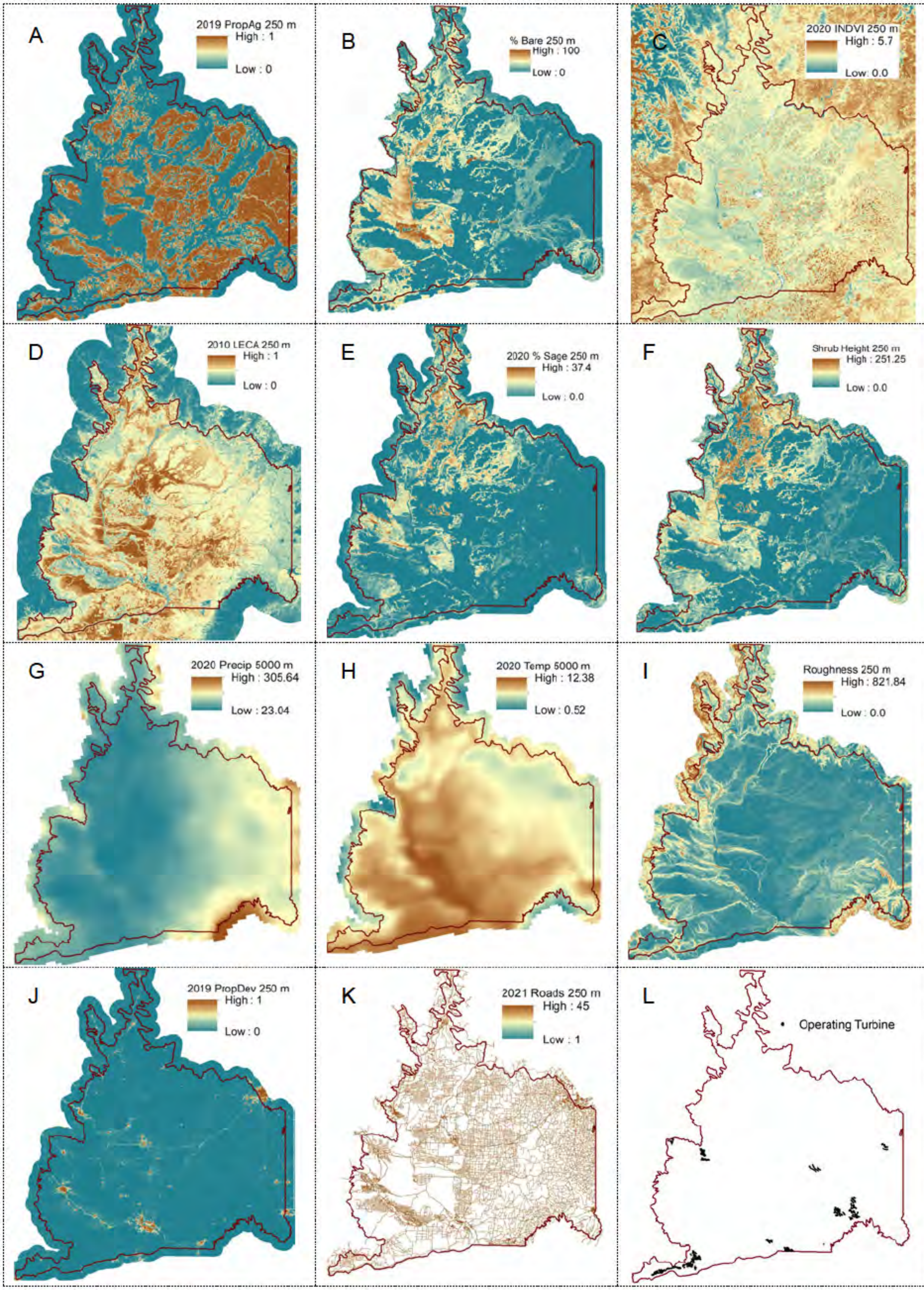
Appendix A. Example data layers used as spatial covariates to model ferruginous hawk nest selection within the Columbia Plateau Ecoregion of eastern Washington.

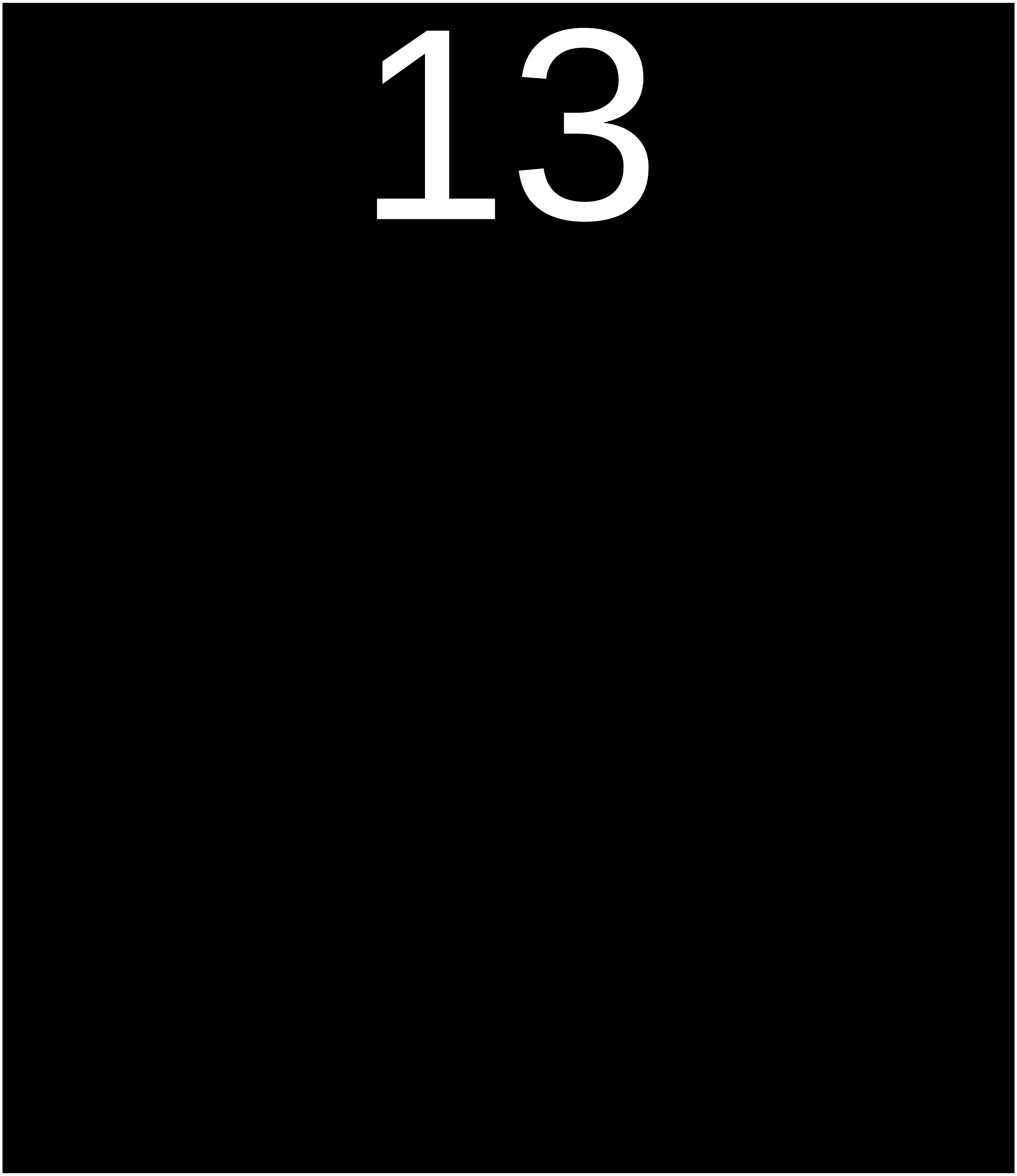
A full description and reference to remotely sensed spatial data layers are found in Section 3.2 and Table 1. Examples used for illustration include,

A) Agriculture 2019 layer at 250-m scale
B) Bare Ground 2019 layer at 250-m scale
C) Integrated Normalized Difference Vegetation Index 2020 layer at 250-m scale
D) Black-tailed Jackrabbit Habitat 2010 layer at 250-m scale
E) Sagebrush Land Cover 2020 layer at 250-m scale
F) Shrub Height 2019 layer at 250-m scale
G) Precipitation 2020 layer at 5,000-m scale
H) Temperature 2020 layer at 5,000-m scale
I) Roughness 2019 layer at 250-m scale
J) Development 2019 layer at 250-m scale
K) County, Secondary and Primary Roads 2021 layer at 250-m scale
L) Operational Wind Turbine 2021 layer



A
2019 PropAg 250 m
High : 1
Low : 0
B
% Bare 250 m
High : 100
Low : 0
C
2020 INDVI 250 m
High : 5.7
Low: 0.0
D
2010 LECA 250 m
High : 1
Low : 0
E
2020 % Sage 250 m
High : 37.4
Low : 0.0
F
Shrub Height 250 m
High : 251.25
Low : 0.0
G
2020 Precip 5000 m
High : 305.64
Low : 23.04
H
2020 Temp 5000 m
High : 12.38
Low : 0.52
I
Roughness 250 m
High : 821.84
Low : 0.0
J
2019 PropDev 250 m
High : 1
Low : 0
K
2021 Roads 250 m
High : 45
Low : 1
L
Operating Turbine

Appendix B. Distribution of ferruginous hawk nests used to model RSF models in eastern Washington.



Appendix B. Distribution of ferruginous hawk nests used to model RSF models in eastern Washington. Occupied nests were documented as occupied at least once during 21-year dataset.

Appendix C. Five best supported models used to assess ferruginous hawk nest site selection within the Columbian Plateau Ecoregion at the population (second-order selection) and individual (third-order) selection levels. Intercept only (Null) model included for comparison.

Appendix C. Five best supported models used to assess ferruginous hawk nest site selection within the Columbian Plateau Ecoregion at the population (second-order selection) and individual (third-order) selection levels. Intercept only (Null) model included for comparison. Italics denote most informative model used in RSF predictions.

Model[a]	Model Fit Statistic[b]		
	K	ΔAIC$_c$	w_i
Population Level Selection (second-order)			
PropAg$_{0.25km}$ + BareSD$_{0.25km}$ + ShrubHSD$_{10.0km}$ + LECA$_{1.5km}$ + Precipitation$_{10.0km}$ + TPI$_{10.0km}$ + TRI$_{10.0km}$ + PropDev$_{10.0km}$ + TIRoadDist + TurbDist	*11*	*0*	*0.03*
PropAg$_{0.25km}$ + Bare$_{0.25km}$ + Sage$_{10.0km}$ + ShrubHSD$_{10.0km}$ + LECA$_{1.5km}$ + Precipitation$_{10.0km}$ + TPI$_{10.0km}$ + TRI$_{10.0km}$ + WSRoadDens$_{1.5km}$ + TurbCount$_{10.0km}$	11	1.22	0.01
PropAg$_{0.25km}$ + Bare$_{0.25km}$ + Sage$_{10.0km}$ + ShrubHSD$_{10.0km}$ + LECA$_{1.5km}$ + Precipitation$_{10.0km}$ + TPI$_{10.0km}$ + TRI$_{10.0km}$ + TIRoadDist + TurbDist	11	1.23	0.01
PropAg$_{0.25km}$ + Bare$_{0.25km}$ + Sage$_{10.0km}$ + ShrubHSD$_{10.0km}$ + LECA$_{1.5km}$ + Precipitation$_{10.0km}$ + TPI$_{10.0km}$ + TRI$_{10.0km}$ + TIRoadDist + TurbCount$_{10.0km}$	11	1.68	0.01
PropAg$_{0.25km}$ + Bare$_{0.25km}$ + Sage$_{10.0km}$ + ShrubHSD$_{10.0km}$ + LECA$_{1.5km}$ + Precipitation$_{10.0km}$ + Temperature$_{10.0km}$ + TPI$_{10.0km}$ + TRI$_{10.0km}$ + TurbCount$_{10.0km}$	11	1.68	0.01
Intercept Only (Null)	1	564.99	0.00
Individual Level Selection (third-order)			
Bare$_{0.25km}$ + INDVI$_{5.0km}$ + LECA$_{1.0km}$ + URWA$_{1.0km}$ + Slope$_{0.25km}$	*6*	*0*	*0.02*
Bare$_{0.25km}$ + BareSD$_{0.25km}$ + INDVI$_{5.0km}$ + LECA$_{1.0km}$ + URWA$_{1.0km}$ + Slope$_{0.25km}$	7	0.67	0.01
Bare$_{0.25km}$ + INDVI$_{5.0km}$ + LECA$_{1.0km}$ + URTO$_{1.0km}$ + Slope$_{0.25km}$	6	1.01	0.01
Bare$_{0.25km}$ + INDVI$_{5.0km}$ + LECA$_{1.0km}$ + URWA$_{1.0km}$ + Slope$_{0.25km}$ + PropDev$_{1.0km}$	7	1.15	0.01
Bare$_{0.25km}$ + BareSD$_{0.25km}$ + INDVI$_{5.0km}$ + LECA$_{1.0km}$ + URWA$_{1.0km}$ +	6	1.25	0.01
Intercept Only (Null)	1	91.15	0.00

[a] See Table 1 for description of model covariates. Prey covariates included: LECA = back-tailed jackrabbit, URTO = Townsend's ground squirrel, URWA = Washington ground squirrel

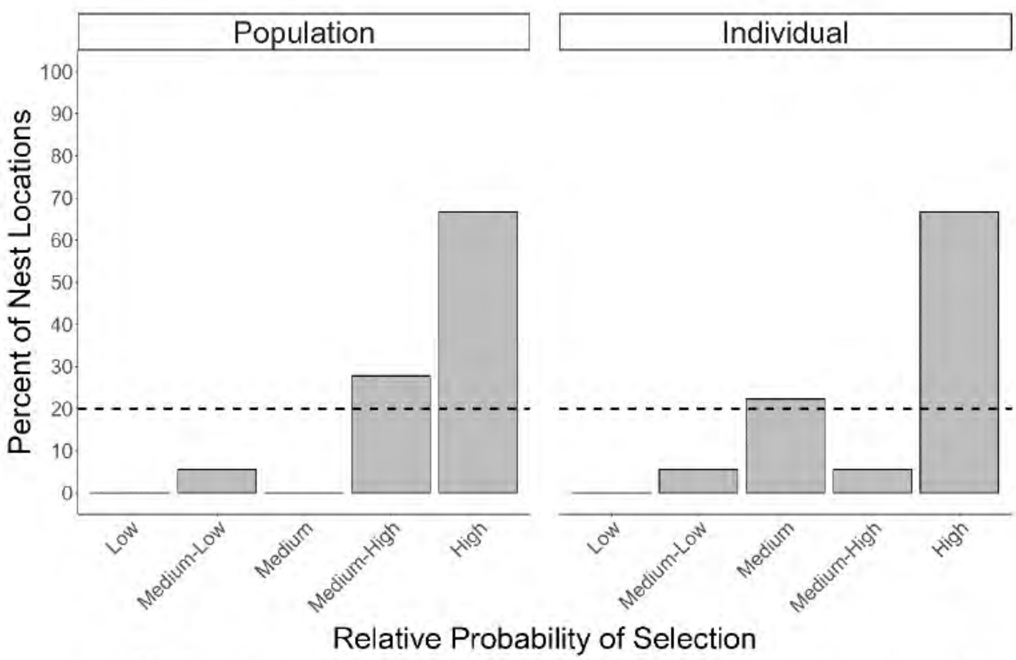
[b] *K* = number of model parameters (includes intercept), ΔAIC$_c$ = difference in AIC$_c$ units between models, w_i = Akaike model weight

Appendix D. 5-fold cross validation results of Population and individual level RSF models from withheld ferruginous hawk nest locations within 5.0-km of the Project.

Appendix D1. 5-fold cross validation results from ferruginous hawk nest site selection at the population (second-order) and individual (third-order) levels within the Columbian Plateau Ecoregion. We considered models (K) good predictors of nest site selection when they had a high coefficient of determination (r^2), and 95% confidence intervals (CI) surrounding slope estimates (B_1) that excluded zero and included 1.

K	r^2	B_0[a]	95% CI	B_1	95% CI
Population Level Selection (second-order)					
1	0.99	-1.25	(-4.37, 1.87)	1.17	(0.94, 1.41)
2	1.00	-0.49	(-1.64, 0.67)	1.07	(0.98, 1.16)
3	0.99	0.64	(-1.14, 2.42)	0.91	(0.77, 1.04)
4	1.00	-0.35	(-0.71, 0.01)	1.05	(1.02, 1.08)
5	0.99	-0.69	(-3.48, 2.09)	1.10	(0.88, 1.31)
Individual Level Selection (third-order)					
1	0.99	-3.28	(-5.76, -0.80)	1.46	(1.19, 1.72)
2	0.96	-1.26	(-5.41, 2.89)	1.18	(0.73, 1.63)
3	0.96	-2.49	(-7.12, 2.13)	1.36	(0.85, 1.87)
4	0.90	-3.86	(-12.53, 4.80)	1.55	(0.59, 2.51)
5	0.97	-1.97	(-5.96, 2.02)	1.28	(0.85, 1.71)

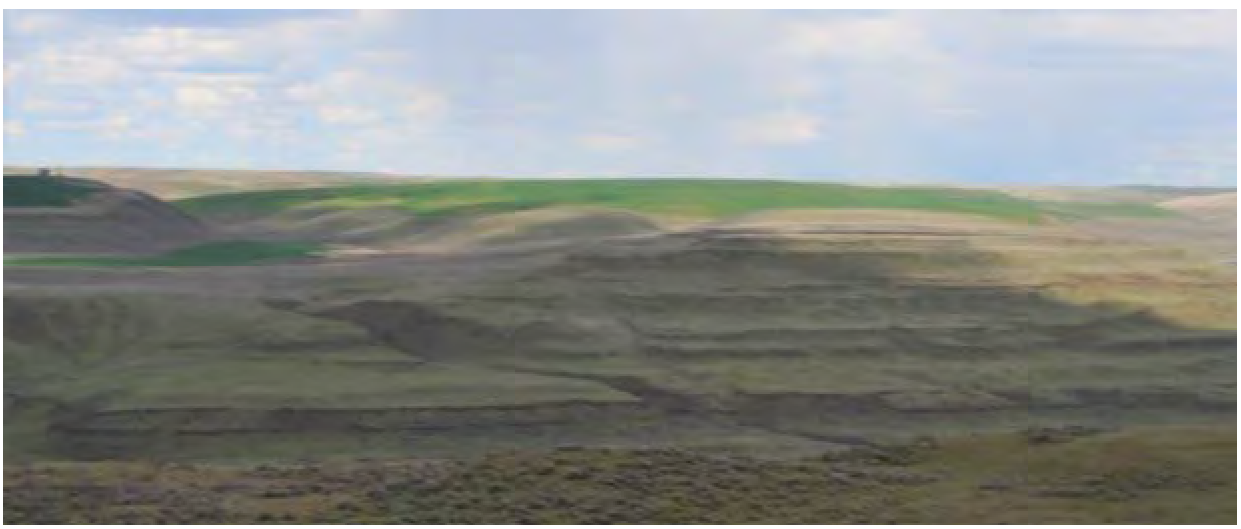
[a] Intercept



Appendix D2. Relative nest site model results from withheld nest locations within 5.0-km of the Project. Bars represent the percentage of nest locations within each RSF mode-predicted bin, from the lowest predicted probability of selection to the highest predicted probability of selection (left to right-most bins). The horizontal dashed line represents the expected percentage of nest locations within each RSF bin if the model performed no better than random.

Appendix E. Representative photographs of landscape covariates used to model ferruginous hawk nest selection within the Columbia Plateau Ecoregion of eastern Washington.

Nesting and foraging habitat within the shrub-steppe grassland matrix of the Saddle Mountains, Grant County, March 2018.



Sloped, basalt terraces within shrub-steppe grasslands provided nesting and foraging habitat in Adams County, March 2017.

13

[redacted]

Prominent cliffs of the Sentinel Bluffs provided nesting habitat in Grant County, April 2017.

13

[redacted]

Small rock outcrops also provided nesting habitat at this historical nest location in Benton County, March 2022.

[redacted]

13

Expanding urbanization decreased suitability for nesting and foraging at this historical nest site in Benton County, March 2022.

Urbanization fragmented, converted habitat and increased road densities in Benton County, May 2022.

Operational wind energy turbines and transmission infrastructure within the grasslands, cropland, and shrub-steppe land cover of the Horse Heaven Hills, Benton County. March 2022.

Operational wind energy turbines within an agricultural dominant landscape, Columbia County. March 2022.

Cumulative Effects to Birds, Bats, and Land Cover from Renewable Energy Development in the Columbia Plateau Ecoregion of Eastern Oregon and Washington

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Final

EXECUTIVE SUMMARY

The Columbia Plateau Ecoregion (CPE) of eastern Oregon and Washington has been a focal point of renewable energy development for the past two decades. Approximately 83% of wind energy generation in Idaho, Oregon, and Washington occurs within the CPE. Over the next decade, renewable energy development will significantly increase to accommodate population growth and government policies that mandate a shift in energy generation from fossil fuels to non-carbon emitting sources. Although hydroelectric power will likely remain the region's predominant source of renewable energy, wind energy and solar energy generation is expected to increase substantially in order to replace a retiring fleet of coal-fired power plants. To meet climate change policy objectives, between 8–12 gigawatts (GW) of new installed capacity by 2030 is projected, which is slightly less than two times the current installed wind energy capacity of 6,757 megawatts (MW). To meet this need, a combination of wind energy, utility-scale solar energy (USSE), battery storage, and improvements in energy efficiency will be needed.

The effect of renewable energy development on wildlife and land cover in the CPE has been a topic of research since the first wind energy facility was installed in 1998. Johnson and Erickson (2008, 2010, 2011) provided a regional summary and characterization of the effects of wind energy development on birds and bats in the CPE. This assessment extended upon their framework by including a decade of new post-construction fatality monitoring (PCFM) data of birds and bats, updated bird population estimates, updated remotely-sensed land cover data, and incorporated the emergence of USSE as an energy source to support carbon free policy objectives. The primary questions for wind energy and USSE development were,

- Do the current and future levels of wind energy generation increase the potential for sustained direct impacts that negatively affect bird and bat populations in the CPE?
- Using spatially explicit constraints and solar resource models, what are the affected biological resources in areas where USSE development is most likely to occur?

The basis of the wind energy assessment combined data from post-construction fatality monitoring studies conducted from 1999−2020 in the CPE with breeding bird population estimates to extrapolate the estimated number of annual bird and bat fatalities expected to occur under various wind energy development scenarios. Based on projections of future installed capacity from the region's leading energy utilities, we modeled 10 GW of new capacity and assumed 40–60% wind energy combined with a comparable amount of solar energy would be needed to achieve renewable energy policy objectives. We compared current and future fatality rates with population sizes and trends in the CPE to evaluate whether wind energy development would contribute to cumulative impacts of species or species groups.

A total of 3,073 bird fatalities were documented at 42 wind energy facilities during 55 studies. Passerines composed the majority of all fatalities (60.5%) followed by Upland Game Birds (11%), Unidentified Birds (9%), and Diurnal Raptors (8%). Collectively, Owls and Vultures composed less than 2%. The remaining 12% of species included the Doves/Pigeons group and other species' groups that had comparatively fewer fatalities. Species commonly associated with aquatic habitats (Gulls/Terns, Loons/Grebes, Rails/Coots, Shorebirds, Waterbirds, Waterfowl) comprised approximately 2% of the total fatalities. Compared to Johnson and Erickson (2011), mean fatalities/MW/year estimated from PCFM increased from 2.36 to 2.57 birds/MW/year (8.8%) for the All Bird group, increased from 0.08 to 0.12 birds/MW/year (50%) for the Raptor group, and decreased from 1.14 to 1.08 bats/MW/year (5.3%) for the Bat group; however, species composition within each group (i.e., Passerine, Upland Game Bird, migratory tree roosting bat, etc.) was similar.

Based on the current and future levels of wind energy development within the CPE, between 17,000–33,000 birds (excluding raptors) would be killed annually, the majority (67%) of which would be composed of species in the Passerine group that have robust populations (>1 million individuals) followed by non-native species in the Upland Game Bird group (12%) that have open hunting seasons. Based on the current and future levels of wind energy development within the CPE, between 800–1,500 raptors would be killed annually, of which, the majority (81.5%) would be species in the Diurnal Raptor group. Red-tailed hawk (*Buteo jamaicensis*) and American kestrel (*Falco sparverius*) fatalities would be highest but composed 0.4–0.8% of their estimated population in the CPE, respectively.

Results of the analysis suggested no significant population level effects are likely associated with bird species most often found during PCFM (Passerines and Upland Game Birds) based on the small proportion of the robust populations affected. However, some species may be disproportionately affected by wind energy development due to small populations or low reproductive rates. Ferruginous hawk (*Buteo regalis*) is a Washington state endangered species with increased conservation concern due to declining population trends in the region and a small population size. Elevated projected fatality estimates for the breeding population of ferruginous hawk in future development scenarios will likely contribute to cumulative effects with other stressors in the CPE (e.g., habitat loss, prey availability, shooting). Although fewer ferruginous hawk fatalities have been documented at wind energy facilities compared to other raptors, ferruginous hawk breeding populations in the CPE are comparatively small with sustained declining populations that makes the species more sensitive to increased mortality from any source.

Overall, wind energy mortality did not have a measurable population-level impact on the majority of bird species found during PCFM and is comparatively much smaller than other anthropogenic sources of bird mortality including cat predation, collisions with vehicles and buildings, electrocutions, or pesticides, among others. In North America, the difference in bird mortality between other anthropogenic sources and wind energy development can be measured in the order of magnitudes but may affect species differently. For example, an estimated 2.9 billion birds are killed annually by domestic and feral cats but typically do not affect raptors. The concern of cumulative impacts to raptors are comparatively higher than other bird species because raptors are typically long-lived species with delayed reproductive maturity, low reproductive rates and flight behaviors that make them more susceptible to wind turbine collisions.

Reliable estimates of bat populations in the CPE and larger regional scales remain unavailable, making conclusions about the cumulative impact from wind energy development difficult to determine. Based on current and future levels of wind energy development, between 7,300–13,800 bats would be killed annually, of which, the majority (96%) would be composed of migratory tree roosting bats that include hoary bat (*Lasiurus cinereus*) and silver-haired bat (*Lasionycteris noctivagans*). Although the proportion of wind energy derived mortality on bat populations and other sources of bat mortality in the CPE are unknown, bat occupancy rates in the CPE have declined in past years, suggesting declining populations. White-nose syndrome (WNS; *Pseudogymnoascus destructans*), a lethal fungus that has decimated bat populations in the Midwestern and Eastern US, was first detected in Washington in 2016 and within the CPE (Kittitas County) in 2018 and Chelan and Yakima counties in 2020. The scale of bat mortality in the US caused by WNS is analogous to cat mortality in songbird populations. Of the 14 bat species that occur within the CPE; six species have exhibited a symptomatic lethal response to the fungus, three species have been asymptomatic (including silver-haired bat), and five species currently have no documented response (including hoary bat). As the disease spreads in the western US and potentially changes pathology to affect more bat species, WNS could have a decimating impact on bat populations in the CPE as observed elsewhere in the US. Better estimates of bat population sizes and dynamics are crucially needed as a first step to understanding the effect of wind energy mortality on bat populations.

We used the current electrical transmission grid, topographic slope, biological and human-built constraints to model the potential USSE development corridor within the CPE. The affected land cover and biological resources within the development corridor were compared to the resources outside the corridor to evaluate whether USSE would disproportionately impact a particular resource. Land cover included vegetation types from the National Land Cover Dataset and National Wetland Inventory; biological resources included federal or state-listed or sensitive wildlife, plant, or high-value plant communities tracked by state Natural Heritage Programs (NHP) and Audubon Important Bird Areas (IBA).

The potential effect of USSE on habitat integrity and connectivity of two focal species that require large areas of habitat were evaluated in greater detail and included Rocky Mountain mule deer (*Odocoileus hemionus hemionus*; mule deer) and greater sage-grouse (*Centrocercus urophasianus*; sage-grouse). After exclusion criteria were applied (e.g., land >2 mi from the electrical grid, topography >10% slope, all perennial waters, Urban Growth Boundaries, federal/First Nation ownership), the potential USSE development corridor composed 32% of the CPE. Modeling corresponded well with USSE development and included the location of all 48 operational, under construction, approved or proposed USSE projects planned through 2025, as of December 2020. No land cover type was disproportionately within the corridor than outside; however, approximately 45% of the cultivated cropland in the CPE was within the corridor. Shrub-steppe (Shrub/Scrub in NLCD) was the sensitive land cover type with the largest amount of area

(29% of mapped area) within the corridor. The second most abundant wetland type in the CPE, freshwater emergent wetland, had the highest proportion (41%) located within the corridor. Four IBAs had a larger proportion of their area located within the corridor than outside, the most relevant being the Boardman Grasslands (61%) in Oregon.

Records of two wildlife species, pygmy rabbit (*Brachylagus idahoensis*; federal and state endangered) and sagebrush lizard (*Sceloporus graciosus*; state candidate) were located more often within the corridor than outside. Of the 11 rare plant species that had proportionately more records within the corridor than outside, gray cryptanta (*Cryptantha leucophaea*; state threatened) had the largest area (10.6 mi^2) but was the sixth most documented rare plant species.

Abundant and widely-distributed land cover, high-quality plant communities and wildlife species are more vulnerable to impacts by USSE, but because of their abundance, are less susceptible to cumulative impacts. Areas with limited distribution such as the Potholes Reservoir IBA or high-quality plant communities such as needle-and-thread grasslands (*Hesperostipa comata*) whose records are located almost entirely within the corridor, are less likely to be affected but impacts would be proportionately greater because of their scarcity on the landscape.

Models of mule deer and sage-grouse habitat concentration areas and their connectivity within the USSE corridor showed areas where development would affect habitat connectivity and impede seasonal movement but also highlighted opportunities where appropriate preconstruction assessments and site selection would be able to avoid sensitive areas. Wildfire is the greatest threat to sage-grouse populations in the CPE and encroachment of USSE into core areas or impeding connectivity between areas would be a cumulative impact. Excluding associated USSE infrastructure (e.g., roads), land use estimates of 4.2 ac/MW for solar tracking arrays represented less than 0.5% of the modeled USSE corridor regardless of development scenario. Site selection and the appropriate biological assessments to avoid cumulative impacts to sensitive biological resources will be crucial to achieve renewable energy policy objectives in a sustainable, environmentally compatible manner.

Our model scenario of 10 GW of new renewable energy in the CPE by 2030 represented the median in a predicted range and a reasonable and understandable starting point but likely underestimates the scope of development. Nevertheless, if predictions hold, renewable energy development in the CPE is beginning another period of intense development pressure, similar or greater to what was observed in the 2000s. The rate of development is outpacing the biological paradigms of yesteryear and updated data-driven policies, procedures, and guidance are needed to match the scale of renewable energy development. Of particular importance is the need to update decade old wind energy guidelines and the development of regional science-based USSE guidelines which are currently absent within the CPE. At the end of this document, we outline a list of processes that would improve the siting opportunities for renewable energy development in the CPE and future cumulative impact assessments.

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REPORT REFERENCE

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PHOTO CREDITS

Cover Page: Shepherds Flat Wind Project and surrounding wind energy projects, Morrow County, Oregon, May 2020. All Photographs: E. W. Jansen

Unit Conversions

Imperial	Metric
1 foot	0.3048 meter
3.28 feet	1 meter
1 mile	1.61 kilometer
0.621 mile	1 kilometer
1 acre	0.40 hectare
2.47 acre	1 hectare
Common Conversions	
0.5 miles	800 meters
0.12 miles	200 meters
0.5 miles	0.8 kilometers
10 miles	16.1 kilometers

Imperial units are used unless otherwise noted.

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ABBREVIATIONS AND ACRONYMS

APLIC	Avian Power Line Interaction Committee
BBS	Breeding Bird Survey
BCC	Bird of Conservation Concern
BCR	Bird Conservation Region
BGEPA	Bald and Golden Eagle Protection Act
BLM	Bureau of Land Management
BPA	Bonneville Power Administration
CPE	Columbia Plateau Ecoregion (Level III)
CRP	Conservation Reserve Program
DOE	United States Department of Energy
ECPG	Eagle Conservation Plan Guidance
EFSC	Energy Facility Siting Council (Oregon)
EFSEC	Energy Facility Site Evaluation Council (Washington)
EPA	Environmental Protection Agency
GIS	Geographic Information System
GW	gigawatt
IRP	Integrated Resource Plan
MW	megawatt
NABat	North American Bat Program
NLCD	National Land Cover Database
NPCC	Northwest Power and Conservation Council
NPP	Northwest Power Plan
OAR	Oregon Administrative Rules
ODFW	Oregon Department of Fish and Wildlife
PCFM	post-construction fatality monitoring
PED	Population Estimate Database
PIF	Partners in Flight
PV	photovoltaic
RSH	rotor-swept height
US	United States
USSE	utility scale solar energy
USDHS	United States Department of Homeland Security
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WECC	Western Electricity Coordinating Council
WNS	white-nose syndrome (*Pseudogymnoascus destructans*)

1 INTRODUCTION

Since the early 2000's, the Columbia Plateau Ecoregion (CPE) of eastern Oregon and Washington has been a regional focus for renewable energy development which has included wind energy and most recently solar energy. The electrical transmission systems originally developed to supply power from hydroelectric dams to communities and urban areas during the 20th century has grown into a vast network of distribution systems for load centers located throughout the Pacific Northwest and beyond. Combined with a transmission system and robust wind resource capable of utility-scale power generation, wind energy has grown into the leading form of renewable energy development within the CPE, excluding hydroelectric, which accounts for over 50% of the regions electrical supply (Northwest Power and Conservation Council [NPCC] 2021; Photo 1). More recently, advances in photovoltaic solar energy technology and legislation mandating carbon free energy sources has resulted in increased development of utility scale solar energy (USSE) within the CPE.

Over the next decade, installation of renewable energy facilities are projected to significantly increase to accommodate population growth and government policies that focus on shifting energy generation from fossil fuels to non-carbon emitting sources. The region is losing 60% of its coal fleet over the next decade and replacement resources will be needed to complement the existing system and meet power supply demand (NPCC 2021). Mandated by policy, Oregon and Washington have passed Renewable Portfolio Standards that aim to generate a substantial proportion of their energy supply from renewable energy sources over the next several decades. In Oregon, Senate Bill 1547 mandated at least 50% of the utility-scale electrical supply must be produced by renewable energy sources by 2040[1] while House Bill 2021[2] mandated 100% by 2040 for investor-owned utilities. In Washington, Senate Bill 5116 mandated an electricity supply free of greenhouse emissions by 2045[3].

Cumulative impacts to bird, bats, and associated habitats from the development and operation of wind and solar energy is an area of active research within the United States (US) and around the World (International Finance Corporation 2017, Gill and Hein 2022). Because of the geographic scale of development, concerns of population-level effects have been raised and actions are necessary to prioritize conservation efforts and management action. Recent studies have used various analytical approaches to evaluate cumulative impacts to birds, bats and habitat. Diffendorfer et al. (2021) used demographic and biological removal models to quantify impacts on 14 raptor species, assuming a future US wind energy scenario of 241 gigawatts (GW) of installed capacity. Katzner et al. (2020) described a cumulative impact framework and used genetic data to evaluate impacts from solar energy to greater roadrunners (*Geococcyx californianus*) in the US southwest desert and impacts from wind energy to red-tailed hawk (*Buteo jamaicensis*) in central California. Macgregor and Lemaitre (2020) used bat fatalities, facility size,

1 Oregon Senate Bill 1547

2 Oregon House Bill 2021

3 Washington Senate Bill 5116-2019-20

elevation, and geographic location to predict the cumulative impacts to bats in Quebec, Canada. Walston et al. (2021) modeled ecosystem services at 30 solar energy facilities in the midwestern US In general, studies of cumulative impacts typically note the inherent difficulties in evaluating effects to wide-ranging species with varying degrees of accuracy in population estimates, demographic rates, and other anthropogenic stressors (Stanton et al. 2019, Katzner et al. 2020). This report provides a contemporary review of available bird and bat fatality data, and impacts to land cover from wind and solar energy development to assist stakeholders in future planning decisions within the CPE of eastern Oregon and Washington.

1.1 Assessment Objective

The objective of this assessment was to contextualize, on a broad geographic scale, the past, current, and future direct effects of wind and solar energy development on birds, bats, and land cover within the CPE through 2030. The Environmental Protection Agency (EPA) defines cumulative impacts as "when the effects of an action are added to or interact with other effects in a particular place and within a particular time" (EPA 1999). A slightly different version is considered in the context of the National Environmental Policy Act (NEPA), where cumulative impacts are defined as "impacts on the environment which result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency or person undertakes such other actions (40 Code of Federal Regulations 1508.7)." This assessment blends the EPA and NEPA definitions to define cumulative impacts when "impacts resulting from the construction and operation of wind or solar energy facilities increase the potential for sustained impacts to negatively affect species' group populations or land cover types over time".

Over a decade ago, Johnson and Erickson (2008, 2010, 2011) visited the same question in regards to cumulative impacts resulting from wind energy development in the CPE. The primary differences between the previous version and this assessment are the inclusion of contemporary bird and bat post-construction fatality data, biological and remotely sensed data, and the emergence of USSE as an energy source to support carbon free policy objectives.

Although USSE development is still relatively recent in the CPE and rigorous studies on impacts to bird and bats from USSE in the CPE are lacking, the projected level of development and increasing scale of land use intensity over the next decade warrants the inclusion of this development type in this assessment. In addition, without electrical transmission and distribution, wind and solar projects would not be developed; therefore, transmission was considered a factor in this assessment. Because the potential effects to birds, bats, and land cover differ significantly between wind and USSE development, the organization of the assessment was divided among the two renewable energy types, where the questions involving wind energy and USSE were considered separately.

- Do the current and future levels of wind energy generation increase the potential for sustained direct impacts (collision mortality) that negatively affect bird and bat populations in the CPE?
- Using spatially explicit constraints and solar resource models, what are the affected biological resources in areas where USSE development is most likely to occur?

What this Assessment Does Not Do

This assessment does not model species-specific demographic parameters that estimate the effect of renewable energy impacts on population trends or viability over time. The inclusion of demographic parameters such as birth, death, immigration, and emigration traditionally used in population matrix models or viability analyses are not within the scope of the current study. This was not a sensitivity analysis to understand mortality thresholds. Rather, the construct of this assessment was to contextualize the magnitude of the effect on a species or primary species group (group) and qualitatively evaluate the direct impacts based on existing population trends and other environmental stressors. Conversely, the effects of compensatory mitigation or other conservation programs as a result of renewable energy development have not been factored into the assessment. This assessment is not meant to inform project specific impacts, and while it may be useful in evaluating cumulative impacts of future renewable energy scenarios, environmental assessments of individual renewable energy projects should continue to follow applicable federal, state, and county guidelines/protocols.

Photo 1. Wind energy turbines in Sherman County, Oregon, March 2022.

2 CHARACTERIZATION OF THE ANALYSIS AREA

Defining the geographic scale and current characteristics within the analysis area is a fundamental step in impact analyses (Katzner et al. 2020). This section characterizes the past, current, and future conditions of the natural environment and human-built environment within the geographic boundary of the Level III CPE which is defined as the 32,097 mi^2 (20,542,106 acre [ac]) area within Idaho, Oregon, and Washington (Omernik 1987; Figure 1). Where possible, comparisons between the datasets used in the Johnson and Erickson (2011) report and contemporary datasets were made to help contextualize how conditions have changed over the past decade. Consistent with Johnson and Erickson (2011), Oregon and Washington were the focus for data summaries and subsequent analyses because no operational or proposed renewable energy facilities occur in the Idaho portion of the CPE.

2.1 Natural and Human Environment

This section characterizes the land cover, land ownership and management, and the human-built environment that may affect cumulative impacts to bird and bat communities within the CPE. Impacts of the human built environment are presented in the results and discussion section (*see* Section 4 and 5) where past and future characteristics provide context, where applicable.

2.1.1 Land Cover

Located predominantly within Oregon and Washington, the CPE is bound in all directions by comparatively more mountainous ecoregions; the diverse topographic relief is a function of its dynamic geologic history. Rising approximately 4,500 feet above sea level, topography in the CPE is characterized by broad, flat plateaus, rolling hills with lakes and potholes, channeled scablands and bisected by steep canyons and river systems and reservoirs (Cleland et al. 2007). Annual precipitation averages seven to 18 inches. Soils are derived from parent material resulting from erosion and re-deposition by great floods and strong winds across the relatively level lava plateau (Cleland et al. 2007). Windblown sediment (loess) covers most of the CPE providing deep fertile soil, only to be interrupted by the geologic mayhem of the Missoula Floods that created areas of flood-scoured, channeled scablands (Spokane Valley, WA), potholes (Othello area, WA), and steep topography (Columbia River Gorge, OR, Blue Mountain Foothills, OR, Saddle Mountain, WA), present throughout the CPE (Alt 2001).

Grasslands and shrub-steppe form a mosaic of native vegetation that comprise the dominant habitat types within the CPE. Clinal variation in vegetation communities range from grasslands and shrub-steppe in lower elevations transitioning to landscapes dominated by trees in higher elevations (Figure 1). Regional variation of vegetation communities throughout the CPE exists; however, generally, native grass species consist of Idaho fescue (*Festuca idahoensis*), needle-and-thread (*Hesperostipa comata*), and bluebunch wheatgrass (Pseudoroegneria spicata). Forbs include buckwheat (*Eriogonum* spp.), hawkweed (*Hieracium* spp.), salsify (*Tragopogon* spp.), balsam arrowroot (*Balsamorhiza sagittata*), and an assortment of wildflowers (e.g., larkspur [*Delphinium* spp.]). Dominant shrubs include a variety of sagebrush (*Artemisia* spp), rabbitbrush (Ericameria spp.), antelope bitterbrush (*Purshia tridentata*), greasewood (*Sarcobatus vermiculatus*), and buckbrush (*Ceanothus cuneatus*). Higher elevations and drainages have ponderosa pine (*Pinus ponderosa*), western juniper (*Juniperus occidentalis*), cottonwood (*Populus* spp.), Siberian elm (*Ulmus* spp.), and hawthorn (*Crataegus* spp.; Clarke and Bryce 1997). Introduced from Eurasia and the Mediterranean, cheatgrass (downy brome, *Bromus tectorum*) continues to be a major threat to biodiversity, functionally eliminating native plant species in areas, modifying wildlife populations and increasing the risk of wildfire (Pilliod et al. 2021). The establishment of other non-native grasses (e.g., wiregrass, *Ventenata dubia*) in the CPE has been identified as an emerging conservation threat and in need of additional research (Ridder et al. 2022).

Promoted by the Columbia Basin Project Act, hydroelectric development began in 1941 with the Grand Coulee dam in Grant and Okanogan counties and agricultural irrigation began in 1952, forever changing the land cover in the CPE (US Bureau of Reclamation 1964). Between 1973 and 2000, the proportion of lands converted to agriculture steadily increased, only outpaced in 1986−1992 with more lands enrolled in Conservation Reserve Program (CRP) lands (Sleeter et al. 2012). Currently, natural land cover in the CPE is characterized by a mosaic of shrub-steppe and grasslands[4] that composed approximately 50% of the CPE in 2019. Cultivated crops, predominantly winter wheat, continue to represent the dominant land cover type in the CPE as it has since the early 1970's (Table 1, Figure 1; Sleeter 2012). Land cover and land use within the CPE has changed substantially over the past decade (Table 1, Figure 1). Between 2006 and 2019 shrub-steppe land cover decreased approximately 700,000 ac (13%) while grasslands increased over 500,000 ac (10%). Most conversion of shrub-steppe to developed areas occurred around the urban areas including Moses Lake and the Tri-cities area of Kennewick, Pasco, and Richland, Washington (Figure 2). Beyond urban areas, broader areas of shrub/scrub conversion to developed cover types were in areas of higher-density wind energy development along the Columbia River of the Oregon/Washington border.

Impacts to land cover from the construction of wind and solar projects must be offset through compensatory habitat mitigation per Oregon and Washington policy[5]. The Oregon Department of Fish and Wildlife (ODFW) and Washington Department of Fish and Wildlife (WDFW) implement mitigation policy standards as described in wind energy guidance documents and department policy (ODFW 2008; WDFW 1999, 2009). Although Oregon and Washington habitat mitigation policies differ, the general approach is to achieve no net loss of habitat resulting from construction activities. In both policies, habitat (i.e., land cover types) are assigned to a category or class, depending on its conservation value for wildlife. A higher mitigation ratio (amount of mitigation: amount of impact) is assigned for habitats that have greater conservation value for a particular species and whether habitat impacts are permanent or can be restored through habitat restoration following construction. Habitat mitigation strategies vary by project and state but can include land acquisition of conservation parcels held in perpetuity, on site restoration activities, a fee option paid by the developer to support state conservation programs, or combination of strategies.

[4] Analogous to shrub/scrub and herbaceous NLCD cover types presented in Table 1, Figures 1 and 2, and described by Johnson and O'Neil (2001).

[5] Oregon Administrative Rule (OAR) 635-415; Washington Administrative Code (WAC) 463-60-332.

Table 1. Change among National Land Cover Database (NLCD) land cover types between 2006 and 2019 and percent composition (% Comp.) within the Columbia Plateau. Data sorted by % *change.*

NLCD Land Cover Type[1]	2006 Area (ac)	2019 Area (ac)	2019 % Comp.[2]	2006−2019 Difference (ac)	2006−2019 % Change
Developed					
Developed, High Intensity	23,732	31,741	0.2	8,010	33.8
Developed, Medium Intensity	134,766	169,665	0.8	34,899	25.9
Developed, Low Intensity	260,085	264,893	1.3	4,808	1.8
Developed, Open Space	402,807	382,270	1.9	-20,537	-5.1
			Net Change	***27,179***	***56.4***
Vegetated and Barren					
Herbaceous	5,225,389	5,754,282	28.0	528,893	10.1
Cultivated Crops	7,943,204	8,103,839	39.4	160,635	2.0
Deciduous Forest	4,334	4,393	0	59	1.4
Hay/Pasture	331,537	335,172	1.6	3,634	1.1
Mixed Forest	1,606	1,559	0	-47	-2.9
Evergreen Forest	372,692	354,121	1.7	-18,571	-5.0
Shrub/Scrub	5,282,369	4,582,935	22.3	-699,434	-13.2
Barren Land	7,104	5,622	0	-1,482	-20.9
			Net Change	***-26,313***	***-27.4***
Waters and Wetlands					
Woody Wetlands	57,809	58,615	0.3	806	1.4
Emergent Wetlands	141,920	143,697	0.7	1,777	1.3
Open Water	352,626	349,177	1.7	-3,450	-1.0
			Net Change	***-867***	***1.7***

1. Included 125 acres (ac) of land cover categorized as Unclassified in 2006 and 2019. Descriptions of land cover types are found in Homer et al. (2020).
2. 2019 % composition was calculated as the 2019 land cover type (ac) divided by the total area of the CPE (20,542,106 ac).

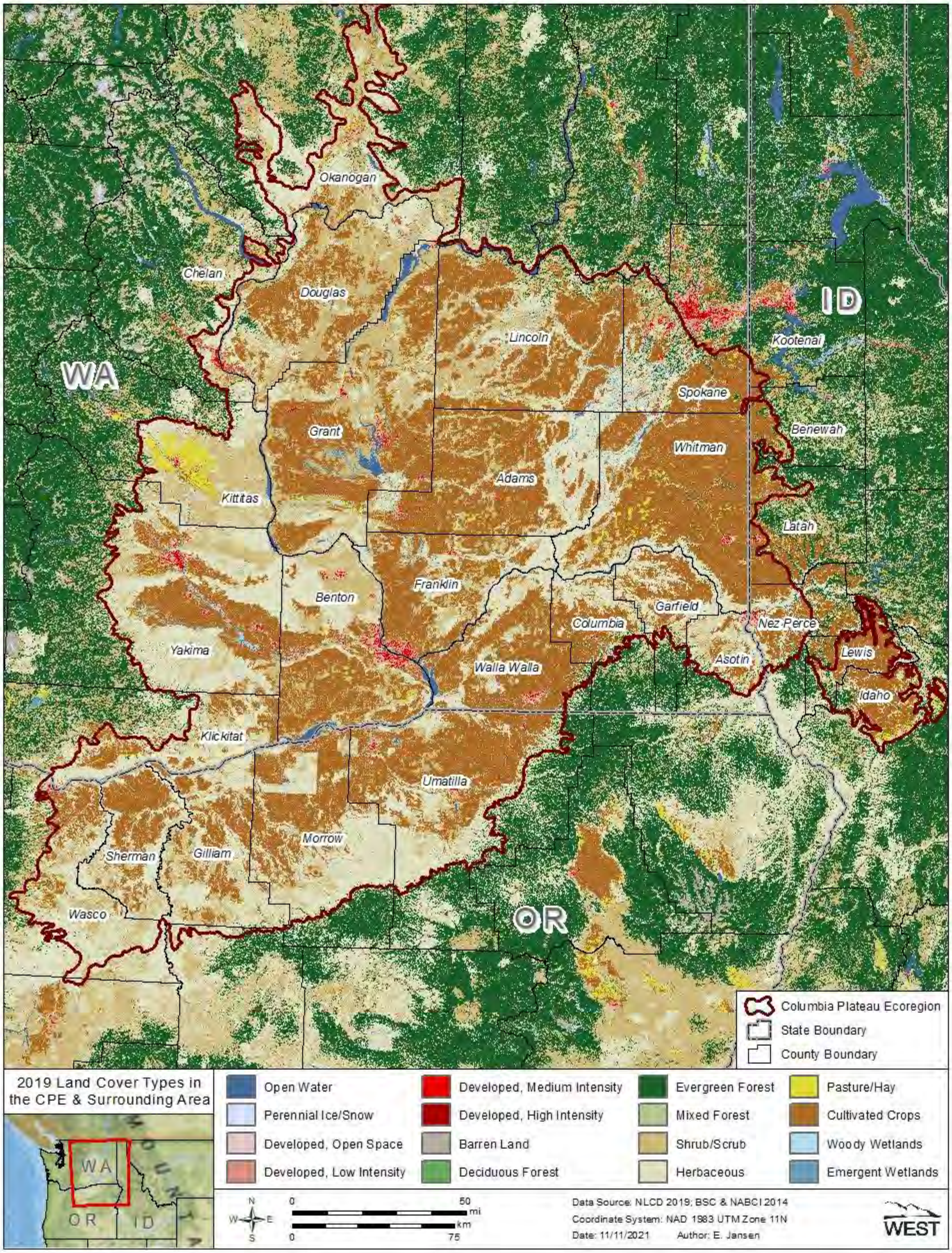

Figure 1. Land cover types within the Columbia Plateau Ecoregion.

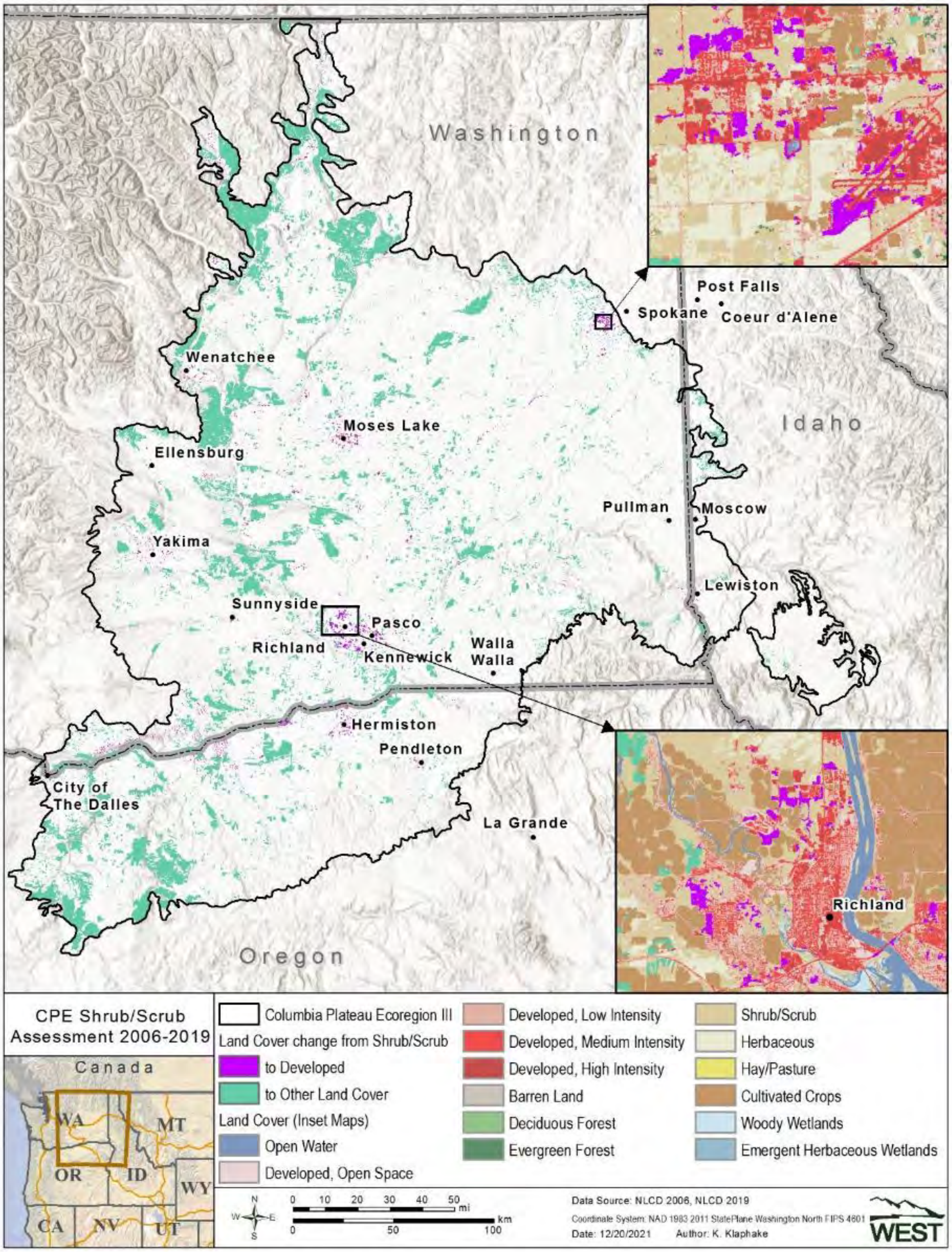

Figure 2. Conversion of shrub/scrub to developed or other land cover types 2006–2019 within the Columbia Plateau Ecoregion.

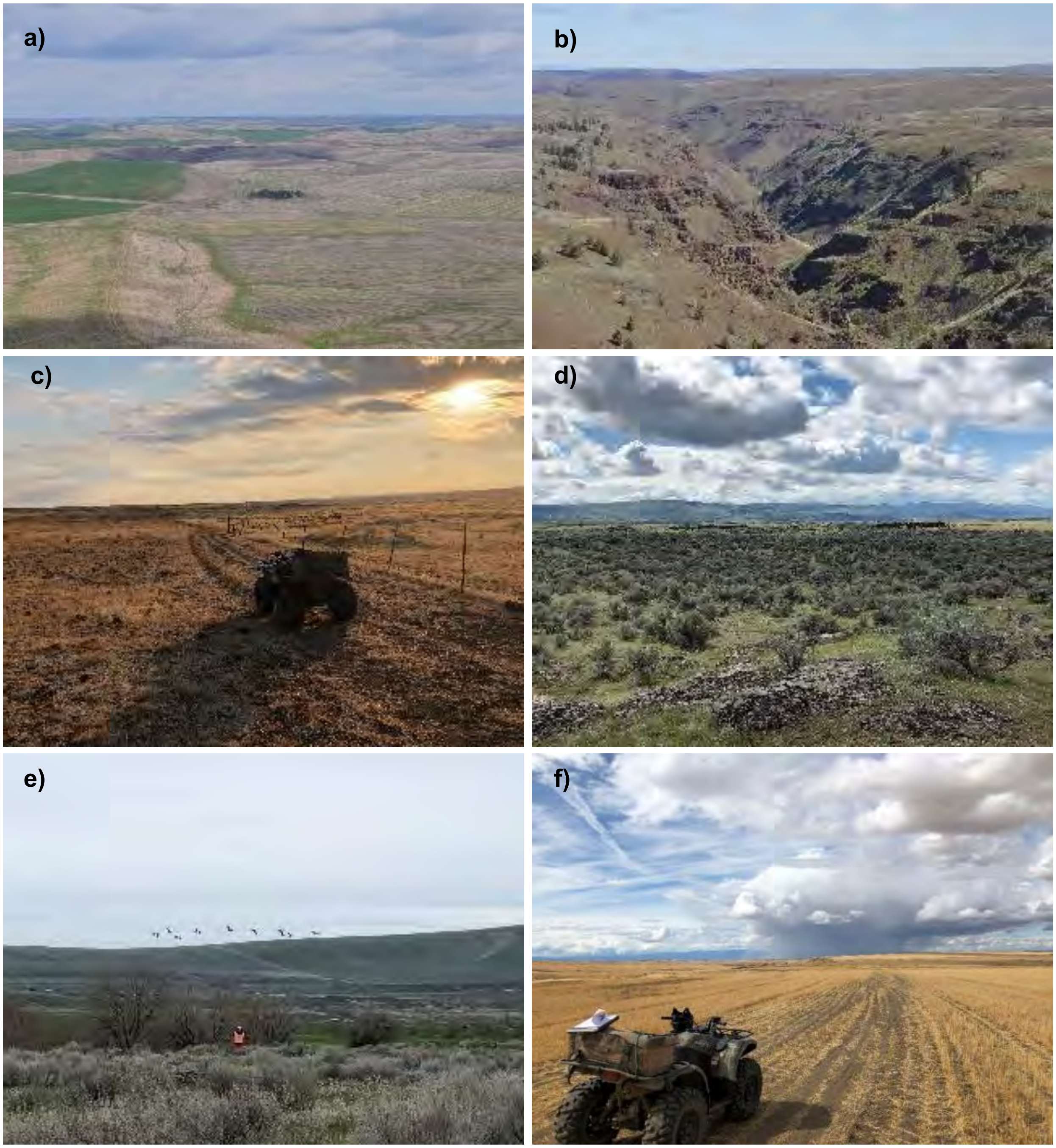

Photo 2. Representative photographs of land cover and topography within the Columbia Plateau Ecoregion, 2018–2022.

Photos include a) rolling agricultural fields of the Palouse Hills, Adams County, Washington; b) dissected basalt canyons near the John Day River, Sherman County, Oregon; c) heavily grazed grasslands, Wasco County, Oregon; d) depression of dense sagebrush, Adams County, Washington; e) sandhill cranes over rabbitbrush and Russian olive, Adams County, Washington; f) flat plateau of harvested winter wheat, Wasco County, Oregon.

2.1.2 Land Ownership and Management

Reflective of land cover characteristics, land within the CPE is predominantly privately owned (74%) and primarily managed for cultivated crops or livestock (Tables 1 and 2; Appendix F1).

Private lands managed for conservation are encouraged by a number of Farm Service Agency programs to incentivize conversion of cropland to native vegetation through the Conservation Reserve Program (CRP) and similar initiatives. Contract length with the landowner is 10-15 years until renewal is needed. The majority of CRP lands in Oregon and Washington are located within the CPE. For 35 years, Washington has consistently accounted for an average of 67% ± 4% of CRP lands within the CPE, annually, followed by Oregon (28% ± 4%) and Idaho (4.8% ± 1%). Since the beginning of the program in 1985, CRP had the highest enrollment in 2007 with approximately 1,900,000 acres. In 2019, there were approximately 1,450,000 acres of CRP enrolled in counties within the CPE, which is equivalent to CRP enrollment in the early 2000's (Figure 3). Approximately 1,430,000 acres are set to expire in the CPE by 2030 unless contracts are renewed (annual 12-year average = 119,179 ± 135,675 ac; Figure 3). CRP lands enhance soil, water, and habitat productivity for many wildlife species and provide a landscape-scale conservation opportunity for grassland birds (Pavlacky et al. 2021) and synergistic environmental benefits when combined with non-carbon emitting sources of renewable energy (Wiesner 2007). The persistence of greater sage-grouse (*Centrocercus urophasianus*) in Washington has been attributed to the amount of lands enrolled in CRP, particularly in Douglas and Lincoln counties (Schroeder and Vander Haegen 2006, 2011; Shirk et al. 2017) and CRP continues to be an important conservation tool for wildlife in modified landscapes, particularly for native grassland birds such as ferruginous hawk (*Buteo regalis*; Shaffer et al. 2019, Hayes and Watson 2021).

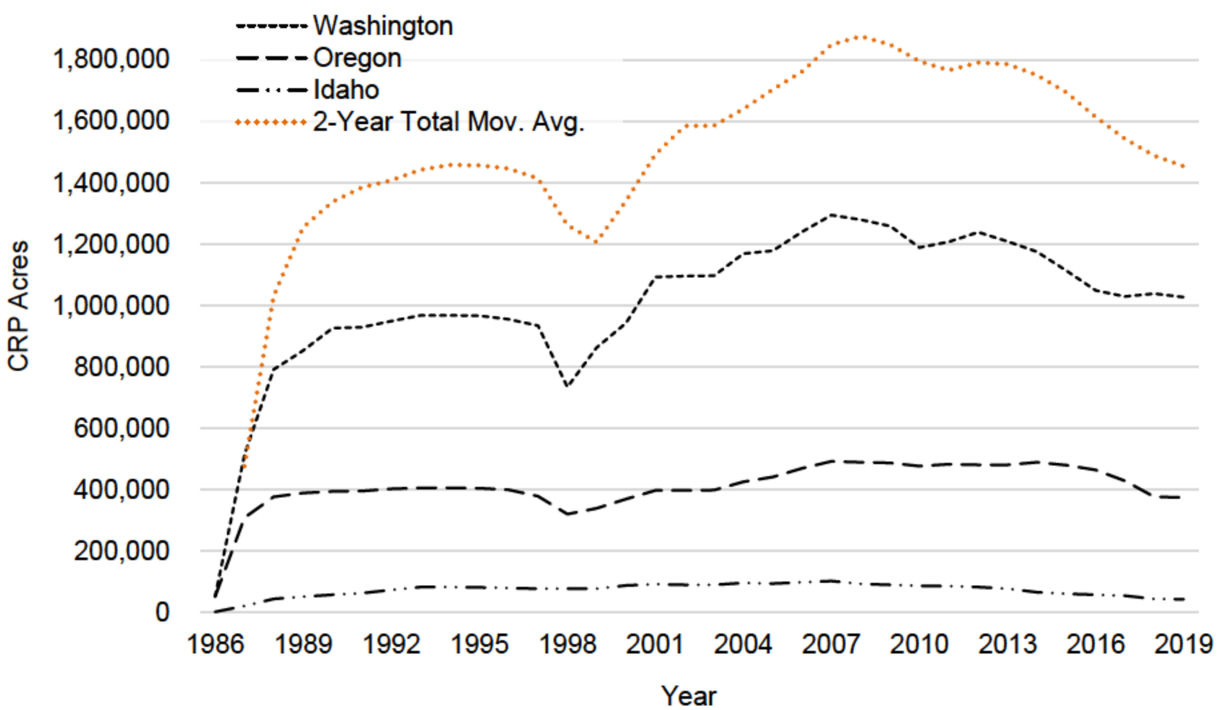

Figure 3. Total acres of land enrolled in the Conservation Reserve Program in 27 counties within the Columbia Plateau Ecoregion, 1986−2019 (NRCS 2021).

Following private, ownership within the CPE consists of federal agencies (12%), First Nations (8%), state agencies (6%), non-governmental organizations (<1%) and an assortment of county, city or other designations (<1%; Table 2). The majority of federal ownership within the CPE is managed by the Bureau of Land Management with the largest parcels along the designated Wild and Scenic John Day River and Deschutes River in Oregon, both of which provide excellent raptor nesting habitat. Additional BLM-managed lands include Areas of Environmental Concern and Wilderness Study Areas scattered throughout the CPE. The US Fish and Wildlife Service is the second largest federal land manager in the CPE with a large system of National Wildlife Refuges and Monuments that provide important year-round and migratory habitat for birds and bats (USFWS 2011). First Nations are administered by the Bureau of Indian Affairs and consist of the Confederated Tribes and Bands of the Yakima Nation (WA), Colville (WA), Spokane (WA), Umatilla (OR), Warm Springs (OR), Nez Perce (ID), and Coeur d'Alene (ID). First Nation ownership within the CPE is approximately 8% and managed independently as a sovereign nation. State ownership is approximately 6% of the CPE with the majority managed by Washington Department of Natural Resources as Trust Lands intended to generate revenue by leasing for agriculture, ranching, mineral, and wind energy development. Departments of Fish and Wildlife in Oregon and Washington and Fish and Game in Idaho manage a variety of Wildlife Complexes and Natural Areas for the explicit purpose of wildlife conservation. Non-governmental organizations (NGO; land conservancies and trusts) form a small portion of land ownership in the CPE (<1%) and management objectives typically include land stewardship and habitat conservation. Many NGOs in the CPE provide options to assist renewable energy developers to mitigate habitat impacts from wind and solar energy development.

Table 2. General land ownership and management agency within the Columbia Plateau Ecoregion. Data sorted by sub-total (*italics*).

Ownership/Management		Acres	% Composition
Private	***Sub-Total***	***15,227,100***	***74***
Federal			
Bureau of Land Management		670,035	28
Fish and Wildlife Service		478,076	20
Department of Defense		394,910	17
Forest Service		294,849	12
Army Corps of Engineers		213,392	9
Department of Energy		211,091	9
Bureau of Reclamation		46,511	2
National Park Service		43,827	2
National Resource Conservation Service		11,157	0
	Sub-Total	***2,363,848***	***12***
First Nations	***Sub-Total***	***1,734,886***	***8***
State			
Washington Department of Natural Resources		614,526	52
Department of Fish & Wildlife/Game		495,928	42
Parks and Recreation		34,555	3
Oregon Department of Lands		7,093	1
	Sub-Total	***1,152,102***	***6***
Non-Governmental Organization	***Sub-Total***	***39,136***	***<1***
Other[1]	***Sub-Total***	***25,035***	***<1***
	Total	**20,542,107**	**100**

[1] Other = City, County, or other designation.

Source: US Geological Survey (2020).

2.1.3 Human Population Growth

Population growth and the underlying land management decisions to accommodate an expanding population and the associated economy are inextricably linked with changes in land cover, renewable energy development, and impacts to bird and bat populations. From 2020–2030, annual population growth within the CPE is projected to increase approximately 1% per year to 1,887,351 individuals, a 10.3% increase by 2030 (Washington Office of Financial Management 2018, Portland State University 2021). Growth management acts in Oregon and Washington guide land use decisions in response to the growing population as well as intersect with energy development to ensure consistency with policy statues that mandate sustainable and thoughtful development. The demands for increased energy production extend far beyond the boundary of the CPE to the growing population of the western US. The decentralized transmission system in the CPE is part of the Western Interconnection that services states in the western US and will have a regional influence in the scale of energy development within the CPE.

Photo 3. Expanding urbanization into the Horse Heaven Hills fragments shrub-steppe and encroaches into ferruginous hawk nesting areas, Benton County, Washington. May 2022.

2.1.4 Vertical Obstruction

As populations grow and society continues to change into an increasingly digital world reliant upon electricity, the numbers of radio and microwave towers, communication systems, transmitters and repeaters (collectively, communication towers) have grown exponentially in the CPE. A vast network of infrastructure has been installed and modified over decades to support cellular, television, microwave, and paging communications from civilian and military applications. Infrastructure takes a variety of forms, dependent upon purpose, but all are raised to free-stand or supported by guy wires, illuminated with various indicator systems, and occupy variable amounts of airspace (Photo 4). Occupation of the airspace by this infrastructure has resulted an on-going source of mortality to birds and bats for decades (Gehring et al. 2009; Kerlinger et al. 2010; Longcore et al. 2012, 2013; Lundston et al. 2013). In general, studies have shown that a combination of taller towers with solid or pulsating red lighting and guy wires increase the likelihood of attraction and mortality (Manville 2013).

When adjusted for sample effort, searcher efficiency, and carcass persistence, Longcore et al. (2012) estimated bird collision mortality was approximately 6.8 million birds a year at 70,414 communication towers in the US and Canada, with approximately 20,700 birds (0.00−0.06 birds/km^2) in the Great Basin BCR, where the CPE is located (Appendix F2). Neotropical migrants incur the greatest mortality (97.4%) which are composed mostly of warblers (Parulidae; 58.4%), vireos (Vireonidae; 13.4%), thrushes (Turdidae; 7.7%), and sparrows (Emberizidae; 5.8%; Longcore et al. 2013). The number of fatalities of a particular species may be disproportionate to their abundance, which suggests that mortality is not a random factor that affects all migratory birds equally (Longcore et al. 2013). Although bats appear deterred by magnetic fields surrounding air traffic control radar stations (Nicholls and Racey 2007), bat use has been documented at communication towers (Gehring 2012). However, no bats were discovered during a three-year study at two monopole towers (31-40 m tall) in Washington D.C. and, unlike birds, evidence of collisions with communication towers has been largely anecdotal (Dickey et al. 2012, Manville 2016).

Publicly available data report approximately 946 communication structures have been permitted in the CPE since 1992, which range between 1−148 m tall (Figure 4; TowerMaps 2020, US Department of Homeland Security 2021). Longcore et al. (2012) estimated approximately 15.6% (1.02 million) of bird fatalities in the US occur at towers 60−150 m tall, which are approximately 1.5−3.5 times taller than the average height, but includes the range of tower heights found in the CPE (Table 3). Bird mortality estimates from communication tower collisions in the US are mostly derived from studies in the eastern and mid-western US Because of the differences in the total number and type of towers, bird species composition, weather and migration patterns, Longcore et al. (2012) cautions against extrapolation of mortality patterns to towers in the western US, pending regional-specific study.

Table 3. Summary of communication towers located in the Columbia Plateau Ecoregion.

Tower Type[1]	# Structures	Tower Height (m)			
		Min	Max	Average	St. Dev.
Tower	547	3	148	44	25
Pole	169	1	66	26	12
Lattice Tower	103	8	92	49	22
Structure	42	2	83	30	22
Monopole	41	12	59	31	12
Guy Tower	32	18	110	73	26
Mast	12	9	73	37	21

[1.] As defined by the Federal Communication Commission (FCC 2010):

Tower – A free standing or guyed structure used for communications purposes

Pole – Any type of pole, used only to mount an antenna

Lattice Tower – Free standing or guyed

Structure – Mounted on buildings, smokestacks, silos, or other structure

Monopole – Singular, free standing or guyed

Guyed Tower – Guyed structure used for communication purposes

Mast – Structure used to elevate mounted antennas to reach height for quality signals

m = meter; St. Dev. = Standard Deviation

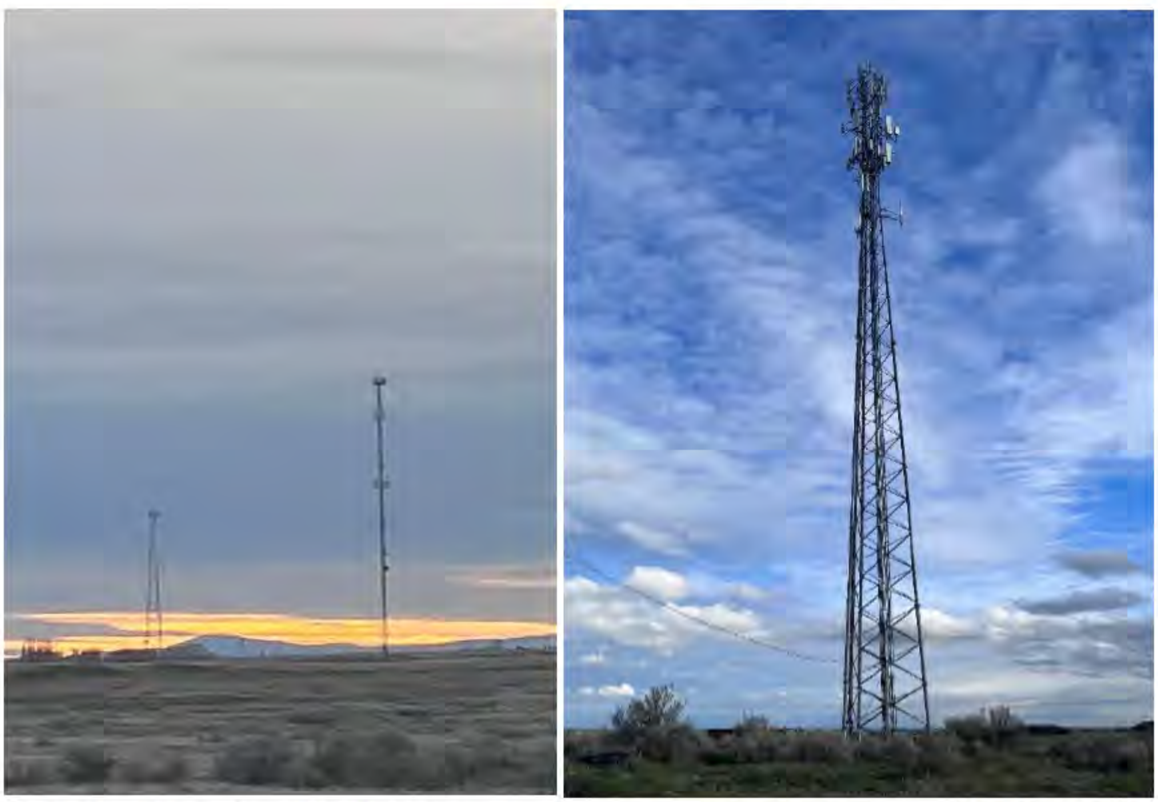

Photo 4. Examples of self-supported and guyed communication towers (left) and self-supporting tower (right) in Franklin County, Washington, March 2022.

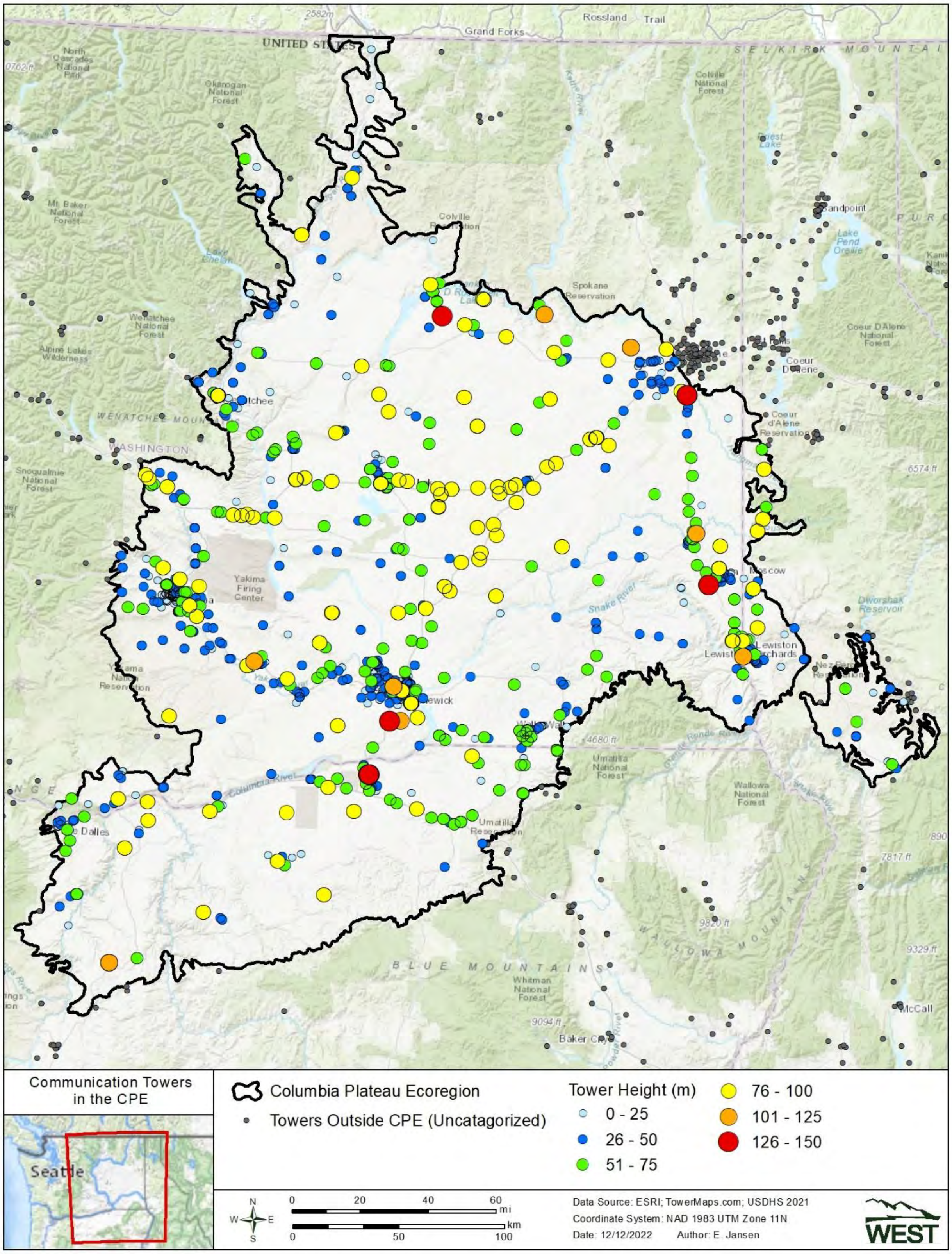

Figure 4. Communication towers located within the Columbia Plateau Ecoregion, 1992–2021. Tallest tower height displayed in cases where co-location occurs.

2.1.5 Electrical Transmission and Distribution

Energy production, in any form, must include a system of distribution networks to deliver the energy produced at a facility to the consumer. As discussed, a concerted effort to organize electrical transmission within the CPE began with the advent of hydroelectric in the mid-1940s which extended beyond the border of the CPE. The electric transmission grid in the CPE is part of a broader, decentralized market of the Western Interconnection under the auspice of the Western Electricity Coordinating Council (WECC) that covers 14 western states (Appendix F3). Similar to communication towers, electrical systems are raised structures that pose a collision risk but also include risk of electrocution. The impacts to birds from electrical systems have been a long-standing concern (Olendorff et al. 1981) and substantial efforts have been taken by electrical utilities and renewable energy developers to avoid, minimize, and mitigate impacts (Avian Power Line Interaction Committee [APLIC] 2012, 2014, 2015; USFWS 2013). Electrocutions occur primarily at low-voltage distribution lines with voltages between 2.4 and 60 kilovolts (kV) while collisions occur at both distribution lines and transmission lines with voltages >60 kV (APLIC 2012, Dwyer et. al 2014).

Loss et al. (2014) used 14 studies throughout the US to estimate between 12 and 64 million birds are killed each year at US power lines, with between 8 and 57 million birds killed by collision and between 0.9 and 11.6 million birds killed by electrocution. Because of their comparatively larger body size, bird species most commonly electrocuted are eagles, hawks, and ravens (Kagen 2016, McClure et al. 2018, Mojica et al. 2018). Mortality rates are not uniform over the landscape but are influenced by species, surrounding environmental factors, and structure related factors (Loss et al. 2014, Bedrosian et al. 2020, Biasotto et al. 2022).

The Bonneville Power Administration (BPA) was, and continues to be, the primary electrical provider in the CPE. Electrical systems are designed where power generated at a facility is converted through a series of substations and infrastructure to allow long-distance transmission to the consumer or load center. As a result, the electrical network in the CPE consists of distribution (<115 kV), sub-transmission (115−161 kV), and high-voltage transmission lines (>230 kV) that span over 9,120 mi (Figures 5 and 6; Photo 5; US Department of Homeland Security [USDHS] 2021). Measured per mile by voltage class, high-voltage transmission systems comprise approximately 52% of the electric system in the CPE, followed by sub-transmission (40%), and distribution (8%; USDHS 2021). Smaller-voltage distribution lines that supply exurban areas such as ranches and farmsteads are likely underestimated in the dataset because of the inherent difficulty in tracking and mapping. Although widely distributed throughout the CPE, electric systems, especially high-voltage transmission and sub-transmission voltages, are typically co-located and follow established corridors where the rights-of-way have been established, thus consolidating the footprint of the grid as seen around Boardman, Oregon, for example (Figure 6). Several regional working groups have been established to help facilitate the future design and planning of electrical transmission.

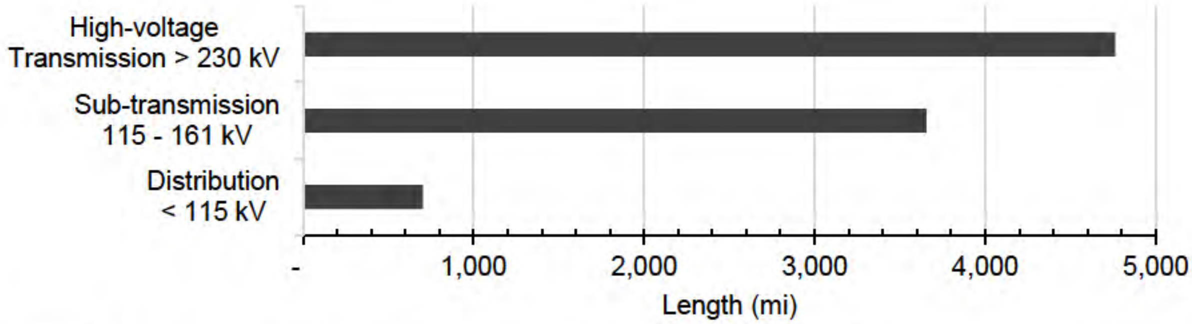

Figure 5. Electrical transmission systems in the Columbia Plateau Ecoregion (USDHS 2021).

Photo 5. Example of a high-voltage (500 kV) transmission tower with a raptor nest on the upper truss, Morrow County, Oregon (left), and distribution line with long-billed curlew (*Numenius americanus*) in the foreground, Gilliam County, Oregon, April 2021 (right).

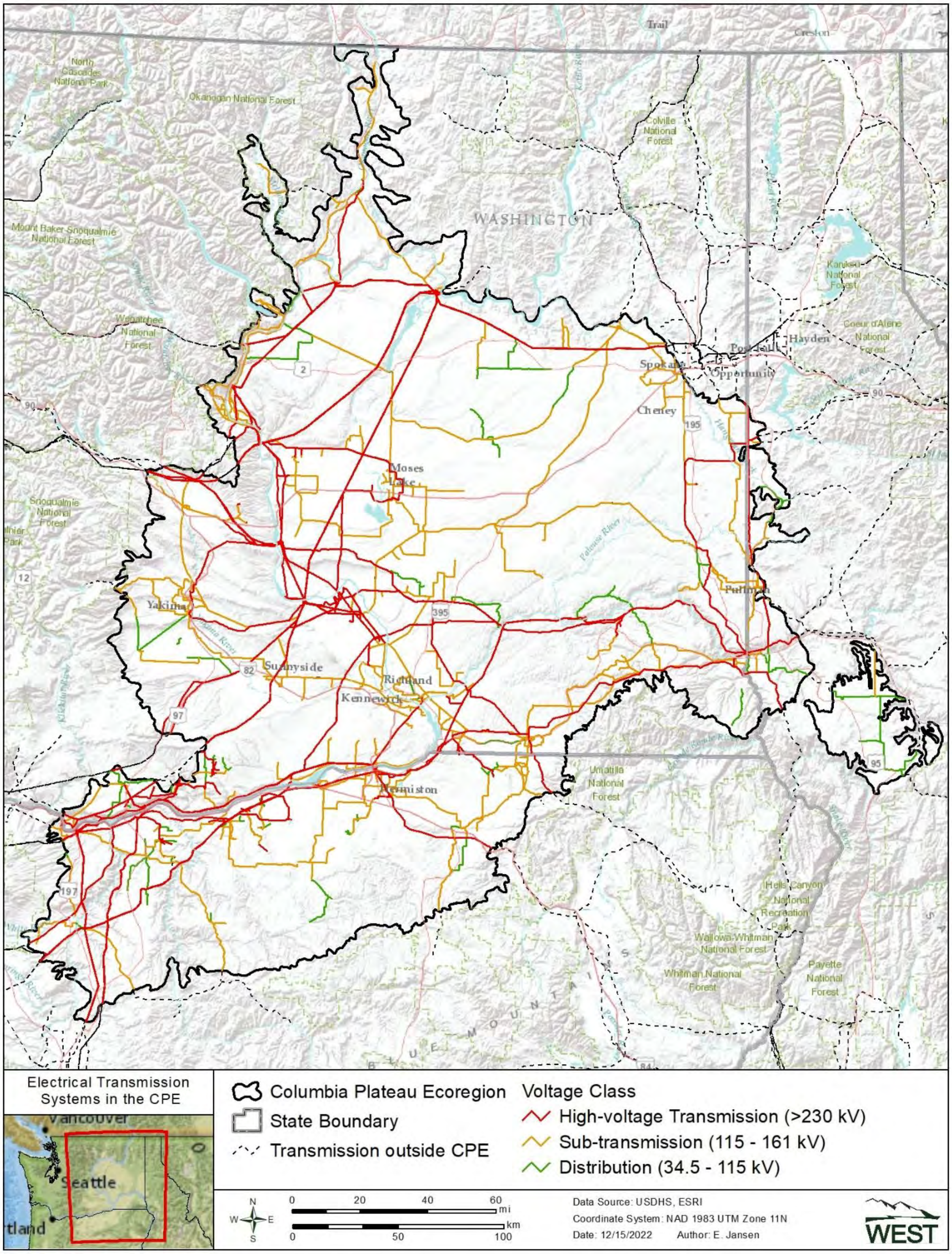

Figure 6. Electrical transmission systems in the Columbia Plateau Ecoregion. Highest voltage class displayed in cases where co-location occurs.

Photo 6. Example of a Bonneville Power Administration high-voltage electrical transmission corridor in southern Benton County, Washington, April 2022.

2.1.6 Bird Community

The diverse geologic, land cover, and ownership types within the CPE provide suitable nesting, foraging, and migratory stopover habitat for a high diversity of bird species. The CPE is a geographic subset of the Great Basin BCR 9 and lies within the Pacific Administrative Flyway (Appendix F2; Bird Studies Canada and US North American Bird Conservation Initiative [NABCI] 2014, USFWS 2014, EPA 2016). Located along the Pacific Flyway, birds within the CPE are a mixture of year-round residents, summer breeding species and migratory species. Summer breeding species may arrive in the CPE from as far away as South America to nest (e.g., Swainson's hawk [*Buteo swainsonii*]; Kochert et al. 2011), while some highly migratory species that winter in California fly through the CPE to nest in Alaska (i.e., sandhill crane [*Antigon canadensis*]; Stinson 2017). Twenty species that occur within the CPE are listed by state and federal agencies as sensitive species[6] (Appendix T1).

The National Audubon Society (Audubon) identified approximately 10% of the CPE occurs in 29 separate state priority and two global priority Important Bird Areas (IBAs; Audubon 2022). IBAs are defined as distinct areas that provide essential habitat for one or more species of birds during

[6] As defined here "sensitive" species include any species in Oregon or Washington which is either a) listed as an endangered, threatened, or candidate species under the federal Endangered Species Act of 1973, subject to the Bald and Golden Eagle Protection Act of 1940, or Oregon Endangered Species Act, or Washington State Environmental Protection Act; b) is designated by federal or state law, regulation, or other formal process for protection and/or management by the relevant agency or other authority; or c) has been shown to be significantly adversely affected by renewable energy development (WDFW 2009, USFWS 2012a)

breeding, wintering, or migration. Approximately 56% of areas identified as IBAs are located on lands managed by federal or state agencies with the remaining area privately owned. Annual Breeding Bird Surveys (BBS) conducted in the month of June along 147 routes within the Great Basin BCR 9 of Oregon, Washington, and Idaho provide population estimates and long-term population trends. Pardieck et al. (2020) provides BBS survey protocols and the 1966−2019 dataset (Appendix F4). Partners in Flight used BBS data to calculate population estimates for 172 species that occur within the Great Basin BCR 9 and CPE that are used in this assessment (Will et al. 2020). Further discussion regarding how bird populations within the CPE were estimated is provided in Section 3.2.

2.1.7 Bat Community

Bat population sizes in the Pacific Northwest are not well understood (Hayes and Wiles 2013, Rodhouse et al. 2019). Their high seasonal mobility, cryptic roosting and nocturnal behaviors result in a notoriously difficult group to obtain reliable population estimates. Previous focal inventory surveys conducted in the National Wildlife Refuges, Hanford Nuclear Site, and Yakima Training Center form the basis for our understanding of species composition (Christy et al. 1995, Gitzen et al. 2002, Hagar et al. 2013, Barnett 2014). Based on net capture and acoustic monitoring data, 14 bat species occur within the CPE (Table 4). Seven species are considered species of conservation concern due to low relative abundance, perceived threats, or for which population viability is a concern (Table 4).

Buildings, bridges, mine adits and shafts, lava tubes, basalt cliffs, and riparian areas provide suitable bat habitat for roosting, maternity colonies, and hibernacula throughout the CPE (Hayes and Wiles 2013). Data from the Priority Habitats and Species Program in Washington report 54 maternity colonies, 54 roosting colonies, and three hibernacula within the CPE (WDFW 2021). Although the data do not represent a randomized sample, maternity colonies were more often reported in buildings (74%), roosts were mostly under bridges and in mines (78%), and two hibernacula were identified in a cave in Douglas County. The majority of reported features were in Okanagan County (44%, 49 features) and Lincoln County (23%, 25 features) in the northern portion of the CPE (WDFW 2021).

Bats migrate in diffuse movement patterns, which are influenced by their hibernating strategy; species that hibernate underground tend to migrate shorter distances than tree-roosting bats that occur aboveground year-round where temperatures are less stable (Cryan and Veilleux 2007). A small bat population in the CPE appears to reside year-round and does not migrate as evidenced by a small number (<2%) of the 1,512 records of bat occurrence data in disparate locations throughout Washington collected in winter (WDFW 2021). Of the 14 bat species known to occur within the CPE, hoary bat and silver-haired bat are tree and leaf roosting species that undergo long-distance migration and typically do not occur in the CPE in winter (Cryan 2003). First detected in the eastern US in 2006, white-nose syndrome (WNS) — caused by a highly lethal fungus (*Pseudogymnoascus destructans*) — was first detected in Washington in 2016 and within the CPE (Kittitas County) in 2018 and Chelan and Yakima counties in 2020 (WNS Response Team 2021). Severe impacts to populations (i.e., >90% mortality), particularly for species that form large hibernacula, have been recorded in 27 states and two Canadian provinces

(Cheng et al. 2021). Six species (43%) that occur within the CPE have symptomatic, lethal responses to the fungus, of which two species are considered species with conservation status (Table 4).

Table 4. Bat species known to occur within the Columbia Plateau Ecoregion and response to white-nose syndrome.

Common Name	Scientific Name	Status (BLM; State)[1]	WNS Response[2]
big brown bat	*Eptesicus fuscus*	-- ; --	S
California myotis	*Myotis californicus*	-- ; --	--
canyon bat	*Parastrellus hesperus*	-- ; --	--
fringed myotis	*Myotis thysanodes*	OR-SEN ; --	S
hoary bat	*Lasiurus cinereus*	-- ; OR-SEN	--
little brown bat	*Myotis lucifugus*	WA-SEN ; --	S
long-legged myotis	*Myotis volans*	-- ; --	S
pallid bat	*Antrozous pallidus*	OR-SEN ; OR-SEN	--
silver-haired bat	*Lasionycteris noctivagans*	-- ; OR-SEN	D, AS
spotted bat	*Euderma maculatum*	OR-SEN ; OR-SEN	--
Townsend's big-eared bat	*Corynorhinus townsendii*	OR-SEN ; OR-CRI, WA-CAN	D, AS
western long-eared myotis	*Myotis evotis*	-- ; --	S
western small-footed myotis	*Myotis ciliolabrum*	-- ; --	D, AS
Yuma myotis	*Myotis yumanensis*	-- ; --	S

[1]. OR-CRI: Oregon Critical, OR-SEN: Oregon Sensitive, WA-CAN: Washington Candidate, WA-SEN: Washington Sensitive; -- ; -- = no federal or state status.

[2]. S = Symptomatic, lethal response; D, AS = Fungus detected, asymptomatic response; -- = No current documented response to WNS.

Source: Hayes and Wiles (2013), ISSSSP (2021), ODFW (2021), WDFW (2021), WNS Response Team (2021).

The most comprehensive bat population sampling effort applicable to the CPE consisted of the Bat Grid interagency bat-monitoring program conducted form 2003−2010 at 241 sample sites throughout Oregon and Washington (Ormsbee et al. 2006; Hayes et al. 2009; Rodhouse et al. 2012, 2015). Researchers used forest cover, elevation, precipitation and topographic roughness to model the probability of species occurrence on the landscape (occupancy probability; Rodhouse et al. 2015). Multi-year occupancy models and the inherent changing occupancy probabilities not only reflect changes in bat species distribution but also reflect the underlying latent changes in population size (Rodhouse et al. 2019). Two measures of population variability were modeled as *trend*, which was the estimated total proportional change in the probability of occurrence 2003−2010, and *turnover,* which was the estimated probabilities a previously unoccupied sample site would become occupied. The occupancy probabilities were modeled for 11 of the 14 bat species known to occur within the CPE (Appendix F5). Townsend's bat, spotted bat and pallid bat were encountered so infrequently that predictive maps could not be generated. Percent forest cover was the strongest predictor of bat occupancy. Occupancy patterns were distinctly higher outside the CPE for leaf and tree roosting bats that include long-legged myotis, long-eared myotis silver-haired bat, and little brown bat (Appendix F5). Of the 11 species modeled, fringed myotis was the only species that exhibited declining occurrence probability with reliable precision (Rodhouse et al. 2015). Measures of net trend over the eight year study period resulted in flat or slightly positive trends (~1 or >1) among most species; yearly trends provided similar evidence but had low precision. Exceptions included the high but imprecise positive trend for the canyon bat and positive trends for the long-eared myotis and hoary bat. Turnover was also low among many species but variable. The lowest and most precise estimates were for long-eared myotis, little brown myotis, small-footed myotis, Yuma myotis and big brown bat. Turnover was comparatively lower for cliff and cave roosting species than migratory species (silver-haired bat, hoary bat), presumably because of higher site fidelity and the security of cave and cliff roosts.

When restricted to the CPE, mean predicted occupancy probabilities ranged from 0.18−0.93 (Figure 7). The unique physical characteristics of the CPE relative to the surrounding regions resulted in distinct occupancy patterns, particularly for arid-land species that include small-footed bat and canyon bat. The relatively homogenous landscape characteristics of the CPE (e.g., low % forest cover, low precipitation and even topographic roughness) resulted in a uniform distribution of predicted occupancy across the CPE (Appendix F5). However, there were distinct patterns in summertime occupancy for some species with unique habitat requirements. For example, canyon bats had a higher likelihood to occur along the steep cliffs adjacent to the Deschutes and John Day rivers in Oregon and Grand Coulee and Columbia River in Washington, whereas long-eared myotis were predicted to occur more often in higher elevations, away from major drainages (Appendix F5). Identification of habitat requirements for bats on the landscape can assist in predicting the likelihood of occupancy for bats, particularly for species associated with niche features that include cliffs, waters, or forests.

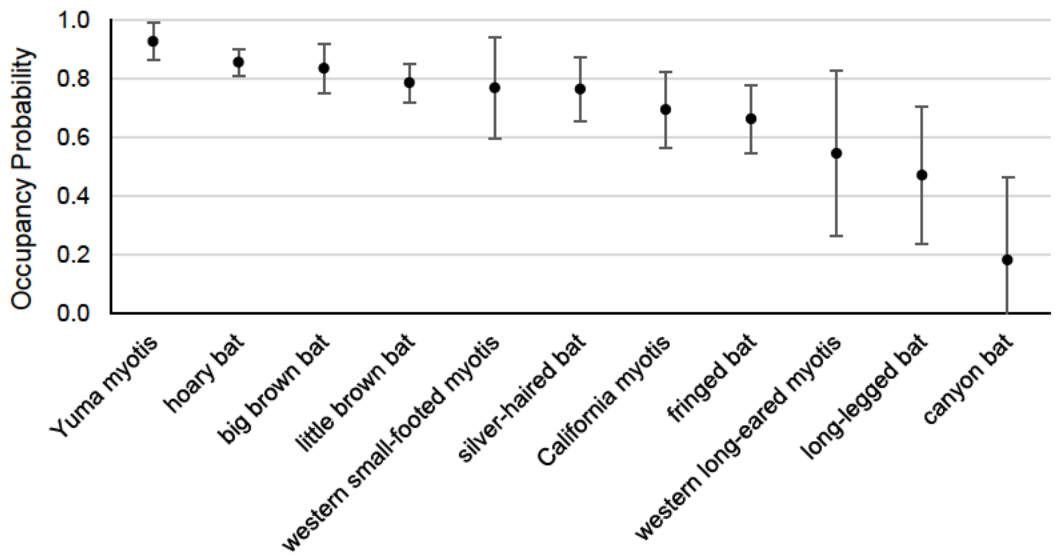

Figure 7. Mean predicted occupancy probability of bats during summer within the Columbia Plateau Ecoregion, 2010, conditioned on occurrence states 2003-2009. Variation expressed as the standard deviation of the sample mean. Data derived from Rodhouse et al. (2015).

Following the arrival of WNS and expanded wind energy development in the Pacific Northwest, Rodhouse et al. (2019) modeled little brown bat and hoary bat occupancy probabilities with additional data collected form 2016−2018 at 190 sample sites using the same Bat Grid methodology as Rodhouse (2015). Rodhouse et al. (2019) updated analysis found evidence of region-wide summertime decline for the hoary bat ($\hat{\lambda}$=0.86 ± 0.10) since 2010, but no evidence of decline for the little brown bat ($\hat{\lambda}$=1.1 ± 0.10).

Concurrent with Rodhouse et al.'s regional efforts in the Pacific Northwest, Loab et al. (2015) developed a continent-wide program (NABat; Program) to monitor bat distributions and indices of abundance at range wide, regional, and local scales in response to the decimating effects of WNS, on-going threats, and uncertainty of bat population sizes. The general approach of the Program is to conduct systematic-random monitoring of bats over a broad geographic area to document species occurrence and derive population estimates or trends in abundance. The sample framework is a grid-based approach similar to Ormsbee et al. (2006), with a number of sample grids located within the CPE. The number of projects contributing to the Program has exponentially increased since 2019; however, no population estimates are currently available for the CPE or Pacific Northwest.

2.2 Renewable Energy Development

This section characterizes past, current and future wind and USSE development within the CPE. Discussion of past and future characteristics provide context to current conditions, where applicable. The effects of renewable energy development in context with other biological resources are briefly discussed here with greater detail in Sections 4 and 5.

2.2.1 Wind Energy Development

The CPE is the Pacific Northwest's leading producer of wind energy in the tri-state area of Oregon, Washington, and Idaho. As of December 2021, there were 65 operational wind energy projects (includes phases) in the CPE with an estimated 6,757 MW of installed nameplate capacity, which represents approximately 83% (8,105 MW) of all wind energy capacity in the tri-state area (Figure 8; Oregon Department of Energy 2021, USGS 2021, WDFW 2021).

Since the installation of the first facility in 1998, the amount of development has varied over time, largely following the renewal of tax subsidies such as the Production Tax Credit (PTC; Figure 9; NWRC 2021). Spatially, early wind energy development focused on the Columbia River Gorge where wind energy resources and access to existing high-voltage transmission systems were readily available. Compared to the early boom of wind energy in the CPE from 1999−2009, which saw a 113% average annual increase in installed capacity, the average annual rate of development between 2010−2020 was 6% (22-year compound average growth of 29%; Figure 4). Post 2009, wind energy development has continued to consolidate in the form of in-fill projects that use existing land leases and infrastructure to add additional capacity to areas where wind energy is already present, repowering projects to modernize outdated turbine technologies, or have expanded to other portions of the CPE.

Wind energy siting considers the wind energy resource, land ownership, transmission, and energy needs, among other factors (Christol et al. 2021). Numerous federal and state wind energy guidance documents have been developed to assist in the assessment of biological resources (ODFW 2008; WDFW 2009; USFWS 2012, 2013). Unsurprisingly, there is a high correspondence between wind resources and wind energy development within the CPE. In the CPE, high quality wind resources are restricted to particular geographic regions that are typically higher elevation with prevailing winds such as found in the Columbia River Gorge, Oregon, and Kittitas Valley and Snake River foothills, Washington, for example (Figure 10). All operational or proposed wind energy projects are located in areas with average annual wind speeds ≥ 6 m/sec as measured 100 m above ground level. In areas of high wind speeds, development typically occurs on private lands because of the comparatively less complex permitting process than federal and state lands. The distance to and availability of electrical transmission is a major consideration, particularly for smaller projects that do not have the economy of scale to construct new transmission, which has been estimated at over $1,000,000 per mile, even for lower voltage classes (i.e., 69 kV; MISO Energy 2019, Desantis et al. 2021). Power purchase agreements with electrical utilities also guide the siting process; a down-stream power consumer and utility must be established to make any renewable energy project viable. We assume future wind energy development within the CPE should generally follow the geographically constrained nature of high wind resources, leverage the existing infrastructure in the CPE, and expand to areas with viable wind resource potential if transmission becomes available (*see* Section 2.2.3).

The aging fleet of wind turbines installed in the early 2000's are nearing the limits of their operational life and will most likely be replaced or retrofitted with contemporary technology in a process called repowering. Repowering optimizes energy production, extends the operational lifetime and involves the replacement of entire turbines with new turbines or retrofitting the components on existing towers (i.e., the nacelle and rotors). Repowering may result in taller turbines with larger rotor diameters that occupy larger air space, but also reduces the total number of turbines due to the increased energy production and land use constraints (Kitzing et al. 2020). A number of repowering projects have already occurred or are currently underway (Shepherds Flat, Stateline and Vancycle) and repowering is expected to continue throughout the CPE.

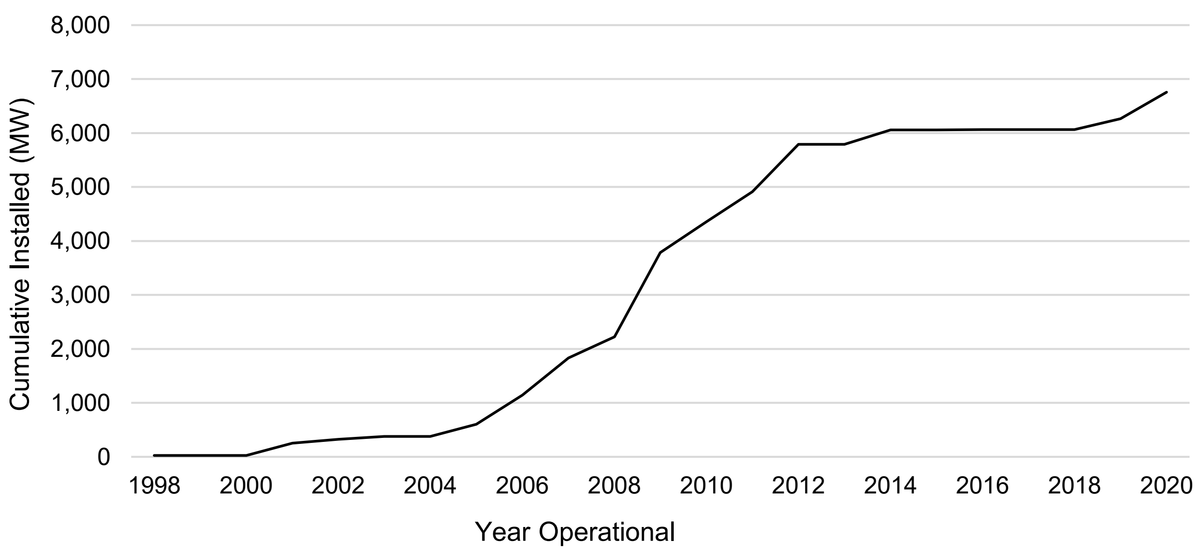

Figure 8. Cumulative installed wind energy (MW) per year within the Columbia Plateau Ecoregion, 1998−2020. Energy production represents the cumulative nominal nameplate capacity.

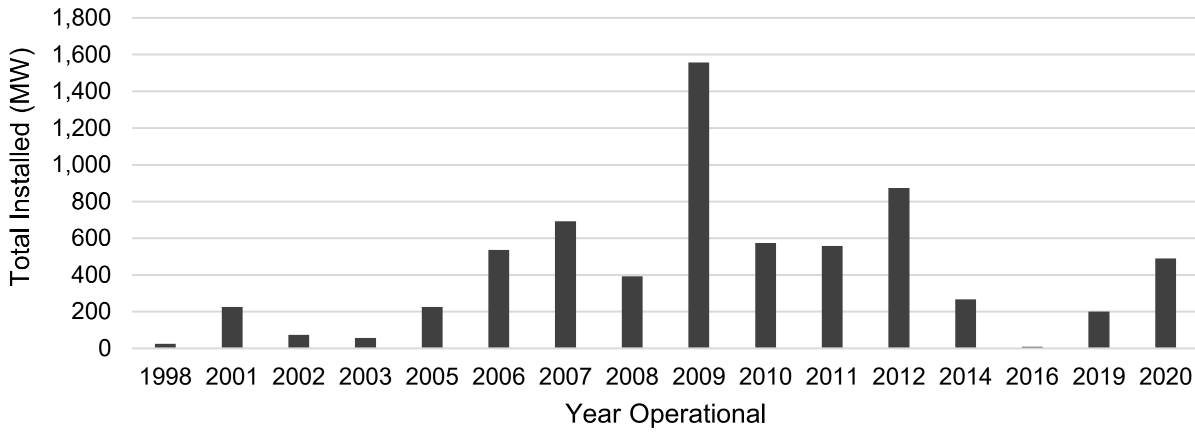

Figure 9. Total installed wind energy (MW) per year within the Columbia Plateau Ecoregion, 1998−2020. Energy production represents the total nominal nameplate capacity.

Photo 7. Operational wind energy turbines in eastern Klickitat County, Washington, May 2020.

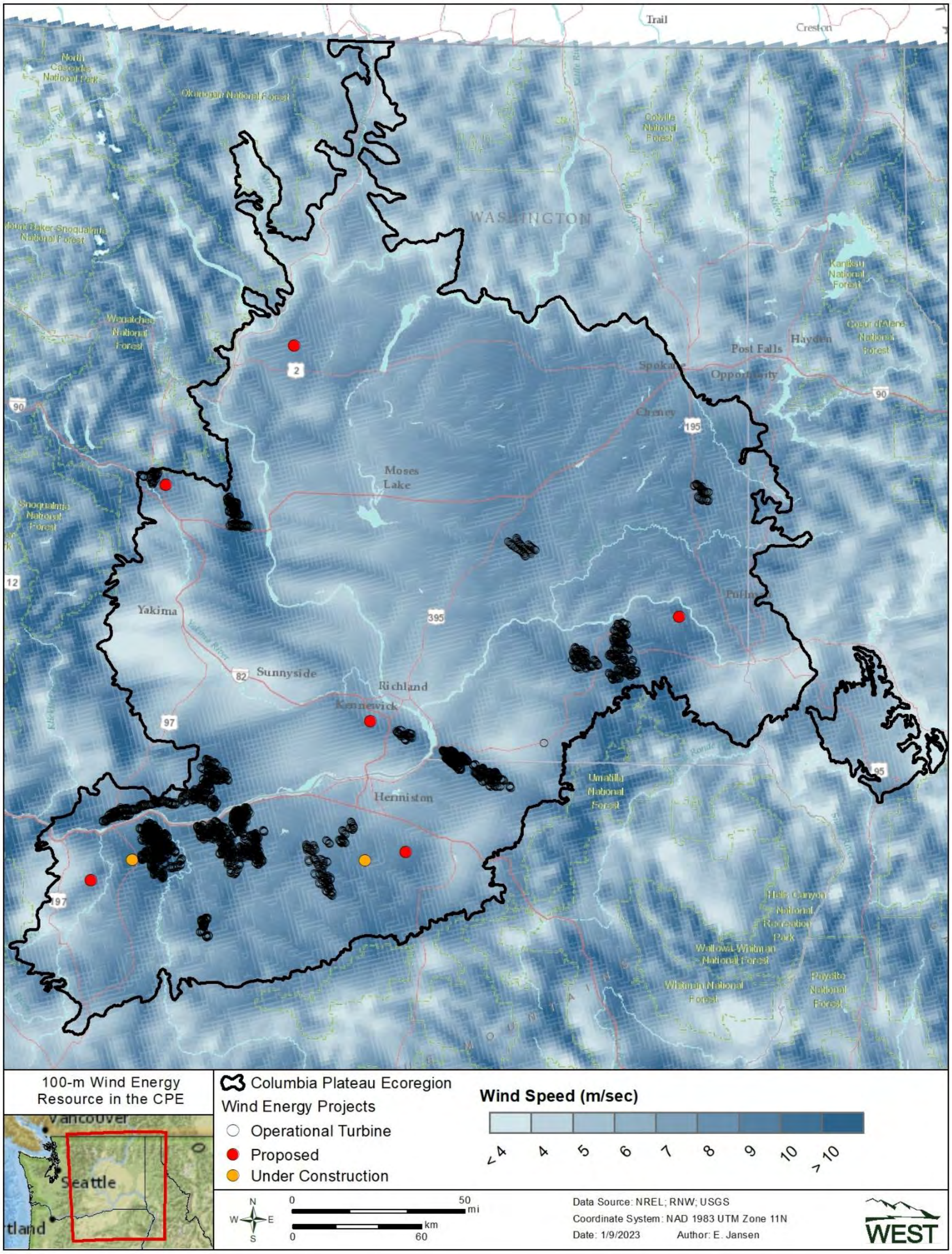

Figure 10. Wind energy projects and average annual wind speed at 100 m above ground level within the Columbia Plateau Ecoregion.

2.2.2 Solar Energy Development

The majority of installed USSE in Oregon and Washington was located outside the CPE; development of USSE in the CPE has been recent compared to wind energy development. Solar development in the CPE began in 2016 with the installation of the 1.3 MW Moyer-Tolles Solar Station by the Umatilla Electric Cooperative. Development remained relatively stagnant for the next three years until 2020 when the amount of installed or proposed capacity increased from 236 MW to 3,603 MW planned through 2025[7] (Figure 11). Of the 48 USSE projects in the CPE, five were operational, nine were approved or under construction, and 34 were proposed as of December 2020. The range of installed or proposed project capacity is high (1.3−500 MW, average = 94 ± 119 MW) although projections included in permit applications do not always result in the eventual installed capacity. Modifications to project capacity after the permit application has been submitted results from a number of factors including engineering, environmental, and financial.

Absent federal or state-specific USSE siting guidelines for the CPE, solar siting currently relies on the procedures and guidance described in the aforementioned wind energy siting guidelines. Siting considerations for USSE differ from the issues posed by wind energy development and focus more on impacts to land cover and land use because of the design of USSE that consolidates development on blocks of land (Bolinger and Bolinger 2022). The tracking panels commonly used in the CPE have a lower power production per acre (0.18 MW/ac) compared to fixed panels (0.28 MW/ac) because of the wider space needed between rows to avoid self-shading (Bolinger and Bolinger 2022). The most productive solar resources, as measured by the average annual solar potential (kW hrs/kW potential), are located in the western third of the CPE; however, solar resources are more uniform through the CPE compared to wind resources, resulting in greater flexibility in siting options (Figure 12). The capacity of USSE typically requires development closer to existing transmission lines (i.e., ≤ 2 mi) unless the scale of the project allows the construction of new transmission. For example the scale of the proposed 500 MW Wagon Trail Solar Project allows the construction of a new eight mile 230-kV transmission line, whereas smaller projects like Goose Prairie Solar (80 MW) and Quincy Solar (120 MW) are directly underneath existing transmission. We assume future USSE development will generally align with the existing and proposed transmission infrastructure within the broad area of solar resource potential within the CPE.

[7] Includes 26 projects for which data were available and should be interpreted as a minimum estimate

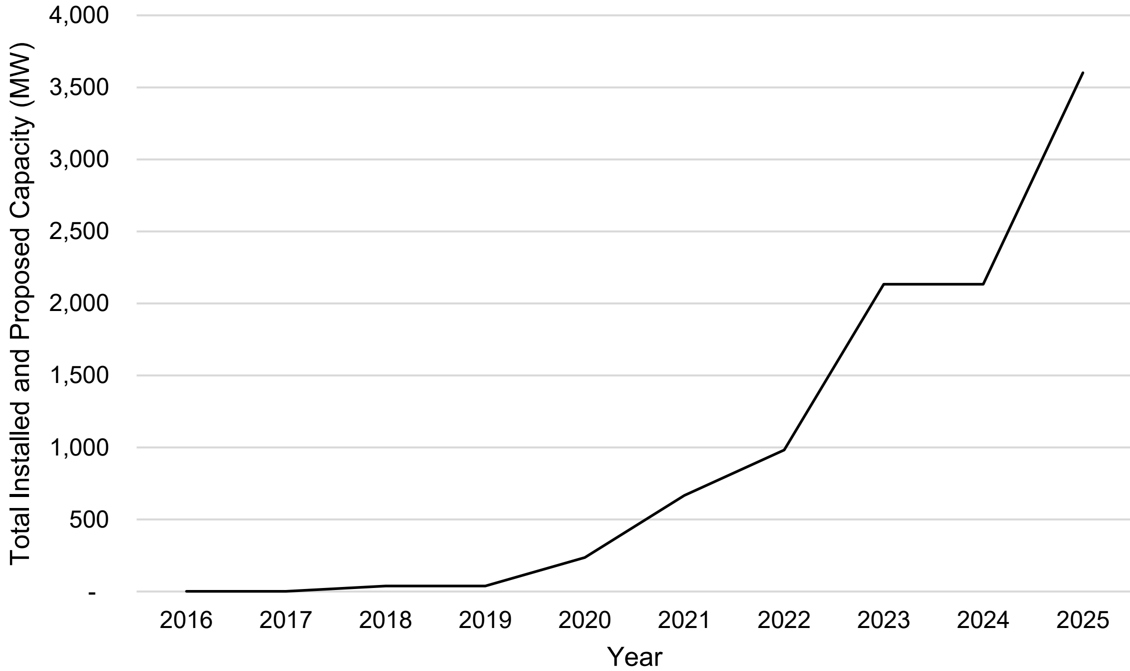

Figure 11. Cumulative installed and proposed USSE projects within the CPE.

Photo 8. An example of a newly constructed USSE facility co-located with wind energy in dryland wheat agriculture, Sherman County, Oregon, March 2022.

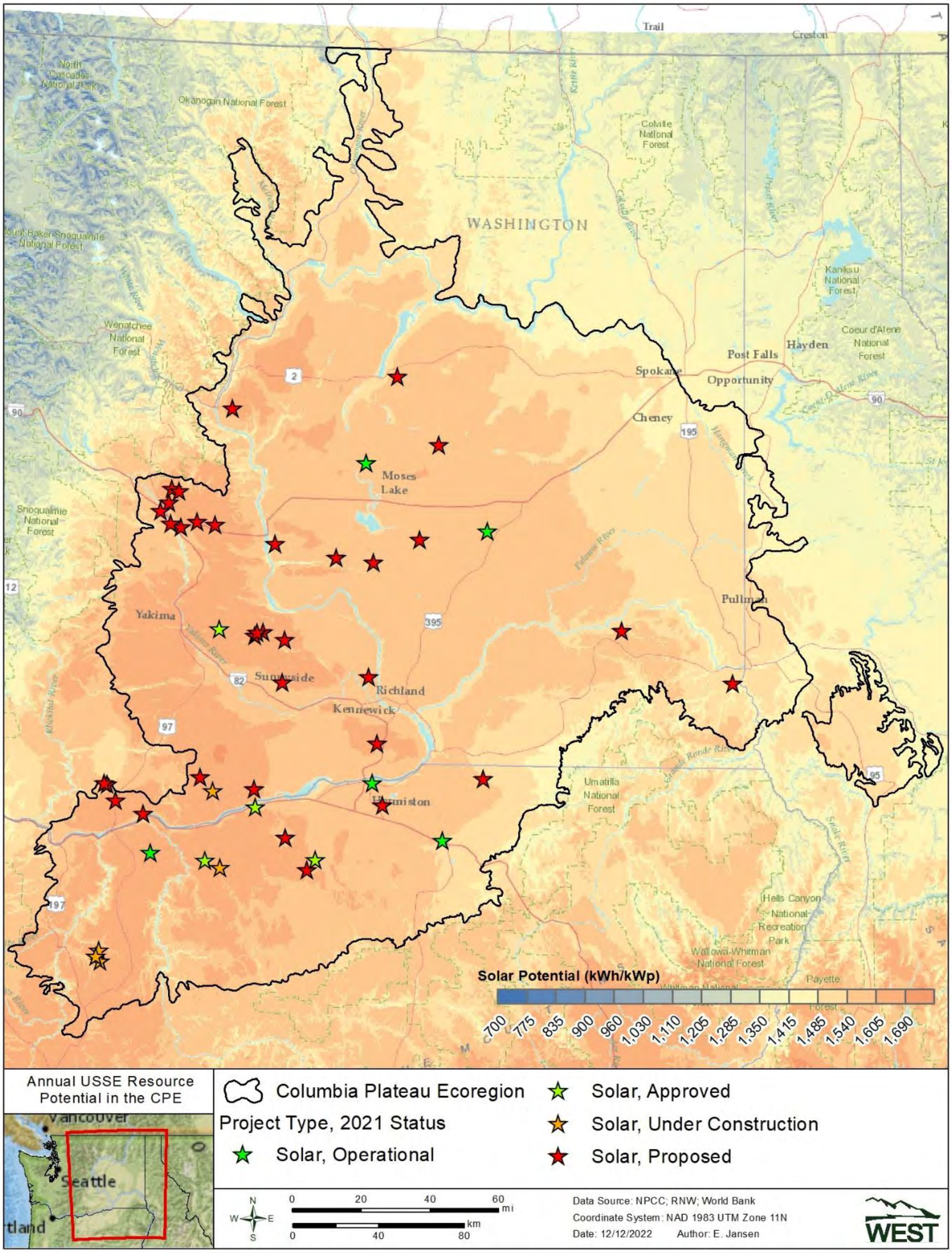

Figure 12. Average annual USSE power potential, 1999−2018 (World Bank 2020). Potential is calculated as kW produced per hour divided by annual kW produced at peak performance.

Photo 9. Construction of a USSE project in Morrow County, Oregon, March 2022. Visible infrastructure includes access roads, PV panels, posts, and associated electrical infrastructure.

2.2.3 Projected Scenario of Installed Capacity

The 2021 Northwest Power Plan (NPP) provides the most comprehensive analysis of current and future renewable energy scenarios over the next two decades (Northwest Power and Conservation Council [NPCC] 2021). The NPP models integrate technological, economic, social and political drivers that forecast various renewable energy development scenarios at multiple scales including the WECC and the NPP Region located primarily in Oregon, Washington, Idaho and Montana (Region; Appendix F3). The Region is defined as all areas within the Columbia River Basin plus areas outside the Basin where BPA is able to sell power (NPCC 2021). Located within the Region, the CPE is part of a broader decentralized electrical grid that exchanges power throughout the WECC and between subregions with local utilities that require unique resource potential and seasonal demands (Appendix F3). Accordingly, forecasted estimates of installed capacity within the CPE will respond to the regional trends and the WECC. Aside from policy initiatives, the most influential factors affecting renewable development in the CPE include the retirement of coal-fired power plants and the elimination of new natural-gas-fired generation from the fleet of available resources in the Region (NPCC 2021).

This assessment used three models from the NPP as a basis for comparison to forecast a range of reasonably foreseeable scenarios of installed capacity within the CPE, 1) Baseline, 2) Early

Coal Retirement, and 3) Early Coal Retirement – No New Natural Gas. Each scenario has a wide array of assumptions[8] that introduce uncertainty and are not intended to represent a particular forecast of an expected future (NPCC 2021). However, in the context of this assessment, the range of installed capacity described by the scenarios provided the sideboards for estimating cumulative impacts.

- Baseline: Develops the foundation from which subsequent scenarios are modeled. The baseline does not assume business as usual, rather, the baseline is responsive to meet renewable energy policy objectives, assumes increases in energy efficiency, affects from climate change on river flows for hydropower generation, and alignment with the expected retirement schedule[9] for regional coal plants, among other factors. The NPP recommends a minimum of 3.5 GW of new renewable generation by 2027 as a cost-effective option for meeting demand and policy objectives (NPCC 2021).
- Early Coal Retirement: Assumes an advanced retirement schedule for coal fired plants within the Region. Early retirement of 13 coal plants in the Region by 2026 will create a deficit of 7.43 GW of capacity (NPCC 2021). Greenhouse emissions will be reduced by 80% in the Region and 40% throughout the WECC; the discrepancy related to the strong hydrological power system that supports the Region compared to other parts of the WECC. Without limiting the types of new generation, approximately 1,400 MW of new natural-gas-fired generation is expected in the Region by 2030 (NPCC 2021). The proportion of wind to solar development is similar to the baseline but due to the lower nameplate capability compared to coal-fired generation, renewable development proceeds at an accelerated rate over the next decade (Figure 13).
- Early Coal Retirement – No New Natural Gas: Assumes similar conditions in the previous scenario but excludes the development of new natural gas-fired generation in the Region. Considering the decisions that would lead to early coal retirement, it seems unlikely that new natural-gas-fired generation would be considered for replacing retired coal generation (NPCC 2021). By eliminating new natural-gas-fired generation from consideration, the expected renewable-energy addition in the Region substantially increases (Figure 13). Conversely, removing limits to new natural gas generation would substantially reduce the need for renewable energy to supplement the demand; however, policy objectives would not be met.

The NPP scenarios estimated between 8.2 GW and 12.3 GW of new renewable energy capacity within the Region by 2030 (Figure 13). The extreme complexity of long-term forecasting and the associated uncertainty resulted in a simplification for the purposes of this assessment. NPP models and electrical utilities function at much larger geographic scales than the CPE; therefore,

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8 Nearly every facet of the supply and demand chain of power generation was modeled in the NPP; from energy efficiency and demand responses, fluctuating energy prices, population changes, greenhouse gas parameters, climate change considerations, to social costs of carbon, each factor having a different effect on the scenario. Readers are directed to the 2021 NPP and supplemental material for a comprehensive description of each scenario, which is beyond the scope of this assessment.

9 As defined as the announced retirement date or end-of-useful life dates used in utility Integrated Resource Plans.

to simplify the application and interpretation, this assessment considered a development scenario of 10 GW in the CPE by 2030 (Figure 13). This assessment addressed uncertainty in which types of technology will be used to achieve the 10 GW scenario using two models to derive the percent of new capacity expected from wind and USSE in the CPE.

- *Model 1*: Considering the Early Coal Retirement scenario, total new installed capacity was calculated WECC-wide for wind energy and USSE by 2030. Of the 370.9 GW of new capacity in the WECC, approximately 156.5 GW (42%) will be from wind energy and 214.4 GW (58%) will be from USSE (Table 5).
- *Model 2*: Preferred portfolio objectives from Integrated Resource Plans[10] of five major regional utilities were used to calculate Regional new capacity expected from wind and USSE sources by 2030. Utility IRP's forecast approximately 11.7 GW of new resource additions, of which approximately 7.2 GW (62%) will be from wind energy and 4.5 GW (38%) from USSE (Table 5).

Table 5. The proportion of new wind and USSE capacity used to estimate the range of potential development outcomes in the CPE by 2030. The balance of this estimate was used to generalize productive estimates.

Model	Data Source	Scale	Total (GW)	% Wind	% USSE
1	NPP Early Coal Retirement	WECC	370.9	42	58
2	Utility IRP*	Region	11.7	62	38

* IRP = Integrated Resource Plan. See footnote [10]

Models illustrate a regional difference in the level of wind energy development versus USSE; likely influenced by the strong solar resources found in the arid southwest region of the WECC. Nevertheless, this assessment considered a range of scenarios to account for uncertainty that included 40% new USSE and 60% new wind energy development and vice versa to achieve 10 GW of new generating capacity. Assuming a current wind generating capacity of 6,757 MW, future nominal installed capacity would be 10,757 MW and 12,757 MW, for the 40% and 60% scenarios, respectively.

[10] 2021 IRPs from Avista Corporation, Idaho Power, PacifiCorp, Portland Gas & Electric, and Puget Sound Energy were referenced and can be found on their corporate websites. Analysis excluded battery storage technology, for consistency.

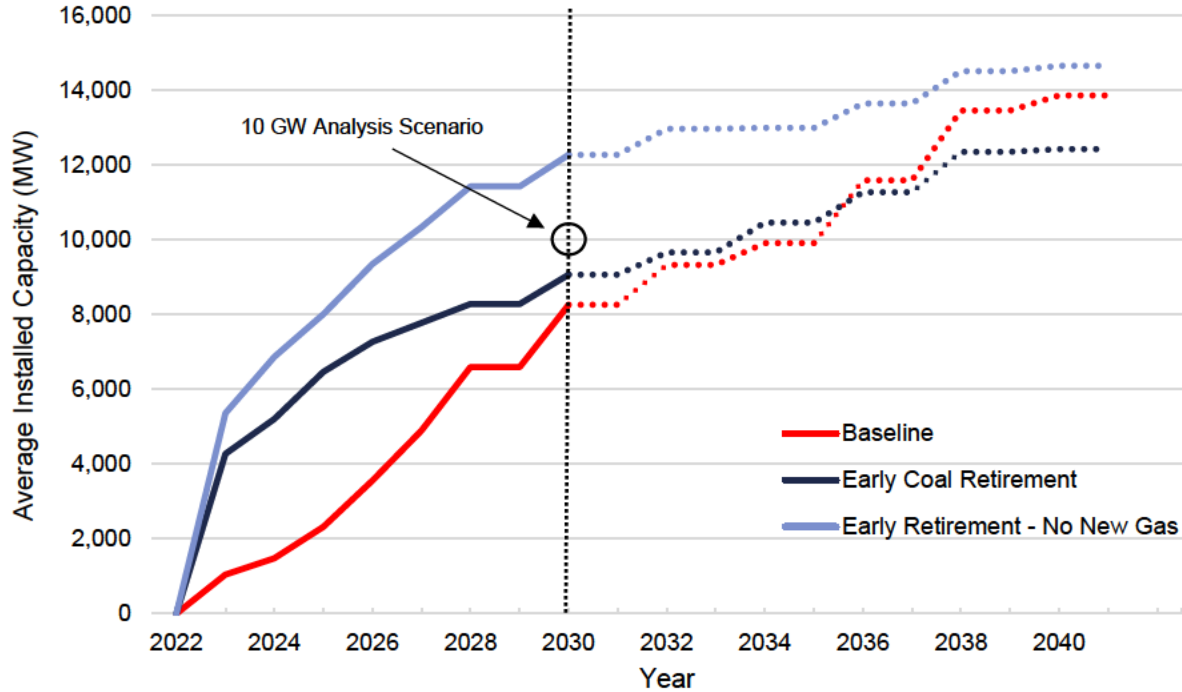

Figure 13. Forecasted new renewable energy generation scenarios within the NPP Region through 2030 and beyond.

2.2.3.1 Transmission

To meet renewable energy policies, the construction of new electrical systems and system upgrades will form the backbone of the expanding renewable energy demand. In response, electrical utilities are undertaking a number of projects throughout the CPE to accommodate the expansion or upgrade of all voltage classes and related infrastructure (substations). In 2022, BPA identified 116 requests for transmission totaling 5,842 MW of capacity, mainly from proposed solar and wind energy projects in the CPE that would require $845 million in system upgrades (Harrison 2022). The 290 mi 500-kV Boardman to Hemingway Transmission Line Project will increase the transmission capacity by one gigawatt between eastern Oregon and Idaho and is scheduled for service in 2026. The 100 mi Cascade Renewable Transmission Project will increase the transmission capacity by 1.1 GW, linking the renewable energy sources in the CPE to load centers in Portland, Oregon via a submarine cable trenched into the Columbia River and is scheduled for service in 2026. BPA's Tri-cities Reinforcement Project will include a number of new 115-kV lines, substations, and system upgrades from 2022−2025 that will increase transmission capacity by 1.75 gigawatts and provide reliability in the Kennewick, Pasco, and Richland area. Public utility district's pursue distribution and sub-distribution projects to maintain and expand electrical services to the growing population within the CPE. The expanding application of battery storage and pumped storage (i.e., non-wire alternatives) will play an emerging role to balance distribution during off-peak time and supplement traditional renewable energy sources. Strategic use and placement of battery storage can optimize a constrained transmission system, eliminate the need for new transmission, and increase overall renewable capacity (NPCC 2021).

3 METHODS

For wind energy development, this assessment provided a qualitative analysis of post-construction fatality monitoring (PCFM) studies, estimated bird populations, and published literature of existing sources of mortality to compile a cumulative impact assessment of bird and bat populations. The general approach was to summarize fatality monitoring studies at operational wind energy facilities within the CPE, and use those results to estimate impacts for a projected 4–6 GW of additional wind energy development within the same ecoregion. Impacts from wind energy development were placed in context with other sources of bird and bat mortality.

For USSE development, this assessment assumed a land-based modeling framework that developed a spatially explicit model that quantified the underlying land cover and biological resources in areas where development may occur in the future. The general approach was to summarize potential resources affected assuming a projected 4–6 GW of additional USSE development. This assessment used a land-based approach due to the limited publicly available data on bird and bat fatalities at USSE.

3.1 Wind Energy Development

3.1.1 Fatality Estimates from Post-construction Fatality Monitoring (PCFM)

The foundation of this cumulative impact assessment was to quantify bird and bat fatalities documented at wind energy facilities within the CPE. Prior to analyses, state wildlife agencies, county planning departments and state permitting councils were contacted to obtain all publicly available PCFM studies. All details of the project (number and specification of turbines), study area (primary habitat types), species counts, and fatality estimates of primary groups (all birds [excluding raptors], raptors, and bats) were entered into a relational database that contained PCFM data throughout the US to facilitate comparisons of wind mortality within the CPE to broader geographic scales (WEST 2021). A *project* was defined as a facility that was permitted or developed as a unique entity; separate phases were considered separate projects (e.g., Biglow Canyon I, II, and III represent three separate projects). A *study* was defined as a survey period when PCFM was reported and traditionally consisted of one full year (four seasons) of data collection. *Seasons* were defined as spring (March – May), summer (June – August), fall (September – November), and winter (December – February). Data as reported in the original study were used without modification or reanalysis. Caveats reflecting the statistical robustness of each study are presented in Appendix T2.

The average annual fatality rate per MW (fatalities/MW/study period) was calculated by group. Estimates on a per-MW scale facilitated comparisons across projects with wind turbines that have varying dimensions. Fatality estimates were reported for primary groups including All Birds, Raptors (including Diurnal Raptors, Owls and Vulture groups), and Bats. The All Bird group was divided further into similar phylogenetic groupings (e.g., Passerines, Waterbirds, Shorebirds) to calculate species composition and temporal patterns of fatalities.

3.1.2 Bird Population Estimates

To define the bird population within the CPE, the assessment used BBS data collected from 2006−2015 within the Great Basin BCR 9 and the Partners in Flight approach (PIF; Will et al. 2020). The PIF Population Estimate Database (PED) represents the most recent analysis of BBS data available for the region and substantially improved previous versions (Blancher et al. 2007) to incorporate confidence intervals that address uncertainty, adjustments to account for detection probability, and incorporate adjustments for time-of-day and groups of birds (Will et al. 2020). Estimates from the PIF PED represent the most statistically rigorous estimates of bird populations within North America and were used in all analyses unless otherwise noted.

The PIF's population estimation methodology was designed to provide a consistent approach across all landbird species and across the Great Basin BCR and subregions. Thus the PED breeding season estimates provide regional context for environmental impact assessments, assessments of population vulnerability and resiliency, and the cumulative effects of various sources of mortality on bird populations (Will et al. 2020). To provide additional context, this assessment used BBS population trend estimates (percent annual change, 2006–2019), associated confidence intervals, and measures of regional credibility to further inform bird population trends and the potential effects of cumulative impacts (Thomas and Martin 1996; Appendix T5).

PIF population estimates used species counts collected from 2006−2015 along 147 BBS routes within the Great Basin BCR 9 of Idaho, Oregon and Washington (Physio-political Region). Using these data to represent the total breeding population of the Tri-state area, this assessment extracted population estimates from the PIF PED by Physio-political Region to obtain a population estimate within the BCR by state. Bird populations within the CPE were calculated as a proportion of area located within the Great Basin BCR 9 (Table 6, Figure 14). Unrounded population estimates within each Physio-political Region were multiplied by the percentage of CPE located within the Great Basin BCR 9, then summed to derive a single population estimate for 172 bird species (Table 6; Appendix T5). Using this reductive, proportional approach, confidence intervals calculated in the PIF PED for the entire Great Basin BCR were not applicable to the CPE population estimates. An example using American kestrel (*Falco sparverius*) is calculated in Table 7.

Birds were divided into two primary groups that included an All Bird group (excluding raptors) and a separate Raptor group to identify possible relative cumulative impacts to bird species. Groups were differentiated to distinguish between the variable resilience to stressors on a population in groups that include shorter-lived species with high biological productivity (e.g., passerines; r-selected species) and longer-lived species with low biological productivity (e.g., raptors; K-selected species) that may be more susceptible to changes in populations from environmental or demographic stressors (Parry 1981). Because of their conservation concern, bird species characterized as sensitive were evaluated in greater detail to identify potential issues of cumulative impacts from wind energy development (Appendix T1).

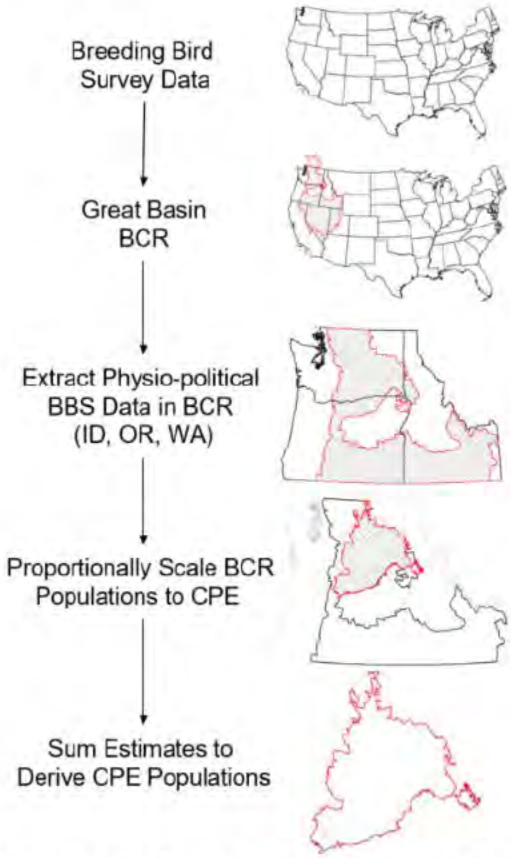

Figure 14. Geographic scales used to derive bird population data in the CPE.

Despite the robust modeling framework on which the PIF PED and BBS was built, this assessment acknowledges a number of important limitations identified during the application of this methodology.

- Bird population abundance was uniform throughout the Great Basin BCR and each corresponding Physio-political Area.
- Species' population estimates were based on BBS data collected during the breeding season at a time of year when some migratory species may not be present. Impacts to species that migrate thought the CPE may not represent the local population found in the CPE.
- Species abundance may be so low that population estimates were unavailable despite on-going conservation concern.

To address these uncertainties, population data for a sensitive species that were unavailable or noted as deficient in the PIF PED were queried through alternative sources. Other sources included technical species assessments, abundance and population tends to evaluate potential effects of cumulative impacts (USFWS 2016, eBird 2021). Data requested from the USFWS for CPE-specific information on golden eagle and bald eagle mortality was unavailable at the time of writing; therefore, data regarding eagle mortality and population sizes in the CPE were derived from USFWS (2016, 2019, 2022).

Table 6. Percent of Columbia Plateau Ecoregion Level III within the Great Basin Bird Conservation Region 9.

State	Area of CPE by State (ac)	Area of Great Basin by State (ac)[1]	State-specific % of CPE in GB
Idaho	945,584	27,307,900	3.46
Oregon	4,370,940	28,552,400	15.31
Washington	15,226,200	24,525,800	62.08

1. Physio-political Region.

Table 7. Example population estimate of American kestrel within the Columbia Plateau Ecoregion, derived from Great Basin BCR Population Estimates within each Physio-political Region (Will et al. 2020)

State	GB Pop. Estimate	Lower 95%	Upper 95%	% of CPE in GB	Pop. in CPE by State[1]
Idaho	91,115	47,954	161,624	3.46	3,155
Oregon	73,959	35,355	131,624	15.31	11,322
Washington	55,126	28,123	95,453	62.08	34,223
			Total Population in CPE		**48,700**

[1.] Example population estimate reflects minor rounding errors. For example, as expressed, Idaho was 91,115 × 0.346 = 3,152 birds.

Current and projected annual bird mortality from wind turbines were derived from publicly available PCFM data and future wind energy scenarios. First, to estimate the number of annual fatalities in each primary group, the average annual fatality rate by group was multiplied by the total nominal generating capacity (MW) for each development scenario. Second, the total number of individuals by species documented during PCFM was divided by the total number of individuals per group to estimate the percent composition of each species. Finally, total annual mortality by group or species was estimated by multiplying the percent species composition by the predicted generating capacity for each development scenario.

The potential for cumulative effects to occur for a particular group or species was evaluated by calculating the proportion of the CPE population affected by turbine mortality, considered BBS population trend indices (Appendix T5) and life history traits for a particular species (e.g., r-selected versus K-selected). For example, sustained population-level impacts resulting from 10% annual mortality in a population of 10,000 red-tailed hawks (*Buteo jamaicensis*) was more likely than 10% mortality in a population of 10,000 yellow warblers (*Setophaga petechia*).

3.1.3 Bat Population Estimates

Bat populations continue to be a difficult group to estimate reliable population sizes (O'Shea and Bogan 2003). No reliable population estimates were available in the western US that can be reduced to a regional scale, similar to the methodology used to estimate bird populations in the CPE. Absent reliable bat population data in the western US, impacts to bat populations from wind energy operation were quantified from post-construction fatality studies and compared to other sources of bat mortality.

3.2 Solar Energy Development

Areas of USSE development and the associated impacted land cover and biological resources were developed using areas of USSE potential and land use constraints. A Geographic Information System (ArcMap 10.7.1, Redlands, California) was used for all aspects of the model framework. A number of USSE developers operating in the CPE were contacted prior to data collection to identify primary constraints considered during USSE siting. Combined with their feedback, exclusionary criteria identified in BLM and DOE (2010) were used to develop a constraints layer.

The spatially explicit model used a hierarchical approach that first identified areas where USSE development was mostly likely based on the existing electrical transmission grid. Proximity to transmission lines and substations is a limiting factor in USSE development and projects are typically sited as close as possible to reduce the amount of new transmission construction. All transmission lines, regardless of voltage, were buffered by a 2-mi radius (potential development area; PDA). After the PDA was created, areas where USSE development was unlikely were excluded based on a variety of bio-physical and human-built constraints. Bio-physical constraints included topography greater than 10% slope and perennial water features including lakes and freshwater ponds. Human-built constraints included lands managed by federal agencies, non-governmental organizations, First Nations, and delineated as urban growth boundaries (Table 8; Appendix F6).

The remaining areas in the PDA considered the USSE development corridor (corridor) were quantified and included land cover and biological resources (Figure 15). Land cover included NLCD land cover types and USFWS wetlands; biological resources included federal or state-listed or sensitive wildlife, plant, or high-value plant communities tracked by state Natural Heritage Programs (NHP) and Audubon IBAs (Table 8). The NHP species with a greater number of records in the corridor were analyzed for species-specific affects and spatial patterns. In addition, potential overlap with habitat concentration areas (HCA) and least cost pathways (LCP) between HCAs were evaluated for two focal species that require large areas of habitat, Rocky Mountain mule deer (*Odocoileus hemionus hemionus*; mule deer) and greater sage-grouse (*Centrocercus urophasianus*; sage-grouse; Appendix F6). Modeled specifically for the CPE, HCAs were defined as significant habitat areas that are expected or known to be important for focal species based on survey data or habitat association modeling, and LCPs were defined as optimal connectivity corridors between HCAs with the least resistance to movement (Washington Wildlife Habitat Connectivity Working Group [WHCWG] 2012). Focal species represented a highly mobile species that can move long distances between summer and winter ranges (mule deer) and a sagebrush obligate species with isolated sub-populations that rely on connectivity for genetic intermixing and population viability (sage-grouse).

The proportion of an area or number of biological resources within a corridor was compared with resources outside the corridor. Resources were mapped and quantified to provide an indication of resources most likely to be impacted by USSE. Adjusted for area, the relative proportion of a resource within the corridor compared to outside the corridor was used as a metric to identify resources that may be more at risk of impacts from USSE development. A resource was identified as having a relatively disproportionate risk of impacts from USSE development by calculating the proportional difference between resources within and outside the corridor using an index called a vulnerability score. A vulnerability score (V) was calculated as,

$$V = \frac{a_i}{x} - \frac{a_o}{x}$$

where a_i was the amount (mi, mi^2, or #) of a particular resource inside the corridor divided by the total resource documented in the CPE (x) subtracted by the amount of the resource outside the corridor (a_o) divided by the total resource documented in the CPE (*x*). The difference of the proportions was interpreted as a vulnerability score on a scale of -1 to 1 where negative values represented resources with proportionally less resources located inside the corridor, values near zero indicated an equal proportion of resources within and outside the corridor, and positive values represented a higher proportion of resources within the corridor than the larger area of the CPE. For focal species, linear regression was used to identify the correlation between the vulnerability score and the total size/length of the HCA/LCP within the CPE.

Caveats to note when interpreting results include the sampling bias inherent with Natural Heritage Program data which often do not represent a systematic sample of the species range or habitats. Because a resource has not been recorded in a particular area does not necessarily mean it is absent and may rather result from a lack of survey effort. Similarly, the number of records of a species does not reflect the biological abundance of a species in a particular area, rather, records are used as a relative comparison of where a species was most often documented and proxy for occurrence absent more rigorous data of population abundance on a landscape scale. Issues with spatial accuracy and resolution can result in misrepresenting the geographic location of the resource. Spatial accuracy issues arise when records are plotted from written notes or coarse mapping, while resolution issues arise when the location of sensitive data are generalized (masked) for resource protection purposes. In Washington, spatial accuracy varied up to 0.25 mi and had fine resolution, while accuracy in Oregon varied up to 2.5 mi and had poor resolution. Because of the poor resolution in Oregon with an average spatial resolution of 10 ± 76 mi^2, Natural Heritage data were only analyzed for Washington Priority Habitat and Species (WDFW 2022). Finally, the ranges of some species are highly restricted (greater sage-grouse) and do not have an equal probability of occurring throughout the CPE; thus comparisons between the affected resource and habitat availability/resource occurrence outside the corridor should be interpreted with caution.

Table 8. Covariates used to model biological resources potentially affected by USSE development in the Columbia Plateau Ecoregion.

Covariate	Measurement Type	Description	Reference
Inclusion Layer			
Electrical Transmission	Area	All lands within 3 mi radius of all voltage types	Oak Ridge National Laboratory 2022
Exclusion Layers			
Slope	Percent	>10% average slope in 30×30 m DEM	Leu et al. 2008
Wetlands	Area	Perennial waters (lake, freshwater pond)	USFWS 2022
Ownership	Area	Federal, Non-governmental organization, First Nations	USGS 2022
Urban Areas	Area	Urban Growth Boundary	DLCD 2022, Washington GeoServices 2022
Resource Layers			
Land Cover	Area	All land cover types excluding Developed and Waters	NLCD 2019
Natural Heritage Data	Area, # Occurrence	Federal and state listed wildlife, plants, and vegetative communities	WDFW 2022
Rare Plant Locations	Area # Occurrence	Current rare and imperiled species and plant communities	WDNR 2022
Rock Mountain Mule Deer	Area, Length	Habitat Concentration Areas and Least Cost Path Linkages	WHCWG 2010
Greater Sage-grouse	Area, Length	Habitat Concentration Areas and Least Cost Path Linkages	WHCWG 2010
Important Bird Areas	Area	Global and State classifications	Audubon 2022
Wetlands	Area	All wetland types, excluding lakes and freshwater ponds	USFWS 2022

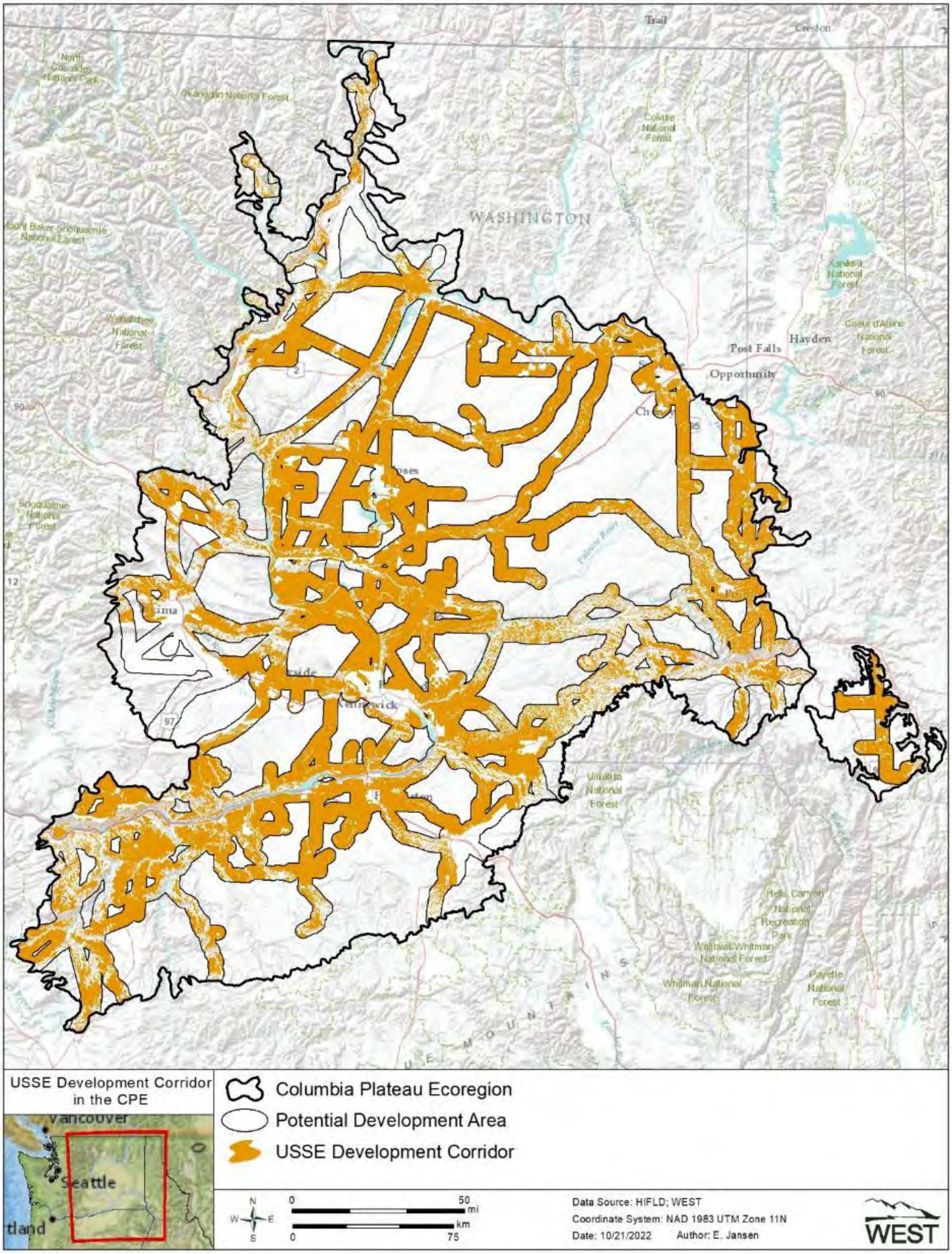

Figure 15. Corridor used to identify land cover and biological resources potentially affected by USSE development within the Columbia Plateau Ecoregion.

4 RESULTS

Of the 65 operating wind energy facilities in the CPE[11], 55 PCFM studies at 42 projects were used to calculate overall fatality estimates. Raptor fatalities were not reported in seven studies and were reported as zero in 10 studies (Appendix T2). Bat fatalities were reported in 48 PCFM studies at 37 projects. Collectively, PCFM data used in this assessment reflected a 120% increase of available studies and 61% increase of projects reporting bird and bat fatality estimates since Johnson and Erickson (2011). Fatality estimates from Nine Canyon II and Condon were not used due to the limited study period, as well as the absences of bias trials and use of a statistically meaningful estimator (Fishman Ecological Services 2003, Erickson et al. 2005). Statistical caveats inherent to PCFM studies used to calculate average annual fatalities are noted in Appendices T2 and T4.

4.1 Existing Data from Wind Energy Facilities

4.1.1 Overall Bird and Bat Fatality Estimates

The average All Bird (excluding raptors) fatality estimate was 2.57 birds/MW/year (0.16−8.45 ± 1.95 birds/MW/year). The average Raptor fatality estimate was 0.12 birds/MW/year (0.00−0.47 ± 0.12 birds/MW/year). Annual estimated Bat fatalities were 1.08 bats/MW/year (0.0−3.78 ± 0.12 bats/MW/year; Figure 16). Compared to Johnson and Erickson (2011), mean fatality rates for the All Bird group increased from 2.36 to 2.57 birds/MW/year (8.8%), increased from 0.08 to 0.12 birds/MW/year (50%) for the Raptor group, and decreased from 1.14 to 1.08 bats/MW/year (5.3%) for the Bat group. Based on the average fatality rate from PCFM studies conducted in the CPE from 1999−2020, current annual estimated bird and bat mortality from wind energy was 17,369 birds, 793 raptors, and 7,292 bats based on the installed nameplate capacity of 6,757 MW as of December 2021 (Table 9).

Table 9. Annual estimated bird and bat fatalities at wind energy facilities within the Columbia Plateau Ecoregion. Assumed operational capacity of 6,757 MW as of December 2021.

Group	Range	Median/MW	Mean/MW[1]	1st and 3rd Quartile of the Mean	Estimated Annual Fatalities
All Bird[2]	0.16−8.45	2.33	2.57	1.25−3.10	17,369
Raptor[3]	0.00−0.47	0.08	0.12	0.00−0.15	793
Bat	0.00−3.78	0.77	1.08	0.41−1.75	7,292

1. Summary statistics rounded for simplicity and consistency. For example, mean annual raptor fatalities was 0.11733 birds/MW/year. Use of 0.12 raptors/MW/year would result in 811 raptors/MW/year.
2. Excludes raptors
3. Included diurnal raptors, owls, and turkey vulture (*Cathartes aura*)

[11] As of December 2021 (Hoen et al. 2018 v. 4.2.0).

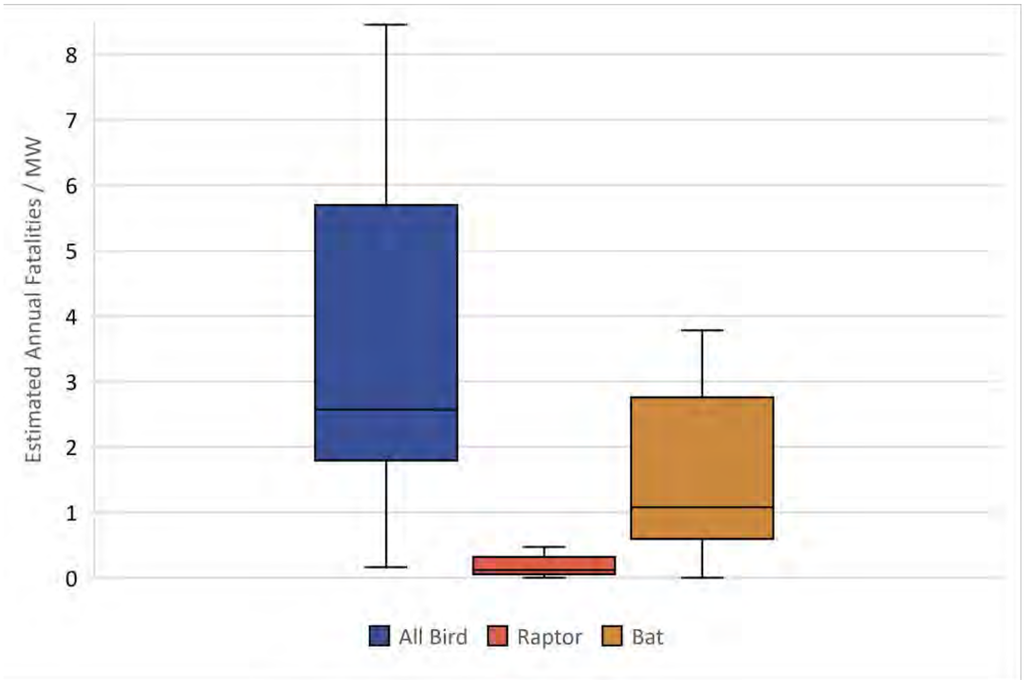

Figure 16. Annual bird and bat fatality estimates from 55 post-construction monitoring studies conducted in the Columbia Plateau Ecoregion, 1999−2020. Box blots represent the average (bar) fatalities within the interquartile range and corresponding maximum and minimum estimates.

4.1.2 Bird Fatalities and Species Composition

A total of 3,073 birds was documented at 42 wind energy facilities during 55 studies conducted from 1999−2020 (Appendix T2). Passerines composed the majority of fatalities (60.5%) followed by Upland Game birds (approximately 11%), Unidentified birds (approximately 9%), and Diurnal Raptors (approximately 8%). Collectively, Owls and Vultures composed less than 2%. The remaining 12% of species included the Doves/Pigeons group and other species' groups that had comparatively fewer fatalities (Table 10). Species commonly associated with aquatic habitats (Gulls/Terns, Loons/Grebes, Rails/Coots, Shorebirds, Waterbirds, Waterfowl) composed approximately 2% of the total fatalities. Aggregated, bird fatalities were documented most often during fall, relatively equal during spring and summer and least often during winter (Figure 17). Of the five groups most commonly found during PCFM, Passerines, Upland Game Birds, Unidentified Birds, and Doves/Pigeons were found most often during fall, whereas raptors were found in relatively equal numbers across seasons (Figure 18).

Since 2011, the total number of estimated passerine fatalities approximately tripled and the number of upland game bird and raptor fatalities doubled, while there was a marginal increase in the collective Waterbird/Waterfowl/Shorebird group from 24 to 37 fatalities (Johnson and Erickson 2011).

Table 10. Total count of fatalities by group documented during post-construction fatality monitoring at operational wind energy facilities within the Columbia Plateau Ecoregion, 1999−2020.

Group	Total Fatalities	Composition (%)
Passerines	1,859	60.49
Upland Game Birds	334	10.87
Unidentified Birds	274	8.92
Diurnal Raptors[1]	242	7.88
Doves/Pigeons	131	4.26
Owls[1]	51	1.66
Large Corvids	34	1.11
Woodpeckers	33	1.07
Swifts/Hummingbirds	28	0.91
Waterfowl	22	0.72
Nightjars	21	0.68
Gulls/Terns	14	0.46
Shorebirds	10	0.33
Rails/Coots	6	0.20
Loons/Grebes	5	0.16
Waterbirds	5	0.16
Vultures[1]	4	0.13
Total	**3,073**	**100**

[1.] groups included in the Raptor group.

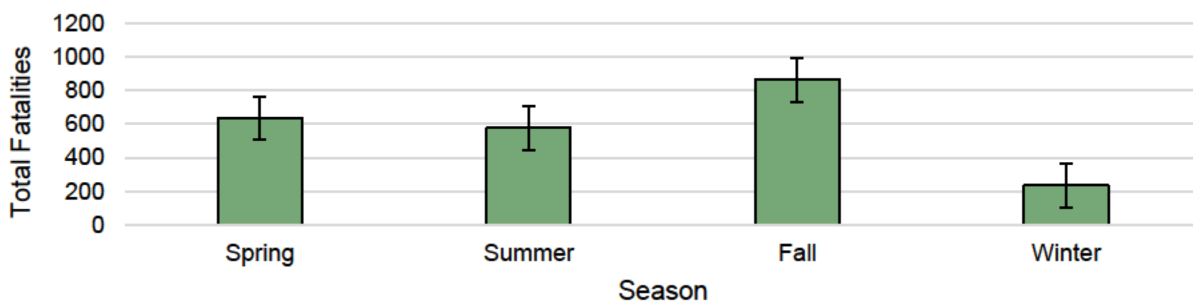

Figure 17. Seasonal count of bird fatalities documented during post-construction fatality monitoring at operational wind energy facilities within the Columbia Plateau Ecoregion (1999−2020). Variance expressed as standard error.

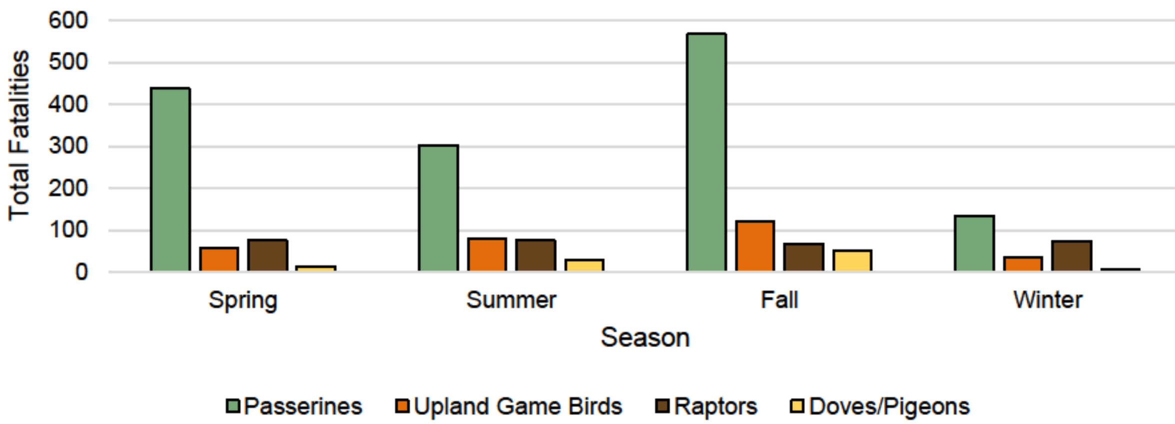

Figure 18. Total bird fatalities by season of the four groups documented most often during post-construction fatality monitoring in the Columbia Plateau Ecoregion, 1999−2020.

4.1.2.1 All Bird Group (Excluding Raptors)

Horned lark (*Eremophila alpestris*) composed the majority of the 2,776 bird fatalities (34.5%) documented during PCFM studies and approximately 48% of fatalities in the Passerine group (1,937 total individuals; Appendix T3). The second most frequent fatality documented during PCFM was an unidentified bird of unknown size (184 occurrences; 7%). Unidentified birds of unknown size were documented when a carcass was either too decomposed to classify into a more specific size class or group (e.g., unidentified large bird or unidentified shorebird) or when the remaining evidence of a fatality are feathers that cannot be identified. If found within a PCFM search plot, the disposition of an unidentified carcass or feather spot was attributed to turbine mortality despite the possibility that the feather spot was the result of a predation event (e.g., raptor plucking area).

As discussed, Passerines composed the majority of all fatalities in the CPE. In addition to horned lark (48% of fatalities), golden-crowned kinglet (*Regulus satrapa*; 6%), western meadowlark (*Sturnella neglecta*; 5%), unidentified passerine (4%), and the non-native European starling (*Sturnus vulgaris*; 5%) composed the top five abundant fatalities in the Passerine group. Both migratory and resident passerine species were documented. Seasonal patterns of fatalities were more pronounced for migratory species such as golden-crowned kinglet, a boreal nesting species, than horned lark, which occurs in the CPE year-round.

Upland game birds composed approximately 11% of all fatalities. Within the Upland Game Bird group, three non-native species accounted for 98% of all mortality: gray partridge (*Perdix perdix*; 46%), ring-necked pheasant (*Phasianus colchicus*; 30%), and chukar (*Alectoris chukar*; 22%).

Bird groups commonly associated with aquatic habitats (gulls/terns, loons/grebes, rails/coots, shorebirds, waterbirds, waterfowl) composed approximately 2% fatalities in the All Bird group. Eighteen species associated with aquatic habitats composed 62 fatalities, of which Canada goose (*Branta canadensis*) was documented most often (18%, 11 fatalities) followed by long-billed curlew (15%, 9 fatalities); however, both species are not obligate aquatic species and are often found in agricultural or grassland habitats, respectively. Obligate aquatic species such as horned grebe (*Podiceps auritus*), Virginia rail (*Rallus limicola*), and sora (*Porzana carolina*), and American white pelican and composed approximately 19% (12 fatalities) of aquatic associated species but <1% of bird fatalities overall (Appendix T2).

Excluding raptors, 8 of the 14 sensitive species that occur within the CPE were documented during PCFM. The sensitive species most frequently documented was common nighthawk (*Chordeiles minor*; 18 fatalities; ODFW Sensitive, WDFW Candidate; Appendix T1). Although upland game birds composed approximately 11% of fatalities, greater sage-grouse and Columbian sharp-tailed grouse (*Tympanuchus phasianellus columbianus*), both WDFW endangered, were not documented during PCFM.

In addition to the species in the Upland game bird group discussed above, species found during PCFM not protected under the Migratory Bird Treaty Act (85 FR 21262) composed approximately 16% (481 fatalities) of all fatalities. Species included European starling (76 fatalities), rock pigeon (*Columba livia*; 61 fatalities), and house sparrow (*Passer domesticus*; 10 fatalities).

4.1.2.2 Raptor Group

The *Buteo* group (broad-winged or soaring hawks) comprised the majority (45%) of the 297 raptor fatalities documented during PCFM studies, followed by species in the Accipiter and Falcon group (33%), and Owls (17%; Figure 19). The remaining species in the Eagle group, Other group (turkey vulture [*Cathartes aura*] and osprey [*Pandion haliaetus*]) and Unidentified Raptor group comprised approximately 5% of raptor fatalities documented during PCFM studies (Figure 19).

Collectively, red-tailed hawk and American kestrel accounted for over half (53%) of all raptor fatalities documented during PCFM conducted from 1999–2020. Red-tailed hawk was the species most frequently documented (80 fatalities) and comprised 61% of the *Buteo* group. Although documented less often than red-tailed hawk, American kestrel (73 fatalities) was the predominant species documented (80%) in the Accipiter and Falcon group. Compared to the *Buteo* and Accipiter and Falcon groups, where fatalities disproportionately comprised one species, short-eared owl (*Asio flammeus*; 16 fatalities, 31%) and barn owl (*Tyto alba*; 14 fatalities, 27%) had a relatively similar number of fatalities documented in the Owl group (Figure 19). Golden eagle carcasses (4) were documented more often than bald eagle carcasses (1).

Six of the seven sensitive raptor species that occurred within the CPE were documented during PCFM. (Figure 19; Appendix T1). The species most frequently documented included Swainson's hawk (33 fatalities, ODFW Sensitive), followed by short-eared owl (16 fatalities; USFWS Sensitive, USFWS BCC) and ferruginous hawk (8 fatalities; WDFW Endangered; Appendices T1 and T3).

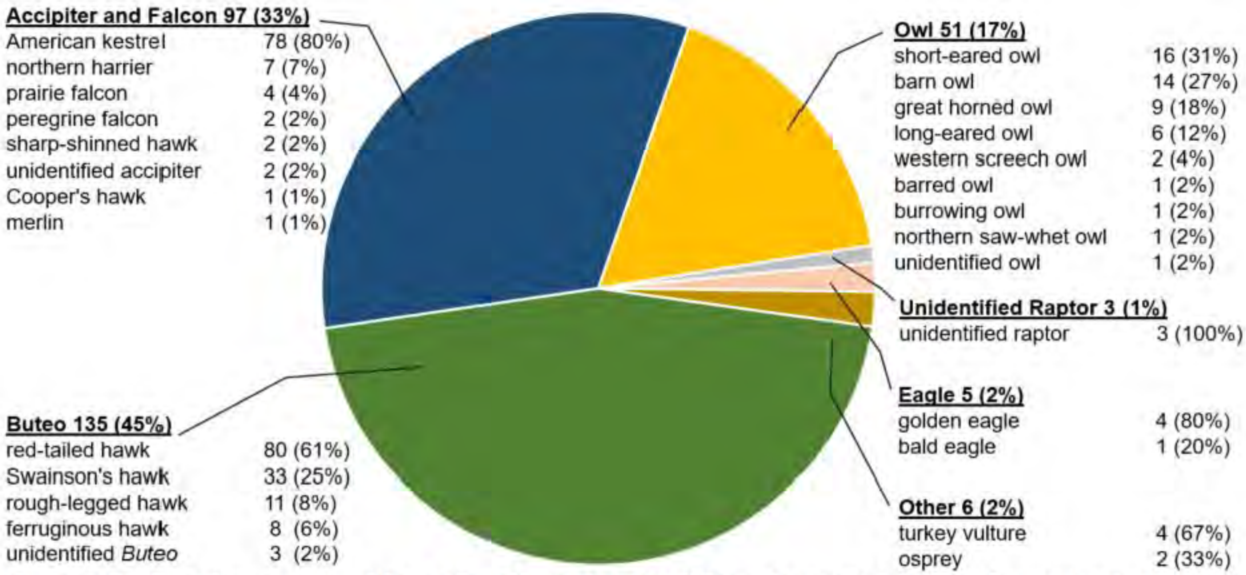

Figure 19. Species composition of 297 raptor fatalities documented in 48 post-construction monitoring studies at wind energy facilities in the Columbia Plateau Ecoregion, 1999−2020.

4.1.3 Bat Fatalities and Species Composition

A total of 1,124 bat fatalities were documented at 37 wind energy facilities during 48 studies conducted from 1999−2020 (Appendix T4). Migratory tree and leaf roosting species including hoary bat (*Lasiurus cinereus*) and silver-haired bat (*Lasionycteris noctivagans*) composed 96% of the bat fatalities in the CPE (Table 11). Fatalities typically occur from April through September, peaking during the fall migration which is consistent with patterns observed in other regions in the US (Figure 20; Goldenberg et al. 2021).

Compared to 2011, the total number of hoary bat and silver-haired bat fatalities nearly doubled with hoary bat replacing silver-haired bat as the species most often found during PCFM. There were marginal increases in the total number of fatalities found for other species with one additional little brown bat and three additional big brown bats documented (Johnson and Erickson 2011).

Table 11. Total count and species composition of bat fatalities documented at 37 projects (48 studies) during post-construction fatality monitoring at operational wind energy facilities within the Columbia Plateau Ecoregion, 1999−2020.

Common Name	Total Fatalities	Composition (%)
hoary bat	573	51.0
silver-haired bat	506	45.0
unidentified bat	29	2.6
little brown bat	8	0.7
big brown bat	7	0.6
unidentified myotis	1	0.1
Total	**1,124**	**100**

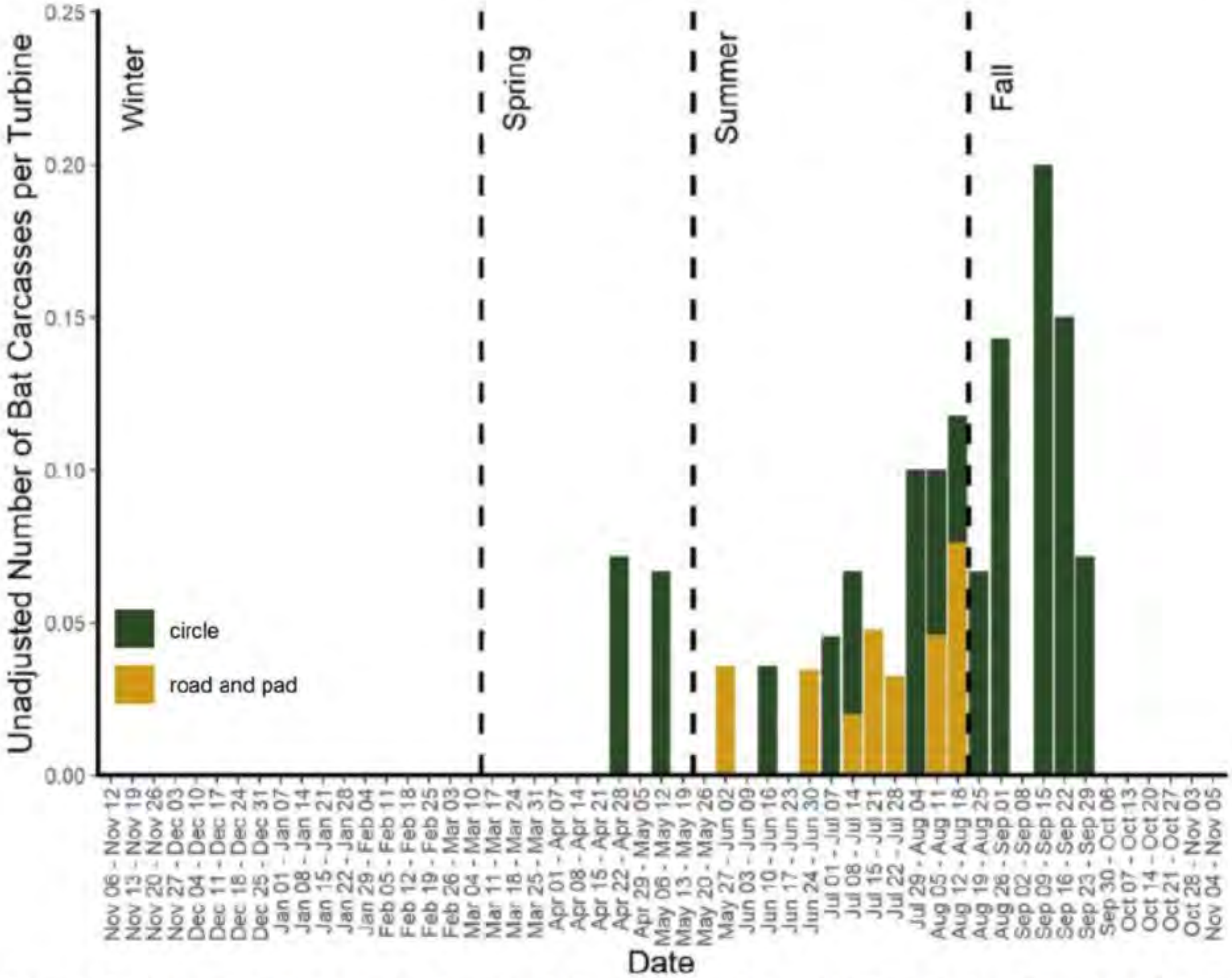

Figure 20. Example of the typical temporal distribution of bat fatalities in the Columbia Plateau Ecoregion. Data from Montague Wind Power Project, Gilliam County, Oregon, November 12, 2019 to November 5, 2020 (Chatfield and Martin 2021). Legend distinguishes PCFM search areas: circle = all ground within 150 m of turbine base, road and pad = high visibility (graveled) areas within 150 m of turbine base. Variable search effort.

4.2 Mortality Estimates and Population Effects

4.2.1 All Bird Group (Excluding Raptors)

Passerines composed the majority of bird fatalities and were found at every project in the CPE (Table 12). Assuming species composition and overall fatality rates remain stable over time, it is estimated that 11,600−22,000 Passerines would be killed annually, depending on development scenario. Fatalities were not found during PCFM for species with PIF populations less than an estimated 5,000 individuals (Appendix T5). A migratory species, ruby-crowned kinglet (*Corthylio calendula*) had the highest percent of its population affected by wind energy development because of its comparatively smaller population size. Although ruby-crowned kinglet composed only 2% (40 individuals) of all passerine fatalities, the estimated 240–453 annual fatalities expected to occur from wind energy development represent 1.9% of the estimated CPE population (23,456 individuals). This species prefers nesting in more mountainous and forested regions in North America, habitats that do not occur in the CPE. Because no breeding habitat is present in the CPE, the majority of ruby-crowned kinglet fatalities occurred during spring (13%) and fall (84%) migration. Migratory ruby-crowned kinglets found in the CPE are part of the much larger Great Basin BCR 9 population of 273,000 individuals and average population trends from 2006−2019 were positive albeit statistically insignificant (0.39, 97.5%CI: -2.51–3.58; Appendix T5). Average apparent adult survival rates of ruby crowned kinglet from 15 years (1992–2006) of banding data was 0.38 (SE ± 0.05), indicating a large proportion of the population does not survive to the preceding year (Desante et al. 2015). Despite sustaining high annual mortality (0.68), population trends appear stable and the species is not on a watchlist (Rosenburg et al. 2019); thus a cumulative impact of 1.9% to the CPE population is negligible. Although a higher percent of the population was affected compared to other species in the Passerine group, cumulative effects would not be expected due to the small number of fatalities in an overall large, stable population.

Horned lark fatalities were disproportionately higher (48%; 936 individuals) than the second and third most abundant species found during PCFM, golden-crowned kinglet (6%; 113 individuals), and western meadowlark (5%; 101 individuals). As a wide-spread, abundant species throughout the CPE during all seasons, an estimated 5,600−10,600 horned larks would be killed annually, depending on the wind energy development scenario. Horned larks are the fourth most abundant passerine in the CPE with an estimated population of 1.22 million birds (Appendix T5). The estimated number of horned lark fatalities from wind turbine collisions would be <1% of the horned lark population and therefore, cumulative impacts would not be expected. Similarly, cumulative effects to species with larger populations including golden-crowned kinglet (1.36 million) and western meadowlark (1.42 million) but less abundant during PCFM are thought to be negligible. American robin (*Turdus migratorius*), the most abundant passerine in the CPE (2.53 million), composed <0.01% (16 individuals) of documented fatalities in the Passerine group and no cumulative effect on the CPE population would be expected.

Table 12. Species composition of current and future estimated fatalities in the All Bird group under different wind energy development scenarios.

Group	% Comp.[1]	Current (2020)[2]	40% New Wind[2]	60% New Wind[2]
Passerines	67.0	11,631	18,517	21,959
Upland Game Birds	12.0	2,090	3,327	3,945
Unidentified Birds	9.9	1,714	2,729	3,237
Doves/Pigeons	4.7	820	1,305	1,547
Large Corvids	1.2	213	339	402
Woodpeckers	1.2	206	329	390
Swifts/Hummingbirds	1.0	175	279	331
Waterfowl	0.8	138	219	260
Nightjars	0.8	131	209	248
Gulls/Terns	0.5	88	139	165
Shorebirds	0.4	63	100	118
Rails/Coots	0.2	38	60	71
Loons/Grebes	0.2	31	50	59
Waterbirds	0.2	31	50	59
Total	**100**	**17,369**	**27,651**	**32,792**

1. composition derived from 55 PCFM studies conducted in the CPE, 1999−2020 and assumed a constant average annual fatality rate of 2.5704 birds/MW/year.

2. current capacity = 6,757 MW; 40% = 10,757 MW, 60% = 12,757 MW.

Upland game birds were the second most abundant group (12%; 334 individuals) found during PCFM, but measurably lower than the Passerine group (Table 12). Gray partridge composed the majority of fatalities (46%; 154 individuals), followed by ring-necked pheasant (30%; 99 individuals), and chukar (22%; 75 individuals). Assuming species composition and overall fatality rates remain stable over time, an estimated 960−1,800 gray partridge, 620−1,170 ring-necked pheasant, and 470−885 chukar would be killed annually, depending on the wind energy development scenario. When maximum fatality estimates are considered (60% new wind), wind energy fatalities would comprise 15%, 1%, and 3% of gray partridge, ring-necked pheasant, and chukar populations, respectively. Although wind energy mortality would affect a higher percent of the gray partridge population, average population trends 2006–2019 were positive (1.37, 97.5%CI: -4.75–8.2; Appendix T5) and populations are robust (WDFW 2014, ODFW 2016). All upland game bird species documented during PCFM have hunting seasons with populations regulated through bag limits and wildlife habitat enhancement programs. Large annual fluctuations in game bird populations are a result of weather rather than hunting pressure which is managed at sustainable levels (ODFW 2020). The majority of upland game bird hunting in Washington occurs in the CPE. Upland game bird harvest data from WDFW report an average 4,207 gray partridge, 60,308 ring-necked pheasant, and 11,474 chukar were harvested annually from 2013−2021 (WDFW 2022). Because hunting upland game birds typically does not increase mortality rates that would otherwise occur from other sources (compensatory mortality; ODFW 2020), cumulative effects to populations from the comparatively small numbers of fatalities associated with wind energy development are not anticipated.

Excluding raptors, the remaining bird groups composed approximately 10% of bird fatalities anticipated in future wind energy development scenarios. Excluding European starling, an introduced species with no regulatory protection, the species with the next highest number of fatalities was dark-eyed junco (*Junco hyemalis*), with 330−624 total annual fatalities, depending on development scenario. However, this represents less than 0.1% of the estimated population in the CPE and no cumulative impacts are expected.

4.2.2 Raptor Group

Diurnal Raptors composed the majority of raptor fatalities and were documented in 37 of the 55 PCFM studies from 1999−2020 (Table 13). Assuming species composition and overall fatality rates remain stable over time, it is estimated 800−1,500 raptors would be killed annually, depending on development scenario. Two of the most abundant raptor species, red-tailed hawk and American kestrel, composed a relatively equal proportion (~26–27%) of all documented raptor fatalities. Depending on the development scenario, approximately 215–400 red-tailed hawks and 210−395 American kestrels would be killed annually. As wide-spread species that occupy a variety of habitats, red-tailed hawk and American kestrel populations in the CPE are approximately 47,990 and 48,700 individuals, respectively. Estimated annual fatality rates would comprise 0.4–0.8% of the populations of both species. In the absence of human-caused mortality, annual raptor survival rates (inversely, mortality rates) correlate with body mass with approximately 0.70–0.85 annual survival for species in the genus *Falco* and *Buteo* (Newton et al. 2016). An increase of <1% of direct impact to red-tailed hawks and American kestrel populations from wind energy development is not expected to contribute to declines in long-term population trends. Both species are considered year-round residents in the CPE, although portions of both populations are likely partially migratory, especially American kestrel. Average BBS population trends in the Great Basin BCR 9 from 2006−2019 were stable to increasing for red-tailed hawk (1.64 [95%CI: 0.42−2.90) while American kestrel were decreasing (-1.41 [95%CI: -2.89−0.14; Appendix T5). Both species are two of the most common raptors found during PCFM in the US (WEST 2021).

Estimates of sustainable harvest rates of raptors from falconry offers a metric of sensitivity to raptor populations and were calculated as 1–5% of their US population size, depending on the species demographic vital rates (Millsap and Allen 2006). Red-tailed hawk was estimated to be able to sustain a 4.5% maximum harvest rate while other species found during PCFM were had comparatively lower harvest rates including American kestrel (1.5%) and ferruginous hawk (1%). In a public records request, Ash (2016) found 288 raptors were harvested by falconers from 2000–2009, of which red-tailed hawk (52%, 188 individuals), northern goshawk (14%, 40 individuals), and American kestrel (11%, 34 individuals) composed the majority of species. In the maximum wind energy development scenario, annual red-tailed hawk fatalities (403 fatalities) would represent 0.84% of the CPE population and American kestrel fatalities (393 fatalities) would represent 0.81% of the CPE population; thus contributing a marginal cumulative effect in the CPE. However, in a study that considered up to 241 GW of new wind capacity nationwide, both American kestrel and red-tailed hawk showed relatively larger estimated declines in population growth rates with increasing levels of wind energy development (Diffendorfer et al. 2021). Although both species are abundant, on-going and increased number of fatalities within the CPE may contribute to cumulative effects the species incur throughout their range (Katzner et al. 2020).

Of the 23 raptor species documented as fatalities during PCFM, six (26%) were classified as sensitive by state or federal agencies (Appendix T1). Raptor species found as fatalities included both eagle species occurring in the CPE (bald eagle and golden eagle), two migratory owl species (burrowing owl [*Athene cunicularia*] and short-eared owl) and two migratory hawk species (ferruginous hawk and Swainson's hawk). Sensitive species are discussed in further detail in Section 4.2.3.

Three of the 14 raptor species with PIF population data in the CPE were not documented during PCFM: great gray owl (*Strix nebulosi*), northern goshawk (*Accipiter gentilis*), and northern pygmy owl (*Glaucidium californicum*). These three species are associated with more forested habitats which are largely absent in the CPE. Future population level effects to these species from wind energy related mortality are not anticipated.

Table 13. Species composition of current and future estimated fatalities by raptor group under different wind energy development scenarios.

Group	Comp. (%)[1]	Current (2020)[2]	40% New Wind[2]	60% New Wind[2]
Diurnal Raptors	81.5	646	1,028	1,220
Owls	17.2	136	217	257
Vultures	1.3	11	17	20
Total	**100**	**793**	**1,262**	**1,497**

1. composition derived from 48 PCFM studies conducted in the CPE, 1999−2020 and assumed a constant average annual fatality rate of 0.1173 raptors/MW/year.
2. current capacity = 6,757 MW; 40% = 10,757 MW, 60% = 12,757 MW.

4.2.3 Sensitive Bird Species

Of the 20 species listed in Oregon and/or Washington as sensitive (Appendix T1), 14 (70%) were documented during PCFM conducted from 1999–2020 (Table 14; Appendix T1). Raptor species composed 43% of the sensitive species found during PCFM. Swainson's hawk was documented most frequently, totaling 33 individuals. Assuming the 2020 level of installed wind energy capacity, fatalities of all but the ferruginous hawk composed less than 1% of populations of sensitive bird species within the CPE (Table 14). Although ferruginous hawk composed a comparatively small proportion of raptor fatalities documented during PCFM with approximately 3% of Raptor fatalities and 6% in the *Buteo* group, the species status warrants additional analysis and is discussed in further detail below (Section 4.2.3.1). Seven sensitive species (30%) present in the CPE were not found during PCFM and included two upland gamebirds (sage-grouse, sharp-tailed grouse), a forest-nesting raptor (northern goshawk), shrub-steppe passerine (loggerhead shrike [*Lanius ludovicianus*]), and two waterbird species (sandhill crane and upland sandpiper [*Bartramia longicauda*]). Seasonal abundance of sensitive species in the CPE ranged from extremely rare (e.g., upland sandpiper) to more abundant (e.g., sandhill crane) and are discussed in greater detail below.

Compared to other upland gamebird species documented more frequently during PCFM, turbine -collision mortality of sage-grouse and sharp-tailed grouse has not been documented. To date, wind turbine-related fatalities of upland game birds in the CPE have been associated with introduced, non-native species with open hunting seasons (Section 4.2.1). Due to habitat modification from urban/rural and agricultural development, the distribution of both sage-grouse and sharp-tailed grouse are highly restricted in the CPE and do not overlap with current installed wind energy development (Schroeder et al. 2015, Hoen et al 2018). As habitat-limited species that require large areas of habitat for breeding and nesting, native grouse in the CPE may be more prone to the indirect effects of renewable energy development which include avoidance and displacement that may affect survival or fecundity (Lloyd et al. 2022). Sage-grouse are evaluated as a Focal Species in Section 4.5.2.2.2.

Sandhill crane is a charismatic and celebrated species in the CPE. Three subspecies (greater sandhill crane [*A. c. tabida*], lesser sandhill crane [*A. c. canadensis*], and Canadian sandhill crane [*A. c. rowani*) occur in the CPE (Stinson 2017). The majority of individuals in the CPE migrate to nesting areas in Canada and Alaska although several small (<100 individuals) breeding populations occur in Klickitat and Yakima counties. Migratory birds use the mosaic of agriculture-grassland-wetlands as stopover habitat, important for refueling along their long migratory path. No sandhill crane fatalities have been documented at wind energy facilities in the CPE and studies of flight behavior suggest high flight avoidance of wind energy turbines (Nagy et al. 2013, Pearse et al. 2016, Derby et al. 2018). Based on the absence of documented sandhill crane fatalities during PCFM and high flight avoidance behavior, cumulative impacts to sandhill crane are not expected in current or future wind energy development scenarios.

Once a nesting species in the grasslands of the CPE, upland sandpiper is considered extirpated in Oregon and Washington (WDFW 1995, ODFW 2015). The CPE is located at the edge of the nesting range in North America and the species has historically been a rare breeder in the CPE. The most recent publicly-available record of possible nesting in the CPE is from 1993 in Kittitas County, Washington (WDFW 1995). Extensive modification of suitable grassland nesting habitat has likely shifted the species ability to reestablish a stable breeding population in the CPE. Absent large-scale landscape conservation efforts to protect grassland nesting habitat, upland sandpiper occurrence in the CPE will likely remain rare, comprised of vagrants from more robust populations east of the CPE (WDFW 1995). Based on the scarcity and likely extirpation of the species in the CPE, wind energy development is unlikely to contribute to cumulative impacts that would further reduce the occurrence or persistence of upland sandpiper.

4.2.4 Focal Species: Ferruginous Hawk

With a breeding and nesting population at the northwestern edge of the species distribution in the US Pacific Northwest, ferruginous hawk population trends in the CPE have been a conservation concern for nearly half a century (Hayes and Watson 2021). Landscape-scale conversion of nesting and foraging habitat to agricultural and residential development in the CPE has eliminated most of the species historical habitat (Richardson 1996, Sleeter 2012). Combined with a prolonged drought that has reduced the availability of an essential prey base (small mammals) and other environmental stressors, ferruginous hawk breeding populations in the CPE have declined at a rate that prompted listing the species as Washington state endangered in 2021.

Photo 10. Adult nesting ferruginous hawk, Benton County, Washington, May 2019.

Although fewer ferruginous hawk fatalities were documented during PCFM compared to other raptor species, the effect on the nesting population in the CPE was higher because of the smaller estimated population size (Table 14). Eight ferruginous hawk fatalities were documented at six facilities during PCFM studies conducted from 1999–2020 (WEST 2021). The majority of fatalities were adults (5 individuals) followed by juvenile (1 individuals) and 2 of unknown age. Of the eight ferruginous hawk fatalities documented during PCFM, four (3 adults and 1 juvenile) were at two wind facilities in Washington. Hayes and Watson (2021) estimated there were 32 breeding pairs in the Washington portion of the breeding population based on 2016 raptor nest surveys. Based on the installed wind energy capacity in 2020, annual ferruginous hawk mortality of 21 individuals could account for approximately 3.4% of the 626 birds based on PIF population data (Table 14). Impacts would be sustained across the age range of breeding and non-breeding individuals and could occur year-round although winter resident populations (~6%) in the CPE appear small (Watson et al. 2018); thus, impacts to the breeding adult population would likely be lower than 3.4%. Using a model for red-tailed hawk as a surrogate, Millsap and Allen (2006) estimated a 1% sustainable harvest rate of juvenile ferruginous hawks for falconry purposes. Considering an updated North America PIF population estimate of 110,000 ferruginous hawks (Will et al. 2020) composed of 30% juveniles (derived from Millsap and Allen 2006), a 1% sustainable annual falconry harvest would result in 330 individuals in the US. For context, the average number of juvenile ferruginous hawks harvested for falconry in the US during 2003 and 2004 was 6.5 birds which represented 2% of the sustainable harvest modeled by Millsap and Allen (2006). Mortality levels from wind energy fatalities or harvested for falconry appear small compared to background mortality rates sustained by ferruginous hawk. Annual mortality rates are highly variable throughout the range and life stages of ferruginous hawk (Hayes and Watson 2021) with an estimated 57% annual juvenile mortality (fledge to 1 year) and adult mortality (≥ 1 year old) ranging 24–30% (Watson and Pierce 2003, Schmutz et al. 2008).

The effect of wind energy mortality on ferruginous hawk populations in increasing levels of wind energy development is expected to increase when combined with other environmental stressors in the CPE and as well as within their broader distribution in the western US. Although BBS population trend estimates in the Great Basin from 2006–2019 indicate a non-significant annual rate of change of 2.44% (95%CI: -0.78–5.83), breeding populations in Washington have continuously declined over the past half century; thus, a population size of 626 individuals in the CPE is likely an overestimate. Results from a four-year study of migratory movements that tracked 28 ferruginous hawks trapped in Washington and tracked by satellite telemetry indicated the population was self-sustaining (Watson 2003); however, when combined with other sources of ferruginous hawk mortality (e.g., shooting, poisoning), continued and potential increases in fatalities at wind turbines under all development scenarios may result in an additive cumulative effect on population growth in the CPE because of the small population size and low reproductive rates of this species.

Table 14. Sensitive bird species documented during PCFM at wind energy facilities in the CPE from 1999–2020 and the proportion of the estimated population affected under various development scenarios.

Common Name	# Fatalities	% Comp.[1]	Current (2020) 6,757 MW	40% New Wind 10,757 MW	60 % New Wind 12,757 MW	Pop. Est.	Min % Pop.[2]	Pop. Source
Swainson's hawk	33	11.11	88	140	166	9,128	0.97	PIF 2021[3]
common nighthawk	18	0.65	5	8	10	263,624	0.00	PIF 2021
short-eared owl	16	5.39	43	68	81	5,109	0.84	PIF 2021
Brewer's sparrow	14	0.50	4	6	8	442,080	< 0.01	PIF 2021
long-billed curlew	9	0.32	3	4	5	4,000	0.06	Fellows and Jones 2009[4]
ferruginous hawk	8	2.69	21	34	40	626	3.41	PIF 2021[5]
golden eagle	4	0.14	1	2	2	786	0.15	USFWS 2016[6]
sage thrasher	2	0.07	1	1	1	175,169	< 0.01	PIF 2021
American white pelican	1	0.04	0	0	1	5,656	0.01	Stinson 2022[7]
bald eagle	1	0.34	3	4	5	1,032	0.26	USFWS 2016[8]
burrowing owl	1	0.34	3	4	5	1,590	0.17	PIF 2021
grasshopper sparrow	1	0.04	0	0	1	161,261	< 0.01	PIF 2021
Lewis's woodpecker	1	0.04	0	0	1	9,717	< 0.01	PIF 2021
sagebrush sparrow	1	0.04	0	0	1	56,575	< 0.01	PIF 2021

1. Percent composition of documented fatalities within the All Bird (n = 2,776) or Raptor (n = 297) groups.
2. Percent of the population affected by the estimated annual fatalities in the Current (2020) development scenario (6,757 MW).
3. PIF 2021 = CPE population estimate derived from PIF Great Basin BCR 9 data (Section 3.2).
4. Conservative population estimate from the entire Columbia Basin BCR 10.
5. Hayes and Watson (2021) estimated 47 occupied nests and 32 breeding pairs (64 individuals) in eastern WA based on 2016 survey data.
6. Based on proportion of CPE in the BCR × 2014 median population estimate in BCR 9 (0.119 × 6,596 eagles).
7. Includes total number of pelicans at the largest breeding colony in WA (Badger Island) in 2018.
8. Based on the proportion of CPE in the North Pacific Flyway Eagle Management Unit (EMU) × 2014 median population estimate in the EMU (0.028 × 14,792 eagles).

4.2.5 Bats

A disproportionate number of migratory tree and leaf roosting bats were found during PCFM studies. Hoary bat and silver-haired bat composed nearly 96% of all bat fatalities; therefore, the total number of fatalities from new wind energy development should affect these two species comparatively more than little brown bat or big brown bat. Assuming species composition of fatalities is similar over time and overall fatality rates remain stable, it is estimated that 11,600-13,800 bats would be killed annually, depending on the wind energy development scenario (Table 15).

Table 15. Species composition of current and future estimated bat fatalities under different wind energy development scenarios.

Common Name	% Comp.[1]	Current (2020)[2]	40% New Wind[2]	60% New Wind[2]
hoary bat	51	3,717	5,918	7,018
silver-haired bat	45	3,283	5,226	6,197
unidentified bat	3	188	299	355
little brown bat	1	52	83	98
big brown bat	1	45	72	86
unidentified myotis	< 1	6	10	12
Total Fatalities	**100**	**7,292**	**11,608**	**13,766**

1. composition derived from 48 PCFM studies conducted in the CPE, 1999−2020 and assumed a constant average annual fatality rate of 1.079 bats/MW/year.

2. current capacity = 6,757 MW; 40% = 10,757 MW, 60% = 12,757 MW.

It is difficult to place the relative effects from wind energy mortality on bats in context because population sizes and other sources of mortality are poorly understood, particularly in the western US (Hayes and Wiles 2013, Weller et al. 2018). At a national scale, the average bat fatality rate in the CPE (1.08 bats/MW/year) was lower than regions in the midwest and eastern US where karst limestone and mines that provide hibernacula, tree lots and forested areas that provide roosting habitat, and perennial waters that provide foraging habitat are more abundant. Examples include wind energy projects in Iowa (8.7 bats/MW/year), Texas (15.3 bats/MW/years) and Tennessee (>30 bats/MW/year; Arnett et al. 2008, Miller 2008). Hayes (2013) estimated approximately 600,000−900,000 bats were killed in 2012 at 21 wind energy facilities throughout the US with fatality rates that ranged from 0.2−53.3 bats/MW/year. An emerging threat in the CPE includes WNS, which was first detected in Washington in 2016. The fungus has decimated hibernating bat populations in the eastern US; however, the magnitude of its effect on western migratory tree roosting bat populations is currently unknown (WNS Response Team 2021). All species documented during PCFM, except hoary bat, are susceptible to the disease and WNS may have a larger effect on bat populations than turbine collisions. Nevertheless, multiple studies have quantified a sustained decline in occupancy and thus species abundance of hoary bat and little brown bat prior to the arrival of WNS (Loeb et al. 2015, Rodhouse et al. 2019). Although bat fatality rates appear to be comparatively lower in the CPE than other regions in the US, collisions with wind turbines are likely to contribute to cumulative effects sustained throughout the year and compound with impacts sustained in their winter ranges located outside the CPE (Hayes et al. 2015, Wieringa et al. 2021).

4.3 Bird Mortality in Context

In a human-built environment, bird species are exposed to a wide variety of environmental stressors that contribute to population level-effects (Calvert et al. 2013, Loss 2016). Characterizing mortality from wind energy development in context with other sources of anthropogenic mortality is helpful to understand its contribution to potential cumulative effects on a population (Smith and Dwyer 2016). Studies that summarized the effects of anthropogenic sources of bird mortality in the US and Canada reported similar patterns where the overall leading mortality sources included cat predation, collisions with buildings, vehicles, communication towers and electric transmission lines, and electrocution at distribution lines (Calvert et al. 2013, Loss 2016). Among the sources of mortality, direct mortality from collisions with wind turbines ranked last (Table 16, Figure 21). European summaries followed similar patterns where vehicle collision was the source most often attributed to bird mortality, although fatalities were not quantified similarly to summaries in the US and Canada (Garcês et al. 2020). Although mortality estimates among sources are not directly comparable because of the different data collection methods, variable spatial and temporal scales, and the susceptibility of different groups and their associated responses to a mortality source; the overall magnitude of mortality from wind energy is relatively smaller than other sources of anthropogenic mortality. Median All Bird fatality rates (# fatalities/MW/year) documented in the CPE (Table 9) were within the range of the 95% Confidence Interval of the All Bird fatality estimate for the western US (Table 16; Loss et al. 2013) and the national estimate for Passerine group (Table 16; Erickson et al. 2014). A Canadian study (Zimmerling et al. 2013) that estimated mortality from turbine collision and habitat loss was not included because estimates were reported per turbine, instead of per MW. Median fatality rates for all primary groups were lower than fatality estimates calculated by Smallwood (2013) who included older-generation lattice towers in their analysis which are no longer widely used. Older generation towers have a different risk profile than newer generation tubular monopole designs due to the increased perching opportunities that place birds at greater risk of mortality (USFWS 2012, Durr and Rasran 2017) although turbine height, when adjusted for nameplate capacity, appears less of a factor influencing fatality rates (Huso et al. 2021).

Summaries of anthropogenic sources of mortality are useful to show the magnitude in the differences between human-induced mortality; however, species-specific effects of impacts from wind energy are lost in this generalization. Although overall mortality appears low compared to other forms of anthropogenic sources, wind energy may disproportionately affect species with small populations, or may affect demographic vital rates differently between species due to the spatial or temporal timing of the impact. An example of potential effects to small populations comes from Diffendorfer et al. (2021) who modeled the vulnerability in maintaining stable or positive population growth rates for 14 raptor species from current (106 gigawatt [GW]) and future (241 GW) installed wind energy generation scenarios in the US. The authors found barn owl (*Tyto alba*), ferruginous hawk, golden eagle, American kestrel, and red-tailed hawk were more susceptible to changes in populations from turbine-related mortality compared to other species. The population-level effect of turbine mortality may be more likely in the CPE on a species like ferruginous hawk as their populations are relatively low in this region (Hayes and Watson 2021). Despite the observed stability of ferruginous hawk populations across the US, BBS trend results in Washington corresponded with a -1.59% annual change (97.5% CI: -7.01−3.66) from 1999–

2019 (Sauer et al. 2019). Small changes to the breeding population may be more acute in populations with few individuals particularly when combined with other sources of mortality that include vehicle collisions, shooting, and poisoning (Horne et al. 2020).

In a study of bird mortality from collisions with communication towers and buildings in North America, Arnold and Zink (2011) found horned lark strongly avoid collisions with both types of structures, characterizing the species as a ‘super-avoider.’ Although horned lark fatalities are rarely documented at these structures, horned lark compose the majority of Passerine fatalities at wind energy facilities in the Pacific, Midwest, and Mountain-prairie regions in the US (WEST 2021). Estimated overall bird mortality from communication towers and buildings are magnitudes higher than wind turbines but affect horned larks at a lower rate. Cumulative impacts to horned lark populations from wind energy are not anticipated because of the robust populations in the CPE and surrounding regions; however, observed fatality rates suggest a species-specific response of horned lark to the type of mortality threat on the landscape.

Timing of the fatalities varies among species and can disproportionately affect nesting success and fecundity when fatalities occur during the nesting period (Beston et al. 2016). An example of this dynamic is with Swainson’s hawk, a neotropical migrant that only occurs in the CPE during the summer nesting period. The risk of turbine collision is highest in the breeding range of North America (Watson 2021). Swainson’s hawks nest throughout the CPE and were the second most abundant *Buteo* found during PCFM. Because of the species’ long lifespan, low fecundity, and flight behavior that make Swainson’s hawk more susceptible to turbine collision, Beston et al. (2016) identified Swainson’s hawk as having a greater relative risk of experiencing population declines from wind energy. In a two-year study in the CPE, Kolar and Bechard (2016) attributed reduced juvenile survival at nests within three mi of wind turbines to collision mortality of adults, or the indirect effects of disturbance or displacement of adults who are no longer able to provision juveniles. Reduced juvenile survival may have generational effects in the population demographics when the pattern of reduced nesting success and fecundity persists over time.

The totality of anthropogenic pressure on bird and bat populations in North America is vast and the relative contribution from wind energy is clear even if estimates are off by several magnitudes due to uncertainty (Figure 21). Although previous research suggests bird collision mortality at wind energy facilities has no discernable effect on population trends of North American birds compared to other mortality sources (Arnold and Zink 2011) or species within a particular group such as Passerines (Erickson et al. 2014), certain species within the CPE, particularly those with small populations that exhibit relatively higher levels of mortality, unique habitat niches, or pressured by other environmental stressors, are at risk of cumulative effects. Environmental stressors include declining prey availability due to drought, persecution, and degraded or eliminated nesting or foraging habitats (Loss et al. 2015, Katzner et al. 2020, Hayes and Watson 2021). Wide ranging or migratory species are at greater exposure to environmental stressors as they navigate hazards at multiple spatial and temporal scales. In a review of 428 breeding bird species in the US, it was found that raptors were most vulnerable to these deleterious stressors (Beston et al. 2016). Results from Beston et al. (2016) are consistent with other studies that highlight raptors as a primary group of conservation concern, sensitive to fluctuations in habitat and prey availability, survival, and the additive effects of turbine-related mortality (Diffendorpher et al. 2020). Patterns from these studies translate into increased conservation concern for species that occur within the CPE including golden eagle, ferruginous hawk, and Swainson's hawk.

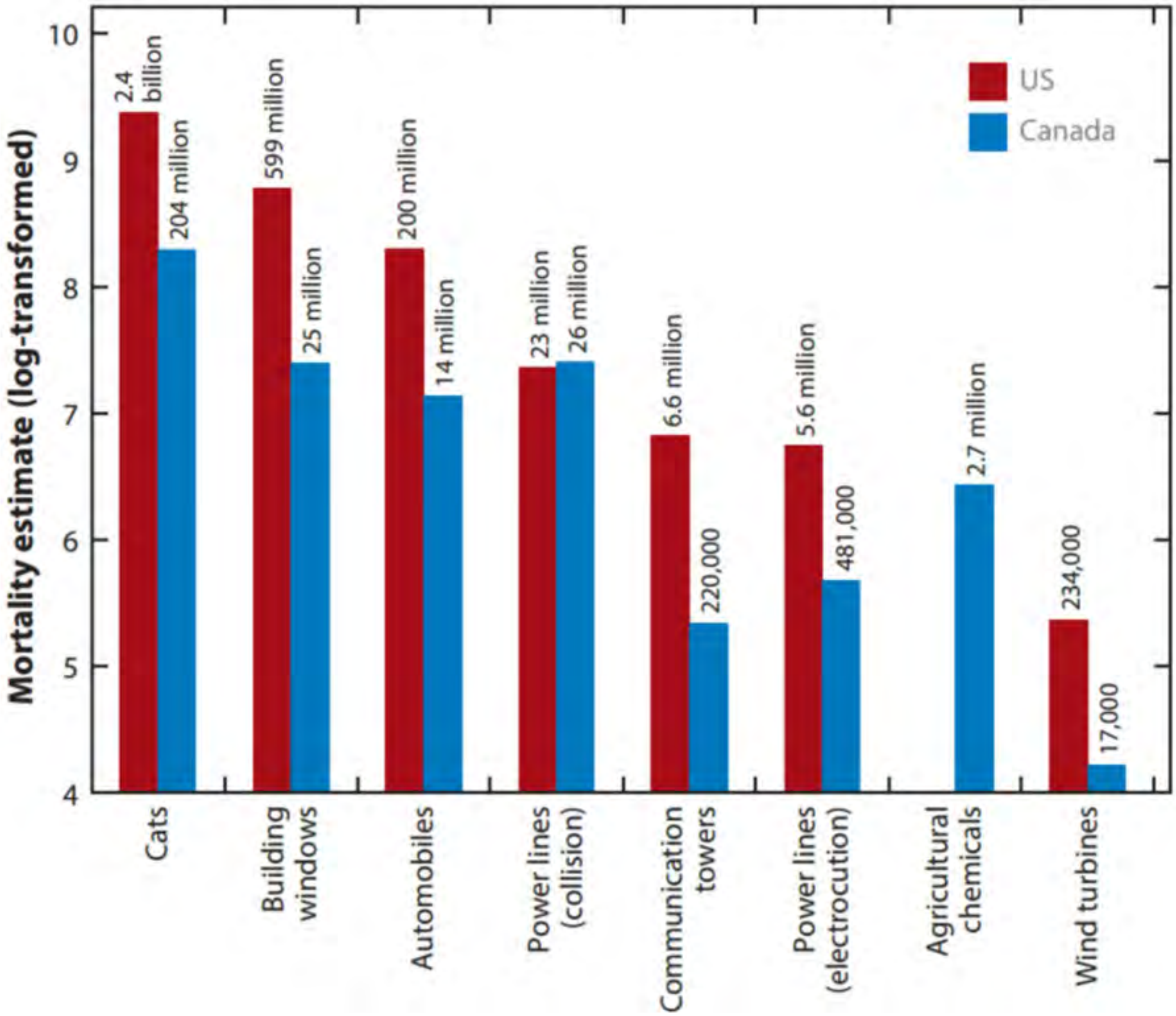

Figure 21. Comparison of major sources of anthropogenic mortality of birds in the United States and Canada (Loss et al. 2015). Note logarithmic scale in mortality estimate for comparisons.

Table 16. Comparison of anthropogenic mortality of birds and bats from human infrastructure and activities in the US and Canada.

Mortality Source	Estimate	Annual Mortality/Unit x = median; r = range	Unit	Primary Group Affected[1]	Source
Cat Predation	2.9 billion 95%CI: 1.3 – 5.3 billion	r = 24.4 – 51.4	cat	2	Loss et al. 2013[2]
Building Collision	599 million 95%CI: 365 – 988 million	x = 3.7 95%CI: 2.0 – 6.8	building	2	Loss et al. 2014
Residence	253.2 million	x = 2.1 95%CI: 1.3 – 3.1	building	2	Loss et al. 2014
Low-rise	245.5 million	x = 6.3 95%CI: 4.1 – 44.0	building	2	Loss et al. 2014
High-rise	409.4 million	x = 24.3 95%CI: 5.0 – 76.6	building	2	Loss et al. 2014
Vehicle Collision	197 million 95%CI: 78 – 398 million	x = 48.8 95%CI: 19.4 – 98.5	km	2, 3, 4	Loss et al. 2014[3]
Transmission Line Collision	25.5 million 95%CI: 8 – 57 million	x = 29.6 95%CI: 9.3 – 66.4	km/pole	3, 5, 6	Loss et al. 2014
Distribution Line Electrocution	5.63 million 95%CI: 0.9 – 11.6 million	x = 0.03 95%CI: 0.01 – 0.06	km/pole	3	Loss et al. 2014
Agricultural Pesticides	2,695,415 95%CI: 960,011 – 4,430,819	NA	NA	1	Calvert et al. 2013[4]
Oilfield Wastewater Ponds	500,000 – 1 million	NA	NA	5, 6	USFWS 2009
Wind Turbines (Lattice and Monopole)					
All Bats	x = 650,538 90%CI: 352,427 – 948,650	x = 12.6 90% CI: 6.83 – 18.37	MW	7	Smallwood 2013[5]
All Birds	x = 573, 093 90%CI: 467,097 – 679,089	x = 11.1 90% CI: 9.1 – 13.15	MW	2, 3	Smallwood 2013[5]
All Raptors	x = 82,608 90%CI: 56,123 – 109,094	x = 1.6 90% CI: 1.1 – 2.1	MW	3	Smallwood 2013[5]
Wind Turbines (Monopole only)					
All Birds (US)	x = 234,012 95%CI: 140,438 – 327,586	x = 4.1 95%CI: 2.47 – 5.76	MW	2, 3	Loss et al. 2013[6]
All Birds (Western US)	x = 27,117 95%CI: 19,671 – 34,682	x = 2.83 95%CI: 2.05 – 3.62	MW	2, 3	Loss et al. 2013[6]
Passerines	19,896 – 31,871	r = 2.09 – 3.35	MW	2	Erickson et al. 2014[7]
Communication Tower Collision	20,744	r = 0.00 – 0.06	km^2	2	Longcore et al. 2012[8]
Oil and Gas Activities	x = 20,008 (all) 90%CI: 14,957 – 27,539	x = 13,260 (well pads) 95% CI: 10,550 – 16,265	NA	2	Van Wilgenburg et al. 2013[9]

Table 16. Comparison of anthropogenic mortality of birds and bats from human infrastructure and activities in the US and Canada.

Mortality Source	Estimate	Annual Mortality/Unit x = median; r = range	Unit	Primary Group Affected[1]	Source
Oil Sands Tailing Ponds	r = 458 − 5,029	x = 50.16 r = 7.15 − 189.5	km^2	5, 6	Timoney and Ronconi 2010[10]

1. 1 = all bird groups, 2 = passerines, 3 = raptors, 4 = corvids, 5 = waterfowl, 6 = waterbirds, 7 = tree roosting.
2. Data from US studies only; included both owned and un-owned cats.
3. Data from US studies only; reflected full set of studies that met inclusion criteria.
4. Data from Canada.
5. Estimated from 71 studies, including 19 at the Altamont Pass Wind Resource Area, California and at an operating capacity of 51,630 MW.
6. Estimated from 53 studies through US at operating capacity of 56,852 MW; Western US estimates from 17 studies in 7 states, excluding California at an operating capacity of 9,590 MW.
7. Estimated from 41 studies, within the Intermountain West at an operating capacity of 9,500 MW.
8. Data from Great Basin BCR 9 – estimates extrapolated to a national scale were approximately 6.6 million birds, annually.
9. Data from western Canada; estimate included all activities associated with oil and gas including clearing well pads, pipeline right-of-way, seismic lines.
10. Data from Canada; inclusive of systematic mortality surveys and landing-oiling rates.

4.3.1 Focal Species: Bald Eagle and Golden Eagle

Because of their regulatory status and life history traits, bald and golden eagles exhibit a level of management and conservation concern greater than most other bird species. Protected by BGEPA, both species are long-lived with high adult survival, low fecundity (K-selected species), and flight behaviors that increase susceptibility with turbine collisions and increase stressors on populations (USFWS 2016, Millsap et al. 2022). In the CPE, bald eagles are found in higher densities along large river and reservoir systems associated with the Columbia River, Deschutes River, John Day River, Snake River, and their tributaries, whereas golden eagles are associated with arid shrub-steppe grasslands that provide suitable nesting substrates including cliffs, trees, rock outcroppings, and transmission towers (Photos 11 and 12; Isaacs and Anthony 2011, Isaacs 2021).

Photo 11. Adult bald eagle nesting with at least one young along the Snake River, Garfield County, Washington, March 2022.

Comparatively few bald eagle and golden eagle fatalities have been documented in the CPE during PCFM relative to other raptor groups; eagles composed approximately 2% of the 297 raptor fatalities documented during PCFM from 1999−2020 (Table 15). In the ETP for the Marengo I & II Wind Facility in Columbia County, the USFWS reported 29 unpermitted golden eagle fatalities from wind turbine collisions and 19 electrocutions from 2011–2020 (USFWS 2021). Eagle mortality from wind energy persists in the CPE despite measures undertaken to minimize collision risk via removal of nests in proximity to turbines or turbine curtailment. Electrocution risk persists at non-APLIC compliant electrical structures despite the construction and retrofit of electrical infrastructure in compliance with APLIC standards throughout the CPE.

In the US, Pagel et al. (2013) reported six bald eagle fatalities and 79 golden eagle fatalities, found from 1997–2012, with the majority detected incidentally to PCFM. Reports since then indicated a larger breadth of the impacts, particularly in Wyoming where eagle densities were relatively much higher than the CPE (Department of Justice 2013, 2022). In the US, the leading cause of natural mortality of golden eagles from 1997–2016 was starvation/disease while the leading anthropogenic cause was shooting (Millsap et al. 2022). Although national summaries were not available for bald eagle, data from Michigan (1986–2017), and Canada (1991–2016) implicated collisions with vehicles and transmission lines as the leading causes of mortality (Mathieu et al. 2020, Simon et al. 2020). Both species continue to sustain exposure to lead poisoning in the CPE and surrounding regions at levels high enough to suppress population growth (Photo 13; Slabe et al. 2022).

Contemporary publicly-available information on eagle mortality in the CPE are from analyses provided by the USFWS for the Skookumchuck Wind Energy Project in Lewis County, western Washington (USFWS 2019). The radius of the Local Area Population (LAP; natal dispersal area) for bald and golden eagles (89- and 109-mi radius, respectively) analyzed by the USFWS overlapped the CPE and provided insights into other sources of mortality. The USFWS reported shooting bald eagles as the most prevalent known cause of death in the LAP and incidents of poaching remain a conservation concern (USFWS 2019). Over the past decade, incidents in and around the Yakama Nation involved more than 100 eagles where parts from at least 31 bald eagles were recovered (KHQ 2010; DOJ 2015a, 2015b). Poisoning was another major cause of death for bald eagles in the LAP, with nine bald eagles killed in five events documented between 2007 and 2017, including three involving pesticides. Electrocution accounted for seven suspected or confirmed cases documented between 2003 and 2015. Six eagles were found dead due to trauma from 2004 through 2016, in several cases apparently following collisions with vehicles, wires, or other objects. One bald eagle was found dead in 2009 after being caught in a trap (USFWS 2019). From 2002–2016, 29 bald eagles were reported succumbing to various natural causes (e.g., starvation, disease, accident). Sources of mortality correspond to patterns observed at the national scale (USFWS 2016). Despite these sources of regional and national mortality, bald eagle populations are increasing or stable (USFWS 2022). Because of the increasing to stable regional population trends, low fatality estimates, and siting of wind energy projects where bald eagles are less likely to occur, cumulative impacts from wind energy development are unlikely.

Photo 12. Adult golden eagle nesting in a Douglas-fir tree along Bakeoven Creek in Wasco County, Oregon, March 2018.

Similar to bald eagle, shooting was the most prevalent mortality source in the LAP of golden eagles (USFWS 2019). The same 2009 event on the Yakama Nation resulted in 26 golden eagles and multiple incidences thereafter (USFWS 2015, 2022). Second to shooting mortality, collisions with wind turbines was the only other known cause of death for golden eagles within the LAP for the years 2002 through 2017 (USFWS 2019). In 2019, three wind energy facilities were in the process of acquiring eagle take permits (ETP) under BGEPA, and the mortality rates associated with these facilities was an estimated average of 1.77 golden eagles/yr (USFWS 2019). Wind turbines may also affect golden eagle nest occupancy, thus altering the raptor nest community in the surrounding area. Using a before-after-control-impact study design, Watson et al. (2021) recorded fewer nesting golden eagles and higher densities of common raven within 2-mi of CPE wind energy facilities compared to preconstruction levels, although results were proportionally similar to the control site and statistically insignificant. In an evaluation of cumulative effects, the USFWS listed energy production as one of nine additional stressors that affect eagle populations within the LAP (USFWS 2016). The disparity between the levels of human persecution and wind-related mortality are difficult to reconcile;

however, because of the small regional population and decreasing BBS population trends, wind energy-related mortality has the potential to contribute to golden eagle declining population trends (USFWS 2019).

Historically, permits authorizing eagle take were not available under the BGEPA; however, rule changes in 2009 and 2016 provided a mechanism to acquire permits for incidental take associated with otherwise lawful activities, including wind energy generation (50 CFR § 22.26). The policy framework mandates compensatory mitigation for eagle take which typically includes retrofitting dangerous electrical power pole infrastructure to avoid eagle electrocution. The longevity of the retrofit depends on the type of infrastructure that is repaired or replaced but is commensurate with the level of take anticipated for the duration of the ETP. While the incidental take of eagles is anticipated to continue, and possibly increase depending on the development scenario, offsetting compensatory mitigation required under such permits should at least offset the impacts of "permitted take" resulting from wind energy development. A recent assessment of permitted and unpermitted table of golden eagle and bald eagle for a wind energy facility with an LAP overlapping the majority of the CPE, found cumulative impacts from wind facilities represented <5% threshold of the prescribed take level (USFWS 2021).

Photo 13. Golden eagle fatality found during preliminary pre-construction biological field surveys in Yakima County, Washington, April 15, 2019. Posture and disposition suggests poisoning.

4.4 Bat Mortality in Context

Bat populations sustain mortality from multiple natural and human-caused sources in North America. In a review of 688 reports of bat mortality events (defined as studies that reported ≥ 10 bat fatalities counted or estimated) in North America from 1790–2015, O'Shea et al. (2016) classified the causes of bat mortality into nine groups including abiotic, accidental, bacterial/viral disease, biotic, contaminants, intentional killing, unexplained, wind turbines, and WNS. Anthropogenic sources (e.g., intentional killing, contaminants, wind energy) of mortality accounted for 41% of the reported sources of mortality whereas 59% of the reported mortality sources were from other causes listed above (e.g., abiotic, accidental, bacterial/viral disease, etc.; O'Shea et al. 2016). Anthropogenic sources of mortality likely contributes to a larger proportion since unexplained sources were suspected as a result of exposure to organochlorine insecticides and other pesticides. Consistent with O'Shea et al. (2016), WNS was not considered an anthropogenic source of mortality. Literature reporting bat mortality events from bacterial or viral diseases ranked lowest in North America (1.9%) and globally (2.1%).

Historically, intentional killing and human persecution composed the greatest number of reported bat mortalities in North America. Destruction of hibernacula or roosting areas, and poisoning directly or indirectly through chemical exposure has been reported in North America for over 100 years; however, a notable shift in the literature occurred around the year 2000 when reports of bat mortalities caused by wind energy turbines and WNS were dominant. Of the 688 reports of bat mortality events in North America, wind energy turbines (31%) and WNS (39%) comprised 70% and occurred in the span of approximately 15 years (O'Shea et al. 2016). Although the order of magnitude of the maximum unadjusted number of carcasses documented at wind energy turbines (10^2) was lower than abiotic sources (10^5), unexplained (10^5), or even WNS (10^4) the spatial extent of wind energy development and disproportionate effect on migratory tree roosting bats has been a growing conservation concern (Frick et al. 2017).

The representation of scientific literature quantifying impacts to bats from wind energy development and WNS compared to other sources of mortality is likely a combined function of policy/regulations, funding, and interest in the conservation community. For example, multiple years of PCFM, analyses, and reporting are required as a condition of permit approval at many wind energy facilities in the US, whereas pest control services or other commercial/industrial/agricultural sectors are not required to report the number of bat deaths from fumigation, pesticide application, or other sources of known bat mortality. Despite the irregularities in reporting in the scientific literature, it is clear the emergence of wind energy generation and WNS can substantially impact bat populations (Hoyt et al. 2021). In a simulation of the effect of wind energy-related mortality and WNS on the federally endangered Indiana bat (*Myotis sodalis*), Erickson et al. (2016) found effects of wind turbines were localized and focused on specific spatial subpopulations whereas WNS had a depressive effect on the species across its range. Together, the combined effect of the two stressors were greater than would be expected from either alone. When characterizing the effect of WNS on bat populations, Hoyt et al. (2021) stated WNS "…has resulted in the collapse of North American bat populations and restructured species communities." Although the extent of WNS is not yet pervasive in the CPE, bat populations should not presumed to be immune to the synergistic, deleterious effects from wind energy development with other greater stressors (WNS) that have been observed in other regions of the US (*see* Section 2.1.7; Table 4).

4.5 Solar Energy Resource Assessment

Without the exclusion criteria applied, approximately 51% of the CPE is located within 2 mi of an electrical transmission line (*V* = 0.03; Table 17). Approximately 6,077 mi^2 were excluded from the PDA after bio-physical and human-built constraints were applied, resulting in approximately 63% (10,400 mi^2) of the PDA within the corridor. The corridor composed approximately 32% of the CPE (*V* = -0.35; Table 17). All proposed or operational USSE projects in the CPE overlapped the boundary of the PDA (Figure 22; Photo 14). All except two of the 48 USSE projects had the majority (>50%) of the project boundary within the corridor which shows close correspondence between the modeled corridor, where USSE occurs or is planned, and the underlying affected resources. Each resource layer is discussed in further detail below.

Table 17. Modeling results of areas used to characterize biological resources inside and outside the USSE development corridor within the Columbia Plateau Ecoregion.

Type	Inside		Outside		V^1	CPE Total
	mi^2	%	mi^2	%		(mi^2)
Potential Development Area	16,478.1	0.51	15,618.9	0.49	0.03	32,097
Development Corridor	10,401.5	0.32	21,695.5	0.68	-0.35	32,097

1. *V* = vulnerability score (Section 3.4)

Photo 14. Early phase construction of USSE in Gilliam County, Oregon, May 2022. Racking systems (white posts) are installed with solar arrays staged nearby. Wind energy turbines in the distance.

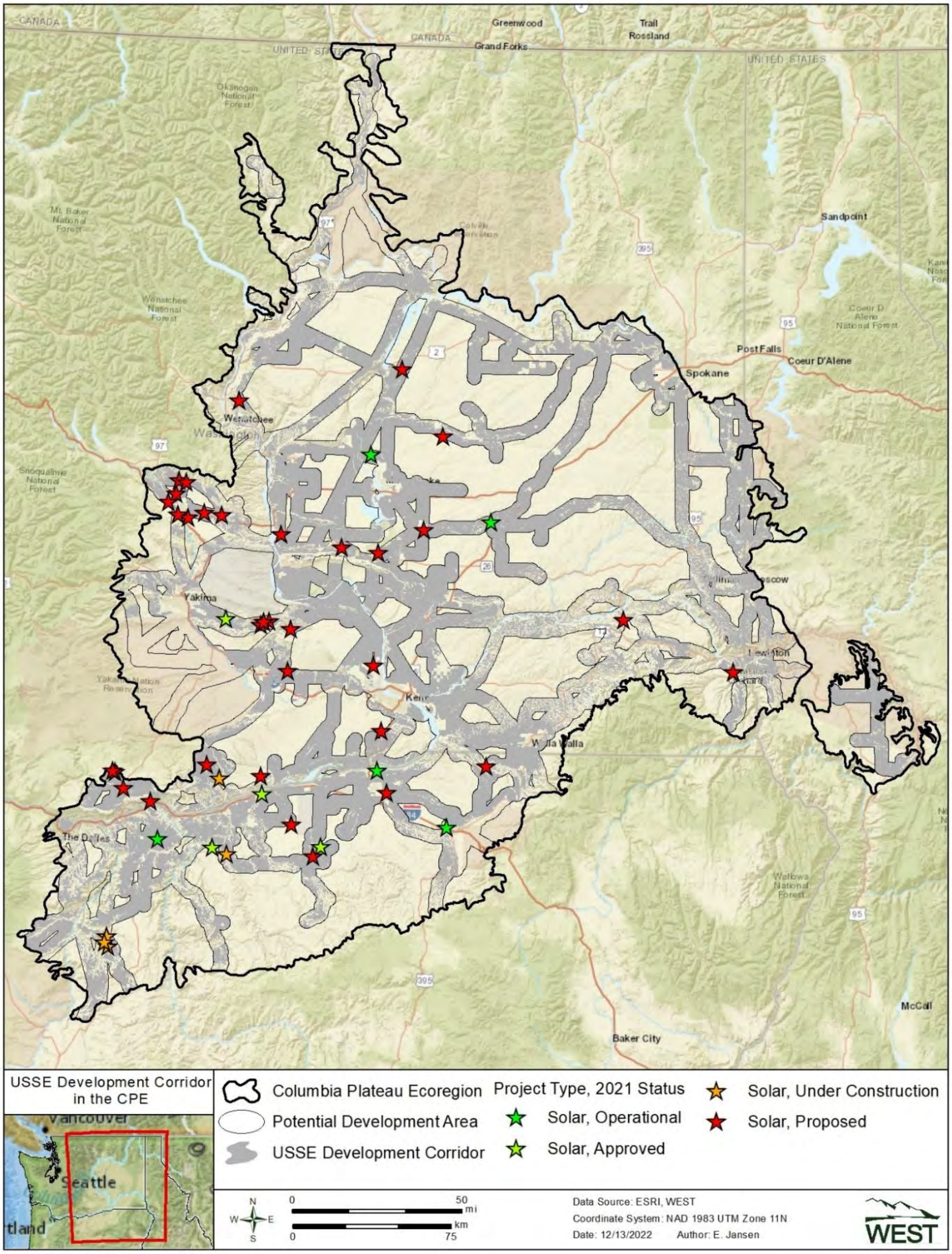

Figure 22. Location of USSE development within the development corridor.

4.5.1 Land Cover

Eight land cover types were located within the corridor, excluding developed and aquatic land cover types which were either exclusionary criteria or quantified by NWI data. Cropland, the most abundant land cover in the CPE, had the highest vulnerability index and nearly in equal proportion to the amount of cropland found outside the corridor (55%; *V* = -0.10; Table 18). Vulnerability indices were inconsistent with the relative abundance of land cover within the CPE. Approximately 20% of grasslands, the second most abundant land cover type in the CPE, was located inside the corridor (*V* = -0.60). However, shrub/scrub (e.g., shrub-steppe), the third most abundant land cover type in the CPE, was comparatively more abundant in the corridor (29%) than grasslands and had a higher vulnerability score (*V* = -0.42). Grasslands and shrub-steppe habitat have been identified as priority habitats in need of conservation (WDFW 2015, ODFW 2016). If avoidance is not possible, compensatory mitigation for impacts to grassland and shrub-steppe habitats from USSE construction would follow Oregon and Washington state mitigation policies[12].

In general, large areas of forested habitat are rare in the CPE and are typically confined to drainages or in larger stands at higher elevations around the periphery of the CPE (Figure 1). Because of their rarity, forested land cover types are also designated as conservation priorities that would follow the similar mitigation framework as grasslands and shrub-steppe. Of particular conservation interest are Deciduous and Mixed Forest land cover types predominantly composed of Oregon white oak (*Quercus garryana*). In Washington, the distribution was restricted to drainages and adjacent uplands in Klickitat, Kittitas, and Yakima counties on the western boundary of the CPE where approximately 22% (2.69 mi^2) was located within the corridor (*V* = -0.55). Future impacts to Oregon oak woodlands are unanticipated due to its distribution along drainages and immediately adjacent uplands, which USSE typically avoids.

Table 18. NLCD land cover types inside and outside the USSE development corridor within the Columbia Plateau Ecoregion. Excludes developed and aquatic land cover types.

	Inside Corridor		Outside Corridor			
Type	**mi^2**	**%**	**mi^2**	**%**	***V***	**Total (mi^2)[1]**
Cultivated Crops	5,688.6	0.45	6,973.7	0.55	-0.10	12,662.2
Hay/Pasture	211.7	0.40	312.0	0.60	-0.19	523.7
Shrub/Scrub	2,063.5	0.29	5,097.3	0.71	-0.42	7,160.8
Deciduous Forest	1.7	0.24	5.2	0.76	-0.51	6.9
Mixed Forest	0.5	0.22	1.9	0.78	-0.55	2.4
Herbaceous	1,781.0	0.20	7,210.1	0.80	-0.60	8,991.1
Barren Land	1.5	0.17	7.3	0.83	-0.67	8.8
Evergreen Forest	58.1	0.10	495.2	0.90	-0.79	553.3

[1]. rounding resulted in minor rounding errors.

Excluding lakes and ponds, the overall area of NWI wetlands within the corridor (36%) composed proportionately less area than outside the corridor (64%, *V* = -0.28; Table 19). The majority of wetlands within the corridor were freshwater emergent wetlands (96 mi^2) followed by riverine (90

[12] Oregon: OAR 635-415
Washington: WAC 463-60-332

mi^2) and freshwater forested/scrub wetlands (20 mi^2). The extent of wetlands typically followed a predictable pattern along drainage bottoms and lowlands where riverine and freshwater forested/scrub wetlands were most abundant. Freshwater emergent wetlands were mostly located in the uplands within swales, potholes, and depressions and form biologically high-value playas, vernal pools, and alkaline depressions where rare plant species occur. Wetlands located within the uplands are most susceptible to impacts from USSE because development typically avoids drainage bottoms; however, roads and associated linear infrastructure may cross drainages where riverine and freshwater forested/scrub wetlands occur. If avoidance is not possible, compensatory mitigation for impacts to wetlands and other waters of the state would follow Oregon and Washington state mitigation policies[13] and related federal Clean Water Act regulations.

Table 19. NWI wetland types inside and outside the USSE development corridor within the Columbia Plateau Ecoregion.

	Inside Corridor		Outside Corridor			
Type	**mi^2**	**%**	**mi^2**	**%**	***V***	**Total (mi^2)**
Freshwater Emergent Wetland	96.3	0.41	137.2	0.59	-0.18	233.5
Freshwater Forested/Shrub Wetland	20.0	0.31	43.9	0.69	-0.37	63.9
Riverine	90.7	0.33	184.3	0.67	-0.34	275.0
Overall	207.0	0.36	365.5	0.64	-0.28	572.5

4.5.2 Important Bird Areas, Wildlife, and Rare Plant Species/Communities

4.5.2.1 Important Bird Areas

Thirty-one distinct areas classified as state- or globally-recognized IBAs comprise approximately 3,196 mi^2 (10%) of the CPE and 27% was located in the corridor (*V* = -0.46). Six State IBAs totaling 125 mi^2 were located entirely outside the corridor. Overall, there was comparatively more area of State IBA within the corridor than Global IBA (Table 20). Four State IBAs had a larger proportion of their boundary within the corridor than outside (*V* = 0.01–0.87; Table 20).

The largest, most contiguous area of State IBA within the corridor included the Boardman Grasslands in Gilliam and Morrow counties, Oregon, west of the Boardman Naval Systems Weapons Training Facility. Ranked the fourth largest IBA in the CPE, the corridor contained 61% of the 326 mi^2 Boardman Grasslands (*V* = 0.22). Despite a large BPA electrical transmission and interstate transportation corridor along the northern perimeter of the IBA and degraded rangelands in the west, native land cover types provide habitat for high concentrations of burrowing owl, grasshopper sparrow (*Ammodramus savannarum*), and long-billed curlew. Located in proximity to existing transmission corridors and load centers increases the suitability for USSE but may be incompatible with the conservation of grassland birds and habitat if USSE is sited in areas with higher conservation value. Three remaining IBAs with positive vulnerability scores were small areas strategically located around aquatic habitats that provide important overwintering habitat for high concentrations of waterfowl. Although located in the corridor, the

[13] Oregon: ORS 196.795-990
Washington: WAC 173-201A

small size of the IBAs and proximity to aquatic habitats decreases the potential of impacts from USSE development.

Of the two globally-recognized IBAs in the CPE, the majority of the Yakima Training Center was excluded due to federal ownership; however, approximately 30% (248 mi^2) of the Leahy-Junction – Moses Coulee IBA was within the corridor (*V* = -0.38; Table 20). The corridor is oriented parallel to Banks Lake, on the eastern edge of the IBA with several short corridors into the IBA. The IBA is recognized for its relatively larger sage-grouse subpopulation compared to other areas of Washington. USSE development, particularly within the IBA would affect year-round sage-grouse habitat and populations. Sage-grouse was included as a focal species and is discussed in further detail below.

Table 20. Audubon Important Bird Areas inside and outside the USSE development corridor within the Columbia Plateau Ecoregion. Ten IBAs with the highest vulnerability index (*V*) presented.

	Inside Corridor		Outside Corridor			
IBA Priority	**mi^2**	**%**	**mi^2**	**%**	***V***	**Total (mi^2)[1]**
State	577.2	0.30	1,378.0	0.70	-0.41	1,955.2
Global	277.7	0.22	962.7	0.78	-0.55	1,240.4
IBA Name						
Potholes Reservoir	2.9	0.94	0.2	0.06	0.87	3.1
Boardman Grasslands	199.0	0.61	127.3	0.39	0.22	326.2
Snake and Clearwater Rivers Confluence	1.2	0.60	0.8	0.40	0.21	2.1
Cold Springs National Wildlife Refuge	2.5	0.51	2.4	0.49	0.01	4.9
Columbia National Wildlife Refuge	39.2	0.44	50.9	0.56	-0.13	90.1
Columbia Hills	65.3	0.37	112.2	0.63	-0.26	177.5
Hanford Reach	11.9	0.34	23.0	0.66	-0.32	34.9
Lake Creek	161.5	0.32	343.4	0.68	-0.36	505.0
Antelope Creek Basin	2.0	0.32	4.3	0.68	-0.37	6.4
Leahy Junction - Moses Coulee	256.0	0.31	569.7	0.69	-0.38	825.7

[1.] rounding resulted in minor rounding errors.

4.5.2.2 Wildlife

Records of 89 species composed of 27,015 occurrences were found in the PHS database. Approximately 27% of the total number of occurrences in the PHS database were documented within the corridor (*V* = -0.46). Of the 89 wildlife species recorded in the CPE, 68 species (76%) occurred within the corridor. Species with the highest number of records included Columbia sharp-tailed grouse and sage-grouse (both state endangered) which had 5 to 10 times the records than the third most documented species, pygmy rabbit (*Brachylagus idahoensis*; federal and state endangered). Sage-grouse and sharp-tailed grouse have been the subjects of intense research due to their state endangered status, which resulted in comparatively more records in the CPE than other wildlife species. Both grouse species had low vulnerability scores with ≤ 25% of the records occurring in the corridor (Table 21). Three of the 20 species most frequently documented were recorded more often within the corridor than outside the corridor and included pygmy rabbit (*V* = 0.44), unidentified jackrabbit species (*Lepus* spp.; *V* = 0.53; state candidate), and sagebrush lizard (*Sceloporus graciosus*; *V* = 0.15; State Candidate; Table 21).

Considered a sagebrush-steppe obligate species, pygmy rabbit populations in the CPE are located within three recovery areas in Douglas and Grant counties, Washington (Hayes 2018). Reintroductions have occurred since 2011 to help species recovery, although populations remain small (<200 individuals) and continue to be impacted by disease and wildfire (Gallie and Hayes 2020). The majority of occurrences within the corridor were located in Douglas County, which is part of the Sagebrush Flats Recovery Area. Habitat fragmentation of sagebrush-steppe from USSE development would have additive cumulative effects to this small, geographically isolated population. USSE development within or immediately surrounding recovery areas should be avoided to minimize impacts to native habitat and population viability.

Signsof unidentified jackrabbit species was documented three times more often within the corridor than outside (*V* = 0.53; Table 21). The majority of records occurred in a geographically small cluster within Douglas County, Washington as part of a WDFW study in 2010. The majority (>98%) of occurrences consisted of pellets, followed by tracks, and observations of individuals. The occurrence of sign (pellets and tracks) does not necessarily correspond to relative species abundance within the corridor where one rabbit can be responsible for multiple sign. In fact, observations of individual white-tailed jackrabbit (*Lepus townsendii*; *V* = -0.31) and black-tailed jackrabbit (*L. californicus*; *V* = -0.58) were documented more often outside the corridor than within the corridor (Table 21). Spatial data of jackrabbit HCA and connectivity are available from WHCWG and can be used during the project development phase to minimize impacts to jackrabbit species.

Over half of the 157 occurrences of sagebrush lizard occurred within the corridor and were distributed throughout the CPE. Closely associated with unstabilized dunes intermixed with sandy shrub-steppe land cover, much of the historical land cover for sagebrush lizard has been lost to conversion for agricultural use or modified by non-native, invasive plant species (Green et al. 2001, Drake 2018). Wildfire and the resulting sweeping changes in plant communities post-fire have altered vast portions of once suitable habitat within the lizards' range (Drake 2018). Although USSE development has not been considered a primary threat (ODFW 2016, WDFW 2015), precautions can be taken to locate facilities away from dune and sandy shrub-steppe habitats to minimize impacts to sagebrush lizard populations.

One record of one species was documented within the corridor that was not located outside the corridor; Rocky Mountain tailed frog (*Ascaphus montanus*; State Candidate) was documented in the Walla Walla Valley. Primarily associated with aquatic habitats, the species in not expected to be impacted from USSE development.

Table 21. Washington Priority Habitat and Species records within and outside the USSE development corridor. Data sorted by 20 most abundant species inside the corridor. Bold species indicate species with higher proportion of records inside the corridor.

	Inside Corridor		Outside Corridor			
Common Name	**#**	**%**	**#**	**%**	***V***	**Total**
greater sage-grouse	2,657	0.25	7,915	0.75	-0.50	10,572
Columbian sharp-tailed grouse	791	0.15	4,491	0.85	-0.70	5,282
pygmy rabbit	**716**	**0.72**	**279**	**0.28**	**0.44**	**995**
loggerhead shrike	452	0.47	503	0.53	-0.05	955
burrowing owl	444	0.46	515	0.54	-0.07	959
Northern leopard frog	354	0.44	448	0.56	-0.12	802
Western gray squirrel	285	0.31	637	0.69	-0.38	922
sage thrasher	183	0.28	460	0.72	-0.43	643
jackrabbit spp.	**168**	**0.76**	**52**	**0.24**	**0.53**	**220**
ring-necked pheasant	155	0.37	268	0.63	-0.27	423
sagebrush sparrow	149	0.25	440	0.75	-0.49	589
white-tailed jackrabbit	146	0.34	280	0.66	-0.31	426
ferruginous hawk	106	0.19	441	0.81	-0.61	547
sagebrush lizard	**90**	**0.57**	**67**	**0.43**	**0.15**	**157**
Washington ground squirrel	83	0.14	518	0.86	-0.72	601
black-tailed jackrabbit	42	0.21	160	0.79	-0.58	202
Yuma myotis	34	0.20	134	0.80	-0.60	168
Western small-footed myotis	31	0.15	174	0.85	-0.70	205
little brown bat	29	0.19	120	0.81	-0.61	149
Columbia spotted frog	27	0.32	57	0.68	-0.36	84

Records of 21 species were located entirely outside the corridor. Primary habitat associations of species outside the corridor included aquatic (10 species), forested (9 species) and canyon (1 species) habitats typically unconducive to USSE development. One record of one shrub-steppe and grassland associated species was documented outside the corridor and consisted of hundreds of giant Palouse earthworms (*Driloleirus americanus*; State Candidate) in the uplands above the Columbia River in Chelan County.

4.5.2.2.1 Focal Species: Rocky Mountain Mule Deer

An iconic symbol of the American West, mule deer represent an important component of the cultural, recreational, and ecological structure in the CPE (Meyers 2012). To utilize resources, mule deer exhibit seasonal movements that vary in distance and elevation, depending on the herd, but can migrate long distances between summer and winter ranges making connectivity between these areas a topic of conservation concern (Wakeling et al. 2015).

Photo 15. Mule deer in a CRP field with wind turbines on the horizon, Klickitat County, Washington, May 2020.

Fifty-five discrete HCAs composing approximately 6,527 mi^2 was modeled within the CPE. Despite a comparatively small overall total area of HCAs located within the corridor (10%; V = -0.81), portions of 48 of the 55 HCAs (87%) were located within the corridor. There was high variability around the average proportion of the HCA's located within the corridor (12 ± 11%, range: <1%−42%). The largest HCA (418 mi^2) with the highest proportion (25%) within the corridor was located along the Snake River breaks within Columbia, Garfield, and Walla Walla counties, Washington. All HCAs had a greater proportion of their total area located outside the corridor (V < 0.01). The most effected HCAs included 19.7 mi^2 (V = -0.197) in the Lake Creek area of northcentral Lincoln County, Washington. There was a poor correlation between the vulnerability score and the total size of the HCA (R^2 = <0.001), suggesting the proportion of the HCA within the corridor was independent of the total area of the HCA. Overall, HCAs in Washington had a higher proportion within the corridor than HCAs in Oregon where HCA are grouped at higher elevations along the southern boundary of the CPE, bordering the Blue Mountains Ecoregion.

One hundred discrete LCP composing approximately 1,725 mi was modeled in the CPE. Although there was a greater overall proportion of LCPs outside the corridor (V = -0.34), 23 of 100 LCPs were disproportionately affected totaling approximately 394 mi (Table 22). Of the 23 LCPs with V > 0.5, the average proportion was comparatively higher (63 ± 8%, range: 50−78%) than the proportion of HCA within the corridor. The longest LCP (66 mi) with the highest proportion (40%) within the corridor connects the largest HCA along the Snake River breaks within Columbia, Garfield, and Walla Walla counties with the Rattlesnake Hills HCA in northern Benton County, Washington. There was a poor correlation between the vulnerability score and the total length of the LCP (R^2 = 0.06), suggesting the proportion of the LCP within the corridor was independent of the total LCP length. Washington had a greater proportion of LCPs within the corridor than Oregon and the LCPs were spatially grouped in higher concentrations within the northcentral portion of the CPE in Adams, Douglas, Grant, and Lincoln counties. Seven of the 10 LCPs with the highest vulnerability score were less than 4 mi long, indicating short LCPs connecting close groups of HCAs may have a comparatively larger affect to their continuity than larger HCAs with multiple LCPs.

Although mule deer populations within the CPE appear stable and support recreational hunting, impacts to the species and habitats are considered by ODFW and WDFW during USSE development. Mule deer HCAs represent some of the remaining contiguous areas of intact shrub-steppe and channelized scablands necessary to support this widespread species with seasonal movements throughout the CPE (Myers 2013). Although HCAs were widely distributed around the CPE, biological and human-made barriers constrict the connectivity corridors between HCAs, which are essential to seasonal dispersal, gene flow and sub-population viability. Models indicate some state highways and wide water courses present the strongest barriers to mule deer movement (Myers 2013). However, impacts that further reduce access to seasonal habitats or restrict connectivity may compound existing stressors to mule deer populations (Wakeling et al. 2015).

Secretarial Order 3362 provided guidance and financial incentive for states in the CPE to enhance and improve the quality of big-game winter range and migration corridors on federal and state lands, while recognizing private property rights (USDOI 2018). Within the CPE, WDFW has implemented restoration projects that include fence modification in the Moses Coulee area, incentivizing SAFE Program participation and habitat restoration along the Crab Creek drainage in Grant County to enhance connectivity between HCAs (WAFWA 2019). ODFW continues planning and prioritization efforts (ODFW 2019). Future USSE development within the CPE can utilize spatial data from WHCWG and leverage knowledge from resource agencies with site-specific field surveys to minimize cumulative impacts to connectivity corridors or on-going conservation efforts to improve big-game habitat.

Table 22. Mule deer least cost pathways with a positive vulnerability score documented within the USSE development corridor in the Columbia Plateau Ecoregion.

	Inside Corridor		Outside Corridor			
LCP ID[1]	mile	%	mile	%	V	Total (mi)
54	8.7	0.78	2.5	0.22	0.56	11.2
124	1.9	0.76	0.6	0.24	0.52	2.5
1	2.0	0.76	0.6	0.24	0.51	2.6
111	0.5	0.71	0.2	0.29	0.41	0.7
63	2.5	0.69	1.1	0.31	0.38	3.6
3	1.9	0.68	0.9	0.32	0.37	2.8
46	1.3	0.68	0.6	0.32	0.36	1.9
80	4.6	0.65	2.5	0.35	0.30	7.0
51	10.4	0.63	6.0	0.37	0.27	16.4
7	1.0	0.63	0.6	0.37	0.25	1.6
86	13.3	0.62	8.0	0.38	0.25	21.4
150	24.5	0.62	15.0	0.38	0.24	39.5
72	6.2	0.62	3.8	0.38	0.24	10.0
94	28.1	0.60	18.5	0.40	0.21	46.6
129	39.6	0.60	26.8	0.40	0.19	66.4
67	3.3	0.59	2.2	0.41	0.19	5.5
100	15.3	0.59	10.6	0.41	0.18	25.8
76	22.1	0.57	16.9	0.43	0.13	39.0
65	5.2	0.55	4.2	0.45	0.11	9.3
179	0.6	0.52	0.5	0.48	0.03	1.1
96	34.5	0.52	32.5	0.48	0.03	67.0
70	6.0	0.51	5.8	0.49	0.01	11.8
119	0.3	0.50	0.3	0.50	0.00	0.6

1. Myers 2012 for location of LCP corridors

4.5.2.2.2 Focal Species: Greater Sage-grouse

A shrub-steppe obligate species, sage-grouse populations in the CPE have been relegated to three subpopulations with a total of 775 birds at 21 leks as of 2020 (Stinson 2021). The species can have large home ranges and are mostly reliant on large areas of shrub-steppe for all stages in their life cycle (Knick and Connelly 2011).

Four discrete HCAs composing approximately 1,440 mi^2 were modeled within the CPE; however, a reintroduced population by the Yakama Nation was lost between 2018–2019 (Table 23; Stinson 2021). Despite a comparatively small overall total area of HCAs located within the corridor (17%; V = -0.66), portions of all HCAs were located within the corridor. There was high variability in the proportions of the HCA located within the corridor (mean = 16% ± 14%, range: 1−34%). The largest HCA (724 mi^2) that had the second highest proportion within the corridor was the Moses Coulee – Mansfield Plateau HCA located in Douglas County, Washington. The largest populations within the CPE are located within the Moses Coulee – Mansfield Plateau HCA. The HCA with the greatest proportion within the corridor included 54.2 mi^2 (V = -0.33) of the Crab Creek area in northcentral Lincoln County, Washington (Table 23). There was a poor correlation between the vulnerability score and the total size of the HCA (R^2 = <0.01), suggesting the proportion of the HCA within the corridor was independent of the total area of the HCA.

Table 23. Greater sage-grouse habitat concentration areas inside and outside the USSE development corridor within the Columbia Plateau Ecoregion.

		Inside Corridor		Outside Corridor			Total
HCA ID[1]	HCA Name	mi^2	%	mi^2	%	V	(mi^2)
1	Crab Creek	54.2	0.34	107.0	0.66	-0.33	161.2
2	Moses Coulee – Mansfield Plateau	143.8	0.20	577.6	0.80	-0.60	721.4
6	Yakima Training Center	45.6	0.10	393.7	0.90	-0.79	439.4
7[2]	Toppenish Ridge	1.6	0.01	116.1	0.99	-0.97	117.8

1. Robb and Schroeder (2012) for locations of HCAs.
2. Yakama Nation reintroduction believed extirpated in 2018–2019 (Stinson 2021).

Three discrete LCPs composing approximately 146 mi were modeled within the CPE. Despite a greater overall proportion (86%) of connections located outside the corridor, portions of all three LCPs were within the corridor (Table 24). The LCP with the highest proportion within the corridor was between the Moses Coulee – Mansfield Plateau HCA and Crab Creek HCP (29%, Table 24). The longest LCP was between the Yakama Training Center and Toppenish Ridge, where populations are believed to be extirpated. The correlation between the vulnerability score and the total length of the LCP was uninformative due to the low sample size; however, impacts from development within LCPs that hamper connectivity or survival are likely biologically meaningful due to the small overall population size and importance of gene flow between subpopulations (Robb and Schroeder 2012).

Table 24. Greater sage-grouse least cost pathways inside and outside the USSE development corridor within the Columbia Plateau Ecoregion.

		Inside Corridor		Outside Corridor			
LCP ID[1]	HCA Connection[2]	mi	%	mi	%	V	Total (mi)
1	1-2	12.2	0.29	29.9	0.71	-0.42	42.0
4	2-6	3.7	0.09	39.0	0.91	-0.83	42.8
5	6-7	4.8	0.08	56.0	0.92	-0.84	60.9

1. Robb and Schroeder (2012) for locations of LCPs.
2. HCA IDs connected by the LCP.

Photo 16. Shrub-steppe habitat near the Toppenish Ridge sage-grouse population on the Yakama Nation, Yakima County, Washington, April 2017.

In 2020, wildfires burned tens of thousands of acres of eastern Washington sage-grouse habitat. Habitat loss was the single greatest threat to this species and was exacerbated by the immediate threat of wildfire. WDFW estimates the full impacts to grouse populations may not be known for two to three years but fires may eventually reduce the number of greater sage-grouse by 30 to 70 percent, bringing the statewide population dangerously low (Stinson 2021). Reintroductions into the Toppenish Ridge subpopulation and Crab Creek subpopulations are believed to have failed. The overall outlook for greater sage-grouse population sustainability in the CPE appears dire, with nearly all subpopulations trending downward and some trending toward extinction (Stinson 2021). Impacts from future USSE development in and surrounding populations with suitable sage-grouse habitat (sagebrush dominant shrub-steppe grasslands) are likely cumulative to the host of other environmental stressors on the landscape and should be avoided.

4.5.2.3 Rare Plants Species/Communities

Approximately 82% (100 species) of the 122 rare plant species within the CPE had at least one record within the corridor. The majority of rare plants in the corridor are listed by WDNR as threatened (51%), followed by sensitive (34%) and endangered (15%). Of these species, four are listed by the USFWS as federally threatened. Records of two species, rosy pussypaws (*Calyptridium roseum*, state threatened) and shortstemmed mousetail (*Myosurus sessilis*, state endangered), were only documented within the corridor and composed approximately 0.8 mi^2. Records of rosy pussypaws were limited to the area of the Hanford Nuclear Site and shortstemmed moustail is a vernal pool obligate with a restricted distribution in the northeastern corner of the CPE. Records of 11 rare plant species were located in greater proportion within the corridor than outside (Table 25). Gray cryptantha (*Cryptantha leucophaea*, state threatened) had the largest area within corridor with approximately 52% of records within the corridor (V = 0.03; Table 25). Associated with sandy areas in shrub-steppe and grassland habitats, this species is comparatively more vulnerable from USSE because of its broad distribution throughout the central portion of the CPE and narrow habitat niche that requires wind-derived movement of open sands (Camp and Gamon 2011). Although gray cryptantha had the largest area documented in the corridor, the species was sixth most documented rare plant in the CPE. This relationship shows the spatial heterogeneity in the distribution of rare plants in the CPE.

Table 25. WDNR rare plant species documented in the corridor with a positive vulnerability score (*V*).

Common Name Scientific Name	WDNR Status[1]	Inside Corridor mi²	Inside Corridor %	Outside Corridor mi²	Outside Corridor %	*V*	Total (mi²)
Columbia crazyweed *Oxytropis campestris var. columbiana*	E	0.1	1.00	0.0	0.00	0.99	0.1
Thompson's sandwort *Eremogone franklinii var. thompsonii*	S	4.5	0.97	0.1	0.03	0.94	4.6
arrow thelypody *Thelypodium sagittatum sagittatum*	T	0.6	0.90	0.1	0.10	0.80	0.7
spreading pygmyleaf *Loeflingia squarrosa*	T	2.9	0.88	0.4	0.12	0.76	3.2
red poverty-weed *Micromonolepis pusilla*	T	0.7	0.77	0.2	0.23	0.55	1.0
delicate gilia *Lathrocasis tenerrima*	T	1.1	0.73	0.4	0.27	0.47	1.5
hairy bugseed *Corispermum villosum*	S	1.4	0.68	0.7	0.32	0.36	2.1
Great Basin gilia *Aliciella leptomeria*	T	1.0	0.57	0.7	0.43	0.15	1.7
woven-spore lichen *Texosporium sancti-jacobi*	T	0.6	0.55	0.5	0.45	0.09	1.0
ribseed biscuitroot *Lomatium tamanitchii*	S	1.2	0.52	1.1	0.48	0.03	2.3
gray cryptantha *Cryptantha leucophaea*	T	10.6	0.52	9.9	0.48	0.03	20.5

[1] E = Endangered; T = Threatened; S = Sensitive

Sixty-six of the 100 high-quality plant communities documented in the CPE also occurred in the corridor. Although WDNR does not assign regulatory status to high-quality plant communities, high-quality native plant communities may contain rare plant species, and ODFW and WDFW consider generalized habitat types (e.g., grasslands, oak woodlands, shrub-steppe) would qualify for compensatory habitat mitigation (*see* Section 4.4.1). Records of one plant community, streamside wildrye (*Elymus lanceolatus*)/needle-and-thread was only documented in the corridor and composed approximately 0.12 mi². This high-value plant community is associated with inland sand dunes with one record near the Desert Unit of the South Columbia Basin State Wildlife Recreation Area in Grant County, Washington. The most abundant vegetation communities are likely the most vulnerable to USSE where 69–75% of the Antelope Bitterbrush (*Purshia tridentata*)/Indian Ricegrass (*Achnatherum hymenoides*) and Wyoming Big Sagebrush (*Artemisia tridentata* ssp. *wyomingensis*)/Needle-and-thread shrublands were within the corridor, primarily in northern Benton County and southern Grant County, Washington, and both are associated with shrub-steppe habitat (Table 26). Potential effects from USSE development increases for larger-sized high-value plant communities that have a greater proportion of their area within the corridor.

Table 26. High-value plant communities documented in the corridor with a positive vulnerability score (*V*). Sorted by descending order for plant communities with greater proportion (*V*) of the documented area within the corridor.

	Inside Corridor		Outside Corridor			
Plant Community[1]	**mi²**	**%**	**mi²**	**%**	***V***	**Total**
Needle-and-thread Grassland	2.0	0.99	< 0.01	0.01	0.99	2.0
Ponderosa Pine Forest	< 0.01	0.99	< 0.01	0.01	0.98	< 0.01
Oregon White Oak - Ponderosa Pine Forest	0.1	0.96	< 0.01	0.04	0.92	0.1
Greasewood/Saltgrass Wet Shrubland	0.2	0.95	< 0.01	0.05	0.91	0.2
Clustered Field Sedge Wet Meadow	< 0.01	0.91	< 0.01	0.09	0.82	< 0.01
Sandbar Willow/Field Horsetail Shrubland Wet Shrubland	< 0.01	0.89	< 0.01	0.11	0.79	< 0.01
Bitterbrush/Indian Ricegrass	12.7	0.75	4.1	0.25	0.51	16.8
Wyoming Big Sagebrush/Needle-and-thread	11.3	0.69	5.1	0.31	0.38	16.4
Sand Dropseed - Sandberg's Bluegrass	0.4	0.68	0.2	0.32	0.37	0.6
Black Cottonwood/Western Water-hemlock Riparian Forest	< 0.01	0.67	< 0.01	0.33	0.35	0.1
Saltgrass Alkaline Wet Meadow	< 0.01	0.63	< 0.01	0.37	0.26	< 0.1
Bluebunch Wheatgrass - Sandberg's Bluegrass	0.6	0.63	0.4	0.37	0.26	1.0
Douglas' Buckwheat/Sandberg's Bluegrass	0.5	0.55	0.4	0.45	0.10	1.0

[1] Common species names provided. Classification follows US National Vegetation Classification Group and Associations. Detailed descriptions of plant communities are provided by Rocchio and Crawford (2015)

5 DISCUSSION

5.1 Wind Energy and Avian Mortality

Our assessment summarized over 20 years of PCFM data at wind energy facilities in the CPE and evaluated the potential cumulative direct impacts to bird and bat populations. Species composition and seasonal patterns of bird and bat mortality from wind energy were similar to patterns reported over one decade ago (Johnson and Erickson 2011) and consistent with patterns documented on a broader scale at wind energy facilities throughout the western US (AWWI 2020, WEST 2021). Compared to Johnson and Erickson (2011), mean fatalities/MW were slightly higher (8.8%) for the All Bird group, increased 50% for the Raptor group, and decreased 5.3% for the Bat group; however, species composition by group (i.e., Passerine, Upland Game Bird, migratory tree roosting bat, etc.) was similar. Results of the analysis suggested no significant population level effects are likely associated with species most often found during PCFM (Passerines) based on the small proportion of the robust populations affected. In an analysis of 116 PCFM studies throughout the US, Erickson et al. (2014) found Passerines composed 62.5% of all fatalities; however, the cumulative species-specific effects from wind mortality affected <0.1% of the populations. When bird population sizes were proportionally adjusted for populations assumed to occur in the CPE, results from this study were consistent with population-level affects calculated at larger spatial scales. PCFM are typically performed by humans which studies have shown to underestimate the true number of fatalities compared to dogs, which have a higher detection probability, particularly for smaller-sized species (Mathews et al. 2013, Reyes et al. 2016, Smallwood et al. 2020). Assuming fatality estimates of horned lark, the species most often found during PCFM in the CPE, are doubled or tripled, population-level effects of collision mortality would still result in affecting <1% of the population. However, conservation initiatives generally do not focus on abundant, wide-ranging species with robust populations. Rather, future concerns will undoubtedly focus on species found ‘in the middle’, where species mortality is not prevalent but because of their population size and life-history traits, mortality levels may be a source of conservation concern.

To address the ecological and conservation significance of wind energy mortality, permitting authorities have attempted to set mortality thresholds where exceedance would result in remedial measures to minimize or compensate for impacts. Examples include the European Union (EU) who set mortality limits ranging from 1–5% of the overall annual natural mortality in the relevant biogeographical populations, depending on species and county (European-Commission 1993, Backes and Akerboom 2018). The USFWS set a cumulative limit of 5% of populations for golden eagle and bald eagle take within a particular LAP or EMU (USFWS 2016).

In Oregon, facilities permitted by EFSC adhere to ‘thresholds of concern’ for sensitive groups that include All Raptors, Raptor Species of Concern, Grassland Birds, State Sensitive Birds, and Bats. EFSC recognizes the thresholds are a rough measure to inform Council intervention and based on limited scientific basis (EFSC 2006). Thresholds of concern are defined as annual fatalities/MW and are essentially an indicator used to compare facility-level impacts with average fatality rates within the region. EFSC thresholds are currently 28% below the mean fatality rate calculated for raptors (0.09 raptors/yr/MW) and 79% higher than the mean fatality rate for bats (2.5 bats/yr/MW; Table 9). In this analysis, EFSC group fatality rates were not calculated for other groups (e.g., Raptor Species of Special Concern, Grassland Species, State Sensitive Species), but future work can help calibrate thresholds to align with contemporary mortality levels and species of conservation concern using more sophisticated analytical methods.

In their assessment of mortality thresholds in the EU, Schippers et al. (2020) used potential biological removal (PBR) models to predict population trajectories for eight species ranging from European starling to white-tailed eagle (*Haliaeetus albicilla*) as a result of incremental increases in mortality. Researchers found small changes in mortality had disproportionate effects on population trends over 10 years, particularly for long-lived species with low reproductive rates that would be more sensitive to increases in adult mortality and less able to compensate by increasing reproduction (K-selected; Schippers et al. 2020). Using PBR, Diffendorfer et al. (2021) studied the response of 14 raptor species to wind energy development scenarios in the US and found greater susceptibility to population changes for barn owl, ferruginous hawk, golden eagle, American kestrel, and red-tailed hawk, whereas burrowing owl, Cooper’s hawk *(Accipiter cooperii*), great horned owl (*Bubo virginianus*), northern harrier (*Circus hudsonius*), turkey vulture, and osprey had a relatively lower potential for population impacts.

In a comparative risk assessment of 428 species from wind energy development that incorporated both direct and indirect impacts to breeding birds in the US, Beston et al. (2016) found raptors, specifically long-eared owl (*Asio otus*), ferruginous hawk, Swainson’s hawk, and golden eagle to be more susceptible to population impacts than species in the Passerine group. The patterns found by Diffendorfer et al. (2021) and Beston et al. (2016) were largely reflected in this assessment where species with low populations and sustained mortality such as golden eagle and ferruginous hawk may be more susceptible to cumulative impacts from renewable wind energy development in the CPE.

5.2 USSE and Renewable Energy Land Use

Our solar energy resource assessment modeled sensitive resources where USSE development is most likely to occur and identified resources that would potentially be affected. Our assessment identified pygmy rabbit and sagebrush lizard as species more likely to be affected by USSE, based on the greater proportion of records within the development corridor than outside the corridor. Records of 11 rare plants and 13 ecologically high-value plant communities were found in greater proportions within the corridor than outside. Sensitive plant species and communities that have a larger distribution or area within the corridor have a higher likelihood to be affected; in particular, species and communities with limited distribution or small extent that are only located within the corridor have the highest potential for deleterious cumulative impacts from development. For example, approximately 75% (12.7 ac) of Bitterbrush/Indian Ricegrass plant community was found within the corridor. Impacts to this high-value plant community are relatively higher than the small distribution of needle-and-thread grassland (2 ac); however, nearly all recorded occurrences of needle-and-thread grasslands were found within the corridor. Although less likely to be impacted, the limited extent of needle-and-thread grasslands that only occur within the corridor warrants increased conservation concern.

With sensitive plant and vegetation communities identified, early project development can integrate these data into project siting decision that avoid sensitive resources. The occurrence of sensitive resources in publicly-available spatial layers do not represent a systematic sample of resources in the CPE; rather, the data reflect opportunistic reports/observations or focal surveys in specific areas that were part of research studies. Therefore, desktop project-specific assessments should always be supplemented with field surveys that identify, quantify, or delineate sensitive resources following the tiered approach described in various guidelines and protocols (e.g., WDFW 2009; USFWS 2012, 2013; Fertig 2020). Not all resources with a negative *V*-score merit a lower conservation concern. Although there was proportionally less shrub-steppe land cover within the corridor, overall shrub-steppe land cover decreased approximately 13% in the CPE from 2006–2019 and nearly 80% of its historical range has been lost in Washington (Azerrad et al. 2011). Combined with the reliance of various shrub-steppe obligate wildlife species, and long regeneration time to recover degraded or deteriorated stands, avoidance of shrub-steppe land cover should be a priority when siting renewable energy projects in the CPE.

An expanding USSE sector in the CPE will include blocks of land where solar arrays, inverters, access roads, electrical systems and related infrastructure are consolidated. The amount of land necessary for USSE to achieve renewable energy objectives will be limited, in part, by the technological efficiency of the solar arrays. In a study of 736 USSE facilities in the US installed from 2007–2019, the median power density (MW Direct Current [$_{DC}$]/ac) of fixed-tilt solar arrays was 0.35 MW_{DC}/ac and 0.24 MW_{DC}/ac for tracking arrays that reposition themselves according to the orientation of the sun (Bolinger and Bolinger 2022). Thus, 1 MW of solar energy produced from tracking arrays would require approximately 4.2 ac. Based on power densities reported by

Bolinger and Bolinger (2022) and assuming tracking arrays will be the prevalent technology used in the CPE, approximately 16,667–25,000 ac of new USSE arrays (excludes infrastructure) would be needed in the CPE, depending on development scenario. The amount of land estimated for new USSE arrays represents 0.25–0.38% of the total area modeled within the corridor (6,656,980 ac). This land use estimate excludes other infrastructure associated with USSE including roads, electrical substations, operations and maintenance buildings, if not already constructed for a co-located wind energy facility, and does not include the biological effects from fencing or other indirect effects.

Future advances in solar technology will increase power densities resulting in less land necessary for equivalent levels of energy generation. Bolinger and Bolinger (2022) estimates of power density underrepresented bifacial solar arrays which did not significantly infiltrate the USSE industry by 2019, and represented the last year of their sample period. Bifacial solar arrays maximize energy generation by utilizing reflected irradiation on the underside of the solar panels and could have a significant influence of the land needed for USSE development (Bolinger and Bolinger 2022). In addition, co-location of USSE (and battery storage) within the footprint of existing wind energy facilities provides efficiencies in leveraging existing infrastructure (i.e., access roads, electrical distribution lines, substitutions) and also minimizes new greenfield development in areas where no development exists (Pattison 2015). In an assessment of 39 facilities in the US, the total amount of land transformed by the development of a wind energy facility varied substantially from 0.27 to 10.6 ac/MW of installed capacity, which may constitute 5% to 10% of the total project area (Diffendorfer and Compton 2014). Assuming the average land use estimate of 0.74 ac/MW from 172 wind energy facilities within the US, approximately 2,960–4,440 ac of new wind energy development would be needed (Denholm et al. 2009). Thus, spacing between and among turbines inherent in wind energy facility designs provides co-location opportunities. Although land use intensity has the potential to increase at co-located facilities, consolidating technologies increases energy security, reduces costs and most importantly, reduces the extent of new development across the landscape (Boroski 2019).

5.3 Indirect Effects

Our assessment focused on direct impacts to bird and bat populations from turbine collision and direct impacts to land cover and vegetation from USSE. However, indirect impacts from habitat fragmentation or loss and species avoidance or displacement that result in reduced survival or reproductive productivity can also impact populations. Combined with direct effects, indirect effects can be amplified, particularly for small populations or species that occupy a small ecological niche such as sagebrush obligate species. Greater sage-grouse are an example of a species that requires large areas of shrub-steppe and has small, isolated subpopulations with tenuous population levels (Stinson 2021). Development activities that modify the landscape can change predator communities, habitat quality/selection, sage-grouse movement and survival rates (Doherty et al. 2011; LeBeau et al. 2014, 2017; Gibson et al. 2018). In Washington, sage-grouse nest locations were located further away from distribution lines (~12kV) and contained greater shrub cover (Stonehouse et al. 2015). LeBeau et al. (2019) found that transmission lines had a negative effect on sage-grouse habitat selection and survival. However, the authors determined that the effect varied by proximity to occupied leks and habitat suitability, suggesting that the magnitude of effects may be minimized by siting transmission lines in unsuitable habitats when they occur within 1.9 mi from an occupied lek (LeBeau et al. 2019). Another example of a species with a small population and vulnerable to indirect effects is ferruginous hawk, which simulations have shown population trends declining at greater rates due to permanent loss of suitable nesting territories compared to collision mortality in the Washington nesting population (Jansen and Swenson 2022).

Indirect effects sustained by already struggling populations may compound existing environmental stressors and have cumulative effect on population growth when combined with other environmental stressors. Spatial and temporal buffers surrounding areas of biological importance (e.g., nesting territories, breeding or roosting areas or areas of high concentrations) can be implemented during construction or operation that minimize the potential for indirect effects (Romin and Muck 1999, Larson et al. 2004, ODFW 2008)

The effects of renewable energy development on big game is a concern, particularly the interruption of movement and connectivity corridors to seasonal winter and summer ranges (Lutz et al. 2011, Wakeling et al. 2018). In a 17-year study of mule deer response to oil and gas development in Wyoming, mule deer were less abundant and avoided development up to 0.6 mi even after restoration efforts were completed (Sawyer et al. 2017). Although the study did not measure the demographic response of mule deer, oil and gas development has a much higher land use intensity than wind energy and patterns of mule deer avoidance and reduced recruitment have been documented (Sawyer et al. 2013, Johnson et al. 2017, Wyckoff et al. 2018). Disruption to movement corridors connecting seasonal ranges (defined as LCPs in this study) can increase energy expenditure and alter migratory routes that may increase exposure to impacts for both resident and migratory herds (Sawyer et al. 2020). Fences surrounding USSE and land parcels have been shown to limit pronghorn (*Antilocapra americana*) movement and habitat connectivity (Jones et al. 2019, Reinking et al. 2019, Sawyer et al. 2022). Combined with project-level assessments, remotely sensed spatial data similar to products from the WHCWG can be used to site projects that avoid impacts to movement and connectivity and minimize potential indirect impacts from renewable energy development. A more comprehensive review of indirect impact potential on bird and bat populations due to renewable energy development can be found in Beston et al. (2016) and Moorman et al. (2016).

5.4 Toward 2030 and Beyond

The effects of renewable energy development on wildlife and other environmental resources cannot be consolidated into a winners and losers framework (Rand and Hoen 2017). Relative impacts to birds and bats should be viewed upon a spectrum in conjunction with other stressors in the environment where proactive measures may manifest into conservation outcomes that supersede the marginal relative benefits from minimization measures proposed at renewable energy facilities. For example, mortality from building collisions are magnitudes higher than wind energy-derived mortality (Loss et. al. 2014). Realization of on-going initiatives to darken night skies from artificial night would reduce collision rates of neotropical migrants and reestablish disrupted migratory routes (Korpach et al. 2022, Sordello et al. 2022). The basis of species recovery plans outline holistic approaches to species conservation that address multiple conservation concerns. For example, WDFW discussed a range of conservation efforts needed for ferruginous hawk that included installment of artificial nest platforms, comprehensive monitoring and research, increased funding and emphasis placed on habitat management and enhancement programs, reduced application of industrial chemicals, and strategic conservation planning that minimizes human encroachment into unfragmented native habitats (Richardson 1996, Hayes and Watson 2021). Mitigation of stressors that affect wildlife, plants, and habitat should be implemented across the broad range of factors within the human-built environment in order to maintain viability of local populations over time.

Looking toward the future, energy generation within the CPE will continue to be bolstered by the region's large amount of hydropower, nuclear, and traditional thermal resources including those that burn natural gas and coal (NPCC 2021). Success in meeting state-mandated renewable energy goals in the CPE will depend on technological advances in energy efficiency, battery storage, optimization in electrical distribution loads and capacity. If projections hold, renewable energy development in the CPE is beginning another period of intense development pressure, similar or greater to what was observed in the 2000s. The balance between energy efficiency and ecological integrity and conservation will rely on clear and consistent guidance from regulatory agencies that developers can use to develop, construct, operate, and decommission energy facilities in a manner that is consistent with current environmental conditions.

Wind energy guidance for wildlife and habitats in Oregon and Washington are over a decade old and solar energy guidance is absent (ODFW 2008, WDFW 2009). Advances in Oregon to map wildlife connectivity and linkages, similar to WHCWG (2012), are promising but currently lack directives that synchronize with renewable energy guidance and wildlife issues (ODFW 2019). In conversations with participants during the development of this assessment, two common themes emerged that could be grouped into two general categories that deal with processes and systems. In general, *processes* were related to guidance and implementation of environmental policies whereas *systems* were related to the opportunities and challenges in energy generation, storage, and distribution. System concerns included repowering, strategic placement of battery storage, advances in energy efficiency, and transmission queue issues but are outside the scope of this assessment. Reflecting process-oriented recommendations from the study participants and previous researchers (Allison et al. 2019, Copping et al. 2020, Conkling et al. 2021), processes that would improve future cumulative impact assessments include:

- Updating wind energy development guidelines using contemporary science, methods and metrics to facilitate consistent and measurable outcomes throughout the project life-span.
- Developing USSE policy, procedure, and guidance/guidelines that provide clear, measurable, replicable science-based methods and metrics.
- Allocating greater funding to resource agencies to develop or update state- or county-specific distributions of sensitive resources that can be used to proactively identify sensitive resources early in the development process.
- Encouraging and funding long-term, systematic sampling of bat populations within the CPE such as NABat protocols.

- Developing spatial data layers of sensitive species and resources with uniform spatial accuracy and resolution, similar to CPE products available from WHCWG.
- Facilitating the exchange of information in a way that provides a non-punitive process to collect and aggregate data in a manner that allows informed analyses and adaptive management in siting decisions and analyses.

Biologically, the CPE represents a unique ecosphere carved out by the epic Missoula Floods and bound in all directions by different habitats, higher elevations, and different wildlife and plant species associations. Energetically, the CPE represents a discrete geographic renewable resource area in the Pacific Northwest that maximizes energy generation in the broader WECC which supplies the western US with its growing energy demands. Despite biological and energetic uniformity, the CPE is fractured by multiple scales of administrative boundaries, each with different policies, procedures, and guidance. The majority of the CPE encompasses two states with two separate state-level permitting Councils, a handful of various resource agencies, and 25 different counties (excluding Idaho) with their own Comprehensive Management Plans and local regulations. The discontinuity between the biological similarities within the CPE and the regulatory discordance throughout the various jurisdictions results in difficulties for developers to site and develop early-stage projects that avoid impacts, biologists to recommend viable alternatives and perform necessary studies, and resource agencies unable to provide standardized guidance to inform proactive and science-based measures. The ability to truly evaluate the cumulative impact of wildlife, plants, and habitats from renewable energy development, and strategically plan for future development that minimizes environmental impact will hinge on the collective assembly of stakeholders to form collaboratives that address these issues for the next decade and beyond.

Photo 17. Mountain bluebird nest box with wind turbines in the background, Klickitat County, Washington, May 2020.

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APPENDIX TABLES AND FIGURES

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Appendix T1. Bird species of conservation concern and regulatory status known to occur within the Columbia Plateau Ecoregion.

		ODFW[1]		WDFW[2]		BLM / USFS[3]		USFWS[4]	
Birds	**Scientific Name**	**S**	**CR**	**E**	**T**	**C**	**OR-S**	**WA-S**	**BCC**
American white pelican	*Pelecanus erythrorhynchos*	–	–	–	X*	–	X	X	X*
bald eagle	*Haliaeetus leucocephalus*	–	–	–	–	–	X	X	–
Brewer's sparrow	*Spizella breweri breweri*	X	–	–	–	–	–	X	–
burrowing owl	*Athene cunicularia hypugaea*	–	–	–	–	X	–	X	X
common nighthawk	*Chordeiles minor*	X	–	–	–	–	–	–	–
ferruginous hawk	*Buteo regalis*	–	X	X	–	–	–	–	X
golden eagle	*Aquila chrysaetos*	–	–	–	–	X	–	–	–
grasshopper sparrow	*Ammodramus savannarum perpallidus*	X	–	–	–	–	X	–	–
greater sage-grouse	*Centrocercus urophasianus*	–	–	X	–	–	X	X	X
Lewis's woodpecker	*Melanerpes lewis*	–	X	–	–	–	X	X	X*
loggerhead shrike	*Lanius ludovicianus*	X	–	–	–	X	–	–	–
long-billed curlew	*Numenius americanus*	–	X	–	–	–	–	X	X
northern goshawk	*Accipiter gentilis*	–	–	–	–	X	–	X	–
sage thrasher	*Oreoscoptes montanus*	–	–	–	–	X	–	X	X*
sagebrush sparrow	*Artemisiospiza nevadensis*	–	X	–	–	X	–	X	–
sandhill crane	*Antigone canadensis*	–	–	X	–	–	–	X	–
sharp-tailed grouse	*Tympanuchus phasianellus col.*	–	–	X	–	–	–	X	–
short-eared owl	*Asio flammeus flammeus*	–	–	–	–	–	–	X	X*
Swainson's hawk	*Buteo swainsoni*	X	–	–	–	–	–	–	–
upland sandpiper	*Bartramia longicauda*	–	–	X	–	–	X	–	X

1. ODFW (OAR 635-100-0040). S = Sensitive: small or declining populations, are at-risk, and/or are of management concern; CR = Critical: current or legacy threats that are significantly impacting their abundance, distribution, diversity, and/or habitat.
2. WDFW (WAC 220-200-100; 220-610-010). E = Endangered: seriously threatened with extinction throughout all or a significant portion of its range within the state; T = Threatened likely to become endangered within the foreseeable future throughout a significant portion of its range within the state without cooperative management or removal or threats; C = Candidate: factors suggest species may be a candidates for listing as Endangered, Threatened, or Sensitive.
3. BLM (Manual Section 6840). S = Sensitive: species that require special management consideration to avoid potential future listing under the ESA; USFS (Manual Section 2670.5 & .32). S = Sensitive: population viability is a concern, as evidenced by significant current or predicted downward trends in population numbers or density and habitat capability that would reduce a species' existing distribution; management must not result in a loss of species viability or create significant trends toward federal listing.
4. USFWS (16 U.S.C. 2901–2912). BCC = Bird of Conservation Concern: species, subspecies, and populations of all migratory nongame birds that, without additional conservation actions, are likely to become candidates for listing under the Endangered Species Act. Species included only if included in other State/Federal Lists; Asterix notates designation specific to Great Basin BCR 9; all other species are of continental concern. Eagles are protected under the Bald and Golden Eagle Act.

* American white pelican down listed to state sensitive by the Washington Fish and Wildlife Commission September 23, 2022

Source: ISSSSP 2021, ODFW 2021, USFWS 2021, WDFW 2021

Appendix T2. All bird and raptor fatality estimates at operating wind energy facilities in the Columbia Plateau Ecoregion.

Project Name, State, Study Period	All Bird Fatalities/MW/Study Period	Raptor Fatalities/MW/Study Period	Reference
Windy Flats, WA (2010-2011)	8.45	0.04	Enz et al. 2011
Biglow Canyon II, OR (2009-2010)	7.72	0.20	Enk et al. 2011
Montague, OR (2019-2020)*	7.61	0.07	Chatfield and Martin 2021
Leaning Juniper, OR (2006-2008)*	6.66	0.21	Gritski et al. 2008
Linden Ranch, WA (2010-2011)*	6.65	0.27	Enz and Bay 2011
Shepherd's Flat North (2012-2014)*	6.39	0.06	Smith et al. 2015a
Biglow Canyon III, OR (2011-2012)*	4.41	0.06	Enz et al. 2013
White Creek, WA (2007-2011)*	4.05	0.47	Downes and Gritski 2012
Shepherd's Flat Central (2012-2014) *	3.74	0.15	Smith et al. 2015b
Mary Hill & Hoctor Ridge, WA (2011-2012)*	3.42	0.11	Enz et al. 2012
Willow Creek (2009-2011)	3.22	0.38	Northwest Wildlife Consultants 2011
Tuolumne, WA (2009-2010)	3.20	0.29	Enz and Bay 2010
Stateline, OR, WA (2001-2002)*	3.17	--	Erickson et al. 2004
Klondike II, OR (2005-2006)*	3.14	--	NWC and WEST 2007
Klondike IIIa, OR (2009-2010)*	3.06	0.12	Gritski et al. 2011
Hopkins Ridge, WA (2008-2008)*	2.99	0.07	Young et al. 2009
Shepherd's Flat South (2012-2014)*	2.86	0.09	Smith et al. 2015c
Nine Canyon, WA (2002-2003)*	2.76	0.03	Erickson et al. 2003
Stateline, OR, WA (2003-2003)*	2.68	0.09	Erickson et al. 2004
Klondike III, OR (2007-2009)*	2.65	0.27	Gritski et al. 2010
Biglow Canyon II, OR (2010-2011)	2.60	--	Enk et al. 2012
Combine Hills, OR (2004-2005)*	2.56	0.00	Young et al. 2006
Big Horn, WA (2006-2007)	2.54	0.15	Kronner et al. 2008
Klondike IIIa, OR (2008-2009)*	2.54	0.00	Gritski et al. 2011
Leaning Juniper II, OR (2011-2013)*	2.50	0.07	Downes et al. 2013
Biglow Canyon I, OR (2009-2009)*	2.47	0.00	Enk et al. 2010
Juniper Canyon, WA (2011-2012)*	2.44	0.16	Enz and Bay 2012
Combine Hills, OR (2011-2011)*	2.33	0.05	Enz et al. 2012
Biglow Canyon III, OR (2010-2011)*	2.28	0.00	Enk et al. 2012
Hay Canyon, OR (2009-2010)	2.21	0.00	Gritski and Kronner 2010
Rattlesnake Road (2009-2011)*	2.16	0.06	Gritzki et al. 2011
Pebble Springs, OR (2009-2010)	1.93	0.04	Gritski and Kronner 2010
Chopin, OR (2016-2017)*	1.80	--	Hallingstad and Riser-Espinoza 2017
Biglow Canyon I, OR (2008-2008)*	1.76	0.03	Jeffrey et al. 2009
Wild Horse, WA (2007-2007)*	1.55	--	Erickson et al. 2008
Kittitas Valley, WA (2012-2013)*	1.54	0.31	Stantec Consulting 2013

Appendix T2. All bird and raptor fatality estimates at operating wind energy facilities in the Columbia Plateau Ecoregion.

Project Name, State, Study Period	All Bird Fatalities/MW/Study Period	Raptor Fatalities/MW/Study Period	Reference
Tucannon River, WA (2015-2015)*	1.50	0.16	Hallingstad et al. 2016
Wheat Field (2009-2011)	1.42	0.28	Gritzki and Downes 2011
Goodnoe Hills, WA (2009-2010)*	1.40	0.17	URS 2010
Lower Snake River, WA (2012-2013)*	1.30	0.31	Thompson et al. 2018
Vantage, WA (2011-2012)*	1.27	0.29	Ventus Environmental Solutions 2012
Hopkins Ridge, WA (2006-2006)*	1.23	0.14	Young et al. 2007
Stateline, OR, WA (2006-2006)	1.23	--	Erickson et al. 2007
Lower Snake River, WA (2017-2017)*	1.17	0.09	Thompson et al. 2018
Tucannon River, WA (2018-2018)*	1.14	0.12	Hallingstad et al. 2019
Kittitas Valley, WA (2011-2012)*	1.06	0.09	Stantec Consulting 2012
Klondike, OR (2002-2003)*	0.95	0.00	Johnson et al. 2003
Vansycle, OR (1999-1999)*	0.95	0.00	Erickson et al. 2000
Star Point, OR (2010-2011)	0.80	0.00	Gritski and Downes 2011
Palouse Wind, WA (2012-2013)*	0.72	--	Stantec 2013
Stateline 3, OR (2011-2012)*	0.36	0.05	Kronner et al. 2012
Marengo I, WA (2009-2010)*	0.27	0.00	URS 2010
Marengo I, WA (2010-2011)*	0.22	0.03	URS Corporation 2011
Marengo II, WA (2010-2011)*	0.17	0.00	URS Corporation 2011
Marengo II, WA (2009-2010)*	0.16	0.05	URS 2010

* issues identified with the study included unclear bias trial reporting, study length less than or greater than one year, or estimates not designated as overall.

Appendix T3. Bird population data derived from Partner in Flight Population Estimate Database from the Tri-state physio-political region within the Great Plains BCR. Great Basin BBS trend estimates are the percent change per year and associated credible intervals (CI), 2006–2019. Credibility levels assigned by USGS BBS Program.

Group / Species[1]	CPE Population PIF Estimate (2006 – 2015)	Great Basin BCR BBS Trend (2006 – 2019)	2.5% CI	97.5% CI	Credibility
Upland Game					
California Quail	428,289	-0.43	-2.32	1.44	🔵
Ring-necked Pheasant	229,832	-2.52	-4.11	-0.84	🔴
Chukar	26,814	-0.81	-5.12	3.33	🟡
Gray Partridge	11,694	1.37	-4.75	8.2	🔵
Gambel's Quail	1,409	-2.88	-12.89	8.92	🟡
Mountain Quail	726	1.91	-3.35	8.68	🔵
Sharp-tailed Grouse	38	-1.24	-10.40	8.52	🟡
Pigeons and Doves					
Mourning Dove	668,326	-5.11	-6.29	-3.93	🔴
Rock Pigeon	245,357	-1.28	-4.00	1.35	🔵
Eurasian Collared-Dove	76,517	42.17	35.92	48.96	🔵
Band-tailed Pigeon	5,374	2.28	-2.07	7.79	🟡
Swallows, Swifts and Goatsuckers					
Cliff Swallow	1,374,999	-1.42	-3.45	0.58	🔵
Northern Rough-winged Swallow	435,986	-1.17	-3.26	0.79	🔴
Common Nighthawk	263,624	-0.88	-2.82	0.95	🟡
Barn Swallow	373,784	-1.45	-2.70	-0.25	🔴
Bank Swallow	251,532	-3.23	-7.57	1.29	🟡
White-throated Swift	108,597	-0.98	-5.25	4.07	🟡
Vaux's Swift	38,448	-1.42	-5.11	1.73	🟡
Common Poorwill	24,942	0.40	-2.85	4.78	🟡
Black Swift	1,378	-2.61	-11.25	7.11	🔴
Hummingbirds					
Rufous Hummingbird	490,184	-1.59	-2.68	-0.30	🔴
Calliope Hummingbird	176,532	-1.74	-4.45	0.87	🟡
Black-chinned Hummingbird	26,630	0.85	-1.42	3.65	🔵
Anna's Hummingbird	6,557	3.24	-3.60	13.94	🔵
Broad-tailed Hummingbird	4,343	-0.11	-3.14	2.90	🔵
Diurnal Raptors and Vulture					
American Kestrel	48,700	-1.41	-2.89	0.14	🔴
Red-tailed Hawk	47,991	1.64	0.42	2.90	🔵
Turkey Vulture	18,980	3.94	1.23	6.98	🔵
Northern Harrier	16,913	-0.77	-2.59	1.07	🟡
Swainson's Hawk	9,128	3.85	1.92	5.87	🔵
Osprey	6,052	2.33	-0.56	5.54	🔵
Cooper's Hawk	4,665	0.56	-2.40	3.54	🔵
Prairie Falcon	3,274	1.33	-1.18	2.80	🔵

Appendix T3. Bird population data derived from Partner in Flight Population Estimate Database from the Tri-state physio-political region within the Great Plains BCR. Great Basin BBS trend estimates are the percent change per year and associated credible intervals (CI), 2006–2019. Credibility levels assigned by USGS BBS Program.

Group / Species[1]	CPE Population PIF Estimate (2006 – 2015)	Great Basin BCR BBS Trend (2006 – 2019)	2.5% CI	97.5% CI	Credibility
Sharp-shinned Hawk	1,547	-0.44	2.61	1.51	🔵
Northern Goshawk	1,437	-0.11	-2.55	2.34	🔵
Ferruginous Hawk	626	2.44	-0.78	5.83	🔵
Merlin	134	3.72	-3.06	11.14	🔵
Owls					
Great Horned Owl	26,530	1.37	-1.02	3.9	🔵
Barred Owl	8,285	1.94	-2.54	6.9	🔵
Western Screech-Owl	5,330	0.09	-2.26	3.95	🔵
Short-eared Owl	5,109	-9.52	15.63	-3.88	🟡
Long-eared Owl[3]	4,438	-	-	-	-
Barn Owl	2,034	2.65	-1.42	5.87	🔵
Burrowing Owl	1,590	-0.45	-4.71	4.28	🟡
Northern Pygmy-Owl	1,414	0.06	-1.43	2.35	🟡
Great Gray Owl[3]	19	-	-	-	-
Woodpeckers					
Northern Flicker	80,604	-0.2	-4.08	3.9	🟡
Hairy Woodpecker	61,837	-0.34	-1.79	1.81	🔵
Red-breasted Sapsucker	41,548	-2.02	-4.98	0.89	🔵
Red-naped Sapsucker	31,250	-4.35	-7.21	-1.51	🔴
Williamson's Sapsucker	19,048	-0.94	-4.89	1.99	🟡
Downy Woodpecker[3]	14,618	-	-	-	-
Lewis's Woodpecker	9,717	-0.2	-4.08	3.9	🟡
Black-backed Woodpecker	6,815	2.19	-4.25	8.84	🔵
Pileated Woodpecker	6,394	-0.52	-2.98	2	🔵
White-headed Woodpecker	4,844	2.26	-0.33	4.68	🔵
American Three-toed Woodpecker	150	3.27	-4.31	11.62	🔵
Kingbirds and Flycatchers					
Western Kingbird	416,991	-1.97	-3.23	-0.8	🔵
Hammond's Flycatcher	398,892	-0.93	-3.00	1.04	🔵
Pacific-slope Flycatcher	243,524	-0.45	-1.84	0.97	🔴
Dusky Flycatcher	209,191	-1.67	-3.14	-0.16	🟡
Say's Phoebe	136,103	1.43	-0.34	3.26	🔵
Eastern Kingbird	127,492	-2.01	-3.83	-0.27	🔴
Gray Flycatcher	92,018	0.89	-1.55	3.06	🔵
Loggerhead Shrike	26,602	0.1	-2.22	2.5	🟡
Olive-sided Flycatcher	18,123	-0.2	-2.1	1.73	🔴
Cordilleran Flycatcher	11,689	-0.45	-1.84	0.97	🔴
Ash-throated Flycatcher	9,752	-0.6	2.33	2.2	🔵

Appendix T3. Bird population data derived from Partner in Flight Population Estimate Database from the Tri-state physio-political region within the Great Plains BCR. Great Basin BBS trend estimates are the percent change per year and associated credible intervals (CI), 2006–2019. Credibility levels assigned by USGS BBS Program.

Group / Species[1]	CPE Population PIF Estimate (2006 – 2015)	Great Basin BCR BBS Trend (2006 – 2019)	2.5% CI	97.5% CI	Credibility
Least Flycatcher	798	-1.33	-6.46	3.97	🔵
Corvids and Allies					
Black-billed Magpie	169,969	-2.24	-3.62	0.86	🔴
American Crow	62,286	-1.62	-2.77	0.49	🟡
Steller's Jay	45,850	0.56	-0.68	1.85	🔵
Common Raven	44,632	2.03	0.43	3.59	🔵
California Scrub-Jay[2]	8,591	-1.15	-3.44	1.07	🔵
Canada Jay	8,436	0.66	-2.5	4.07	🟡
Clark's Nutcracker	4,016	0.79	-2.39	3.79	🔵
Pinyon Jay	1,703	-0.41	5.32	5.05	🟡
Passerines and Allies					
American Robin	2,527,860	-2.32	-2.94	-1.70	🟡
Western Meadowlark	1,416,927	-1.20	-2.24	-0.19	🟡
Golden-crowned Kinglet	1,362,970	-2.56	-5.29	0.08	🔴
Horned Lark	1,228,334	-0.96	-2.13	0.20	🔴
European Starling	1,153,507	-0.60	-1.92	0.74	🟡
Red-winged Blackbird	1,078,517	-1.14	-2.15	-0.14	🟡
House Sparrow	1,072,434	-1.69	-3.13	-0.22	🔴
Chipping Sparrow	880,616	-3.32	-4.39	-2.25	🔴
Brewer's Blackbird	856,017	-2.79	-4.03	-1.61	🔴
Brown-headed Cowbird	819,184	-3.45	-4.55	-2.37	🟡
Dark-eyed Junco	752,244	-3.70	-5.02	-2.43	🔴
House Finch	737,633	-0.94	-2.98	1.13	🔵
Spotted Towhee	709,688	0.36	-0.97	1.85	🔵
Song Sparrow	627,045	-2.13	-3.18	-1.13	🔵
Townsend's Warbler	606,219	-3.44	-5.30	-1.47	🔴
Savannah Sparrow	603,485	-3.49	-5.16	-1.96	🔴
Yellow-rumped Warbler	587,798	-0.38	-1.43	0.66	🟡
Warbling Vireo	509,861	-0.93	-2.05	0.17	🔵
Pine Siskin	502,657	7.58	0.94	14.72	🟡
Black-headed Grosbeak	490,047	1.86	0.71	2.91	🔵
Western Tanager	482,040	0.43	-0.64	1.57	🔵
Swainson's Thrush	470,642	0.22	-1.43	23.84	🟡
Cedar Waxwing	457,974	0.27	-1.81	2.38	🔵
Brewer's Sparrow	442,080	-3.84	-6.21	-1.59	🟡
Vesper Sparrow	360,470	-2.98	-4.29	-1.69	🟡
Evening Grosbeak	356,636	-6.01	11.34	-0.31	🔴
Western Wood-Pewee	325,515	-0.56	-1.46	0.35	🔵

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Group / Species[1]	CPE Population PIF Estimate (2006 – 2015)	Great Basin BCR BBS Trend (2006 – 2019)	2.5% CI	97.5% CI	Credibility
Yellow Warbler	317,932	-1.53	-2.60	-0.52	● (yellow)
House Wren	305,032	3.59	2.03	4.99	● (blue)
Red-breasted Nuthatch	303,122	-0.92	-2.78	1.10	● (blue)
Bullock's Oriole	290,986	0.11	-0.99	1.21	● (blue)
Chestnut-backed Chickadee	289,054	-1.33	-4.43	1.42	● (yellow)
MacGillivray's Warbler	286,529	-0.56	-1.89	0.79	● (red)
American Goldfinch	272,720	0.78	-2.26	0.70	● (yellow)
Nashville Warbler	229,554	-0.82	-2.98	1.34	● (blue)
Mountain Chickadee	222,072	-2.74	-4.12	-1.40	● (red)
Lazuli Bunting	213,880	4.07	2.18	6.62	● (blue)
Yellow-headed Blackbird	204,450	-1.79	-4.88	1.15	● (yellow)
Willow Flycatcher[2]	177,590	0.02	-1.35	1.35	● (red)
Sage Thrasher	175,169	-2.00	-1.14	-0.06	● (yellow)
Violet-green Swallow	169,967	-2.56	-4.52	-0.67	● (yellow)
White-crowned Sparrow	164,542	3.15	0.95	7.21	● (blue)
Black-capped Chickadee	163,062	-3.66	-5.72	-1.67	● (yellow)
Tree Swallow	161,599	-1.08	-2.82	0.59	● (blue)
Grasshopper Sparrow	161,261	-4.17	-7.26	-1.03	● (yellow)
Pacific Wren	150,575	-6.98	-9.52	-4.58	● (yellow)
Red Crossbill	144,223	2.07	-2.32	7.11	● (blue)
Hermit Thrush	142,286	0.60	-1.09	2.33	● (red)
Varied Thrush	137,883	-1.31	-3.98	1.34	● (yellow)
Marsh Wren	126,274	1.94	0.06	4.06	● (blue)
Mountain Bluebird	122,264	-0.82	-2.84	0.97	● (blue)
Wilson's Warbler	120,346	-0.64	-3.83	2.08	● (yellow)
Cassin's Finch	120,285	1.59	-0.54	3.69	● (blue)
Cassin's Vireo	119,890	1.43	-0.18	3.15	● (blue)
Brown Creeper	116,525	-1.60	-4.23	0.92	● (yellow)
Western Bluebird	112,264	2.93	0.11	6.40	● (blue)
Black-throated Gray Warbler	98,244	0.94	-2.31	3.82	● (blue)
Rock Wren	89,302	-1.59	-3.49	0.33	● (blue)
Gray Catbird	85,925	1.75	-0.43	4.01	● (blue)
Common Yellowthroat	84,154	2.68	0.08	4.85	● (blue)
Green-tailed Towhee	58,775	-1.35	-4.09	0.90	● (yellow)
Pygmy Nuthatch	57,458	-0.64	-4.54	3.11	● (blue)
Sagebrush Sparrow[2]	56,575	-1.39	-3.85	0.93	● (red)
Purple Finch	46,816	0.88	-1.71	3.82	● (red)
Veery	41,684	0.41	-1.10	2.12	● (red)

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Group / Species[1]	CPE Population PIF Estimate (2006 – 2015)	Great Basin BCR BBS Trend (2006 – 2019)	2.5% CI	97.5% CI	Credibility
Black-throated Sparrow	34,210	-7.57	-10.53	-4.52	🔵
Lark Sparrow	33,497	-0.48	-2.72	1.77	🔵
Orange-crowned Warbler	31,562	-2.50	-4.74	-0.09	🟡
Yellow-breasted Chat	31,379	1.86	-0.12	3.62	🔵
White-breasted Nuthatch	27,465	-0.98	-3.38	1.48	🔵
Lincoln's Sparrow	26,963	5.19	1.96	8.74	🔵
Townsend's Solitaire	25,033	1.67	-0.37	3.80	🔵
Ruby-crowned Kinglet	23,456	0.39	-2.51	3.58	🟡
Red-eyed Vireo	23,393	-0.73	-3.29	1.89	🔴
Fox Sparrow	13,665	-3.44	-12.89	1.83	🔵
Hermit Warbler	13,529	-0.14	-3.96	4.23	🔵
Canyon Wren	9,776	-0.05	-3.69	3.33	🔵
Lesser Goldfinch	8,057	2.42	-6.88	12.17	🔵
Belted Kingfisher	7,406	-0.83	-2.83	1.23	🔴
Bobolink	7,372	-1.09	-7.12	6.53	🔴
Bewick's Wren	5,943	0.86	-4.02	5.99	🔵
Hutton's Vireo	5,620	2.57	-5.16	11.14	🔵
Blue-gray Gnatcatcher	5,184	3.58	-0.05	7.76	🔵
American Dipper	3,072	-0.21	-2.18	1.47	🟡
Bushtit	2,958	-1.46	-10.89	6.80	🔵
American Redstart[3]	1,052	-	-	-	-
White-winged Crossbill	732	-15.42	-37.85	9.26	🟡
Plumbeous Vireo	192	1.71	-2.61	8.40	🔵
Northern Mockingbird	160	0.79	-2.07	5.06	🔵
California Towhee	134	-1.41	-7.99	1.56	🔵
Juniper Titmouse	49	1.70	-1.98	5.59	🔵
Common Grackle	36	-0.88	-9.96	7.10	🔵
Virginia's Warbler	16	0.45	-5.17	7.37	🔵
Great-tailed Grackle	14	1.94	-7.97	14.48	🔵
Lark Bunting	4	1.57	-21.03	36.88	🔵

1. Phylogenetic order roughly follows Chesser et al. 2021. PIF population estimates unavailable for the following species: Ruffed Grouse, Greater Sage-Grouse, Dusky Grouse, Sooty Grouse, Wild Turkey, Golden Eagle, Bald Eagle, Peregrine Falcon

2. BBS trends are grouped for the following species: Woodhouse's Scrub-jay grouped with California Scrub-Jay; Alder Flycatcher grouped with Willow Flycatcher; Bell's Sparrow grouped with Sagebrush Sparrow

3. BBS population trend data unavailable

Reference to Credibility Levels from the USGS BBS Program in Appendix T3

🔴 This category reflects data with an important deficiency. In particular:

- 1. The regional abundance is less than 0.1 birds/route (very low abundance),
- 2. The sample is based on less than 5 routes for the long term (very small samples), or
- 3. The results are so imprecise that a 5%/year change (as indicated by the half-width of the credible intervals) would not be detected over the long-term (very imprecise).

  A variety of circumstances may lead to imprecise results. For example, imprecise results are sometimes a consequence of a failure of the models to converge in those local areas, even though the model performs adequately in larger regions.

🟡 This category reflects data with a deficiency. In particular:

- 1. The regional abundance is less than 1.0 birds/route (low abundance),
- 2. The sample is based on less than 14 routes for the long term (small sample size), or
- 3. The results are so imprecise that a 3%/year change (as indicated by the half-width of the credible intervals) would not be detected over the long-term (quite imprecise), or

🔵 This category reflects data with at least 14 samples in the long term, of moderate precision, and of moderate abundance on routes.

Note:

- 1. Due to changes in the way N of samples (in BBS analysis, it is defined as the N of routes on which the species occurred), relative abundance (taken directly from the hierarchical model results), and the precision (half-width of the credible intervals), these categories are slightly different than those used in earlier analyses.
- 2. Even data falling in the 🔵 category may not provide valid results. There are many factors that can influence the validity and use of the information, and any analysis of BBS data should carefully consider the possible problems with the data. As noted above, judging whether technical issues associated with model convergence are leading to imprecise results can be difficult in analyses based on many strata, but these categories help users to screen for suspect results.

Appendix T4. Number and species composition of bird fatalities documented at post-construction fatality studies at wind facilities located within the Columbia Plateau Ecoregion, 1999−2020.

Common Name	Total Fatalities	Composition (%)
horned lark	936	30.46
unidentified bird (unknown size)	184	5.99
gray partridge	154	5.01
golden-crowned kinglet	113	3.68
western meadowlark	101	3.29
ring-necked pheasant	99	3.22
red-tailed hawk	80	2.60
American kestrel	78	2.54
unidentified small bird	78	2.54
European starling	76	2.47
chukar	75	2.44
mourning dove	70	2.28
rock pigeon	61	1.99
unidentified passerine	56	1.82
dark-eyed junco	55	1.79
white-crowned sparrow	49	1.59
ruby-crowned kinglet	40	1.30
yellow-rumped warbler	38	1.24
Swainson's hawk	33	1.07
Townsend's warbler	33	1.07
northern flicker	27	0.88
common raven	24	0.78
red-breasted nuthatch	22	0.72
common nighthawk	18	0.59
Savannah sparrow	17	0.55
Vaux's swift	17	0.55
American robin	16	0.52
short-eared owl	16	0.52
warbling vireo	15	0.49
winter wren	15	0.49
barn owl	14	0.46
Brewer's sparrow	14	0.46
unidentified sparrow	14	0.46
unidentified warbler	13	0.42
unidentified large bird	12	0.39
vesper sparrow	12	0.39
Wilson's warbler	12	0.39
Canada goose	11	0.36
house wren	11	0.36
rough-legged hawk	11	0.36
chipping sparrow	10	0.33
house sparrow	10	0.33
spotted towhee	10	0.33
black-billed magpie	9	0.29
cliff swallow	9	0.29
great horned owl	9	0.29
long-billed curlew	9	0.29
white-throated swift	9	0.29
ferruginous hawk	8	0.26
orange-crowned warbler	8	0.26
unidentified kinglet	8	0.26
western tanager	8	0.26

Appendix T4. Number and species composition of bird fatalities documented at post-construction fatality studies at wind facilities located within the Columbia Plateau Ecoregion, 1999−2020.

Common Name	Total Fatalities	Composition (%)
northern harrier	7	0.23
song sparrow	7	0.23
house finch	6	0.20
long-eared owl	6	0.20
ring-billed gull	6	0.20
California quail	5	0.16
common yellowthroat	5	0.16
golden-crowned sparrow	5	0.16
Lincoln's sparrow	5	0.16
mallard	5	0.16
unidentified gull	5	0.16
yellow warbler	5	0.16
American goldfinch	4	0.13
Cassin's vireo	4	0.13
golden eagle	4	0.13
great blue heron	4	0.13
MacGillivray's warbler	4	0.13
prairie falcon	4	0.13
turkey vulture	4	0.13
varied thrush	4	0.13
western grebe	4	0.13
American coot	3	0.10
bank swallow	3	0.10
common poorwill	3	0.10
dusky flycatcher	3	0.10
Hammond's flycatcher	3	0.10
hermit thrush	3	0.10
herring gull	3	0.10
mountain bluebird	3	0.10
Pacific wren	3	0.10
red-winged blackbird	3	0.10
unidentified *Buteo*	3	0.10
unidentified duck	3	0.10
unidentified kingbird	3	0.10
unidentified raptor	3	0.10
unidentified vireo	3	0.10
western kingbird	3	0.10
American pipit	2	0.07
black swift	2	0.07
Brewer's blackbird	2	0.07
Bullock's oriole	2	0.07
downy woodpecker	2	0.07
fox sparrow	2	0.07
gray flycatcher	2	0.07
Nashville warbler	2	0.07
northern rough-winged swallow	2	0.07
osprey	2	0.07
Pacific-slope flycatcher	2	0.07
peregrine falcon	2	0.07
pine siskin	2	0.07
purple finch	2	0.07
rock wren	2	0.07

Appendix T4. Number and species composition of bird fatalities documented at post-construction fatality studies at wind facilities located within the Columbia Plateau Ecoregion, 1999−2020.

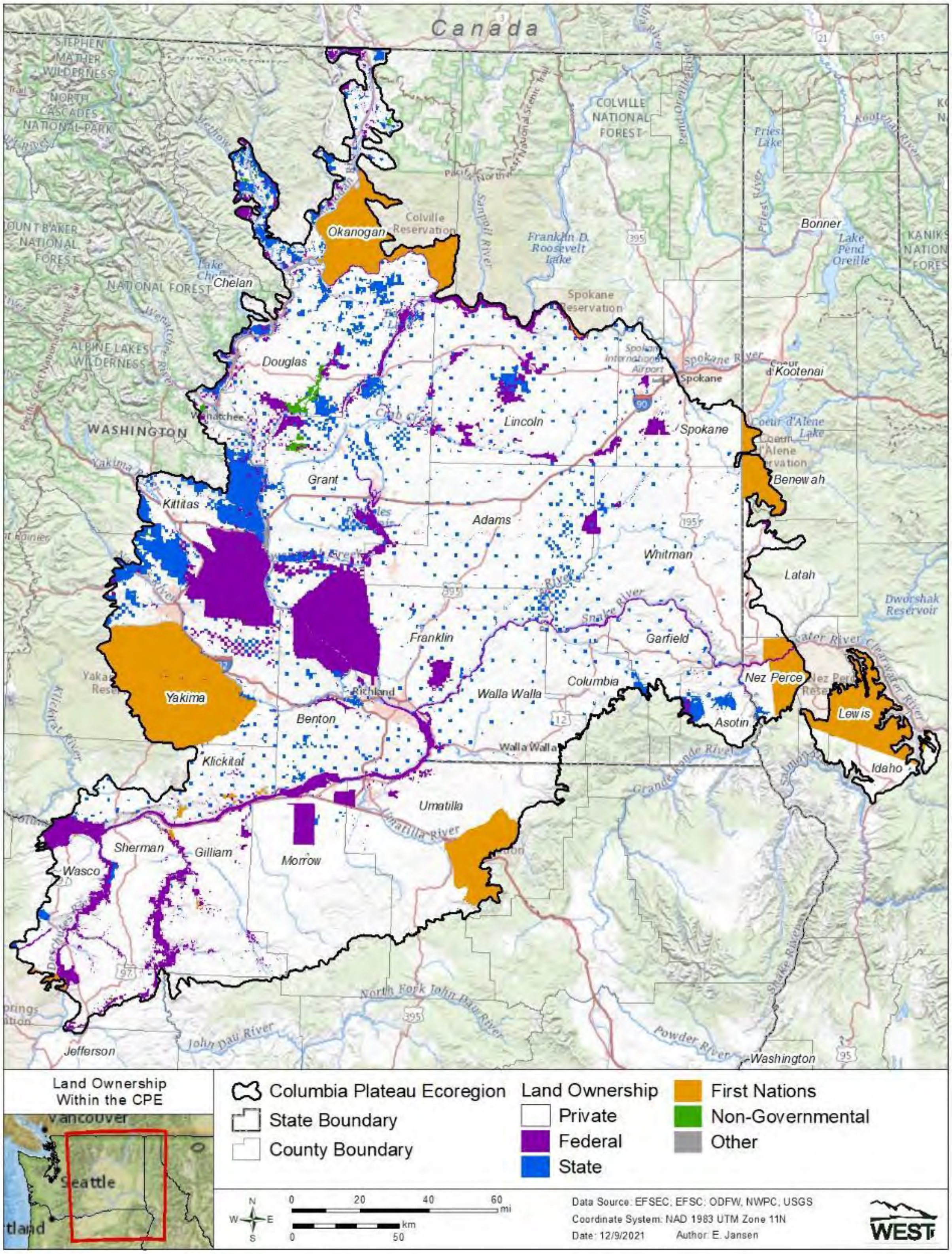
Common Name	Total Fatalities	Composition (%)
sage thrasher	2	0.07
Say's phoebe	2	0.07
sharp-shinned hawk	2	0.07
Swainson's thrush	2	0.07
Townsend's solitaire	2	0.07
tree swallow	2	0.07
unidentified *Accipiter*	2	0.07
unidentified *Corvid*	2	0.07
unidentified *Empidonax*	2	0.07
unidentified swallow	2	0.07
Virginia rail	2	0.07
western screech owl	2	0.07
white-breasted nuthatch	2	0.07

Species with one (1) fatality (3% composition) recorded during PCFM included: American crow, American white pelican, ash-throated flycatcher, bald eagle, barred owl, black-throated gray warbler, black-throated sparrow, brown-headed cowbird, bufflehead, burrowing owl, cackling goose, Cooper's hawk, eastern kingbird, evening grosbeak, grasshopper sparrow, gray catbird, hairy woodpecker, horned grebe, killdeer, lark sparrow, lazuli bunting, Lewis's woodpecker, merlin, northern bobwhite, northern pintail, northern saw-whet owl, northern shrike, olive-sided flycatcher, red-naped sapsucker, sagebrush sparrow, sora, Steller's jay, unidentified blackbird, unidentified owl, unidentified thrush, western bluebird, western wood-pewee, Williamson's sapsucker, willow flycatcher.

Appendix T5. Bat fatality estimates from post-construction fatality monitoring studies at operational wind energy facilities within the Columbia Plateau, 1999-2020.

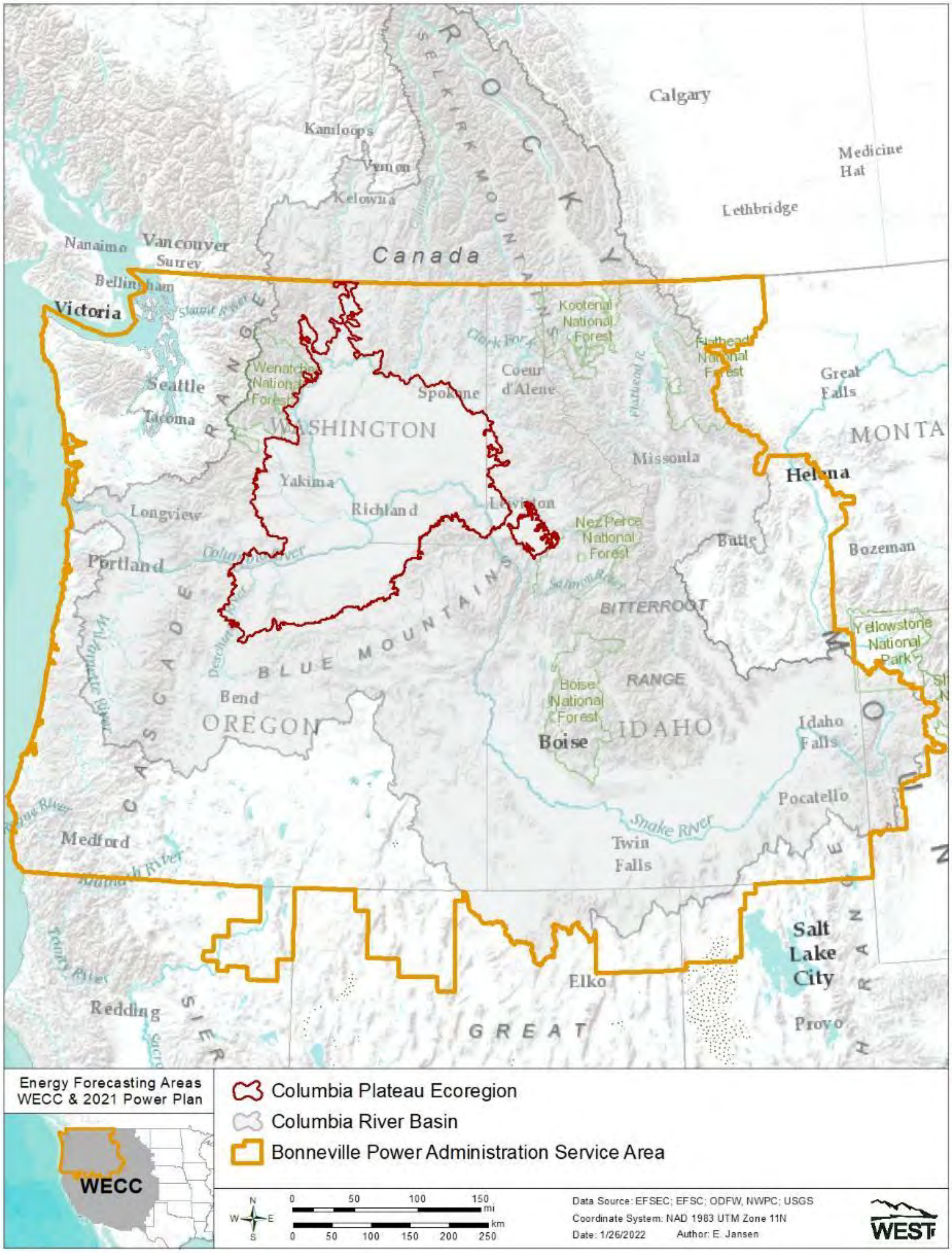
Facility Name, State, Study Period	All Bat Fatalities/MW/Study Period	Reference
Biglow Canyon II, OR (2009-2010)	3.78	Enk et al. 2011
Rattlesnake Road (2009-2011)	2.87	Gritzki et al. 2011
Nine Canyon, WA (2002-2003)	2.47	Erickson et al. 2003
Tucannon River, WA (2018-2018)	2.32	Hallingstad et al. 2019
Stateline, OR, WA (2003-2003)	2.29	Erickson et al. 2004
Tucannon River, WA (2015-2015)	2.22	Hallingstad et al. 2016
White Creek I	2.04	Downes and Gritski 2012
Biglow Canyon I, OR (2008-2008)	1.99	Jeffrey et al. 2009
Big Horn, WA (2006-2007)	1.90	Kronner et al. 2008
Chopin, OR (2016-2017)	1.90	Hallingstad and Riser-Espinoza 2017
Chopin, OR (2016-2017)	1.90	Hallingstad and Riser-Espinoza 2017
Combine Hills, OR (2004-2005)	1.88	Young et al. 2006
Linden Ranch, WA (2010-2011)	1.68	Enz and Bay 2011
Juniper Canyon, WA (2011-2012)	1.60	Enz and Bay 2012
Pebble Springs, OR (2009-2010)	1.55	Gritski and Kronner 2010
Hopkins Ridge, WA (2008-2008)	1.39	Young et al. 2009
Stateline 3, OR (2011-2012)	1.18	Kronner et al. 2012
Vansycle, OR (1999-1999)	1.12	Erickson et al. 2000
Mary Hill and Hoctor Ridge, WA (2011-2012)	1.04	Enz et al. 2012
Shephard's Flat North (2012-2014)	1.03	Smith et al. 2015a
Stateline, OR, WA (2006-2006)	0.95	Erickson et al. 2007
Tuolumne, WA (2009-2010)	0.94	Enz and Bay 2010
Lower Snake River, WA (2012-2013)	0.88	Thompson et al. 2018
Willow Creek (2009-2011)	0.81	Northwest Wildlife Consultants 2011
Combine Hills, OR (2011)	0.73	Enz et al. 2011
Montague, OR (2019-2020)	0.73	Chatfield and Martin 2021
Wheat Field (2009-2011)	0.69	Gritzki and Downes 2011
Biglow Canyon III, OR (2011-2012)	0.66	Enz et al. 2013
Hopkins Ridge, WA (2006-2006)	0.63	Young et al. 2007
Leaning Juniper II, OR (2011-2013)	0.63	Downes et al. 2013
Biglow Canyon II, OR (2010-2011)	0.57	Enk et al. {,2012 #14130}
Lower Snake River, WA (2017-2017)	0.54	Thompson et al. 2018
Hay Canyon, OR (2009-2010)	0.53	Gritski and Kronner 2010
Star Point, OR (2010-2011)	0.49	Gritski and Downes 2011
Shephard's Flat Central (2012-2014)	0.42	Smith et al. 2015b
Klondike II, OR (2005-2006)	0.41	NWC and WEST 2007
Windy Flats, WA (2010-2011)	0.41	Enz et al. 2011
Vantage, WA (2011-2012)	0.40	Ventus Environmental Solutions 2012
Wild Horse, WA (2007-2007)	0.39	Erickson et al. 2008
Goodnoe, WA (2009-2010)	0.34	URS 2010
Kittitas Valley, WA (2012-2013)	0.31	Stantec Consulting 2013
Marengo II, WA (2009-2010)	0.27	URS {2010
Shephard's Flat South (2012-2014)	0.25	Smith et al. 2015b
Biglow Canyon III, OR (2010-2011)	0.22	Enk et al. 2012
Marengo I, WA (2009-2010)	0.17	URS 2010
Marengo I Yr 2, WA (2010-2011)	0.15	URS Corporation 2011
Kittitas Valley, WA (2011-2012)	0.12	Stantec Consulting 2012
Marengo II Yr 2, WA (2010-2011)	0.00	URS Corporation 2011

* 2-year study.

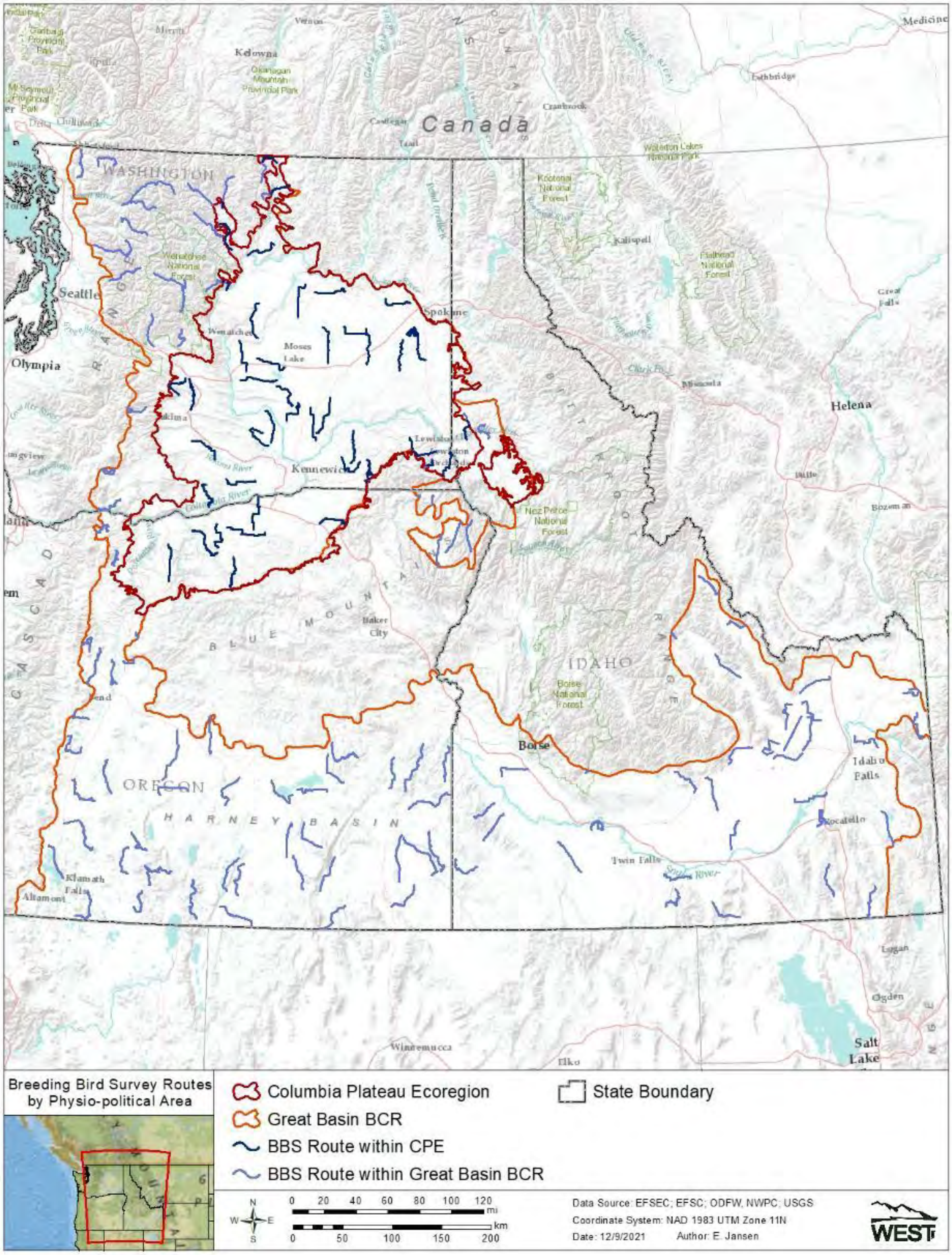


Appendix F1. Land ownership within the Columbia Plateau Ecoregion.

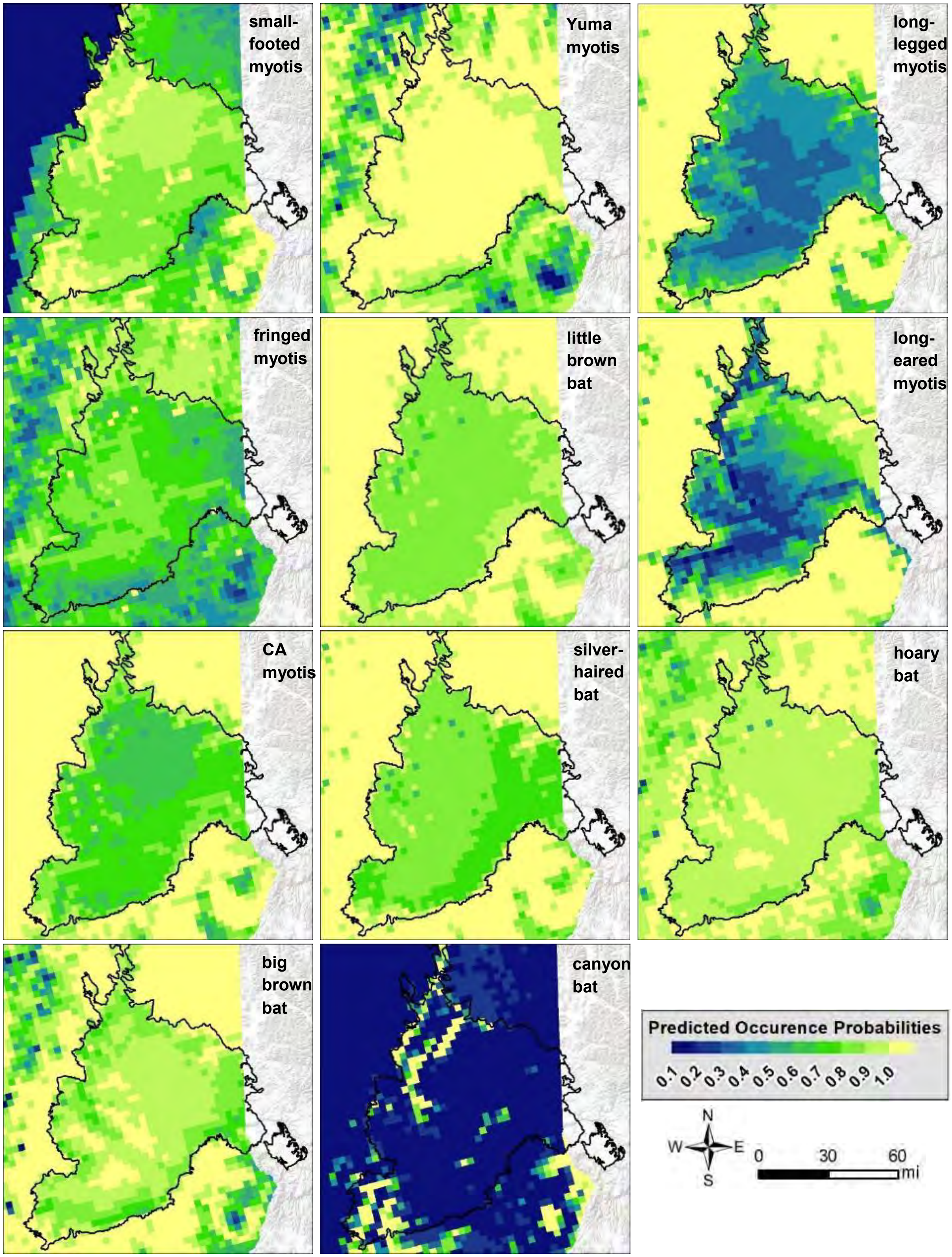
Appendix F2. Columbia Plateau Ecoregion within the Great Basin BCR and USFWS Pacific Administrative Flyway.



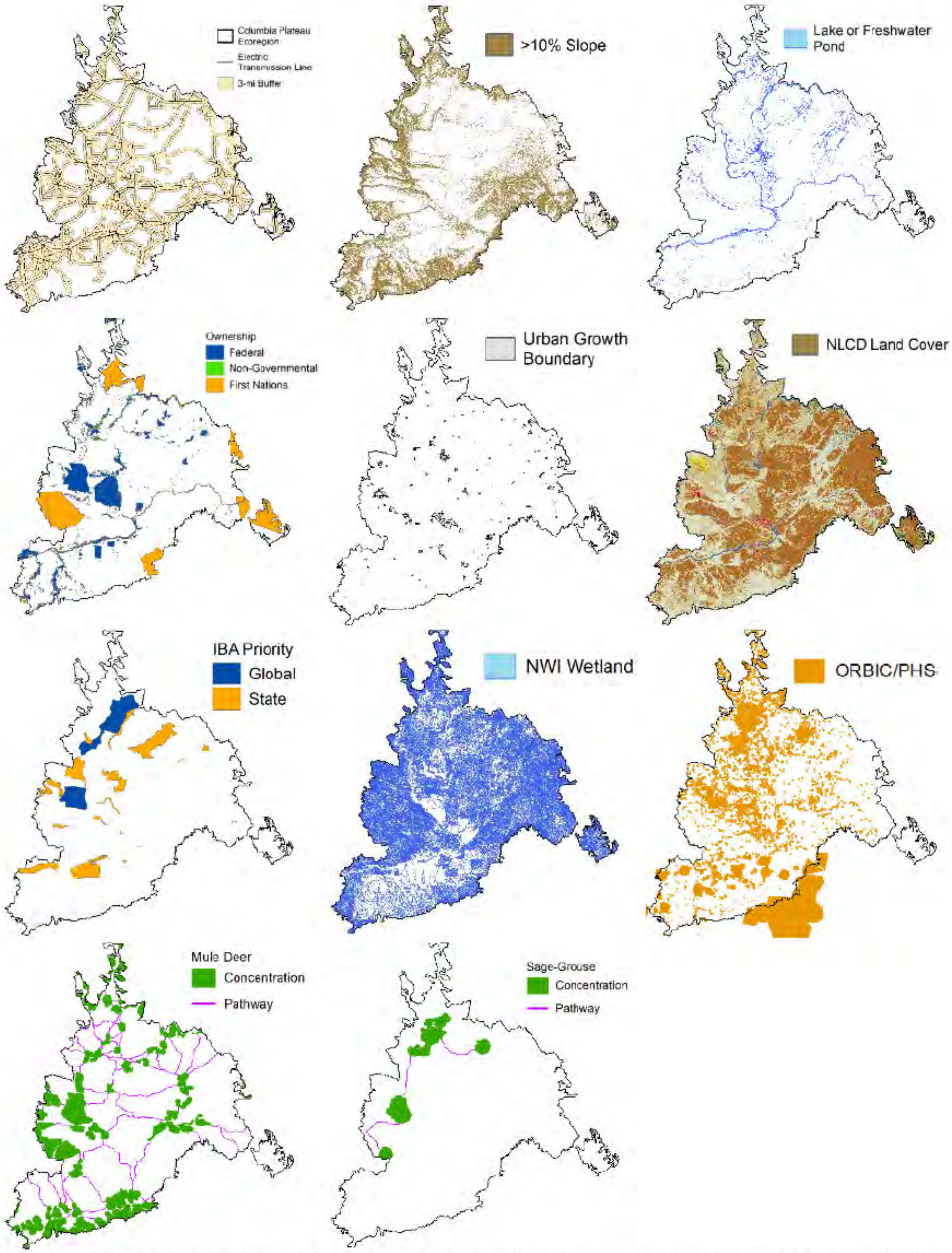
Appendix F3. Multi-scale relationship of energy markets in the western US Renewable energy projections in the CPE were derived from the NPP analyses in the BPA Service Area, which are influenced by trends in the larger Western Interconnection region of the WECC.



Appendix F4. USGS Breeding Bird Survey Routes within the Great Basin Bird Conservation Region 9 Physio-political boundary of Idaho, Oregon, and Washington and subset within the Columbia Plateau Ecoregion.



Appendix F5. Bat predicted distribution and occurrence probabilities in 2010 within the Columbia Plateau Ecoregion. Occupancy probabilities were conditioned on the occurrence states of the previous seven years, 2003-2009 (Rodhouse et al. 2015).



Appendix F6. Data layers used as spatial covariates to model USSE resources within the Columbia Plateau Ecoregion.

2023 Raptor Nest Surveys for the Horse Heaven Clean Energy Center, Benton County, Washington


Adult Red-tailed Hawk on Nest 07


Adult Bald Eagle on Nest 48 – Peavine Territory


Landscape Surrounding Swainson's Hawk Nest 28


Adult Common Raven on Historic Ferruginous Hawk Nest 101

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August 3, 2023

EXECUTIVE SUMMARY

Horse Heaven Wind Farm, LLC, is proposing development of the Horse Heaven Clean Energy Center (Horse Heaven and/or Project) in Benton County, Washington. As part of Project development, Western EcoSystems Technology, Inc. (WEST) was contracted to conduct raptor nest surveys within 2.0 miles (mi; 3.2 kilometers [km]) of proposed wind turbine generators (WTG) and solar arrays (Survey Area) during the 2023 nesting period. Raptor nest surveys complied with guidelines described by the Washington Department of Fish and Wildlife (WDFW) and recommendations from the US Fish and Wildlife Service (USFWS). The principal objective of this survey focused on searching for new raptor nests, documenting the status and condition of all historical ferruginous hawk nests, and checking all raptor nests documented during surveys conducted 2017 – 2019 and in 2022. This report summarizes the nesting status and condition of all raptor nests within the Survey Area in 2023 and how the results compare to previous survey efforts conducted for the Project. Combining historical ferruginous hawk nest data with previous survey data from 2017 – 2019 and 2022, 103 historical and current nest locations were checked during the 2023 surveys. Primary conclusions from this assessment include:

- In 2023, 63 raptor and/or common raven nests were documented. Of these 63 nests, 55 nests were located within the Survey Area and eight (all bald eagle nests) were located outside the Survey Area.
- Of the 55 occupied nests located within the Survey Area, the majority contained common raven (40%) followed by red-tailed hawk (23%), Swainson's hawk (23%), and great horned owl (10%); 25 nests were unoccupied; and 40 nests previously documented in the Survey Area could not be located and were considered Gone. Seven of the 58 historical ferruginous hawk nests documented in 2023 were occupied by species other than ferruginous hawk; 18 historical ferruginous hawk nests were unoccupied and 32 nests were Gone; one historical nest was not surveyed due to safety.
- Eight occupied bald eagle nests with young were located along the Columbia River during 2023 surveys. All nests were outside the Survey Area but were checked to maintain a nesting record. The distance of bald eagle nests to the nearest proposed WTG ranged from 3.7 mi to 10.7 mi (6.0 km to 17.2 km; average = 6.8 mi ± 2.4 mi [10.9 km ± 3.9 km]). Bald eagle nests were located beyond the 2.0-mile Survey Area that USFWS uses to evaluate project impacts to nearby nesting eagles.
- Ferruginous hawk nesting was infrequently observed during 10 survey rounds conducted over five survey years. The overall 5-year average of nest and territory occupancy was 4.4% and 5.6%, respectively. Historical ferruginous hawk nests were more likely to be occupied by other raptor species.
- Over 50% of land cover within the 2.0-mi core range of historical ferruginous hawk nests was agriculture, exceeding the threshold where populations of ferruginous hawk consistently decline. Residential development near 28 nests (48%) are likely a contributing factor in the relatively low ferruginous hawk nest occupancy in the Horse Heaven Hills.

- As Richardson et al. (2004) discusses, although nests can be found in areas with 50% to 100% wheatland within 1.9 mi (3.0 km; Bechard et al. 1990), ferruginous hawk populations decline consistently once cultivated land exceeds 30% of the area (Schmutz 1987, 1989). Agriculture comprises over 50% of land cover within the core area of historical ferruginous hawk nests within 3.2 km (2.0 mi) of the proposed WTGs. Analyses of resource selection around occupied nests in eastern Washington resulted in similar landscape patterns. In an analysis of 194 occupied ferruginous hawk nests in eastern Washington, 2000–2020 (28% of the 677 nests in the PHS database), occupied nests were more likely to be located with less agriculture within 0.25 mi (0.40 km) and avoided human development within 1.0 mi (1.6 km; Jansen et al. 2022). Occupied nests were selected closer to publicly accessible roads which may be a function of convenience sampling along roads, or the perching and access to foraging habitat that has been documented in other studies (Migaj et al. 2011, Nordell et al. 2017, Watson 2020).
- Although land conversion to agriculture and levels of human disturbance from housing, transportation, and electrical networks have been a historical feature in the Horse Heaven Hills, residential development into the foothills has increased over the past two decades, and noticeably since aerial surveys began in 2017. Housing development into the foothills is expected to continue, with new and on-going residential development in close proximity to Badger Canyon, Clodfelter, Clodfelter West, and Sheep Canyon ferruginous hawk territories decreasing the likelihood these nesting territories will become re-occupied by ferruginous hawks.

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Unit Conversions

Imperial	Metric
1 foot	0.3048 meter
3.28 feet	1 meter
1 mile	1.61 kilometer
0.621 mile	1 kilometer
1 acre	0.40 hectare
2.47 acre	1 hectare

Common Conversions

Imperial	Metric
0.5 miles	800 meters
0.12 miles	200 meters
0.5 miles	0.8 kilometers
10 miles	16.1 kilometers

STUDY PARTICIPANTS

Erik Jansen	PM, Field, GIS, Reporting
Joel Thompson	Senior Reviewer
Stephen Crane	Field Biologist
Timothy Lawes	Field Biologist
Andrea Palochak	Technical Editor

Photo Credits: All Photos by E. W. Jansen, Benton County, Washington.

REPORT REFERENCE

Jansen, E. W. 2023. 2023 Raptor Nest Surveys for the Horse Heaven Clean Energy Center, Benton County, Washington. Prepared for Horse Heaven Wind Farm, LLC., Boulder, Colorado. Prepared by Western EcoSystems Technology, Inc. (WEST), Corvallis, Oregon. August 3, 2023. 26 pages + appendices.

INTRODUCTION

Horse Heaven Wind Farm, LLC (HHWF) is proposing development of the Horse Heaven Clean Energy Center (Horse Heaven and/or Project) in Benton County, Washington. Since 2017, HHWF has conducted raptor nest surveys to characterize the raptor nesting community at the Project. Raptor nest surveys complied with recommendations described by the Washington Department of Fish and Wildlife (WDFW) *Wind Power Guidelines* (WPG; WDFW 2009), and the US Fish and Wildlife Service's (USFWS) *Land-based Wind Energy Guidelines* (WEG; USFWS 2012), Appendix C(1)(a) of the *Eagle Conservation Plan Guidelines* (USFWS 2013), and the *Revisions to Regulations for Eagle Incidental Take and Take of Eagle Nests* (81 Federal Register 91494 [December 16, 2016]).

In 2020, USFWS regulations reduced the survey area for bald eagles (*Haliaeetus leucocephalus*) from 10.0 miles (mi; 16.1 kilometers [km]) to 2.0 mi (3.2 km) surrounding a wind facility, indicating that the 2.0-mi survey buffer will provide sufficient information to evaluate project impacts to nearby nesting eagles (USFWS 2020). The change in regulation reduced the survey area; however, the HHWF chose to continue surveying all eagle nests in the greater 10.0-mi radius of the Project for due diligence purposes and to maintain the nesting record.

The ferruginous hawk (*Buteo regalis*) was listed as a state threatened species in 1983 and uplisted to endangered in 2021. Hayes and Watson (2021) listed habitat loss, degradation, and fragmentation among factors affecting ferruginous hawk population viability in Washington. Aerial surveys conducted since 2017 in the Horse Heaven Hills have noted the vast agricultural landscape and fragmented habitat, and past and on-going residential development in proximity to historical nests. A desktop analysis of land cover and human disturbance around historical ferruginous hawk nests was conducted in this report to supplement survey data.

As part of Project development, Western EcoSystems Technology, Inc. (WEST), was contracted to conduct raptor nest surveys in 2023 surrounding proposed wind turbine generators (WTG) and solar energy arrays. The objectives of this study were to:

1) document the status of previously identified and new raptor nests within 2.0 mi of the Project,
2) summarize historical and current ferruginous hawk territory status, including land cover characteristics within 2.0-mi (3.2 km) radius core areas and 6.2-mi (10.0-km) home ranges, and human disturbance within 1.0 mi (1.6 km),
3) document previously identified and new bald eagle nests within 10.0 mi (16.1 km) of the Project, and
4) summarize raptor nest data collected during surveys conducted at the Project from 2017 − 2019 and 2022 – 2023.

SURVEY AREA

Raptor nest surveys occurred in the eastern portion of the Horse Heaven Hills, in southeastern Benton County, Washington. A 245.5 mi^2 (635.8 km^2) Survey Area was designated by creating a 2.0-mi buffer around proposed WTG and solar arrays, which is the distance recommended by the WDFW (2009) and equal to the radius of the ferruginous hawk core area calculated by Hayes and Watson (2021). The 10 mi eagle survey radius is not displayed on figures because the distance is no longer a federal recommendation but is being proactively monitored by HHWF to maintain data continuity, ensure due diligence, and provide data to the scientific community. The Survey Area was located adjacent to the Tri-cities urban areas of Kennewick, Richland, and Pasco, and included portions of exurban communities associated with Benton City and Highland.

A prominent topographic feature in the Survey Area was a broad, northeast-facing anticline ridge along the northern perimeter, consisting of numerous highly eroded drainages and cliff-lined canyons (Badger Canyon, Coyote Canyon, Nine Canyon, Webber Canyon; Figure 1). South of the ridge, toward the interior of the Survey Area, the landscape transitions to relatively rolling topography with shallow, meandering canyons that drain south into the Columbia River. Elevation within the Survey Area was lowest toward the Columbia River to the east (approximately 350 feet [ft]; 107 meters [m]), rising to above 2,000 ft (610 m) at prominent features, including Chandler Butte (2,046 ft; 624 m), Johnson Butte (2,043 ft; 623 m), and Jump Off Joe (2,200 ft; 671 m), which all have radio and telecommunication installations (Figure 1).

Land cover within the Survey Area is a mosaic of dryland and irrigated cropland, shrub-steppe grasslands, and rural/urban development (HHWF 2021). Cropland is the dominant land cover throughout the Project and surrounding area (more than 80%; HHWF 2020). Shrub-steppe is found in topographically steep areas and drainage bottoms where conversion to cropland was not possible. A portion of the lands near the Project are enrolled in the US Department of Agriculture's Conservation Reserve Program. Raptor nest habitat includes the talus slopes, rock outcrops, and cliffs along the major canyons and drainages, isolated trees scattered throughout the Survey Area along roads and drainage bottoms, electrical transmission towers, and outbuildings. Tree cover was very sparse in the Survey Area.

Land use in the Survey Area consists predominantly of actively managed dryland winter wheat (*Triticum aestivum*) and associated infrastructure including silos and warehouses. Historic land use is reflected in abandoned and working farmsteads scattered in low density throughout the landscape. New residential development encroaches into the foothills and on top of the Horse Heaven Hills ridge, indicative of a growing Tri-cities area population. Several rock quarries in the Survey Area are actively used for on-going road maintenance and other construction projects. Electrical systems include radio and telecommunication towers, several high-voltage (115–500-kilovolt [kV]) Bonneville Power Administration (BPA) transmission lines bisecting the Survey Area, and numerous low-voltage (12.5-kV) distribution lines servicing business and residential buildings. Portions of the 63-WTG Nine Canyon Wind Project were located within or adjacent to the Survey Area (Figure 1).

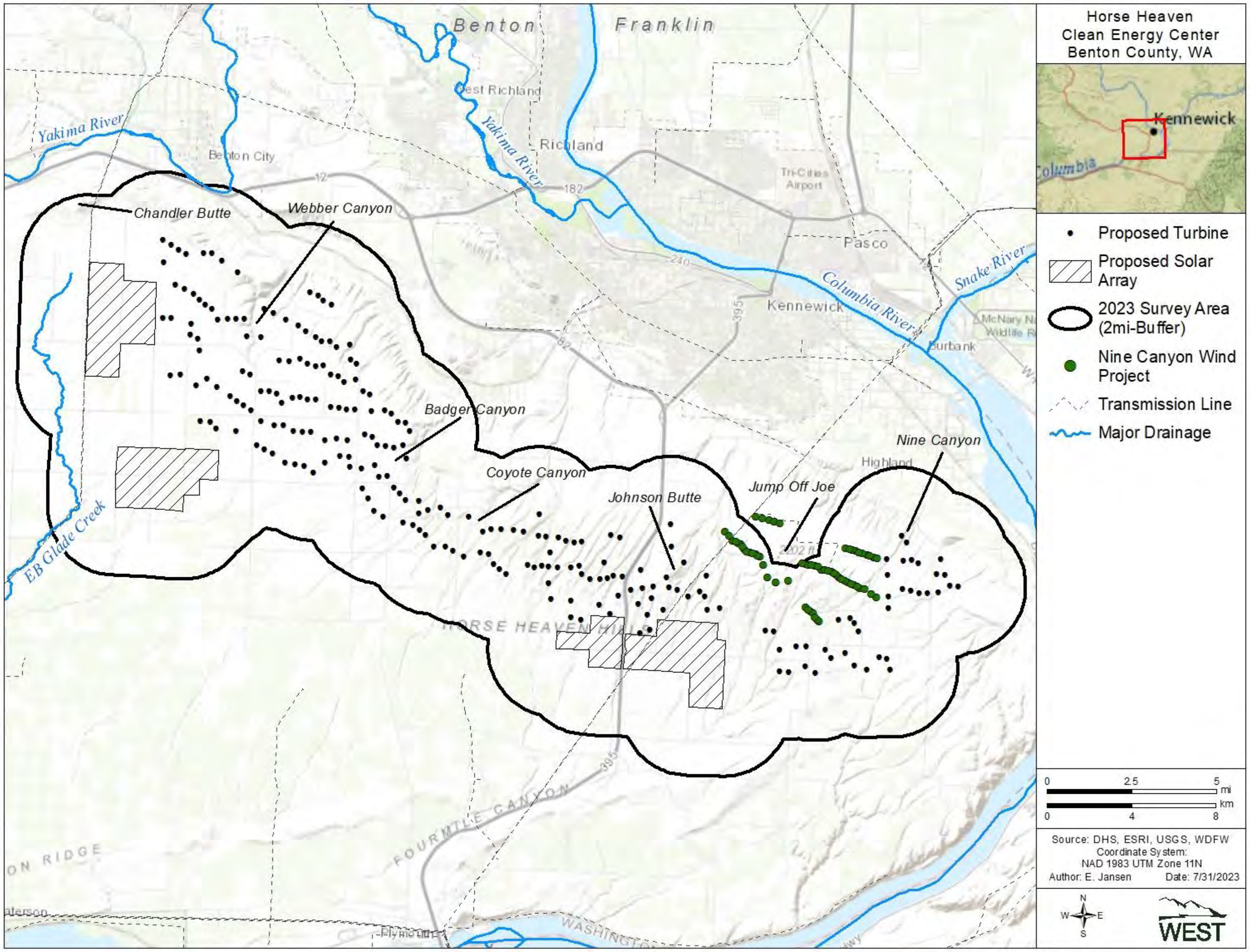

Figure 1. Landscape features within the 2023 raptor nest Survey Area for the Horse Heaven Clean Energy Center, Benton County, Washington.

METHODS

The 2017 study design and survey methods incorporated guidance described in the WDFW WPG and the WEG, with specific measures adapted for bald eagles and golden eagles (*Aquila chrysaetos*) as described by the USFWS (Pagel et al. 2010, USFWS 2013; 81 FR 91494 [December 16, 2016]). The same survey methods were used during previous raptor nest surveys conducted for the Project (Chatfield 2019a, 2019b; Jansen 2017, 2022a, 2022b; Jansen and Brown 2018; Jansen et al. 2019, Jansen 2022a, b).

Aerial Survey Preparation and Design

In fall 2022, WEST obtained records of all historical ferruginous hawk nests from the WDFW Priority Habitats and Species (PHS) database. Prior to aerial surveys in 2023, WEST integrated historical ferruginous hawk nest data with four years (2017 − 2019, 2022) of intensive WEST survey data to develop a comprehensive nest database. Proposed Project WTG and solar arrays, as presented in the updated Application for Site Certificate (HHWF 2021), were buffered by 2.0 mi in ArcMap (Esri, Redlands, California) to create the Survey Area. WEST developed a survey plan by plotting previously identified nests on maps and digital tablets (LG, Seoul, South Korea) with navigational software (Gaia GPS, Berkeley, California) that was used to guide aerial surveys.

Raptor nest surveys were conducted during two rounds of a double-observer (i.e., a primary and secondary observer) aerial survey. Survey rounds were conducted at least 30 days apart and performed using a Robinson R-44 Raven II helicopter with bubble windows that provided excellent visibility (Pagel et al. 2010, USFWS 2013). The first survey round was conducted early in the season prior to deciduous tree leaf out to ensure easier detection of nests. Conducting the survey early in the season also ensured the search effort coincided with the period when eagles were likely tending nests or incubating eggs and was based on chronology for nesting eagles in the region (Pagel et al. 2010, Isaacs and Anthony 2011, USFWS 2013, Isaacs 2021). The second survey round was conducted in May when eagles should have young in the nest and ferruginous hawks would be incubating or brooding young (Watson et al. 2018). Late-nesting species, including Swainson's hawk (*Buteo swainsoni*), should have also been occupying territories and initiating nesting by this time.

Aerial Survey Methods

Surveys rounds focused on checking the status of historical ferruginous hawk nests, checking previously identified bald eagle nests, checking previously identified raptor nests, and searching for new nests. Using the comprehensive ferruginous hawk nest database, 2023 surveys focused on visiting each historical nest location twice (March and May) to document known nests and search for possible new nests. Emphasis was placed on locating and documenting the status of historical nests by repeating standard survey protocols used during previous surveys that entailed a cautious approach, including circular or stationary hover and multiple sweeps, if needed, until sufficient confidence was established regarding nest status.

All stick nests that could be attributed to any raptor species or common ravens (*Corvus corax*) were documented within the Survey Area due to the potential for species to interchangeably use nests.

Surveys utilized an intuitive controlled survey method that focused on areas with the highest potential to support raptor nests, including rock outcrops and cliffs, basalt talus and scree slopes along incised drainages and canyons, transmission towers, distribution poles, windmills, and trees. Nests located during the first survey round were revisited during the second survey to further evaluate nesting status while also searching for new nests constructed after the first survey round was completed.

During aerial surveys, the helicopter was positioned to allow thorough visual inspection of all appropriate habitat features. In general, the helicopter maintained a distance of no closer than 66 ft (20 m) from cliff faces and nests. When a nest was located, the helicopter reduced speed and adjusted the flight track to allow for a clear view of the nest for documentation and photographing. The amount of time spent circling/searching a particular area or the distance to which a nest was approached was adjusted when birds were present on or near the nest to minimize survey-related disturbance (e.g., flushing). In the event of the presence of eggs/nestlings, deference was provided and nests located directly adjacent to the eggs/nestlings (e.g., within 656 ft [200 m]) were not surveyed.

For each nest or group of nests (e.g., nest site), Global Positioning System (GPS) coordinates were recorded, photographs were taken from a distance using a Nikon digital single lens reflex camera with 55−200-mm telephoto lens to reduce nest disturbance, and nest attribute data were collected. A nest site was defined as two or more nests that occurred on the same shelf, cliff face, or trees near one another. Data collected at each nest included the nesting species, status, and physical attributes that included condition, substrate, size, and signs of recent nest tending that included fresh sticks, greenery, or whitewash. The following definitions were used to characterize nests:

<u>Nest Status</u>

- Occupied Active = evidence of nest tending, with eggs/fragments, nestlings, and/or an adult in incubating/brooding position present at the time of the survey;
- Occupied Inactive = evidence of recent tending of the nest or presence of an adult, but no eggs, nestlings, or an adult in incubating/brooding position observed;
- Unoccupied = nest was classified as inactive for at least two consecutive survey rounds;
- Inactive = no evidence of nest tending and no eggs, nestlings, or adults present;
- Gone = previously documented nest determined to be completely missing or so degraded that only remnant material (scattered, loose sticks) were present, and that would need complete reconstruction in order to be used;
- Did Not Survey = Nest was outside the survey area for that particular survey year.
- Did Not Locate = Nest was not located during survey; typically historical nests in remnant condition;
- Unknown = nest likely present, but status cannot be determined. This scenario typically arises when cryptic nests were obscured by tree leaves, survey was aborted due to young on a neighboring nest, or disturbance issues related to horses or other human factors limited survey effort.

<u>Nest Condition</u>

Nest condition is a strong indicator of nest status; nests that are in better condition reflect the likelihood that the nest is currently in use or has recently been in use. However, longevity of the nest on the landscape is also affected by the stability of the nest construction, exposure of the nest to weather, wildfire, or human removal (WDFW 1996).

- Good = in excellent condition with very well-defined bowl, no sagging, may contain fresh material; possible to use immediately or currently in use;
- Fair = in generally good condition with fairly well-defined bowl, minor sagging of material but lacks substantive damage; may require some repair or addition to use immediately;
- Poor = material sloughing or sagging that would require reconstruction of the nest bowl in order to be used; most likely not being used during the current nesting season and possibly multiple nesting seasons, depending on nest exposure and other factors;
- Remnant = only loose or scattered material remains at the nest site, which would require complete reconstruction of the nest base, body, and bowl to be usable;
- Unknown = condition is unknown due nest not able to be located, typically due to leaf out or safety reasons.
- Gone = nest status unequivocally determined to be Gone, thus, condition is also Gone.

After each survey round, high-resolution aerial imagery, topographic maps, and flight tracks were used in ArcMap to georectify GPS coordinates recorded in the field to accurately correspond with the nest structure (tree, cliff face, rock outcrop, etc.) where the nest was observed. Nest photos were downloaded and labeled and a geodatabase was developed that tracked the status of each nest over the survey period.

Three types of metrics were used to compare the number of nests documented or occupied among survey years. Nest density by species was calculated as the number of nests documented during a survey year divided by the size of the Survey Area. Nests located beyond the 3.2 km Survey Area (i.e., bald eagle nests) and nests that were Gone, were excluded from the nest density calculation. Territory and nest occupancy was calculated for ferruginous hawk only and was calculated as the number of occupied territories or nests divided by the number of territories surveyed or the number of nests that were available for survey. The term territory was used for bald eagle and ferruginous hawk and was defined as a confined locality where nests are found, usually in successive years, and where no more than one pair is known to have bred at one time (Steenhof and Newton 2007). A territory can potentially consist of several alternate nests within a nesting territory that are not being used for laying eggs in a given year (Millsap et al. 2015). Metrics were calculated annually and over the 5-year survey period (2017–2019, 2022–2023).

Ferruginous Hawk Territory Characteristics

Total land cover by type within the 3.2 km radius core area and 10 km radius home range of historical and current ferruginous hawk nests were characterized using the National Land Cover Database (2019). The 3.2 km radius core area and 10 km radius home range were defined using distances described by Hayes and Watson (2021). Land cover composition between the core area and home range was compared by subtracting the relative composition of land cover found in the home range from the core area.

The straight-lined distance of the edge of the nearest existing human disturbances within 1.6 km to each nest was measured using historical and current aerial photographs from 1986 to April 29, 2023 (Google Earth 2023). The distance of 1.6 km was used as the distance construction and other types of human disturbance WDFW recommends be avoided around a ferruginous hawk nest (Larsen et al. 2004). Human disturbance was defined as any ground disturbing activity, construction, or development that was not historically present on the landscape (e.g., county roads, agriculture fields, farmsteads). Publicly available real estate records and historical aerial imagery were used to determine the approximate year of the disturbance.

Database Management

Management of the raptor nest database was performed to remove non-ferruginous hawk nest sites retained in the database despite the total removal of the nesting substrate (e.g., tree or windmill) that resulted in no likelihood for nest rebuilding or site re-occupancy. Raptor nests colonized by black-billed magpies (*Pica hudsonia*) were retained due to the potential for raptor re-occupancy that has been documented in previous survey years. Fallen trees were retained due to the potential for raptor re-occupancy that has been documented in previous survey years. Similarly, sites of previously documented nests blown out of trees and no longer present were retained since re-occupancy of trees tends to be high due to the relative scarcity of trees on the landscape. Nest sites and the rational for database removal are reported in the results.

RESULTS

2023 Survey Results

Raptor nest surveys were conducted March 21, 22, and May 15, 2023, with a total of 103 historical and current nest surveyed (Table 1). Among the 103 locations, 63 nests were physically present during 2023 surveys, down 7.3% from 2022 surveys (68 nests), and 40 nests were Gone, up 8.1% from 2022 surveys (37 nests). The increase in the number of Gone nests resulted from nest disturbance (e.g., blown out of a tree or falling from a cliff, etc.) that eliminated sign of the nest on the nesting substrate. Of the 63 nests documented, 55 nests were located within the Survey Area and eight (all bald eagle nests) were located outside the Survey Area (Figures 2 and 3). Representative photographs of nests are found in Appendix C.

Table 1. Raptor nest status documented during 2023 raptor nest surveys for the Horse Heaven Clean Energy Center, Benton County, Washington.

	Nest Status				
Species or Status	**Occupied/Active**	**Occupied/Inactive**	**Unoccupied**	**Gone**	**Total**
bald eagle	8	–	–	1	9
common raven	12	–	1	–	13
great horned owl	3	–	–	–	3
red-tailed hawk	7	–	–	–	7
Swainson's hawk	7	–	–	–	7
unknown raptor	–	1	24	–	25
gone	–	–	–	39	39
Total	**37**	**1**	**25**	**40**	**103[a]**

[a] Excludes one nest (ferruginous hawk historical Territory Sprit Lane Nest 87) that was not surveyed in 2023, and three other nests that were removed from the database.

Non-eagle Nests

Of the 30 occupied nests in the Survey Area, most contained common raven (40.0%), followed by red-tailed hawk (23.3%; *Buteo jamaicensis*), Swainson's hawk (23.3%), and great horned owl (10.0%; *Bubo virginianus*; Table 1). The higher number of common raven nests was a result of the increased nesting activity along a high-voltage transmission corridor in the western portion of the Survey Area. Nesting activity was low and delayed, with only eight non-eagle nests occupied during the first survey round, including four red-tailed hawk nests and four great horned owl nests. Nests occupied by common raven were not documented until the second survey round, which is uncharacteristic compared to previous survey years. The majority of unoccupied raptor nests (24 nests) were identified as historical ferruginous hawk nests in the WDFW PHS database. Ferruginous hawk is discussed in further detail below.

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Figure 2. Raptor nests (excluding eagle and ferruginous hawk nests) surveyed in 2023 for the Horse Heaven Clean Energy Center, Benton County, Washington.

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Figure 3. Nesting status of historical ferruginous hawk nests from the Washington Department of Fish and Wildlife Priority Habitat and Species database surveyed in 2023 for the Horse Heaven Clean Energy Center, Benton County, Washington.

Ferruginous Hawk

No ferruginous hawks were observed nesting within the Survey Area. One ferruginous hawk was observed circle soaring above Webber Canyon during the second survey round; however, additional focus on nests within the Webber Canyon area did not result in sign of nesting tending or maintenance. Over half of the 58 historical ferruginous hawk nests (32 nests; 55.2%) listed in the WDFW PHS database were classified as Gone, 18 nests (31.0%) were classified as unoccupied, and seven (12.1%) were classified as occupied by common raven (six nests) or great horned owl (one nest) and one nest was not surveyed (Figure 3; Appendix A). The [redacted] Lane historical ferruginous hawk nest (Nest 87) is in a horse pasture in the backyard of a residential area and was not surveyed due to the horses: 2022 surveys documented great horned owl occupancy. Future surveys may discontinue surveys at [redacted] Lane to avoid horse disturbance, which can be dangerous to people on the ground and livestock. The likelihood for a ferruginous hawk to occupy a nest deep in a residential area is considered low.

Four ferruginous hawk nests documented during 2022 surveys could not be relocated and were classified as Gone, including the tree nest in the [redacted] Territory that was occupied by Swainson's hawk in 2022, two ground nests in the [redacted] Canyon Territory that were in Remnant condition in 2022, and one cliff nest in [redacted] Canyon that was in fair condition in 2022 (Jansen 2022a). The majority of unoccupied ferruginous hawk nests were in poor or remnant condition. Historical ferruginous hawk nests in good condition were occupied by another bird species. Discovered by WEST in 2017, the [redacted] Canyon Territory (Nest 03) was occupied by ferruginous hawk in 2017 – 2019, by Swainson's hawk in 2022, and contained two great horned owl nestlings during the second survey round in 2023.

Aerial surveys conducted since 2017 have noted the construction of residential houses in proximity to historical ferruginous hawk nests. Human development and habitat conversion with the 3.2 km core area and 10 km home range surrounding a nest modifies foraging habitat, reduces nest site suitability, and has been identified as a conservation concern (Hayes and Watson 2021). Land cover was quantified within the 3.2 km radius core range and 10 km radius home range of historical nests, recognizing a circular radius around a nest likely does not represent the true distribution of an individual's movement (Isted et al. 2023). There is 11.0% more agriculture (i.e., cultivated crop) and 3.5% more grassland (e.g., grassland/herbaceous) within the core area than the home range (Table 2, Figure 4). There was an approximately equal percent composition of shrub-steppe (i.e., shrub/scrub) in the core area and home range. Developed land cover types, from open space to high intensity, comprised 6.7% (6,033.1 ac [2,441.5 ha]) of the core area and 13.1% (35,173.1 ac [14,234.0 ha]) of the home range, which overlaps the Tri-cities area.

Of the 58 historical ferruginous hawk nests, 28 nests (48.3%) in eight territories had residential development or other forms of human disturbance (e.g., water canal expansion) within 1.6 km of the nest. The average distance of development to a nest was 0.23 mi (0.37 km; median = 0.16 mi [0.25 km], range 0–0.96 mi [0–1.55 km]; Table 3). Historical nests near residential development tended to be Gone (64%) or in Poor or Remnant condition (25%) indicating no recent nest occupancy. If historical nests near residential development were occupied, the nesting species was typically common raven, which tends to be more tolerant of human disturbance and is a competitor of ferruginous hawk (Coates et al. 2020, Hayes and Watson 2021).

Residential development in the Horse Heaven Hills is likely to continue. Publicly available real estate data indicates there are eight lots for sale totaling about 55 ac (22 ha) of shrub-steppe habitat in the Sheep Canyon Territory, two lots totaling 55.14 ac (22.31 ha) of shrub-steppe habitat in the Badger Canyon Territory, four lots totaling 22.24 ac (9.00 ha) of agriculture and shrub-steppe in the Clodfelter Territory, and an additional 19 lots totaling 156.14 ac (63.19 ha) of shrub-steppe, agriculture, and grasslands listed for residential development throughout the Horse Heaven Hills (Redfin 2023). The most frequently available lot size was 5 ac (2 ha), but the listings included several larger lots intended for subdivision.

Table 2. Land cover composition within the ferruginous hawk core area and home range of historical nests within 3.2 kilometers of the Horse Heaven Clean Energy Center, Benton County, Washington. Data sorted by % in Core Area.

	3.2 km Core Area		10 km Home Range		% in
Land Cover Type	**Acres**	**% Comp**	**Acres**	**% Comp**	**Core Area[1]**
Cultivated Crop	48,816.7	53.7	114,454.7	42.7	+11.0
Grassland/Herbaceous	14,590.4	16.0	33,632.7	12.5	+3.5
Deciduous Forest	2.2	<0.1	2.7	<0.1	<+0.1
Barren Land	3.6	<0.1	10.2	<0.1	<-0.1
Mixed Forest	–	–	4.0	<0.1	<-0.1
Evergreen Forest	1.6	<0.1	12.9	<0.1	<-0.1
Pasture/Hay	2,296.7	2.5	7,161.5	2.7	-0.1
Emergent Wetlands	44.0	<0.1	1,053.0	0.4	-0.3
Developed, High Intensity	67.6	0.1	1,191.4	0.4	-0.4
Woody Wetlands	13.8	<0.1	1,376.4	0.5	-0.5
Shrub/Scrub	18,827.5	20.7	56,923.0	21.2	-0.5
Developed, Open Space	2,556.0	2.8	9,911.0	3.7	-0.9
Developed, Low Intensity	2,449.9	2.7	13,843.2	5.2	-2.5
Developed, Medium Intensity	959.6	1.1	10,227.5	3.8	-2.8
Open Water	292.4	0.3	18,437.6	6.9	-6.6
Total[2]	**90,922.0**	**100**	**268,241.8**	**100**	

[1] Percent difference in core area compared to the home range.

[2] Values can differ from numbers shown due to rounding

Comp = composition

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Figure 4. Land cover types within the 3.2 km core area and 10 km home range surrounding historical ferruginous hawk nests from the Washington Department of Fish and Wildlife Priority Habitat and Species database within 3.2 km of the Horse Heaven Clean Energy Center, Benton County, Washington.

Table 3. Nearest disturbance distances within 1 mi (1.6 km) of historical ferruginous hawk nests located within 2 mi (3.2 km) of the Horse Heaven Clean Energy Center, Benton County, Washington.

Territory Name	Nest ID	2023 Condition	Distance (km)	Comment
Badger Canyon	97	gone	0.64	2023 - new road and residential construction; expanded construction plans
Badger Canyon	8	gone	0.68	2023 - new road and residential construction; expanded construction plans
Badger Canyon	96	gone	0.76	2023 - new road and residential construction; expanded construction plans
Badger Canyon [redacted]	61	poor	0.77	2022 - 6.4 acres shrub-steppe cleared for new housing
Badger Canyon [redacted]	85	poor	0.62	2022 - 6.4 acres shrub-steppe cleared for new housing
Badger Canyon [redacted]	89	gone	0.24	2023 - new road to subdivision under construction
[redacted] Road	64	gone	0.00	1992 - nest removed by residential development
[redacted] Road	43	good	0.50	2023 - expanded equipment laydown; common raven occupied 2023
[redacted]	22	remnant	0.23	2017 - residential development
[redacted]	60	gone	0.28	2017 - residential development
[redacted]	65	gone	0.25	2017 - residential development
[redacted]	66	gone	0.09	2017 - residential development
[redacted]	113	gone	0.25	2017 - residential development
[redacted]	114	gone	0.04	2004 - 5-acre shrub-steppe cleared for housing
[redacted]	81	gone	0.18	1992 - residential development
[redacted]	67	remnant	0.53	2020 - expanded residential development
[redacted]	4	poor	0.10	2018 - residential development
[redacted]	86	gone	0.09	2016 - residential development
[redacted] Road	78	remnant	0.22	2021 - expanded canal construction
[redacted] Road	12	good	0.42	2021 - expanded canal construction; common raven occupied 2023
[redacted] Canyon	11	remnant	0.19	2023 - new residential construction along [redacted]
[redacted] Canyon	99	gone	0.15	2023 - new residential construction along [redacted]
[redacted] Canyon	100	gone	0.31	2023 - new residential construction along [redacted]
[redacted] Canyon	109	gone	0.60	2023 - new residential construction along [redacted]
[redacted] Canyon	116	gone	1.55	2023 - new residential construction along [redacted]
[redacted]	102	gone	0.30	2015 - residential development
[redacted]	106	gone	0.23	2015 - residential development
[redacted]	101	good	0.09	2015 - residential development; common raven occupied 2023
		Mean	**0.37**	
		Median	**0.25**	

Bald Eagles

Eight occupied bald eagle territories were located along the Columbia River and its tributaries during 2023 surveys (Figure 5). Two of the bald eagle nests were newly documented on Foundation Island (Nest 129) and Peavine Island North (Nest 130), in addition to the six occupied bald eagle nests documented in 2022. Each of the occupied nests contained one to three young, approximately 4–6-weeks old, during the second survey round conducted on May 15. All eight territories were located along the major drainages of the Columbia River, Walla Walla River, and Yakima River. Bald eagle territories occurring from west to east in the Survey Area are discussed briefly below.

- *Prosser Territory* [redacted] and has consistently produced two or three young since surveys began in 2019.
- *Yakima River Mouth* [redacted] the nest has consistently produced one to three young each year and has longest survey history since surveys began in 2017.
- *Port of Pasco* [redacted] the nest has consistently produced one or two young each year since surveys began in 2019.
- *Burbank* – [redacted] surveys at the nest began in 2022 when the National Audubon Society notified the Project of the nest. The nest failed in 2022 based on the presence of an incubating adult during the first survey round and an absence of adults or of other sign on or near the nest bowl (e.g., eggshells, feathers, prey items) during the second survey round. Surveys in 2023 resulted in one young approximately 5–6-weeks old and two adults perched in the nest tree during the second survey round. As a practical and safety measure, WEST typically does not survey residential areas for eagle or other raptor nests.
- *Foundation Island* [redacted] the nest was first documented in 2023 and contained one young appropriately 5–6-weeks old during the second survey round.

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Figure 5. Bald eagle nests surveyed in 2023 for the Horse Heaven Clean Energy Center, Benton County, Washington.

- *Peavine Island* [redacted] however, the alternate nest could not be located and was assumed to be Gone in 2022. A new occupied nest (Peavine Island North) located 0.7 mi (1.1 km) north of Peavine Island is the closest distance among occupied bald eagle nests in the Survey Area. Peavine Island has produced at least one or two young since surveys began in 2019; Peavine Island North had three young approximately 5–6-weeks old during the second survey round in 2023. Nests on Peavine Island are the nearest bald eagle nests to the proposed WTGs (3.7–3.9 mi [6.0–6.3 km] away).
- *McNary NWR* [redacted] the nest was first documented in 2019 and produced two young in 2023. Dense tree cover along the floodplain has resulted in difficult survey conditions during the second survey rounds, but nest occupancy or young have been observed during each of the three years surveyed.
- *Sand Station* [redacted] the nest contained two eggs during the second survey round in 2019, was unoccupied and in poor condition during 2022 surveys, and Gone in 2023. The nest was located along an exposed, windy stretch of the river and considered Gone after an intensive survey. Nest material was observed on the ground below the nest location.

Database Management

Three nests were removed from the database due to the removal of nesting substrate with no likelihood for nest re-occupancy (Table 4). After multiple years of surveys, the likelihood for nest building and re-occupancy at the location was determined as none.

Table 4. Historical raptor nests removed from the raptor nest database due to missing nesting substrate within 2.0 miles (3.2 kilometers) of the Horse Heaven Clean Energy Center, Benton County, Washington.

Nest ID	Nesting Species	Nest Status	Nest Substrate	Nest Condition	Comments
05	gone	gone	deciduous	gone	Nest located in uplands with no tree in area.
06	gone	gone	windmill	gone	Windmill removed.
14	gone	gone	deciduous	gone	Tree removed by canal construction.

2017 – 2019 and 2022 – 2023 Survey Comparison

The size of the Survey Area varied annually and ranged from 74−329 mi^2 (192–852 km^2), depending on the size of the Project Area under consideration (Table 5; Appendix B). A survey of suitable habitat within the Survey Area was typically accomplished within one-two days, depending on the size of the Survey Area. The following sections provide a summary comparison of raptor nests documented during surveys conducted from 2017 – 2019 and 2022 – 2023.

Table 5. Aerial raptor nest survey dates and area surveyed within the Horse Heaven Hills, 2017 – 2019 and 2022 – 2023.

Year	Survey Date[a] Round 1	Survey Date[a] Round 2	Survey Area (mi²)[b]	Reference
2017	March 31	May 10	74.7	Jansen 2017
2018	March 5	May 10	152.6	Jansen and Brown 2018
2019	March 5, 7	May 16	328.8	Chatfield et al. 2019a, 2019b, Jansen et al. 2019
2022	March 23	May 5	245.5	Jansen 2022a, b
2023	March 21, 22	May 15	245.5	This Study

[a] During 2017 – 2019, in addition to aerial surveys, ground-based surveys to document new nests and follow-up surveys were conducted for certain nests during year-round avian point count surveys

[b] Survey Area 2017 = Generalized, conceptual area + 2.0-mile (mi) buffer

Survey Area 2018 – 2019 = Leased lands + 2.0-mi buffer

Survey Area 2022 – 2023 = Proposed turbines and solar arrays + 2.0-mi buffer

Non-eagle Nests

Between 20 and 61 stick nests were documented within the Survey Area during the 2017 – 2019 and 2022 – 2023 aerial surveys (Table 6). Although the number of nests located within the Survey Area increased annually from 2017 to 2022, nest density in 2022–2023 was lower than in 2017 because the Survey Area was approximately three to four times larger due to Project expansion. During 2017 – 2019 surveys, nests occupied by *Buteo* species (i.e., soaring hawks) composed the majority (70% to 83%) of all occupied nests; however, in 2022 and 2023, *Buteo* species composition decreased to 44% and 48%. In contrast, common raven occupancy increased significantly, from 10% in 2017 to 47% in 2022 and 41% in 2023 (Table 6). The increase in common raven nests in 2022 and 2023 was especially evident along the BPA transmission line on the western side of the Survey Area, where six to nine common raven nests (and one red-tailed hawk nest) were documented in 2022–2023 compared to one common raven nest in 2017 (Figure 2).

Table 6. Raptor nest survey results within a 2.0-mile Survey Area at the proposed Horse Heaven Clean Energy Center, Benton County, Washington.

Species[a]	2017 # Nests	2017 Nest Density (#/mi²)[b]	2018 # Nests	2018 Nest Density (#/mi²)[b]	2019 # Nests	2019 Nest Density (#/mi²)[b]	2022 # Nests	2022 Nest Density (#/mi²)[b]	2023 # Nests	2023 Nest Density (#/mi²)[b]
common raven	1	0.013	1	0.007	5	0.015	16	0.065	12	0.049
ferruginous hawk	2	0.027	1	0.007	1	0.003	0	0.000	0	0.000
great horned owl	2	0.027	2	0.013	3	0.009	3	0.012	3	0.012
red-tailed hawk	4	0.054	8	0.052	14	0.043	11	0.045	8[c]	0.033
Swainson's hawk	1	0.013	6	0.039	7	0.021	4	0.016	7	0.029
unknown raptor[d]	10	0.134	14	0.092	14	0.043	27	0.110	25	0.102
Total	**20**	**0.268**	**32**	**0.210**	**44**	**0.134**	**61**	**0.248**	**55**	**0.224**

[a] Data excludes nests determined as gone and bald eagle nests outside the Survey Area

[b] Nest density = # nests documented / Survey Area. Sums/values can differ from what is shown due to rounding. Survey Area: 2017 = 74.66 square miles (mi²); 2018 = 152.60 mi²; 2019 = 328.80 mi², 2022-2023 = 245.51 mi²

[c] One occupied/inactive nest was attributed to red-tailed hawk, for simplicity

[d] Unknown raptor stick nests were documented as unoccupied and inactive during surveys

The number of unoccupied nests in 2023 was comparable to the previous survey year. Unoccupied nests were often associated with old farmsteads or residential buildings, and on cliffs and large rock outcrops located along highly eroded drainages and cliff-lined canyons near the northern perimeter of the Survey Area. Nests located along the [redacted] were commonly associated with historical ferruginous hawk nests; however, no ferruginous hawks were observed nesting within the [redacted] since 2017. Many of the historical ferruginous hawk nests along the [redacted] were classified as Gone, Remnant, or Poor condition, which suggests that nests have not been maintained for a number of consecutive years (Jansen 2022a).

Ferruginous hawk nesting was infrequently observed during 10 survey rounds conducted over five survey years. During the five survey years, four nesting attempts were made at two nests located in the [redacted] and Badger Canyon territories. Of 12 historical ferruginous hawk nests surveyed three or more years, two nests (Nest 03 in [redacted] and Nest 08 in Badger Canyon) were occupied at least one year. Nest 03 was occupied active during three consecutive survey years (2017 − 2019). Nest 08 was occupied inactive in 2017 and remained in Good condition during the 2018 − 2019 surveys, but was Gone during 2022 and 2023 surveys, with sticks from the nest scattered throughout the area.

During the 5-year survey period, the number of occupied ferruginous hawk territories and nests declined, even as the number of surveyed territories and nests increased (Table 7). Annual territory and ferruginous hawk nest occupancy was highest in 2017 at approximately 20% and declined to no nest activity observed in 2022 or 2023. The overall 5-year average nest and territory occupancy was 4.4% and 5.6%, respectively. Historical nests were occupied by other raptor species and common raven more frequently than by a ferruginous hawk. Over five survey years, 11 historical ferruginous hawk nests were occupied 17 times by species other than a ferruginous hawk; the majority by common raven (11 occurrences), Swainson’s hawk (three occurrences), great horned owl (two occurrences), or red-tailed hawk (one occurrence). Historical ferruginous hawk nests not occupied by ferruginous hawk had an overall occupancy rate of 19.5% ((17 nests occupied by other species ÷ (91 nest opportunities–4 nests occupied by ferruginous hawk)). Ferruginous hawk occupancy of nesting territories in the Horse Heaven Hills during the five years of surveys was 5.6%, which was much lower than the 14-year (1978 – 2016) statewide ferruginous hawk occupancy of nesting territories of 41.0% (Hayes and Watson 2021).

Table 7. Annual and overall ferruginous hawk territory and nest occupancy 2023 for the Horse Heaven Clean Energy Center, Benton County, Washington.

Survey Year	# Occupied	Territories		Nests		
		# Surveyed	% Occupied[1]	# Available	% Occupied[1]	Comment[2]
2017	2	9	22.2	10	20	Nest 08 = OI Nest 03 = OA
2018	1	10	10.0	12	8.3	Nest 03 = OA
2019	1	17	5.9	16	6.3	Nest 03 = OA
2022	0	18	0.0	28	0.0	Nest 03 = SWHA
2023	0	18	0.0	25	0.0	Nest 03 = GHOW
Total / Average	**4**	**72**	**5.6**	**91**	**4.4**	

[1] % occupied = # occupied divided by the # territories surveyed or the number of nests recorded in a survey year; all values rounded

[2.] OA = Occupied Active, OI = Occupied Inactive, SWHA = Swainson's hawk, GHOW = great horned owl

Raptor species observed during ground-based avian point count surveys conducted from 2017 − 2020 at the Project that were not observed nesting in 2023 included American kestrel (*Falco sparverius*), golden eagle, northern harrier (*Circus hudsonius*), osprey (*Pandion haliaetus*), peregrine falcon (*F. peregrinus*), short-eared owl (*Asio flammeus*), snowy owl (*Bubo scandiacus*), and turkey vulture (*Cathartes aura*). These species were likely not observed nesting due to a lack of suitable nesting habitat, cryptic nesting habitats not conducive to aerial survey methods, or the location of the Project outside the species' breeding range.

Bald Eagles

During aerial surveys conducted in 2017 – 2019 and 2022 – 2023, eight bald eagle territories were documented within approximately 10 mi of the Project (Table 8, Figure 5). The distance of bald eagle nests to the nearest proposed WTG ranged from 3.7 mi to 10.7 mi (average = 6.8 mi [10.9 km], standard deviation = 2.4 mi [3.9 km]). Overall nest occupancy was high (91%), with only one unoccupied nest (2022 Sand Station) and two Gone nests (2022 Peavine Island alternate, 2023 Sand Station) during the 5-year survey period. Two new bald eagle nests were documented in the 2023 breeding period, representing a substantial (33%) increase in the bald eagle nesting population compared to previous survey years. Each occupied nest contained at least one to three young between 4–6 weeks old. Historically, Peavine Island had an alternate and primary nest, with the alternate nest being missing in 2022. This is the first survey year two occupied nests were located so close to each other (0.69 mi [1.11 km]).

Table 8. Bald eagle nest status documented during surveys conducted 2017 – 2019 and 2022 – 2023 in the Study Areas surrounding the Horse Heaven Hill Clean Energy Center, Benton County, Washington.

Territory Name[1]	Nest Status	Nest Productivity	Distance to Turbine (mi)[2]
Prosser	2017 - not in survey area 2018 - not in survey area 2019 - occupied/active 2022 - occupied/active 2023 - occupied / active	2017 - No data 2018 - No data 2019 - 2–3 young, ~4-weeks old 2022 - 2–3 young, ~4-weeks old 2023 - 2 young, ~5–6-weeks old	10.7
Yakima River Mouth	2017 - occupied/active 2018 - occupied/active 2019 - occupied/inactive 2022 - occupied/active 2023 - occupied / active	2017 - 1 young, ~3-weeks old 2018 - 2 young, ~3-weeks old 2019 - Adult flushed from nest 2022 - Adult on nest in brooding position and adult perched nearby 2023 - 3 young, ~5–6-weeks old	8.1
Port of Pasco	2017 - not in survey area 2018 - not in survey area 2019 - occupied/active 2022 - occupied/active 2023 - occupied/active	2017 - No data 2018 - No data 2019 - 2 young, ~3–4-weeks old 2022 - 1 young, ~3– 4-weeks old 2023 - Adult on nest in brooding position	6.5
Burbank	2017 - not in survey area 2018 - not in survey area 2019 - did not locate 2022 - occupied/inactive 2023 - occupied/active	2017 - No data 2018 - No data 2019 - No data 2022 - Adult on nest during first survey, no sign on nesting during second survey 2023 - 1 young, ~5–6-weeks old, adults perched in tree	7.2
Foundation Island	2023 - occupied/active	2023 - 1 young ~5–6-weeks old, new nest	4.4
Peavine Island	2017 - not in survey area 2018 - not in survey area 2019 - occupied/active 2022 - occupied/active 2023 - occupied/active	2017 - No data 2017 - No data 2019 - 2 young, ~3-weeks old 2022 - Adult on nest in brooding position, at least 1 young, ~3–4-weeks old; alternate nest gone. 2023 - 1 young, ~5–6 weeks old	3.7
Peavine Island North	2023 - occupied/active	2023 - 3 young, ~5–6-weeks old; new nest	3.9
McNary National Wildlife Refuge	2017 - not in survey area 2018 - not in survey area 2019 - occupied/active 2022 - occupied/active 2023 - occupied/active	2017 - No data 2018 - No data 2019 - 2 young, ~3-weeks old 2022 - Adult on nest, tree leafed out and obscuring nest contents 2023 - 2 young, ~5–6-weeks old	7.8
Sand Station	2017 - not in survey area 2018 - not in survey area 2019 - occupied/active 2022 - unoccupied/inactive 2023 - gone	2017 - No data 2018 - No data 2019 - 2 eggs 2022 - Nest in poor condition 2023 - No data	9.2

1. Territory names established by Western EcoSystems Technology, Inc; 2. Distance to nearest proposed turbine.

DISCUSSION

The raptor nesting community in 2023 was similar to previous years; however, nest occupancy was uncharacteristically low during the first survey round, suggesting a later raptor nest season that may be influenced by weather conditions, among other factors (Sarasola et al. 2018). Despite having a delayed start to the nesting season, the second survey round documented seven Swainson's hawk nests; Swainson's hawks typically nest later in the breeding season compared to red-tailed hawks and great horned owls. One ferruginous hawk, another later-nesting species, was observed flying above Webber Canyon; thus, surveys overlapped the period when territory occupancy and nest tending should have occurred. It is possible ferruginous hawk nest occupancy may have followed a delayed temporal pattern observed in other raptor species; however, the condition and status of historical ferruginous hawk nests was consistent with previous survey years and were primarily Gone or in Poor and Remnant condition. Consistent with previous years, historical ferruginous hawk nests were more likely to be occupied by another bird species. Six historical ferruginous hawk nests were occupied by common raven and the Coyote Canyon Territory was occupied by a great horned owl with two nestlings. Based on five years of raptor nest surveys at the Project, annual nest occupancy fluctuated slightly, and species occupancy turnover fluctuated slightly (e.g., different species occupying the same nest); however, nest locations were consistent due to the lack of suitable nesting substrates on the landscape. When not occupied by another raptor species, historical ferruginous hawk nests generally remained in a state of poor or degraded condition which indicated no recent nest tending or maintenance.

Bald eagle nest occupancy and productivity was high in 2023, consistent with previous survey years. One new bald eagle nest was documented on Foundation Island and a second occupied nest was documented on Peavine Island, only 1.2 km (0.69 mi) from the existing occupied nest in Peavine Island. In a study of bald eagle nests along the Lower Columbia River, Issacs and Anthony (2011) found density dependent factors likely began affecting nesting success when occupied bald eagle nests in adjacent breeding areas were less than< 3.2 km (2.0 mi) apart, and there was a strong negative influence at < 1.6 km (1.0 mi). The relatively close spacing of nests along this stretch of the Columbia River may reflect resource availability and an increasing bald eagle nesting population, which in Washington had increased 707% from 1981 – 2005 an increasing annual population trend of 9.4% (97.5% confidence interval: 6.5–12.5; Stinson et al. 2005, Ziolkowski et al. 2023). All nests are greater than 2.0 mi from proposed WTGs which the USFWS uses to evaluate project impacts to nearby nesting eagles (USFWS 2020).

WDFW management recommendations for ferruginous hawk encourage surrounding landowners to protect 50% or more of the shrub-steppe within a home range, avoid construction within 1.0 mi (1.6 km) of nests, and implement various spatial and temporal disturbance buffers around nests (Richardson et al. 2004; M. Ritter, WDFW Wind and Solar Lead, pers comm.; Appendix D). Based on land cover characteristics and human-caused disturbances, it appears residential development in the Horse Heaven Hills does not conform to WDFW management recommendations. As Richardson et al. (2004) discusses, although nests can be found in areas with 50% to 100% wheatland within 1.9 mi (3.0 km; Bechard et al. 1990), ferruginous hawk populations decline consistently once cultivated land exceeds 30% of the area (Schmutz 1987, 1989). Agriculture comprises over 50% of land cover within the core area of historical ferruginous hawk nests within 3.2 km (2.0 mi) of the proposed WTGs. Analyses of resource selection around occupied nests in eastern Washington resulted in similar landscape patterns. In an analysis of 194 occupied ferruginous hawk nests in eastern Washington, 2000–2020 (28% of the 677 nests in the PHS database), occupied nests were more likely to be located with less agriculture within 0.25 mi (0.40 km) and avoided human development within 1.0 mi (1.6 km; Jansen et al. 2022). Occupied nests were selected closer to publicly accessible roads which may be a function of convenience sampling along roads, or the perching and access to foraging habitat documented in other studies (Migaj et al. 2011, Nordell et al. 2017, Watson 2020).

Although land conversion to agriculture and levels of human disturbance from housing, transportation, and electrical networks have been historical features in the Horse Heaven Hills, residential development into the foothills has increased over the past two decades, and noticeably since aerial surveys began in 2017. Housing development into the foothills is expected to continue, with new and on-going residential development in close proximity to Badger Canyon, Clodfelter, Clodfelter West, and Sheep Canyon ferruginous hawk territories decreasing the likelihood these nesting territories will become re-occupied by ferruginous hawks.

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Appendix A. Raptor Nests Documented During the 2023 Raptor Nest Survey at the Horse Heaven Clean Energy Center, Benton County, Washington

Appendix A. Raptor nests documented during the 2023 raptor nest survey at the Horse Heaven Clean Energy Center, Benton County, Washington.

Nest ID	Nesting Species	Nest Status	Nest Substrate	Nest Condition	Comments
01	great horned owl	occupied/active	deciduous	good	1 adult on nest
02	Swainson's hawk	occupied/active	deciduous	good	1 adult on nest
03	great horned owl	occupied/active	deciduous	good	Coyote Canyon Territory; ferruginous hawk nested in 2017–2019; 2 young and 1 adult on nest
04	unknown raptor	unoccupied/inactive	cliff	remnant	Clodfelter West Territory; historical ferruginous hawk nest; rocks in nest
07	red-tailed hawk	occupied/active	deciduous	good	2 young and 1 adult on rebuilt nest in northern tree
08	gone	gone	ground	gone	Badger Canyon Territory; historical ferruginous hawk nest; occupied inactive in 2017; scattered stick material
09	unknown raptor	occupied/inactive	deciduous	good	Fresh greenery, white wash and condition of recent maintenance.
10	unknown raptor	unoccupied/inactive	ground	poor	Sheep Canyon Territory; historical ferruginous hawk nest
11	unknown raptor	unoccupied/inactive	ground	remnant	Sheep Canyon Territory; historical ferruginous hawk nest, new residential construction within 0.19 km
12	common raven	occupied/active	cliff	good	[redacted] Road Territory; historical ferruginous hawk nest; 2 young
13	unknown raptor	unoccupied/inactive	ground	remnant	[redacted] Road Territory; historical ferruginous hawk nest
15	unknown raptor	unoccupied/inactive	ground	poor	Webber Canyon Territory; historical ferruginous hawk nest
16	unknown raptor	unoccupied/inactive	ground	poor	Webber Canyon Territory; historical ferruginous hawk nest
17	unknown raptor	unoccupied/inactive	rock outcrop	poor	Webber Canyon Territory; historical ferruginous hawk nest
18	bald eagle	occupied/active	deciduous	good	Yakima Mouth Territory; 3 young, ~5-weeks old
19	Swainson's hawk	occupied/active	deciduous	good	1 adult brooding; tree falling down
20	red-tailed hawk	occupied/active	deciduous	good	1 adult in brooding posture
22	unknown raptor	unoccupied/inactive	ground	remnant	Clodfelter Territory; historical ferruginous hawk nest
24	red-tailed hawk	occupied/active	deciduous	good	1 young with 1 adult tending nest, next to highway
25	gone	gone	deciduous	gone	Nest blown out of tree; next to highway
26	unknown raptor	unoccupied/inactive	platform	good	Nest platform along wind row that contains another stick nest - both inactive. Backyard next to highway.
27	unknown raptor	unoccupied/inactive	deciduous	poor	Ragged nest needing maintenance; poplar tree stand adjacent to residence.
28	Swainson's hawk	occupied/active	deciduous	good	1 adult on nest in east bush, 1 common raven on nest in west bush – 2 nests.
29	Swainson's hawk	occupied/active	deciduous	good	Head of Webber Canyon; 1 adult incubating position; former BBMA nest
30	unknown raptor	unoccupied/inactive	ground	poor	Webber Canyon Territory; historical ferruginous hawk nest
31	Swainson's hawk	occupied/active	deciduous	good	3 eggs; ragged tree stand; nest low; near old farmhouse
32	Swainson's hawk	occupied/active	conifer	good	1 adult incubating on nest next to commercial building
33	unknown raptor	unoccupied/inactive	cliff	fair	[redacted] Territory; historical ferruginous hawk nest; double side-by-side nest
34	unknown raptor	unoccupied/inactive	cliff	fair	Chandler Butte Territory; historical ferruginous hawk nest; substantial material sloughing off
35	common raven	occupied/active	building	good	Nest moved from pine tree next to house to opening at top of granary; conifer was the historical location
37	bald eagle	occupied/active	deciduous	good	Port of Pasco Territory; 2 young ~5-weeks old

Appendix A. Raptor nests documented during the 2023 raptor nest survey at the Horse Heaven Clean Energy Center, Benton County, Washington.

Nest ID	Nesting Species	Nest Status	Nest Substrate	Nest Condition	Comments
38	unknown raptor	unoccupied/inactive	tower	fair	On BPA tower; nest low, center of tower on horizontal truss
39	red-tailed hawk	occupied/active	deciduous	good	2 young and 1 adult in nest
40	red-tailed hawk	occupied/active	deciduous	good	3 young, 2 adults present
41	Swainson's hawk	occupied/active	deciduous	good	1 adult on nest in incubating position; tree slumped over
43	common raven	occupied/active	deciduous	good	[redacted] Road Territory; historical ferruginous hawk nest; 3 young; 3 nests in ragged tree patch
44	gone	gone	deciduous	gone	Nest gone; common raven in 2022
46	common raven	occupied/active	deciduous	good	[redacted] Road Territory; historical ferruginous hawk nest; 1 adult in nest, brooding
47	unknown raptor	unoccupied/inactive	deciduous	fair	Trending toward black-billed magpie nest, adjacent to agriculture
48	bald eagle	occupied/active	deciduous	good	Peavine Island Territory; 1 young ~5-6 weeks old
49	unknown raptor	unoccupied/inactive	deciduous	good	Large nest in windrow
50	red-tailed hawk	occupied/active	deciduous	good	3 young and 1 adult on nest
51	red-tailed hawk	occupied/active	deciduous	good	1 young and 1 adult on nest; 2 nests stacked on top of each other
52	great horned owl	occupied/active	deciduous	good	1 adult in nest with 2 owlets
53	gone	gone	deciduous	gone	Peavine Island Territory; 2019 alternate nest Gone
54	bald eagle	occupied/active	deciduous	good	McNary NWR Territory; 2 young ~5-weeks old
55	bald eagle	gone	deciduous	gone	Sand Station Territory; nest evidence gone
58	bald eagle	occupied/active	deciduous	good	Prosser Territory; 2 young and 1 adult on nest
59	gone	gone	gone	gone	Webber Canyon Territory; historical ferruginous hawk nest
60	gone	gone	rock outcrop	gone	Clodfelter Territory; historical ferruginous hawk nest; below residential subdivision
61	unknown raptor	unoccupied/inactive	ground	remnant	Badger Canyon NW Territory; historical ferruginous hawk nest; new residential construction within 0.77 km
63	gone	gone	deciduous	gone	West Fourmile Canyon Territory; historical ferruginous hawk nest
64	gone	gone	deciduous	gone	[redacted] Road Territory; historical ferruginous hawk nest; removed by residential development
65	gone	gone	rock outcrop	gone	Clodfelter Territory; historical ferruginous hawk nest; below residential subdivision
66	gone	gone	rock outcrop	gone	Clodfelter Territory; historical ferruginous hawk nest; below residential subdivision
67	unknown raptor	unoccupied/inactive	ground	remnant	Clodfelter West Territory; historical ferruginous hawk nest
68	common raven	occupied/active	deciduous	good	West Fourmile Canyon Territory; historical ferruginous hawk nest
69	gone	gone	gone	gone	Webber Canyon Territory; historical ferruginous hawk nest; no sign on barren landscape
70	gone	gone	gone	gone	Webber Canyon Territory; historical ferruginous hawk nest
71	gone	gone	ground	gone	Webber Canyon Territory; historical ferruginous hawk nest; Remnant 2022, currently Gone
72	gone	gone	ground	gone	Webber Canyon Territory; historical ferruginous hawk nest; 2022 = Remnant

Appendix A. Raptor nests documented during the 2023 raptor nest survey at the Horse Heaven Clean Energy Center, Benton County, Washington.

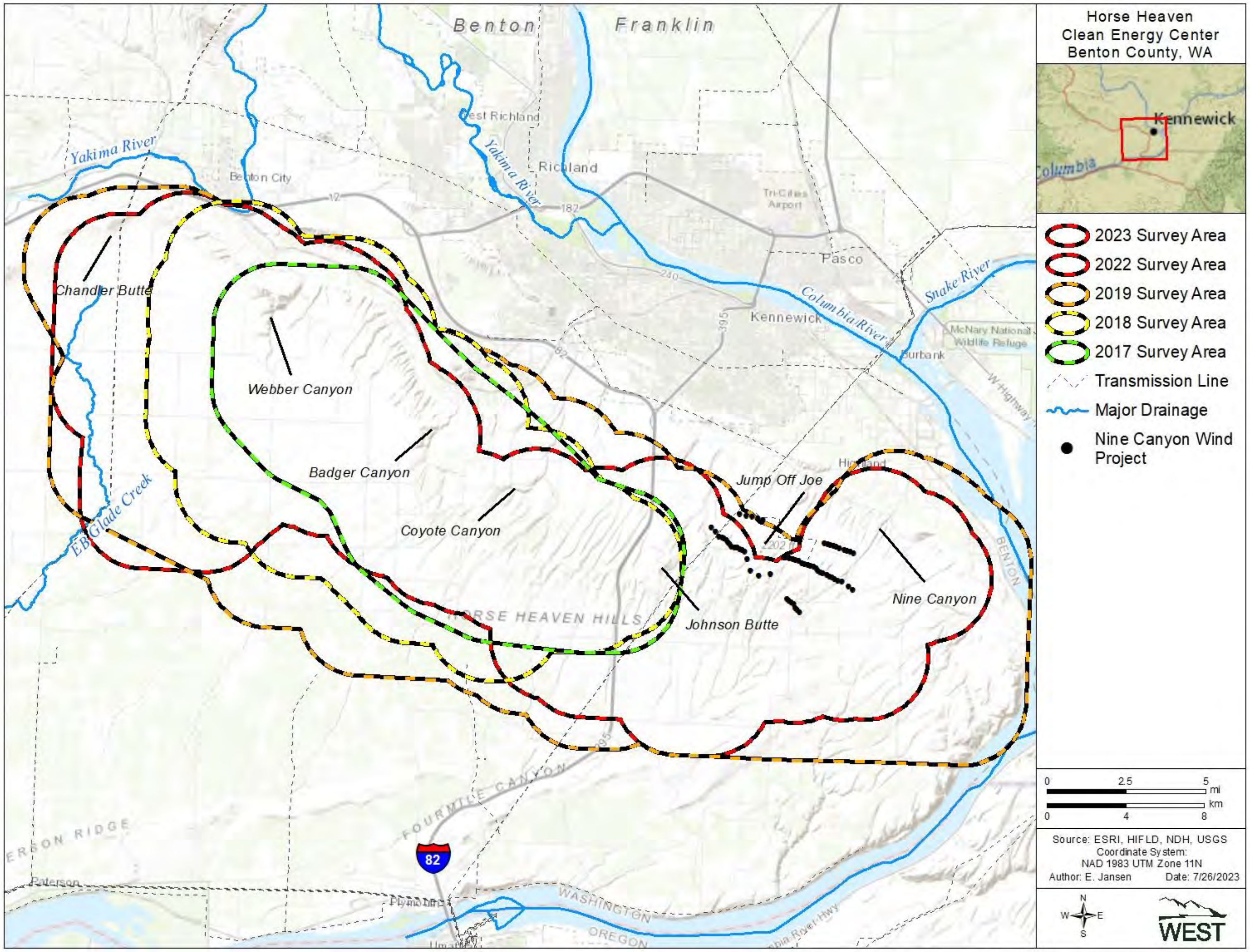
Nest ID	Nesting Species	Nest Status	Nest Substrate	Nest Condition	Comments
74	gone	gone	ground	gone	[redacted] Road Territory; historical ferruginous hawk nest
75	gone	gone	ground	gone	[redacted] Road Territory; historical ferruginous hawk nest
76	gone	gone	ground	gone	Webber Canyon Territory; historical ferruginous hawk nest
77	unknown raptor	unoccupied/inactive	cliff	remnant	[redacted] Road Territory; historical ferruginous hawk nest; small nest
78	unknown raptor	unoccupied/inactive	ground	remnant	[redacted] Road Territory; historical ferruginous hawk nest
80	gone	gone	gone	gone	Webber Canyon Territory; historical ferruginous hawk nest
81	gone	gone	rock outcrop	gone	Clodfelter Territory; historical ferruginous hawk nest; below residential subdivision
84	unknown raptor	unoccupied/inactive	ground	remnant	[redacted] Road Territory; historical ferruginous hawk nest; rocks in nest
85	unknown raptor	unoccupied/inactive	ground	remnant	Badger Canyon NW Territory; historical ferruginous hawk nest; new residential construction 0.62 km
86	gone	gone	ground	gone	Clodfelter Territory; historical ferruginous hawk; below residential subdivision
87	did not survey	unknown	deciduous	unknown	[redacted] Lane Territory; historical ferruginous hawk nest; horse pasture in middle of residential area; survey aborted
89	gone	gone	unknown	gone	Badger Canyon Territory; historical ferruginous hawk nest; no rock outcrop at coordinates; shrub-steppe
92	common raven	occupied/active	cliff	good	Chandler Butte Territory; historical ferruginous hawk nest; 2 young and 1 adult on nest
94	gone	gone	unknown	gone	Webber Canyon Territory; historical ferruginous hawk nest
95	gone	gone	ground	gone	Badger Canyon Territory; historical ferruginous hawk nest
96	gone	gone	ground	gone	Badger Canyon Territory; historical ferruginous hawk nest
97	gone	gone	ground	gone	Badger Canyon Territory; historical ferruginous hawk nest
99	gone	gone	ground	gone	Sheep Canyon Territory; historical ferruginous hawk nest; new residential construction 0.15 km away
100	gone	gone	ground	gone	Sheep Canyon Territory; historical ferruginous hawk; new residential construction 0.31 km away
101	common raven	occupied/active	cliff	good	[redacted] Territory; historical ferruginous hawk nest; in quarry; 3 young
102	gone	gone	rock outcrop	gone	[redacted] Territory; historical ferruginous hawk nest
106	gone	gone	rock outcrop	gone	[redacted] Territory; historical ferruginous hawk nest
109	gone	gone	tree	gone	Sheep Canyon Territory; historical ferruginous hawk nest; tree removed by cropland
111	gone	gone	deciduous	gone	[redacted] Territory; historical ferruginous hawk nest; Swainson's hawk 2022; broken branch and nest material on ground
112	gone	gone	ground	gone	Nine Canyon Territory; historical ferruginous hawk
113	gone	gone	rock outcrop	gone	Clodfelter Territory; historical ferruginous hawk; below residential subdivision
114	gone	gone	ground	gone	Clodfelter Territory; historical ferruginous hawk nest; 43 m from mansion
115	bald eagle	occupied/active	deciduous	good	Burbank Territory; 1 young ~5–6-weeks old

Appendix A. Raptor nests documented during the 2023 raptor nest survey at the Horse Heaven Clean Energy Center, Benton County, Washington.

Nest ID	Nesting Species	Nest Status	Nest Substrate	Nest Condition	Comments
116	gone	gone	ground	gone	Sheep Canyon Territory; historical ferruginous hawk nest; fair condition in 2022
117	gone	gone	tower	gone	Nest blown off tower, no sign
118	gone	gone	tower	gone	Nest blown off tower, no sign
119	common raven	occupied/active	tower	good	On BPA tower; adult incubating
120	common raven	occupied/active	tower	good	On BPA tower; adult incubating
121	common raven	occupied/active	tower	good	On BPA tower; adult incubating
122	common raven	occupied/active	tower	good	On BPA tower; adult standing on nest
123	gone	gone	tower	gone	Nest blown off tower, no sign
124	gone	gone	tower	gone	Nest blown off tower, no sign
125	unknown raptor	unoccupied/inactive	cliff	good	Nest in very low cliff adjacent to Webber Canyon Road; raven 2022
126	unknown raptor	unoccupied/inactive	tower	fair	On BPA tower
127	common raven	occupied/active	tower	good	On BPA tower; adult incubating
128	unknown raptor	Unoccupied/Inactive	platform	fair	New platform installed by Washington Department of Fish and Wildlife
129	bald eagle	occupied/active	tree	good	Fountain Island Territory; 1 young and adult on nest; ~5–6-weeks old
130	bald eagle	occupied/active	tree	good	Peavine Island Territory; 3 young and adult on nest; ~5–6-weeks old

BPA = Bonnevile Power Administration; km = kilometer; m = meter; mi = mile

Appendix B. Survey Areas for Raptor Nest Surveys Conducted from 2017 – 2019 and 2022 – 2023 for the Horse Heaven Clean Energy Center, Benton County, Washington



Appendix B. Survey Areas for raptor nest surveys conducted from 2017 – 2019, 2022 – 2023 for the Horse Heaven Clean Energy Center, Benton County, Washington.

Appendix C. Representative Photographs of Raptor Nests and Surrounding Landscape Documented During Raptor Nest Surveys Conducted March 21, 22 and May 15, 2023 for the Horse Heaven Clean Energy Center, Benton County, Washington

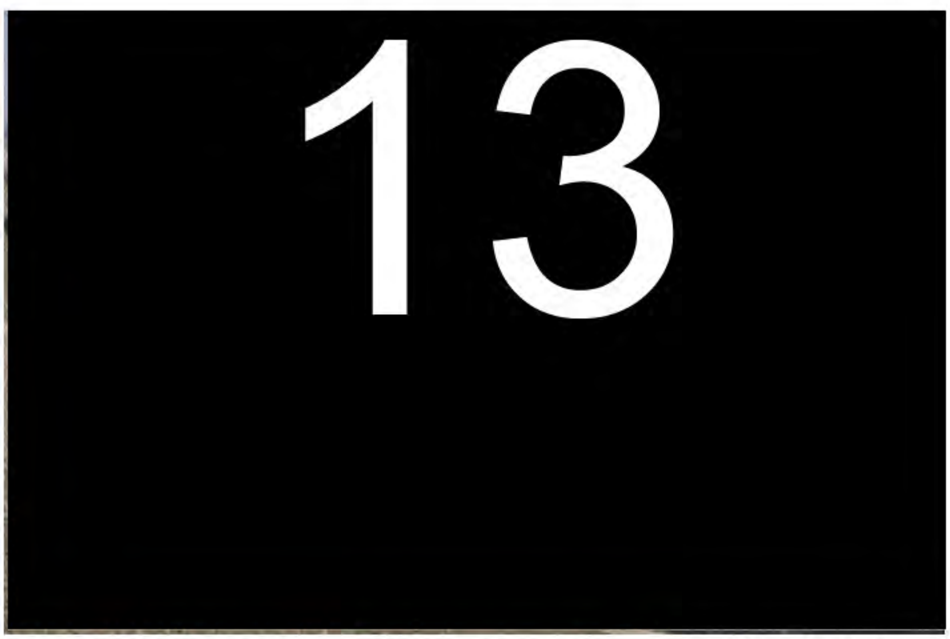
Appendix C1. Operating Nine Canyon wind energy turbines and transmission infrastructure within the grasslands, cropland, and shrub-steppe landscape of the Survey Area; March 2022.

Appendix C2. Dark morph red-tailed hawk perched at Nest 24 with one young on the nest. Nest consistently occupied by ed-tailed hawk from 2018 – 2019, 2022–2023

Appendix C3. Adult bald eagle perched at Nest 48, with at least one 3–4-week-old young – Peavine Territory, May 2022. Occupied 2023.

Appendix C4. Adult bald eagle perched at Nest 58 with at least two approximately 4-week- old young − Prosser Territory, May 2023.

Appendix C5. Coyote Canyon historical ferruginous hawk Nest 03 during the second survey round in 2023 with a great horned owl adult and two young in the nest.



Appendix C6. Landscape of historical ferruginous hawk Nest 08 that was occupied/inactive in 2017 and located at the rock outcrop noted by the red arrow. Nest appeared in good condition in 2018 and 2019, and was gone in 2022 and 2023.

Appendix C7. Example of historical ferruginous hawk Nest 13 in remnant condition located in the [redacted] Road Territory, March 2022. Same condition in May 2023.

Appendix C8. Existing residential development along the ridgeline in proximity of the Clodfelter and Clodfelter West territories. The majority of the nests were Gone or in Remnant condition, May 2023.

Appendix D. Ferruginous Hawk Disturbance Recommendation for the Horse Heaven Clean Energy Center, Benton County, Washington, from Mike Ritter, Washington Department of Fish and Wildlife Statewide Technical Lead, Wind and Solar, January 28, 2020

WEST

Erik Jansen <ejansen@west-inc.com>

Ferr. Hawks

1 message

Ritter, Michael W (DFW) <Michael.Ritter@dfw.wa.gov> Tue, Jan 28, 2020 at 12:48 PM
To: Erik Jansen <ejansen@west-inc.com>, "Fossum, Linnea" <Linnea.Fossum@tetratech.com>, "pat@scoutcleanenergy.com" <pat@scoutcleanenergy.com>

Ferruginous hawk:

Taken from WDFW Priority Habitats and Species recommendations (2004)

Disturbance

Brief human access and intermittent ground-based activities should be avoided within a distance of 250 m (820 ft) of nests during the hawks' most sensitive period (1 March to 31 May) (White and Thurow 1985). Prolonged activities (0.5 hr to several days) should be avoided, and noisy, prolonged activities should not occur, within 1 km (0.6 mi) of nests during the breeding season (1 March to 15 August) (Suter and Joness 1981). Construction or other developments near occupied nests should be delayed until after the young have dispersed (Konrad and Gilmer 1986), which generally occurs about a month after fledging (Olendorff 1993; A. Jerman, unpubl. data).

Spatial and temporal buffers should be tailored to the individual hawks involved (Knight and Skagen 1988), based on factors such as line-of-sight distance between nest and disturbance, nest structure security, history of disturbance, observed responses, and nest elevation in relation to the disturbance.

Michael Ritter

Fish and Wildlife Area Habitat Biologist

Statewide Technical Lead: Wind and Solar

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