Endangered Species Act – Section 7 Programmatic Consultation

for

Oregon Department of Transportation

Oregon Federal Aid Highway Program
2021

Action Agency: Federal Highway Administration

Consultation Conducted By: U.S. Fish and Wildlife Service, Oregon Fish and Wildlife Office
Portland, Oregon

Date Issued: July 7, 2021

CRAIG ROWLAND

Digitally signed by CRAIG ROWLAND
Date: 2021.07.07 09:06:55 -07'00'

Issued by: Paul Henson, Ph.D., State Supervisor
Oregon Fish and Wildlife Office

Refer to: USFWS Cons #01EOFW00-2020-F-0179

Table of Contents

CONSULTATION HISTORY AND BACKGROUND

This programmatic biological and conference opinion (PBO) are in response to the April 27, 2018 Federal Highway Administration's (FHWA) request for consultation and Oregon Department of Transportation's (ODOT) 2020 Programmatic Biological Assessment (PBA) for its Oregon Federal Aid Highway Program (FAHP) 2021-2036 (Program). For the purposes of this consultation the action agency is referred to as FHWA/ODOT. The PBO is based on information provided in the FHWA/ODOT's PBA for the Oregon Federal Aid Highway Program 2020 (FHWA/ODOT 2020) and supporting reference information; regular meetings and discussions between the Federal regulatory agencies and ODOT personnel and file information and reference material located at the U.S. Fish and Wildlife Service's (USFWS) (Service) Oregon Fish and Wildlife Office. A complete administrative record of this consultation is on file at the Oregon Fish and Wildlife Office.

Consultation discussions for the PBO began in spring 2018 with meetings between ODOT and Service personnel. This document only addresses species under the Service's jurisdiction under the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.). An annual meeting to review FAHP funded projects implemented that calendar year should occur and when necessary amendments to the PBA when the proposed action or affects to listed species changes.

The FHWA/ODOT requested initiation of formal consultation with its determinations that the proposed Program "*may affect, is likely to adversely affect*" the Bradshaw's desert-parsley, bull trout (Columbia River Distinct Population Segment [DPS] and Klamath River DPS), Fender's blue butterfly, Kincaid's Lupine, Lost River sucker, marbled murrelet, Nelson's checker-mallow, northern spotted owl (spotted owl), Oregon spotted frog and shortnose sucker.

The FHWA/ODOT is also requesting initiation of formal consultation with its determinations that the proposed Program may adversely affect designated or proposed critical habitat for bull trout, Fender's blue butterfly, Kincaid's Lupine, Lost River sucker, marbled murrelet, short-nosed sucker, spotted owl and Oregon spotted frog.

In addition to the above formal consultation determinations, FHWA/ODOT have also made effects determinations of "may affect, is not likely to adversely affect" for Applegate's milkvetch, Columbian white-tailed deer, Cook's lomatium, Gentner's fritillary, gray wolf, Howell's spectacular thelypody, Large-flowered wooly meadowfoam, MacFarlane's four-o'clock, rough popcorn flower, Spalding's catchfly, streaked horned lark, western lily, Willamette daisy and yellow-billed cuckoo. FHWA/ODOT is requesting concurrence on the determinations for these species. Since the time FHWA/ODOT requested consultation the Bradshaw's desert-parsley has been delisted, effective April 7, 2021 (86 FR 13200), although it may still appear in places within this document.

The FHWA made these requests in accordance with section 7 of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 et seq.) and as outlined in Table 1.

Table 1. Species addressed in this PBO, listing status, and FHWA/ODOT's effects determinations (ODOT) 2020.

Species	Scientific name	Federal Status	Determination
Birds			
Marbled murrelet	*Brachyramphus marmoratus*	T/CH	LAA LAA for CH
Northern spotted owl	*Strix occidentalis caurina*	T/CH	LAA LAA for CH
Streaked Horned lark	*Eremophila alpestris strigata*	T/CH	NLAA
Yellow-billed cuckoo	*Coccyzus americanus*	T/CH	NLAA N/A for CH
Mammals			
Columbia white-tailed deer Columbia River DPS	*Odocoileus virginianus leucurus*	T	NLAA NLAA for CH
Gray Wolf	*Canus lupus*	T	NLAA CH ND
Amphibians			
Oregon spotted frog	*Rana pretiosa*	T/CH	LAA LAA for CH
Fish			
Bull trout Columbia River DPS	*Salvelinus confluentus*	T/CH	LAA LAA for CH
Bull trout Klamath River DPS	*Salvelinus confluentus*	T/CH	LAA LAA for CH
Lost River sucker	*Deltistes luxatus*	E/PCH	LAA LAA for PCH
Short-nosed sucker	*Chasmistes brevirostris*	E/PCH	LAA LAA for PCH
Invertebrates			
Fender's blue butterfly	*Icaricia icarioides fenderi*	E/CH	LAA LAA for CH
Plants			
Applegate's milkvetch	*Astragalus applegatei*	E	NLAA
Cook's lomatium	*Lomatium cookii*	E/CH	NLAA NLAA for CH
Gentner's Fritillary	*Fritillaria gentneri*	E	NLAA
Howell's spectacular thelypody	*Thelypodium howellii spectabilis*	T	NLAA
Kincaid's lupine	*Lupinus sulphureus* ssp. *kincaidii*	T/CH	LAA LAA for CH
Large-flowered wooly meadowfoam	*Limnanthes floccose* spp. *grandiflora*	E/CH	NLAA
MacFarlane's four-o'clock	*Mirabilis macfarlanei*	T	NLAA
Nelson's checkermallow	*Sidalcea nelsoniana*	T	LAA
Rough popcornflower	*Plagiobothrys hirtus*	E	NLAA

Spalding's catchfly	*Silene spaldingii*	T	NLAA
Western lily	*Lilium occidentale*	E	NLAA
Willamette daisy	*Erigeron decumbens* var. *decumbens*	E/CH	NLAA NLAA for CH

(E) – Endangered (T) –Threatened (CH) - designated Critical Habitat (PCH) – proposed Critical Habitat (NLAA) – not likely to adversely affect (LAA) – likely to adversely affect (NLAA for CH) – not likely to adversely affect proposed or designated critical habitat (N/A)-not applicable (ND) – not designated

BIOLOGICAL OPINION

1.0 Proposed Action

1.1 General Information

The proposed action consists of eleven types of Federal Highway Administration (FHWA)-funded transportation projects that "May Affect" ESA listed species. Figure 1 shows the proportions of project types using programmatic consultation in the last five years. The proportions of various project types are expected to remain relatively consistent in the future although various State funding packages may change the quantity of these project types.

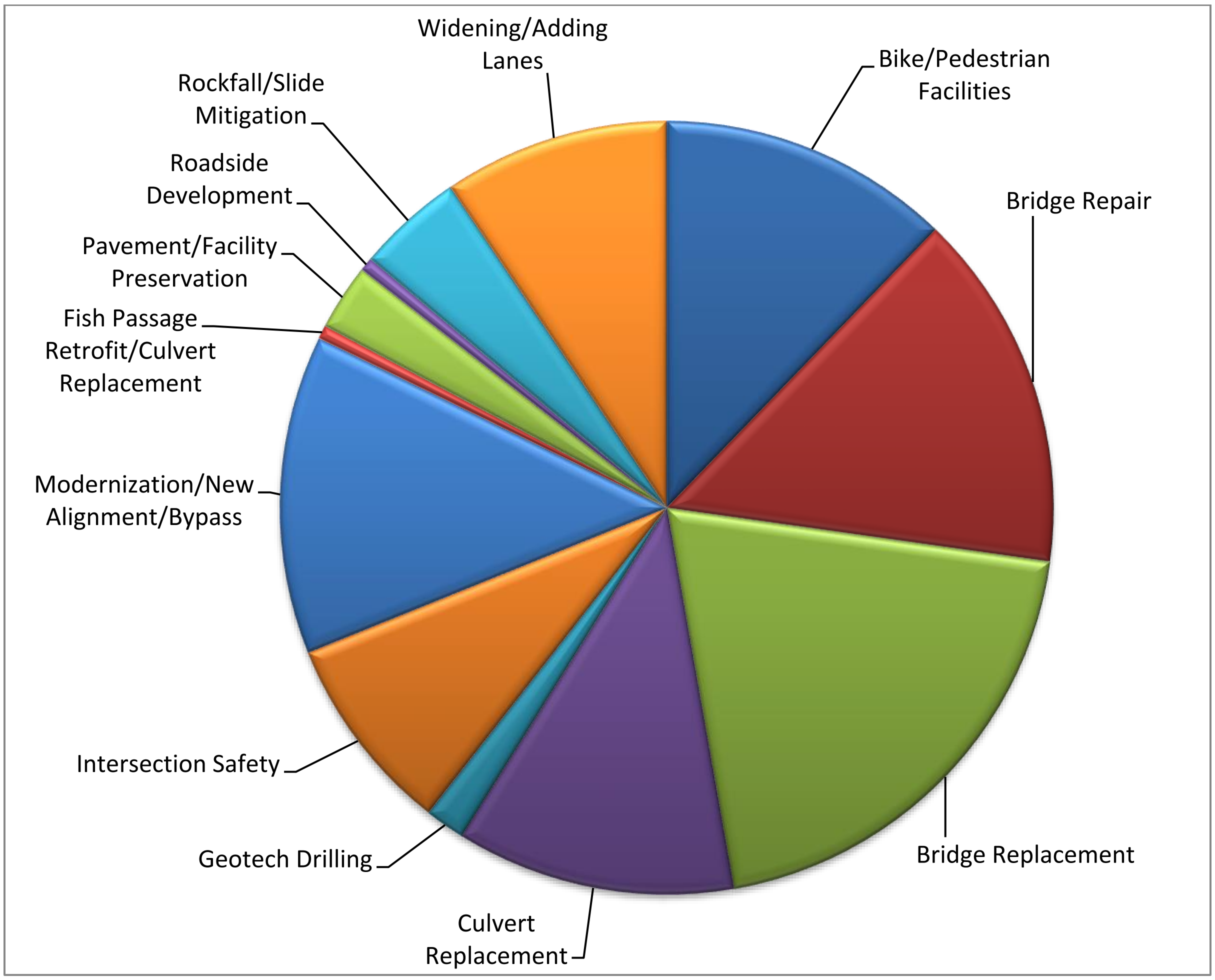

Figure 1. ODOT-FHWA project types with ESA consultations 2014-2017 for NMFS and USFWS species.

Project types are labeled by focusing on the main component of a transportation improvement action. Projects may be narrowly scoped, such as stand-alone culvert replacements, or they could encompass several of these categories but have a defined purpose such as the Modernization or Preservation project types. The categories of project types presented in this PBO serve as an ODOT naming system to support Endangered Species Act (ESA) consultation tracking. The project types are broken down into multiple project activities which may be common to several project types and this deconstruction allows for a complete effect's analysis.

Table 2. Anticipated average number of projects per year FAHP program statewide

Project Type	**Anticipated Average Number of Projects Per Year**
Bike/Pedestrian Facilities	14
Bridge Repair	16
Bridge Replacement	22
Culvert Extension/Repair	1
Culvert Replacement	11
Intersection Safety	10
Modernization/New Alignment/Bypass	14
Pavement/Facility Preservation	4
Roadside Development	2
Rockfall/Slide Mitigation	6
Widening/Adding Lanes	10
Total	**110**

Table 2 presents a summary of the anticipated average number of projects per year by project type that will use the Federal Aid Highway Program (FAHP) PBA for coverage of anticipated affects to USFWS listed species. Projects with impacts to USFWS species typically represent a small subset of this total (approximately 10 percent), therefore approximately 11 projects (ODOT PBA 2020) are expected to use this programmatic consultation annually. The specific project type of these 11 projects will vary each year but we anticipate a larger portion to be bridge and culvert related projects.

Table 3 presents a summary of various project activities and the project types they are typically associated with. This breakdown is not a prediction of all project activities that will occur during a certain project type, but it is indicative of the range of effects that may be expected per project type. ODOT's Standard Specifications are required of all construction contracts administered by ODOT. They include several measures to minimize disturbance to environmental resources. Appendix B contains the Standard Specifications most relevant to this PBA.

Additional impact Avoidance and Minimization Measures were developed for this PBO, detailed in the Special Provisions document (ODOT 2015a), in which ODOT will implement or add to Contract Special Provisions (e.g., ODOT 2015b). Since Special Provisions are updated as needed to comply with current regulatory and technical guidance, these measures are not presented as specification language. Instead, they are presented as design goals or performance objectives. The special provisions can be site and species specific. An example would be a seasonal restriction for guardrail installation not to begin until after the marbled murrelet breeding season in areas where suitable habitat has not been surveyed. The Avoidance and

Minimization Measures represent best practices and design criteria primarily from Standard Local Operating Procedures for Endangered Species (SLOPES V)(ODOT 2008b)(NMFS 2013)(ODOT 2014a), ODOT Routine Road Maintenance, Water Quality and Habitat Guide, Best Management Practices (Revised 2014) Office of Maintenance, Salem, OR (ODOT 2014b), and the Oregon Transportation Investment Act (OTIA III PBA) (ODOT 2004).

In addition to impact Avoidance and Minimization Measures, ODOT and FHWA propose offsetting measures for permananly impacted habitat. Spotted owl and marbled murrelet habitat requiring mitigation will be compensated for at a ratio of 3:1. All other occupied suitable habitat permanently removed for listed species by adverse effects identified in this PBO, will be restored on site when possible or in a conservation bank or other approved sites mutually agreed upon by ODOT, FHWA and the Service.

Table 3. Proposed activities that typically occur with different types of FAHP projects.

Sub-Section #	ACTIVITIES (ODOT Specifications)	Project Types[1]													
		Bike/Ped Facilities	Bridge Repair	Bridge Replacement	Culvert Extension/ Repair	Culvert Replacement	Geotech Drilling	Fish Passage Retrofit	Intersection Safety	Modernization/New Alignment/Bypass	Pavement/Facility Preservation	Roadside Development	Rockfall/Slide Mitigation	Signals/Signs	Widening/Adding Lanes
1	Geotech Drilling			X		X	X			X			X	X	
2	Material Source	X		X					X	X	X		X		X
3	General Heavy Construction (Sec 200-500)	X	X	X	X	X		X	X	X	X	X	X		X
4	Mobilization, Staging & Disposal (Sec 210; 225)	X	X	X	X	X				X	X		X		X
5	Erosion & Pollution Control (Sec 280; 290)	X	X	X	X	X	X	X	X	X	X	X	X		X
6	Temporary Access Roads (Sec 220.40b; SP230[2])			X			X								
7	Barges (Sec 210)		X	X			X								
8	Temporary Bridges (SP250-252)			X						X					
9	Work Area Isolation (SP 245, SP 290.35(c-2)); Coffer Dams (Sec 510.03)			X	X	X		X		X					
10	Clearing & Earthwork (Sec. 310-330)	X		X		X			X	X	X	X	X		X
11	Weed Removal	X		X		X	X		X	X	X	X	X		X
12	Tree & Down Timber Removal (Sec 320.40)			X			X			X					X
13	Blasting (Sec 3303 335)												X		
14	Slope Stabilization. (Sec 390-398) & Dewatering (Sec 405.43)												X		
15	Streambank Stabilization & Scour Protection (Sec 390)					X									X
16	Culvert Removal (Sec 310), Bridge Removal (Sec. 510)			X		X				X					
17	Bridge Repair & Rehabilitation (Sec 500)		X												X
18	Bridge Installation, Steel (Sec 560); Concrete (Sec 540, 550, 590); Treated Wood (Sec 570)			X						X					
19	Pile Removal (SP 290.34), Drilled Shafts (Sec 512); Pile Driving (Sec 520)			X						X					
20	Culvert Install., Repair, Extension, Retrofit (Sec 440-490, 595), Lining (Sec 410)					X				X	X				

[1] X=most common activities for the type of project.
[2] SP indicates existing Special Provision (ODOT 2015b).

21	Painting/Coating (Sec 593-594)		X												
22	Asphalt & Concrete Paving (Sec 700)	X		X					X	X		X	X		X
23	Other Permanent Roadway Structures (Sec 586, 587, 800, 900, 1050, 1070, 1100)	X	X	X					X	X	X	X		X	X
24	Site Restoration - Permanent. Erosion Control (Sec 280); Seeding (Sec 1030); Tree Planting (Sec 1040)	X	X	X	X	X		X	X	X	X	X	X		X
25	Channel Modification & Waterway Enhancements (Sec 1090, SP 1091)							X							
26	Stormwater Management (SP 1092)	X		X					X	X		X			X

1.2 Project Scoping/Development

All projects require scoping, in which the Region Environmental Coordinator (REC) gathers basic project information and coordinates with specialists (e.g., Biologists, Historians, etc.) to summarize potential affected environmental resources and determine NEPA classification (CE, EA, or EIS). The Biologists (including, but not limited to ODOT Region Biologists and ODOT regulatory liaisons with Oregon Department of Fish and Wildlife (ODFW), USFWS, and National Marine Fisheries Service (NMFS) provide input on potential presence of listed species.

Determination of suitable habitat for listed species, presence/absence of listed species and potential impacts to listed species may be made by an ODOT biologist[3], an ODOT-qualified consultant biologist (as per ODOT Technical Services Bulletin GE-14-03(B) or updates), (ODOT 2014), appropriate Agency or Tribal biologist (e.g., U. S. Forest Service if project is on their lands) or an appropriate regulatory biologist (NMFS, USFWS, ODFW or Oregon Department of Agriculture (ODA) Plant Conservation Unit, depending on species). When suitable habitat is present, ODOT will either conduct surveys following current USFWS protocols or will assume species presence.

When presence of a listed species is known or assumed, the ODOT biologist will determine if the project's activities "May Affect" the listed species or designated critical habitat. If the project "May Affect" listed species, ODOT's Biologist will determine the most appropriate ESA compliance mechanism. For projects funded within scope of this PBO, ODOT will:

1. Complete early coordination with the Service if it anticipated affects to listed species and initiate a Project Initiation Form ODOT internal project tracking).
2. Complete a Notification Form (see Section 3.4.2 of this PBO).
3. Coordinate with the project team and designers to avoid direct and indirect effects to the species and habitat, including identifying No Work Zones or Regulated Work Areas in construction plans.
4. Minimize the effects if avoidance is not achievable within the project limits and mitigate permanent habitat impacts as required (see Special Provision, Avoidance and Minimization Measures 1-9, 15-6, 18-5, and 26-1, (ODOT 2015b, pages 13-15, 36, 39 and 51).
5. Include locations and descriptions of No Work Zones in appropriate Contract documents (e.g., identify locations in plans and develop special provisions for physically marking the limits [markers, erosion control fencing, or orange construction zone fencing, as appropriate]) to avoid direct and indirect impacts to protected resources in those areas from construction personnel, equipment, and

[3] An ODOT biologist may be classified as a Biologist, or another ODOT environmental employee qualified to performs biological resource and assessment work.

associated pollutants (e.g., noise, sediments, chemical contaminants).

6. Include location and description of Regulated Work Areas (see Glossary, Appendix A) in appropriate Contract documents (e.g., identify locations and timing restrictions in plans and special provisions) to minimize impacts in those areas from construction personnel, equipment, and associated pollutants (e.g., noise, sediments, chemical contaminants).

1.3 Covered Activities

1.3.1 General Heavy Construction

Most transportation projects require the use of heavy equipment, (e.g., bull dozers, cranes, front-end loader, flatbed and large pick-up trucks). The equipment is typically much larger, heavier, and louder than standard vehicles. Guardrail replacement is included in this section because posts may need to be installed with impact pile drivers.

While more specific activities involving heavy equipment are described in their corresponding sections, this section addresses general habitat disturbance and increased noise and activity levels at construction sites.

<u>Avoidance and Minimization Measures:</u>
The following measures will be implemented on all projects performed under this PBO, during design or in Contract Special Provisions:

1-1. Conduct periodic environmental inspections, as needed to observe construction activities to assure BPMs are being followed to minimize adverse effects to listed species.

1-2. Select and operate heavy equipment as necessary to minimize adverse effects on the environment (e.g., minimally-sized, low pressure tires, minimal hard turn paths for tracked vehicles, temporary mats or plates within wet areas or sensitive soil, etc.).

1-3. Complete all work within the active channel of aquatic habitat supporting listed species in accordance with the Oregon Guidelines for timing of in-water work to protect fish and wildlife resources (ODFW 2008b) except:

i Hydraulic, topographic measurements and encased geotechnical drilling may be completed at any time, if a fish biologist determines that the affected area is not occupied by listed adult fish congregating for spawning or in an area where redds are occupied by eggs or pre-emergent alevins.

ii Other exceptions/modifications require regulatory approval (see Section 3.2).

1-4. Except as allowed temporarily during in-water work area isolation (see Section 2.3.9, Measure 9-4), provide safe passage around or through the isolated work area for adult and juvenile migratory fish unless passage did not previously exist.

1-5. For all projects that affect fish passage (listed species), design structures to provide adult and juvenile passage that meets ODFW and NMFS fish passage standards (ODFW 2011) or the most up to date version, for the life of the structure. This may be modified as long as it meets Program Goals as per ODFW Fish Passage Plan Approvals, Waivers, or Exemptions (ODFW 2011) and provides access for spawning and migration of listed species; requires regulatory approval (see Section 3.2 of this PBO).

1-6. If a project cannot provide fish passage as per 1-5, offset the functional equivalent, (see Glossary, Appendix A) of the fish passage, following the ODFW fish passage exemption or waiver process, with USFWS review/approval. Generally, the standard is removal of a similar fish passage barrier in the same subbasin, although alternatives may be proposed/negotiated (see Administration, Section 3.2 of this PBO).

1-7. Do not allow equipment to cross directly through aquatic habitat supporting listed species for temporary construction access, unless shown on project plans, and only under the following conditions:

i. A fisheries biologist must survey the proposed crossing for presence of sensitive aquatic resources.
ii. ODOT will allow stream crossings if the proposed crossing will not interfere with spawning behavior, eggs, or pre-emergent juveniles in an occupied redd, or native submerged aquatic vegetation as confirmed by a fish biologist.
iii. If the crossing is a ford, it must be located and designed to provide for foreseeable risks, such as flooding and associated bed load and debris, to prevent the diversion of stream flow out of the channel down the road if the crossing fails.
iv. If vehicles and machinery must cross riparian areas and streams, utilize the shortest crossing possible.
v. If warranted and feasible, use temporary mats or plates.
vi. When a crossing is no longer needed, block the area from future incidental access, obliterate the route, and restore the soils and vegetation (see Site Restoration, Section 2.3.24 of this PBO).

1-8. If water is required for construction, divert streamflow only if water from developed sources (e.g., municipal supplies (free of chlorine and chloramines), ponds, reservoirs, or tank trucks) is unavailable or inadequate, the diversion will not exceed 10 percent of the available flow at any given time. For streams with less than 5 cubic feet per second (cfs), drafting will not exceed 0.03 cfs (18,000 gallons per day). Intakes will be screened and maintained as follows:

i. Clean and repair water intake screening to maintain adequate flow and protection of aquatic life.
ii. Provide ditch screens with a bypass system to transport fish safely and rapidly back to the stream.
iii. When drawing or pumping water from any stream, protect fish by equipping intakes with screens having a minimum 27 percent open area and meeting the following requirements:

Perforated plate openings shall be 3/32 inch or smaller.
Mesh or woven wire screen openings shall be 3/32 inch or smaller in the narrowest direction.
Profile bar screen or wedge wire openings shall be 1/16 inch or smaller in the narrow direction.

- Choose size and position of screens to meet the criteria in Table 6.

Table 4. Fish screen criteria.

Type	Approach Velocity[4] (Ft./Sec.)	Sweeping Velocity[5] (Ft./Sec.)	Wetted Area of Screen (Sq. Ft.)	Comments
Ditch Screen	0.4	Shall exceed approach velocity	Divide max. water flow rate (cfs) by 0.4 ft/sec	If screen is longer than 4 feet, angle 45° or less to stream flow
Screen with proven self-cleaning system	0.4	–	Divide max. water flow rate (cfs) by 0.4 ft/sec	–
Screen with no cleaning system other than manual	0.2	–	Divide max. water flow rate (cfs) by 0.2 ft/sec	Pump rate 1 cfs or less

1-9. Identify No Work Zones in Plans and Special Provisions, as needed to restrict access to locations with protected resources. For example, if listed plants or butterfly habitat are disturbed by construction activities, ODOT will notify the Service in the pre-project stage of planning and jointly develop necessary minimization, avoidance and mitigation measures replace the functional equivalent of the species or critical habitat, on-site when property is available or off-site when suitable protected lands are available.

1-10. The following noise and visual activity restrictions apply for projects within 328 feet of occupied or unsurveyed suitable nesting habitat for marbled murrelet[6] when the work involves high noise producing activities (> 90 dBA at 50 feet, typical of many types of construction equipment and activities). Modifications requiring review/approval from USFWS (see Section 3.2).

i. Conduct activities outside the typical April 1 through August 5 critical nesting period, if possible. Since these would be infrequent and unique situations ODOT will contact the Service to assess and develop measures to minimize these effects.
ii. If activities will occur from April 1 through September 15, do not allow nighttime work between two hours before sunset and two hours after sunrise:
iii. To minimize adverse effect due to disruption and ensure Contractor is complying with timing restrictions, conduct inspections when high noise producing work may occur during the seasonal restriction period. See Section 3.4.3 of this PBO.

4 Velocity perpendicular to screen face at a distance of approximately 3 inches.

5 Velocity parallel to screen

6 Based on recommendations from murrelet researchers that advised buffers of greater than 100 (328 feet)meters to reduce potential noise and visual disturbance to murrelets (Hamer and Nelson 1998, p. 13, USFWS 2012c, pp. 6-9).

1-11 The following noise and visual activity restrictions apply for projects within one mile of occupied or unsurveyed suitable nesting habitat for spotted owl when the work involves blasting.

i To minimize adverse effect due to disruption and ensure Contractor is complying with timing restrictions, conduct Federal Aid Highway Program (FAHP) Construction Monitoring Compliance Inspections (posted on the FAHP Web Map) when high noise producing work may occur during the seasonal restriction period. See Administration Section 3.4.3.

ii For spotted owl: Avoid blasting activities during the following critical nesting periods:

- March 1 to July 7 for the Oregon Coast Range.
- March 1 to June 30 for the Oregon Klamath Province.
- March 1 to July 15 for the Western Oregon Cascades.
- March 1 to July 15 for the Willamette Valley.
- March 1 to September 30 for the Eastern Oregon Cascades, and unlisted areas.

1-12 If working in a documented gray wolf activity area, check with USFWS to confirm no known den or rendezvous site within one mile when the work involves high-noise producing activities (> 90 dBA at 50 feet; typical of many types of construction equipment and activities).

1.3.2 Geotechnical Drilling

Geotechnical drilling is typically needed for identifying aggregate material sources, or for projects that involve construction of new or changes in weight-bearing foundations (e.g., bridge abutments), or for slope stabilization. Geotechnical drilling site investigations are conducted to determine construction design conditions or constraints. It includes drilling to remove rock and soil samples, along with drilling to evaluate soil stability and other soil characteristics. Drilling may be required to confirm soil and rock conditions including vertical and horizontal extent for temporary or permanent structures. Geotechnical drilling associated with the Proposed Action is briefly described below.

<u>Drill Pad Preparation.</u> Drill pads are the areas where the drill rig and support equipment are parked when the drill is operating. The drilling rig is stabilized using hydraulic leveling jacks that require a level pad. If a pad location has irregular or steep terrain, it will be graded to provide a level surface for drill operation. This activity is almost always associated within or immediately adjacent to the road prism and associated with an unstable slope investigation or establishment of a new bridge approach. The site would be surveyed for listed species prior to implementation of the project if listed species are present BPMs would implement.

<u>Drilling and Sampling Operations, Mobilization, and Setup.</u> Drilling and sampling methods vary depending on the project and the anticipated subsurface conditions at the site. Methods used to wash cuttings from the bore (see Sec 2-1, page 18) vary from compressed air to water and drilling mud. Sampling techniques involve inserting and retrieving sampling instruments in the boring during the drilling process. Other exploration methods might include digging test pits with tire or track mounted backhoes, or shallow borings with hand tools (hand augers or probes). If water is required for drilling, a water tanker is parked as close to the drill rig as possible.

Auger Drilling. Auger drilling involves attaching an auger, with a carbide-toothed bit attached at the bottom, to the rotary drive spindle of the drill. The drilling is accomplished by rotation and downward pressure applied to the auger by the drill; additional flights are attached as necessary, and the drilling is advanced to the necessary depth.

Water or Mud Rotary Drilling. This method of drilling consists of advancing drill steel into the ground by applying rotation and downward pressure to the drill steel and bits. Water or drilling mud (fluid), typically bentonite (inert clay), is pumped down inside the drill steel to the bottom of the boring where it exits the bit. Frequently after drilling begins, the drill fluid return ceases as the fluid is lost through more permeable zones of subsurface materials.

In-water Drilling. It may be necessary to drill in wetted stream channels especially when conducting sub-surface sampling for bridge foundations. When this occurs, the drilling equipment typically operates from the existing bridge or a barge. The drilling occurs within a sleeve or casing so it is isolated from water. The drilling fluids are returned up through the casing to the drill platform and captured in a collection tank. A small pulse of turbidity may result when the drill penetrates the top layer of the substrate and when the drill is removed after completion. When the sleeves are removed after drilling, minor amounts of residual fluids may escape.

Drilling fluids are disposed of in upland locations, either infiltrated across the ground surface through the existing vegetation or are directed to a temporary sediment pond or containment system. Soil recovered from drilling in upland areas is typically spread out over the site and stabilized by seeding and mulching or are contained and removed from the site. If no instrumentation is installed in the drill borings, they are abandoned by filling them with bentonite chips, pellets, or cement-bentonite grout.

Avoidance and Minimization Measures:
The following measures will be implemented for all drilling work performed under this PBA during design or in Contract Special Provisions:

2-1. For drilling/boring/jacking within 150 feet of habitat supporting listed species or No Work Zones (this distance may be modified based on site conditions and justified in the Project Notification; see Section 3.4.2 of this PBO):

i Design, build, and maintain facilities to collect and treat all construction and drilling discharge water using the best available technology applicable to site conditions. Provide treatment to remove debris, nutrients, sediment, petroleum hydrocarbons, metals, and other pollutants likely to be present. An alternate to treatment is collection and proper disposal offsite.

ii Isolate drilling operations from wetted stream to prevent drilling fluids and waste from contacting aquatic habitat supporting listed species.

2-2. If drilling fluid or waste is released to any aquatic habitat supporting listed species or No Work Zones, contact appropriate regulatory agencies within 48 hours. Remediation, if necessary, would be conducted after discussions with the Service.

1.3.3 Material Sources

ODOT can make earthen materials needed for construction projects available to Contractors when fully permitted (including environmental permits and clearances) ODOT owned and/or controlled material sources are located near the project sites. This strategy is aimed at reducing traffic congestion, haul costs, and consumption of fuels on ODOT projects. Via Contract requirement, the Agency can offer Agency-furnished sources of fill material and/or aggregate material either as prospective[7] or mandatory[8]. Agency-furnished material sources are typically located outside the project limits, although occasionally are within the project limits. Most sites require additional operational development (grading, extraction, processing, etc.), and associated operational specifications are included in the Contract Special Provisions.

Most Agency-furnished material sources that are located outside the project limits are developed independently, including environmental permits and clearances. They may be used to provide borrow for fill material and/or aggregate on multiple projects. Independent development of Agency-furnished material sources may be completed internally or via Contracts. Regardless of the mechanism for development, if completed using FHWA funds, the Agency may utilize this PBO for ESA consultation if the work can be completed within the scope of the PBO.

If ODOT does not furnish material sources, the Contractor is responsible for furnishing or acquiring such sites and obtaining all the required permits and environmental clearances. Some Contractors own or control aggregate sources, while others use available commercial, private, or some public sites.

> <u>Avoidance and Minimization Measures:</u>
> No distinct Avoidance and Minimization Measures. Use of ODOT-furnished material source sites within scope of this PBO will follow applicable Avoidance and Minimization Measures.

1.3.4 Mobilization, Staging and Disposal

Construction mobilization consists of site preparation in advance of primary construction activities, and includes preparation and installation of environmental controls, preparation of equipment and material storage areas, and relocation of utilities. If utilities are owned by ODOT, the work is part of the contracted project. If not, ODOT or the contractor will coordinate with utility companies or owners of the utility during project development. Relocation work will take place either prior to or during mobilization if possible. When an independent utility company must perform the relocation, the company is required to comply with environmental regulations (see Interrelated and Interdependent Actions, Section 2.4).

Construction staging or equipment storage areas may be within or outside of the project area and/or agency ROW and they are secured, cleared, and developed, as needed. Staging area development may include grading and storage of soil overburden from within the necessary area,

---

[7] Per Standard Specification 00160.00(a) (ODOT 20015a): Prospective Source – Agency-furnished Materials source, use of which by the Contractor is optional. The Agency makes no guarantee or representation, by implication or otherwise, of the land use status, quantity, quality, or acceptability of Materials available from it, except as may be stated in the Special Provisions.

[8] Per Standard Specification 00160.00(b) (ODOT 2015a): Mandatory Source – Agency-furnished Materials source, use of which by the Contractor is required.

and laying crushed rock or gravel as needed for dust and erosion control, or as a stable foundation for construction trailers, mobile fabrication or paint sheds, debris bins, etc. Environmental controls may include establishment of clearing limits, installation of temporary erosion controls, and preparation of site-specific pollution and erosion control plans.

Contractors may use storage areas and staging sites that are outside of the project limits, as per Standard Specifications, which state that "staging and disposal sites to be located in previously improved or disturbed sites, including existing roadways, pullouts, turnouts, parking lots, and storage yards that have been compacted, graveled and paved, unless otherwise approved in writing by the Engineer" (see Appendix B, Section 00290.10). For locations of disposal, Contractors may dispose of clean fill at Agency-furnished sites, and any other construction waste at public facilities (Agency property, municipal recycling or landfills) or private property. When the Contractor utilizes private sites, they are responsible for obtaining all the required permits and environmental clearances. However, the Agency may elect to designate and permit sites for the Contract. ODOT completed guidance for project teams and Construction Project Managers to help determine when it is appropriate to designate an Agency-furnished site, whether the site should be prospective or mandatory, and which party is responsible for environmental clearances and permitting (ODOT 2008a).

Avoidance and Minimization Measures:
The following measures will be implemented on all projects performed under this Programmatic, during design or in Contract Special Provisions:

4-1. For projects with high environmental sensitivity, plan and designate staging areas and disposal sites as per ODOT Technical Services Bulletin GE08-04(B) (ODOT 2008c) according to relevant permits and best management practices (BMP).

4-2. For Contractor-designated sites within project limits or agency ROW, approve equipment storage, staging areas, and disposal sites on undeveloped or undisturbed areas only when undeveloped land is the only reasonable alternative. In such cases, locate sites at least 150 feet from aquatic habitat supporting listed species or No Work Zones (this distance may be modified based on site conditions and justified in the Project Notification, see Section 3.4.2 of this PBO).

1.3.5 Erosion, Sedimentation and Pollution Control

Although ODOT will develop an Erosion and Sediment Control Plan as part of contract documents, the Contractor is required by Standard Specifications to modify or update the Plan as needed for construction practices and site conditions. ODOT's Standard Specifications also require the Contractor to install the controls before any other ground-disturbing activities (see Appendix B, Section 00280.02).

ODOT will use erosion and sediment control measures to ensure compliance with applicable National Pollutant Discharge Elimination System (NPDES) requirements and local permits governing sediment discharge from construction areas. Generally, ODOT will install silt fences near the toe of the road embankment fill slopes in areas where sediment-laden water has a potential of entering aquatic habitat supporting listed species or leaving the work area. Straw wattles or other devices may be used in areas that are sensitive or need extra protection. Rock check dams may be constructed at regular intervals throughout the roadside ditch system to slow the flow of water. These are just a few of the more common types of controls; some other typical methods are provided in Appendix B. The Contractor may propose other methods (requires approval by ODOT).

Avoidance and Minimization Measures:
Erosion and pollution Avoidance and Minimization Measures provided in ODOT Standard Specifications as well as ODOT Special Provisions Sections 00280 and 00290, are required of all ODOT contracts. The following additional measures will be implemented on all projects performed under this Programmatic, during design or in Contract Special Provisions:

5-1. Do not discharge contaminated or sediment-laden water, or water contained within a work isolation area, directly into any aquatic habitat. Discharge will not occur until the water has been satisfactorily treated to turbidity requirement in Measure 5-2, BMPs and relevant permits.

5-2. Do not exceed turbidity standards in aquatic habitat supporting listed species covered by this PBO. The turbidity standard is no more than 10 percent above background reading (up to 100-feet upstream of the project) as measured 100-feet downstream of the project based on established BMPs.

5-3. The following minimum pollution control measures are required of all construction vehicles and other heavy equipment to prevent leaks and spills from entering protected areas (see Appendix B, Section 00290.30a). Distances may be modified based on site conditions and justified in the Project Notification (see Section 3.4.2 of this PBO).

i. Inspect and clean all equipment prior to operating within 150 feet of any aquatic habitat supporting listed species, No Work zone, or storm inlet. Check for fluid leaks and remove all external oil, grease, weed seed, and dirt.
ii. Locate areas for parking, refueling and servicing mobile equipment and vehicles at least 150 feet away from any aquatic habitat supporting listed species, No Work Zone, or storm inlet.
iii. Maintain and protect as necessary any generators, cranes and any other stationary equipment operated within 150 feet of any aquatic habitat supporting listed species or No Work Zones.
iv. Inspect heavy equipment, storage containers, staging areas and other potential sources of hazardous substances daily to identify and prevent potential releases.

5-4. Treat all discharge water created by construction (e.g., concrete washout, pumping for work area isolation, vehicle wash water, drilling fluids) must be treated using the best available technology applicable to site conditions to remove debris, nutrients, sediment, petroleum products, metals and other pollutants likely to be present.

5-5. Implement containment measures adequate to prevent pollutants or construction and demolition materials, such as waste spoils, fuel or petroleum products, concrete cured less than 24 hours, concrete cure water, silt, welding slag and grindings, concrete saw cutting by-products and sandblasting abrasives, from entering contact any aquatic habitat supporting listed species or No Work Zones.

1.3.6 Temporary Access Roads

ODOT may need temporary access roads for geotechnical drilling, staging or access to portions of the project that cannot otherwise be accessed. Access roads may be design features of the project or left to the contractor to design. Construction of access roads typically involves clearing and grading to create an improved surface and slope suitable for construction equipment. Crushed rock or gravel may be used for stability, dust and erosion control, and to facilitate site reclamation.

<u>Avoidance and Minimization Measures:</u>
The following measures will be implemented for all projects performed under this PBO that have temporary access roads, either during design or in Contract Special Provisions:

6-1. Unless no reasonable alternatives are available, do not design or allow new temporary access roads within 150 feet of any habitat supporting listed species or No Work Zones (this distance may be modified based on site conditions and justified in the Project Notification, see Section 3.4.2 of this PBO).

6-2. When new roads are needed:

i. Do not design or allow temporary access routes on steep slopes, where grade, soil, or other features suggest a likelihood of excessive erosion (e.g., rills or gullies) or failure;
ii. Design site restoration with the goal of obliterating all temporary access routes, stabilizing the soil and restoring the natural vegetation (see Section 2.3.24).

6-3. Follow Avoidance and Minimization Measure 1-7 if temporary stream crossings are needed.

1.3.7 Barges

Barges may be used for bridge replacement or repair work, geotechnical investigation, or as needed to access structures near large bodies of water. The use of barges may be necessary if a navigation channel must remain open to commercial and recreational uses, thereby precluding the contractor from constructing a work bridge across the channel. Barges may be used to set sheet pile cofferdams, drill shafts for new bridge foundations, deliver materials to the site, set new prefabricated bridge elements into place, transport existing bridge off-site, or contain demolition materials. Anchoring of the barge typically is accomplished by lowering spuds to the bed of the waterway and allowing them to sink in solely by their weight. Spuds sometimes are augmented by a system of anchors. Equipment on the barge will have its own containment, including containment pans or absorbent booms to contain minor spills.

<u>Avoidance and Minimization Measures:</u>
The following measures will be implemented for all projects performed under this PBO with relevant work in aquatic habitat supporting listed species, during design or in Contract Special Provisions:

7-1. Rather than leaving it up to the discretion of the Contractor, specify if barges are allowed or disallowed.

7-2. If a barge is allowed, include the following additional Special Provisions for the Contractor:

i. Barges will be of sufficient size and within the safe load capacity to remain stable under adverse conditions such as severe weather and large waves.
ii. Move the barge if there is a possibility of grounding at low tide.
iii. Prior to bringing a barge to the project site, ensure the barge and ballast are free of invasive species.
iv. Load, secure, contain, stabilize and maintain the barge, as well as equipment and materials on the barge, to meet Pollution Control measures (see ODOT Special Provisions, Sections 00290.20 and 00290.30)(ODOT 2015b) .
v. Dock the barge in a safe location if weather forecasts suggest that unsafe conditions for the barge may occur. Unsafe conditions include loss of balance or stability, loss of anchorage, and any condition that reduces safe load capacity below actual loading.

1.3.8 Treated Materials

Wood and steel materials are used in many aspects of highway construction - as support for temporary or permanent bridges, pedestrian bridges, fences and barriers, various types of containment systems, shoring for roadwork or culvert replacement, and concrete falsework. Untreated wood or steel may decay, and depending on the duration of its use, treated wood or other more stable materials may be necessary. Non-treated materials may be specified, but require planning and coordination, and may not always be economically feasible.

Avoidance and Minimization Measures:
The following measures will be implemented for all projects performed under this PBO that may involve treated wood near aquatic habitat supporting listed species, during design or in Contract Special Provisions (other Avoidance and Minimization Measures throughout this consultation may apply):

8-1. Unless no reasonable alternatives are available, do not design or allow the use of construction materials treated or preserved with pesticide compounds; and offer cleaner alternatives.

8-2. If treated materials are used over-water or in-water structure, all surfaces exposed to leaching by precipitation, overtopping waves, or submersion will be coated with a water-proof seal or barrier to be maintained for the life of the structure.

8-3. Any treated structures located below the ordinary high-water elevation (OHWE), including pilings, must have design features to avoid or minimize impacts and abrasion that would deposit treated wood debris and dust in riparian or aquatic habitat.

8-4. The following conditions are required for use of treated materials below OHWE:

i. Store pesticide-treated wood in appropriate dry storage areas, at least 150 feet away from aquatic habitat supporting listed species or where it will not drain into such habitat. This distance may be modified based on site conditions and justified in the Project Notification (see Section 3.4.2 of this PBO).
ii. Avoid contact with standing water and wet soil.
iii. Ensure pesticide-treated wood is free of residue, bleeding of preservative,

preservative-saturated sawdust, contaminated soil, or other pollutants.

iv. Use prefabrication whenever practicable to minimize onsite cutting, drilling, and field preservative treatment.

v. Do not discharge of sawdust, drill shavings, excess preservative and other debris into riparian or aquatic habitat.

8-5. For removal of treated wood over aquatic habitat supporting listed species, require that the Contractor develop a work containment plan (WCP) for the design and implementation of a work containment system (WCS) to avoid or minimize disturbance and potential release of construction debris, material, or other contaminants to riparian and aquatic habitat. Minimum design standards are:

i. Not constructed of treated timber, unless implemented as per Measures 8-2 and 8-3.

ii. Provides full containment of, and spill prevention for, hazardous liquids (already a requirement in ODOT Standard Specifications).

iii. As applicable, is fire retardant or resistant to fire from welding slag, torch operation, or any sparks from work.

iv. Able to withstand dead load, live load, and wind load.

1.3.9 Work Area Isolation

Work area isolation may be required for work conducted in water. Although the Contractor has the responsibility to determine which method or combination of methods best matches the project objectives, ODOT can require measures to avoid and minimize impacts to protected resources. ODOT's Standard Specifications limit the timing of work performed within Regulated Work Areas to only within the regulated in-water work periods, that are described in project Special Provisions (unless modified by Special Provision). Standard Specifications do not allow equipment to enter any waters of the State or U.S. or the Regulated Work Area except as allowed in permits issued for the Project (see Appendix B, Section 00290.34). ODOT has Special Provisions for temporary water management, water intake screens, and surface water diversion (currently in SP00245 and SP00290; ODOT 2015a), which are updated as needed to comply with current regulatory guidance.

ODOT will coordinate with the Contractor to schedule fish salvage by qualified biologists. Fish salvage normally takes place just prior to stream diversion. When water levels are too high, the diversion process takes place when water levels are low enough to permit proper salvage. Pumping or temporary gravity-fed piping are used to divert stream flow around the work area. Whenever pumping is used for conveying water, the system must be monitored on a continuous basis, and a fully operational backup pump must be available at the site at all times. The pump system is fitted with screens to exclude any fish, following NMFS guidelines (see Avoidance and Minimization Measure 1-9). Consequently, while pumping occurs, both up and downstream fish migration may be blocked. Contract specifications will not permit the stream to be de-watered below the project site at any point during the construction process. Gravity fed, bypass pipes may require excavation and temporary shoring.

ODOT commonly uses sandbag dams with stream diversion, coffer dams, and floating silt curtains for work area isolation (although other methods may be used). Culvert replacements and smaller bridge replacements (e.g., reinforced concrete box culvert [RCBC]) typically use sandbag dams and dewatering to completely isolate the in-stream work area during construction.

Stream flow is diverted during the ODFW defined in-water work period. Isolating the stream flow from the work area may reduce potential effects to water quality and limit the exposure of aquatic species to effects from in-channel operations. ODOT Standard Specifications require the Contractor to submit a dewatering plan to ODOT for review and approval.

Cofferdams are temporary barriers constructed to exclude water from an area that is normally submerged, such as a bridge pier. Usually, they are welded steel structures, with components consisting of sheet piles and cross braces. Fish salvage takes place within the isolated cofferdam, water is then pumped out or air is pumped into the space to displace the water and allow a semi-dry work environment below the surface. Work can take place inside a cofferdam outside of the normal in-water work period as long as the cofferdam is not overtopped or breached.

Floating silt curtains are barriers that help contain and control the suspended sediment and silt in waterbodies. They are used when water levels are too deep for complete work area isolation within a cofferdam, and often can be used for work at stream margins, such as bank stabilization and bridge bents demolition or construction. They also can be deployed downstream prior to flow reintroduction to reduce turbidity. When silt curtains are used as an alternative to a cofferdam, fish salvage typically will be attempted within the water body isolated by the silt curtain. Whenever possible, silt curtains will be deployed in a manner that excludes fish as they are moved from the bank to deeper water to reduce handling of fish and other aquatic species. Strong currents can limit their application.

<u>Avoidance and Minimization Measures:</u>
The following measures will be implemented for all projects performed under this PBO with in-water work in aquatic habitat supporting listed species, during design or in Contract Special Provisions:

9-1. Comply with in-water timing requirements during installation and removal of work area isolation (see Avoidance and Minimization Measure 1-3).

9-2. Ensure that fish and/or amphibian capture and removal is completed in work areas isolated from the active channel, except where infeasible in deep water situations or as recommended by the biologist.

i. Biologists with current ODFW fish & amphibian salvage permit must remove fish and aquatic life from the isolation work areas.
ii. Require that the Contractor allow fish biologists access into the isolation work areas as necessary.
iii. Any fish and/or amphibians trapped within the isolated work area must be captured and released using a trap, seine, electrofishing, or other methods as prudent to minimize the risk of injury, before being released at a safe release site.
iv. If electrofishing is used to capture fish, NMFS electrofishing guidelines must be followed (NMFS 2000).

9-3. Develop a Temporary Water Management Plan and require that the Contractor update the plan as necessary for their construction methods. The Plan must meet pollution and erosion control requirements in this PBO and include at least the following information:

i. The sequence and schedule for dewatering and re-watering.
ii. Methods to isolate the work area from the active stream flow.

iii. As applicable, methods to route and convey stream flow around or through the isolated work area.
iv. As applicable, methods to de-water the isolated work area.
v. As applicable, methods to pump and treat water before it is discharged downstream.
vi. Specifications for on-site backup materials and equipment.
vii. Calculations of water withdraw pumps capacity.

9-4. Operate temporary water management as follows:
i. Maintain a downstream water flow rate of at least 50 percent of the upstream water flow rate at all times.
ii. Provide safe passage around or through the isolated work area for adult and juvenile migratory fish unless passage did not previously exist.

9-5. If pumps are used:
i. Operate the pumps as needed up to 24 hours a day during the diversion to prevent de-watering of the stream downstream of the diversion.
ii. Monitor pumps continuously when in operation.
iii. Keep a backup pump on site, fueled, and immediately available in the event of failure of the primary pump and/or unexpected higher flows.
iv. As feasible, maintain a negative pressure inside the isolated work area to contain turbidity.
v. After completion of the work, if significant sediment has accumulated within the isolated work area, pump out the sediment and filter through existing vegetation.

9-6. Install, operate, and maintain all water intake screens including pumps used to isolate the in-water work area per Avoidance and Minimization Measure 1-8.

1.3.10 Clearing, Grubbing and Earthwork

Clearing and grubbing is performed to remove and dispose of vegetation and buried matter within the work area. Within excavation and embankment limits, contractors will remove tree stumps, roots, and other vegetation and dispose of this matter and debris on- or off- site by chipping, burying, or other proper methods of disposal. Standard Specifications limit vegetation clearing and grubbing to areas shown on plans or 10 feet from relevant highway features (see Appendix B, Section 00320). As needed to protect sensitive resources, project Plans and Special Provisions will designate avoidance within No Work Zones (see Section 2.2 of this PBO).

Earthwork consists of excavation, ditching, backfilling, embankment construction, grading, leveling, and other earth-moving work required in the construction of the project. Earthwork normally requires the use of mechanical equipment such as tracked excavators, backhoes, bulldozers, and grading equipment. ODOT Standard Specifications require that all earthwork conform to the lines, grades and cross sections established in contract plans. The plans will specify whether fill material is furnished by ODOT or if it is the responsibility of the Contractor.

<u>Avoidance and Minimization Measures:</u>
The following measures will be implemented for all projects performed under this PBO with clearing, grubbing, and earthwork, during design or in Contract Special Provisions (see Avoidance and Minimization Measure 1-9 to avoid and minimize impacts to listed

plants and butterfly habitat):

10-1. Minimize vegetation disturbance to the greatest extent practicable as follows:

i. Leave native materials where they are found when possible.
ii. Clip vegetation at ground level in areas to be cleared to retain root mass and encourage reestablishment of native vegetation.
iii. If use of large wood, native top soil, or native channel material is required for the site restoration per the Roadside Development Plans, stockpile all large wood, native vegetation, weed-free topsoil, and native channel material displaced by construction during site preparation.

1.3.11 Weed Removal

Manual and chemical control of noxious and invasive weeds is often required by construction specifications, prior to site grading, prior to landscaping, and during plant establishment and post-construction site maintenance. The purpose of weed control prior to site grading is to prevent the spread of weeds during construction. Mowing or manual removal is often the most effective method. Grubbing or herbicide treatment may be specified in temporarily disturbed areas. Re-growth of weeds may be treated with manual removal or herbicide.

<u>Avoidance and Minimization Measures:</u>
Weed control measures are provided in ODOT Standard Specifications. The following additional measures are based on the NMFS Biological Opinion with FHWA (NMFS 2011). These will be implemented on all projects performed under this PBA that may require weed control in (or within buffer distances listed below) habitats supporting listed aquatic species, during design or in Contract Special Provisions (alternative treatments may be approved on a case-by-case basis, as long as the effects are within scope of this programmatic, as approved by NMFS or USFWS, see Section 3.2 of this PBO).

11-1. Specify Weed Management Areas in project plans and special provisions.

11-2. Herbicide buffer distances. The following no-application buffers, which are measured in feet and are based on herbicide formula, stream type, and application method, will be observed during herbicide applications (Table 7). Herbicide applications based on a combination of approved herbicides will use the most conservative buffer for any herbicide included. Buffer widths are measured as map distance perpendicular to the bankfull elevation for streams, the upland boundary for wetlands, or the upper bank for roadside ditches. Before herbicide application begins, the upland boundary of each applicable herbicide buffer will be flagged or marked to ensure that all buffers are in place and functional during treatment.

11-3. Liquid or granular forms of herbicides must be applied as follows:

i. Broadcast spraying – handheld nozzles attached to backpack tanks or vehicles, or vehicle mounted booms.
ii. Spot spraying – handheld nozzles attached to backpack tanks or vehicles, hand-pumped spray, or squirt bottles to spray herbicide directly onto small patches or individual plants.
iii. Hand/selective – wicking and wiping, basal bark, fill (“hack and squirt”), stem

injection, cut-stump.

iv. Triclopyr – will not be applied by broadcast spraying.
v. Keep the spray nozzle within 4-feet of the ground; 6-feet for spot or patch spraying more than 15-feet from the high-water mark (HWM) if needed to treat tall vegetation.
vi. Apply spray in swaths parallel towards the project area, away from the creek and desirable vegetation, i.e., the person applying the spray will generally have their back to the creek or other sensitive resource.
vii. Avoid unnecessary run off during cut surface, basal bark, and hack-squirt/injection applications.

11-4. Minimization of herbicide drift and leaching. Herbicide drift and leaching will be minimized as follows:

i. Do not spray when wind speeds exceed 10 miles per hour or are less than 2 miles per hour.
ii. Be aware of wind directions and potential for herbicides to affect aquatic habitat area downwind.
iii. Keep boom or spray as low as possible to reduce wind effects.
iv. Increase spray droplet size whenever possible by decreasing spray pressure, using high flow rate nozzles, using water diluents instead of oil, and adding thickening agents.
v. Do not apply herbicides during temperature inversions, or when ground temperatures exceed 80 degrees Fahrenheit.
vi. Wind and other weather data will be monitored and reported for all broadcast applications.
vii. Herbicides shall not be applied when the soil is saturated or when a precipitation event likely to produce direct runoff to salmon bearing waters from the treated area is forecasted by the NOAA National Weather Service or other similar forecasting service within 48 hours following application. Soil-activated herbicides can be applied as long as the label is followed
viii. Herbicides can be applied as long as label is followed. Do not conduct hack-squirt/injection applications during periods of heavy rainfall.
ix. Washing spray tanks. Spray tanks shall be washed 300-feet or more away from any surface water.

11-5. The only herbicides allowed under this PBO are (some common trade names are shown in parentheses):

i. aquatic imazapyr (e.g., Habitat)
ii. aquatic glyphosate (e.g., AquaMaster, AquaPro, Rodeo)
iii. aquatic triclopyr-TEA (e.g., Renovate 3)
iv. chlorsulfuron (e.g., Telar, Glean, Corsair)
v. clopyralid (e.g., Transline)
vi. imazapic (e.g., Plateau)
vii. imazapyr (e.g., Arsenal, Chopper)
viii. metsulfuron-methyl (e.g., Escort)
ix. picloram (e.g., Tordon)
x. sethoxydim (e.g., Poast, Vantage)

xi. sulfometuron-methyl (e.g., Oust, Oust XP)

11-6. The only adjuvants allowed under this PBO are shown on Table 8. Do not use polyethoxylated tallow amine (POEA) surfactant and herbicides that contain POEA (e.g., Roundup or Roundup Pro).

11-7. Limit herbicide carriers (solvents) to water or specifically labeled vegetable oil.

11-8. Apply herbicides at the lowest effective label rates, including the typical and maximum rates given below (Table 9). For broadcast spraying, do not exceed the typical label rates for application of herbicides or surfactant.

11-9. Herbicide application from locations with listed plants or butterfly habitat or designated No Work Zones. However, spot spraying may be permitted at times when protected resources are dormant/inactive, and directly coordinated with the ODOT biologist[9] or USFWS.

11-10. Herbicide transportation and safety plan. The applicator will prepare and carry out an herbicide safety/spill response plan to reduce the likelihood of spills or misapplication, to take remedial actions in the event of spills, and to fully report the event.

11-11. Spill cleanup kit. A spill cleanup kit will be available whenever herbicides are used, transported, or stored. At a minimum, cleanup kits will include, Material Safety Data Sheets, the herbicide label, emergency phone numbers, and absorbent material such as cat litter to contain spills.

11-12. Herbicide applicator qualifications. Herbicides will be applied only by an appropriately licensed applicator using an herbicide specifically targeted for a particular plant species that will cause the least impact.

11-13. Dyes. A non-hazardous indicator dye (*e.g.*, Hi-Light or Dynamark) is required to be used with herbicides within 100-feet of live water. The presence of dye makes it easier to see where the herbicide has been applied and where or whether it has dripped, spilled, or leaked. Dye also makes it easier to detect missed spots, avoid spraying a plant or area more than once, and minimize over-spraying (SERA 2017)

11-14 Herbicide will not be used within 100-feet of designated Oregon spotted frog critical habitat

[9] See footnote 11, Section 2.2.

Table 5. Herbicide application buffer distances, based on herbicide formula, stream type, and application method.

Herbicide Active Ingredient	Buffer Distance (in feet)					
	Perennial Streams, Wetlands, or Intermittent Streams and Roadside Ditches with flowing or standing water			Dry Intermittent Streams and Wetlands, Dry Roadside Ditches		
	Broadcast Spraying	Spot Spraying	Hand Selective	Broadcast Spraying	Spot Spraying	Hand Selective
Labeled for Aquatic Use						
Aquatic Glyphosate	100	waterline	waterline	50	none	none
Aquatic Imazapyr	100	15	waterline	50	none	none
Aquatic Triclopyr-TEA	**Not Allowed**	15	waterline	**Not Allowed**	none	none
Low Risk to Aquatic Organisms						
Imazapic	100	15	OHWE	50	None	none
Clopyralid	100	15	OHWE	50	None	none
Metsulfuron-Methyl	100	15	OHWE	50	None	none
Moderate Risk To Aquatic Organisms						
Imazapyr	100	50	OHWE	50	15	OHWE
Sulfometuron-Methyl	100	50	5	50	15	OHWE
Chlorsulfuron	100	50	OHWE	50	15	OHWE
High Risk To Aquatic Organisms						
Picloram	100	50	50	100	50	50
Sethoxydim	100	50	50	100	50	50

Table 6. Herbicide adjuvants, trade names, mixing rates, and application rates.

Adjuvant Type	Trade Name	Mixing Rate [10]	Application Areas
Surfactants	Activator 90	0.16 - 0.64	Upland
	Agri-Dee	0.16 - 0.48	Riparian
	Hasten	0.16 - 0.48	Riparian
	LI 700	0.16 - 0.48	Riparian
	R 11	0.16 - 1.28	Riparian
	Super Spread MSO®	0.16 - 0.32	Riparian
	Syl-Tae	0.16 - 0.48	Upland
Drift Retardants	41-A	0.03 - 0.06	Riparian
	Vale	0.16	Upland

[10] Fluid ounces adjuvant per gallon of herbicide.

Table 7. Typical and maximum rates for herbicide applications.

Herbicide	Typical Rate11	Maximum Rate
Imazapic	0.1	0.1875
Clopyralid	0.35	0.5
Metsulfuron-methyl	0.03	0.15
Imazapyr	0.45	1.5
Sulfometuron-methyl	0.045	0.38
Chlorsulfuron	0.056	0.25
Triclopyr	1.0	10.0
Picloram	0.35	1.0
Sethoxydim	0.3	0.45
Glyphosate	2.0	8.0

1.3.12 Tree and Down Wood Removal

Removal of trees and down wood (also referred to as logs, large woody material or large woody debris) may be part of clearing and grubbing operations. ODOT's Standard Specifications require that the Contractor remove vegetation and debris within the project footprint, including removal of sod, weeds, dead vegetation, down timber, brush, other vegetation, sticks and branches with diameters greater than 1/2 inch, stumps, and specified trimmings (see Appendix B, Section 00320). Trees and down wood are valuable to most terrestrial and aquatic species, as a vital resource for many species' life cycles, for air and water quality, stream temperature control, and maintaining natural water cycles. If vegetation and debris, including trees or down wood are to be preserved, it must be specified in Contract Plans and Special Provisions.

Avoidance and Minimization Measures:
The following measures will be implemented for all projects performed under this PBO that involve tree and down wood removal in the habitat areas specified below, during design or in Contract Special Provisions:

12-1. When feasible, plan and design to avoid removal of native coniferous trees[12] and down wood from habitat areas described in Measures 12-2 and 12-3.

12-2. For projects that have tree/timber removal within the riparian zone of listed aquatic species, ensure that:

i. Native coniferous trees or wood greater than 18 inches diameter at breast height (DBH) are salvaged and used for aquatic habitat enhancement (small, localized and opportunistic enhancement) when applicable and feasible.[13] Coordinate with a USFWS or ODOT hydraulic engineer for appropriate size requirements of trees salvaged for aquatic habitat.
ii. Replace the functional equivalent (see Glossary, Appendix A) of the number and sizes

---

[11] Typical and maximum rates are in pounds of active ingredient per acre.

[12] A native tree is indigenous to Oregon and provides necessary functions for listed species, including watershed functions for listed fish or foraging habitat for listed birds.

[13] Salvage of trees or down timber is considered feasible when suitable on-site uses are available and part of project plans (e.g., bank stabilization, waterway enhancements, site restoration, roadside development), or when off-site storage is readily available and salvaged materials have been designated for specific uses either by Agency or others. If use is by others, ODOT will be responsible for transportation costs up to 60 miles from the project.

of trees or down wood either on-site when property is available, or off-site when suitable protected lands are available (see Section 2.3.25 of this PBO).

12-3. When mature trees (generally greater than 18 inches DBH) are removed from suitable nesting habitat for marbled murrelet or nesting/roosting/foraging habitat for spotted owl, ODOT will ensure that similar or higher quality habitat will be permanently conserved as part ODOTs existing 65.66 acre Walker Creek spotted owl and murrelet conservation back near Jewel, Oregon, established in 2017. ODOT is actively considering another mitigation site in the Oregon Coast Range or Southwest Oregon. Generally, the standard will be conserving three times the area of suitable habitat removed, although alternatives may be proposed/negotiated with USFWS (see Section 3.2 of this PBO).

1.3.13 Blasting

Blasting may be necessary to remove bedrock. ODOT may identify the need for blasting by conducting exploratory drilling during project development. It is also possible that rock is encountered when in construction. The Contractor is required to develop a Blasting Plan for ODOT review and approval. The avoidance and minimization measures are focused on reducing disturbance effects to spotted owl and marbled murrelet and hydroacoustic and habitat (from blast material) effects to aquatic species.

<u>Avoidance and Minimization Measures:</u>
The following measures will be implemented for all projects performed under this PBA that may involve blasting work, during design or in Contract Special Provisions:

13-1. Blasting is not allowed in or directly adjacent (within 300 feet) to aquatic habitat supporting listed species below the OHWE. If this would be necessary ODOT would do an individual consultation with the Service.

13-2. The following seasonal noise restrictions are required if occupied or suitable unsurveyed nesting habitat for marbled murrelet or spotted owl occurs within 1 mile of the blasting activities:

iii For marbled murrelet habitat: Do not blast from April 1 to September 15th.

iv For spotted owl: Do not blast during the following critical nesting periods:

- March 1 to July 7 for the Oregon Coast Range.
- March 1 to June 30 for the Oregon Klamath Province.
- March 1 to July 15 for the Western Oregon Cascades.
- March 1 to July 15 for the Willamette Valley.
- March 1 to September 30 for the Eastern Oregon Cascades and unlisted areas.

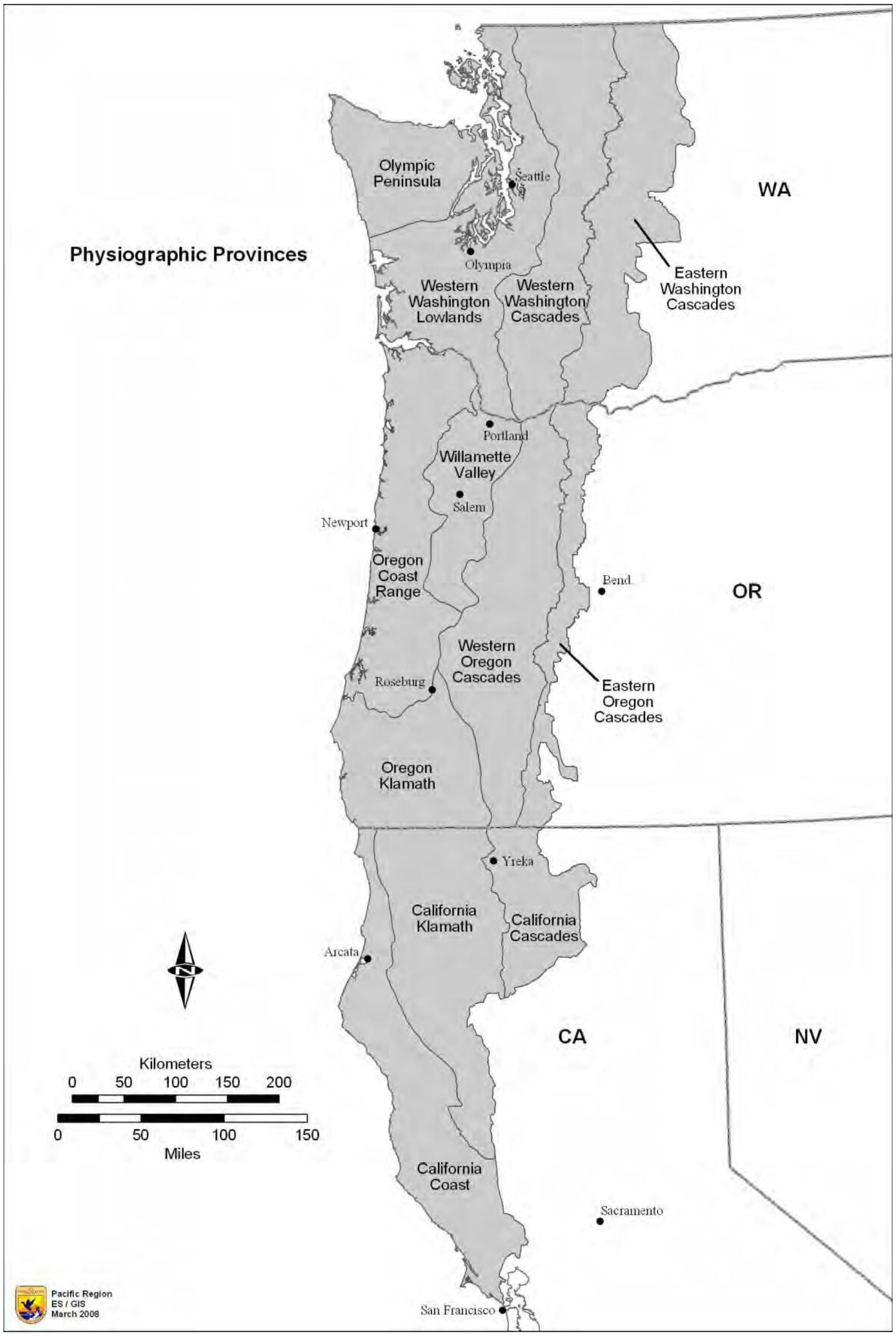

Figure 2. Physiographic provinces within the range of the spotted owl in the United States. (USFWS 2011).

1.3.14 Slope Stabilization and Drainage

This activity includes various forms of rock slope stabilization and reinforcement, typically involved in rockfall/slide mitigation work to stabilize or prevent slopes above roadways from eroding and harming drivers and pedestrians. ODOT will design the stabilization as needed to meet site conditions based on geotechnical investigations. Slope drainage (also referred to as dewatering) is often a component of slope stabilization, and drainage systems will be designed to meet site conditions.

Avoidance and Minimization Measure:
No new Avoidance and Minimization Measures are proposed for this activity. Appropriate sediment and erosion controls will be designed and implemented, including dewatering drainage systems, to meet ODOT Standard Specifications and Special Provisions, Sections 00280 and 00290 (ODOT, 2015b), and applicable NPDES and local permits.

1.3.15 Streambank Stabilization and Scour Protection

ODOT conducts bank stabilization and scour protection of roadbeds located along streambanks, stormwater outfalls, bridge abutments, or the ends of culverts. Riprap or rock armoring is not preferred but is necessary when water velocities or safety considerations prevent the use of natural vegetation or seeding. Common types of riprap may include filter blankets, backing, loose, keyed-in or grouted-in materials. Riprap is the most common method for stream bank stabilization at bridge end bents and culvert ends to prevent scour damage, or for repairing streambank scour as needed to protect the roadway. Retaining walls provide another form of streambank protection. These are typically formed concrete and/or mechanically stabilized earth.

Streambank stabilization also may be achieved with “bioengineering” techniques that utilize live vegetation material to provide stability. This method is preferred due to the habitat benefits that it can provide. Additionally, habitat elements, such as root wads and logs, may be incorporated into streambank protection designs (see Channel Modification and Waterway Enhancements, Section 2.3.25 of this PBO).

Avoidance and Minimization Measures:
The following measures will be implemented for all projects performed under this PBO that involve streambank stabilization in aquatic habitat supporting listed species, either during design or in Contract Special Provisions:

15-1. Except as designed to replace existing quantity/location of hard armoring, any uses of hard armoring below OHWE (listed habitat areas) requires approval from USFWS and documentation in the Project Notification (see Sections 3.2 and 3.4.2). The Notification must include design justification, as well as type, size, quantity, location, and description of relevant Avoidance and Minimization Measures. These areas are required to be vegetated and are very uncommon.

15-2. Design the amount of hard armoring to the minimum necessary to protect the integrity of a structure from erosion or scour.

15-3. Whenever practicable, incorporate the following types of natural material into stream bank stabilization or scour protection designs:
i. Vegetated riprap with large wood.
ii. Partially spanning porous weir.
iii. Woody plantings.
iv. Herbaceous cover, in areas where the native vegetation does not include trees or shrubs; bank reshaping and slope grading.
v. Coir logs.
vi. Deformable soil reinforcement.

vii. Engineered log jams.
viii. Floodplain flow spreaders.
ix. Floodplain roughness.

15-4. Design and install with-in the In-Water Work Period (IWWW) vegetated riprap with large wood meeting the following minimum standards:

i. When practicable, use natural hard points, such as large, stable trees or rock outcrops, to begin or end the toe of the revetment.
ii. Develop an irregular toe and bank line to increase roughness and habitat value.
iii. Place larger sizes of rock at the toe of the slope and smaller sizes higher in the bank where the shear stress is generally lower.
iv. Except where bridge cover would shade out plant growth, incorporate soil and plantings above critical scour elevations to provide a better growing medium for plants. To facilitate and improve success, install soil and plantings during construction of riprap slopes.
v. To improve plant growth, avoid using geotextile fabrics as filter behind the riprap whenever practicable.
vi. Include large wood as an integral component to create roughness, pools and cover whenever practicable (see Channel Modification and Waterway Enhancements, Section 2.3.25 of this PBO).
vii. Terrace slopes wherever practicable.

15-5. Visually inspect natural bank stabilization and vegetated riprap each year following installation during the monitoring period (see Administration, Section 3.4.5 of this PBO), during low flows, to examine transitions between undisturbed and treated banks to ensure that native soils above and behind the riprap are not collapsing, sinking, or showing other evidence of piping loss or movement of rock materials. To access the overall integrity of the riprap treatment, evaluate the following:

i. Loss of rock materials.
ii. Survival rate of vegetation (see Section 2.3.24 of this PBO).
iii. Anchoring success of large woody debris placed in the treatment.
iv. Any channel changes since construction.

15-6. If hard armoring is required (very rare occurrence) below the OHWE (which exceeds replacement of existing armoring) that does not incorporate natural material (per Measure 15-3) or vegetated riprap (per Measure 15-4), replace the functional equivalent of the area of new hard armoring (excluding that which replaces existing quantity/location) on-site when property is available, or off-site when suitable protected lands are available. Generally, the standard is removal of the same quantity of hard armoring in the same subbasin, although alternatives may be proposed/negotiated with USFWS, depending on species (see Section 3.2 of this PBO).

1.3.16 Culvert and Bridge Removal

Culvert removal and bridge demolition typically require in-water work and are timed during the in-water work period. Some bridge demolition activities, such as decking and superstructure removal occur out of the channel and can be conducted year round. Although ODOT cannot prescribe the exact methods for structure demolition and removal, Contract Special Provisions will be developed to minimize impacts to protected resources. Standard Specifications require that the Contractor properly recycle and dispose of waste materials while preventing construction debris or pollutants from entering any waters of the State or the U.S. (see Appendix B, Section 00290.20[c-3]).

For culvert removal, a crane, large excavator, or similar equipment is typically used to remove a culvert in one piece or in sections. It may be necessary to break up the concrete or sawcut it to lift it out. Concrete, if present, would be broken up using a concrete saw, jack hammers, or a stinger on a backhoe.

For bridge demolition, work sequencing depends on whether the new bridge is being constructed on the existing or different alignment. Bridges are often cut with a wire saw or broken into pieces with a hydraulic hoe ram and the pieces removed with a crane. A demolition platform is often constructed under the existing bridge prior to its removal and may be required by special provisions when needed to prevent debris and/or containments from entering the stream or floodway. If the waterway is large enough, barges may be used to transport bridge sections. Containment systems are extremely diverse, depending on site conditions and project scope, and may be comprised of work platforms, retaining walls, or coffer dams. In sensitive areas, ODOT can direct the Contractor to develop and install a project-specific Containment Work System and prepare and submit a Containment Work Plan following specified design constraints (see Avoidance and Minimization Measures, below). ODOT has review/approval authority over the Contractor's design and methods.

Concrete bridge decks may be sawed into pieces and lifted out of the work area via a crane parked on the road surface. Once the bridge deck is gone, the girders, truss and bents are then dismantled either by sawing or breaking them down into pieces.

> Avoidance and Minimization Measures:
> The following measures will be implemented for all projects performed under this PBO with removal of bridges, culverts, piles or associated facilities in/over aquatic habitat supporting listed species, during design or in Contract Special Provisions:
>
> 16-1. For culvert and bridge removal and repair activities in or over aquatic habitat supporting listed species, ODOT requires that the Contractor develop a Work Containment Plan for a Work Containment System, as per Avoidance and Minimization Measure 8-5. For example, a second hard surface work platform beneath the existing bridge deck to contain concrete cutting during bridge deck demolition.

1.3.17 Bridge Repair and Rehabilitation

Bridge repair may range from replacing damaged components like bridge rails, to repainting or seismic retrofits. Bridge preservation and rehabilitation projects generally include the types of activities listed below. Appendix C provides a more detailed description of each of these activities.

- Preparation and Coating of Steel and Reinforced Concrete Bridge Components
- Concrete Patching
- Cathodic Protection
- Pack Rust Removal on Steel Bridges

- Cap Replacement, Crossbeam Repairs, Replacement of Timber Components, and External Post-Tensioning
- Structural Steel Repairs
- Installation, Upgrading, and Removal of Access Hardware
- Mechanical, Electrical, and Architectural Rehabilitation
- Historic Rail Retrofit
- Deck Replacement
- Pavement Removal and/or Resurfacing, Concrete Sealer Application, Bridge Deck Overlays, and Bridge Deck Concrete Repairs up to Full Depth
- Fiber-reinforced Polymer Strengthening and Crack Injection
- Seismic Retrofit, Bearing Retrofit, and Bridge Deck Joint Repair/Retrofit
- Bridge Lane Widening
- Vertical Clearance Improvement

The purpose of bridge preservation/rehabilitation projects is to extend the useful life of existing bridges.

Depending on the scope of the bridge repair or rehabilitation, containment may be necessary. Standard Specifications Section 00253 describes different types of containment required for field painting and coating activities often associated with bridge repair and rehabilitation (see Appendix C).

Avoidance and Minimization Measures:
No distinct Avoidance and Minimization Measures are proposed for this activity. Refer to related Avoidance and Minimization Measures, including Sections 2.3.1 (General Construction), 2.3.4 through 9 (Mobilization, Staging and Disposal through Work Area Isolation), 2.3.15 (Streambank and Scour Protection), 2.3.16 (Culvert and Bridge Removal), and 2.3.21 (Painting and Coating).

1.3.18 Bridge Construction

Bridge construction can include many construction activities that were previously described and can take multiple construction seasons. The length of the bridge is typically a compromise between cost and accommodating landscape feature below the bridge. Longer bridges not only require longer superstructures, but typically they require more foundation work.
Bridge design varies considerably depending on site conditions. However, many bridges have cast-in-place concrete decks, supported by pre-cast concrete beams and/or steel truss and girders that are fabricated on-site. When constructed on-site, concrete forms are constructed, reinforcing steel is placed and concrete is poured. After the deck is cured, cast-in-place concrete curbs are typically constructed on each side of the bridge. Bridge rails may be steel or concrete, either prefabricated barriers or cast-in place, and the components and design vary considerably depending on site conditions and other requirements (e.g., local codes and scenic requirements).

Foundations (i.e., end bents, piers, piling) may be drilled shafts, concrete spread footings, or driven steel or wood piles. Drilled shafts are reinforced concrete sections, cast-in-place against in situ soil, rock, or a casing. Concrete spread footings may be necessary when drilled shafts or pile driving are not feasible such as when there is shallow bedrock. ODOT Standard Specifications require that concrete work be performed under dry conditions to ensure that uncured or green concrete does not enter a stream. Dewatering, containment, and stream diversion may be necessary (see Work Area Isolation, Section 2.3.9 of this PBO). The removal of old abutments, piers, and pilings, and pile driving are separated from other bridge installation activities due to the effects to aquatic species (see Culvert and Bridge Removal, Section 2.3.16 and Pile Removal and Pile Driving, Section 2.3.19). Infrequently, bridge replacement may involve relocating agency-owned utilities. To minimize aquatic impacts, hanging utilities on structure is prioritized (see Avoidance and Minimization Measure 18.7 of this PBO).

Bridge replacements typically require some kind of temporary bridge, either as a containment and work platform, or for staged construction and traffic detours. The design for a temporary bridge depends on the scope of its intended use and load bearing capacity. When project team determines that the scope of a temporary structure merits up-front design/bid items, ODOT will design and specify temporary work or detour bridges. Contractors sometimes utilize the same temporary bridge for containment of demolition material as well as construction access. ODOT has boiler plate special provisions for the construction of temporary work bridges, which may be updated as needed to comply with current regulatory guidance.

<u>Avoidance and Minimization Measures</u>:

The following measures will be implemented for all projects performed under this PBO that have new and replacement bridges and cross streams with listed aquatic species, either during design or in Contract Special Provisions. These measures may be modified as long as project meets Program Goals as per Section 1.5; modifications require USFWS approval, (see Section 3.2 of this PBO).

18-1. For existing roads, only new crossings in a new location where a crossing currently does not exist that reconnect stream channels with floodplains and do not represent part of a new road network are covered by this PBO (see Section 2.3.25 of this PBO).

18-2. For any replacement of a permanent stream crossing ODOT will discuss with the Services as to how the bridge will not impair the physical and biological processes associated with a fully functional floodplain, and will restore any physical or biological process that was degraded by the previous crossing (see Section 3.4.2 of this PBO).

18-3. Design stream crossings to maintain or restore floodplain function by meeting the following conditions:

i. Maintain a clear unobstructed opening above the general scour prism; streambank and channel stabilization may be applied below the general scour elevation.
ii. For a single span structure, including culverts, the necessary opening is presumed to be 1.5 times the active channel width, or wider.
iii. For a multiple span structure, the necessary opening is presumed to be 2.2 times the active channel width, or wider, except for piers or interior bents.
iv. Install relief conduits, as necessary, within existing road fill at potential flood flow pathways based on analysis of flow patterns or floodplain topography.
v. Remove all other artificial constrictions within the functional floodplain that are not otherwise a component of the final design:
    - Remove vacant bridge supports to 3 feet below substrate unless the vacant support is part of the rehabilitated or replacement stream crossing.
    - If a bridge support is in contaminated sediment, cut off the support off at the

sediment line.

- Remove existing roadway fill, embankment fill, approach fill, or other fill.
- Reshape exposed floodplains and streambanks to match upstream and downstream conditions.

18-5. If a replacement or new bridge cannot provide basic goals of a functional floodplain, offset the functional equivalent (e.g. remnant of a legacy structure abandoned in place) of the area of floodplain fill, either on-site when property is available, or off-site when suitable protected lands are available. Generally, the standard is removal of the same quantity of floodplain fill in the same subbasin, although alternatives may be proposed/negotiated with USFWS (see Section 3.2).
18-6. Remove temporary bridges or trestles when no longer needed, obliterate the route, and restore the soils and vegetation (see Avoidance and Minimization Measures in Section 2.3.24).

The following measures will be implemented for all projects performed under this PBO that construct agency owned utility lines in or above streams with listed aquatic species, during design or in Contract Special Provisions.

18-7. Agency owned utility lines

a. Design utility lines and stream crossings in the following priority:
   i Aerial lines, including lines hung from existing bridges.
   ii Directional drilling, boring and jacking that spans the channel migration zone and any associated wetland.
   iii Trenching – this method is restricted to intermittent streams and may only be used when the stream is naturally dry, all trenches must be backfilled below the ordinary high water line with native material and capped with clean gravel suitable for fish use in the project area.
   iv Plowing – this method is used to install submarine cables in estuarine (mudflat) environments.
b. Align each crossing as perpendicular to the watercourse as possible, and for drilled, bored or jacked crossings; ensure that the line is below the total scour prism.
c. Any large wood displaced by trenching or plowing must be returned as nearly as possible to its original position, or otherwise arranged to restore habitat functions.
d. Avoid impacts to eelgrass beds when locating submarine cable.

1.3.19 Pile Removal and Pile Driving

Driven piles are often used to support temporary structures such as detour bridges and work bridges. They may also be used to provide additional support to permanent spread footings (see Section 2.3.18). The size and type of piles depends on site conditions, substrate, and load generated by the bridge and expected introduced load from traffic, and other design considerations. The best placement of piles sometimes requires exploratory pile driving. For replacement bridges, old piles are typically removed during other bridge demolition activities

Pile driving may be accomplished by vibratory or impact hammer (air steam, open-end diesel, closed-end diesel, gravity, or hydraulic hammers), supported on the temporary work bridge or land. Typically, harder substrates require the use of impact hammers, and bearing capacity can only be determined with impact hammers. Pile driving equipment must be approved by ODOT. Additional work components for steel pile driving include pile cushions to protect the heads of concrete piles, metal helmets to protect impact hammers, hammer cushions to prevent damage to the hammers or piles (ODOT Standard Specifications disallow the use of wood, wire rope, or asbestos hammer cushions), a follower to transmit energy, and leads to support the piles in line. In some cases, piles are installed by pre-drilling and setting the piles.

Permanent steel piles may be epoxy-coated to provide corrosion protection and have a cast-in-place concrete pile cap or an outer sealant to prevent coal/tar from leaching into aquatic habitats. After the piles are driven, concrete pile caps are typically formed, reinforced steel placed, and the concrete poured.

ODOT Standard Specifications require that concrete work be performed under dry conditions (uncured or green concrete is not allowed to enter a stream). Dewatering, containment, and stream diversion may be necessary (see Section 2.3.9).

<u>Avoidance and Minimization Measures:</u>
The following measures will be implemented for all projects performed under this PBA that involve removal or installation of bridge piles below the bankfull elevation (see Glossary, Appendix A) of streams with protected aquatic species, either during design or in Contract Special Provisions:

19-1. During removal of bridge piles below the OHWE, in addition to standard pollution and erosion control measures (see Section 2.3.5) implement the following measures to minimize creosote release, sediment disturbance and total suspended solids:

i. Install floating surface booms or other measures to capture floating surface debris.
ii. Utilize methods to dislodge piles that minimize sediment disturbance.
iii. Fill the holes left by each removed pile with clean, native sediments immediately upon removal.
iv. For broken or intractable piling:
    - Do not excavate broken or intractable piles.
    - If a pile in uncontaminated sediment is intractable or breaks above or below the water surface, when feasible, cut off the pile or stump at least three feet below the surface of the sediment; cap with clean, native substrates that match surrounding streambed materials.
    - If a pile in contaminated sediment is intractable or breaks above the surface, when feasible, cut off the pile or stump at the sediment line.
        - If a pile breaks below the surface in contaminated sediment, make no further effort to remove it and cover the hole with a cap of clean substrate appropriate for the site.
    - If dredging is likely where broken piles are buried, use a GPS device to record the location of all broken piles for future use in site debris characterization.

19-2. Implement the following hydro-acoustic impact minimization measures for pile driving below bank full elevation. These may be modified as long as project meets Program Goals as per Section 1.5; modifications require USFWS approval (see Section 3.2).

i. Design or specify pile made of untreated wood, concrete, H-pile 24 inches or smaller, steel round pile 24 inches in diameter or smaller, and numbers of driven piles are minimized.

ii. When practicable, use drilled shafts or a vibratory hammer for installing piles (i.e., avoid or minimize impact pile driving).

iii. When using an impact hammer to drive or proof steel piles, one of the following sound attenuation methods must be used to effectively dampen sound.

1. Completely isolate the pile from flowing water by dewatering the area around the pile.

2. If water velocity is 1.6 fps or less surround the pile being driven with a bubble curtain, that curtain must distribute small air bubbles around 100% of the pile perimeter for the full depth of the water column.

3. If water velocity is greater than 1.6 fps, surround the pile being driven by a <u>confined</u> bubble curtain that must distribute air bubbles around 100% of the pile perimeter for the full depth of the water column.

iv. Only allow pile driving with an impact hammer between one hour after sunrise and one hour before sunset, regardless of the material type. This is to ensure that pile driving does not occur at dawn or dusk, the peak movement period for juvenile and adult ESA-listed fish.

v. In the event of an observance of any dead, injured, or distressed fish (bull trout), collect the specimens if possible and immediately notify USFWS.

1.3.20 Culvert Extension, Repair and Installation

Culverts convey flowing water underneath the roadway. ODOT must design replacement culverts in fish bearing streams to meet ODFW and NMFS fish passage standards (ODFW 2011). To meet these standards, culverts are typically countersunk below the overall longitudinal flowline profile and backfilled with a rock substrate mix to provide a simulated streambed throughout the culvert. The rock substrate mix may be imported, or suitable in-situ material may be obtained from construction excavation, and range from very large, angular boulders to fine sands and silts. Larger boulders help hold the reconstructed channel in place during the design flood, preventing channel head cutting and formation of new fish passage barriers. Finer materials may be specified to help fill interstitial spaces between the larger rocks, keeping the stream from flowing subsurface and this substrate material may be field blended with high pressure water to simulate “water compaction”.

Culverts and drainpipes may be lined as opposed to replaced when trenching and replacing the pipe are cost prohibitive. Pipe lining work typically takes less time than more invasive types of culvert replacement work. Pipe lining consists of rehabilitating existing pipes by furnishing and installing pipe liners by pipe bursting and lining, slip lining, or cured-in-place lining. Resin is typically used for the rehabilitation process, as well as general purpose or enhanced strength unsaturated, thermosetting, polyester, vinylester, or epoxy resin and a catalyst system compatible with the installation process. Prior to lining operations, the pipe is flushed and cleaned to remove all debris and obstructions. Cleaning methods may include washing with high-pressure water, mechanical removal, sandblasting of the walls, entry with hand tools, or other methods as approved by ODOT.

Avoidance and Minimization Measures:
The following measures will be implemented for all projects performed under this PBO with culverts or drainpipes installed or repaired in streams with protected aquatic species, during design or in Contract Special Provisions:

20-1. Ensure structures meet stormwater management standards (Section 2.3.26).

20-2. ODOT will ensure that fish passage, work area isolation and containment are implemented as needed to protect aquatic and riparian habitat during culvert replacement and repair activities.

1.3.21 Painting and Coating

Several highway components require painting and coatings for protection from the elements, and for aesthetics. Most projects entail removing old/deteriorated paint, coating, or markings, and replacing them with newer materials. Components subject to repainting or recoating will be cleaned of all existing coating and corrosion down to clean, bare steel, typically by sand blasting or high-pressure water jetting.

Painting and coating activities may occur off-site at a factory, at Contractor's offices, in staging areas, or in-place. Powder coating involves preparing and powder coating new and existing metal structures and features, including steel, galvanized, aluminum, and other specified surfaces. ODOT's Standard Specifications (Section 00594.05) (ODOT 2015b) have detailed containment requirements for field preparation and painting/coating, and hazardous waste pollution control. Re-coating materials can not contain lead.

Waste material becomes the property of the Contractor at the point of origin. This includes all grindings and all removed marking material. Disposal must follow standard pollution control measures (see Appendix B, Section 00290.20).

Avoidance and Minimization Measures:
The following measures will be implemented for all projects performed under this PBA with painting and coating, or similar types of chemical applications, near habitat supporting listed aquatic species, during design or in Contract Special Provisions:

21-1. Whenever practicable, ensure that painting, coating or other similar chemical applications are conducted at an approved off-site facility or within a designated staging area (see Section 2.3.4).

21-2. Ensure that work area isolation and containment is implemented, as needed to protect aquatic and riparian habitat during painting, coating, or other activities that may have similar water quality effects.

1.3.22 Asphalt and Concrete Paving

Typical paving construction activities include: (1) grind/inlay of various existing asphalt; (2) construction or reconstruction of new and existing subgrade (the in-situ material underneath a constructed roadbed) and shoulders; (3) reconstruction interchanges; and (4) installation of precast and cast-in-place concrete features. Paving projects may be preservation of the existing roadway without any upgrades or may entail safety improvements to correct steep slopes or roadway grades (e.g., due to subsidence, pull-outs, drainage, stream bank scour, or guardrail end treatments). Even with strict preservation projects, guardrail, culverts or drainage systems are often replaced. Shoulder widening may take place as needed to improve safety and to provide anchoring support needed for guardrail, especially in areas with steep irrecoverable slopes and unprotected culvert ends. Additional lanes may be added to Intersection or Safety projects such as the addition of turning or passing lanes or chain-up areas, or to Modernization projects when improved traffic flow is needed.

Avoidance and Minimization Measures:
No distinct Avoidance and Minimization Measures are proposed for this activity. Refer to related Avoidance and Minimization Measures, including Sections 2.3.1 (General Construction), through 2.3.5 (Erosion, Sedimentation and Pollution Control).

1.3.23 Other Permanent Roadway Structures

Transportation facilities involve many permanent roadway structures not described in other sections of this PBA. These may include, but are not limited to (per ODOT Standard Specifications (ODOT 20015); retaining and sound walls (Sections 00596-00597), various forms of safety barriers (cable barrier, bollards, concrete barrier, impact attenuators; Section 00800), various forms of signs (Sections 00905-00941), fences (Section 01050), electrical systems (Section 00950-00965), roadway illumination (Section 00970), signals (Section 00990), and irrigation systems (Section 01100). These seemingly disparate activities are grouped in this section because each may involve ground disturbing work. The majority of this work is within upland habitat beyond the road shoulder or median. The work may involve clearing, grubbing and earthwork (see Section 2.3.10) and possibly trenching similar to that described under Culvert Extension, Repair and Installation (see Section 2.3.20).

Avoidance and Minimization Measures:
The following measures will be implemented for all projects performed under this PBO that have other permanent roadway structures in areas described below, either during design or in Contract Special Provisions:

23-1. If any listed plants or habitat for Fender’s blue butterfly (see Covered Species, Section 1.4) occur within the construction footprint of these permanent roadway features (based on pre-construction surveys as per Section 2.2), design the project to avoid damaging plants or removing habitat. See Avoidance and Minimization Measure 1-9 if avoidance is not feasible.

23-2. If night lighting is added to bridges over streams with listed fish or anywhere within 300 feet of suitable nesting habitat for spotted owl or marbled murrelet (this distance may be modified based on site conditions and justified in the Project Notification, see Section 3.4.2):

i. Design permanent lighting such that it is directed on the roadway facilities, not into habitat areas; and
ii. Include contract specifications that restrict use of temporary construction lighting directed into habitat areas.

1.3.24 Site Restoration and Enhancement Plantings

Standard specifications require seeding for temporary and permanent erosion control (see Appendix B, Section 00280). The Contractor must temporarily stabilize exposed soils every 14 days or more frequently if needed or directed by ODOT. Permanent seeding must be completed within certain time frames depending on geographic and climatic conditions. ODOT will provide a seed mix and fertilizer requirements in project Special Provisions. Application methods may entail direct seeding (by hand, drill, blower or spreader) or hydroseeding (with or without hydromulch and tackifier). Special Provisions may specify the method. Unlike woody plantings, seeding requires an establishment period to meet soil coverage requirements.

Woody plantings will be a design feature, included in Roadside Development Plans. Standard Specifications describe approved methods and acceptance criteria for plantings (see Appendix B, Section 01040). Project Plans and Specifications will describe planting locations, preparation, species and plant sizes, soil amendments, and requirements for herbicide or pesticides. The Contractor is responsible for maintaining plantings during the specified plant establishment period (typically one year after installation). For full payment, the Contractor must replace dead plantings.

ODOT and FHWA avoid extending plant establishment beyond the one-year establishment period to limit the time Construction Contracts are left open, for legal requirements and to reduce Contract management costs. The allowance for replacement plantings at the end of the one-year establishment period means the Contractor will no longer be responsible for subsequent plant care. To solve the problem of poor maintenance and survival of mitigation plantings, ODOT has dedicated funding for post-construction restoration site management. Success of restoration plantings has dramatically improved since this program became available.

Another option that ODOT has for improving success of restoration plantings is to set aside funds from the Contract to independently hire a landscaping Contractor. This may be conducted when ODOT wants to be more directly involved with the planting work or utilize the same Contractor for design, planting and longer establishment periods.

<u>Avoidance and Minimization Measures:</u>
The following measures will be implemented for all projects performed under this PBO with temporary ground disturbances within the following areas: (1) the functional floodplain and riparian zone of listed aquatic species (see Glossary, Appendix A), and (2) the range of and suitable habitat for spotted owl, marbled murrelet, Oregon spotted frog, streaked horned lark, yellow-billed cuckoo, Fender's Blue butterfly and listed plants in this Programmatic, during design or in Contract Special Provisions:
24-1. Do not install trees or shrubs within the 20 feet of roadway clear zone (the area adjacent to the roadway needed for sight distance and safety), bridges, culverts, behind guardrail or adjacent to other permanent roadways structures[14].

[14] This is an ODOT standard to minimize potential conflicts with routine maintenance and safety needs.

24-2. Develop a Site Restoration Plan for submittal with the Project Notification (see, Section 3.4.2 of this PBO).

24-3. The goals of site restoration are:

i. Human and livestock disturbance, if any, are confined to small areas necessary for access or other special management situations.
ii. Areas with signs of significant past erosion are completely stabilized and healed, bare soil spaces are small and well-dispersed.
iii. Soil movement, such as active rills and soil deposition around plants or in small basins, is absent or slight and local.
iv. Native woody and herbaceous vegetation, and germination micro-sites, are present and well distributed across the site.
v. Plants have normal, vigorous growth form, and a high probability of remaining vigorous, healthy and dominant over undesired competing vegetation.
vi. Vegetation structure has rooting throughout the available soil profile.
vii. Plant litter is well distributed and effective in protecting the soil with little or no litter accumulated against vegetation as a result of active sheet erosion ("litter dams").
viii. A continuous corridor of shrubs and trees appropriate to the site are present to provide shade and other habitat functions for the entire streambank.
ix. Streambanks are stable, well vegetated, and protected at margins by roots that extend below baseflow elevation, or by coarse-grained alluvial debris.

24-4. Base the site restoration species composition and numbers on pre-construction data or reference sites[15], differentiated among revegetation units as appropriate for slope and aspect, hydrology, and soils, and will include a range of successional stages (early, mid, and late) (following guidance in FHWA 2007). Locate reference site within the same watershed, ecoregion, or recovery zone (depending on species).

24-5. Install revegetation seeding and plantings at the appropriate planting season (see Appendix B, Section 01040).

24-6. Exclude livestock from restoration areas on Agency-owned lands using wildlife-friendly fencing, unless otherwise justified and presented in the Project Notification (see Section 3.4.2).

24-7. Measure revegetation success separately in each revegetation unit. Base success criteria on the average percent cover of each stratum in the pre-construction or reference site revegetation unit, minus 20 percent, or as otherwise described in the site restoration plan. (Example calculation: reference site revegetation unit has 30 percent average herbaceous cover and 70 percent average tree and shrub canopy cover; success will then be measured as at least 10 percent herbaceous cover and 50 percent tree and shrub canopy cover.)

24-8. Perform annual monitoring of Site Restoration areas until site restoration goals

[15] Reference sites should have similar site characteristics as the corresponding revegetation unit.

(Measure 24-3) and success criteria (Measure 24-7) have been met, following ODOT Biology Mitigation Monitoring standards (http://www.oregon.gov/ODOT/GeoEnvironmental/Pages/Biology.aspx) (see Section 3.4.5).

1.3.25 Channel Modification and Waterway Enhancements

Waterway enhancements encompass the range of in-stream and riparian habitat improvements for fish passage or stream restoration. ODOT has Special Provisions (currently in SP01091; ODOT 2011a) for constructing waterway enhancements using fish rocks, logs, boulders, gravels, and other types of waterway habitat elements, that may be updated as needed to comply with current regulatory guidance. The following types of channel modifications and waterway enhancements in streams with ESA-listed species or critical habitat are covered by this PBO (from SLOPES V for Restoration, NMFS 2013). Channel modifications or waterway enhancements in non-ESA fish bearing streams or critical habitat are also covered when the action has no adverse effect to downstream ESA-listed resources. If adverse effects are determined a separate formal consultation would be developed.

<u>Main Types of Channel Modifications/Enhancements:</u>

i. Boulder Placement to increase habitat diversity and complexity, improve flow heterogeneity, provide substrate for aquatic organisms, moderate flow disturbances, and provide refuge for fish during high flows by placing large boulders in stream beds where similar natural rock has been removed.

ii. Large Wood Restoration to increase coarse sediment storage, habitat diversity and complexity, retain gravel for spawning habitat, improve flow heterogeneity, provide long-term nutrient storage and substrate for aquatic macro invertebrates, moderate flow disturbances, increase retention of leaf litter, and provide refuge for fish during high flows by placing large wood in areas where natural wood accumulations have been removed.

iii. Spawning Gravel Restoration to improve spawning substrate by compensating for an identified loss of a natural gravel supply.

iv. Piling Removal to improve water quality by eliminating chronic sources of toxic contamination.

v. Streambank Restoration to restore eroding streambanks by (a) bank shaping and installation of coir logs or other soil reinforcements as necessary to support riparian vegetation; (b) planting or installing large wood, trees, shrubs, and herbaceous cover as necessary to restore ecological function in riparian and floodplain habitats; or (c) a combination of the above methods.

vi. Fish Passage Restoration to improve fish passage by installing or improving step weirs, fish ladders, or lamprey ramps at an existing facility, or replacing or improving culverts.

vii. Off- and Side-Channel Habitat Restoration to reconnect stream channels with floodplains, increase habitat diversity and complexity, improve flow heterogeneity, provide long-term nutrient storage and substrate for aquatic macro invertebrates, moderate flow disturbances, increase retention of leaf litter, and provide refuge for fish during high flows by restoring or modifying hydrologic and other essential habitat features of historical river floodplain swales, abandoned side channels, and floodplain channels.

viii. Set-back Existing Berms, Dikes, and Levees to reconnect stream channels with floodplains, increase habitat diversity and complexity, moderate flow disturbances, and provide refuge for fish during high flows by increasing the distance that existing berms, dikes or levees are set back from active streams or wetlands.

ix. Water Control Structure Removal to reconnect stream corridors, reestablish wetlands, improve fish passage, and restore more natural channel and flow conditions, by removing earthen embankments, subsurface drainage features, spillway systems, tide gates, outfalls, pipes, instream flow redirection structures (e.g., drop structure, gabion, groin), or similar devices used to control, discharge, or maintain water levels.

Avoidance and Minimization Measures:
The following measures will be implemented for all projects performed under this PBO that construct waterway enhancements in streams with listed aquatic species, during design or in Contract Special Provisions. Standards may be modified when the project meets Program Goals as per Section 1.5; modifications require USFWS approval (see Section 3.2):

25-1. Obtain review/approval from USFWS for the design and specifications of Activities v.-ix. above (Streambank Restoration, Off- and Side-Channel Habitat Restoration, Set-back Existing Berms/Dikes/Levees, Water Control Structure Removal).

25-2. The following standards are required for design and implementation of boulder placement:
i. Stream reaches must have the following features:
   - An intact, well-vegetated riparian area, including trees and shrubs where those species would naturally occur, or that are part of riparian area restoration action.
   - A stream bed that consists predominantly of coarse gravel or larger sediments.
ii. The cross-sectional area of boulders may not exceed 25 percent of the cross-sectional area of the low flow channel or be installed to shift the stream flow to a single flow pattern in the middle or to the side of the stream.
iii. Boulders will be machine-placed (no end dumping allowed).
iv. Permanent anchoring, including rebar or cabling may not be used.

25-3. Step weir, fish ladder, and culvert replacement must be consistent with NMFS fish passage criteria (NMFS 2008a).

25-4. Include large wood in each streambank restoration action to the maximum extent feasible.

25-5. The following standards are required for the design and implementation of large woody material.
i. Stabilizing or key pieces of large wood that will be relied on to provide streambank stability or redirect flows must be intact, hard, and undecayed to partly decaying, and should have untrimmed root wads to provide functional refugia habitat for fish.
ii. Do not use decayed or fragmented wood found lying on the ground or partially sunken.
iii. Wood that is already within the stream or suspended over the stream may be repositioned to allow for greater interaction with the stream.

1.3.26 Stormwater Managment

Information in this section is based on the most updated version of ODOT's Stormwater Management Environmental Performance Standard (EPS). The purpose of this EPS is to ensure that road and highway projects are designed and implemented in a manner that manages project runoff to protect receiving waters and support their beneficial uses (ODOT 2011). This section can be interpreted as both an activity and also Avoidance and Minimization Measures for related triggering activities described above.

Water quality treatment will be provided for projects that have one or more of the following triggering actions:

i. Produce new impervious surface area.
ii. Change the total Contributing Impervious Area (CIA; see Glossary, Appendix A).
iii. Change the type, location, direction, length or endpoint of the pre-project stormwater conveyance system, including the addition of curbing.
iv. Replace or widen a stream crossing structure.
v. Require a Clean Water Act Section 404 permit and actively involve modification of impervious surfaces.
vi. Reconstructing the highway from the subgrade (in-situ material underneath a constructed roadbed).

At a minimum, flow control of highway runoff will be provided when uncontrolled stormwater discharges to receiving streams increase by 0.5 cfs or more during the 10-year, 24-hour storm event when compared to pre-project conditions and the upstream drainage area of the receiving water is less than 100 mi^2.

ODOT's stormwater management criteria are:

1. Treat all of the runoff generated by the Water Quality Design Storm (see Glossary, Appendix A) from the CIA using best management practices that are recognized as effective at treating highway runoff pollutants and incorporate infiltration, media filtration and filtration through vegetation.
2. Avoid an increase in sediment transporting flows from pre-project to post-project (i.e., match the existing hydrology) by managing runoff between the following design storms:
   - 42 percent of the 2-year, 24-hour event in western Oregon or 50 percent of the 2-year, 24-hour event in Eastern Oregon.
   - Either the channel over-topping event for streams with an entrenchment ratio that is greater than or equal to 2.2 (i.e., slightly incised) or the 10-year, 24-hour event for streams with an entrenchment ratio that is less than 2.2 (i.e., moderately to severely incised).

<u>Exceptions:</u>
Certain individual minor actions do not automatically trigger the requirement to meet the Stormwater EPS. Actions that are not required to treat stormwater runoff involve impervious surfaces that are not intended for use by motor vehicles or for other pollutant generating activities, sheet flow to pervious surfaces, or are limited in area so generate relatively little stormwater runoff. The following actions are excluded from the water quality portion of the Stormwater EPS:

- Sidewalk and bicycle/pedestrian paths that do not result in substantial alteration of the highway drainage system.

- Small, localized increases in impervious area for non-driving purposes.
- Small, localized excavation into the subgrade and repaving for maintenance actions or as part of 1R projects (single-lift, non-structural overlay or inlay as described in ODOT Technical Services Bulletin TSB09-01(B)(ODOT 2009a).
- Repair or replacement in-kind of existing stormwater drainage facilities.
- Seismic upgrades of bridges that do not include widening of the bridge deck.

Projects whose triggering actions consist solely of an individual turn lane or the replacement of a stream culvert are not required to treat the whole contributing impervious area. These types of projects are required to provide "opportunistic" water quality treatment for the runoff only for the impervious surface that was modified by the action (removed and replaced or increased). An example would be directing runoff to a vegetated ditch instead of directly discharging to a waterbody.

Projects are exempt from the flow control portion of the Stormwater EPS if the project:

i. Discharges directly into large water bodies. Large water bodies include rivers with an upstream drainage area of $100mi^2$ or greater, lakes, reservoirs and estuaries.
ii. Discharges into other waterbodies where it can be demonstrated that hydrological changes will not have adverse morphological or ecological effects. This may include waterbodies with tidally controlled or influenced hydrology, streams with lakes or reservoirs a short distance downstream of the project discharge point, and those wetlands, or other waterbodies where hydrologic/hydraulic analysis shows non-substantial effects.

Minimization Measure

The following measure will be implemented for all projects performed under this PBO that trigger stormwater management and contribute stormwater runoff to streams with listed aquatic species, except where exempted above:

26-1. If the stormwater management criteria above cannot be fully met on-site, offset the functional equivalent of the CIA off-site when suitable protected lands are available, although alternatives may be proposed/negotiated with NMFS or USFWS, depending on species. Generally, the standard is treatment of runoff carrying at least the same average pollutant load and from impervious area at least equal to that at the project site, within the same 4^{th} field Hydrologic Unit Code (HUC).

1.4 Effects of the Action

Effects of the action are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action.

FAHP funded projects are intended, in part, to enhance public safety. Projects such as curve corrections, clearing landslides and adding additional lanes result from site specific data collected to identify problem areas to motorists. Since data collection drives the development of these projects they are not known until data identify problem areas. We know these projects to address hazards will be proposed but not specifically where until data identifies existing issues.

Oregon Department of Transportation rights-of-way exist State-wide and the adjacent ownerships are lands administered or managed by many Federal, State and municipal agencies, commercial and prive ownership. It is very likely that the ODOT proposed actions will lead to other actions by these adjacent land managers although at this time we cannot predict what, where or when these actions will be, so they are not reasonably certain to occur.

1.4.1 Utilities and Disposal

Some of the most common consequences associated with transportation projects are utility relocations, aggregate source material, disposal sites for construction debris or excess subsurface material. FHWA and ODOT typically do not have legal authority to direct these activities except as described in Section 2.3.3. However, ODOT's Standard Specifications (ODOT 2015b) require the contractor to comply with all applicable State and Federal laws and regulations.

Construction projects often require relocation of utilities, including overhead and underground lines, towers and poles, junction boxes, or other associated features. Except for those owned and operated by ODOT or the local agency (e.g., for traffic cameras, highway illumination, active warning signs, water/sewer), the utility company is responsible for relocating lines in the way of a public transportation improvement project. The Oregon Department of Justice has set limits on how far ODOT can go in directing utility work. In general, ODOT cannot stipulate the exact methods or locations of the utility relocation activities. However, as a condition of their miscellaneous/access permit on public right of way, the utility company is held individually responsible for compliance with applicable environmental laws and obtaining their own permits when needed.

ODOT's Standard Specifications (ODOT 2015b) make excess construction material the property of the Contractor and allow the Contractor to use disposal sites that are outside of the project limits. When Contractors arrange for their disposal sites and aggregate sources, they are responsible for obtaining all the required permits and environmental clearances, such as a Clean Water Act Section 404 permit from the U.S. Army Corps of Engineers when applicable.

1.4.2 Maintenance

Maintenance activities associated with newly constructed infrastructure, such as new stormwater treatment and detention facilities, or new road segments, may be interrelated actions. Maintaining existing infrastructure, when using FHWA funds, is addressed as part of the proposed action.

ODOT's Routine Road Maintenance Program (Blue Book) (ODOT 2014b) establishes measures to avoid and minimize adverse effects to listed species from maintenance that does not involve FHWA funding. USFWS coordinated with ODOT and NMFS during development of the Blue Book and supported many of the measures adopted by ODOT. Additionally, ODOT and USFWS finalized the Oregon Department of Transportation Statewide Habitat Conservation Plan (HCP) for Routine Maintenance Activities, March 31, 2017 (80 FR 60169 Page: 60169-60171). This HCP covers routine road maintenance along highways that focuses on vegetation management and its effects on listed butterflies and State and Federal listed plants. Consequently, these affects are not covered by this PBO.

Avoidance and Minimization Measures incorporated into this proposed action, (e.g., the fluvial performance standard in Measure 18-2) are anticipated to reduce the need for some maintenance actions that could result in adverse effects. Increasing the hydraulic opening of crossing structures tends to reduce the amount of debris removal and scour repair.

1.5 Action Area

The action area is defined as all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). In delineating the action area, we evaluated the farthest reaching physical, chemical, and biotic effects of the action on the environment.

The Action Area for this BO would encompass ODOT rights-of-way and lands administered by ODOT within the state of Oregon and potentially extend further from the area down stream of immediate affects/project area. The Project Design Criteria (PDC)/Best Management practices (BMP) are robust enough to significantly narrow the Action (analysis) Area to a very proximate and local area, generally extending 100 yards to one quarter mile from the proposed action. The PDC and BMPs minimize or eliminate the geographic scope or extent of impacts of FHWY/ODOT projects making the action area of this consultation closely bound to the project areas, staging areas and hauling corridors. As required by Oregon Department of Environmental Quality permitting (or other state regulatory permits) the action agency must follow current BMPs or a “stop work” situation results. Turbidity monitoring via electronic meter and a log of measurements is required.

2.0 Programmatic Administration

2.1 Improvements and Enhancements

ODOT and FHWA anticipate projects delivered through this programmatic consultation will result in overall ecological uplift to the environmental baseline (see Program Goal #1, Section 1.5). For example, culvert and bridge replacements will improve ecological function and connectivity through compliance with ODFW and NMFS Fish Passage Criteria and floodplain design criteria. Although designed for fish, these standards could help improve connectivity for other organisms (e.g., reptiles, amphibians, small mammals). The weed control and revegetation Avoidance and Minimization Measures in this PBO can help improve the condition of supporting habitat for listed and non-listed species and ecological functions.

ODOT and FHWA will track improvements and enhancements through the use of key parameters and metrics captured in data fields in the FAHP-ESA Database, Project Notification, Project Completion and Annual monitoring reports (see Section 3.4.2). For example, the Project Completion Report may identify miles of stream improved for fish access, acres (and type) of habitat disturbed and restored, and numbers of trees removed and planted.

2.2 Modifications

Some projects may not be able to implement certain standards as stated in the Avoidance and Minimization Measures. Modifications may be justified based on a variety of project-specific factors, including but not limited to, habitat conditions, site constraints, project scope, and activity timing. Certain design modifications require review and approval by the Service and are summarized on Table 10.

ODOT will discuss modifications with the Service during early coordination. All modifications must be documented in the Project Notification Report (see Section 3.4.2) or Project Change form if the change is needed after submittal of the Notification (Per the latest ODOT Template on the Geo-Environmental Section, Biology Program website). Any proposed modification must meet the Program Goals (Section 1.5) and must not exceed the amount of take anticipated and reported in the Project Notification Report.

Table 8. Typical situations when design modifications require Services approval.

Activity	Modifications That Require Approval	Minimization Measures (Measure Number[16])
Terrestrial Resources: [17]		
Removal of listed plants or butterfly habitat outside the breeding season and with discussions with the Service.	Removal of Fender's blue butterfly habitat, Fenders blue butterfly eggs, or Kincaid's lupine	Minimize impacts; 3:1 habitat conservation (based on area of habitat removed) (minimization measure 1-9)
High noise producing work within 328 ft of murrelet habitat[18]	Cannot avoid such activities April 1 – August 5	Daily timing restrictions or seasonal restrictions would be applied if necessary, after preproject planning technical assistance with the Service. Daily inspections would occur during high noise activities at the project site. (1-10)
Removal of trees/timber from owl/murrelet habitat areas outside the breeding season (September through February).	Removal of mature conifer trees (>= 18-in DBH)	Minimize disturbance of habitat features; 3:1 habitat conservation at ODOT bank site(based on area of habitat disturbed) (12-3)
Aquatic Resources:		
In-water work timing	Extensions of in-water work period	Case-by-case basis (1-3) and if there are unanticipated affects to listed species will consult with ODFW for In-water work extension and contact the Service.
Fish passage for listed species	Designs that do not meet standards but still improve fish passage	Provides access for spawning and migration; or removes barrier in same subbasin (1-6)
Herbicides near fish habitat	Modifications to herbicide treatment standards	Specified chemicals and adjuvents; minimize disturbance to native vegetation (11-2 through 11-8)
Streambank stabilization or other hard armoring in fish habitat	Any uses of hard armoring below OWH except to replace existing quantity/location	Incorporate natural material into stream bank stabilization or scour protection designs (15-3); vegetated riprap (15-4); or remove the same quantity of new hard armoring in the same subbasin (15-6)
Bridge replacement in/over fish habitat	Does not meet functional floodplain standards	Crossing spans the functional floodplain (18-3); or remove the same quantity of floodplain fill in the same subbasin (18-5)
Impact pile driving in fish habitat	Modifications to pile installation impact minimization measures	Hydro-acoustic impact minimization measures (19-2)
Channel modification and waterway enhancements	Activities v.-ix. in Section 2.3.25 (fish passage retrofits, channel restoration, set-backs, water control)	Aquatic impact minimization measures (25-1 through 25-5)
Stormwater Management	Projects that cannot fully meet the stormwater management criteria on-site.	See Section 2.3.26; or provide treatment within the same watershed for stormwater from a comparable CIA with similar traffic volumes (ADT) (26-1)

16 Measures numbers cross reference to Avoidance and Minimization Measures in the Proposed Action (Section 2.3, pages 14-50).
17 Aquatic habitat supporting listed species.
18 Known or presumed occupied and during nesting season (see Section 2.2).

2.3 Data Management

All projects that utilize this programmatic consultation are documented and tracked in a centralized data management system coordinated by the ODOT Geo-Environmental Section. The system has two key components, the FAHP ESA Database and the ODOT FHWA ESA Programmatic website. The FAHP-ESA Database provides for tracking and reporting (Figure 2). ODOT's FAHP ESA Programmatic website provides a graphic format for external stakeholders on the status and performance of projects from the early coordination process until the project has completed post construction reporting (Figure 2). A more detailed description of data management is located in the FAHP User's Guide .

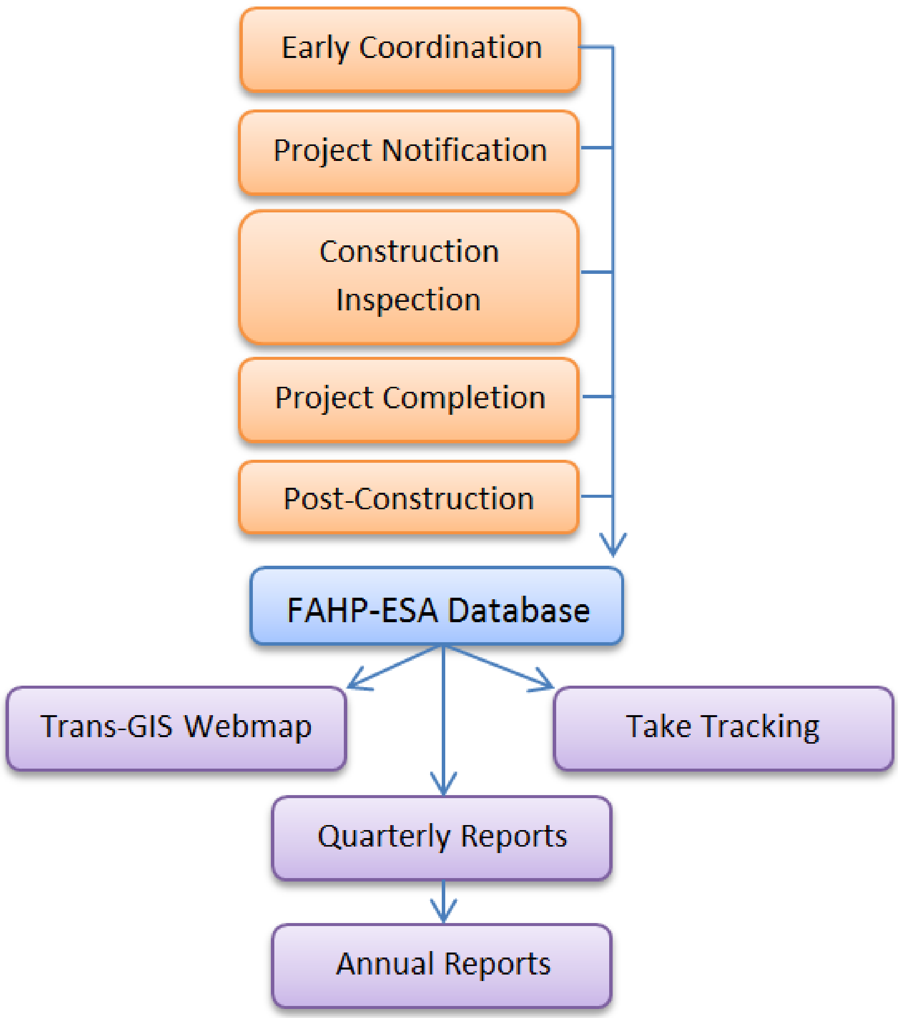

Figure 3. Components of data management.

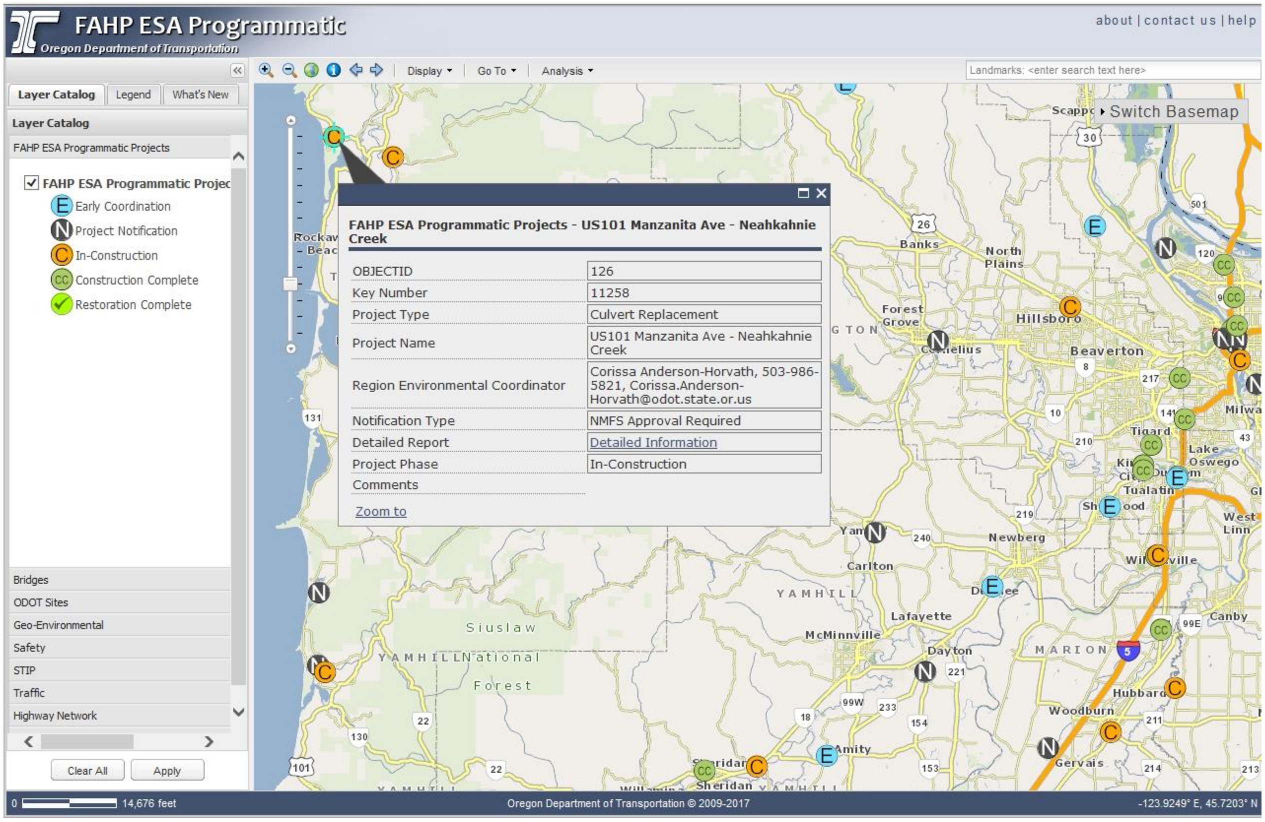

Figure 4. FAHP ESA Programmatic website showing project locations and status.

2.4 Coordination & Reporting

The use of the FAHP programmatic is required for all FHWA-funded projects that “May Affect” listed species or critical habitat. This is assuming program requirements described in this BO can be met. If not, a separate consultation will be initiated. There are several key steps for FAHP users to follow, including:

1. Early Coordination. This requires the completion of the Initiation Form which establishes project stakeholders and notifies this group that a project intends to pursue programmatic coverage. Especially in cases of design modifications, it can prevent possible project delays by giving the USFWS a chance to weigh in on alternate approaches

2. Project Notification**.** All projects require a Project Notification report, which will identify species present, project scope, location, and design features; expected impacts to species and habitat (e.g., area of habitat disturbance); relevant Avoidance and Minimization Measures; and informational attachments (photographs, site restoration plan, other key design drawings). ODOT will coordinate (pre-project planning) with the Service prior to submitting this form to FHWA for review. FHWA will submit the form to the Service and copy ODOT if Service approval is required. If a FHWY funded project does not fit within the FAHP BO a separate consultation will be developed. If no approval is required for projects that fit within the FAHP BO, the project may proceed as described with courtesy notification submitted to the Service. These projects instead are

formally summarized in the annual reporting to USFWS. When review and approval is required, USFWS will respond regarding the sufficiency of the documentation, need for additional information, or approval, within 30 days of notification.

3. Construction Inspection. Construction inspection is a key component of ODOT and FHWA's commitment to regulatory compliance. Each project will include ODOT's field verification of BMP implementation. Regular site inspection and adaptive management through these inspections will be completed by the REC, Biologist or certified Environmental Construction Inspector as needed during construction and the project brought back into BPMs. Inspection frequency is based on the complexity of the project, timing of activities that affect regulated resources, and best professional judgment. The Inspector will complete a construction inspection report with submittal via email to stakeholders with all forms available on the ODOT FAHP ESA Programmatic website. Failure to comply with BMPs will be reported to the Services and subject to stop work orders by ODOT and fines state and federal regulatory agencies.

4. Project Completion Report. ODOT will submit a Project Completion Report for each project. The reports will be uploaded to ODOT FTP site & e-mailed to FAHP_ESA@odot.state.or.us within 90 days after the construction end date, which is defined as the final installation of project components; after site restoration but at the start of the establishment period. These reports will be available to stakeholders via the ODOT-FHWA ESA Programmatic website. The report will include: 1) the start and end date of construction; 2) the start and end dates of in-water work or habitat removal, when applicable; 3) a summary of environmental compliance, including environmental inspection; 4) a summary of work area isolation and fish salvage, if applicable; 5) a description and map of site restoration or alternative impact minimization measures; and 6) photos of habitat conditions before, during, and after project completion.

5. Annual Reporting and Adaptive Management. FHWA and ODOT will provide annual summary reporting to USFWS and will present the information during an annual meeting. The summary will contain a list of projects covered by the FAHP programmatic in the reporting year, as well as a breakdown of predicted/corrected Take against the Take authorized by the programmatic BO. The summary will also highlight relevant information specific to construction inspection findings, environmental enhancements, and mitigation implementation. The annual meeting will support the discussion of the overall performance of the FAHP programmatic specific to meeting the program goals and requirements. It will also provide an opportunity to implement adaptive management, such as needed updates and process improvements

A detailed discussion of the coordination protocols and reporting requirements is provided in the FAHP User's Guide (FHWY, 2016).

3.0 Endangered Species Act Informal Concurrence

The FHWA/ODOT made a determination of "may affect, is not likely to adversely affect" for ten listed plant species. The species include: Applegate's milkvetch, Cook's lomatium, Gentner's fritillary, Howell's spectacular thelypody, large-flowered woolly meadowfoam, MacFarlane's four-o'clock, rough popcornflower, Spalding's catchfly, western lily, and Willamette daisy. The Service worked with FHWA/ODOT personnel during the early coordination process to incorporate a Survey and Avoid conservation measure similar to the OTIA III *Species Avoidance - Environmental Performance Standard* (ODOT 2004) that addresses the thirteen listed plant species. A project site is first evaluated (Project scoping/development, section 2.2 in the PBA) for the potential occurrence of a species based on the presence of suitable habitat or soil types which are known to support listed plants. Project locations will be screened using known habitat or soil types and using existing plant location databases to determine whether a listed plant is potentially in the area. If suitable habitat or soil types are indicated to be present, surveys will be conducted by a botanist during the appropriate time of year (during the flowering period) to locate the plants. If the plants listed below are present, they will be flagged to delineate the site and will be avoided during all aspects of the project (section 2.3.1, 1-9). Pre-construction and construction activities will be monitored to ensure personnel do not alter the hydrology of the site or cause effects due to dust or shading. If plants and their habitat cannot be avoided, FHWA/ODOT will conduct an individual site specific formal consultation for that particular project.

Based on the Survey and Avoid conservation standard, the Service concurs with the FHWA/ODOT determination that the Program "may affect, is not likely to adversely affect" the Applegate's milkvetch, Cook's lomatium, Gentner's fritillary, Howell's spectacular thelypody, large-flowered woolly meadowfoam, MacFarlane's four-o'clock, rough popcornflower, Spalding's catchfly, western lily, and Willamette daisy as affects are extremely unlikely to occur to these listed plants and would therefore be considered discountable. If projects cannot avoid impacts to listed plants then it will be addressed in an individual consultation.

In the PBA the FHWA/ODOT also made a determination that the proposed action "*may affect, is not likely to adversely affect*" Cook's lomatium, large-flowered woolly meadowfoam and Willamette daisy designated Critical Habitat (CH). Because CH for these species was designated only for known populations of these plants (not unoccupied suitable habitat) and all are mapped and tracked through most plant databases, the Service believes the same rationale used above for the plants applies to CH because it's occupied and therefore plants would need to be avoided to be covered under this consultation. FHWA/ODOT will contact the Service if a project may be planned near or within CH with functioning Physical and Biological Features (PBFs) and affects to listed plants cannot be avoided. Based on the Survey and Avoid conservation standard, the Service concurs with the determination of "*may affect, is not likely to adversely affect*" Cook's lomatium, large-flowered woolly meadowfoam and Willamette daisy designated CH as adhering to their Survey and Avoid standard, it is extremely unlikely that any adverse effects will occur.

The FHWA/ODOT made a determination of "may affect, is not likely to adversely affect" for the Columbia white-tailed deer. Based upon the information in your request for concurrence and accompanying PBA, other available information, and our analysis of the proposed project, the Service concurs with your determination that the proposed action "may affect, but is not likely to adversely affect" the Columbia white-tailed deer for the following reasons: 1) No Columbia white-tailed deer habitat is proposed to be removed; 2) Columbia white-tailed deer would move out of or avoid the immediate vicinity of the proposed action areas discussed in the PBO if noise or human presence disturbed them; and, 3) background noise of traffic (including heavy truck traffic) would be of similar nature to the episodic activity's proposed that would be adjacent to white-tailed deer habitat so therefore they are accustomed to such noise and would not disturb them. As such, the effects of the proposed action on the Columbia white-tailed deer are discountable.

The FHWA/ODOT made a determination of "*may affect, is not likely to adversely affect*" for the grey wolf. Based upon the information in your request for concurrence and accompanying PBA, other available information, and our analysis of the proposed project, the Service concurs with your determination that the proposed action "*may affect, but is not likely to adversely affect*" the grey wolf for the following reasons: 1) grey wolves are human averse and as such their den sites and rendezvous points are expected to be far from proposed action areas (active state roadways); and, 2) grey wolf would move out of or avoid the immediate vicinity of the proposed action areas discussed in the PBO if noise or human presence disturbed them. As such, the effects of the proposed action on the grey wolf are both negligible and discountable.

The FHWA/ODOT made a determination of "*may affect, is not likely to adversely affect*" for the yellow-billed cuckoo. Based upon the information in your request for concurrence and accompanying PBA, other available information, and our analysis of the proposed project, the Service concurs with your determination that the proposed action "*may affect, but is not likely to adversely affect*" the yellow-billed cuckoo for the following reasons: 1) the yellow-billed cuckoo is very rare in Oregon and unlikely to be encountered; and 2) no yellow-billed cuckoo habitat is proposed to be removed. As such, the effects of the proposed action on the yellow-billed cuckoo are discountable.

The FHWA/ODOT made a determination of "*may affect, is not likely to adversely affect*" for the streaked-horned lark. Based upon the information in your request for concurrence and accompanying PBA, other available information, and our analysis of the proposed project, the Service concurs with your determination that the proposed action "*may affect, but is not likely to adversely affect*" the streaked-horned lark for the following reasons: 1) outside the breeding season streaked-horned lark would be expected to move away from proposed projects addressed in this PBO due to human presence and noise of vehicles and equipment; and 2) robust BMPs involving proposed action area surveys for listed species would identify streaked-horned lark habitat and avoidance and minimization measures would be implemented to avoid effects to nesting larks. As such, the effects of the proposed action on the streaked-horned lark are negligible and discountable.

4.0 Endangered Species Act Formal Consultation

Analytical Framework for the Jeopardy and Destruction or Adverse Modification Determinations

Jeopardy Determination

Section 7(a)(2) of the Act requires that Federal agencies ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of any listed endangered or threatened species. The analysis in this Biological Opinion relies on the following four components: (1) the Status of the Species, which evaluates the range wide condition of the listed species addressed, the factors responsible for that condition, and the species' survival and recovery needs; (2) the Environmental Baseline, which evaluates the condition of the species in the action area, the factors responsible for that condition, and the relationship of the action area to the survival and recovery of the species; (3) the Effects of the Action, which determines the consequences of the proposed Federal action; and (4) Cumulative Effects, which evaluates the effects of future, non-federal activities in the action area on the species.

In accordance with policy and regulation, the jeopardy determination is made at the rangewide scale by evaluating the effects of the proposed federal action in the context of the species' current status, taking into account any cumulative effects, to determine if implementation of the proposed action is likely to cause an appreciable reduction in the likelihood of both the survival and recovery of listed species in the wild.

The jeopardy analysis in this Biological Opinion emphasizes the rangewide survival and recovery needs of the listed species and the role of the action area in providing for those needs. It is within this context that we evaluate the significance of the proposed Federal action, taken together with cumulative effects, for purposes of making the jeopardy determination.

Destruction or Adverse Modification Determination

Section 7(a)(2) of the Act requires that Federal agencies ensure that any action they authorize, fund, or carry out is not likely to destroy or to adversely modify designated critical habitat. A final rule revising the regulatory definition of "destruction or adverse modification of critical habitat" was published on August 27, 2019 (84 FR 44976); the final rule became effective on October 28, 2019 (84 FR 50333). The revised definition states: "Destruction or adverse modification means a direct or indirect alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species."

Past designations of critical habitat have used the terms "primary constituent elements" (PCEs), "physical or biological features" (PBFs) or "essential features" to characterize the key components of critical habitat that provide for the conservation of the listed species. The critical habitat regulations discontinue use of the terms "PCEs" or "essential features," and rely exclusively on use of the term "PBFs" for that purpose because that term is contained in the statute. However, the shift in terminology does not change the approach used in conducting a "destruction or adverse modification" analysis, which is the same regardless of whether the original designation identified PCEs, PBFs or essential features. For those reasons, in this Biological Opinion, references to PCEs or essential features should be viewed as synonymous with PBFs. All of these terms characterize the key components of critical habitat that provide for the conservation of the listed species.

Our analysis for destruction or adverse modification of critical habitat relies on the following four components: (1) the Status of Critical Habitat, which evaluates the range-wide condition of designated critical habitat for the listed species in terms of PBFs, the factors responsible for that condition, and the intended recovery function of the critical habitat overall; (2) the Environmental Baseline, which evaluates the condition of the critical habitat in the action area, the factors responsible for that condition, and the recovery role of the critical habitat in the action area; (3) the Effects of the Action, which determines all consequences to critical habitat that are caused by the proposed action on the essential features, or PBFs and how those effects are likely to influence the recovery role of affected critical habitat units; and (4) Cumulative Effects, which evaluates the effects of future, non-Federal activities in the action area on the essential features, or PBFs and how those effects are likely to influence the recovery role of affected critical habitat units.

For purposes of making the destruction or adverse modification finding, the effects of the proposed Federal action, together with any cumulative effects, are evaluated to determine if the proposed action will appreciably diminish the value of critical habitat as a whole for the conservation of the species.

Biological Information and Critical Habitat (Status of the Species)

Detailed information on the status of each species and critical habitat is contained in Appendices D-L of this PBO. The following is a summary.

Status of the Spotted Owl and Spotted Owl Critical Habitat

The Service listed the northern spotted owl (*Strix occidentalis caurina*) as threatened on June 26, 1990 (USFWS 1990b, p. 26114) and first designated critical habitat on January 15, 1992 (USFWS 1992b, p. 1796). The Service revised critical habitat on August 13, 2008, and again on December 4, 2012 (USFWS 2012a, p. 71876). The physical and biological features determined to be essential to the conservation of the spotted owl conservation are forested lands that can be used for nesting, roosting, foraging, or dispersing (USFWS 2012a, p. 71904). These features need to be distributed in a spatial configuration that is conducive to the persistence of populations, survival and reproductive success of resident pairs, and survival of dispersing individuals until they can recruit into a breeding population (USFWS 2012a, p. 71904).

The threats to the species at the time of listing, and that still threaten the species today, are the loss and adverse modification of suitable habitat as a result of timber harvest and development (USFSW 1990b, p. 26114). New threats identified since listing are competition with barred owls and loss of genetic variation (USFWS 2011a, p. B-12; USFWS 2012a, p. 71878). All of these threats are exacerbated by changes in forest ecosystem processes and dynamics, including patterns of wildfires, insect outbreaks, and disease, which are occurring at faster rates due to climate change (USFWS 2012a, p. 71879).

A Revised Recovery Plan for the spotted owl (USFWS 2011, entire) was published in 2011. The Revised Recovery Plan established 11 recovery units. Portions of the Project occur in four recovery units. Each recovery unit provides an essential survival and recovery function for the species such that impairment of any one recovery unit’s capacity to provide both its survival and recovery functions could jeopardize the species (USFWS 2011, p.III-1).

According to the Northwest Forest Plan (NWFP) 20-Year Report on Status and Trends of Northern Spotted Owl Habitats (Davis et al. 2016, pp. 22, 32), across the 11 recovery units for the species:

- Spotted owl nesting/roosting habitat has declined since the species was listed in 1990: models predict nesting/roosting habitat on all land ownerships across Washington, Oregon, and California of approximately 12.1 million acres in 2012 compared to 12.5 million acres in 1993 at the start of the NWFP.

- Spotted owl dispersal habitat has also declined: models predict dispersal habitat across Washington, Oregon, and California of approximately 25.7 million acres in 2012 compared to 26.3 million acres in 1993 at the start of the NWFP.

• Spotted owl habitat within Oregon has declined since listing: habitat models indicate losses of 252,600 acres of nesting/roosting habitat and 301,600 acres of dispersal habitat in Oregon from 1993-2012.

• Recent modelling of spotted owl population (Dugger et al. 2015, p. 70) suggests negative population trends range-wide and in Oregon specifically. The mean annual rate of population change across Washington, Oregon, and California is -3.8 percent (SE = 0.019), and the mean annual rate of population change in Oregon is -3.5 percent (average of five values ranging from -2.4 to -5.1 percent with SEs between 0.008 and 0.024). It is believed that competition with an expanding population of barred owls is the primary driver of this negative population trend.

Spotted owl CH was designated on December 4, 2012 (77 FR: 71875-72068) and the PBFs include: 1) Space for individual and population growth and for normal behavior; (2) Food, water, air, light, minerals, or other nutritional or physiological requirements; (3) Cover or shelter; (4) Sites for breeding, reproduction, or rearing (or development) of offspring; and (5) Habitats that are protected from disturbance or are representative of the historical, geographical, and ecological distributions of a species.

For more detailed information on Status of the Species and Status of Critical Habitat see Appendix D.

Status of the Marbled Murrelet and Marbled Murrelet Critical Habitat

The marbled murrelet (*Brachyramphus marmoratus*) was listed as a threatened species on September 28, 1992, in Washington, Oregon, and northern California (USFWS 1992c, p. 45328). The marbled murrelet critical habitat was first designated on May 24, 1996 (USFWS 1996, p. 1) and revised as recently as 2016 (USFWS 2016, p. 51506).

The threats to the species at the time of listing, which are still relevant today, are:

• Habitat destruction and modification in the terrestrial environment from timber harvest and human development

• Increased forest "edge effects" from timber harvest

• Other anthropogenic factors, such as oil spills and fishing nets used in gill-net fisheries

New threats identified since listing include predation and various impacts to the marine environment (Service 2019, pp. 29, 43).

A final Recovery Plan for the marbled murrelet was published in 1997 (USFWS 1997, entire). The Recovery Plan established six Conservation Zones within the marbled murrelets range in recognition that viable populations in at least four of six zones are essential for the long-term survival and recovery of the marbled murrelet. Portions of this Project occur in two of these Conservation Zones.

In summary, across the six Conservation Zones for the species:

1. Marbled murrelet habitat in the contiguous U.S. has declined since the species was listed in 1992: models predict habitat across Washington, Oregon, and California of approximately

2.23 million acres in 2012 compared to 2.53 million acres at the start of the NWFP (1993) (Raphael et al. 2016b, p. 69, in Falxa and Raphael 2016).

2. Potential marbled murrelet nesting habitat was estimated in 2012 as 66 percent on Federal lands and 34 percent on non-Federal lands, where it was at 59 percent and 41 percent in 1993, respectively (Falxa and Raphael 2016, pp 65-69).

3. Marbled murrelet habitat within Oregon has declined since listing; habitat models indicate a loss of 88,000 acres of suitable habitat in Oregon from 1993-2012 (Falxa and Raphael 2016, p. 72).

4. There is currently no evidence of a positive or negative population trend for murrelets throughout its listed range (Service 2019c, pages 16-17). However, there is evidence for a slightly positive trend in the state of Oregon (average 1.8 percent per year, with 95 percent confidence limits of 0.1 to 3.6 percent), and a substantial negative trend in Washington (USFWS 2019c. pp. 15-16).

Marbled murrelet CH was designated May 24, 1996 (61 FR: 26256-26320) and the PBFs include: (1) Space for individual and population growth, and for normal behavior; (2) Food, water, air, light, minerals or other nutritional or physiological requirements; (3) Cover or shelter; (4) Sites for breeding, reproduction, rearing of offspring; and (5) Habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of a species.

For more information on Status of the Species and Status of Critical Habitat, see Appendix E.

Status of the Bull Trout and Bull Trout Critical Habitat

The bull trout (*Salvelinus confluentus*) was listed as a threatened species in the coterminous United States in 1999 (64 FR 58910-58933). Throughout its range, bull trout are threatened by the combined effects of habitat degradation, fragmentation, and alterations associated with dewatering, road construction and maintenance, mining, grazing, the blockage of migratory corridors by dams or other diversion structures, poor water quality, incidental angler harvest, entrainment, and introduced non-native species. Since the listing of bull trout, there has been very little change in the general distribution of bull trout in the coterminous United States, and we are not aware that any known, occupied bull trout core areas have been extirpated (Service 2015, p. 7).

The 2015 recovery plan for bull trout identifies six recovery units within the listed range of the species (Service 2015, p. 36). Each of the recovery units are further organized into multiple bull trout core areas, which are mapped as non-overlapping watershed-based polygons, and each core area includes one or more local populations. Within the coterminous United States we currently recognize 109 occupied core areas, which comprise 600 or more local populations of bull trout (Service 2015, p. 34). Core areas are functionally similar to bull trout metapopulations, in that bull trout within a core area are much more likely to interact, both spatially and temporally, than are bull trout from separate core areas.

The Service has also identified a number of marine or mainstem riverine habitat areas outside of bull trout core areas that provide foraging, migration, and overwintering (FMO) habitat that may be shared by bull trout originating from multiple core areas. These shared FMO areas support the viability of bull trout populations by contributing to successful overwintering survival and dispersal among core areas (Service 2015, p. 27).

On October 18, 2010, the Service issued a final revised critical habitat designation for the bull trout (75 FR 63898; USFWS 2010b). The critical habitat designation includes 32 critical habitat units in six recovery units located throughout the coterminous range of the bull trout in Washington, Oregon, Idaho, Montana, and Nevada. Designated bull trout critical habitat is of two primary use types: 1) spawning and rearing, and 2) FMO habitat. The conservation role of bull trout critical habitat is to support viable core area populations (75 FR 63943). Critical habitat units generally encompass one or more core areas and may include FMO areas, outside of core areas, that are important to the survival and recovery of bull trout.

The final rule excludes some critical habitat segments. Critical habitat does not include 1) waters adjacent to non-federal lands covered by legally operative incidental take permits for Habitat Conservation Plans (HCPs) issued under the Act, in which bull trout is a covered species on or before the publication of this final rule; 2) waters within or adjacent to Tribal lands subject to certain commitments to conserve bull trout or a conservation program that provides aquatic resource protection and restoration through collaborative efforts, and where the Tribes indicated that inclusion would impair their relationship with the Service; or, 3) waters where impacts to national security have been identified (75 FR 63898).

Bull trout have more specific habitat requirements than most other salmonids (USFWS 2010b). The predominant habitat components influencing their distribution and abundance include water temperature, cover, channel form and stability, spawning and rearing substrate conditions, and migratory corridors. The PBFs of bull trout critical habitat include:

1. Springs, seeps, groundwater sources, and subsurface water connectivity (hyporheic flows) to contribute to water quality and quantity and provide thermal refugia.

2. Migration habitats with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and freshwater and marine foraging habitats, including but not limited to permanent, partial, intermittent, or seasonal barriers.

3. An abundant food base, including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.

4. Complex river, stream, lake, reservoir, and marine shoreline aquatic environments, and processes that establish and maintain these aquatic environments, with features such as large wood, side channels, pools, undercut banks and unembedded substrates, to provide a variety of depths, gradients, velocities, and structure.

5. Water temperatures ranging from 2 to 15° C (36 to 59° F), with adequate thermal refugia available for temperatures that exceed the upper end of this range. Specific temperatures within this range will depend on bull trout life-history stage and form; geography; elevation; diurnal and seasonal variation; shading, such as that provided by riparian habitat; streamflow; and local groundwater influence.

6. In spawning and rearing areas, substrate of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. A minimal amount of fine sediment, generally ranging in size from silt to coarse sand, embedded in larger substrates, is characteristic of these conditions. The size and amounts of fine sediment suitable to bull trout will likely vary from system to system.

7. A natural hydrograph, including peak, high, low, and base flows within historic and seasonal ranges or, if flows are controlled, minimal flow departure from a natural hydrograph.

8. Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited.

9. Sufficiently low levels of occurrence of non-native predatory (e.g., lake trout, walleye, northern pike, smallmouth bass); interbreeding (e.g., brook trout); or competing (e.g., brown trout) species that, if present, are adequately temporally and spatially isolated from bull trout.

For more information on Status of the Species and Status of Critical Habitat, see Appendix F.

Status of the Species and Status of Critical Habitat for the Lost River and Short nosed Suckers

The Lost River sucker (*Deltistes luxatus*) and short nosed sucker (*Chasmistes brevirostris*) were both federally listed as endangered throughout their entire range under the Act on July 18, 1988 (USFWS 1988) (53 FR: 27130-27134). Critical habitat for both species was designated by the Service on December 11, 2012 (Service 2012b) (77 FR: 73740-73768). The threats to the species at the time of listing, and still threaten the species today, are degraded habitat conditions, entrainment, and severely impaired water quality (USFWS 2012b).

The status of the Lost River sucker and short nosed sucker has declined since listing. The short-nosed sucker is especially vulnerable because of substantial population declines in Upper Klamath Lake (UKL) and relatively small populations overall. Adverse water quality in UKL in the 1990s caused massive die-offs of both Lost River sucker and short nosed sucker. Since 2001, short nosed sucker in UKL have declined by as much as 70 to 80 percent and Lost River sucker by as much as 40 to 60 percent, leading to poor resiliency for those populations. Short nosed sucker in UKL are also vulnerable because most are well past their average life expectancy. Lost River sucker are at their average life expectancy, thus the rate of decline could increase if there is not substantial recruitment into the adult age class. Recruitment of both species into the adult population in UKL in the past decade has been nearly nonexistent, and there is no evidence of large groups of young suckers that could enter the adult population in the next few years. Loss of the UKL populations would leave only one self-sustaining population of the Lost River Sucker and two self-sustaining populations of the short-nosed sucker; thus, there is little redundancy for either species, adding to their risk of extinction. Given this information, the Service finds that Lost River sucker and short nosed sucker populations, especially the short nosed sucker population in UKL, are at a high risk of extinction (USFWS 2012a, p. 1; 2013a, p. 16; USFWS 2019, p. iii).

Lost River and short nosed sucker CH was designated December 11, 2012 (77 FR: 73740-73768) and the PBFs include: (1) Space for individual and population growth and for normal Behavior;

2) Food, water, air, light, minerals, or other nutritional or physiological requirements; 3) Cover or shelter; 4) Sites for breeding, reproduction, or rearing (or development) of offspring; and, 5) Habitats that are protected from disturbance or are representative of the historical, geographical, and ecological distributions of a species.

For more information on Status of the Species and Status of Critical Habitat, see Appendix G.

Status of the Oregon Spotted Frog and Oregon Spotted Frog Critical Habitat

On August 29, 2014, the Service listed the Oregon spotted frog (*Rana pretiosa*) as threatened (79 FR 51657). This species is the most aquatic native frog in the Pacific Northwest. It is almost always found in or near a perennial body of water that includes zones of shallow water and abundant emergent or floating aquatic plants, which the frogs use for basking and escape cover. Oregon spotted frogs currently have a very limited distribution west of the Cascade crest in Oregon. The species is considered to be extirpated from the Willamette Valley in Oregon and may be extirpated in the Klamath and Pit River basins of California (USFWS 2016b, pp. 29351).

The Service designated 68,038 acres and 20.3 stream miles as critical habitat for the Oregon spotted frog throughout Washington and Oregon on May 11, 2016 (81 FR 29336). Critical habitat for Oregon spotted frog was designated within 14 units, delineated by river sub-basins where spotted frogs are extant. The PBFs of spotted frog CH are: 1) Ephemeral or permanent bodies of fresh water, including, but not limited to, natural or manmade ponds, springs, lakes, slow-moving streams, or pools within or oxbows adjacent to streams, canals, and ditches, that have one or more of the following characteristics:

(A) Inundated for a minimum of 4 months per year (B, R);

(B) Inundated from October through March (O);

(C) If ephemeral, areas are hydrologically connected by surface water flow to a permanent water body (e.g., pools, springs, ponds, lakes, streams, canals, or ditches) (B, R);

(D) Shallow-water areas (less than or equal to 12 inches (30 centimeters), or water of this depth over vegetation in deeper water (B, R);

(E) Total surface area with less than 50 percent vegetative cover (N);

(F) Gradual topographic gradient (less than 3 percent slope) from shallow water toward deeper, permanent water (B, R);

(G) Herbaceous wetland vegetation (i.e., emergent, submergent, and floating-leaved aquatic plants), or vegetation that can structurally mimic emergent wetland vegetation through manipulation (B, R);

(H) Shallow-water areas with high solar exposure or low (short) canopy cover (B, R); and

(I) An absence or low density of nonnative predators (B, R, N).

2) Aquatic movement corridors. Ephemeral or permanent bodies of fresh water that have one or more of the following characteristics:

(A) Less than or equal to 3.1 miles (5 kilometers) linear distance from breeding areas; and

(B) Impediment free (including, but not limited to, hard barriers such as dams, impassable culverts, lack of water, or biological barriers such as abundant predators, or lack of refugia from predators).

3) Refugia habitat. Nonbreeding, breeding, rearing, or overwintering habitat or aquatic movement corridors with habitat characteristics (e.g., dense vegetation and/or an abundance of woody debris) that provide refugia from predators (e.g., nonnative fish or bullfrogs).

For more information on Status of the Species and Status of Critical Habitat, see Appendix H.

Status of the Fender's Blue Butterfly and Fenders Blue Butterfly Critical Habitat

The Fender's blue butterfly (*Icaricia icarioides fenderi*) is a subspecies of Boisduval's blue butterfly (*Icaricia icarioides*) found only in the upland prairie and oak savannah habitats of the Willamette Valley in western Oregon. The Service listed the Fender's blue butterfly as endangered, without critical habitat, under the Endangered Species Act on January 25, 2000 (65 FR 3875). At the same time, the Service listed one of the butterfly's primary host plants, the Kincaid's lupine (*Lupinus sulphureus* ssp. *kincaidii*), as threatened (65 FR 3875). At the time of listing in 2000, Fender's blue butterfly and Kincaid's lupine were confined almost exclusively on the western side of the Willamette Valley in Oregon. Critical habitat for the Fender's blue butterfly was designated on October 31, 2006, in Benton, Lane, Polk, and Yamhill Counties, Oregon (71 FR 63862) and a recovery plan was published in May 2010, establishing three recovery zones as well as population and habitat targets.

Fenders blue butterfly critical habitat was designated October 31, 2006 (71 FR 63861-63977) and it's PBFs include: 1) Early seral upland prairie, wet prairie, or oak savanna habitat with a mosaic of low-growing grasses and forbs, an absence of dense canopy vegetation, and undisturbed subsoils; 2) Larval host plants *Lupinus sulphureus* ssp. *kincaidii*, *L. arbustus*, or *L. albicaulis*; 3) Adult nectar sources, such as: *Allium acuminatum* (tapertip onion), *Allium amplectens* (narrowleaf onion), *Calochortus tolmiei* (Tolmie's mariposa lilly), *Camassia quamash* (small camas), *Cryptantha intermedia* (clearwater cryptantha), Eriophyllum lanatum (wooly sunflower), *Geranium oreganum* (Oregon geranium), *Iris tenax* (toughleaf iris), *Linum angustifolium* (pale flax), *Linum perenne* (blue flax), Sidalcea campestris (Meadow checkermallow), *Sidalcea virgata* (rose checker-mallow), *Vicia cracca* (bird vetch), *V. sativa* (common vetch), and *V. hirsute* (tiny vetch); and, 4) Stepping-stone habitat, consisting of undeveloped open areas with the physical characteristics appropriate for supporting the short-stature prairie oak savanna plant community (well drained soils), within 1.2 miles (~2 km) of natal lupine patches.

For more information on Status of the Species and Status of Critical Habitat, see Appendix I.

Status of the Kincade's Lupine and Kincade's Lupine Critical Habitat

Kincaid's lupine (*Lupinus sulphureus* ssp. *Kincaidii*) was listed as threatened, on January 25, 2000 (Federal Register 65:3875-3890). Critical habitat was designated on October 6, 2006 (FR 71: 20636-20637). A recovery plan was finalized for this species on May 20, 2010 (USFWS 2010a). This species is found in Oregon (Benton, Lane, Polk and Yamhill counties) and Washington (Lewis County). This species is on the state of Oregon's Threatened Plant list; in Washington it is classified by the WNHP as endangered (USFWS 2010a).

The PBFs of CH for Kincaid's lupine are the habitat components that provide: 1) early seral upland prairie or oak savanna habitat with a mosaic of low growing grasses, forbs, and spaces to establish seedlings or new vegetative growth, with an absence of dense canopy vegetation providing sunlight for individual and population growth and reproduction, and with undisturbed subsoils and proper moisture and protection from competitive invasive species; and 2) the presence of insect pollinators, such as bumblebees (*Bombus mixtus* and *B. californicus*), with unrestricted movement between existing lupine patches, critical for successful lupine reproduction (USFWS 2010). Critical habitat does not include human-made structures existing on the effective date of the rule and not containing one or more of the PBFs, such as buildings, aqueducts, airports, and roads, and the land on which such structures are located.
Critical habitat is designated for Kincaid's lupine on 584.6 acres in central Oregon and southwest Washington (USFWS 2006). Of those, 500 acres are designated on private lands, 78.1 on Federal lands, and six on State lands.

Critical Habitat was designated for Kincaid's lupine on October 31, 2006 (71 FR 63861-63977) and it's PBFs include: 1) Early seral upland prairie, or oak savanna habitat with a mosaic of low-growing grasses and forbs, and spaces to establish seedlings or new vegetative growth; an absence of dense canopy vegetation; and undisturbed subsoils; and, 2) The presence of insect outcrossing pollinators, such as Bombus mixtus and B. californicus, with unrestricted movement between existing lupine patches.

For more information on Status of the Species and Status of Critical Habitat, see Appendix J.

Status of the Nelson's Checkermallow

Nelson's checkermallow (*Sidalcea nelsoniana*) was listed as Threatened on February 12, 1993 (USFWS 1993) without designated critical habitat. A recovery plan for the species was finalized on May 20, 2010 (USFWS 2010a). This species is on the state of Oregon's Threatened Plant list, and in Washington it is classified by the WNHP as endangered. Nelson's checkermallow occurs in Oregon (Benton, Linn, Marion, Polk, Tillamook, Yamhill, and Washington counties) and Washington (Cowlitz and Lewis counties).

Nelson's checkermallow primarily occurs in Oregon's Willamette Valley, but is also found at several sites in Oregon's Coast Range and at two sites in the Puget Trough of southwestern Washington. The 2010 Recovery Plan states that Nelson's checkermallow was known from about 90 sites, comprising about 1,277 acres of total cover (USFWS 2010). Results contained within a 2016 range-wide inventory report indicated that greater than 350,000 plants were extant across at least 71 siteskerns. Using methods for determining populations in recovery plan, info in current geodatabase suggests there are 46 populations extant across the range of the species (42 in OR). Populations are mainly concentrated west of the Willamette River

Nelson's checkermallow is a perennial herb in the mallow family (*Malvaceae*). It has tall, lavender to deep pink flowers that are borne in somewhat open clusters 50 to 150 cm (19.2 to 48 inches) tall at the end of short stalks (USFWS 1993). The plant can reproduce vegetatively, by rhizomes, and by seeds, which drop near the parent plant. Flowering typically occurs from late May to mid-July but may extend into September in the Willamette Valley.

In the Willamette Valley, Nelson’s checkermallow is known from wet prairies and stream sides (USFWS 2010). Nelson’s checkermallow populations occur at low elevations (below 200 m (650 feet)) within a mosaic of urban and agricultural areas, with concentrations around the cities of Corvallis and Salem. Coast Range Nelson’s checkermallow populations typically occur in open, wet to dry grassy meadows, intermittent stream channels, and along margins of coniferous forests, with clay to loam soil textures (Glad *et al.*1987) at elevation ranging from 490 to 600 m (1,610 to 1,970 feet). These areas generally support more native vegetation than Willamette Valley sites.

Nelson’s checkermallow threatened by urban and agricultural development, ecological succession that results in shrub and tree encroachment of open prairie habitats, and competition with invasive weeds (USFWS 1993). At many Willamette Valley sites, seedling establishment is inhibited by the dense thatch layer of non-native grasses (Gisler 2004). Other factors specific to Nelson’s checkermallow include pre-dispersal seed predation by weevils (Gisler and Meinke 1998), the potential threat of inbreeding depression due to small population sizes, and habitat fragmentation (Gisler 2003).

Habitats occupied by Nelson’s checker-mallow contain native grassland species and numerous introduced taxa (USFWS 2010). In some areas, habitats occupied by Nelson’s checker-mallow are undergoing an active transition towards a later seral stage of vegetative development, often due to the encroachment of non-native, invasive species (i.e., brush competition). Due to this rapid invasion by woody vegetation (especially Scot’s broom) in some areas and the suppression of natural fire regimes, secondary successional pressures on these plant populations are expected to increase over time. Habitat conversion via succession and/or agricultural activities poses measurable threats to the long-term stability of Nelson’s checker-mallow populations.

Agricultural and urban development have modified and destroyed habitats, fragmenting populations into small, widely scattered patches (USFWS 2010). In the Willamette Valley, extirpation is an ongoing threat to many Nelson’s checker-mallow occurrences on private lands, roadsides, and undeveloped lots zoned for industrial and residential development.

Prior to European colonization of the Willamette Valley, naturally occurring fires and fires set by Native Americans maintained suitable Nelson's checkermallow habitat (USFWS 2010). Current fire suppression practices allow succession of trees and shrubs in Nelson's checkermallow habitat. Remnant prairie patches in the Willamette Valley have been modified by livestock grazing, fire suppression, or agricultural land conversion. Stream channel alterations, such as straightening, splash dam installation, and rip-rapping cause accelerated drainage and reduce the amount of water that is diverted naturally into adjacent meadow areas. As a result, areas that would support Nelson's checkermallow are lost.

For additional information on recovery goals, objectives, and criteria, see *Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington (USFWS 2010a)*: http://www.fws.gov/oregonfwo/Species/PrairieSpecies/Documents/PrairieSpeciesFinalRecoveryPlan.pdf.

For more information on Status of the Species, see Appendix K.

Environmental Baseline

Regulations implementing the Act (50 CFR 402.02) define the environmental baseline as the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline.

The environmental baseline for the respective listed species covered in this PBO are listed below.

- Spotted owl is in Appendix D
- Marbled Murrelet is in Appendix E
- Bull Trout is in Appendix F
- Short Nosed and Lost River Sucker is in Appendix G
- Oregon Spotted Frog is in Appendix H
- Fenders Blue Butterfly is in Appendix I
- Kincade's Lupine is in Appendix J
- Nelsons Checker-mallow is in Appendix K

5.0 Effects of the Action

The ESA Section 7 implementing regulations (50 CFR 402.02) define "effects of the action" as:

> Effects of the action are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (50 CFR 402.02).

The bulk of the proposed action involves the upkeep, repair and maintenance of existing roadways and infrastructure, including bridges, overpasses, rights-of-ways, etc., and the majority of disturbance of the physical environment will be confined to those roadways and areas directly adjacent to them. ODOT will employ the Avoidance, Minimization and Conservation Measures included in Section 2.0, which we consider to be an integral and necessary part of the proposed action. By following the proposed action as described in Section 2.0, the vast majority of potential long-term adverse effects to listed species will be avoided, adequately minimized, or offset. Those that cannot be completely avoided, will be minimized to the greatest extent practicable or offset by compensatory mitigation actions. The conservation measures will also serve to avoid and minimize potential short-term adverse effects to listed species and maximize potential beneficial effects to listed species. The Service is consulting under the assumption that all pertinent conservation measures will be fully implemented throughout project administration, design, construction, monitoring and reporting from project inception to completion of monitoring and reporting.

Any activity that affects PBFs of designated CH, either directly or indirectly, may affect CH. Effects which are discountable, insignificant, or entirely beneficial are not likely to adversely affect CH. Effects that exceed this level are likely to adversely affect CH.

The following analysis considers the potential effects of the proposed action on the spotted owl and its CH, the murrelet and its CH, bull trout and its CH, Lost River sucker and its CH, short nosed sucker and it's CH, Oregon spotted frog and its CH, Fenders' blue butterfly and its CH, Nelson's checkermallow, and Kincaid's lupine.

5.1 Effects of the Proposed Action

The effects analysis for individual species in the PBA was conducted by evaluating how the proposed action will impact listed species, their habitats and/or the PBFs of their CH. Essentially, all effects to listed species are delivered through the displacement, disruption, degradation, removal, or addition of air, soil, chemicals, vegetation, and direct effects on individuals of a species. In the proposed action, FHWA/ODOT described the effects from very specific project elements/activities that may occur under the Program. Measures in Section 2 were designed to avoid or minimize those specific effects associated with the various construction activities associated with highway projects. For the purposes of the effects analysis here, we will further examine and analyze potential effects from specific repair activities in the proposed action and that are likely to adversely affect listed species.

The Service recognizes that bird species and individuals respond to auditory and visual stimuli differently based on life history, behavior, and existing level of exposure, and that there is a gradient of potential outcomes from a stimuli, ranging from not being detected to disruption (i.e., injury) (ONFBO). In this PBO, the Service is using two basic effects definitions for this analysis which are important for quantifying adverse effects to a species: (1) a *disturbance* is any potential auditory or visual stimuli or deviation from ambient/baseline conditions an individual bird, at a given site, is likely to detect and potentially react to; and (2) *disruption* is to be distracted to such an extent as to disrupt its normal behavior and create the likelihood of injury or loss of reproduction. The Service interprets a disturbance response to be something equivalent to showing apparent recognition or avoidance of the sight or sound by hiding, defending itself, moving its wings or body, or postponing a feeding so that the adult still feeds its young the same prey item and is a level less than disruption. In this PBO we are broadening our definition of disturbance somewhat by including what the ONFBO termed the "alert threshold." The Service has interpreted the disruption threshold to be exceeded if an adult is flushed from a nest or aborts a feeding visit such that the young does not receive the prey item or is kept from, or repeatedly flushed from, a nest, winter roost or important foraging area. Ultimately, disruption may lead to reduced productivity or survival due to lower fledging weight, physical injury or death of adult, hatchling or egg, from reduced feeding visits, nest inattentiveness (i.e., exposure or depredation), flushes, and high energy expenditure (ONFBO). Therefore, disruption primarily pertains to the critical nesting period for the spotted owl and marbled murrelet.

Following these definitions, a disturbance is any project-generated event that for a wildlife species may rise, at some point (i.e., via peak dBA, frequency, or duration), to the level of disruption. Therefore, this analysis should address the likelihood that potential disturbance associated with project activities will rise to the level of disruption based on the Service's current disruption thresholds and seasonal timing for each species and the ambient/baseline conditions existing along the roadway or adjacent to associated project activities.

A disturbance can be measured in many ways, including, but not limited to: proximity, frequency, duration, and intensity (i.e., peak dBA). Noise and visual stimuli may also be attenuated by topography, vegetation, humidity, and construction methods (i.e., the use of sound dampening or visual screening devices). However, because noise attenuation factors vary greatly (e.g., humidity, topography, and vegetation) and do not work as well for birds nesting high in the canopy, they will not be addressed in detail here. For birds occurring at a specific site, disturbance factors need to be viewed in the context of the existing ambient/baseline conditions, whether natural and manmade. An individual nesting near a roadway has likely become habituated to a predictable sight and sound stimulus pattern which are roadway-generated as well as natural stimuli. It is likely that because they are predictable, and no effects has come from them in the past, they are not perceived as a threat. An individual nesting in the interior of a forest is often only accustomed to naturally generated stimuli. The introduction of a foreign sight or sound stimulus may elicit a disturbance or disruption response from an individual in this situation because the stimulus was not predictable and thus perceived as a potential threat. The Service also believes that a stimulus, at a site with human activity, which exceeds the baseline proximity, frequency, duration or intensity conditions of that site, may also result in a disturbance or disruption response.

Effects to the Spotted Owl

The exception to this general pattern may be for spotted owls. Spotted owls are cryptic in appearance and behavior which helps them avoid detection and predation and often display behavior that appears to be naïve to human activity. This is the foundation for much of the research and monitoring used for spotted owls where close approaches by researchers are used to determine nesting and to capture them for banding (Forsman et al. 1984). In fact, often individual spotted owls become more agitated by the visual proximity of researchers shortly after they have been captured and handled (David Leal, USFWS, pers. obs.). The Service does not believe at this time that a visual disruption threshold for spotted owls is warranted.

The guidelines in Table 12 are based on the best available information regarding distances of which noise disturbance likely rises to the level of disruption. This is based on analyses of available disturbance and disruption data for the spotted owl in the ONFBO and internal discussion. Table 12 gives the distance for more common types of noise generating activities where the Service believes disruption to nesting spotted owls may be likely.

Table 9. Disturbance and disruption distances for spotted owl.

Distances for all activities except drone use are measured from the edge of the nest patch, unless the current nest tree is known, in which case the distance is measured from that tree. Distances for drone use apply to the nest patch even if the current nest tree is known. For all activities (including drone use), distances for murrelets are measured from the edge of occupied suitable habitat or unsurveyed suitable habitat.

Disturbance Source	Disturbance Distance During the Entire Breeding Season	Disruption Distance During the Critical Breeding Season	Disruption Distance During the Late Breeding Season*
Light maintenance of roads, campgrounds, and administrative facilities	0.25 mile	No restrictions; NA[1]	No restrictions; NA
Log hauling on open roads	0.25 mile	No restrictions; NA[2]	No restrictions; NA
Chainsaws (includes felling hazard/danger trees), Drones	0.25 mile	65 yards (spotted owls), 110 yards (murrelets)2	No distance restrictions, but time-of-day restrictions required for murrelets*
Heavy equipment for road construction, road repairs, bridge construction, culvert replacements, etc.	0.25 mile	65 yards (spotted owls), 110 yards (murrelets)[2]	No distance restrictions, but time-of-day restrictions required for murrelets*
Pile-driving (steel H piles, pipe piles), rock crushing, and screening equipment	0.25 mile	120 yards[3]	No distance restrictions, but time-of-day restrictions required for murrelets*
Blasting	1 mile	0.25 mile[3]	100 yards (spotted owls)[4], 0.25 mile (murrelets)[3]
****Helicopter: Chinook 47d (described as a large helicopter in the rest of this document)**	0.5 mile	265 yards[5]	100 yards (hovering only)[6]
****Helicopter: Boeing Vertol 107, Sikorsky S-64 (SkyCrane)**	0.25 mile	150 yards[7]	50 yards (hovering only)[6]
****Helicopters: K-MAX, Bell 206 L4, Hughes 500**	0.25 mile	110 yards[8]	50 yards (hovering only)[6]
****Small fixed-wing aircraft (Cessna 185, etc.)**	0.25 mile	110 yards	No distance restrictions, but time-of-day restrictions required for murrelets*
Tree Climbing	25 yards (spotted owls), 110 yards (murrelets)	25 yards (spotted owls), 110 yards (murrelets)[9]	No distance restrictions, but time-of-day restrictions required for murrelets*
Burning (prescribed fires, pile burning)	0.25 mile (spotted owls), 1 mile (murrelets)	0.25 mile[10]	No distance restrictions, but time-of-day restrictions required for murrelets*
Drone Use	0.25 mile	65 yards (spotted owls), 110 yards (murrelets)	N/A (spotted owls, as long as spotted owls are not pursued), 110 yards (murrelets)
Other activities	35 yards (spotted owls), 100 yards (murrelets)	35 yards (spotted owls), 100 yards (murrelets)	35 yards (spotted owls), 100 yards (murrelets)

** Aircraft normally use above ground level (AGL) as a unit of measure. For instance to not cause a disruption by medium and small helicopters during the late breeding season, the AGL would be 350 feet 350 feet AGL would account for 200 foot tall trees that spotted owls or murrelets would be occupying plus the 50 yards disruption distance.

1. NA = not applicable. Based on information presented in Tempel and Gutiérrez (2003, p. 700), Delaney et al. (1999, p. 69), we anticipate that the few spotted owls that select nest sites in close proximity to open roads either are undisturbed by or habituate to the normal range of sounds and activities associated with these roads. We anticipate that the few marbled murrelets that select nest sites in close proximity to open roads either are undisturbed by or habituate to the normal range of sounds and activities associated with these roads (Hamer and Nelson 1998, p. 21).

2. Based on Delaney et al. (1999, p. 67) which indicates that spotted owl flush responses to above-ambient equipment sound levels and associated activities are most likely to occur at a distance of 65 yards (60 m) or less. Based on recommendations from murrelet researchers that advised buffers of greater than 100 meters to reduce potential noise and visual disturbance to murrelets (Hamer and Nelson 1998, p. 13, USFWS 2012c, pp. 6-9).

3. Impulsive sound associated with blasts and pile-driving is highly variable and potentially injurious at close distances. We selected a 0.25-mile radius around blast sites as a disruption distance based on observed prairie falcon flush responses to blasting noise at distances of 0.3 – 0.6 miles from blast sites (Holthuijzen et al. 1990, p. 273). We have conservatively chosen a distance threshold of 120 yards for impact pile-driving and rock-crushing operations to avoid potential hearing loss effects and to account for substantial behavioral responses (e.g., flushing) from exposure to continuous sounds from impact pile driving.

4. Exposure to peak sound levels that are >140 dBA are likely to cause injury in the form of hearing loss in birds (Dooling and Popper 2007, pp. 23-24). We have conservatively selected 100 yards as an injury threshold distance based on sound levels from experimental blasts reported by Holthuijzen et al. (1990, p. 272), which documented peak sound levels from small blasts at 138 – 146 dBA at a distance of 100 m (110 yards).

5. Based on an estimated 92 dBA sound-contour from sound data for the Chinook 47d presented in Newman et al. (1984, Table D.1).

6. Rotor-wash from large helicopters is expected to be disruptive at any time during the nesting season due the potential for flying debris and shaking of trees located directly under a hovering helicopter. Hovering rotor-wash distance is based on a 300-ft radius rotor-wash zone for large helicopters hovering at < 500 above ground level (from WCB 2005, p. 2 – logging safety guidelines). We reduced the hovering helicopter rotor-wash zone to a 50-yard radius for all other helicopters based on the smaller rotor-span for all other ships. Because murrelet chicks are present at the nest until they fledge, they are vulnerable to direct injury or mortality from flying debris caused by intense rotor wash directly under a hovering helicopter.

7. Based on an estimated 92 dBA sound contour from sound data for the Boeing Vertol 107 the presented in the San Dimas Helicopter Logging Noise Report (USFS 2008, chapters 5, 6).

8. Based on Delaney et al. (1999, p. 74), which concluded that a buffer of 105 m (115) yards for helicopter overflights would eliminate flush responses from military helicopter overflights. The estimated 92 dBA sound contours for these helicopters is less than 110 yards (e.g., K-MAX (100 feet) (USFS 2008, chapters 5, 6), and Bell 206 (85-89 dbA at 100 m) (Grubb et al. 2010, p. 1277).

9. Distance for spotted owls is based on Swarthout and Steidl (2001, p. 312) who found that 95 percent of flush responses by spotted owls due to the presence of hikers on trails occurred within a distance of 24 m. Distance for murrelets is based on recommendations from murrelet researchers that advised buffers of greater than 100 meters to reduce potential noise and visual disturbance to murrelets (Hamer and Nelson 1998, p. 13, USFWS 2012c, pp. 6-9).

10.Based on recommendations presented in Smoke Effects to Northern Spotted Owls (USFWS 2008a, p. 4). The disruption distance for prescribed burning during the critical breeding period is based on concerns with dense, persistent smoke occurring at a site where spotted owls are nesting. Many factors influence how much smoke is produced and how far and in which direction it drifts.

Based on (1) the high ambient noise spotted owls are typically exposed to along forested sections of Federal and State highways and the spotted owl's tendency to nest away from high activity, (2) the noise level generated by construction equipment with blasting excluded (avoidance and minimization measure, section 2.3.13) which will not exceed overall daily ambient noise associated with traffic (including heavy truck traffic) on state highways, (3) the nocturnal foraging behavior of spotted owls, and (4) the relatively narrow disruption distance threshold (roughly 195 feet maximum for construction equipment and chainsaws) presented in table 7, the Service does not believe that most Program project construction activity will rise to the level of disruption for spotted owls and these projects would be considered to *not likely to adversely affect spotted owls*. In a more behavioral description, we anticipate that construction noise is not expected to cause spotted owls to flush from their roost, or demonstrate agitated behavior associated with stress. The exception to this would be the infrequent, large/loud, stationary projects (one to three per year) such as bridge replacement or other longer term projects that may span more than one construction season and potentially have adverse effects to spotted owls. These projects may cause stress behavior and agitation resulting in flushing from it's from a perch exposing it to depredation and expending energy it would otherwise not have used. This sort of activity could result in the injury or death of one spotted owl by predation of young resulting in death of 3 juveniles or eggs over the 15-year time frame of this PBO.

Most of habitat removal or alteration associated with the proposed action is related to project area clearing, equipment staging in proximity to construction sites or when creating access for equipment. Full implementation of the Sections 2.3.1, 2.3.12 and 2.3.24 conservation measures should help avoid and minimize adverse effects from construction activity on listed species habitat and include mitigation for unavoidable effects to habitat during implementation of the proposed action. An example of unavoidable effects to be mitigated would be the use of the spotted owl and murrelet mitigation bank established by ODOT to mitigate the loss of either species' habitat. These activities would include bridge replacement, curve corrections, laying back the slope at slide areas and adding additional lanes to a roadway.

Vegetation clearing may involve either riparian or adjacent upland vegetation. Vegetation clearing may be necessary despite avoidance and minimization measures to stage equipment or for access of a project site such as a bridge. The temporal and spatial scales of vegetation removal under the proposed action are important factors in evaluating the effects of the action. The temporal nature of vegetation removal is typically related to the age of the vegetation being removed and the time required to restore it (i.e., re-grow the vegetation). Mature trees take longer to be replaced and upland vegetation often takes longer to grow than riparian vegetation. Therefore, while the removal of younger riparian vegetation is considered a relatively temporary effect, the loss of mature conifers suitable for spotted owl can functionally be considered a long-term adverse effect equivalent to a loss. Through time, habitat loss along highways due to maintenance activities and widening projects often results in a small but permanent loss of habitat.

The effects of vegetation removal carried out during site specific FAHP projects are variable. Mature forests can function as nesting, roosting, foraging and/or dispersal habitat for spotted owls depending on stand size and landscape characteristics. The removal of suitable habitat may further limit nesting, roosting and foraging opportunities within a territory.

In the effects analysis, ODOT has estimated six anticipated Program projects which may affect spotted owls and these projects are expected to result in removal of up to two acres of spotted owl habitat annually. While this amount of habitat being removed across the range of the spotted owl in Oregon is relatively small, these incremental losses of habitat within owl territories may result in a reduced ability to support productivity and survival of owl pairs, especially if in close proximity to the nest site. Because the occupancy status of spotted owls in unsurveyed suitable habitat at proposed projects is usually not known it is difficult to know how much affect a given project is having at the territory level spotted owls are believed to avoid nesting along high activity roadways and highways due to the ambient high noise levels which would impair their detection of prey and avoidance of depredation.

Based on the timing, location and nature of the activities associated with Program projects and the critical nesting periods listed above for spotted owls, the probability of actions occurring during critical nesting periods within the respective disruption distances is relatively low. In their impact assessment, FHWA/ODOT (2018) estimated six anticipated projects annually *may effect, but are not likely to adversely affect* spotted owls. The majority of Program projects are localized, such as culvert replacement, or are a moving and temporary activity such as guard rail installation or paving and will occur in a moving fashion and not in one spot for more than a day (likely much less) and in high activity roadway corridors. Construction noise is not expected to be significantly higher (i.e., peak dBA) than existing baseline conditions but visual activity patterns will be different than the baseline condition. Based on this analysis it is likely that a very limited number of Program projects will occur during the spotted owl critical nesting periods within the disruption distance thresholds for noise (defined above) during the 15-year term of this PBO. This could result in the failed nesting/rearing of young or eggs. We anticipate one Program project every five years may result in fatal effects to one young or egg. Because spotted owls are more affected by noise than to visual stimulus, there is no visual disruption distance established for spotted owl.

Conclusion

Based on the small number of projects ODOT anticipates under the Program that will likely have construction activities within the 195-foot disruption threshold of suitable nesting habitat the Service believes that up to three individual spotted owls juveniles or eggs (three projects within 15 years) across the range of the species in Oregon will experience the effects of disruption from Program activities over this PBO term. The territorial nature of spotted owls precludes more than one pair or resident single spotted owl being in close proximity to a Program project. Depending on the timing of the event, disruption of a spotted owl may result in interrupting a juvenile feeding attempt by an adult, cause an adult or branching juvenile to demonstrate agitated behavior and turn their head, move or flush, disclosing their presence and subjecting them to predation.

While the amount of habitat being removed across the range of the spotted owl in Oregon is relatively small, these incremental losses of habitat may result in a reduced ability to support reproduction and survival of spotted owls at the local stand level. The loss of nesting habitat for spotted owls is not a benefit to the species or the population in Oregon but is such a small area in scattered amounts such that it would not preclude nesting at any spotted owl site.

Effects to Spotted owl Critical Habitat

Any activity occurring within designated CH that alters the PBFs, either directly or indirectly may affect spotted owl CH. Effects which are discountable, insignificant, or entirely beneficial to the PBFs are not likely to adversely affect CH. Effects that exceed this level are likely to adversely affect CH. Spotted owl habitat removal or alteration below 40% canopy cover results in the removal of nesting/roosting (PBF 2), foraging (PBF 3), and dispersal habitat (PBF 4). Due to the limiting nature of these habitats, removal of nesting/roosting and foraging habitats ***may affect, and is likely to adversely affect*** spotted owl CH.

In some cases, individual tree removal could include the removal of individual trees with spotted owl nesting structure from areas where the loss of such a tree or trees would limit nesting by spotted owls. In those cases, the loss of trees in suitable habitat ***may affect, and is likely to adversely affect*** spotted owl CH because such trees would substantially downgrade the ability of the area to provide spotted owl nesting habitat (PBF 2) in the future.

The PBA estimates the removal or degradation, collectively, of one acre of spotted owl CH annually associated with multiple projects that may only remove one or several trees each scattered across the action area, for a total of 15 acres over the life of the BO. The proposed action would affect PBFs 2, 3 and 4, although proportions of each are difficult to predict. The removal or degradation of these PBFs will, at the project scale, reduce the conservation value of the CH. If all the effects were to occur from one project and in one location, and all be in PBF 2, nesting/roosting habitat, there is a chance the effects could reduce the conservation value of one or up to two overlapping spotted owl territories comprised of resident single spotted owls, two pairs of spotted owls, or a combination of resident single and pair territories.

There are 1,024,122 acres of designated critical habitat for the spotted owl in Oregon. The smallest CHU in Oregon (Unit 10, Hood River) is 42,700 acres. A reduction of one acre would impact 0.00234 percent of that CHUs or 0.0000976 percent of CH in Oregon. The total acreage of one acre of impact is not likely to have a significant enough impact to reduce the conservation value of even one CHU. With a small number of acres potentially impacted, however, projects carried out by ODOT and funded by FAHP are not likely to impact the conservation value of CH at the CH subunit scale, so it also will not affect the conservation value at the critical habitat unit (CHU) or network-wide scales.

Because the impacts from the proposed action will result in a miniscule impact that the conservation value of the CH network will not be impacted, the CH network as a whole will continue to provide the existing and intended conservation value post-project.

Effects to the Marbled Murrelet

The proposed action is primarily associated with highways and higher use roadways. These highways currently experience a wide range of vehicular traffic levels. Individual birds nesting proximal to these roadways are doing so in the presence of high ambient/baseline noise levels in the 60 dBA to 80 dBA range from vehicles and likely experience other irregular noises such as chain saws, “jake” brakes, and guns exceeding 80 dBA. Marbled murrelets are sensitive to human presence and activities in close proximity to their nest trees. Auditory noise thresholds which would typically be applied to construction-generated noise (Hamer and Nelson 1998, p. 13, USFWS 2012c, pp. 6-9) are 330 feet or more. Therefore, for this analysis the more conservative 300-foot visual threshold (Table 13) will be used to determine the impacts to murrelets in the effects analysis. Noise and visual disturbance may disturb adult or juvenile murrelets and could cause them to flush from their nest site, cause a juvenile to prematurely fledge, or, more likely, could interrupt feeding attempts by the adult during the critical nesting period. While the effects of such disturbance are not clear, any of these impacts could result in the reduced fitness or even death of an individual bird due to missed feedings, or reduced protection of the young if adults are disturbed. The Service considers this to be a disruption of normal behavioral patterns.

Exposure to peak sound levels that are >140 dBA is likely to cause injury in the form of hearing loss in birds (Dooling and Popper 2007, pp. 23-24). Experimental blasts reported by Holthuijzen, et al. (1990, p. 272) documented peak sound levels from small blasts at 138 – 146 dBA at a distance of 100 m (110 yards). The Service has conservatively selected 100 yards as an injury threshold distance for noises in this range. Based on analyses of available disturbance and disruption data for the murrelet and internal discussion by the Service, Table 13 represents the disruption distance thresholds for more common types of noise-generating activities where the Service believes disruption to nesting murrelets may be likely.

Table 10. Disturbance and disruption distances for marbled murrelet.

Distances for all activities except drone use are measured from the edge of the nest patch, unless the current nest tree is known, in which case the distance is measured from that tree. Distances for drone use apply to the nest patch even if the current nest tree is known. For all activities (including drone use), distances for murrelets are measured from the edge of occupied suitable habitat or unsurveyed suitable habitat.

Disturbance Source	Disturbance Distance During the Entire Breeding Season (*April 1 to September 15*)	Disruption Distance During the Critical Breeding Season (*April 1 to August 5*)	Disruption Distance During the Late Breeding Season* (*August 6 to September 15*)
Light maintenance of roads, campgrounds, and administrative facilities	0.25 mile	No restrictions; NA[1]	No restrictions; NA
Log hauling on open roads	0.25 mile	No restrictions; NA[2]	No restrictions; NA
Chainsaws (includes felling hazard/danger trees), Drones	0.25 mile	65 yards (spotted owls), 110 yards (murrelets)2	No distance restrictions, but time-of-day restrictions required for murrelets*
Heavy equipment for road construction, road repairs, bridge construction, culvert replacements, etc.	0.25 mile	65 yards (spotted owls), 110 yards (murrelets)[2]	No distance restrictions, but time-of-day restrictions required for murrelets*
Pile-driving (steel H piles, pipe piles), rock crushing, and screening equipment	0.25 mile	120 yards[3]	No distance restrictions, but time-of-day restrictions required for murrelets*
Blasting	1 mile	0.25 mile[3]	100 yards (spotted owls)[4], 0.25 mile (murrelets)[3]
****Helicopter: Chinook 47d (described as a large helicopter in the rest of this document)**	0.5 mile	265 yards[5]	100 yards (hovering only)[6]
****Helicopter: Boeing Vertol 107, Sikorsky S-64 (SkyCrane)**	0.25 mile	150 yards[7]	50 yards (hovering only)[6]
****Helicopters: K-MAX, Bell 206 L4, Hughes 500**	0.25 mile	110 yards[8]	50 yards (hovering only)[6]
****Small fixed-wing aircraft (Cessna 185, etc.)**	0.25 mile	110 yards	No distance restrictions, but time-of-day restrictions required for murrelets*
Tree Climbing	25 yards (spotted owls), 110 yards (murrelets)	25 yards (spotted owls), 110 yards (murrelets)[9]	No distance restrictions, but time-of-day restrictions required for murrelets*
Burning (prescribed fires, pile burning)	0.25 mile (spotted owls), 1 mile (murrelets)	0.25 mile[10]	No distance restrictions, but time-of-day restrictions required for murrelets*
Drone Use	0.25 mile	65 yards (spotted owls), 110 yards (murrelets)	N/A (spotted owls, as long as spotted owls are not pursued), 110 yards (murrelets)
Other activities	35 yards (spotted owls), 100 yards (murrelets)	35 yards (spotted owls), 100 yards (murrelets)	35 yards (spotted owls), 100 yards (murrelets)

** Aircraft normally use above ground level (AGL) as a unit of measure. For instance to not cause a disruption by medium and small helicopters during the late breeding season, the AGL would be 350 feet 350 feet AGL would account for 200 foot tall trees that spotted owls or murrelets would be occupying plus the 50 yards disruption distance.

1. NA = not applicable. Based on information presented in Tempel and Gutiérrez (2003, p. 700), Delaney et al. (1999, p. 69), we anticipate that the few spotted owls that select nest sites in close proximity to open roads either are undisturbed by or habituate to the normal range of sounds and activities associated with these roads. We anticipate that the few marbled murrelets that select nest sites in close proximity to open roads either are undisturbed by or habituate to the normal range of sounds and activities associated with these roads (Hamer and Nelson 1998, p. 21).

2. Based on Delaney et al. (1999, p. 67) which indicates that spotted owl flush responses to above-ambient equipment sound levels and associated activities are most likely to occur at a distance of 65 yards (60 m) or less. Based on recommendations from murrelet researchers that advised buffers of greater than 100 meters to reduce potential noise and visual disturbance to murrelets (Hamer and Nelson 1998, p. 13, USFWS 2012c, pp. 6-9).

3. Impulsive sound associated with blasts and pile-driving is highly variable and potentially injurious at close distances. We selected a 0.25-mile radius around blast sites as a disruption distance based on observed prairie falcon flush responses to blasting noise at distances of 0.3 – 0.6 miles from blast sites (Holthuijzen et al. 1990, p. 273). We have conservatively chosen a distance threshold of 120 yards for impact pile-driving and rock-crushing operations to avoid potential hearing loss effects and to account for substantial behavioral responses (e.g., flushing) from exposure to continuous sounds from impact pile driving.

4. Exposure to peak sound levels that are >140 dBA are likely to cause injury in the form of hearing loss in birds (Dooling and Popper 2007, pp. 23-24). We have conservatively selected 100 yards as an injury threshold distance based on sound levels from experimental blasts reported by Holthuijzen et al. (1990, p. 272), which documented peak sound levels from small blasts at 138 – 146 dBA at a distance of 100 m (110 yards).

5. Based on an estimated 92 dBA sound-contour from sound data for the Chinook 47d presented in Newman et al. (1984, Table D.1).

6. Rotor-wash from large helicopters is expected to be disruptive at any time during the nesting season due the potential for flying debris and shaking of trees located directly under a hovering helicopter. Hovering rotor-wash distance is based on a 300-ft radius rotor-wash zone for large helicopters hovering at < 500 above ground level (from WCB 2005, p. 2 – logging safety guidelines). We reduced the hovering helicopter rotor-wash zone to a 50-yard radius for all other helicopters based on the smaller rotor-span for all other ships. Because murrelet chicks are present at the nest until they fledge, they are vulnerable to direct injury or mortality from flying debris caused by intense rotor wash directly under a hovering helicopter.

7. Based on an estimated 92 dBA sound contour from sound data for the Boeing Vertol 107 the presented in the San Dimas Helicopter Logging Noise Report (USFS 2008, chapters 5, 6).

8. Based on Delaney et al. (1999, p. 74), which concluded that a buffer of 105 m (115) yards for helicopter overflights would eliminate flush responses from military helicopter overflights. The estimated 92 dBA sound contours for these helicopters is less than 110 yards (e.g., K-MAX (100 feet) (USFS 2008, chapters 5, 6), and Bell 206 (85-89 dbA at 100 m) (Grubb et al. 2010, p. 1277).

9. Distance for spotted owls is based on Swarthout and Steidl (2001, p. 312) who found that 95 percent of flush responses by spotted owls due to the presence of hikers on trails occurred within a distance of 24 m. Distance for murrelets is based on recommendations from murrelet researchers that advised buffers of greater than 100 meters to reduce potential noise and visual disturbance to murrelets (Hamer and Nelson 1998, p. 13, USFWS 2012c, pp. 6-9).

10. Based on recommendations presented in Smoke Effects to Northern Spotted Owls (USFWS 2008a, p. 4). The disruption distance for prescribed burning during the critical breeding period is based on concerns with dense, persistent smoke occurring at a site where spotted owls are nesting. Many factors influence how much smoke is produced and how far and in which direction it will travel when burning.

All visual and noise-producing activities conducted within the above distance thresholds of known nest sites or unsurveyed suitable habitat during the murrelet critical nesting period of *April 1 to August 5* will be considered to result in adverse effects because these noises could; 1) cause flushing of adult murrelets brooding eggs which could cool off the eggs causing the young to die; 2) flushing that raises susceptibility of depredation on juveniles or eggs by corvids; 3) cause stress to brooding adults and their chicks; or, 4) cause an adult to abort an attempt to deliver food to the nest resulting in lowered fitness of the young due to lack of nourishment. Visual and non-blasting noise producing construction activities conducted from *August 6 to September 15* and implementing a daily limited operating period (LOP) of daytime work being conducted from two hours after sunrise to two hours before sunset are not likely to result in adverse effects because this will allow undisrupted morning and evening feeding of murrelet chicks by the adults.

Habitat removal or alteration associated with the Program is related to project area clearing, equipment staging in proximity to construction sites or when creating access for equipment. Full implementation of the Sections 2.3.1, 2.3.12 and 2.3.24 conservation measures should help avoid and minimize adverse effects from construction activity on vegetation and addresses mitigation for unavoidable effects to marbled murrelet habitat during Program activities.

Vegetation clearing may involve either riparian or adjacent upland vegetation. Vegetation clearing may be necessary despite avoidance and minimization measures to stage equipment or for access of a project site such as a bridge. The temporal and spatial scales of vegetation removal under this proposed action are important factors in evaluating the effects of the action. The temporal nature of vegetation removal is typically related to the age of the vegetation being removed and the time required to restore it (i.e., re-grow the vegetation). Mature trees take longer to be replaced and upland vegetation often takes longer to grow than riparian vegetation. Therefore, while the removal of younger riparian vegetation is considered a relatively temporary effect, the loss of mature conifers suitable for murrelet habitat can functionally be considered a long-term adverse effect equivalent to a loss. Habitat along highways has an increased susceptibility to maintenance activities and widening projects which often results in a permanent loss of habitat.

The effects of vegetation removal carried out during site specific FAHP projects are variable. Mature forests can function as nesting habitat for murrelets, depending on stand size and landscape characteristics. The removal of suitable nest trees for murrelets is essentially a loss due to relative scarcity of these mature trees on the landscape and the extended time it takes them to grow to those sizes again. Additionally, removal of younger trees surrounding suitable murrelet nest trees can degrade the quality of nesting stands by eliminating cover for thermoregulation and from predation.

Research has indicated that murrelets were more likely to nest further away from paved roads than random sites and that “nesting birds may be avoiding more human or predator activity along roads, rather than noise, per se” (Golightly et al. 2006). The distance to the nearest paved road was the best habitat correlate of nest site use at the stand scale (Manley and Nelson 1999; Meyer, et al. 2002, p 106), finding that murrelets were more likely to nest farther away from paved roads. Murrelets may be nesting farther from roads to avoid anthropogenic disturbance and nest predators such as Steller’s jays, which tend to be more abundant along forest edges (Marzluff et al. 2004) and near human settlements (Marzluff and Neatherlin, 2006). Roads create this forest edge and human settlements and campgrounds often occur along roads. Murrelet occupancy was most related to availability of low elevation, unfragmented old-growth forests within the fog zone that were close to highly productive marine areas (Meyer 2002, p 110).

For an example of nesting abundance, the Service’s analysis in the 2020 formal consultation for disturbance actions for the North Coast Planning Province (USFWS 2022 p.113) estimated a total acreage of 1,076,724 acres of suitable murrelet nesting habitat for both inland zones 1 and 2 within the north and south range of Recovery Zone 3. This Conservation Zone extends from the Columbia River, south to North Bend, Coos County, Oregon, and includes waters within 1.2 miles of the Pacific Ocean shoreline and extends inland a distance of up to 35 miles from the Pacific Ocean. The estimated at sea murrelet population in 2018 for Conservation Zone 3 was estimated at 8,414 birds, with a confidence interval from 5,866 to 12,183 birds (McIver et al. 2019, p 15). This was the close to the long-term average and there is no evidence for a long-term trend (McIver et al. 2019, p 9). Of the 4,207 potential nesting pairs for the north coast from at-sea surveys, dividing the acres of potential nesting habitat by the estimate of murrelet nesting pairs gives us 256 acres of suitable habitat per nesting pair, or actions within 0.36 mile (1886 foot) radius proximity. This is a very general landscape level view which does not address the fact that murrelets may nest in locally higher densities, however, it still illustrates that a very limited number of murrelets are likely to be nesting within the 330 foot radius (6.5 acres for a point project, larger for a linear project) visual disruption threshold for a given Program project.

Based on the information provided in the PBA, approximately three projects are anticipated to potentially occur annually within the coastal zone where murrelet nesting occurs (within 40 miles of the coast) during the critical breeding period. Minimization measures for auditory and visual disturbance discussed in the PBA include; 1) avoiding working within disruption distances of occupied or unsurveyed habitat during the critical breeding period; 2) observing daily timing restrictions in the late breeding period; and 3) operating outside the breeding season, would be implemented to avoid adverse effects to murrelets, although adverse effects may not be avoidable in all cases. Some of the larger projects may take multiple years to complete but the majority of the Program projects are smaller and many, such as paving and bridge restoration projects, can be done in one season which could minimize effects to murrelets from constant disturbance. With many of the highways and bridges along the coast being along forested habitat, it is likely that a small number of projects over the life of this PBO will occur within/adjacent to murrelet habitat; however, the probability of it occurring within the 330 foot visual disruption distance threshold of suitable habitat is low because most roadside habitat does not display interior forest conditions due to the edge effect influence of the road prism which reduces habitat suitability (increased light penetration, desiccation, altered vegetation species composition) for nesting. In areas where suitable nesting habitat does exist within 330 foot of a proposed action work will be completed outside the critical breeding period of the murrelet and honor daily timing restrictions in the later part of the breeding season. If working outside the critical breeding period within 330 feet of suitable murrelet habitat is not possible a separate consultation would be developed for that project.

Based on the timing, location and nature of the activities associated with Program projects and the murrelet critical nesting period, the probability of actions occurring during critical breeding period is relatively low. In their impact assessment, FHWA/ODOT (2020) estimated three projects annually may occur within 100 yards of murrelet nesting habitat during the critical nesting period, which could potentially adversely affect murrelets by interrupting a feeding attempt by adults or by startling a chick on the nest causing it to become more visible to predators. In these instances, the minimization measures discussed in the previous paragraph for auditory and visual disturbance would not be sufficient to avoid potential adverse effects. Most Program projects are localized work (culvert replacement, bridge repair, guardrail installation) and will occur in high activity roadway corridors. Construction noise is not expected to be significantly higher (i.e., peak dBA) than existing baseline conditions because Program funded projects occur on heavily traveled State roads and highways that already have a heavy baseline noise and where a great deal of human activity is already occurring.

While visual activity patterns will be different than the baseline condition due to workers walking around, we also expect a bird that relies on cryptic coloration and camouflage in the nest as a defense to continue to stay hidden when humans were nearby on the ground. By definition murrelet nesting habitat is dense forest and does not facilitate visual corridors where a murrelet on a nest could likely see the work activity on the roadway unless the nest was quite close to the busy roadway (well within 330 feet). In these situations we would expect murrelets nesting along the roadway (within the visual and sound-based disturbance distances above) to be acclimated to a heightened level of human activity, and those further away to be shielded from the view of construction by dense forest habitat.

Based on the small number of projects under the Program that will likely have construction activities within the 330-foot disruption distance, the acclimatization of murrelets near busy roadways, and the protective nature of dense forest from visual disturbance, the Service expects up to one individual murrelet chick within Oregon will experience disruption from the Program activities every five years. Over this PBOs 15-year initial term that would total 3 disruption events. Although unlikely given the murrelet's cryptic coloration and camouflage defense mechanism, on a rare occasion a murrelet chick could display agitated behavior disclosing their presence, and could possibly then be subjected to predation by corvids due to this disruptive action, resulting in nest depredation, chick death and that breeding seasons nest failure. The three murrelet per 15-year figure represents a reasonable worst-case scenario

Conclusion

In the biological assessment, FHWA/ODOT have estimated three anticipated Program projects may adversely affect murrelets through the removal of up to one acre of murrelet habitat annually. While this amount of habitat being removed across the range of the murrelet in Oregon is relatively small, these incremental losses of habitat may result in a reduced ability to support reproduction and survival of murrelets at the local stand level where these effects occur. Because these effects are not insignificant or discountable, we've determined they will adversely affect the marbled murrelet.

Over the life of the PBO, up to three murrelet chicks may be exposed to a greater risk of predation due to disruption from program activities during the breeding season. Whether this will result in actual predation is unknown, but the potential does exist. The potential loss of three murrelet chicks over 15 years is not a small impact, but would not be expected to result in a demographic impact that would preclude recovery of the species because of the existing population size, the available habitat within the coastal zone, and the timeframe over which these impacts may occur. While mitigation of impacts to habitat will occur and be offset by using credits in ODOTs spotted owl and murrelet habitat mitigation bank, that will not preclude the demographic impact of losing any murrelet chick to predation.

While these impacts have the potential to impact murrelet reproduction and numbers at the local stand level, they will not have more than an incremental impact on the species due to the factors listed above. In addition, we do not anticipate they will not have any impact on the overall distribution of the species.

Effects to Marbled Murrelet Critical Habitat

Any activity occurring within designated CH that alters the PBFs, either directly or indirectly, may affect murrelet CH. Effects which are discountable, insignificant, or entirely beneficial are not likely to adversely affect CH. Effects that exceed this level are likely to adversely affect CH. When an individual nest tree, PBF 1, is removed the surrounding stand may still function to support the life history needs of the murrelet. In this case the action may adversely affect PBF 1 and, therefore, murrelet CH, but is not expected to affect the conservation value of the larger area or stand.

This analysis of effects to murrelet CH focuses on the two PBFs specific to the species:

1) PBF1: Individual trees with potential nesting platforms, and

2) PBF 2: Forested areas within 0.5 mile of individual trees with potential nesting platforms, and with a canopy height of at least one-half the site-potential tree height. This includes all such forest, regardless of contiguity.

These PBFs are essential to provide and support suitable nesting habitat for successful reproduction of the murrelet. Impacts to forested non-habitat that occurs beyond 0.5 miles from stands with nesting structure would have no effect on murrelet CH because these areas are not associated with the PBFs.

Management between 300 feet and 0.5 mile from suitable habitat or nesting structure could cause fragmentation of the forested landscape and affect PBF 2.

The PBA estimates the removal or degradation, collectively, of one acre of murrelet CH annually associated with multiple projects that may only remove one or several trees each. The proposed action would affect both PBF 1 and PBF 2, although we don't know the proportions of each. The removal or degradation of these PBFs will, at the localized scale, degrade the quality of the PBFs of the CH at the project scale. If all the effects were to occur from one project and in one location, there is a chance the effects could impact the conservation value of one or two nesting stands. At this low level of effect, projects carried out by ODOT and funded by FAHP are not likely to impact the conservation value of CH at any scale beyond the stand level.

If, instead, the effects to murrelet CH cause fragmentation in numerous stands, the impacts would likely result in a decrease of the conservation value of those stands resulting from an increase in predation due to the facilitation of predators. Increases in murrelet nest predation have been documented when openings produce, cause, or result in berry production (Zharikov et al. 2006, p. 117). The increased time Steller's jays spend foraging for berries and insects in open stands may also result in more time to locate a murrelet nest in an adjacent stand. Additionally, removal of forested habitat adjacent to ODOT ROWs could reduce wind firmness and change the microclimate of the adjacent stand. Therefore, the murrelet recovery plan recommends a 300-600-foot forested buffer around murrelet habitat to help maintain successful murrelet nesting. It is difficult to predict the overall impact of numerous small openings spread throughout murrelet nesting habitat within coastal Oregon, but the total acreage of one acre of impact is not likely to have enough of an impact to the PBFs to impact the conservation value of even one critical habitat unit (CHU). There are 1,024,122 acres of designated critical habitat for the murrelet in Oregon. The smallest CHU is OR-06-a, at 39 acres, and the next smallest is OR-02-f, at 1079 acres. A reduction of one acre would impact 2.564 percent or 0.0927percent respectively of these CHUs as a worst-case scenario.

Conclusion

Because the impacts from the proposed action are expected to result in only a small impact to any CHU, the conservation value of no CHUs will be impacted, and the CH network as a whole will continue to provide the existing and intended conservation value post-project. However, because the effects to murrelet CH PBFs are not insignificant or discountable, we've determined the proposed action is likely to adversely affect murrelet CH.

Bull Trout

In the PBA, FHWA/ODOT conducted an impacts analysis to estimate the number of projects that may affect the fish in this consultation. Table 15 (below) summarizes the FHWA/ODOT bull trout impacts assessment for the proposed Program. These impact acreages were acknowledged to be conservative estimates due partly to an assumption that the projects would all adversely affect bull trout.

Projects that could adversely affect bull trout by increased localized turbidity (water quality) would be associated with culvert removal and upsizing, culvert replacement with a bridge, bridge repair and scour repair associated with undermining roads. These projects could result in a loss of vegetation cover adjacent to streams and have the potential to adversely affect fish through increased turbidity, increased water temperatures, increased susceptibility to erosion, and reduced opportunity for recruitment of large woody debris. The loss of vegetation at the localized scale is expected to result in increased sediments washing into the stream resulting in increased turbidity. This increase can result in damage to the gills of bull trout and causing bull trout to expend energy to relocate to other high-quality waters and increasing their exposure to depredation and thermal stress. Bull trout are very sensitive to water quality changes and seek rearing and breeding habitat in the upper reaches of a watershed where lack of turbidity (high water quality) and cool temperatures (canopy cover) are present and constant.
On the scale of individual projects, vegetation removal adjacent to streams is not expected to be a major effect to the bull trout. The ODOT Standard Specifications require ODOT to restore disturbed riparian habitat to proper functioning condition as well as the Avoidance and Minimization Measures described in the PBA sections 2.3.1, 2.3.5, 2.3.9, 2.3.10, 2.3.12, 2.3.15 - 2.3.20, 2.3.24-2.3.26.

The only metric for available bull trout habitat is designated critical habitat. Temporarily degrading two acres of bull trout habitat in the Mid-Columbia River Distinct Population Segment which consists of 93,500 acres, and 0.75 acres of bull trout habitat in the Klamath DPS which consists of 92,000 acres would impact 0.002139 percent and 0.000815 percent of designated critical habitat, respectively, in those DPS. In a worst-case scenario, some actions may occur in relative proximity to each other for construction efficiency based on ages and type of bridges being repaired, or replaced, or multiple emergency actions in a given system following a high water event. However, even in these situations the small impact areas for individual projects mean that potential additive adverse effects due to multi-projects impacts with a vegetation removal component could potentially increase turbidity and increased temperature which may cause the adult bull trout to expend energy in their pursuit of cold, high quality water elsewhere to forage and rear in. The impacts are still anticipated to be relatively small in scale on the watershed or species management unit (i.e., recovery or critical habitat unit) level, and therefore have minimal effects on local or watershed populations.

Table 11. FHWA/ODOT Estimated maximum yearly projects that may affect USFWS fish species from FAHP projects (FHWA/ODOT 2018).

Species	Possible yearly projects (#)	Streambank Hardneing – Linear ft	Total Riparian Habitat Impacts (Acres)	Critical Habitat Impacts (Acres)	Individuals handled	Riparian Trees Removed	Aquatic Piles Driven
Fish:							
Bull Trout - Columbia River DPS	10	500	2	2	50	25	100
Bull Trout - Klamath River DPS	3	150	0.75	0.75	15	8	30
Lost River Sucker	2	100	1	1	20	4	20
Shortnose Sucker	2	100	1	1	20	4	20

Streambank hardening will be limited and localized in areas where infrastructure such as a bridge or a road is vulnerable to damage or failure in a high-water event. Streambank armoring is typically above ordinary mean high water and placed to deflect high flow stream energy at bridge abutments and streams adjacent to transportation corridors. Streambank hardening results in the permanent removal of riparian vegetation, reducing stream shading and the input of macroinvertebrates, which bull trout and their fish prey species forage on. We anticipate resident bull trout will be able to move up or downstream to areas with a more robust forage base, and the effects of loss of shading will be extremely localized and small as to have a negligible effect to individuals and the population as a whole.

Riparian trees removed would be only those areas associated with the repair or replacement of a culvert or bridge, or hazard trees threatening health and human safety and at risk of falling on roadways, all of which are on a small scale relative to the bull trout range. Riparian tree removal for Program projects are restricted to a narrow footprint around the proposed action and would be revegetated with native species post construction. The temporary loss of this habitat will increase the potential for erosion and sediment inputs into the stream and reduce the input of invertebrates entering the stream for bull trout and their fish prey species to forage on. Removal of shade trees may allow more sun to hit the waterway, which may increase water temperatures. Increased temperatures could cause thermal stress to bull trout, resulting causing them to leave the area expending energy and increasing exposure to depredation in their search for high quality habitat to hold and rear in. However, vegetation removal at this scale would not likely have a measurable increase in any stream temperature because the area affected will be very small and dispersed between project sites.

Pile Driving (Hydroacoustics)

When site conditions and contract provisions allow, piles will be driven with vibratory hammers. Currently, no fish-kills have been linked to the use of vibratory hammers. To minimize sound pressure wave impacts on listed fish when steel pile must be driven with an impact hammer, the most efficient, practicable sound attenuation devices will be used. Through participation in the Hydroacoustics Working Group (HAWG), ODOT will keep abreast of best available sound attenuation methodologies and modify sound attenuation practices as necessary. Vibratory hammers produce peak pressures that are approximately 17dBA lower than those from impact hammers (Nedwell and Edwards 2002). Sound attenuation devices will not be used if piles are driven with vibratory hammers.

The FHWA/ODOT have proposed activities which will require the installation of permanent and temporary piles which will expose fish to increased underwater sound during pile driving. Those include requirements that a vibratory hammer must be used whenever possible for piling installation (which often still requires impact hammer to proof the bearing capacity of a pile), and full or partial isolation of the pile (bubble curtain) while it is being driven using a hammer strike pile driver. Nonetheless, it is still likely that sound energy will radiate directly or indirectly into the water as a result of pile driving vibrations, although because of these minimization measures widespread propagation of sounds injurious to fish is not expected to occur. Additionally, total suspended sediment will increase with every pile removal.

The installation and removal of piles with a vibratory or impact hammer is likely to result in adverse effects to bull trout and short-nosed suckers due to the increased levels of underwater sound pressure (the effects of turbidity, sedimentation and chemical release are discussed above). A bubble curtain would be employed to abate the sound/shock wave of the use of a hammer strike pile driver to reduce effects to aquatic life. Although there is limited information regarding the effects on bull trout from underwater sound pressure waves generated during piling installation (Anderson and Reyff 2006, Laughlin 2006), laboratory research on the effects of sound on fish has used a variety of species and sounds (Popper and Clarke 1976, Hastings *et al*. 1996, Scholik and Yan 2002). Because those data are not reported in a consistent manner and most studies did not examine the type of sound generated by pile driving, it is difficult to directly apply the results of those studies to pile driving effects on bull trout. However, it is well established that elevated sound pressure can cause injuries to fish swim bladders and internal organs potentially causing death to some individuals. The degree to which normal behavior patterns are altered is less known.

The installation of steel piles with an impact hammer is expected to result in adverse effects to individual fish due to high levels of underwater sound pressure. The degree to which an individual fish exposed to underwater sound will be affected (from startle response, stress and confused behavior, fleeing the area, to mortality) is dependent on a number of variables such as species of fish, size of the fish, presence of a swim bladder, sound pressure intensity and frequency, shape of the sound wave (rise time), depth of the water around the pile and the bottom substrate composition and texture. The startling of a bull trout and causing it to flee an area would cause stress and result in the expenditure of energy and potentially a small increased predation risk. The Department of the Navy conducted a series of experiments to determine the effects on fish from underwater explosions (Goertner *et al*. 1994, Gaspin 1975) which resulted in significant differences in effects to fish depending on whether or not they had swim bladders. Research indicates it's likely the inflated swim bladder rapidly expanding as the sound pressure wave passes through the fish which causes the injuries to internal organs (Keevin and Hempen 1997). An important characteristic of the underwater sound that causes injury is the frequency. During pile installation, most energy is contained within the frequency range (100 to 1,000 Hertz) which results in reverberation of the swim bladder and other internal organs. Studies have shown that the most susceptible tissues that are injured during exposure to underwater sound pressure produced from pile driving are the soft-tissue organs surrounding the swim bladder, such as the liver and kidney (CalTrans 2001, Abbott and Bing-Sawyer 2002). Bubble curtains, dewatering the action area or fish exclusion will be utilized to minimize effects to fish and as such will likely avoid injuring fish. However, there is a chance fish will be injured or killed resulting in adverse effects to individuals.

In the past, FHWA/ODOT anticipated that maximum peak underwater sound pressure level (SPLs) of 206 dB on any particular project that has pile driving will occur at a distance of 10 feet from in-channel piles being installed. According to Hastings and Popper (2005), the use of the sound exposure level (SEL) metric, is a more appropriate metric to use to correlate physical injury to fish from underwater sound pressure produced during the installation of piles than peak sound pressure level. Data collected during monitoring studies in California show a strong relationship between peak pressure and SEL, with an average 25 dB difference between the two metrics (Caltrans 2007).

FHWA/ODOT propose, per current pile driving best practices, to use a confined bubble curtain on each project to help attenuate sound pressure waves associated with pile driving. The 32-inch (or less) temporary piles will be driven in the wetted channel. Any piles driven in the channel with a hammer strike pile driver will be within a confined bubble curtain or other site appropriate abatement device. Bubble curtains are essentially perforated pipes or hoses, surrounding the pile being driven, that produce bubbles when air is pumped through the perforations such that the water column is filled with bubbles (air) which is much less effective at transmitting concussive energy. Bubble curtains have been demonstrated to reduce the mortality of caged shiner surfperch (Caltrans 2001). Air bubbles can reduce sound pressure levels (SPLs) at some frequencies by as much as 30 dB (Gisiner *et al.* 1998). Bubble curtains can also reduce particle velocity levels (MacGillivray and Racca 2005).

A confined bubble curtain used in driving 30-inch steel piles at a Washington State Ferries facility in Eagle Harbor, Washington, attenuated SPLs by an average of 9.1 dB (MacGillivary and Racca 2005, p. 59). Whether confined inside a sleeve made of metal or fabric, or unconfined; these systems were shown to reduce underwater sound pressure (Longmuir and Lively 2001; Reyff and Donovan 2003). Unconfined bubble curtains can lower sound pressure levels by as much as 17 dB (Longmuir and Lively 2001).

Of the average of 62, 12 to 36-inch piles (this includes temporary detour bridges, drilled shaft support structure, work bridges and falsework construction) driven per bridge replacement project (less for a repair project depending on work bridge and detour bridge needs), it varies greatly as to how many strikes it takes to drive a pile depending on substrate and other variable. In looking at several “typical” bridges there were on average 558 strikes per pile. This means a typical bridge replacement project would have approximately 34,596 pile strike of which there would be up to 3500 per day.

To minimize sound pressure wave impacts on bull trout when steel piles are driven with an impact hammer, ODOT commits to using the most efficient, practicable sound attenuation devices. Through participation in the Hydroacoustics Working Group (HAWG), ODOT will keep abreast of best available sound attenuation methodologies and modify sound attenuation practices as necessary. When site conditions and contract provisions allow, piles will be driven with vibratory hammers. Currently, no fish-kills have been linked to the use of vibratory hammers as peak pressures produced by vibratory hammers are approximately 17dBA lower than those from impact hammers (Nedwell and Edwards 2002) and in a range that is not detrimental to the internal organs of fish, obviating the need for sound attenuation devices.

Aquatic pile driving in bull trout habitat would be associated with bridge repair and replacement where vibratory hammers are almost exclusively used. The driving of piles in aquatic habitat will increase turbidity, briefly and temporarily, which could scar bull trout gills and will cause them to expend energy moving out of the impacted area to higher quality waters. There is potential for these sub-lethal, and potentially some lethal effects, to bull trout from these effects, even though we would expect bull trout to move away from inwater projects.

For the three estimated projects annually in bull trout habitat within the Klamath interim recovery unit for bull trout 30 piles will be driven. Of those, most will occur in migratory and foraging habitat because the vast majority of spawning and rearing habitat is at higher elevations where there are fewer highways and roads. Because of the small numbers for most bull trout populations using lower elevation foraging and migratory habitat during the mid to late summer in-water work period, the likelihood of an adult bull trout being within an area where pile driving is occurring is low, so the likelihood of impact is low. In addition, the use of sound abatement techniques, including bubble curtains as directed in section 2.3.19 for minimization for hammer strike pile driving, will reduce the sound pressure to varying degrees depending on stream variables such as water depth and substrate. It is possible there could be delayed migration of a very small number of adult bull trout if fish moving upstream encounter pile driving activities and the associated machinery and human presence. The length of time a bull trout delays its migration will depend on the frequency and overall duration of pile driving activities. Small delays in migration are not expected to impact the ability of bull trout to forage or reproduce in the long term or have an impact to reproduction.

When ODOT does an inwater project they are required to isolate the stretch of the stream and remove all the fish present, including bull trout. This fish removal is conducted by isolating the stream using nets and removing the fish from the isolated portion using electroshocking techniques. The fish are then kept in holding tanks or moved upstream, depending on the conditions of each project. Electroshocking is a proven and safe technique that uses an electrical shock from a battery to stun the fish until it can be scooped up in a net and transferred to a bucket for holding and movement. While safe, the fish are temporarily stunned and kept in captivity for some period of time. While the impacts of these actions are temporary, they can result in stress to the fish from handling, from being kept in a bucket with other fish, etc. During removal and transferring some fish have been known to die, although this is rare. Of the 65 fish handled every year, we expect they will all experience stress from the process, and we anticipate that one bull trout each year may perish from these processes. The stress to all the fish is expected to have a temporary impact with no long-term impacts to bull trout numbers, distribution or reproduction. The lethal loss of 15 bull trout over the life of the PBO will have a small impact to bull trout numbers across the two DPSs, but is not expected to have more than a minor impact on bull trout reproduction or distribution.

Most of the bull trout spawning and rearing habitat is higher in the river system than the vast majority of highways and roadways, but a very limited number of projects may occur there. The avoidance and minimization measures are anticipated to minimize adverse effects from stormwater runoff on bull trout. Those bull trout that are impacted will move out of that downstream area and possibly into another reach of stream that is unaffected.

Conclusion

In the impacts assessment, FHWA/ODOT estimated two acres of bull trout habitat in the Columbia River DPS and 0.75 acre in the Klamath DPS will be degraded or made non-functional per year. Over the course of the 15- year term of this BO would total 30 acres and 11.25 acres respectively. The removal of riparian habitat and trees, pile driving and bank armoring would also contribute to loss of habitat. This loss of this habitat could result in a localized loss of breeding capacity, habitat for foraging and for migration corridors, leading to a reduction in population resilience and genetic isolation. While this amount of habitat being removed across the range of the bull trout in Oregon is relatively small, these incremental losses of habitat may result in a reduced ability to support reproduction and survival of bull trout at the local and watershed level where these effects occur. These effects will be minimalized, however, because these reductions will be in very small and dispersed parcels so adjacent habitat will support local bull trout. Because these impacts to individual bull trout are not insignificant or discountable, the loss of bull trout habitat is an adverse effect.

The annual armoring of 500 linear feet of bull trout habitat in the Columbia DPS and 150 linear feet in the Klamath DPS annually could permanently remove riparian vegetation and trees and eliminate their contribution of shade and invertebrate inputs into the aquatic habitat. Over the course of the 15-year term of this BO this would total 7500 linear feet and 2250 linear feet in these two DPSs, respectively. These removals will be spread across large landscapes and in very small parcels making up the total. Removing shade in these parcels may result in incremental increases in water temperatures causing bull trout to potentially avoid these areas or suffer thermal stress and the expenditure of energy to move out of these areas. The loss of invertebrate inputs into the system would incrementally reduce prey species of the bull trout who utilize these invertebrates as a food source particularly in their early life stages. Because these impacts to individual bull trout are not insignificant or discountable, the permanent loss of bull trout habitat is an adverse effect. Spread across the action area these impacts will be in small pieces and are not expected to have significant impacts at the population scale.

The annual pile driving of 100 piles in bull trout habitat in the Columbia DPS and 30 piles in the Klamath DPS may temporarily increase suspended sediments and cause a bull trout to relocate to avoid this sediment, human and mechanical presence. Over the course of the 15-year term of this BO this would total 1500 and 450 piles, respectively. As noted above the suspended sediments resulting from this activity can scar gills and cause bull trout to relocate to higher quality water causing expended energy and increasing depredation risks. These adverse impacts to individual bull trout are not expected to have long-term impacts to individuals, or to the numbers, reproduction or distribution of bull trout in the action area.

Riparian vegetation and tree removal would affect two acres of riparian habitat and 25 trees in the Columbia DPS and 0.75 acres and eight tees in the Klamath DPS trees annually. Over the course of the 15-year term of this BO would total 30 acres and 11.25 acres respectively and 375 trees and 120 trees respectively. This loss of habitat and trees could increase water temperature at a localized scale causing bull trout to expend energy to avoid the areas of thermal stress and reduce the inputs of invertebrates into the aquatic environment reducing foraging options either on the invertebrates directly or the other fish species who are bull trout prey. Because of their small and dispersed scale, these adverse impacts to individual bull trout are not expected to have more than an incremental impact on bull trout numbers, reproduction and distribution.

Effects to Bull Trout Critical Habitat

Federal Aid Highways Program funding of projects covered in this PBO are rare in higher elevations and in areas bull trout seek out high quality and cold water (PBF 8), and which provide thermal refugia and facilitate spawning and rearing of bull trout, (PBF 6). The projects which would be funded by FAHP are much more likely to occur on state highways in lower elevations and affect PBFs associated with foraging, (PBF 3), and migration, (PBF 2). Aquatic piles driven, bank hardening and riparian trees removed would be action with potential effects to bull trout critical habitat PBFs.

Bull trout CH is quantified in acres of reservoir/lake and miles of river. ODOT's effect to bull trout CH will be much localized and almost totally associated with a stream crossing involving bridge and culvert work or scour repair which is undermining a road. FAHP funded projects would realistically be measured in tens of feet. Hypothetically, up to 100 feet of impacted stream would equal 1.894 percent of a mile of stream habitat. In Oregon, CHU 7, Odell Lake, at 17 river miles is the CHU with the fewest river miles of bull trout CH. If 100 feet of bull trout CH was affected in CHU 7 that would equal 0.1114 percent of the CH in CHU 7. In Oregon, the CHU with the fewest acres of reservoir/lake bull trout CH is Unit 5, Hood River, with 91.1 acres. In a worst-case scenario if all proposed acres affected would occur in CHU 5 reservoirs/lakes component, 2.1978 percent of bull trout CH would be affected. In the Klamath River Basin, CHU 9, there are 9329.4 acres and 276.6 miles of bull trout CH. ODOT proposed projects funded by the FAHP are projected to effect 0.75 acres of bull trout CH. This equates to 0.00801 percent of the existing reservoir/lake CH acres. One-hundred feet of affected river CH would equal 0.00685 percent of bull trout CH in Unit 9.

At this level of effect, projects carried out by ODOT and funded by FAHP are likely to have impacts to bull trout PBFs at the localized scale. Because these impacts are not insignificant or discountable to PBFs at the local scale, these impacts are likely to adversely affect bull trout CH. These effects, however, are so small they are not likely to have an adverse effect to the individual CHUs they are in.

Because the impacts from the proposed action will result in a very small impact, and the conservation value of no CHUs will be impacted, then the CH network as a whole will continue to provide the existing and intended conservation value post-project.

Effects to Lost River and Short-nosed Sucker

In the PBA, FHWA/ODOT conducted an impacts analysis to estimate the number of Program projects that may affect the listed Lost River and short nosed sucker. Table 16 summarizes the FHWA/ODOT impacts assessment for the proposed Program. These impact acreages were acknowledged to be conservative estimates due partly to an assumption that the projects would all adversely affect the Lost River and short nosed sucker. However, it's likely these projects will be a mix of "not likely to adversely affect" and "likely to adversely affect" actions. Based on this and the Service's experience with a limited number of formal consultations on individual transportation projects that resulted in habitat removal, we believe most of these impact estimates are overestimates.

On the scale of individual projects, vegetation removal is not expected to cause a major effect to the Lost River and short nosed sucker as they are not thermally challenged and not reliant on cold, clear water. Some actions may occur in relative proximity to each other for construction efficiency based on ages and type of bridges being repaired or replaced or multiple urgency actions in a given system following a high-water event. However, even in these situations the small impact areas for individual projects mean that potential additive adverse effects due to multi-projects with a vegetation removal component are still anticipated to be relatively small in scale on the watershed or species management unit (i.e., recovery or critical habitat unit) level, and therefore have minimal effects on local or watershed populations.

In the OTIA III Statewide Bridge Delivery Program (FHWA/ODOT 2004) the Service and FHWA agreed on an estimate that 4 acres of Oregon chub habitat would be lost from the bridge replacement and repair projects covered under the programmatic biological opinion. After ten years of the program the actual amount of acreage removed was less than the 4 acres anticipated.

To determine more likely impact numbers the Service has taken the FHWA/ODOT risk assessment numbers and refined them using additional information in ODOT's database. Based on previous consultations, it has regularly been bridge repair and replacement projects that have resulted in small amounts of riparian and aquatic habitat impacts for listed aquatic species. The FHWA/ODOT impact assessment database calculated the average amount of riparian and aquatic habitat impacts for bridge repair and replacement projects based on past projects. The Service then multiplied that by the number of anticipated bridge repair and replacement projects by species in the Program to quantify the anticipated amount of habitat impacted. The results are presented in Table 16. To account for uncertainty in the bridge projects and to account for any impacts from a few non bridge projects that have similar effects to bull trout (e.g., bank stabilization or culvert replacement projects), the Service has doubled the bridge impacts to determine what we believe to be a conservative but more likely estimate of the amount of habitat that will be impacted by projects in the Program.

Table 12. The Service's refined habitat loss estimates based on the FHWA/ODOT impacts analysis database and projected 2020 to 2030 Program projects.

Species	# projects/acres impacted per project	**Total (rounded up)**	**Total x 2 to account for project uncertainty**
Bull trout (Columbia)	10/0.2	2 acres	4 acres
Bull trout (Klamath)	3/0.25	0.75 acre	1.5 acres
Lost River sucker	2/0.5	1 acre	2 acres
Short-nosed suckers	2/0.5	1 acre	2 acres

Increased Erosion, Turbidity, Sediment Transport, and Chemical Exposure

The effects of suspended sediments may result in sub-lethal or lethal direct effects and are generally correlated to the concentration of sediment within the water column. Fish death can be a result of a combination of factors, and thus is difficult to attribute to suspended sediment alone (Waters 1995). Substrate embeddedness has also been shown to affect aquatic macroinvertebrate abundance and species composition, thus altering the availability and suitability of a critical food source. Lastly, soils can act as a delivery mechanism for transferring chemical pollutants from upland sources. Any suckers exposed to additional turbidity from an individual project would be downstream from the construction area. Because work will be conducted from the top of bank during low water period and primarily out of the wetted channel or within isolation, turbidity from construction activities should be short-term, temporary, and during the inwater work period when the species is also unlikely to be present. These suckers are much less sensitive to turbidity than bull trout as they evolved to live in these waterbodies that are subject to periodic and episodic turbidity. Therefore, we do not anticipate adverse effects. Turbidity will decrease as it flows downstream and will likely return to baseline levels at the bottom of the action area.

Based on the robust BMPs we anticipate low levels of turbidity generated by individual bridge Rehabilitation Projects activities the Service does not anticipate adverse effects to occur and does not expect fish passage to be blocked. However, the Service anticipates adverse effects in the form of delays in migration when projects hinder movement and possibly degraded fish health. The BMPs alleviate concerns for fuel and chemical spills associated with Program projects.

Stormwater management is another water quality issue that can affect fish. Research has shown that dissolved copper and other metals found in stormwater runoff from roadways (derived from the copper in vehicle brake pads) can impair salmonid olfactory senses (Brooks 2004) and may affect Lost River and short-nosed suckers as well, however, we are unaware of any specific studies looking at these species. Stormwater runoff from highway systems can deliver a variety of chemical and sediment pollutants to streams from rain (NMFS 2008). While stormwater management is an evolving topic, the avoidance and minimization measures in section 2.3.26 reflect the current best management practices which are practicable for treating water quality before entering a stream. Water quality in the Klamath Basin for the suckers is already considered a limiting factor for those species, particularly during the summer, however, if any waste water is treated as outlined in the conservation measures, it should not significantly affect the lake or riverine systems where these fish reside.

Accidental spills will be contained within the work area following the avoidance and minimization measures in section 2.3.5. In addition, bridge stripping and prep work is required to have negative pressure containment for the purposes of keeping lead or other toxic metals out of the environment (section 2.3.17 and Appendix C in the PBA). A negligible amount of chemical exposure is anticipated from the paint removal and zinc application which is not anticipated to have more than a minor impact to suckers in a very local downstream area. These suckers will likely move out of the area where they can avoid exposure until it is diluted enough to not be an issue. This will cause the sucker to use energy they otherwise wouldn’t have needed to expend and subject them to minor increased depredation risks. As with bridge stripping, for bridge painting, most project activities use an effective and approved level of containment that has been used for the activity previously. However, as our experience on the OTIA III program has shown, small breaches in containment may occur on projects. Monitoring and inspection process have promptly identified and rectified these occurrences. If fish are removed from the area and excluded there would be no effect to fish from chemical exposure.

Development and implementation of the Erosion, Sedimentation, and Pollution Control avoidance and minimization measures (section 2.3.5) specific to each activity will substantially constrain these exposure events. The Service does not expect any lethal effects from increased erosion, turbidity, sediment transport, and chemical exposure to suckers because these suckers evolved in a turbid and warm water environment and the proposed action will be moderated by robust BPMs. Overall adverse effects will be avoided or minimized to the maximum extent practicable or constrained to only those likely to be minimal in nature. The minimal nature and likelihood of adverse effects at any individual project site, and the fact that any such effects that do occur will be distributed across Oregon and over a four year period mean that impacts to local and watershed level fish populations should be extremely small.

Pile Driving (Hydroacoustics)

When site conditions and contract provisions allow, piles will be driven with vibratory hammers. Currently, no fish-kills have been linked to the use of vibratory hammers. To minimize sound pressure wave impacts on listed fish when steel pile must be driven with an impact hammer, the most efficient, practicable sound attenuation devices will be used. Through participation in the Hydroacoustics Working Group (HAWG), ODOT will keep abreast of best available sound attenuation methodologies and modify sound attenuation practices as necessary. Vibratory hammers produce peak pressures that are approximately 17dBA lower than those from impact hammers (Nedwell and Edwards 2002). Sound attenuation devices will not be used if piles are driven with vibratory hammers.

The FHWA/ODOT have proposed activities which will require the installation of permanent and temporary piles which will expose fish to increased underwater sound during pile driving. Those include requirements that a vibratory hammer must be used whenever possible for piling installation (which often still requires impact hammer to proof the bearing capacity of a pile), and full or partial isolation of the pile (bubble curtain) while it is being driven using a hammer strike pile driver. Nonetheless, it is still likely that sound energy will radiate directly or indirectly into the water as a result of pile driving vibrations, although because of these minimization measures widespread propagation of sounds injurious to fish is not expected to occur. Additionally, total suspended sediment will increase with every pile removal.

The installation and removal of piles with a vibratory or impact hammer is likely to result in adverse effects to Lost River and short-nosed suckers due to the increased levels of underwater sound pressure (the effects of turbidity, sedimentation and chemical release are discussed above). A bubble curtain would be employed to abate the sound/shock wave of the use of a hammer strike pile driver to reduce effects to aquatic life. Although there is limited information regarding the effects on bull trout from underwater sound pressure waves generated during piling installation (Anderson and Reyff 2006, Laughlin 2006), laboratory research on the effects of sound on fish has used a variety of species and sounds (Popper and Clarke 1976, Hastings *et al*. 1996, Scholik and Yan 2002). Because those data are not reported in a consistent manner and most studies did not examine the type of sound generated by pile driving, it is difficult to directly apply the results of those studies to pile driving effects on Lost River and short-nosed suckers. However, it is well established that elevated sound pressure can cause injuries to fish swim bladders and internal organs potentially causing death to some individuals. The degree to which normal behavior patterns are altered is less known.

The installation of steel piles with an impact hammer is expected to result in adverse effects to individual fish due to high levels of underwater sound pressure. The degree to which an individual fish exposed to underwater sound will be affected (from startle response, stress and confused behavior, fleeing the area, to mortality) is dependent on a number of variables such as species of fish, size of the fish, presence of a swim bladder, sound pressure intensity and frequency, shape of the sound wave (rise time), depth of the water around the pile and the bottom substrate composition and texture. The startling of a sucker and causing it to flee an area would cause stress and result in the expenditure of energy and potentially a small increased predation risk. The Department of the Navy conducted a series of experiments to determine the effects on fish from underwater explosions (Goertner *et al*. 1994, Gaspin 1975) which resulted in significant differences in effects to fish depending on whether or not they had swim bladders. Research indicates it's likely the inflated swim bladder rapidly expanding as the sound pressure wave passes through the fish which causes the injuries to internal organs (Keevin and Hempen 1997). An important characteristic of the underwater sound that causes injury is the frequency. During pile installation, most energy is contained within the frequency range (100 to 1,000 Hertz) which results in reverberation of the swim bladder and other internal organs. Studies have shown that the most susceptible tissues that are injured during exposure to underwater sound pressure produced from pile driving are the soft-tissue organs surrounding the swim bladder, such as the liver and kidney (CalTrans 2001, Abbott and Bing-Sawyer 2002). Bubble curtains, dewatering the action area or fish exclusion will be utilized to minimize effects to fish and as such will likely avoid injuring fish. However, there is a chance fish will be injured or killed resulting in adverse effects to individuals.

In the past, FHWA/ODOT anticipated that maximum peak underwater sound pressure level (SPLs) of 206 dB on any particular project that has pile driving will occur at a distance of 10 feet from in-channel piles being installed. According to Hastings and Popper (2005), the use of the sound exposure level (SEL) metric, is a more appropriate metric to use to correlate physical injury to fish from underwater sound pressure produced during the installation of piles than peak sound pressure level. Data collected during monitoring studies in California show a strong relationship between peak pressure and SEL, with an average 25 dB difference between the two metrics (Caltrans 2001).

FHWA/ODOT propose, per current pile driving best practices, to use a confined bubble curtain on each project to help attenuate sound pressure waves associated with pile driving. The 32-inch (or less) temporary piles will be driven in the wetted channel. Any piles driven in the channel with a hammer strike pile driver will be within a confined bubble curtain or other site appropriate abatement device. Bubble curtains are essentially perforated pipes or hoses, surrounding the pile being driven, that produce bubbles when air is pumped through the perforations such that the water column is filled with bubbles (air) which is much less effective at transmitting concussive energy. Bubble curtains have been demonstrated to reduce the mortality of caged shiner surfperch (Caltrans 2001). Air bubbles can reduce sound pressure levels (SPLs) at some frequencies by as much as 30 dB (Gisiner *et al.* 1998). Bubble curtains can also reduce particle velocity levels (MacGillivray and Racca 2005).

A confined bubble curtain used in driving 30-inch steel piles at a Washington State Ferries facility in Eagle Harbor, Washington, attenuated SPLs by an average of 9.1 dB (MacGillivary and Racca 2005, p. 59). Whether confined inside a sleeve made of metal or fabric, or unconfined; these systems were shown to reduce underwater sound pressure (Longmuir and Lively 2001; Reyff and Donovan 2003). Unconfined bubble curtains can lower sound pressure levels by as much as 17 dB (Longmuir and Lively 2001).

Of the average of 62, 12 to 36-inch piles (this includes temporary detour bridges, drilled shaft support structure, work bridges and falsework construction) driven per bridge replacement project (less for a repair project depending on work bridge and detour bridge needs), it varies greatly as to how many strikes it takes to drive a pile depending on substrate and other variable. In looking at several “typical” bridges there were on average 558 strikes per pile. This means a typical bridge replacement project would have approximately 34,596 pile strike of which there would be up to 3500 per day.

Of the two projects annually that FHWA/ODOT estimated may affect the Lost River and/or short-nosed suckers there may be projects with pile driving as a component. If pile driving is conducted in occupied spawning habitat in the spring or suitable nearshore lake habitat with suckers present it is likely that injury or mortality would occur, and local spawning populations affected. Program projects conducted during the in-water work period which is in the late summer and early fall would avoid these affects. Project site isolation and moving fish out of the site would also avoid these effects to near shore spawning and rearing suckers. In approximately seven years of bridge replacements and repairs for the OTIA III Statewide Bridge Replacement Program and other miscellaneous bridge projects, none of the above listed fish have been captured during in-water work isolation. This is likely due to the low numbers of these species present in the project locations. It is unlikely to have a Program project be undertaken outside the IWWW and it is unlikely to have suckers in proximity of the project to be injured. If a Program project has no other option than to operate in the spring and early summer when suckers occur in shallow, near shore waters, one adult sucker would be expected to be injured.

In-water Work and Fish Capture and Release

Timing of construction activities can reduce or eliminate potential adverse effects to listed species from in-water work by limiting effects to the listed species habitat. In-water work can disturb fish through turbidity, noise, contact (or near-contact) with equipment, and compaction and disturbance of instream gravel and riparian areas from heavy equipment. Juvenile and resident fish that may be rearing in the vicinity of the action area would most likely be displaced, and migrating adults may be delayed, injured or killed. Measures can be taken, such as isolation of the work area and choosing appropriate equipment, to minimize the potential for disruption.

During periods of in-water work and through in-water work isolation, downstream or upstream passage may be temporarily or partially blocked. The vast majority of projects will be conducted during the recommended In-Water Work Window (IWWW) and will use work area isolation if work is conducted below the OHWM. A few of the larger bridge restoration and replacement projects may extend beyond the recommended IWWW but this does not mean work will be conducted below the OHWM and larger bridges generally do not block passage. Avoidance and minimization measures (section 2.3.1) in the PBA dictates that stream channels will not be obstructed.

Instream use of heavy equipment may compact and disturb stream bed gravels. Compaction and disturbance of stream bed gravels may increase the difficulty of redd excavation and the ability of the gravels to be aerated, reducing egg and fry survival. To avoid these impacts, no heavy equipment will be working in the stream. All work would be conducted from the bank, from work bridges or from a barge.

Fish capture and relocation is considered a minimization measure in and of itself that will be applied for these actions. However, effects (sub-lethal and lethal) on listed fish species can occur during any activity that requires handling or that would otherwise displace listed fish species, (e.g., by blocking passage or access to habitats and displace fish from cover). Handling stress, injury and death, including delayed mortality, from fish capture and release may be a direct result of this program. Although fish capture and relocation is reasonably certain to result in stress potentially resulting in death these effects will be minimized to the maximum extent possible. Effects as a result of fish capture and relocation will be short-term and localized to the immediate project isolation areas. Moving fish will cause stress to the fish and there is potential for injury and mortality.

Short-nosed and Lost River suckers may be rearing or resident in the rivers and lakes where a small percentage of Program projects may occur and the likelihood of capturing them is very low. In approximately seven years of bridge replacements and repairs for the OTIA III Statewide Bridge Replacement Program and other miscellaneous bridge projects, none of the above listed fish have been captured during in-water work isolation. This is likely due to the low numbers of these species present in the project locations during the recommended IWWW's. These suckers generally spawn low down in river systems and larvae move back into lakes relatively soon after emergence and therefore are often out the area during the IWWW. However, when working in nearshore lake habitat juvenile suckers may be encountered. As such there is a low but not discountable probability of a Program project encountering these suckers. If present in a lake near a Program project the suckers would be potentially exposed to increased sediment, presence of humans and heavy equipment, and hydroacoustic disruption from pile driving. This will cause stress and cause the suckers to expend energy to move away from the project activities, or injury to internal organs resulting in injury or death.

While there will be multiple projects under the Program, this PBO covers those conducted over a 15-year period statewide, thus spreading the adverse effects of in-water work and fish capture and release over that timeframe and across watersheds. On an individual Program project basis, in-water work and fish capture and release are expected to result in limited short-term (days) effects to listed species. Moving fish (capture and release) causes stress to the suckers. The suckers will consume more energy because of stress and once released moving out of the area and potentially exposing them to higher risk of depredation. The BMPs and Avoidance, Minimization and Mitigation (AMM) measures detailed in the BA will greatly reduce the risk of injury or mortality, particularly since ODOT has demonstrated a high proficiency and skill in moving fish with little negative result. The amount of adverse effects from in-water work area isolation and subsequent fish capture and release on a Program level is also anticipated to be low based on the high skill level of ODOT staff performing fish salvage and their track record of success over two decades of very low or no fish injury or mortality associated with moving fish at their project sites (ODOT 2018, p 18).

Effects of handling, including mortality, delayed mortality from stress and injury, from fish capture and release was estimated using the following set of assumptions:

1) All in-water work during projects, primarily bridge projects, within a DPS or species range may require in-water work area isolation and fish capture and release. There may be some emergency/urgent projects that require work area isolation and fish capture and release. FHWA/ODOT has estimated two projects and one-half acre (which has been rounded up to 1 acre and doubled to two acres to account for project uncertainty) of habitat will be affected for both the Lost River and short-nosed sucker annually or 30 projects and 30 acres affected for both species over the 15-year term of

this PBO. There will be 10 projects and two acres (doubled to four acres to account for project uncertainty) of affected habitat for the Columbia River DPS annually, or 150 projects/and 60 acres of habitat affected over the 15-year term of the PBO. Three projects and 0.75 acres of affected habitat (doubled to 1.5 acres to account for project uncertainty) for the Klamath DPS annually or 45 projects and 22.5 acres of affected habitat over the 15-year term of the PBO.

2) Based on the results of OTIA III bridge replacement and repair projects in addition to FAHP projects, only a small number of projects over the life of this consultation would be anticipated to occur in bull trout, Lost River and short-nosed sucker habitat (see Table 15).

3) For Program projects requiring in-water work area isolation, FHWA/ODOT anticipates capturing and releasing up to 65 bull trout, 20 Lost River sucker and 20 short-nosed sucker per project annually. This would equate to 975 bull trout, and 300 of both Lost River and short nosed suckers over the 15-year term of the PBO. This is a conservative estimate based on the low probability of these species in an area requiring in-water work but provides for the ability to move a small number of fish if necessary.

4) Electrofishing techniques will be used as a last resort to capture ESA-listed fish. Other fish capture methods (seining, netting, block netting) will be implemented prior to any electrofishing. All electrofishing will follow National Marine Fisheries Service (NMFS) Electrofishing Waters Containing Salmonids Listed Under the Endangered Species Act (June 2000).

5) ODOT estimates that Ninety-four percent of bull trout, Lost River and short-nosed suckers captured and handled are expected to survive with no long-term adverse effects, and six percent are expected to sustain longer-term injuries or be killed (including those that die later as a result of injury) based on a large data set complied by ODOT (pers. comm. Cash Chesselet). This would result in up to 3 Columbia Basin DPS bull trout, one Klamath DPS bull trout and 1 Lost River, and 1 short-nosed sucker dying as a result of the proposed action each year. For the 15-year term of the PBO this would result in death of 30 and 15 bull trout in the Columbia Basin DPS and the Klamath Basin DPS, respectively, and 15 Lost River and 15 shortnose suckers.

Through the development and implementation of the avoidance, minimization and conservation measures for in-water work and fish salvage in the PBA to listed aquatic species will be minimized, to the greatest extent practicable. Therefore, the Service expects any lethal effect from in-water work and fish capture and release to listed aquatic species will be limited to only those individuals impacted during work area isolation and fish capture and removal efforts.

Effects to Critical Habitat for Lost River and Short-nosed Sucker

The Service designates critical habitat based on Physical and Biological Features that are essential to the listed species. These features include water areas with sufficient water quantity and depth within lakes, reservoirs, streams, marshes, springs, groundwater sources, and refugia habitats with minimal physical, biological, or chemical impediments to connectivity. Elements also include natural flow regimes that provide flows during the appropriate time of year or, if flows are controlled, minimal flow departure from a natural hydrograph. Spawning and rearing habitat consists of streams and shoreline springs with gravel and cobble substrate with adequate stream velocity to allow spawning to occur. Areas containing emergent vegetation adjacent to open water that provides habitat for rearing. This facilitates growth and survival of suckers, as well as protection from predation and protection from currents and turbulence. Feeding areas for the suckers contain an abundant forage base, including a broad array of chironomidae, crustacea, and other aquatic macroinvertebrates. Essential features of the suckers habitat include substrate, water quality, water quantity, water temperature, food, riparian vegetation, access, water velocity, space and safe passage. The adjacent shade, sediment, nutrient or chemical regulation, streambank stability, and input of large woody debris or organic matter are all additional essential features.

Information presented in the status and baseline sections (Appendix G) of this PBO show that conditions for spawning, rearing, and migration are degraded from historical conditions. Within the action area there will be short-term adverse effects including temporary disturbances to water quality and temporary increases in sediment, affecting PBF 1, from construction activities. Short-term effects of streambank habitat modification, sedimentation, and water quality impacts could affect spawning areas, PBF 2, and feeding areas, PBF 3, at the local level. These effects are expected to be insignificant at the critical habitat unit scale due to the expected short duration of construction activities, the limited amount of in-water and stream bank work and the use of avoidance, minimization and conservation measures. These effects will occur at a low level for a short duration and therefore will have minimal impacts to the conservation function and value of short-nosed sucker designated CH.

Effects to Oregon Spotted Frog

In the PBA, FHWA/ODOT conducted an impacts analysis to estimate the number of Program projects that may affect the Oregon spotted frog. Table 17 summarizes the FHWA/ODOT impacts assessment for the proposed Program. These impact acreages were acknowledged to be conservative estimates due partly to an assumption that the projects would all adversely affect the spotted frog. However, the reality is that these projects will be a mix of “not likely to adversely affect” and “likely to adversely affect” actions. The replacement of culverts and bridges will affect nearby and adjacent spotted frog habitat, potentially removing existing habitat and altering stream flow dynamics. A reduction in water quality including increased turbidity and increased water temperature will temporarily and negatively affect adult spotted frogs, tad poles and their egg masses by thermally stressing them and with potential injury or death of the one or more of the three life stages. Oregon Department of Transportation will survey for spotted frogs in the planning phase of Program projects. Minimization and mitigation measures will be developed, with the Service review and approval, to offset any loss of habitat. For every acre disturbed or altered ODOT will restore an equivalent amount will be onsite or in nearby adjacent habitat. It is the Service’s experience in our history of working with ODOT that in formal consultations on individual transportation projects that resulted in habitat removal, we believe most of these impact estimates are overestimates.

The minimization of impacts to spotted frog habitat would consist of the restoration of any disturbed habitat (culvert removal and replacement) on the site of the project, which would minimize the long-term impact to the habitat in the project area. Oregon spotted frog emergent vegetation habitat does not take long to regenerate so only short-term habitat impacts on disturbed ground would be expected. Other degraded habitat nearby or within the watershed would be restored if it is not possible to restore areas disturbed by Program projects. If restoration of habitat cannot be implemented on site then near adjacent degraded habitat will be restored equivalent in size to what was altered or damaged.

Table 13. FHWA/ODOT estimated maximum yearly impacts from FAHP projects to Oregon spotted frog.

Species	Possible yearly projects (#)	Total Riparian Habitat Impacts (Acres)	Critical Habitat Impacts (Acres)	Frogs captured/Moved	Frogs injured/killed by handling	Frogs injured by crushing
Oregon Spotted Frog	2	1	0.5	20	1	1

At the scale of individual projects, vegetation removal is expected to have a minor effect to the population of spotted frogs because the amount of habitat loss is so small. Spotted frogs do not rely on vegetation for shade and vegetation is generally not a limiting factor for Oregon spotted frogs. The Covered Activity section 2.3.24 (page 44) Site Restoration and Enhancement Plantings, and section 2.3.25 (page 46), Channel Modification and Waterway Enhancements of this PBO has Avoidance and Minimization Measures speaking directly to avoidance, restoration and mitigation of listed species habitat. The Service will have design and specification review and approval of “Streambank Restoration, Off- and Side-Channel Habitat Restoration, Set-back Existing Berms/Dikes/Levees, Water Control Structure Removal.” This Service review and approval extends to water control structure removal to reconnect stream corridors, reestablish wetlands, improve fish passage, and restore more natural channel and flow conditions, by removing earthen embankments, subsurface drainage features, spillway systems, tide gates, outfalls, pipes, instream flow redirection structures (e.g., drop structure, gabion, groin), or similar devices used to control, discharge, or maintain water levels.

Some actions may occur in relative proximity to each other for construction efficiency based on ages and type of culvert and bridges being repaired or replaced or multiple urgency actions in a given system following a high-water event. However, even in these situations the small impact areas for individual projects mean that potential additive adverse effects such as crushing of adults, disruption of egg masses and a temporary decrease in water quality (turbidity) could occur. A reduction in water levels could isolate tadpoles and adults, expose them to water temperatures that would cause stress and even death. Projects with a vegetation removal component are still anticipated to be relatively small in scale on the watershed or species recovery unit level, and therefore have minimal effects on local or watershed populations.

Amphibian salvage operations will reduce the impacts to frogs by removing them from the project area where injury could occur, in addition to the minimization and mitigation measures above that would be implemented with the Service to offset loss of spotted frog habitat. The capture and moving of an estimated 20 spotted frogs annually may cause capture stress that could result in death of one frog if that stress becomes too great. We think it is unlikely any Oregon spotted frogs will die as a result of trapping operations because they can be transferred fairly quickly, reducing "holding time", and they are less sensitive to changes in holding conditions than fish during transfer. The impacts of stress on Oregon spotted frogs is likely to be a minor reduction in fitness until the individuals are released into suitable habitat and given an opportunity to acclimate to their surroundings.

Although amphibian salvage efforts will occur it is likely one spotted frog will evade detection, not be captured and be crushed by a project in spotted frog habitat, for a total of 15 Oregon spotted frogs killed during the life of the program. This would result in a minor reduction in the breeding population at the local level but not at the CH unit or population level.

Conclusion
In the impacts assessment, FHWA/ODOT estimated one acre of spotted frog habitat will be degraded or made non-functional (wetland fill) and incrementally reduce connectivity of populations between this habitat over the seasons by Program projects annually, which may result in the death of one adult frog. The loss of this habitat or individual frogs could result in small losses of breeding capacity, habitat for rearing of tadpoles, overwintering habitat, refugia habitat of complex structures for spotted frogs to escape predators, and the seasonal connectivity between these habitats, but these impacts are expected to be extremely small. While this amount of habitat being removed across the range of the spotted frog in Oregon is relatively small, these incremental losses of habitat may result in a reduced ability to support reproduction and survival of spotted frogs at the localized scale where these effects occur. At these localized scales we do not expect these impacts to have a population-wide effect. Because the loss of spotted frog habitat is not insignificant or discountable to individual frogs, it is an adverse effect.

Effects to Oregon Spotted Frog Critical Habitat

Any activity occurring within designated CH that alters PBFs, either directly or indirectly, may affect spotted frog CH. Effects which are discountable, insignificant, or entirely beneficial are not likely to adversely affect CH. Effects that exceed these levels are likely to adversely affect CH.

It is likely that culvert replacement or repair projects will occur within designated CH for the spotted frog. This work would occur with-in the recommended in-water work period.

This analysis of effects to CH for the spotted frog focuses on the three PBFs specific to the species:

1) Nonbreeding, breeding, rearing and overwintering habitat which is natural or manmade.
2) Aquatic movement corridors.
3) Refugia habitat.

When spotted frog habitat is altered or removed the larger area may still function to support the life history needs of the spotted frog, which encompasses all three of the above PBFs. In this case the proposed action may adversely affect PBF 1, PBF 2 and PBF 3, through the addition of fill and development of staging areas, at the local, immediate area, but is not expected to affect the function of larger habitat elements of the ephemeral or permanent bodies of fresh water as a whole.

These PBFs are essential to provide and support suitable breeding habitat for successful reproduction of the spotted frog and their persistence on the landscape. The PBA estimates the removal or degradation, collectively, of one-half acre of spotted frog CH annually associated with multiple projects that may typically only remove a fraction of the half acre. The proposed action would affect PBF 1, PBF 2 and PBF 3, although we don't know the proportions of each. The removal or degradation of these PBFs will, at the localized scale, reduce the conservation value of the CH at the project (local) scale. If all the effects were to occur from one project and in one location, there is a chance the effects could degrade or eliminate the conservation value of one occupied site, although we expect the effects to be dispersed.

The Mackenzie River CHU is the smallest spotted frog CHU in Oregon which is 98 acres. A reduction of one acre would affect 1 1 percent of that CHU in a worse-case scenario. At this low level of effect, projects carried out by ODOT and funded by FAHP are not likely to affect the conservation value of CH at the unit level for any of the CHUs.

Because the impacts from the proposed action will result in such a small impact, the conservation value of no CHUs will be impacted, and the CH network as a whole will continue to provide the existing and intended conservation value post-project.

Effects to Fenders' Blue Butterfly

Upland prairie, and, to a lesser degree, wet prairie habitat may provide nectaring and larval foraging plants for Fender's blue butterflies, some of which are listed. Listed plants often grow in roadway Rights-of-Way (ROW) partly due to ODOT management keeping exotic and native woody vegetation mowed, thus eliminating competition and succession that would shade out listed and other desirable nectaring and larval foraging species. Oregon Department of Transportation surveys their properties and ROWs along the State highways for listed plants and butterflies and these areas are monitored as Special Management Areas (SMA) by ODOT and are often mowed following the growing and flowering seasons. The Service and ODOT have completed a Habitat Conservation Plan that covers the effects to Fenders' blue butterfly by routine roadside maintenance. The PBO is addressing new and repair project construction activity to existing roadways and infrastructure. New projects or ones in which the net result is highway widening (i.e., widening, modernization or safety) has the potential to remove habitat that exists along the roadway.

The effects of mowing, soil compaction and soil disturbance from Program activities are expected to be short-term, since habitat recovers, especially with the assistance of habitat mitigation or management activities. Restoration efforts following construction and roadway work can have long-term effects if not done properly, particularly for listed plants. Restoring the site or staging area with exotic grasses, introducing noxious weeds, or top dressing with foreign substrate can lead to long-term habitat loss for native plant species dependent on specific environmental conditions. The Avoidance and Minimization Measures, detailed in the BA which apply to this species are: 1) identify no work zones in plans and the development of special provisions, as needed, to restrict access to locations with protected species (AMM 1-9): 2) plan and designate staging areas and disposal sites for projects that have high environmental sensitivity (AMM 4-1); 3) for contractor-designated sites within project limits or agency ROW, approve equipment storage, staging areas, and disposal sites on undeveloped or undisturbed areas only when undeveloped land is the only reasonable alternative. In such cases, locate sites at least

150 feet from aquatic habitat supporting listed species or No Work Zones (this distance may be modified based on site conditions and justified in the Project (AMM 4-2); and 4) Restrict herbicide application from locations with listed plants or butterfly habitat or designated No Work Zones. However, spot spraying may be permitted at times when protected resources are dormant/inactive, and directly coordinated with the ODOT biologist or USFWS (AMM 11-9) and established BMPs speak directly to this concern.

In the FHWA/ODOT's impact assessment for Fender's blue butterfly, Kincaid's lupine and Nelson's checkermallow habitat loss and impacts are presented in table 18. FHWA/ODOT estimated two projects each based on the projects currently proposed for FY 2021. Projects funded by the FAHP may change but the currently proposed projects should work as a reasonable indicator of what may occur. Of the habitat that is anticipated to be removed, up to approximately 0.196 acres of adult nectaring habitat which would include up to 125 larval host plants. In addition, FHWA/ODOT have committed to offsetting mitigation when butterfly habitat is lost, preferably within the immediate area of loss or as close as possible to the disturbed area. While continuing to create a wider gap between occupied sites across the roadway will increasingly function as a barrier for butterfly movement, mitigation opportunities within the area to offset the loss of function are available. These estimates of plants being impacted are conservative and FHWA/ODOT are unlikely to reach these levels of effects. Minimization and mitigation measures in the proposed action will offset these small habitat losses. Over the 15-year term of the Program, up to 1,875 larval host plants within 2.94 acres of adult nectaring habitat could be affected, although mitigation (collecting seeds, planting new plants) would lessen these impacts to the population.

The loss of rearing habitat for the butterfly will result in localized loss of reproduction and may impact the stepping stone function of the smaller parcels of habitat to a very minor degree given the linear nature of any impacts (highway rights-of-way), resulting in a minor, potentially imperceptible, distancing of the patchwork of habitat parcels. However, the AMM measures are expected to preclude these effects because ODOT surveys for listed plants, identifies the patch/population and establishes No Work Zones in Plans and Special Provisions, as needed to restrict access to locations with protected resources. If listed plants or butterfly habitat (as covered by this PBO) are disturbed by construction activities, ODOT will replace the functional equivalent of the species or critical habitat, on-site when property is available or off-site when suitable protected lands are available (AMM 1-9). ODOT will restrict herbicide application from locations with listed plants or butterfly habitat or designated No Work Zones. However, spot spraying may be permitted at times when protected resources are dormant/inactive, and directly coordinated with the ODOT biologist or USFWS (AMM 11-9).

Table 14. FHWA/ODOT estimated number of Fender's blue butterflies and plants to be impacted annually from projects under the Program (FHWA/ODOT 2020).

Species	Projects	Number of Plants	Impacts to Designated Critical Habitat	Number of Adult butterflies killed
Fender's blue butterfly	2	125 larval host plants/0.196 acres of adult nectaring habitat	0.2 acres	15
Kincaid's lupine	2	125	0.5	
Nelson's checkermallow	2	50	N/A	

A recovery plan for the butterfly was published on May 20, 2010 (USFWS 2010a). The implementation of proposed actions would affect suitable habitat for Fender's blue butterfly and require ODOT to conduct surveys to determine species presence. The actual location and impacts of projects in this Program are still being defined and the values on Table 18 are used only for an estimate of likely impacts. Actual impacts will vary depending on the scope and location of FAHP projects overlapping Fender's blue butterfly habitat, which result in a "May Affect" determination, and the project-specific activities. It is anticipated that impacts to Fender's blue butterflies will not occur every year and may not occur at all due to several AMMs. These Avoidance and Minimization Measures AMMs, detailed in the BA which apply to this species are: 1) identify no work zones in plans and the development of special provisions, as needed, to restrict access to locations with protected species (AMM 1-9): 2) plan and designate staging areas and disposal sites for projects that have high environmental sensitivity (AMM 4-1); 3) For Contractor-designated sites within project limits or agency ROW, approve equipment storage, staging areas, and disposal sites on undeveloped or undisturbed areas only when undeveloped land is the only reasonable alternative. In such cases, locate sites at least 150 feet from aquatic habitat supporting listed species or No Work Zones (this distance may be modified based on site conditions and justified in the Project (AMM 4-2); and 4) Restrict herbicide application from locations with listed plants or butterfly habitat or designated No Work Zones. However, spot spraying may be permitted at times when protected resources are dormant/inactive, and directly coordinated with the ODOT biologist or USFWS (AMM 11-9) and established BMPs that were developed to minimize and offset direct take of Fender's blue butterfly habitat speak directly to this concern. Implementation of proposed management actions *may affect,and are likely to adversely affect* the Fender's blue butterfly because the effects of project activities would not be insignificant or discountable.

These impacts will affect the FBB population where occupied larval plants and nectar plants are impacted. Because the effects will be in narrow, linear parcels along roadways we do not anticipate there will be more than a minor impact to the distribution of the species or the overall population of any habitat patch. Reproduction at the localized (project) scale could be impaired depending on the size of the pre-project habitat patch, but we do not expect these small impacts to impact the reproductive capability at any larger scale. While we could attempt to quantify the number of eggs and larvae impacted within the 7.5 impacted acres, the variability of the number of eggs layed on a plant is broad enough that any estimate would be speculative, at best. The best measure of the impacts on Fender's blue butterfly larvae and reproduction is in the discussions above.

Effects to Fender's Blue Butterfly Critical Habitat

Approximately 3,010 acres of critical habitat in 13 critical habitat units has been designated for Fender's blue butterfly in Benton, Lane, Polk, and Yamhill Counties, Oregon. The smallest critical habitat unit in Oregon for the butterfly is FBB-3 (Mill Creek) at 3.6 acres, and within an ODOT rights-of way. If all the effects to FBB CH were to occur in this one CHU, the removal of 0.5 acre of this unit would equal 13.88 percent decrease of the critical habitat unit, and over the term of the 15-year Program BO would remove, hypothetically, 7.5 acres or twice the size of the unit. In this hypothetical example, the conservation value of that CHU would be lost. The AMMs, detailed in the BA, would be followed to avoid and minimize impacts to the butterfly and its habitat. Surveys by ODOT of ROWs for listed plants are performed in the pre-project planning phase. If listed plants are identified, a no work zone would be established and the development of special provisions, as needed, to restrict access to locations with protected species (AMM 1-9) would be implemented. The designation of staging areas and disposal sites would be appropriately distanced, based on BMPs, from project areas with high environmental sensitivity and which include listed plants (AMM 4-1). Contractor-designated sites within project limits or agency ROW for approved equipment storage, staging areas, and disposal sites on undeveloped or undisturbed areas would only occur when undeveloped land is the only reasonable alternative. These sites would be located at least 150 feet from aquatic habitat supporting listed species or No Work Zones. This distance may be modified based on site conditions and justified in the Project (AMM 4-2). Herbicide application would be restricted from locations with listed plants or butterfly habitat or designated No Work Zones. Spot spraying may be permitted at times when protected resources are dormant/inactive, and directly coordinated with the ODOT biologist or USFWS (AMM 11-9) and established BMPs speak directly to this concern. Also, a mitigation plan would be developed with the Service for loss of listed plant species habitat. A loss of 0.5 acre of the 3,010 total acres of designated critical habitat would represent 0.0166 percent of designated critical habitat for the butterfly and over the term of the PBO 15-year term would equal 0.249 percent. At the population level this would be insignificant and not affect the conservation value of the overall Fender's blue butterfly CH.

The removal of butterfly habitat that provides larval host plants (PBF 2) and nectaring plants for the adults (PBF 3) or contributes to the fragmentation and disruption of butterfly stepping-stone habitat (undeveloped open areas with the physical characteristics appropriate for supporting the short-stature prairie oak savanna plant community, and well drained soils), within 1.2 miles of natal lupine patches (PBF4) would be an adverse effect to Fenders blue butterfly critical habitat function and distribution. Thus, implementation of proposed management actions may affect, and is likely to adversely affect the Fender's blue butterfly CH.

Effects to Kincaid's Lupine

The Program's proposed actions rarely impact Federally listed plant species over the last 20 years of consultation activities. The limited range of the Kincaid's lupine and its potential to overlap with a Program project is uncommon but may occur in the term of this 15-year PBO. The internal requirement for ODOT to perform pre-construction botanical surveys and establishment of no work zones around listed plant populations is a concerted effort by ODOT to avoid impacts to listed plant species. These botanical surveys will help preclude adverse effects to most Federally listed plant species for the majority of the Program proposed actions. However, it is not always possible to fully predict the environmental consequences of the proposed action due to activities such as soil compaction from equipment and associated hydraulic changes. The robust BMPs for containment, pollution and erosion control measures, stormwater management, site restoration and other measures will help to minimize effects to Kincaid's lupine. The AMMs, detailed in the BA, would be followed to avoid and minimize impacts to Kincaid's lupine habitat. Surveys by ODOT of ROWs for listed plants are performed in the pre-project planning phase. If listed plants are identified, a no work zone would be established and the development of special provisions, as needed, to restrict access to locations with protected species (AMM 1-9). The designation of staging areas and disposal sites would be appropriately distanced, based on BMPS, from projects with high environmental sensitivity and which include listed plants (AMM 4-1). Contractor-designated sites within project limits or agency ROW for approve equipment storage, staging areas, and disposal sites on undeveloped or undisturbed areas would only occur when undeveloped land is the only reasonable alternative. These sites would be located at least 150 feet from aquatic habitat supporting listed species or No Work Zones. This distance may be modified based on site conditions and justified in the Project (AMM 4-2). Herbicide application would be restricted from locations with listed plants or butterfly habitat or designated No Work Zones. Spot spraying may be permitted at times when protected resources are dormant/inactive, and directly coordinated with the ODOT biologist or USFWS (AMM 11-9) and established BMPs speak directly to this concern. Also, a mitigation plan would be developed with the Service for loss of listed plant species habitat.

Table 15. Anticipated annual effects to federally listed plants.

Species	Possible Number of Projects	Approximate Impact[19]
Kincaid's lupine	2	125 plants[20]
Kincaid's lupine Critical Habitat	1	0.5 acre
Nelson's sidalcea	2	50 plants

The remainder of the listed plants covered by this programmatic can be avoided and offset with proper implementation of AMMs such as 1-9, 4-1, 4-2 and 11-9.

Kincaid's lupine habitat is described as early seral upland prairie, or oak savanna habitat with a mosaic of low-growing grasses and forbs, and spaces to establish seedlings or new vegetative growth; an absence of dense canopy vegetation; and undisturbed subsoils. Soil compaction and changes to soil hydrology would threaten individual plants and that population by causing desiccation of the Kincaid's lupine or conversely cause sheet erosion and drown and dislodge the plant. A population of plants could inadvertently be crushed accidentally and killed which would be adverse effects.

The loss of individual plants can affect a patch of Kincaid's lupine as they are interconnected (up to 33 feet) by below-ground stems. The loss of a patch could further incrementally fragment the

[19] Rough estimate based on average removal of 25 plants for each bridge and safety project and 100 plants for modernization project, and disturbance to 0.5 acre of critical habitat.

[20] See footnote 41, Section 4.2.3.

population of lupine and contribute to the local extirpation of Kincaid's lupine at the project scale. The current distribution of Kincaid's lupine reflects the best habitat of sufficient quality (including size) to contribute to functioning metapopulations (including areas necessary for connectivity between populations), or that represent unique ecological conditions. Increasing the distances between patches or sub-populations could incrementally reduce the interconnectedness of individual populations.

Effects to Kincaid's Lupine Critical Habitat

Critical habitat units for Kincaid's lupine have been designated in Benton, Lane, Polk and Yamhill Counties, Oregon. Designated Critical habitat for the Kincaid's lupine total 585 acres in these four counties in Oregon. The PBFs of Kincaid's lupine CH are habitat components that provide: 1) early seral upland prairie, or oak savanna habitat with a mosaic of low growing grasses and forbs, and spaces to establish seedlings or new vegetative growth; an absence of dense canopy vegetation; and undisturbed subsoils; and 2) the presence of insect outcrossing pollinators, such as *Bombus mixtus* and *B. californicus*, with unrestricted movement between existing lupine patches.

Oregon Department of Transportation estimates one project per year would impact 0.5 acres of Kincaid's lupine critical habitat and 7.5 acres total over 15 years. The loss of CH for Kincaid's lupine from soil disturbance or compaction could lead to the killing of a patch of lupine, resulting in localized fragmentation of existing patches and sub-populations, but at a very small scale given the expected extent of the program activities. This would undermine the conservation value of the recovery strategy of having the best of existing habitats and the strategic distribution of CH for connectedness. Although the impacts to 0.5 acres of Kincaid's lupine designated critical habitat is an adverse effect, one half acre loss per year out of 585 acres would be 0.08547 percent of critical habit annually and 1.2821 percent of designated critical habitat over 15 years. At this low level of impact, the effects to Kincaid's lupine CH would be considered negligible.

Effects to Nelson's Checkermallow

The Programs proposed actions rarely impact Federally listed plant species. The limited range of the Nelsen's checkermallow and its potential to overlap with a Program project is uncommon and difficult to predict. The internal requirement for ODOT to perform pre-construction botanical surveys and establishment of no work zones around listed plant populations is a concerted effort by ODOT to avoid impacts to listed plant species. These botanical surveys will help develop an effective barrier against adverse effects to most Federally listed plant species for the majority of the Program proposed actions. However, it is not always possible to fully predict the environmental consequences of the proposed action due to activities such as soil compaction from equipment and associated hydraulic changes. The robust BMPs for containment, pollution and erosion control measures, stormwater management, site restoration and other measures will help to minimize effects to Nelson's checkermallow. Avoidance and minimization measures detailed in the BA will reduce the potential for these adverse effects.

The AMMs, detailed in the BA which apply to the checkermallow include: 1) identify no work zones in plans and the development of special provisions, as needed, to restrict access to locations with protected species (AMM 1-9): 2) plan and designate staging areas and disposal sites for projects that have high environmental sensitivity (AMM 4-1); 3) For Contractor-designated sites within project limits or agency ROW, approve equipment storage, staging areas, and disposal sites on undeveloped or undisturbed areas only when undeveloped land is the only reasonable alternative. In such cases, locate sites at least 150 feet from aquatic habitat supporting listed species or No Work Zones (this distance may be modified based on site conditions and justified in the Project (AMM 4-2); and 4) Restrict herbicide application from locations with listed plants or butterfly habitat or designated No Work Zones. However, spot spraying may be permitted at times when protected resources are dormant/inactive, and directly coordinated with the ODOT biologist or USFWS (AMM 11-9) and established BMPs speak directly to this concern.

Table 16. Possible direct effects to federally listed plants.

Species	Possible Number of Projects	Approximate Impact[21]
Kincaid's lupine	2	125 plants[22]
Kincaid's lupine in Critical Habitat	1	0.5 acre
Nelson's checkermallow	2	50 plants

The impacts to listed plants from this program of work can be avoided and offset with proper implementation of AMMs such as 1-9, 4-1, 4-2 and 11-9.

Soil compaction and changes to soil hydrology would threaten individual plants and that population by causing desiccation of the Nelson's checkermallow or conversely cause sheet erosion and drown the plant. The application of the AMMs would in most cases eliminate this risk to listed plants. There is the low likelihood a checkermallow population could be impacted through crushing which would be an adverse effect. The loss in individuals in a patch would affect existing numbers of checkermallow and their connectedness, incrementally impacting their robustness. However, these impacts are expected to be so minimal they would not impact the recovery potential of the species.

6.0 Cumulative Effects

Cumulative effects are defined in 50 CFR 402.02 as "those effects of future State or private activities, not involving Federal activities that are reasonably certain to occur within the action area of the Federal action subject to consultation." The action area are lands within 330 feet of the road prism of Oregon state highway and rights-of-way, where management and activities are largely focused on road maintenance and safety. The Service assumes that future non-federal, private and state actions will continue within the action area as they have up to this point, potentially increasing as population density rises, particularly in the Willamette Valley. The Service is not aware of any specific future non-federal activities within the action area that would cause different effects to listed species than those that presently occur, or that would result in a different baseline than currently exists.

[21] Rough estimate based on average removal of 25 plants for each bridge and safety project and 100 plants for modernization project, and disturbance to 0.5 acre of critical habitat.

[22] See footnote 41, Section 4.2.3.

6.1 Integration and Synthesis of Effects

The Integration and Synthesis section is the final step of the Service's assessment of the risk posed to species and critical habitats as a result of implementing the proposed action. In this section, we start with the Status of the Species (at the rangewide scale) (see Appendices), add the effects of the proposed action (Section 6), any extemporaneous projects from the Environmental Baseline, and also the cumulative effects (Section 6.1) to formulate the Service's biological opinion as to whether the proposed action is likely to: 1) result in appreciable reductions in the likelihood of both survival and recovery of any of these species in the wild by reducing its numbers, reproduction, or distribution; or 2) reduce the value of designated critical habitat for the conservation of the species. These assessments are made in full consideration of the status of the species and critical habitats.

The many individual species and populations affected by the proposed Program vary considerably in their biological status. The species addressed in this PBO have declined due to numerous factors. The one factor for decline that all listed species share is degradation or loss of habitat. Human development of the Pacific Northwest has caused significant negative changes to native habitats across the range of these species. The environmental baselines for individual species and critical habitats vary across the action area.

The programmatic nature of the action precludes a precise analysis of each individual action that eventually will be funded or carried out under this PBO, although each type of action will be carefully designed and constrained by comprehensive design criteria and conservation measures. These criteria and measures will ensure that the proposed activities will cause only short-term, localized, and/or relatively minor effects. Also, Program actions are likely to be widely distributed across any one species' range, so adverse effects are unlikely to be concentrated in time and space within the range of the affected species. This will result in lessening the impact of many of the factors limiting the recovery of these species.

A relatively small number of ESA-listed species will be affected by any single action permitted under the Program. Because characteristics at the range-wide scale will not be affected, the likelihood of survival and recovery of the listed species will not be appreciably reduced by the proposed action.

In the status of the species sections, the Service identified many threats and factors associated with the needs of ESA-listed species that limit their recovery. These factors include, but are not limited to, degradation of suitable habitats, fragmentation and isolation of prairie habitats, elevated water temperatures, excessive sediment, reduced access to spawning and rearing areas, reductions in aquatic habitat complexity, degraded floodplain structure and function, and reduced flow. Cumulative effects within the action area described in Section 6.1 are likely to continue to have the same negative effects on ESA-listed species that they've had in the past which resulted in the status and baselines we see today. The AMMs carried out under the proposed Program will limit the effects of many of these limiting factors over the 15-year term of the PBO. Nevertheless, some adverse effects will occur from the proposed action. These include:

1) Noise/Visual Disruption;
2) Vegetation Removal;

3) Increased Erosion, Turbidity, Sediment Transport, and Chemical Exposure;
4) Pile driving (hydroacoustic impacts); and
5) In-water Work and Fish/frog Capture and Release

The above effects are expected to be localized and constrained by the avoidance, minimization and conservation measures to limit potential long-term adverse effects and greatly minimize short-term adverse effects. Any unavoidable short-term adverse effects will be minimized and any remaining long-term adverse effects, such as removal of spotted owl or marbled murrelet habitat, requires compensatory mitigation action adequate to functionally off-set the habitat loss. Any habitat for listed species removed above what is considered for the covered species in this BO would have to be consulted upon in an individual consultation.

7.0 Conclusion

After reviewing the current status of the marbled murrelet, spotted owl, bull trout, Lost River sucker, short-nosed sucker, Oregon spotted frog, Fender’s blue butterfly, Kincaid’s lupine, and Nelson’s checkermallow, the environmental baseline for the action area, the effects of the proposed action, it’s action area relegated to the rights-of-way along existing roadways, and the cumulative effects, the Service has determined that the Program is not likely to be of a magnitude, duration or extent to jeopardize the continued existence of these species.

The Service has also concluded that the program will not adversely modify designated critical habitat for the marbled murrelet, spotted owl, bull trout, Lost River and short-nosed suckers, Oregon spotted frog, Fender’s blue butterfly, Kincaid’s lupine and Nelsons checkermallow. These conclusions were reached for the following reasons:

Marbled Murrelet

1. Over the life of the 15-year PBO, up to three murrelet chicks may be exposed to a greater risk of predation due to disruption from program activities during the breeding season. Whether this will result in actual predation is unknown, but the potential does exist. The potential loss of three murrelet chicks over 15-year term of the PBO is not a small impact, but would not be expected to result in a demographic impact that would preclude recovery of the species because of the existing population size, the available habitat within the coastal zone, and the timeframe over which these impacts may occur. While mitigation of impacts to habitat will occur and be offset by using credits in ODOTs spotted owl and murrelet habitat mitigation bank that will not preclude the demographic impact of losing any murrelet chick to predation. While these impacts have the potential to impact murrelet reproduction and numbers at the local stand level, they will not have more than an incremental impact on the species due to the factors listed above. In addition, we do not anticipate they will not have any impact on the overall distribution of the species.

2. In the biological assessment, FHWA/ODOT estimated three anticipated Program projects may adversely affect murrelets through the removal of up to one acre of murrelet habitat annually. While this amount of habitat being removed across the range of the murrelet in Oregon is relatively small, these incremental losses of habitat may result in a reduced ability to support reproduction and survival of murrelets at the local stand level where these effects occur, but are not expected to have more than a very minor population-wide impact.

Marbled Murrelet Critical Habitat

The loss of designated murrelet critical habitat will be of such a low amount and spread across the range of the species along roadways in Oregon it would not impede the PBFs of murrelet critical habitat to develop and will not rise to the level of an adverse modification of murrelet critical habitat.

Spotted Owl

1. The proposed action is anticipated to affect up to two acres annually and 30 acres over the 15-year term of the PBO, of potentially suitable spotted owl habitat dispersed across the range of the owl in Oregon. Because these impacts will be widely distributed, the likelihood is low that they will substantially alter the amount of habitat available within any given occupied owl site to the point where it limits the territories ability to support a pair of spotted owls. Collectively, this amount and distribution of affected habitat represents a minor portion of the existing habitat within each province and across the landscape overall, making it unlikely that landscape level habitat availability or connectivity, or spotted owl demographics, will be altered.

2. Habitat being removed is near or within major highway corridors. The utilization and value of this habitat is probably already somewhat degraded due to associated vehicle, human use and management activities. It is not very likely that substantial levels of roosting or nesting are currently supported by this habitat, or those that are nearby are already acclimatized to loud noises. Habitat removal impacts for spotted owls will be small at the site-specific level and will represent only a very small fraction of habitat available in any given ecoprovince; most habitat removal impacts will be localized in areas not expected to support significant levels of nesting, roosting or foraging. For these reasons, the proposed action is not likely to reduce the size, distribution, or productivity of populations at the local, regional, or rangewide scales.

Spotted Owl Critical Habitat

The loss of designated spotted owl critical habitat will be of such a low amount and spread across the range of the species along roadways in Oregon it would not impede the primary biological factors of murrelet critical habitat and not rise to the level of an adverse modification of murrelet critical habitat.

Bull trout

1. The proposed action may remove up to two acres of bull trout habitat annually, 30 acres over the term of the 15-year PBO, within the Columbia River Recovery unit and 1.5 acres of bull trout habitat annually, 22.55 acres over the 15-year term of the PBO, in the Klamath Falls Recovery Units in Oregon. The impact of the habitat being permanently removed will be negligible because the vast majority of Program projects are in migratory and foraging waters where habitat features are already degraded or lacking. This is based on observations of past ODOT bridge projects (Federal Highways State Transportation Improvement Projects Biological Opinion, USFWS 2014). Any

temporary removal of riparian habitat that occurs during construction will be restored on site. This amount of habitat represents a minor portion of the existing habitat within the range of the species and is expected to be distributed spatially and temporally such that no individual population center will be subject to losses that alter site-specific productivity or viability.

2. Minimization and conservation measures are expected to avoid or minimize adverse effects to water turbidity, temperature, and instream habitat availability and will be distributed over a five year period and will not be of an intensity likely to cause mortality at any given location. Work area isolation and fish handling may result in 65 individuals being captured, of which up to 1 would be anticipated to die of associated stress from handling each year but will otherwise avoid or minimize significant adverse effects and mortality from construction activities. For these reasons, the proposed action is not likely to reduce the size, distribution, or productivity of populations at the local, regional, or rangewide scales.

Bull Trout Critical Habitat

Because the impacts will result in a very small impact, primarily in migratory and overwintering habitat, the conservation value of no CHUs will be impacted, and the CH network as a whole will continue to provide the existing and intended conservation value post-project. The loss of designated bull trout critical habitat will be of such a low amount and spread across the range of the species along roadways in Oregon it would not impede the physical and biological factors of bull trout critical habitat from providing their intended conservation value.

Lost River and Short-nosed Suckers

1. The proposed action may remove up to one acre of habitat annually for both sucker species (species habitat and impacts analysis overlap) in the Klamath Basin in Oregon. This represents a small amount of habitat within the range of the species and is expected to be distributed such that no individual population center will be subject to losses that alter site-specific productivity or viability. Any temporary removal of riparian habitat that occurs during construction will be restored on site. This amount of habitat represents a minor portion of the existing habitat within the range of the species and is expected to be distributed spatially and temporally such that no individual population center will be subject to losses that alter site-specific productivity or viability.

2. Minimization and conservation measures are expected to avoid or minimize adverse effects to water turbidity, temperature, and instream habitat availability and will be distributed over a four year period and will not be of an intensity likely to cause mortality at any given location. Work area isolation and fish handling may result in a very small amount (20 individuals of each species) captured, of which one would be anticipated to die of associated stress, but will otherwise avoid or minimize adverse effects and mortality from construction activities. For these reasons, the proposed action is not likely to reduce the size, distribution, or productivity of populations at the local, regional, or rangewide scales.

Lost River and short-nosed sucker Critical Habitat

Within the action area there will be short-term adverse effects including temporary disturbances to water quality and temporary increases in sediment from construction activities. Short-term effects of streambank habitat modification, sedimentation, and water quality impacts could affect spawning and feeding areas at the local level. These effects are expected to be insignificant at the critical habitat unit scale due to the expected short duration of construction activities, the limited amount of in-water and stream bank work and the use of avoidance, minimization and conservation measures. These effects will occur at a low level for a short duration and therefore will have minimal impacts to the conservation function and value of Lost River and short-nosed sucker designated CH.

Fender's blue butterfly

1. ODOT ROWs are surveyed for listed plants including nectaring plants (butterfly habitat) and the vast majority of known populations within ODOT's highway right-of-ways are currently designated as SMAs which are mapped and protected and managed for butterfly habitat.

2. Any vegetation removal used for staging is expected to occur in very small patches distributed across the range of the species and occur near or within major highway corridors, meaning that it is most likely already subject to some level of degradation, further limiting potential utilization by the species. The size and viability of known critical population centers, the size and quality of large, contiguous habitat patches, and overall connectivity between these populations and habitat areas will not be significantly reduced by the proposed action. For these reasons, the proposed action is not likely to reduce the size, distribution, or productivity of populations at the local, regional, or rangewide scales.

3. Of the habitat that is anticipated to be removed, approximately 0.2 acres of that is designated as critical habitat. This critical habitat area (FBB-11) is a 244-acre complex of habitat primarily designed to function as stepping stone habitat between two larger populations. The function of these critical habitat patches will not be significantly degraded if 0.2 acres of habitat is removed along the roadway. These impacts will be mitigated if they occur. There are also important sites available within the recovery unit for such mitigation.

Fender's Blue Butterfly Critical Habitat

A loss of 0.5 acre of the 3,010 total acres of designated critical habitat would represent 0.0166 percent of designated critical habitat for the butterfly and over the term of the PBO 15-year term would equal 0.249 percent. At the population level this would be considered insignificant, not affect the conservation value of the overall Fender's blue butterfly CH, and not raise to the level of adverse modification of critical habitat.

Kincaid's lupine

The proposed action may impact or permanently remove up to 125 Kincaid's lupine plants annually across the range of the species in the Willamette Valley of Oregon. The size and viability of known populations, the size and quality of large, contiguous habitat patches, and overall connectivity between these populations and habitat areas will not be significantly reduced by the Program projects. For these reasons, the proposed action is not likely to reduce the size, distribution, or productivity of populations at the local, regional, or rangewide scales.

Kincaid's Lupine Critical Habitat

Of the habitat that is anticipated to be removed, approximately 0.5 acres of that is designated as critical habitat. This critical habitat area (FBB-11) is a 244-acre complex of habitat primarily designed to function as stepping stone habitat between two larger populations. The function of these critical habitat patches will not be significantly degraded if 0.5 acres of habitat is removed along the roadway, and these impacts will be mitigated close by if they occur. There are important sites available within the recovery unit for such mitigation.

Nelson's Checkermallow

The proposed action may impact or permanently remove up to 50 Nelson's checkermallow plants across the range of the species in the Willamette Valley of Oregon. Because of the large size and viability of known populations, the size and quality of large, contiguous habitat patches, and overall connectivity between these populations and habitat areas will not be significantly reduced by the Program projects. For these reasons, the proposed action is not likely to reduce the size, distribution, or productivity of populations at the local, regional, or rangewide scales.

8.0 Incidental Take Statement

The ESA section 9 [16 USC 1538] prohibits take of endangered species. The prohibition of take is extended to threatened species by section 4(d) rule [50 CFR 223.203]. Take is defined by the statute as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." [16 USC 1532(19)] Harm is further defined by regulation as "an act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation which actually kills or injures fish or wildlife by significantly impairing essential behavior patterns, including, breeding, spawning, rearing, migrating, feeding or sheltering." [50 CFR 222.102] Incidental take is defined as "takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant." [50 CFR 402.02] The ESA at Section 7(o)(2) removes the prohibition from any incidental taking that is in compliance with the terms and conditions specified in a Section 7(b)(4) incidental take statement [16 USC 1536].

The Service has determined that the effects of the proposed action will not jeopardize any of the species affected and will result in the following amounts of anticipated incidental take:

Spotted owl:

- Three pairs of nesting spotted owls may be precluded from successfully nesting.
- Lethal take of three young or eggs.
- All spotted owls associated with the 30 acres of habitat removed.

Marbled Murrelet:

- Three murrelet chicks from depredation due to disruption of adults.
- All murrelets associated with the 15 acres of habitat removed.

Bull Trout:

- Fifteen bull trout may die as a result of being captured and moved.
- 975 bull trout captured and relocated over the 15-year term of the PBO as a result of inwater construction work.
- All bull trout associated with 82.5 acres of habitat impacted.

Lost River Sucker:

- 300 Lost River suckers will be captured and relocated as a result of inwater construction work.
- Fifteen adult Lost river suckers will be lethally taken as a result of being captured and relocated during in-water construction.
- All Lost river suckers associated with 30 acres of habitat impacted.

Shortnose Suckers:

- 300 shortnose sucker are expected to be captured and relocated over the 15-year term of the PBO as a result of inwater construction work.
- Fifteen shortnose suckers will be lethally taken as a result of being captured and relocated during in-water construction.
- All shortnose suckers associated with 30 acres of habitat impacted.

Oregon Spotted Frog:

- 300 spotted frogs are expected to be captured and relocated a result of inwater construction work.
- 15 Oregon spotted frogs will be lethally taken as a result of being captured and relocated during in-water construction.
- All Oregon spotted frogs associated with 15 acres of habitat impacted.

Fender's blue butterfly:

- The take of all Fender's blue butterflies associated with the loss of up to 1,875 larval host plants on 7.5 acres.

- The lethal take of all the Fender's blue butterfly larvae associated with the 7.5 acres of butterfly obligate host plant removed.

8.1 Amount and Extent of the Take

The Service anticipates that activities associated with the Oregon Federal Aid Highway program detailed in the proposed action (Section 2) are reasonably certain to result in incidental take of ESA-listed species because of potential adverse effects from noise/visual disruption; hydro-acoustic; increased erosion, turbidity, sediment transport, and chemical exposure; hydrologic alteration; vegetation removal; fluvial alteration; and in-water work, fish capture, and release.

The Service anticipates incidental take to occur through disruption, harm in the form of lethal mortality and sublethal effects (e.g., handling, stress, noise disturbance) as specified in table 19 due to the action covered by this PBO. In the accompanying PBO, the Service determined that this level of anticipated take is not likely to result in jeopardy to the species. The extent of the take is limited to marbled murrelet, spotted owl, bull trout, Lost River sucker, short-nosed sucker, Fender's blue butterfly and Oregon spotted frog within the action area and to the associated upland, riparian and aquatic habitats in the action area.

Table 17. Quantification and extent of annual incidental take for terrestrial and aquatic species under USFWS Endangered Species Act jurisdiction.

Species	Habitat Removal	Harm	Capture and Handling
	Acre(s)	Individual(s) or acres	Nonlethal/lethal
Marbled murrelet	1acre	0.2 individuals annually/3 individuals over 15-year term	N/A
Northern spotted owl	2 acres	0	N/A
Bull trout (for both interim recovery units)	2.75 acres	65	65/1
Oregon spotted frog	1 acre	0	20/1
Lost River and short-nosed sucker combined	1 acre each annually	0	20/1 each species annually
Fender's blue butterfly	125 host plants (Kincaid's lupine) and 0.2 acres of adult nectaring habitat	0	N/A

9.0 Reasonable And Prudent Measures

The Services believe that the following reasonable and prudent measures are necessary and appropriate to avoid or minimize take of listed species resulting from the action covered by this Opinion and to outline monitoring requirements. In order to monitor the impacts of incidental take, the Federal agency or any applicant must report the progress of the action and its impact on the species to the Services as specified in the incidental take statement. The reporting requirements are established in accordance with 50 CFR 13.45 and 18.27 for USFWS and 50 CFR 220.45 and 228.5 for NOAA Fisheries.

The FHWA/ODOT shall:

1. Ensure completion of a comprehensive monitoring and reporting program regarding all actions authorized or completed using the Program PBO.

2. Avoid pile driving in Lost River and short-nosed sucker spawning habitat when adults, eggs and fry are present. Follow standard hydroacoustic minimization measures at other times.

9.1 Terms and Conditions

To be exempt from the prohibitions of section 9 of the ESA, the FHWA/ODOT and/or their contractors must comply with the following terms and conditions, which implement the reasonable and prudent measures described above. These terms and conditions are non-discretionary.

1. To implement reasonable and prudent measure #1 (ensure completion of a comprehensive monitoring and reporting program), the FHWA/ODOT shall ensure that:

The FHWA/ODOT will submit a monitoring report to the Service annually that describes the FHWA/ODOT's efforts to carry out this PBO. The report will include an assessment of overall program activity including projects being monitored from previous years Program projects, a map showing the location and type of each action authorized and carried out under this PBO, a summary of habitat impacts within each project area reported in acres, the associated restoration or mitigation, numbers of fish salvaged during the previous year, and any other data or analyses the FHWA/ODOT deems necessary or helpful to assess habitat trends as a result of actions authorized under this PBO.

Monitoring reports will be submitted to:

U.S. Fish and Wildlife Service
Oregon Fish and Wildlife Office
2600 SE 98th Ave, Suite 100
Portland, OR 97266

If a dead, injured, or sick listed species is located, initial notification must be made to the nearest Service Law Enforcement Office, located at 9025 SW Hillman Court, Suite 3134, Wilsonville, OR 97070; phone: 503-682-6131. Care should be taken in handling sick or injured specimens to ensure effective treatment or the handling of dead specimens to preserve biological material in the best possible state for later analysis of cause of death. In conjunction with the care of sick or injured endangered and threatened species or preservation of biological materials from a dead animal, the finder has the responsibility to carry out instructions provided by Law Enforcement to ensure that evidence intrinsic to the specimen is not unnecessarily disturbed.

1. To implement reasonable and prudent measure #3 (Avoid pile driving in Lost River and short-nosed sucker spawning habitat when adults, eggs and fry are present), the FHWA/ODOT shall ensure that:

    a. Projects needing pile driving f that are in and around suitable Lost River or short-nosed sucker spawning habitat will avoid pile driving from 15 February to July 15.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purpose of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

1 If Program projects could be conducted outside the breeding season for the spotted owl and marbled murrelet then affects to these two listed species could be avoided that didn’t involve habitat removal.

REINITIATION OF CONSULTATION

To the extent the FHWA/ODOT retains discretionary involvement or control over this action as described in 50 CFR 402.16, the FHWA/ODOT must reinitiate consultation if: 1) The action is modified in a way that causes an effect on the listed species or the species critical habitats that was not previously considered in this PBO; 2) new information or project monitoring reveals effects of the action that may affect the listed species or the species critical habitat in a way not previously considered; 3) a new species is listed or critical habitat is designated that may be affected by the action; or 4) if the amount or extent of incidental take is exceeded (50 CFR 402.16).

If FHWA/ODOT’s, or any agent’s thereof, exercise of the Program is likely to result in or has resulted in effects to any listed species or critical habitats that are not consistent with those described in this PBO, if FHWA/ODOT does not ensure the proposed action (Section 2) is administered as proposed, or if incidental take is exceeded, the Service would consider any of those circumstances to be a modification of the action that causes an effect on listed species not previously considered, potentially resulting in the need to reinitiate consultation.

LITERATURE CITED

Abbot, R., and E. Bing-Sawyer. 2002. Assessment of pile driving on three species of fish. Draft report prepared for Caltrans District 4.

Anderson, C.R. and J.A. Reyff. 2006. Port of Oakland Berth 23–Underwater sound measurement data for the driving of sheet steel piles and square concrete piles. Anderson and Reyeff, Inc. Report to the Port of Oakland.

Caltrans (California Department of Transportation). 2001. Technical guidance for assessment and mitigation of the hydroacoustic effects of pile driving on fish. State of California Department of Transportation, Sacramento, California. 532 pages.

Davis, R. J., Holland, B., Hobson, J., Gower, J., and D. Keenum. 2016. Northwest Forest Plan—The first 20 years (1994–2013): Status and trends of Northern Spotted Owl populations and habitats. USDA Forest Service General Technical Report PNW-GTR-929.

Delaney, D. K., T. G. Grubb, P. Beier, L. L. Pater, and M. H. Reiser. 1999. Effects of helicopter noise on Mexican spotted owls. Journal of Wildlife Management 63:60-76.

Dooling, R.J and A.N. Popper. 2010. Noise impacts on birds: Assessing take of endangered species. The Journal of the Acoustical Society of America 122, 3082 (2007); https://doi.org/10.1121/1.2943006.

Dugger KM, Forsman ED, Franklin AB, Davis RJ, White GC, Schwarz CJ, Burnham KP, Nichols JD, Hines JE, Yackulic CB, Doherty Jr PF. The effects of habitat, climate, and Barred Owls on long-term demography of Northern Spotted Owls. The Condor. 2015 Dec 10;118(1):57-116Dunbar, D. L., B. P. Booth, E. D. Forsman, A. E. Hetherington, and D. J. Wilson. 1991. Status of the spotted owl, Strix occidentalis, and barred owl, Strix varia, in southwestern British Columbia.

Falxa, G.A. and M.G. Raphael, technical editors. 2016. Northwest Forest Plan – The first 20 years (1994-2013): status and trend of marbled murrelet populations and nesting habitat. General Technical Report PNW-GTR-933. U.S. Forest Service, Pacific Northwest Research Station, Portland, Oregon. x + 120 pp + appendices.Fitzpatrick, G.S. and C.B. Schultz. 2001. 2000 status of the Fender's blue butterfly (*Icaricia icarioides fenderi*) in Lane County, Oregon: Population estimates and site evaluations. An unpublished report to Oregon Natural Heritage Program and US Fish and Wildlife Service.

FHWA (Federal Highway Administration). 2007. Roadside Revegetation, an Integrated Approach to Establishing Native Plants, FHWA-WFL/TC-07-005. U.S. Department of Transportation, Federal Highway Administration, Western Federal Lands Highway Division, Vancouver, WA.

FHWA (Federal Highway Adminestration). 2016. Federal Aid Highway Program Users Guide, Version 4: June 2016. https://www.oregon.gov/ODOT/GeoEnvironmental/Documents/FAHP-Users-Guide-Update.pdf

FHWA (Federal Highway Adminestration). 2020. FHWA/ODOT's PBA (Progromatic Biological Assessment) for the Oregon Federal Aid Highway Program 2020 (FHWA/ODOT FHAP 2020).

Gaspin, J.B. 1975. Experimental investigations of the effects of underwater explosions on swimbladder fish, I: 1973 Chesapeake Bay tests. Navel Surface Weapons Center Report NSWC/WOL/TR 75-58.

Gisler, S. D. 2003. Reproductive isolation and interspecific hybridization in the threatened species, Sidalcea nelsoniana. Unpublished master's thesis, Oregon State University Department of Botany and Plant Pathology. 173 pp.

Gisler, S. D. 2004. Developing biogeographically based population introduction protocols for at-risk Willamette Valley plant species. Report to U.S. Fish and Wildlife Service, Portland, Oregon. Native Plant Conservation Program, Oregon Department of Agriculture, Salem, Oregon. 230 pp.

Glad, J. B., R. Mishaga, and R. R. Halse. 1987. Habitat characteristics of Sidalcea nelsoniana Piper (Malvaceae) at Walker Flat, Yamhill County, Oregon. Northwest Science 61(4):257-263.

Goertner, J.F., M.L. Wiley, G.A. Young, and W.W. McDonald. 1994. Effects of underwaterexplosions on fish without swimbladders. Naval Surface Warfare Report NSW TR88-114.

Golightly, R.T. and P.N. Herbert. 2006. Movements, nesting, and response to anthropogenic disturbance of Marbled Murrelets (Brachyramphus marmoratus) in Redwood National and State Parks, California. Tech Report. California Department of Transportation.

Gessner, M.O. and E.Cavaet. 1994. Importance of Stream Microfungi in Controlling Breakdown Rates of Leaf Litter. Journal of Ecology. 10 pp..

Gessner, M.O., Robinson, C.T., and J.V. Ward. 1998. Leaf breakdown and associated macroinvertebrates in alpine glacial streams. Journal of Freshwater Biology. 13pp.

Hamer, T.E and S.K. Nelson. 1998. Effects of disturbance on nesting marbled murrelets: summary of preliminary results. US. Fish and Wildlife Service, Pacific Region, Portland, Oregon. 24 pp.

Hastings, M.C. & A. Popper. 2005. Effects of Sound on Fish. Final Report # CA05-0537. Project P476 Noise Thresholds for Endangered Fish. California Department of Transportation. 85 pages.

Holthuijzen, A.M., W.G. Eastland, A.R. Ansell, M.N. Kochert, R.D. Williams, and L.S. Young. 1990. Effects of blasting on behavior and productivity of nesting prairie falcons. Wildlife Society Bulletin 18:270-281

Keevin, T.M. and G.L. Hempen. 1997. The environmental effects of underwater explosions with methods to mitigate Impacts. A manual published by the U.S. Army Corps of Engineers, St. Louis District, St. Louis, Missouri.

Laughlin, J. 2006. Underwater Sound Levels Associated with Pile Driving at the Cape Disappointment Boat Launch Facility, Wave Barrier Project. pp. 42

Longmuir, C.and T. Liveley. 2001. Bubble curtain systems for use during marine pile driving. Report by Fraser River Pile & Dredge Ltd., New Westminster.

Macgillivary, A. and R. Racca. 2005. Sound pressure and particle velocity measurements from marine pile driving at Eagle Harbor maintenance facility, Bainbridge Island WA.

Prepared for Washington State Department of Transportation. pp 15.

Manely, I.A. and S.K. Nelson. 1999. Habitat characteristics associated with nesting success and predation at Marbled Murrelet nests. Pacific Seabirds 26:40 (abstract).

Marzluff, J.M., J.J.Millspaugh, P. Hurvitz, M.S.Handscock. 2004. Relating Resources to a Probabilistic Measure of Space use: Forest Fragmentatiom and Stellars Jays. Journal of Ecology. 16 pages.

Marzluff, J.M., and E.Netherlin. 2006. Corvid response to human settlements and campgrounds: Causes, consequences, and challenges for conservation. Journal of Biological Conservation.

McIver, W., S.F. Pearson, D. Lynch, N. Johnson, J. Baldwin, M.M. Lance, M.G. Raphael, C. Strong, and R. Young, T. Lorenz, and K. Nelson. 2019. Marbled murrelet effectiveness monitoring. Northwest Forest Plan: 2018 summary report. 22 pp.

Meyer, C. B., S. L. Miller, and C. J. Ralph. 2002. Multi-scale landscape and seascape patterns associated with marbled murrelet nesting areas on the U.S. west coast. Landscape Ecology 17:95-115.

Newman, J.S., E.J. Rickley, T.L. Bland, and K.R. Beattie. 1984. Noise measurement flight test for Boeing Vertol 234/Chinook 47-d. FAA-EE-84-7. Federal Aviation Administration, Washington D.C. 180 pp.

NMFS (National Marine Fisheries Service). 2000. Guidelines for Electrofishing Waters Containing Salmonids Listed Under the Endangered Species Act. Protected Resources Division, Portland, OR.Oregon Department of Administrative Services. 1999. Oregon Economic and Revenue Forecast.Vol. XIX. No. 2. Office of Economic Analysis, Salem.

NMFS (National Marine Fisheries Service). 2008. Anadromous Salmonid Passage Facility Design. NMFS, Northwest Region, Portland, OR.

NMFS (National Marine Fisheries Service). 2011. Endangered Species Act Programmatic Biological Opinion and Magnuson-Stevens Act Essentail Fish Habitat Response for the Federal-Aid Highway Program in the State of Oregon, NMFS No. 2011/02095. Northwest Region, Seattle, WA.

NMFS (National Marine Fisheries Service) SLOPES V. 2013. Endangered Species Act – Section 7 Programmatic Consultation Conference and Biological Opinion and Magnuson-Steens Fishery Conservation and Management Act Essential Fish Habitat Consultation for Revised Standard Local Operating Procedures for Endangered Species to Administer Maintenance or Improvement of Stormwater, Transportation, and Utility Actions Authorized or Carried Out by the U.S. Army Corps of Engineers in Oregon (SLOPES for Stormwater, Transportation or Utilities) NMFS No. 2013/10411. Northwest Region, Seattle, WA

ODFW (Oregon Department of Fish & Wildlife). 2011. Oregon Department of Fish and Wildlife, Fish Division, Fish Programs: Fish Passage. http://www.dfw.state.or.us/fish/passage/, accessed June 28

ODOT (Oregon Department of Transportation). 2004. Programmatic Biological Assessment, OTIA III Statewide Bridge Delivery Program, Highway Division, Major Projects Branch, OTIA III Program, Salem, OR.

ODOT (Oregon Department of Transportation). 2008a. ODOT Technical Services Bulletin GE08-04(B), Designating and Constructing Staging and Disposal Sites. Highway Division, Technical Services Branch, Salem, OR.

ODOT (Oregon Department of Transportation). 2008b. SLOPES V Handbook. Highway Division, Technical Services Branch, Geo-Environmental Section, Salem, OR.

ODOT (Oregon Department of Transportation) 2011. Stormwater Management Program. Highway Division, Technical Services Branch, Geo-Environmental Section, Salem, OR. http://www.oregon.gov/ODOT/HWY/ GEOENVIRONMENTAL/storm_management_program.shtml, accessed June 28.

ODOT (Oregon Department of Transportation) 2014a. ODOT Technical Services Bulletin GE14-03(B), Qualification Program for ESA Effects Determinations. Highway Division, Technical Services Branch, Salem, OR.

ODOT (Oregon Department of Transportation). 2014b. ODOT Routine Road Maintenance, Water Quality and Habitat Guide, Best Management Practices, Revised 2014.

ODOT (Oregon Department of Transportation). 2014c. Technical Services Bulletin GE14-03(B), Qualification Program for ESA Effects Determinations. Highway Division, Technical Services Branch, Salem, OR Maintenance, Salem, OR.

ODOT (Oregon Department of Transportation). 2015a. Oregon Standard Specifications for Construction, Technical Specifications. Highway Division, Technical Services Branch, Salem, OR.

ODOT (Oregon Department of Transportation). 2015b. Boiler Plate Special Provisions. Highway Division, Technical Services Branch, Salem, OR. https://www.oregon.gov/ODOT/HWY/SPECS/Pages/2015_special_provisions.aspx, accessed March 2, 2017.

ODOT (Oregon Department of Transportation). 2018. Annual Report for Oregons Programatic Endangered Species Act Consultation on the Federal Aid Highway Program. National Marine Fisheries Service Biological Opinion No. 2011/02095. 27 pages. March 25. 2019.

ODOT (Oregon Department of Transportation). June 2020. Perogrammatic Biological Assessment Federal Aid Highway Program, ammended June 2020. 81 pages.

Popper, A.N., and N.L. Clarke. 1976. The auditory system of the goldfish (Carassius auratus): Effects of intense acoustic stimulation. Journal of comparative Biochemistry and Physiology. pp.7.

Scholik, A.R. and H.Y. Yan. 2002. Effects of Boat Engine Noise on the Auditory Sensitivity of the Fathead Minnow, *Pimephales promelas.* Journal of Environmental Biology of Fishes. pp. 6.

SERA. 2017. Proceedings, National SERA Confrence June 2017. Southern Extension and Research Activities Information Exchange Group (SERA-IEG-6). https://sera6-2017.uark.edu

Swarthout, E.C.H. and R.J. Steidl. 2001. Flush responses of Mexican spotted owls to recreationists. J. Wildlife Management 65(2):312-317.

Tempel D.J. and R. J. Gutiérrez. 2003. Fecal Corticosterone Levels in California Spotted Owls Exposed to Low-intensity Chainsaw Noise.Thomas, G. 1992. Status of bull trout in Montana. Report prepared for Montana Department of Fish, Wildlife and Parks, Helena, Montana.

USFWS (U.S. Fish and Wildlife Service). 1988. Endangered and threatened wildlife and plants: determination of endangered status for the shortnose sucker and Lost River sucker, Final Rule. Federal Register 53:27130–27134

U FWS (U.S. Fish and Wildlife Service). 1990b. Endangered and threatened wildlife and plants; determination of threatened status for the northern spotted owl; final rule. Federal Register, 50 CFR 17: 26,114-26,194.

USFWS (U.S. Fish and Wildlife Service). 1992b. Endangered and Threatened Wildlife and Plants; determination of critical habitat for the northern spotted owl. Federal Register 57: 1796-1838.

USFWS (Fish and Wildlife Service). 1992c. Final rule: endangered and threatened wildlife and plants; determination of threatened status for the Washington, Oregon, and California population of the marbled murrelet. Federal Register 57(191):45328-45337.

USFWS (U.S. Fish and Wildlife Service). 1993. U.S. Fish and Wildlife Service. 1993. Determination of Threatened Status for the Plant Sidalcea nelsoniana (Nelson's Checker-mallow). Federal Register 58:8235-8243. https://ecos.fws.gov/docs/frdocs/1993/93-3353.pdf

USFWS (U.S. Fish and Wildlife Service). 1996. Final Designation of Critical Habitat for the Marbled Murrelet (*Brachyramphus marmoratus marmoratus*). Final Rule. Vol. 61, No. 102:26255-26320.

USFWS (U.S. Fish and Wildlife Service). 1997. Recovery plan for the threatened marbled murrelet (*Brachyramphus marmoratus*) in Washington, Oregon, and California. Portland, Oregon.

USFWS (U.S. Fish and Wildlife Service). 2008. Recovery Plan for the Northern Spotted Owl. Region 1. U.S. Fish and Wildlife Service. Portland, Oregon.

USFWS (U.S. Fish and Wildlife Service). 2010a. Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington. U.S. Fish and Wildlife Service, Portland, Oregon. xi + 241 pp.

USFWS (U.S. Fish and Wildlife Service). 2010b. Endangered and threatened wildlife and plants; revised designation of critical habitat for bull trout in the coterminous United States; proposed rule. January 14, 2010. Federal Register 75 FR 2269.

USFWS (U.S. Fish and Wildlife Service). 2011. Revised Recovery Plan for the Northern Spotted Owl. Region 1. U.S. Fish and Wildlife Service. Portland, Oregon.

USFWS (U.S. Fish and Wildlife Service). 2012a. Revised Critical Habitat for the Northern Spotted Owl. Region 1. U.S. Fish and Wildlife Service. Portland, Oregon. Published in the Federal Register December 4, 2012.

USFWS (U.S. Fish and Wildlife Service). 2012b. Endangered and threatened wildlife and plants: designation of critical habitat for Lost River sucker and shortnose sucker. Federal Register 77:73740–73768.

U.S. Fish and Wildlife Service (Service). 2012c. Revised in-air disturbance analysis for marbled murrelets. Unpublished agency document prepared by E. Teachout, U.S. Fish and Wildlife Service, Washington Fish and Wildlife Office, Lacey, Washington. 12 pp.

USFWS (U.S. Fish and Wildlife Service). 2013. Revised recovery plan for the Lost River sucker (Deltistes luxatus) and shortnose sucker (Chasmistes brevirostris). U.S. Fish and Wildlife Service, Pacific Southwest Region, Sacramento, California.

USFWS (U.S. Fish and Wildlife Service). 2014. Federal Highways State Transportation Improvements Project (STIP) Formal Biological Opinion.

USFWS (U.S. Fish and Wildlife Service). 2015. Recovery plan for the coterminous United States population of bull trout (Salvelinus confluentus). U.S. Fish and Wildlife Service, Portland, Oregon. xii + 179 pp.

USFSW (U.S. Fish and Wildlife Service). 2016. Final determination: endangered and threatened wildlife and plants; determination of critical habitat for the marbled murrelet. Federal Register 81(150):51348-51370.

USFWS (U.S. Fish and Wildlife Service). 2016b. Endangered and Threatened Wildlife and Plants: Designation of Critical Habitat for the Oregon spotted frog; Final Rule. Federal Register 81 (91): 29336-29396

USFWS (U.S. Fish and Wildlife Service). 2019a. Species status assessment for the endangered Lost River sucker and shortnose sucker. Klamath Falls, Oregon.

USFWS (U.S. Fish and Wildlife Service). 2019c. 5-Year Status Review for the Marbled Murrelet. May 2019.

USFWS (U.S. Fish and Wildlife Service). 2020. Northcoast Planning Provence Fprmal Biological Opinion.

Waters, T.F. 1995. Sediment in streams; sources, biological effects, and control. American Fisheries Society Monograph 7.

Zharikov, Y., D.B. Lank, F. Huettmann, R.W. Bradley, N. Parker, P.P-W. Yen, L.A. Mcfarlane-Tranquilla, and F. Cooke. 2006. Habitat selection and breeding success in a forest-nesting Alcid, the marbled murrelet, in two landscapes with different degrees of forest fragmentation. Landscape Ecology 21(1):107-120.

PERSONAL COMMUNICATIONS

Leal, D., 2010. U.S. Fish and Wildife Service, Oregon Fish and Wildlife Office, Portland, Oregon.

APPENDIX A

PROPOSED ACTION GLOSSARY

Action – All activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies.

Action area – All areas affected directly or indirectly by the federal agency action and not merely the immediate area involved in the action {50 CFR §402.02).

Activity – A distinct component of work associated with a highway construction project, often related to a particular design element, such as stormwater control, streambank stabilization.

Active channel width – The stream width measured perpendicular to stream flow between the ordinary high water lines, or at the channel bankfull elevation if the ordinary high water lines are indeterminate. This width includes the cumulative active channel width of all individual side- and off-channel components of channels with braided and meandering forms, and measure outside the area influence of any existing stream crossing (e.g., five to seven channel widths upstream and downstream).

Area of Potential Impact (API) – The area of direct and indirect impact to listed species and designated critical habitat associated with an individual project.

Bankfull elevation – The point on a streambank at which overflow into the active floodplain begins. The active floodplain is a flat area adjacent to the channel constructed by the stream and overflowed by the stream at a recurrence interval of about 1.5 to two years. If the active floodplain is absent or poorly defined, other indicators may identify bankfull. These include the height of depositional features, a change in vegetation, slope or topographic breaks along the bank, a change in the particle size of bank material, undercuts in the bank, and stain lines or the lower extent of lichens on boulders.

Bent – The part of a bridge substructure that supports a vertical load and is placed transversely to the length of a structure; an end bent is the supporting frame forming part of an abutment.

Bioengineering – The use of biological methods such as live staking, plantings, branch packing, brush layering, and any combination of these to stabilize landscapes from erosion.

Bridge – The structure of any span, as distinguished from culverts, that includes superstructure and substructure components including abutments or arches and supports a deck erected over a depression or an obstruction, such as water, and having a track or passageway for carrying traffic or other moving loads. Single span rigid frame structures with a span 20 feet or greater, measured perpendicular to the centerline of the hydraulic opening, are considered bridges.

Contributing Impervious Area (CIA) – All impervious surfaces associated with pubic highways, roads, streets, roadside areas, and auxiliary features (e.g., rest areas, roadside parks, viewpoints, heritage markers, park and ride facilities, pedestrian and bicycle facilities) that occur within the project area, or are contiguous to the project area, and that discharge runoff into the project area, before being discharged directly or indirectly into a stream, wetland, or subsurface water through a ditch, gutter, storm drain, dry well, other underground injection system.

Critical nesting period – The time of year during which the majority of individuals of a species (birds and some other animals) build nests, lay eggs and raise offspring. In the Pacific Northwest, it is usually in the spring.

Culvert – A structure of any span, as distinguished from bridges, that is usually covered with embankment and is composed of structural material around the entire perimeter including pipes, arches, and box culverts. Some culverts are supported on spread footings with the streambed serving as the bottom of the culvert, such as arches and rigid frames. Single span rigid frame structures with a span of less than 20 feet, measured perpendicular to the centerline of the hydraulic opening, are considered culverts.

Diameter at breast height (DBH) – The width of a plant stem (e.g., tree bole) as measured at 4.5 feet above the ground surface. DBH is measured from the uphill side of the plant.

Distinct Population Segment (DPS) – “Population,” or “distinct population segment,” are terms used for listing, de-listing, and reclassification purposes to describe a discrete stock that may be added or deleted from the list of endangered and threatened species. The use of the term “distinct population segment” will be consistent with the Services’ population policy.

Environmental Performance Standard (EPS) – Measures developed for Agency-wide compliance with ODOT's Jobs and Transportation Act, Section 18. The standards compile and integrate existing environmental performance standards from various programmatic documents, other regulatory requirements, as well as ODOT's standard specifications for construction.

Evolutionarily Significant Unit (ESU) – For a species, a population or set of populations that are morphologically and genetically distinct from other populations, or a population or set of populations with a distinct evolutionary history.

Floodplain - The area adjacent to the stream constructed by the river in the present climate and inundated during periods of high flow.

Floodplain connectivity – The hydrologic linkage between a fluvial channel and its associated floodplain.

Fluvial – Pertaining to streams or rivers, or produced by stream action; also, migrating between main rivers and tributaries.

Ford - A location where a highway crosses a channel by allowing high annual or larger flows to pass over the highway and lower flows to pass through a culvert(s). Often used with cutoff walls, roadway lane markers and paved roadway embankments and traveled way (and shoulders). Warning signs may be included, also.

Functional Equivalent – That which provides an offset for the long term effects of the action, and helps move a system towards Properly Functioning Condition, defined as the sustained presence of natural habitat-forming processes in a watershed (e.g., riparian community succession, bed load transport, precipitation runoff pattern, channel migration) that are necessary for the long-term survival of the species through the full range of environmental variation.

Functional floodplain – This zone comprises land where water has to flow or be stored in times of flood. Developed areas are not generally part of the functional floodplain.

General scour prism – All floodplain, bank and streambed material above the general scour depth or general scour elevation.

Habitat – The type of environment in which an organism or group of organisms normally lives or occurs.

Disruption – Any act of pursuit, torment, or annoyance that has the potential to disturb a listed species in the wild by causing disruption of behavioral patterns, including, but not limited to migration, breathing, nursing, breeding, feeding, or sheltering.

High noise – Sound pressure levels greater than 10 dBA above the ambient as measured by the L_{AFmax} and L_{AFeq} at sensitive receptors (e.g., nests, roosting, nesting, foraging habitat).

Hydrologic Unit Code (HUC) – Divisions and subdivisions of the United States into successively smaller hydrologic units, classified into four levels: regions, sub-regions, accounting units, and cataloging units. The hydrologic units are nested from the smallest (cataloging units) to the largest (regions). Each hydrologic unit is identified by a unique hydrologic unit code (HUC) consisting of two to eight digits based on the four levels of classification in the hydrologic unit system.

Infiltration – The flow or movement of water through the soil surface and into the ground.

Invasive – Describes a species (often non-native) taking over a habitat where it was not previously found, often to the detriment of species (frequently native) present prior to its arrival.

In-water work – Any part of an action that occurs below ordinary high or within the wetted channel (e.g., excavation of streambed materials), fish capture and removal, flow diversion, streambank protection, and work area isolation.

Large wood – A tree, log, or root wad big enough to dissipate stream energy associated with high flows, capture bed load, stabilize stream banks, influence channel characteristics, and otherwise support aquatic habitat function, given the slope and bankfull channel width of the stream in or near which the wood occurs.

Native vegetation – Includes native plant species that occur naturally in a particular region, state, ecosystem, and habitat without direct or indirect human actions.

Off-channel habitat – Aquatic habitat elements within a floodplain such as sloughs, beaver ponds, wetlands, and other permanently or seasonally flooded lands that promote fish spawning and rearing.

Ordinary high-water elevation (OHWE) –The elevation to which the high water ordinarily rises annually in season, excluding exceptionally high-water levels caused by large flood events. Ordinary high water is indicated in the field by one or more of the following physical characteristics: (a) a clear natural line impressed on the bank or shore; (b) destruction of terrestrial vegetation; (c) change in vegetation from riparian to upland; (d) textural change of depositional sediment or changes in the character of the substrate, e.g., from sand to cobbles, or alluvial material to upland soils; (e) the elevation below which no needles, leaves, cones, seeds, or other fine debris occurs; (f) the presence of litter and debris, water-stained leaves, water lines on tree trunks; or (g) other appropriate means that consider the characteristics of the surrounding areas. The ordinary high-water elevation is typically below the bankfull elevation. The ordinary high-water elevation is considered equivalent to the bankfull elevation if the ordinary high water lines are indeterminate.

OTIA III – Oregon Transportation Investment Act – Oregon State House Bill 2041, the transportation funding package. This legislation will use increased DMV and trucking-related fees to finance $2.5 billion in transportation construction projects in Oregon cities and counties, and along the Oregon State highway system.

Pile or piling – A long column driven into the ground to form part of a foundation or substructure.

Primary Constituent Elements (PCEs) – The physical and biological features of designated or proposed critical habitat that are essential to the conservation of the species, including, but not limited to: (1) space for individual and population growth, and for normal behavior; (2) food, water, air, light, minerals, or other nutritional or physiological requirements; (3) cover or shelter; (4) sites for breeding, reproduction, the rearing of offspring, germination, or seed dispersal; and (5) areas that are protected from disturbance or are representative of the historic geographic and ecological distributions of a species.

Project – An independently developed/delivered construction action, defined by its Project Type and inclusive of relevant Activities; also referred to as STIP Project, Construction Project, Contracted Action.

Project Type – The main component of a transportation improvement action associated with a defined problem and solution. ODOT project types may be focused, such as Culvert Replacement or Rock fall Protection, or broad and encompass one or more focused types, such as Modernization or Preservation.

Recovery units – Management subsets of a listed species, created to establish recovery goals or carry out management actions. Pursuant to section 7 of the Endangered Species Act and to lessen confusion, a subset of animal or plant species identified for the purpose of recovery management will be called a “recovery unit” instead of a “population.”

Redd – A nest made in streambed gravel by fish for egg deposition, fertilization, and incubation.

Refugia – Habitat elements such as undercut banks, large boulders, root wads, and debris jams that promote freshwater aquatic habitat.

Regulatory authorities – Includes the ODEQ, ODSL, ODFW, ODA, Corps, and other agencies with project-specific or activity-specific jurisdiction.

Regulated Work Area – Aquatic habitat supporting listed species, and areas with protected aquatic species, defined as the area within the ordinary high water (OHW) elevation. The regulated work area, if applicable, will be identified in the Special Provisions.

Riparian zone – The dynamic zone of interaction between upland and aquatic systems providing the following functions: shade, streambank stability, sediment and nutrient regulation, and input of large woody debris.[23]

Riprap – A permanent erosion resistant, ground cover of large, loose, angular rocks used to stabilize an area.

[23] The USFWS defines riparian areas as “plant communities contiguous to and affected by surface and subsurface hydrologic features of perennial or intermittent lotic and lentic water bodies (rivers, streams, lakes, or drainage ways). Riparian areas have one or both of the following characteristics: 1) distinctly different vegetative species than adjacent areas, and 2) species similar to adjacent areas but exhibiting more vigorous or robust growth forms. Riparian areas are usually transitional between wetland and upland.” (From A System for Mapping Riparian Areas In The Western United States [2009], U.S. Fish and Wildlife Service, Division of Habitat and Resource Conservation, Branch of Resource and Mapping Support, Arlington, VA).

STIP – The Oregon Statewide Transportation Improvement Program (STIP) is the state's four-year transportation improvement program for state and regional transportation systems.

Upland – Those lands that are not defined as wetlands by the National Wetland Classification System; i.e. they do not at least periodically support mainly hydrophytes, are not dominated by hydric soils, and are not covered with water at some time during the growing season of each year.

Water quality design storm – The magnitude of the precipitation event that must be managed for water quality. Treatment facilities are to be designed to handle the volume and peak flow rate generated by the CIA during this event.

Watershed – A geographic area of land, water and biota within the confines of a drainage divide; the United States Geologic Survey's 5th field Hydrologic Unit Code.

APPENDIX B

SUPPLEMENTAL INFORMATION ON BRIDGE PRESERVATION & REHABILITATION

3.1 Programmatic Summary – Bridge preservation/rehabilitation projects generally include preparation and coating of steel bridge components, preparation and coating of reinforced concrete bridge components, impressed current cathodic protection and galvanic cathodic protection of reinforced concrete bridge components, concrete patching, pack rust removal on steel bridges, historic rail retrofit, deck replacement, pavement removal and resurfacing, fiber reinforced-polymer strengthening, structural supports repair and replacement, seismic retrofit, bridge lane widening, vertical clearance improvement, and mechanical, electrical, and architectural rehabilitation on movable bridges. Various types of containment are required for these bridge preservation/rehabilitation activities. Containment systems are described in detail in the programmatic.

The purpose of bridge preservation/rehabilitation projects is to extend the useful life of existing bridges. In some cases, preservation/rehabilitation activities are required to conserve historic resources. In other cases, preservation/rehabilitation activities are warranted for economic reasons, i.e., bridge replacement is often more costly than preservation/rehabilitation and much more disruptive to local communities and traffic flow. On the environmental side, if a current bridge is not restricting water flow, the floodplain, or fish or wildlife passage, activities associated with bridge preservation/rehabilitation will likely have fewer short-term impacts to the environment than full bridge replacement.

The Bridge Preservation Programmatic contain[s] a list of 59 representative bridges . . . that were used to identify the range of actions associated with bridge preservation/rehabilitation and to determine the most appropriate and practicable avoidance, minimization, and conservation measures for each action. Although all 59 bridges on the list warrant preservation/rehabilitation, they are only a representative sample of bridges that could be covered under this programmatic. Because this is a true Programmatic BA, any bridge preservation/rehabilitation project that will utilize actions covered in [the] document, that has a reasonable likelihood of impacting listed species, that will follow the project relevant avoidance, minimization, and conservation measures outlined in this document, and that will follow the project relevant terms and conditions of the resulting Programmatic Opinion from the Services will be covered under [the] programmatic regardless of its inclusion on the representative bridge list used to develop [the] Programmatic BA. Use of [the] programmatic is intended only for bridge preservation/rehabilitation projects when effects on listed or proposed species, or designated or proposed critical habitat, are likely.

3.2 Programmatic Area and Environmental Baseline - [The] bridge preservation/rehabilitation programmatic was developed to cover highway and local bridges across the entire State of Oregon. Oregon is composed of eight principal ecoregions, areas where environmental conditions are relatively homogeneous and species complexes are relatively distinct. The Columbia River and its tributaries drain water from basins in seven of the eight ecoregions. See [the] Ecoregion [S]ection of the FHWA [ESA] Programmatic.

3.4 Bridge Preservation and Rehabilitation Activities – Bridge preservation/ rehabilitation activities identified from the 59 representative bridges are described below. Containment appropriate for each activity will occur on every project.

(a) Preparation and Coating of Steel and Reinforced Concrete Bridge Components

(1) Steel Bridges – Steel bridges require maintenance of their protective coating system to prevent loss of steel structural material, particularly in environments with a marine influence. In some cases, 'Spot Preparation and Coating' can be effective for maintenance of the existing coating. These cases typically involve coatings with less than 20% failed surface. When larger areas of the coating have failed, the more effective preservation strategy is to fully remove the existing coating to bare metal and fully replace the coating. Spot preparation can be done with vacuum-shrouded power tools or vacuum-shrouded abrasive blast, with containment to catch paint chips and debris. Larger-scale preparation is done either by abrasive blast within Type 1A containment or by pressure washing or water jetting within Type 2W containment. Coating can be applied with brushes, pads or rollers, or by spray equipment within containment. Typically, corroded rivets are replaced with bolts during steel bridge coating projects. The existing rivets are removed by drilling, punching using a rivet gun, pressing using a porta-power, or burning out with a magnesium torch. New bolts are installed by standard methods and coated in place.

(2) Concrete Bridges – In addition to the activities described above, concrete bridges sometime require application of sealers to limit the ingress of salts from a marine environment or from de-icing chemicals. Preparation typically involves pressure washing within Type 2W containment or abrasive blasting within Type 1A containment. Application of sealer can be accomplished with brushes, pads or rollers, or by spray equipment within containment.

(b) Concrete Patching – Reinforced concrete bridges, especially when exposed to salts, are subject to corrosion of the steel reinforcement. Corrosion of the steel reinforcement results in corrosion products (i.e., rust) that are six to 11 times thicker than the deteriorated metal. This expansion pushes off the encasing concrete in an action known as 'spalling' and leaves the reinforcement unprotected from the environment. Bridges that exhibit spalling may require hammer tests to locate and remove additional delaminated areas, followed by patching with new concrete. Depending on the location and the reason for the spalling, the bridge may also require some degree of cathodic protection (see below) to avoid further accelerated spalling. This work typically occurs within Type 1A containment as part of a cathodic protection project. In cases of concrete patching without cathodic protection, ground containment or deck containment on a work platform is used to capture chips, debris, and green concrete.

(c) Cathodic Protection

(1) Impressed Current Cathodic Protection of Reinforced Concrete Bridge Components – Impressed current cathodic protection halts the corrosion process by introducing an electrical current between an anode applied as a coating on the outside of the concrete, and the reinforcing bars. Installation of impressed current cathodic protection takes place within Type 1A containment. Areas of spalled and delaminated concrete are repaired as described under the 'Concrete Patching' section above (Section b). The concrete surface is prepared by abrasive blasting and coated with a conductive material (typically arc-sprayed zinc, but conductive paints are also available). Conduits are placed and wires run to allow operation and control of the system from electrical cabinets. Electrical power and telephone lines are connected to the electrical cabinets. Large cathodic protection projects often require work bridges to access and support massive containment structures and tiebacks made up of pilings or groups of pilings to help the containment structures resist high wind loads without imparting excessive forces to the bridge.

(2) Galvanic Cathodic Protection of Reinforced Concrete Bridge Components – Galvanic cathodic protection halts the corrosion process by introducing an electrical current between a discrete anode installed on the structure and the reinforcing bars. The theory of operation is similar to impressed current cathodic protection, except that the current is created by the potential difference between the anode and the reinforcing bars, and there is no external power source. Galvanic cathodic protection work is similar to impressed current cathodic protection work, except that the anode is installed in core-drilled holes in the concrete or cast into concrete patch areas. A variation on this system involves a zinc "tape" product that can be manually applied to the external surface of the concrete.

(d) Pack Rust Removal on Steel Bridges – Sometimes when steel plates are fastened together, rust scale can develop and expand between the plates. This expansion can damage structural members and expose more steel to further corrosion problems. Pack rust can often be removed by the use of ultra-high pressure (up to 40,000 psi) water jetting within Type 2W containment. If water jetting fails to remove all of the pack rust, the remaining scale can often be removed by heating to 212 degrees Fahrenheit which causes it to pop off. After removal of pack rust, sealant is placed between the expanded plates and new fasteners are installed to pull the plates back together. Sometimes pack rust develops between components in a pin and hanger assembly; this can be removed by the same methods.

(e) Cap Replacement, Crossbeam Repairs, Replacement of Timber Components, and External Post-Tensioning – Bridge rehabilitation work often includes repair or replacement of longitudinal load carrying elements (girders and stringers) and transverse load-carrying elements (pile caps, crossbeams, and floor beams). A pile cap is a transverse member that ties together the top of a group of pilings and supports longitudinal members that rest upon it. Cap replacement consists of removing the existing cap and replacing it with a new member, while the longitudinal members are supported by jacks. A typical cap replacement involves removing a rotting timber cap and replacing it with either new timber or a steel beam. Tarps are used to catch drillings and scraps from treated timber. Any new treated timber is coated with Sherwin-Williams Envirolastic AR mastic paint or equivalent. Crossbeam repairs are structural repairs on transverse members in place and can take many forms. The most common forms are: (1) spanning structural steel between columns, (2) constructing additional reinforced concrete cross sections and anchoring the new reinforcements into the existing concrete crossbeams, (3) adding posts between existing columns or pilings, and (4) employing external post tensioning, as explained below. Replacement of timber components, beyond cap replacement, includes replacement of timber stringers, timber decking, timber bracing, and sections of timber piling. Jacking is sometimes required to support the bridge while the timber component is being replaced. Tarps are used to catch drillings and scraps from treated timber. Any new treated timber is coated with Sherwin-Williams Envirolastic AR mastic paint or equivalent. External post-tensioning is sometimes used to strengthen existing reinforced concrete members, both longitudinal and transverse. External post-tensioning consists of anchoring heavy steel fittings to the concrete member, at each end and intermediate points, and routing high-strength steel cable/strand through these fittings. The strand is then loaded using special jacks to stretch the strand to a high percentage of its strength, placing the concrete member in a beneficial state of compression.

(f) Structural Steel Repairs – Steel bridges occasionally require structural repairs to address collision damage, corrosion damage, or fatigue cracking. Truss members often are straightened in place using heat straightening methods that rely upon acetylene torches and sometimes additional forces applied by jacks, chains and come-alongs, and similar methods. Sometimes members can be replaced by removing rivets or bolts and installing a new member made to original dimensions. Often members are strengthened by bolting additional steel onto a weakened member. Sometimes welding is necessary, and submerged metal arc welding (stick process) or flux core arc welding (wire process) typically are employed. Existing coatings are removed before removal, cutting, heating, or welding of steel members, and new coatings are applied after components are repaired and/or installed using the same methods described under "Spot Preparation and Coating" in the "Preparation and Coating of Steel and Reinforced Concrete Bridge Components" section above (Section a).

(g) Installation, Upgrading, and Removal of Access Hardware – Large bridges and movable bridges in particular have access needs for inspection, changing of warning lights, and greasing and routine maintenance of moving parts. These needs are typically addressed by installing ladders, access hatches, stairways, walkways, platforms, handrails, and fall arrest cable systems. This type of work usually involves the same activities described under the "Structural Steel Repairs" section above (Section f); existing coatings are removed before work begins on steel members and new coatings are applied after components are repaired or installed using the same methods described under "Spot Preparation and Coating" in the "Preparation and Coating of Steel and Reinforced Concrete Bridge Components" section above (Section a).

(h) Mechanical, Electrical, and Architectural Rehabilitation – Movable bridges contain many mechanical, electrical, and architectural elements not found on most bridges, and large bridges often have extensive wiring to support warning lights and/or street lights. The conduit runs on bridges often require replacement due to corrosion of the conduits or changes in lighting requirements. Mechanical rehabilitation elements include span drive machinery, span lock machinery, heating, ventilation, air conditioning (HVAC), and plumbing. Span drive machinery typically includes large electric motors, enclosed gearboxes, clutches and brakes, large shafts and shaft couplings, bearings, exposed gearing, and greased wire ropes. Span lock machinery typically includes electric motors, open or closed gearing, and various mechanism elements such as cams or cranks, and may also include brakes. HVAC equipment includes air-source heat pumps, closedloop water-source heat pumps, electric unit heaters, water circulating pumps, pressure tanks, motor-driven louvers, ductwork, and fans. Plumbing equipment includes toilet facilities with incinerators or storage tanks, sinks for wash-up, freshwater tanks, pumps, water heaters and piping serving toilet and wash-up facilities, and fuel tanks and piping for backup generators. This equipment may be removed and replaced or rebuilt during a rehabilitation project. Capture and containment of materials is required, including asbestos dust, asbestos brake and clutch linings, asbestos piping insulation, grease, lubricants, lead-based paint, human wastes, and HVAC working fluids (refrigerant and/or anti-freeze solution). The rehabilitation design typically includes secondary containment for fuel tanks and piping, asbestos-free brake and clutch linings and pipe insulation, and refrigerants meeting current legal requirements. Electrical rehabilitation elements include switchgear, variable frequency drives, electronic controls or programmable logic controllers, proximity sensors, backup generators, wiring and conduits, extensive systems of illumination and warning lights, electrically driven traffic gates, electrically driven traffic barriers, camera systems, traffic signals, and residential type wiring. This equipment may be removed and replaced or rebuilt during a rehabilitation project. Capture and containment of materials is required, including asbestos wiring insulation, lights, and lead-based paint. Architectural rehabilitation elements include windows, doors, roofing, siding, interior walls, ceilings and floors, and some original details such as entry pylons. These items may be removed and replaced during a rehabilitation project. Capture and containment of materials is required, including asbestos wallboard, floor tiles or ceiling tiles, and lead-based paint.

(i) Historic Rail Retrofit – Federal highway regulations mandate retrofit of substandard bridge rails when project work exceeds regular maintenance or painting. To comply with these regulations while meeting the intent of historic preservation laws, historic bridges receive rail retrofits that replace the existing rail with a replica that contains sufficient steel to resist modern rail design forces. Historic rail retrofits begin with sawing or chipping off the existing rail; concrete dust and debris are fully captured by containment. Holes are drilled into or through the deck for new anchor bolts and the new rail can be formed and poured in place or brought in as a precast unit and bolted into place.

(j) Deck Replacement – Some small bridges that are candidates for preservation/rehabilitation work have failing timber decks. Deck replacement consists of removal of the existing timber deck with the capture of all debris and waste within a containment system, placement of forms, and pouring of a new concrete deck with the capture of any green concrete. In some cases, the timber deck can be replaced with fiber-reinforced polymer deck panels (see below) fastened to the stringers with large blind fasteners, and covered with an asphalt concrete or polymer concrete wearing surface.

(k) Pavement (ACWS) Removal and/or Resurfacing, Concrete Sealer Application, Bridge Deck Overlays, and Bridge Deck Concrete Repairs up to Full Depth – Some bridges require removal of the asphalt concrete wearing surface (ACWS) and/or resurfacing for the purpose of removing excessive dead load from the structure (many bridges have eight inches or more of asphalt from repeated overlays and this is detrimental to load capacity) or for maintenance of the wearing surface. Typically asphalt removal is accomplished with standard pavement grinders; deck drains are plugged during the process to contain the grindings on the bridge prior to their collection and removal. Resurfacing may consist of paving back two inches of ACWS, laying down a high performance concrete overlay (microsilica concrete or latex-modified concrete approximately 1.5-inches thick), or laying down a thinpolymer product using polyester, epoxy, methacrylate, or urethane as a binder for the aggregate. Containment for resurfacing is the same as for asphalt removal. The type of resurfacing system selected is dependent upon the environmental, structural, and use conditions of the bridge. Similarly, some bridges with concrete decks require rehabilitation due to studded tire damage, spalling or potholing of concrete due to delamination or reinforcing corrosion, or excessive cracking. A thin layer of the entire deck is ground off or micromilled and any unsound concrete is removed using grinders, mills, jackhammers, or ultra-high-pressure water blasting, in some cases removing the entire thickness of the deck in small areas. The removed unsound concrete is replaced with new structural concrete and the entire deck receives a microsilica concrete or latex modified concrete overlay approximately 1.5- inches thick, or a polymer concrete overlay as described above. Bridge drains are plugged as in the case of ACWS removal, and additional containment must be provided below the deck when concrete removal approaches full deck thickness. When a concrete bridge deck is structurally sound but has some cracks or is expected to be exposed to deicing salts, various sealant products may be applied to slow the ingress of moisture and salts into the deck. These sealants include silane, siloxane, linseed oil, and polymers such as methacrylate, epoxy, urethane, or polyester. Containment for deck sealing is the same as for asphalt removal.

(l) Fiber-reinforced Polymer Strengthening and Crack Injection – Some bridges require strengthening to provide the structural load capacity demanded by modern traffic. A common method of retrofit is to bond strips of fiber-reinforced polymer to the surface of reinforced concrete members. A containment system is used to fully capture debris and polymer drips. At the start of the repair process, existing cracks in the concrete are injected with resin. The surface of the concrete is roughened by sanding or light sandblasting, and the strips of fiber-reinforced polymer are bonded to the structure using resin. The completed repair is sometimes painted to improve ultraviolet resistance. Some reinforced concrete bridges require crack injection without further strengthening.

(m) Seismic Retrofit, Bearing Retrofit, and Bridge Deck Joint Repair/Retrofit – Due to Oregon’s seismic hazard, some bridges require seismic retrofit. Phase 1 seismic retrofit consists of providing adequate seat width and restrainers to prevent spans from moving off their supports during a seismic event. Phase 2 seismic retrofit is more comprehensive and involves retrofitting bridge members to withstand seismic forces; it may include installation of special bearing devices to reduce seismic forces. Phase 1 seismic work involves adding additional reinforced concrete sections in areas where the bridge rests on piers, bents, abutments or other supports, and anchoring fittings and cables to the bridge to function as restrainers. Phase 2 seismic work involves reinforced concrete repairs and bearing replacement. These activities are similar to those described under “Crossbeam Repairs” (Section (e) above) and “Bearing Retrofit” (below). Bearing retrofit consists of the removal of existing bearing devices (which may include steel rockers, steel roller bearings, steel slider plates, or bronze slider plates) and replacing them with new devices including elastomeric bearing pads, stainless steel/Teflon sliders, or specialized seismic devices such as friction pendulum bearings. Jacking is usually required to unload the existing bearings and allow replacement.

Bearing retrofit typically is done to improve seismic resistance or to improve bearing function. Bridge deck joint retrofit consists of removing existing joint materials and steel armor, rebuilding in a new configuration, and installing new joint seals. Deck joint retrofits are needed when a joint seal is unserviceable, cannot be kept from leaking, or has damaged armor. The work includes cutting of steel, chipping concrete with jackhammers, drilling in concrete and steel to set anchors, casting new patch concrete, and installing seals which may be extruded neoprene, foam rubber, or poured silicone and/or rubber compounds. These retrofit activities described in this section typically require the capture and containment of demolition debris, wet concrete, and poured joint seal compounds.

(n) Bridge Lane Widening – A number of historic bridges are structurally sound but categorized as functionally obsolete due to inadequate horizontal clearance. These can sometimes be widened to provide modern lane widths, without adding new lanes. Bridge widening for the purpose of lane widening is a preservation activity because the bridge would otherwise be replaced to safely serve traffic needs. A bridge widening project consists of removal of some deck components (typically the overhang) and bridge rails with the capture and full containment of debris and waste, drilling into existing structures to splice the new work, and building of new concrete and/or steel structure to support the additional width. No new permanent piles are necessary. Typically, the new structure is carefully detailed to visually approach the appearance of the original structure, and these projects typically receive historic rail retrofits.

(o) Vertical Clearance Improvement – Some steel through-trusses on bridges provide less vertical clearance than is demanded by modern traffic. These trusses often can be rebuilt to provide adequate vertical clearance. Vertical clearance improvement is a preservation activity because it eliminates a primary justification for bridge replacement. A vertical clearance project consists of the removal and replacement of certain overhead structural steel members in a particular sequence. Existing coatings are removed before removal of steel members, and new coatings are applied after components are installed, using the same methods described under ‘Spot Preparation and Coating’ in the ‘Preparation and Coating of Steel and Reinforced Concrete Bridge Components’ section above (Section a). Some grade-separation structures (overpasses) provide less vertical clearance for the lower facility than is demanded by modern traffic. Overpasses can be raised by supporting the structure, cutting the supporting columns, jacking the structure to the new elevation, and splicing the columns back together with a new section of reinforced concrete. This type of project also requires that the approach roadways be elevated and usually necessitates that sheet piling or other types of retaining walls be constructed to contain the higher road fill. The bridge jacking and column work is similar to the work described in “Cap Replacement” and “Crossbeam Repairs” above (Section e). Typically, these projects do not affect waterways as the function of the bridge is to cross another highway.

(p) Containment – Projects that include abrasive blasting, water jetting, coating of steel or concrete, zinc metalizing, and concrete removal or patching work typically require containment as specified in ODOT Specifications 00594.05. These specifications deliver a high degree of control and containment of construction materials, wastes, and other materials used or generated by project work. Type 1A containment, specified for dry abrasive blasting, controls lead and dust through use of negative air pressure within the containment (this prevents escape of lead wastes). Dust and debris from the containment is ducted to a dust collector that filters lead waste and other debris from the air before the air is discharged into the environment. The lead waste is contained within special abrasives/additives that are designed to produce a non-hazardous waste (lower concentration of lead). Type 2W containment, specified for water jetting, controls lead and dust by providing water-tight walls and floor to capture paint wastes removed by the jetting action. Wastewater is pumped from the floor of the containment and may be filtered to remove solids and reused. When water is disposed of, it is filtered until clean enough to be accepted by a water treatment facility, then it is pumped into a tanker and hauled to the facility. Lead and dust waste removed by the filters is treated as hazardous waste. The quantity of waste needing disposal is less than that generated from dry abrasive blasting, but the resulting waste is more concentrated. Sometimes bridge preservation work can be accomplished without large, extensive containment by using vacuum-shrouded hand or power tools or abrasive blasting in conjunction with hanging or ground containment, as in ODOT Specifications 00594.05, provided the degree of capture and control of materials is equivalent to full containment standards. Vacuum-shrouded tools include a wide assortment of grinders, sanders, needle guns, flap wheel tools, wire brushes, and scrapers, as well as abrasive blasting equipment. Type 2P containment, specified for vacuum-shrouded hand and power tool work or abrasive blasting, controls lead by ducting dust and paint chips directly to a dust collection system from the tool. A supplemental containment system provides a secondary means of capture in case larger flakes or paint chips escape the shroud system. Lead wastes removed by the dust collection system and collected by the supplemental containment system are treated as hazardous waste.

(q) Tie-Backs – Some projects with large or high containment systems require tiebacks that anchor the system and protect the bridge from excessive wind forces. Tiebacks typically consist of pilings, either individually or in groups, and anchor lines. The tiebacks are removed after project completion, with the pilings pulled if possible and appropriate. As with other pilings, if total removal isn't practicable, the pile is cut off three feet below the mud line.

(r) Barges – Some bridge preservation projects require barges to provide a staging area for equipment, materials, and some waste materials. Specifications have been developed to govern the outfitting and operation of the barge. Barges must be handled and anchored in a seaworthy manner in accordance with all U.S. Coast Guard regulations; all equipment is fastened to the deck of the barge; containers of abrasives, wastes, supplies, and liquid materials are positively closed and fastened to the deck or within larger containers; the amount of fuel on the barge is limited; and secondary containment for spills is provided on the deck of the barge. Anchoring of the barge typically is accomplished by lowering spuds to the bed of the river and allowing them to sink in solely by their weight. Spuds sometimes are augmented by a system of anchors.

(s) Work Bridges - Some projects may require work bridges either for work access or to support large and heavy containment systems. Work bridges typically are built with steel pipe pilings, steel beams, timber beams, a polyethylene membrane between sub-floor components and finish floor, and heavy plywood decking. The entire structure is removed after project completion, with the pilings pulled if possible and appropriate. If total pile removal isn't practicable, the pile is cut off three feet below the mud line.

(t) Cranes – Many projects require cranes for activities such as loading/unloading supplies, materials and wastes; building and removing work bridges; and placing heavy structural components such as sections of bridge rail or decking. Occasionally the function of a crane is served by helicopter lifts. When a barge or work bridge is located adjacent to and under a bridge, cranes are very useful for transferring supplies, wastes and fuel tanks to and from the barge/work bridge. When cranes are necessary, appropriate containment measures are used to prevent spills from reaching the aquatic or terrestrial environment, such as placing the crane on a mat with an absorbent boom.

(u) Cofferdam – A cofferdam is a temporary structure designed to isolate project work from the wetted channel. The most effective cofferdams are tight enough that water can be pumped out of the structure and kept out of the structure to maintain a dry working environment. Work area isolation may be required when preservation/rehabilitation work involves activities in the vicinity of the bank, work bridge construction, and piling repair or replacement.

APPENDIX C

ENVIRONMENTAL BASELINE SUPPORTING DOCUMENTATION

Ecoregion Context
Oregon comprises ten ecoregions, each of which contains multiple habitat types. Ecoregions are relatively uniform geographic areas that respond in a similar manner to physical activities (i.e., rainfall, fire, human land use activities, etc.) (SOER 2000). These ecoregions are based on similarity of important environmental variables such as climate, geology, physiography, vegetation, soils, land use, wildlife, and hydrology. The ecoregion descriptions provide an overview to the current conditions of the regional environment.

The ecoregions used in this analysis were the EPA Level III ecoregion descriptions used by the State of the Environment Report (SOER) Science Panel in the Oregon State of the Environment Report (SOER 2000), the EPA Level IV ecoregion descriptions used in the Oregon Watershed Enhancement Board's Oregon Watershed Assessment Manual (Watershed Professionals Network 2001), and the ODFW and Oregon Natural Resources Heritage Program Level III ecoregion characterizations of patterns within a watershed (Bryce and Woods 2000). Because watersheds within an ecoregion have common attributes, the ecoregion descriptions assist with the effects analysis. Table 1 provides the acreage of the various habitat types within each ecoregion.

<u>Basin & Range.</u> (Bull trout) The Basin and Range ecoregion includes a large portion of southeastern Oregon and is the least populated area of the State (SOER 2000). This ecoregion is Oregon's high desert, and contains numerous flat basins separated by isolated, generally north-south mountain ranges. Malheur Lake is the major drainage basin in this arid ecoregion (Watershed Professionals Network 2001). Runoff from precipitation and mountain snowpacks and basins often flows into flat, alkaline playas, where it forms seasonal shallow lakes and marshes (Bryce and Woods 2000). In addition, the terrestrial landscape is open and treeless, plants are widely spaced, and soils are exposed to the elements. The Basin and Range ecoregion contains many diverse habitats.

The most significant are the sagebrush (*Artemisia* spp.) steppe types, salt desert scrub (Bryce and Woods 2000), and riparian and wetland types, as well as mountain mahogany (*Cercocarpus* spp.) and aspen (Populus spp.) woodlands (SOER 2000).

Many of the major wetland complexes within this arid ecoregion are managed for waterfowl production by State, Federal, or private agencies, although most wetlands are privately owned (SOER 2000). The large wildlife refuges here support some of the largest populations of pronghorn antelope, white pelicans, and sage waterfowl, and are well known for their wildlife diversity (Bryce and Woods 2000). Flooding and drying now occur sooner in the year than they did historically. Historically, playa lakes were wet during winter and spring, and then dried as summer approached. Some playa lakes have been altered for livestock watering, and in drier years water is concentrated in deep pools, thus affecting a smaller area (SOER 2000).

Water is the limiting factor in this ecoregion. Declines in riparian condition and water quality occurred during the heavy grazing early in the 20th century. Stream water quality here is the lowest in the State, generally measured as poor or very poor. The trend in water quality shows no improvement, although in some areas, primarily fenced enclosures, riparian conditions have dramatically improved. Surface water is fully allocated. Much of the water is dammed, and releases from dams keep instream flows close to the required minimums (SOER 2000).

Many of the region's historical wetlands and riparian areas have been converted to agriculture or have been degraded through water diversions and grazing. The region has been heavily affected by grazing pressure, which affects different parts of the landscape in different ways. Improper grazing is particularly destructive in wetland and riparian areas. More than 145 species depend on tall sagebrush-bunchgrass communities. In other places, fire suppression has increased the relative density of sagebrush while diminishing bunchgrasses, which has negatively affected many native species. An additional threat to ecological integrity in upland areas as well as in wetland and riparian areas is the encroachment of invasive plant species (SOER 2000).

<u>Blue Mountains.</u> (Bull trout) The Blue Mountains ecoregion occupies most of northeastern Oregon and encompasses three major ranges: the Ochoco, Blue, and Wallowa Mountains. Deep, rock-walled canyons glacially cut gorges, dissected plateaus, and broad alluvial river valleys characterize the landscape. Extreme changes in elevation across the ecoregion result in a broad range of temperature and precipitation, supporting habitat diversity second only to the Klamath Mountains ecoregion (SOER 2000).

Vegetation in the lowland areas consists of bunchgrasses, sagebrush, and juniper (*Juniperus* spp.*)* (Bryce and Woods 2000). Ponderosa pine (*Pinus ponderosa*) and juniper woodlands are characteristic of mid-elevation areas, with mixed coniferous forests dominating higher altitudes and north- facing slopes at mid-elevations. Extensive grasslands occur in and north of the Wallowa Mountains (SOER 2000).

Riparian areas in valley bottoms are important for aquatic and terrestrial organisms in arid landscapes where streamside vegetation provides shade and refuge. Riparian areas are among the most diverse natural communities in the region, largely concentrated in intermountain basins (SOER 2000). These seasonally flooded wet meadows provide important habitat; the largest remaining blocks of these wetlands, almost all on private lands, are found at Big Summit Prairie, along the upper Silvies River, and in Logan Valley (Watershed Professionals Network 2001).

The diversity of the Blue Mountains landscape provides goods and services long valued by the people of the region. Most of the uplands in the region are federally owned forest and rangeland. Private land generally follows valleys and water courses, where most of the region's agriculture occurs; however, several parcels of privately-owned timber in uplands are present (SOER 2000).

The large, central valleys of the Grande Ronde and Powder Rivers historically contained native riparian forests, wetlands, and grasslands that have been primarily converted to agriculture. Most stream reaches have been simplified by channelization and straightening. Riparian conditions are degraded throughout the region, particularly in the middle and lower reaches of large river valleys such as the Grande Ronde and Umatilla (SOER 2000, OWEB 2001).

Four activities have had profound effects on the landscape of the region: timber harvest, fire suppression, grazing, and agriculture. Fire suppression, in concert with timber harvest, has changed the structure and function of the region's forests; it has also allowed a dense build-up of young trees, creating more biomass than can be supported through times of drought. These dense, over-stocked forests are far more vulnerable to fire and insects (SOER 2000).

Virtually all of the Grande Ronde Valley's historical wetlands have been drained and converted to agriculture. Many wetland sites have been affected, at least temporarily, by water flow alterations as well as by increased sediment and nutrients from agricultural and other activities (SOER 2000). Much of the ecoregion is within a complex of aquatic diversity areas identified by the American Fisheries Society. Much of this complex lies in Federal wilderness areas (SOER 2000, OWEB 2001).

In coordination with regional planning efforts, complex plans for total maximum daily loads of non-point sources of pollution are being developed for stream segments with limited water quality, as identified by the Clean Water Act 303(d) list. Many of the low-lying streams in this ecoregion are listed, primarily as a result of high stream temperatures during the summer. Upland water is of relatively high quality and the conditions of upstream fish habitats are improving (SOER 2000).

Coast Range. (Marbled murrelet and spotted owl) The Coast Range ecoregion extends the entire length of the Oregon coastline as a narrow, jumbled mountain range from the edge of the Pacific Ocean to the Willamette Valley and Klamath Mountains. Along the north coast, cliffs and grassy headlands are separated by stretches of flat coastal plain and estuaries. A broad coastal terrace characterizes much of the south coast, punctuated by steep headlands, inland lakes, and rocky offshore islands (SOER 2000). The region's marine climate causes the wettest habitats in the State, including temperate rainforests, which are some of the most productive forests in the world (SOER 2000).

Much of the commercial and residential development in the region is clustered along 101 and around the larger estuaries and streamside riparian areas. The coastal economies are distinctly different from north to south. The northern counties are evolving from a dependence on fishing and timber to a reliance on tourism and retirement. To the south, the coastal economy has been more dependent on the forest products industry (SOER 2000).

Oregon's 22 estuaries are ecological transition zones, integrating features of the watersheds they drain with those of the marine environment. Although protection currently exists, most Oregon estuaries are dramatically smaller than they were historically—mostly, as a result of the conversion of tidal wetlands to diked and drained pastures in the early 1900s, followed by the filling of bayfront lands for urban and port development. In addition, the construction of jetties has disrupted the natural movement of sand along the coast, burying some areas and eroding others. Further inland, residential development has significantly reduced riparian vegetation along streams (SOER 2000).

Streams in the Coast Range are relatively free flowing, are heavily relied upon by the fishing industry and summer tourism, and are important sources of drinking water. Coastal streams have been disrupted by logging practices. The density of streams in the Coast Range is among the highest in the State; therefore, a high percentage of the landscape falls within riparian buffers. As a result, timber harvests throughout the region have had adverse effects on aquatic organisms such as coho salmon. Removal of large conifers and erosion from logging are the most significant past human effects on riparian areas in the Coast Range (SOER 2000).

Past logging patterns led to dense forests with a high percentage of early successional stages consisting of young trees (less than 40 years old). However, modern logging and silvicultural practices (under the guidance and implementation of new Forest Practice Rules) have greatly minimized effects from recent logging operations. Historically, large fires left a complex matrix of large trees, snags, and downed wood, which provided a diversity of habitats for fish and wildlife. Modern commercial forest management encourages diversity, though not to the same extent as wildfires in unmanaged landscapes.

Almost 40 percent of the ecoregion is publicly owned, primarily as State and Federal forests. Much of the balance is private timberland, interspersed with the public forest. Timber harvest in the late 1990s was about two-thirds of the levels of the late 1980s, due to a major reduction of harvest on Federal lands. About half of Oregon’s future timber harvest is projected to come from this ecoregion (SOER 2000).

The lowland rivers and wetlands have been altered by agriculture and development more than the forested portions of the ecoregion have. Acquisition of coastal wetlands by private land conservancies and State and Federal fish and wildlife agencies have protected some high quality wetlands and restored many acres of degraded wetlands (SOER 2000).

Columbia Basin. (Bull trout) The Columbia Basin ecoregion is semi-arid, with cold winters and hot summers. Farther from the Columbia River, annual precipitation decreases and soil changes from sandy deposits to windblown silts. Most of the ecoregion receives less than 15 inches (38 centimeter) of precipitation per year, mostly in the form of snow.

Much of the ecoregion’s natural vegetation is native bunchgrass prairie. Sandy deposits along the big bend of the Columbia River have created open dunes and areas of shrub-steppe and western juniper. The rivers were once lined with intermountain riparian vegetation, such as black cottonwood (*Populus trichocarpa*), willows, chokecherry (*Prunus* spp.), and aspen, and wetlands were located throughout the plateau. Fire was a natural component of this ecoregion, though the fire recurrence interval is not as clear as in other ecoregions.

The ecoregion has undergone extensive changes over the last 150 years; it is second only to the Willamette Valley in the extent of landscape change. It consists largely of privately-owned agricultural and range land, with over 85 percent of the former sagebrush steppe, grassland, and riparian communities converted to dry land wheat or irrigated agriculture. Only marginal lands that cannot be farmed, such as the steep canyon grasslands and scablands, retain a semblance of native vegetation. Protected areas and publicly owned lands are very limited in this region.

In the conversion to farmland, much of the natural function of the landscape has been lost. Bottomland forests and wetlands have been replaced by irrigated agriculture and rural residential development. Changes in the upland have occurred as sagebrush steppe has been reduced by over 85 percent. Invasive plant species are a major threat to native habitats as well as to the productivity of farmlands and pastures.

Dam construction and subsequent inundation has degraded riparian resource conditions along the Columbia River and confluences. Lake habitats have largely replaced riparian and floodplain wetlands. Large rivers such as the Umatilla River have decreased riparian function and water quality.

East Cascades Slope and Foothills Ecoregion. (Bull trout, Lost River and short-nosed sucker and spotted owl) The East Cascades ecoregion is geologically young, with lava flows, volcanic vents, and a mantle of pumice soil. Ponderosa pine forests predominate, with extensive stands of lodgepole pine (*Pinus contorta*) on deep Mazama ash. The ecoregion is a transition zone that extends from below the crest of the Cascade Range east to where the pine forests intersect with sagebrush-juniper steppe. The northern two-thirds of the East Cascades ecoregion is drained by the Deschutes River system, which includes a series of large lakes and reservoirs near its headwaters high in the Cascade Mountains. The southern third is drained by the Klamath River, which rises from a vast interior wetland before it flows south and west into California. Forests, mostly federally owned, cover most of the region's uplands, with privately-owned agricultural land in the valleys.

The Deschutes River watershed spreads across several ecoregions, with headwaters to the east in the Blue Mountains and to the west in the high Cascades. Several dams have been constructed on the Deschutes River. This has affected flow and sediment, which have influenced the establishment and natural succession of riparian vegetation throughout the downstream river course. Riparian areas have been further altered by dredging, dikes, and flood control activities. Today, all major river systems in the region are dammed, and many of these dams provide no fish passage. Agricultural practices and related water delivery systems remain a significant threat to the recovery of aquatic health in the southern part of the region.

The contrasts of this ecoregion are reflected in its water quality. Clean, cold water flows from perennial springs along the east slope into streams such as the Metolius River and the Little Deschutes, which have some of the highest quality water in the State. The low-lying Klamath Basin, in contrast, has sites such as Klamath Strait and Lost River with some of the poorest water quality in the State. Several of these streams have been placed on the 303(d) list as a result of high temperatures in summer, total dissolved gas, habitat modification, flow modification, pH, sedimentation, turbidity, bacteria, and dissolved oxygen.

Enormous efforts were made in the 1900s to drain vast acreage of wetlands in the Klamath Basin. As a result, the great shallow lake and marsh systems of the upper Klamath Basin have been reduced by an estimated 75 percent. Reductions in riparian vegetation and associated wetlands have contributed to nutrient loading in the rivers and lakes of the region by decreasing the potential for nutrient filtration and uptake in streamside areas. Similarly, riparian areas throughout the Klamath basin have been highly altered and in many cases eliminated by agricultural activities.

Activities affecting key resource systems in this region include changes in the fire regime, alterations of rivers, streams, and wetlands, and rapid urban development.

Klamath Mountains. (Marbled murrelet and spotted owl) Douglas-fir forests, oak woodlands, and ponderosa pine woodlands. Many of these plant communities have changed significantly since fire suppression was widely instituted in the early 20th century, although the plant communities of the Klamath Mountains continue to be among the most diverse in the world. There are pockets of plant communities that occur nowhere else, endemic to a particular condition of the climate or soil type. Of the 4,000 kinds of native plants found in Oregon, about half are found in this ecoregion, and about a quarter of these are found only here.

Nearly a century of fire suppression has dramatically altered the ecology of the forests, savannas, and shrublands in this region. The steep terrain makes the Klamath Mountain ecoregion particularly susceptible to landslides and debris flows, especially in extensively logged basins. Relatively few large conifers remain in the active flood plain, although historic evidence shows that conifers were once abundant in low gradient valley bottoms and were selectively logged in the 1950s and 1960s.

Today the rate of population growth in this region is second only to the Willamette Valley. Most of the population is concentrated in the valleys along Interstate 5, but rapid population growth in the southern and eastern parts of the ecoregion has brought new pressures to the landscape, particularly to the rural areas along rivers such as the Rogue, Umpqua, and Applegate, which were already affected by past development activities. Industrial and rural residential developments are the major threats to ecological health.

<u>High Lava Plains</u>. (Bull trout) The High Lava Plains ecoregion is located in the dry foothills that surround the western perimeter of the Blue Mountains and separates the north-central Blue Mountains from the southern Blue Mountains and Ochoco Mountains. The drainage basins in this ecoregion are the John Day, the Goose and Summer Lakes, the Malheur Lakes, and the Deschutes. The land use in this ecoregion is primarily irrigated pasture, grazing, and recreation.

The geology here is ash beds and the eroded remnants of a mountain chain. The erosion rate is high in ash-dominated areas; most erosion occurs during high intensity runoff events during snow melt periods or during thunderstorms. This ecoregion consists of highly dissected hills, palisades, and ash beds. The steep-sided canyons of the John Day and Crooked Rivers cut deeply through the surrounding terrain. Streams have low to moderate gradient, and the main rivers originate within surrounding ecoregions that have more rain and snow.

This ecoregion has a continental climate with low precipitation (mean annual precipitation is 10 to 20 in [25 to 50 cm]) and wide temperature extremes. This climate is moderated by a marine influence spreading southward from the Columbia River Gorge and eastward through the low passes of the Cascade Mountain range. The marine influence brings more moisture into the region and causes less extreme temperature fluctuations than in other parts of the Blue Mountains. Precipitation falls primarily as rain during the spring and fall months and as light snow in the winter months; most precipitation occurs in the winter months of November, December, and January. Shallow snowpacks can accumulate at higher elevations.

The most frequent natural disturbance in this ecoregion is fire. Fire suppression and grazing have caused an increase in juniper abundance and a decline in grass abundance. The native upland vegetation includes juniper, bluebunch wheatgrass (*Pseudoroegnria spicata*), and Idaho fescue (*Festuca idahoensis*), and the native riparian vegetation includes hardwoods (cottonwood and alder) and shrubs (willows, Douglas spirea [*Spirea douglasii*] and common snowberry [*Symphoricarpos albus*]). Ponderosa pine and juniper are found infrequently in the riparian areas.

Owyhee Uplands. (Bull trout) The Owyhee Uplands ecoregion is located in the southeastern section of Oregon. This ecoregion is similar to the adjacent Basin and Range ecoregion in vegetation; however, it differs markedly in terrain, as the landscape is basically a broad, undulating plateau cut by deep riverine canyons. The Owyhee River and the lower basin of the Malheur River generally drain north through these canyons and to the Snake River Basin located at the border of Oregon and Idaho (Bryce and Woods 2000).

An extreme climate characterizes the ecoregion. Moist springs and cold winters bring precipitation primarily in the form of snow, while summers are hot and dry. Vegetative types are consistent with the high deserts of the Intermountain west, with sagebrush steppe communities being the most dominant. Within this ecoregion less extensive vegetative communities include herbaceous wetland and riparian habitats, mountain mahogany woodlands, and a few examples of salt desert scrub (Bryce and Woods 2000).

Like the adjacent Basin and Range ecoregion, presently, the population of the Owyhee Uplands is sparse, with most of the population centered along the major drainages near the towns of Vail and Ontario. These towns border the confluence of the Malheur and Owyhee Rivers with the Snake River. Irrigated agriculture in these fertile lowlands is the foundation of the local economy (Bryce and Woods 2000). In contrast, the remainder of this ecoregion relies almost entirely on local ranching as their source economy (Bryce and Woods 2000). Decades of livestock grazing has degraded the habitat.

West Cascade Mountains. (Northern spotted owl, Bull trout) The West Cascade Mountains ecoregion is a mountainous spine of volcanic peaks and dense forests. Relatively few people live in the area, which is geologically composed of two parts. The older western Cascade Mountains feature long ridges with steep sides and wide, glaciated valleys—remnants of long-extinct volcanoes. The younger high Cascades to the east include more than a dozen major peaks formed from more recent volcanic activity. Most of the rivers draining the northern two-thirds of the ecoregion flow into the Willamette Valley and then to the Columbia River system; the southern third drains to the Pacific Ocean through the Umpqua and Rogue River systems.

The drier southern half has a fire regime similar to that of the Klamath Mountains, with frequent, lightning-caused fires. In the northern half, the natural fire regime has historically produced less frequent but more severe fires.

Higher elevations receive heavy winter snows. Dense forests cloak the entire ecoregion. Douglas-fir/western hemlock forests dominate large areas up to elevations of about 3,300 feet. Pacific silver fir and mountain hemlock forests occur at higher elevations. Above 7,000 feet, the montane forests often open into alpine parklands with patches of forest interspersed with a variety of habitats, ranging from dwarf shrubs to wetlands and barren expanses of rock and ice.

The conifer forests of the Cascades have been the foundation of a timber-based economy in the ecoregion and in neighboring communities to the east and west; most of the population in the ecoregion is found in small towns where recreation use increasingly supplements this traditional timber-based economy. A continuous ribbon of national forests at middle and high elevations dominates this ecoregion, with private ownership (especially forest industry) at lower elevations. The USFS manages approximately two-thirds of the forest in this ecoregion. More than two-thirds of the Federal forest land in this ecoregion is managed for biological diversity—as late successional reserves, riparian reserves, and extensive wilderness areas.

The major factors that have influenced patterns of riparian condition in the western Cascades are: 1) Fire; 2) floods; 3) timber harvest and log transport; 4) road construction and residential development; and 5) flow regulation by dams (SOER 2000). In the absence of human activities, moist riparian forests were not as susceptible as surrounding uplands to disturbance by fire.

Cascade wetland types are highly variable and include snowmelt-fed slope wetland meadows, high elevation lakes with broad fringing wetlands, bogs, and riparian wetlands along streams. Although many of the high-elevation wetlands along the crest of the Cascades are largely intact, some lower-elevation wetlands have been altered by road construction, timber harvest, and the construction of reservoirs as well as by the offsite changes that result from regulated flows. For the most part, these activities have altered, rather than eliminated, the region's wetlands.

The high proportion of streams with good to excellent water quality is a strong indicator of the health of water resources in this region; this area consistently has the highest water quality in the State. Extensive public ownership of the landscape has protected these upstream reaches from some of the disruptions common farther downstream.

<u>Willamette Valley</u>. (Fender's blue butterfly, Kincaid's lupine, Nelson's checkermallow) The Willamette Valley ecoregion is defined by the Willamette River and Oregon's largest river valley. The river's upper reaches and much of its watershed lie in the Cascade Mountains and Coast Range beyond the ecoregion borders. The ecoregion itself is characterized by broad alluvial flats and low basalt hills, with soils of deep alluvial silts from river deposits, and dense heavy clays from fluvial deposits in the valley bottom's numerous oxbow lakes and ponds. This ecoregion has 70 percent of the State's population, the majority of its industry, and almost half of its farmland. The Willamette Valley ecoregion is largely in private ownership; agriculture, urban areas, and forestland dominate the landscape.

Over the past 150 years, the prairies have been largely converted to farmland, as have most of the riparian forests and wetlands. The rivers have been dammed and channelized to reduce flooding. Open oak savannas and oak-conifer woodlands have been logged to become closed-canopy forests. A growing urban population has replaced agriculture in many areas, and rural residential development continues to encroach on remaining woodlands. Due to the pattern of development, the Willamette Valley is the most altered ecoregion in Oregon, with the most significant natural processes, fire and flooding, almost entirely excluded.

Trends in riparian condition in the Willamette Valley have shown an 80 percent reduction in total riparian area since the 1850s. An estimated 72 percent of the original riparian and bottomland forest is gone, as well as an estimated 99 percent of wet prairies, 88 percent of upland prairies, and 87 percent of upland forests at the margins of the valley (SOER 2000). Much of the valley's agricultural development converted native wet prairie; less than one percent of the original wet prairie remains today and several wet prairie plants are rare or endangered.

Water development projects have reduced the frequency of extremely high and low flows, and have moderated the once dynamic hydrologic pattern of floods and dry spells. Flood control modifications have largely disconnected the Willamette River from its braided channels, oxbows and sloughs—wetland types that characterized much of the historical floodplain. This fundamental alteration to the valley's hydrologic regime has changed the character of the valley's wetlands and greatly altered their functions. Today, most of the mainstem Willamette River exceeds standards for bacteria, temperature, and toxics such as mercury.

The encroachment of invasive species has greatly altered the composition of riparian plant communities, with introduced plants increasing from 10 percent in the headwaters to more than 50 percent of the number of species in the mainstem Willamette.

Table 1. Total acreage of Johnson and O'Neil habitat type within each ecoregion.

Habitat Type	Acreage of Habitat Type within Each Ecoregion									
	Basin and Range	Blue Mountains	Coast Range	Columbia Basin	East Cascades Slopes and Foothills	Klamath Mountains	High Lava Plains	Owyhee Uplands	West Cascade Mountains	Willamette Valley
Agriculture, Pasture, and Mixed Environments	250,430	550,910	164,950	1,740,960	459,780	609,980	299,810	250,250	83,900	1,779,280
Alpine Grasslands and Shrublands	1,180	214,120	0	0	8,920	960	0	0	66,250	0
Bays and Estuaries	0	0	22,450	0	0	0	0	0	860	8,940
Ceanothus-Manzanita Shrublands	0	0	0	0	2,970	48,530	0	0	590	0
Coastal Dunes & Beaches	0	0	42,710	0	0	0	0	0	0	0
Coastal Headlands & Islets	0	0	8,460	0	0	0	0	0	0	0
Desert Playa & Salt Scrub	707,880	0	0	0	90	0	0	11,370	0	0
Dwarf Shrub-steppe	408,120	110	0	0	61,090	0	21,700	22,760	0	0
Eastside (Interior) Canyon Shrublands	0	0	0	239,970	0	0	7570	110,600	0	0
Eastside (Interior) Grasslands	0	1,366,980	12,180	497,510	45,090	0	5,530	0	0	0

Table 1. (continued)

Habitat Type	Acreage of Habitat Type within Each Ecoregion									
	Basin and Range	Blue Mountains	Coast Range	Columbia Basin	East Cascades Slopes and Foothills	Klamath Mountains	High Lava Plains	Owyhee Uplands	West Cascade Mountains	Willamette Valley
Eastside (Interior) Mixed Conifer Forest	3,630	3,038,490	0	4,990	905,830	0	42,280	0	131,220	0
Eastside (Interior) Riparian-Wetlands	21,280	560	0	4,410	200	0	870	3,550	0	0
Herbaceous Wetlands	397,240	1,273,780	59,040	4,980	329,230	4,860	36,030	50,650	9,270	10,780
Lakes, Rivers, Ponds, & Reservoirs	322,520	25,050	24,800	13,540	158,690	16,080	14,540	36,280	76,550	44,050
Lodgepole Pine Forest and Woodlands	20	2,260	0	0	507,590	0	0	0	22,340	0
Marine Nearshore	0	0	3,610	0	0	0	0	0	0	0
Montane Coniferous Wetlands	0	5,400	0	0	41,350	90	130	0	8,930	190
Montane Mixed Conifer Forest	280	485,720	0	0	190,740	39,710	0	0	2,234,840	0
Ponderosa Pine and Eastside White Oak Forest and Woodlands	13,790	2,890,730	0	37,820	2,919,020	79,220	213,630	10	72,420	0
Shrub-steppe	7,093,000	1,986,120	0	1,641,770	457,950	0	1,327,670	4,911,800	0	0

Table 1. (continued)

Habitat Type	Acreage of Habitat Type within Each Ecoregion									
	Basin and Range	Blue Mountains	Coast Range	Columbia Basin	East Cascades Slopes and Foothills	Klamath Mountains	High Lava Plains	Owyhee Uplands	West Cascade Mountains	Willamette Valley
Southwest Oregon Mixed Conifer-Hardwood Forest	0	0	369,470	0	3,580	2,649,320	0	0	989,560	8,240
Subalpine Parklands	4600	0	0	0	7,380	5,650	0	0	66,570	0
Upland Aspen Forest	19,480	210	0	0	0	0	0	0	0	0
Urban and Mixed Environments	3,190	16,270	57,810	29,340	22,570	42,170	20,560	6,030	5,960	366,010
Western Juniper and Mountain Mahogany Woodlands	555,940	471,600	0	72,190	642,080	0	2,178,370	116,900	110	0
Westside Lowland Conifer-Hardwood Forest	0	0	4,961,680	0	10,720	256,560	0	0	3,324,250	785,870
Westside Oak and Dry Douglas-fir Forest and Woodlands	0	0	1,430	0	5,890	106,060	0	0	46,290	273,150
Westside Riparian - Wetlands	0	0	29,070	0	0	6,270	0	0	2,470	120,290
Total Acreage in Ecoregion	9,802,580	11,181,910	5,757,660	4,287,480	6,780,760	3,865,460	4,168,.690	5,520,200	7,142,380	3,396,800

APPENDIX D

NORTHERN SPOTTED OWL

Legal Status

The spotted owl was listed as threatened on June 26, 1990 due to widespread loss and adverse modification of suitable habitat across the owl's entire range and the inadequacy of existing regulatory mechanisms to conserve the owl (USDI FWS 1990a, p. 26114). Listing priority numbers are assigned on a scale of 1C (highest) to 18 (lowest). The "C" reflects conflict with development, construction, or other economic activity (USDI FWS 1983, p. 43104). The spotted owl was originally listed with a recovery priority number of 3C, but that number was changed to 6C in 2004 during the 5-year review of the species (USDI FWS 2004, p. 55). This number reflects a high degree of threat, a low potential for recovery, and the owl's taxonomic status as a subspecies (USDI FWS 1983, p. 51895). The most recent five-year status review was completed on September 29, 2011, and did not propose changes to the listing status or introduce any new threats (USDI FWS 2011a). In 2012, the U.S. Fish and Wildlife Service (Service) was petitioned to uplist the spotted owl from threatened to endangered status under the Endangered Species Act. In April 2015, the Service determined that petition presented substantial information indicating that the listing may be warranted due to a number of listing factors (USDI FWS 2015, pp.19259-19263). The species' status report is currently under review.

Life History

Taxonomy

The spotted owl is one of three subspecies of spotted owls currently recognized by the American Ornithologists' Union. The taxonomic separation of these three subspecies is supported by genetic (Barrowclough and Gutiérrez 1990, pp.741-742; Barrowclough et al. 1999, p. 928; Haig et al. 2004, p. 1354), morphological (Gutiérrez et al. 1995, p. 2), and biogeographic information (Barrowclough and Gutiérrez 1990, p.741-742). The distribution of the Mexican subspecies (*S. o. lucida*) is separate from those of the northern and California (*S. o. occidentalis*) subspecies (Gutiérrez et al. 1995, p.2). Recent studies analyzing mitochondrial DNA sequences (Haig et al. 2004, p. 1354; Chi et al. 2004, p. 3; Barrowclough et al. 2005, p. 1117) and microsatellites (Henke et al., unpubl. data, p. 15) confirmed the validity of the current subspecies designations for northern and California spotted owls. The narrow hybrid zone between these two subspecies, which is located in the southern Cascades and northern Sierra Nevada, appears to be stable (Barrowclough et al. 2005, p. 1116).

Funk et al. (2008, pp. 1-11) tested the validity of the three current recognized subspecies of spotted owls and found them to be valid. During this genetics study, bi-directional hybridization and dispersal between spotted owls and California spotted owls centered in southern Oregon and northern California was discovered. In addition, a discovery of intro-regression of Mexican spotted owls into the northernmost parts of the spotted owl populations in Washington was made, indicating long-distance dispersal of Mexican spotted owls into the spotted owl range (Funk et al. 2008, pp. 1-11). Some hybridization of spotted owls with barred owls has been recorded (Hamer et al. 1994, pp. 487-491; Dark et al. 1998, pp. 50-56; Kelly 2001, pp. 33, 38).

Physical Description

The spotted owl is a medium-sized owl and is the largest of the three subspecies of spotted owls (Gutiérrez et al. 1995, p. 2). It is approximately 46 to 48 centimeters (18 inches to 19 inches) long and the sexes are dimorphic, with males averaging about 13 percent smaller than females. The mean mass of 971 males taken during 1,108 captures was 580.4 grams (1.28 pounds) (out of a range 430.0 to 690.0 grams) (0.95 pound to 1.52 pounds), and the mean mass of 874 females taken during 1,016 captures was 664.5 grams (1.46 pounds) (out of a range 490.0 to 885.0 grams) (1.1 pounds to 1.95 pounds) (Loschl, P. and E. Forsman pers. comm. 2006 cited in USDI FWS 2011b, p. A-1). The spotted owl is dark brown with a barred tail and white spots on its head and breast, and it has dark brown eyes surrounded by prominent facial disks. Four age classes can be distinguished on the basis of plumage characteristics (Forsman 1981; Moen et al. 1991, p. 493). The spotted owl superficially resembles the barred owl, a species with which it occasionally hybridizes (Kelly and Forsman 2004, p. 807). Hybrids exhibit physical and vocal characteristics of both species (Hamer et al. 1994, p. 488).

Current and Historical Range

The current range of the spotted owl extends from southwest British Columbia through the Cascade Mountains, coastal ranges, and intervening forested lands in Washington, Oregon, and California, as far south as Marin County (USDI FWS 1990a, p. 26115). The range of the spotted owl is partitioned into 12 physiographic provinces (see Figure A-1) based on recognized landscape subdivisions exhibiting different physical and environmental features (USDI FWS 2011b, p. III-1; Thomas et al. 1993). These provinces are distributed across the species' range as follows:

- Four provinces in Washington: Eastern Washington Cascades, Olympic Peninsula, Western Washington Cascades, Western Washington Lowlands
- Five provinces in Oregon: Oregon Coast Range, Willamette Valley, Western Oregon Cascades, Eastern Oregon Cascades, Oregon Klamath
- Three provinces in California: California Coast, California Klamath, California Cascades

The spotted owl is extirpated or uncommon in certain areas such as southwestern Washington and British Columbia. Timber harvest activities have eliminated, reduced or fragmented spotted owl habitat sufficiently to decrease overall population densities across its range, particularly within the coastal provinces where habitat reduction has been concentrated (USDI FWS 2011b, pp. B-1 to B-4; Thomas and Raphael 1993).

Behavior

Northern spotted owls are primarily nocturnal (Forsman et al. 1984, pp. 51-52) and spend virtually their entire lives beneath the forest canopy (Courtney et al. 2004, p. 2-5). They are adapted to maneuverability beneath the forest canopy rather than strong, sustained flight (Gutiérrez et al. 1995, p. 9). They forage between dusk and dawn and sleep during the day with peak activity occurring during the two hours after sunset and the two hours prior to sunrise

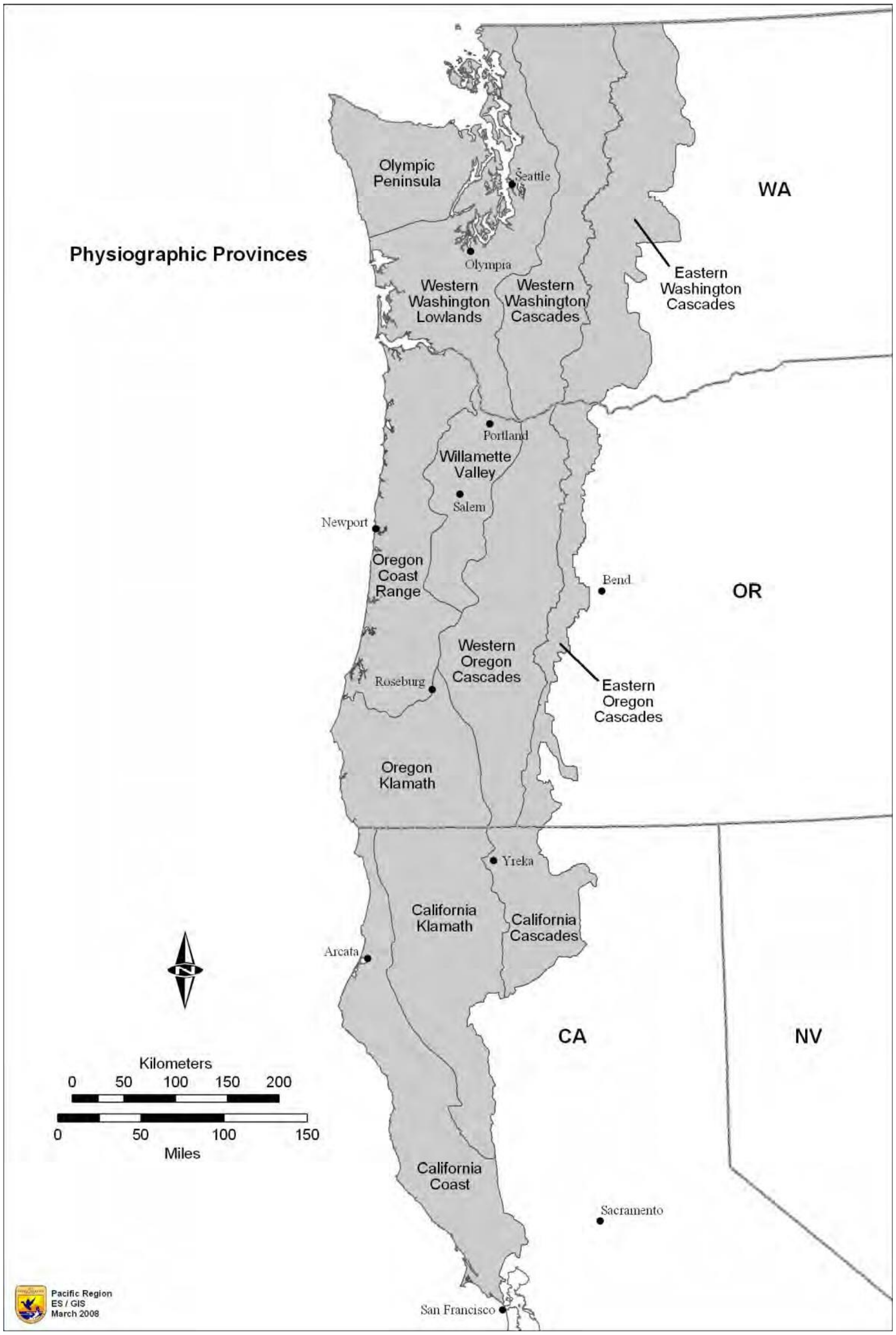

Figure A-1. Physiographic Provinces within the range of the spotted owl in the United States (from USDI FWS 2011b, A-3)

(Gutiérrez et al. 1995, p. 5; Delaney et al. 1999, p. 44). They will sometimes take advantage of vulnerable prey near their roosts during the day (Layman 1991, pp. 138-140; Sovern et al. 1994, p. 202).

Northern spotted owls seek sheltered roosts to avoid inclement weather, summer heat, and predation (Forsman 1975, pp. 105-106; Barrows and Barrows 1978; Barrows 1981; Forsman et al. 1984, pp. 29-30). Spotted owls become stressed at temperatures above 28°C, but there is no evidence to indicate that they have been directly killed by temperature because of their ability to thermoregulate by seeking out shady roosts in the forest understory on hot days (Barrows and Barrows 1978; Forsman et al. 1984, pp. 29-30, 54; Weathers et al. 2001, pp. 678, 684). During warm weather, spotted owls seek roosts in shady recesses of understory trees and occasionally will even roost on the ground (Barrows and Barrows 1978, pp. 3, 7-8; Barrows 1981, pp. 302-306, 308; Forsman et al. 1984, pp. 29-30, 54; Gutiérrez et al. 1995, p. 7). Glenn et al. (2010, p. 2549) found that population growth was negatively associated with hot summer temperatures at their southernmost study area in the southern Oregon Cascades, indicating that warm temperatures may still have an effect on the species. Both adults and juveniles have been observed drinking water, primarily during the summer, which is thought to be associated with thermoregulation (Gutiérrez et al. 1995, p. 7).

Spotted owls are territorial; however, home ranges of adjacent pairs overlap (Forsman et al. 1984, p. 22; Solis and Gutiérrez 1990, p. 746) suggesting that the area defended is smaller than the area used for foraging. They will actively defend their nests and young from predators (Forsman 1975, p. 15; Gutiérrez et al. 1995, p. 11). Territorial defense is primarily effected by hooting, barking and whistle type calls. Some spotted owls are not territorial but either remain as residents within the territory of a pair or move among territories (Gutiérrez 1996, p. 4). These birds are referred to as “floaters.” Floaters have special significance in spotted owl populations because they may buffer the territorial population from decline (Franklin 1992, p. 822). Little is known about floaters other than that they exist and typically do not respond to calls as vigorously as territorial birds (Gutiérrez 1996, p. 4).

Spotted owls are monogamous and usually form long-term pair bonds. “Divorces” occur but are relatively uncommon. There are no known examples of polygyny in this owl, although associations of three or more birds have been reported (Gutiérrez et al. 1995, p. 10).

Habitat Relationships

<u>Home Range and Core Areas</u>

Spotted owls are territorial raptors that range widely in search of prey but are ‘anchored’ during the breeding season to a nest site (central-place forager). Evaluations of spotted owl habitat are usually conducted at two spatial scales; the home range and core areas. The home range is the “area traversed by the individual in its normal activities of food gathering, mating, and caring for young” (Burt 1943:351, cited in USDI FWS 2009). Within home ranges, areas receiving concentrated use, typically surrounding the nest site and favored foraging areas, are called core areas. Because the size and pattern of spotted owl’s space use are typically unknown, estimates of use areas are derived from radio-telemetry studies. Results from Bingham and Noon (1997) showed that spotted owls typically used 20-21 percent of their home range as core use area habitat, which generally included 60-70 percent of the sites within their home range used during the breeding season. As central place foragers, nesting spotted owls are likely very sensitive to activities that occur within their core use areas and especially their nest patch (Swindle et al. 1997, Miller et al. 1989, and Meyer et al. 1998).

The habitat composition within cores and annual home ranges has been found to be directly correlated with demographic response such as occupancy, reproductive success, survival, and fitness. Meyer et al. (1998) examined landscape indices associated with spotted owl sites versus random plots on BLM lands throughout Oregon. Across provinces, landscape indices highly correlated with the probability of spotted owl occupancy included the percent older forest (30 percent) within the 500 acres (analogous to a core-use area) surrounding the site. Zabel et al. (2003, abstract, p. 1033) found the best-fitting model for owl occupancy predictions in northwest California was at the 200-ha (500 acre) scale. Their model found a pseudo-threshold relationship to nesting and roosting habitat (meaning once the quantity of the habitat metric reached some ‘‘threshold’’ level the probability of occupancy did not increase or decrease substantially with more habitat) and a quadratic relationship to foraging habitat. Bart (1995) found that core areas should contain 30-50 percent mature and old growth forest. Results from Thomas et al. (1990), Bart and Forsman (1992) Bart (1995) and Dugger et al (2005) suggest that when spotted owl home ranges have less than 40 to 60 percent nesting/roosting/foraging (NRF), they were more likely to have lower occupancy and fitness. Olson et al. (2005) found similar results on their Oregon Coast Ranges study area.

As further described in the 2009 FWS Guidelines (USDI FWS 2009, “Guidelines”), the probability of occupancy is increased when core areas contain a range of habitat conditions suitable for use by spotted owls, and the survival and fitness of spotted owls is positively correlated with larger patch sizes or proportion of older forests (Franklin et al. 2000, Dugger et al. 2005). The Guidelines express “the strongest type of information relevant to the evaluation of take relates to the fitness of spotted owls to characteristics of their habitat.” Depending on the availability of habitat, fitness may be compromised when additional habitat degradation or losses occur. The final evaluation of incidental take is both a quantitative and qualitative analysis of the actual amount and distribution of habitat available to the spotted owl when compared to the effects of the proposed action and site-specific conditions.

Recently developed habitat-fitness and landscape models have demonstrated the importance of having sufficient amounts of NRF habitat within core use areas to adequately provide for spotted owl survival and reproduction along with access to prey. For example, Franklin et al. (2000) found that the proportion of good habitat was around 60 percent to lesser quality habitat for owl core use areas in northwest California. In a recently published study of spotted owls in the Oregon Klamath Province, survival was negatively correlated with forest fragmentation (Schilling et al. 2013).

Home-range sizes vary geographically, generally increasing from south to north, which is likely a response to differences in habitat quality (USDI FWS 1990a, p. 26117). Estimates of median size of their annual home range (the area traversed by an individual or pair during their normal activities (Thomas and Raphael 1993, pp. IX-15)) vary by province and range from 2,955 acres in the Oregon Cascades (Thomas et al. 1990, p. 194) to 14,211 acres on the Olympic Peninsula (USDI FWS 1994, p. 3). Zabel et al. (1995, p. 436) showed that these provincial home ranges are larger where flying squirrels are the predominant prey and smaller where wood rats are the predominant prey. Home ranges of adjacent pairs overlap (Forsman et al. 1984, p. 22; Solis and Gutiérrez 1990, p. 746), suggesting that the defended area is smaller than the area used for foraging. Spotted owl core areas vary in size geographically and provide habitat elements that are important for the reproductive efficacy of the territory, such as the nest tree, roost sites and foraging areas (Bingham and Noon 1997, p. 134). Some studies have found that spotted owls use smaller home ranges during the breeding season and often dramatically increase their home range size during fall and winter (Forsman et al. 1984, pp. 21-22; Sisco 1990, p. iii). In Southern Oregon, one study found that home range and core areas remained essentially the same between seasons, concluding that perhaps this was due to the quality of available habitat (Shilling et al. 2013).

Although differences exist in natural stand characteristics that influence home range size, habitat loss and forest fragmentation effectively reduce habitat quality in the home range. A reduction in the amount of suitable habitat reduces spotted owl abundance and nesting success (Bart and Forsman 1992, pp. 98-99; Bart 1995, p. 944).

Habitat Use and Selection

Forsman et al. (1984, pp.15-16) reported that spotted owls have been observed in the following forest types: Douglas-fir (*Pseudotsuga menziesii*), western hemlock (*Tsuga heterophylla*), grand fir (*Abies grandis*), white fir (*Abies concolor*), ponderosa pine (*Pinus ponderosa*), Shasta red fir (*Abies magnifica shastensis*), mixed evergreen, mixed conifer hardwood (Klamath montane), and redwood (*Sequoia sempervirens*). The upper elevation limit at which spotted owls occur corresponds to the transition to subalpine forest, which is characterized by relatively simple structure and severe winter weather (Forsman 1975, p. 27; Forsman et al. 1984, pp. 15-16).

Spotted owls generally rely on older forested habitats because such forests contain the structures and characteristics required for nesting, roosting, and foraging. Features that support nesting and roosting typically include a moderate to high canopy closure (60 to 80 percent); a multi-layered, multi-species canopy with large overstory trees (with diameter at breast height [dbh] of greater than 30 inches); a high incidence of large trees with various deformities (large cavities, broken tops, mistletoe infections, and other evidence of decadence); large snags; large accumulations of fallen trees and other woody debris on the ground; and sufficient open space below the canopy for spotted owls to fly (Thomas et al. 1990, p. 19). Weathers et al. 2001, (p. 686) found the spotted owl association with structurally complex habitats containing high canopy closure was in part due to their intolerance of high temperatures. Complex vertically structured habitat such as mature and old-growth forests habitats contain sufficient cover to provides protection from predators (Franklin et al. 2000, p. 578-579).

Spotted owls nest almost exclusively in trees. Like roosts, nest sites are found in forests having complex structure dominated by large diameter trees and high canopy closure (Forsman et al. 1984, p. 30; Hershey et al. 1998, p. 1402, LaHaye et al. 1997, p. 46-48). Even in forests that have been previously logged, spotted owls select forests having a structure (i.e., larger trees, greater canopy closure) different than forests generally available to them (Folliard 1993, p. 40; Buchanan et al. 1995, p. 304-305; Hershey et al. 1998, p. 1406-1407). In eastern Washington, spotted owl nest sites were found to have canopies of dominant and/or codominant and intermediate trees that were farther aboveground, more 35-60-cm (14-24 in)-dbh Douglas-fir *(Pseudotsuga menzies/,* greater basal area of Douglas-fir trees, more 61-84-cm (24-33.5 in) dbh ponderosa pine *(Pinus ponderosa)* trees, more live tree basal and more basal area of Class IV snags (broken snags with no branches and little bark).

Roost sites selected by spotted owls have more complex vegetation structure than forests generally available to them (Barrows and Barrows 1978, p. 2-3; Forsman et al. 1984, pp. 29-30; Solis and Gutiérrez 1990, pp. 742-743, 747). These habitats are usually multi-layered forests having high canopy closure and large diameter trees in the overstory.

Foraging habitat is the most variable of all habitats used by territorial spotted owls (Thomas et al. 1990; USDI FWS 2011b, p. G-2). Descriptions of foraging habitat have ranged from complex structure (Solis and Gutiérrez 1990, pp. 742-744) to a broader range of forests with lower canopy closure and smaller trees than forests containing nests or roosts (Gutiérrez 1996, p. 3-5). Foraging habitat for spotted owls provides a food supply for survival and reproduction. Foraging activity is positively associated with tree height diversity (North et al. 1999, p. 524), canopy closure and woody debris (Irwin et al. 2000, p. 180; Courtney et al. 2004, pp. 5-15), snag volume, density of snags greater than 20 in (50 cm) dbh (North et al. 1999, p. 524; Irwin et al. 2000, pp. 179-180; Courtney et al. 2004, pp. 5-15), density of trees greater than or equal to 31 in (80 cm) dbh (North et al. 1999, p. 524), volume of woody debris (Irwin et al. 2000, pp. 179-180), and young forests with some structural characteristics of old forests (Carey et al.1992, pp. 245-247; Irwin et al. 2000, pp. 178-179). Spotted owls select old forests for foraging in greater proportion than their availability at the landscape scale (Carey et al. 1992, pp. 236-237; Carey and Peeler 1995, p. 235; Forsman et al. 2004, pp. 372-373), but will forage in younger stands with high prey densities and access to prey (Carey et al. 1992, p. 247; Rosenberg and Anthony 1992, p. 165; Thome et al. 1999, pp. 56-57).

Dispersal habitat is essential to maintaining stable populations by filling territorial vacancies when resident spotted owls die or leave their territories, and to providing adequate gene flow across the range of the species. Dispersal habitat, at a minimum, consists of stands with adequate tree size and canopy closure to provide protection from avian predators and at least minimal foraging opportunities (USDI FWS 2011b, p. G-1). Dispersal habitat may include younger and less diverse forest stands than foraging habitat, such as even-aged, pole-sized stands, but such stands should contain some roosting structures and foraging habitat to allow for temporary resting and feeding for dispersing juveniles (USDI FWS 2011b, p. G-1). In a study of the natal dispersal of spotted owls, Sovern and others (2015, pp. 257-260) found the majority of roosts were in forested habitats with at least some large (>50 cm or about 19 inches dbh) trees and they selected stands with high canopy cover (>70 percent) at the landscape scale. These authors suggested the concept of 'dispersal' habitat as a lower quality type of habitat may be inappropriate. Forsman et al. (2002, p. 22) found that spotted owls could disperse through highly fragmented forest landscapes. However, the stand-level and landscape-level attributes of forests needed to facilitate successful dispersal have not been thoroughly evaluated (Buchanan 2004, p. 1341).

Spotted owls may be found in younger forest stands that have the structural characteristics of older forests or retained structural elements from the previous forest. In redwood forests and mixed conifer-hardwood forests along the coast of northwestern California, considerable numbers of spotted owls also occur in younger forest stands, particularly in areas where hardwoods provide a multi-layered structure at an early age (Thomas et al. 1990, p. 158; Diller and Thome 1999, p. 275). In mixed conifer forests in the eastern Cascades in Washington, 27 percent of nest sites were in old-growth forests, 57 percent were in the understory reinitiation phase of stand development, and 17 percent were in the stem exclusion phase (Buchanan et al. 1995, p. 304). In the western Cascades of Oregon, 50 percent of spotted owl nests were in late-seral/old-growth stands (greater than 80 years old), and none were found in stands of less than 40 years old (Irwin et al. 2000, p. 41).

In the Western Washington Cascades, spotted owls roosted in mature forests dominated by trees greater than 50 centimeters (19.7 inches) dbh with greater than 60 percent canopy closure more often than expected for roosting during the non-breeding season. Spotted owls also used young forest (trees of 20 to 50 centimeters (7.9 inches to 19.7 inches) dbh with greater than 60 percent canopy closure) less often than expected based on this habitat's availability (Herter et al. 2002, p. 441).

In the Coast Ranges, Western Oregon Cascades and the Olympic Peninsula, radio-marked spotted owls selected for old-growth and mature forests for foraging and roosting and used young forests less than predicted based on availability (Forsman et al. 1984, pp. 24-25; Carey et al. 1990, pp. 14-15; Thomas et al. 1990; Forsman et al. 2005, pp. 372-373). Glenn et al. (2004, pp. 46-47) studied spotted owls in young forests in western Oregon and found little preference among age classes of young forest.

Habitat use is influenced by prey availability. Ward (1990, p. 62) found that spotted owls foraged in areas with lower variance in prey densities (that is, where the occurrence of prey was more predictable) within older forests and near ecotones of old forest and brush seral stages. Zabel et al. (1995, p. 436) showed that spotted owl home ranges are larger where flying squirrels (*Glaucomys sabrinus*) are the predominant prey and smaller where wood rats (*Neotoma* spp.) are the predominant prey. The availability or abundance of prey can in turn influence reproductive success (Rosenburg et al. 2003, pp. 1720-1723).

The availability and distribution of habitats are important considerations. Landscape-level analyses in portions of Oregon Coast and California Klamath provinces suggest that a mosaic of late-successional habitat interspersed with other seral conditions may benefit spotted owls more than large, homogeneous expanses of older forests (Zabel et al. 2003, p. 1038; Franklin et al. 2000, pp. 573-579; Meyer et al. 1998, p. 43). In Oregon Klamath and Western Oregon Cascade provinces, Dugger et al. (2005, p. 876) found that apparent survival and reproduction was positively associated with the proportion of older forest near the territory center (within 730 meters) (2,395 feet). Survival decreased dramatically when the amount of non-habitat (non-forest areas, sapling stands, etc.) exceeded approximately 50 percent of the home range (Dugger et al. 2005, pp. 873-874). The authors concluded that they found no support for either a positive or negative direct effect of intermediate-aged forest—that is, all forest stages between sapling and mature, with total canopy cover greater than 40 percent—on either the survival or reproduction of spotted owls. It is unknown how these results were affected by the low habitat fitness potential in their study area, which Dugger et al. (2005, p. 876) stated was generally much lower than those in Franklin et al. (2000) and Olson et al. (2004), and the low reproductive rate and survival in their study area, which they reported were generally lower than those studied by Anthony et al. (2006). Olson et al. (2004, pp. 1050-1051) found that reproductive rates fluctuated biennially and were positively related to the amount of edge between late-seral and mid-seral forests and other habitat classes in the central Oregon Coast Range. Olson et al. (2004, pp. 1049-1050) concluded that their results indicate that while mid-seral and late-seral forests are important to spotted owls, a mixture of these forest types with younger forest and non-forest may be best for spotted owl survival and reproduction in their study area. In a large-scale demography modeling study, Forsman et al. (2011, pp. 1-2) found a positive correlation between the amount of suitable habitat and recruitment of young.

Reproductive Biology

The spotted owl is relatively long-lived, has a long reproductive life span, invests significantly in parental care, and exhibits high adult survivorship relative to other North American owls (Forsman et al. 1984; Gutiérrez et al. 1995, p. 5). Spotted owls are sexually mature at 1 year of age, but rarely breed until they are 2 to 5 years of age (Miller et al. 1985, p. 93; Franklin 1992, p. 821; Forsman et al. 2002, p. 17). Breeding females lay one to four eggs per clutch, with the average clutch size being two eggs; however, most spotted owl pairs do not nest every year, nor are nesting pairs successful every year (USDI FWS 1990b; Forsman et al. 1984, pp. 32-34; Anthony et al. 2006, p. 28), and re-nesting after a failed nesting attempt is rare (Gutiérrez 1996, p. 4). The small clutch size, temporal variability in nesting success, and delayed onset of breeding all contribute to the relatively low fecundity of this species (Gutiérrez 1996, p. 4).

Courtship behavior usually begins in February or March, and females typically lay eggs in late March or April. The timing of nesting and fledging varies with latitude and elevation (Forsman et al. 1984, p. 32). After they leave the nest in late May or June, juvenile spotted owls depend on their parents until they are able to fly and hunt on their own. Parental care continues after fledging into September (USDI FWS 1990a; Forsman et al. 1984, p. 38). During the first few weeks after the young leave the nest, the adults often roost with them during the day. By late summer, the adults are rarely found roosting with their young and usually only visit the juveniles to feed them at night (Forsman et al. 1984, p. 38). Telemetry and genetic studies indicate that close inbreeding between siblings or parents and their offspring is rare (Haig et al. 2001, p. 35; Forsman et al. 2002, p. 18). Hybridization of spotted owls with California spotted owls and barred owls has been confirmed through genetic research (Hamer et al. 1994, pp. 487-492; Gutiérrez et al. 1995, pp. 2-3; Dark et al. 1998, p. 52; Kelly 2001, pp. 33-35; Funk et al. 2008, pp. 161-171).

Dispersal Biology

Natal dispersal of spotted owls typically occurs in September and October with a few individuals dispersing in November and December (Miller et al. 1997; Forsman et al. 2002, p. 13). Natal dispersal occurs in stages, with juveniles settling in temporary home ranges between bouts of dispersal (Forsman et al. 2002, pp. 13-14; Miller et al. 1997, p. 143). The median natal dispersal distance is about 10 miles for males and 15.5 miles for females (Forsman et al. 2002, p. 16). Dispersing juvenile spotted owls experience high mortality rates, exceeding 70 percent in some studies (USDI FWS 1990a; Miller 1989, pp. 32-41). Known or suspected causes of mortality during dispersal include starvation, predation, and accidents (Miller 1989, pp. 41-44; USDI FWS 1990a; Forsman et al. 2002, pp. 18-19). Parasitic infection may contribute to these causes of mortality, but the relationship between parasite loads and survival is poorly understood (Hoberg et al. 1989, p. 247; Gutiérrez 1989, pp. 616-617; Forsman et al. 2002, pp. 18-19). Successful dispersal of juvenile spotted owls may depend on their ability to locate unoccupied suitable habitat in close proximity to other occupied sites (LaHaye et al. 2001, pp. 697-698).

There is little evidence that small openings in forest habitat influence the dispersal of spotted owls, but large, non-forested valleys such as the Willamette Valley apparently are barriers to both natal and breeding dispersal (Forsman et al. 2002, p. 22). The degree to which water bodies, such as the Columbia River and Puget Sound, function as barriers to dispersal is unclear, although radio telemetry data indicate that spotted owls move around large water bodies rather than cross them (Forsman et al. 2002, p. 22). Analysis of the genetic structure of spotted owl populations suggests that gene flow may have been adequate between the Olympic Mountains and the Washington Cascades, and between the Olympic Mountains and the Oregon Coast Range (Haig et al. 2001, p. 35).

Breeding dispersal occurs among a small proportion of adult spotted owls; these movements were more frequent among females and unmated individuals (Forsman et al. 2002, pp. 20-21). Breeding dispersal distances were shorter than natal dispersal distances and also are apparently random in direction (Forsman et al. 2002, pp. 21-22). In California spotted owls, a similar subspecies, the probability for dispersal was higher in younger owls, single owls, paired owls that lost mates, owls at low quality sites, and owls that failed to reproduce in the preceding year (Blakesley et al. 2006, p.77). Both males and females dispersed at near equal distances (Blakesley et al. 2006, p. 76). In 72 percent of observed cases of dispersal, dispersal resulted in increased habitat quality (Blakesley et al. 2006, p. 77).

Dispersal can also be described as having two phases: transience and colonization (Courtney et al 2004, p. 5-13). Fragmented forest landscapes are more likely to be used by owls in the transience phase as a means to move rapidly between denser forest areas (Courtney et al 2004, p. 5-13; USDI FWS 2012a, p. 14086). Movements through mature and old growth forests occur during the colonization phase when birds are looking to become established in an area (Miller et al 1997, p. 144; Courtney et al 2004, p. 5-13). Transient dispersers use a wider variety of forest conditions for movements than colonizing dispersers, who require habitats resembling nesting/roosting/foraging habitats used by breeding birds (USDI FWS 2012a, p. 14086). Dispersal success is likely highest in mature and old growth forest stands where there is more likely to be adequate cover and food supply (USDI FWS 2012a, p. 14086).

Food Habits

Spotted owls are mostly nocturnal, although they also forage opportunistically during the day (Forsman et al. 1984, p. 51; 2004, pp. 222-223; Sovern et al. 1994, p. 202). The composition of the spotted owl's diet varies geographically and by forest type. Generally, flying squirrels (*Glaucomys sabrinus*) are the most prominent prey for spotted owls in Douglas-fir and western hemlock (*Tsuga heterophylla*) forests (Forsman et al. 1984, pp. 40-41) in Washington and Oregon, while dusky-footed wood rats (*Neotoma fuscipes*) are a major part of the diet in the Oregon Klamath, California Klamath, and California Coastal provinces (Forsman et al. 1984, pp. 40-42; 2004, p. 218; Ward et al. 1998, p. 84; Hamer et al. 2001, p. 224). Depending on location, other important prey include deer mice (*Peromyscus maniculatus*), tree voles (*Arborimus longicaudus, A. pomo*), red-backed voles (*Clethrionomys* spp.), gophers (*Thomomys* spp.), snowshoe hare (*Lepus americanus*), bushy-tailed wood rats (*Neotoma cinerea*), birds, and insects, although these species comprise a small portion of the spotted owl diet (Forsman et al. 1984, pp. 40-43; 2004, p. 218; Ward et al. 1998; p. 84; Hamer et al. 2001, p.224).

Other prey species such as the red tree vole (*Arborimus longicaudus),* red-backed voles (*Clethrionomys gapperi),* mice, rabbits and hares, birds, and insects) may be seasonally or locally important (reviewed by Courtney et al. 2004, pp. 4-27). For example, Rosenberg et al. (2003, p. 1720) showed a strong correlation between annual reproductive success of spotted owls (number of young per territory) and abundance of deer mice (*Peromyscus maniculatus*) (r2 = 0.68), despite the fact they only made up 1.6±0.5 percent of the biomass consumed. However, it is unclear if the causative factor behind this correlation was prey abundance or a synergistic response to weather (Rosenberg et al. 2003, p. 1723). Ward (1990, p. 55) also noted that mice were more abundant in areas selected for foraging by owls. Nonetheless, spotted owls deliver larger prey to the nest and eat smaller food items to reduce foraging energy costs; therefore, the importance of smaller prey items, like *Peromyscus*, in the spotted owl diet should not be underestimated (Forsman et al. 2001, p. 148; 2004, pp. 218-219). In the southern portion of their range, where woodrats are a major component of their diet, spotted owls are more likely to use a variety of stands, including younger stands, brushy openings in older stands, and edges between forest types in response to higher prey density in some of these areas (Forsman et al. 1984, pp. 24-29).

Population Dynamics

The spotted owl is relatively long-lived, has a long reproductive life span, invests significantly in parental care, and exhibits high adult survivorship relative to other North American owls (Forsman et al. 1984; Gutiérrez et al. 1995, p. 5). The spotted owl's long reproductive life span allows for some eventual recruitment of offspring, even if recruitment does not occur each year (Franklin et al. 2000, p. 576).

Annual variation in population parameters for spotted owls has been linked to environmental influences at various life history stages (Franklin et al. 2000, p. 581). In coniferous forests, mean fledgling production of the California spotted owl (*Strix occidentalis occidentalis*), a closely related subspecies, was higher when minimum spring temperatures were higher (North et al. 2000, p. 805), a relationship that may be a function of increased prey availability. Across their range, spotted owls have previously shown an unexplained pattern of alternating years of high and low reproduction, with highest reproduction occurring during even-numbered years (e.g., Franklin et al. 1999, p. 1). Annual variation in breeding may be related to weather (i.e., temperature and precipitation) (Wagner et al. 1996, p. 74; Zabel et al. 1996, p.81 *In*: Forsman et al. 1996) and fluctuation in prey abundance (Zabel et al. 1996, pp.437-438).

A variety of factors may regulate spotted owl population levels. These factors may be density-dependent (e.g., habitat quality, habitat abundance) or density-independent (e.g., climate). Interactions may occur among factors. For example, as habitat quality decreases, density-independent factors may have more influence on survival and reproduction, which tends to increase variation in the rate of growth (Franklin et al. 2000, pp. 581-582). Specifically, weather could have increased negative effects on spotted owl fitness for those owls occurring in relatively lower quality habitat (Franklin et al. 2000, pp. 581-582). A consequence of this pattern is that at some point, lower habitat quality may cause the population to be unregulated (have negative growth) and decline to extinction (Franklin et al. 2000, p. 583). Recent findings of the spotted owl meta-analysis suggest that competition with barred owls is an important stressor of spotted owl populations, but habitat availability and climatic patterns also appear to influence survival, occupancy, recruitment, and, to a lesser extent, fecundity (Dugger et al. 2016, entire). Authors noted variable annual rates of decline across the range, but the CleElum study area in Washington and the control area in Green Diamond study area in northern California showed the highest annual rates of population decline (Dugger et al. 2016, pp.70-71; further detail provided in *Barred Owls* section below). Rangewide, the weighted mean estimated population was determined to decline 3.8 percent per year (Dugger et al. 2016, p. 71).

Olson et al. (2005, pp. 930-931) used open population modeling of site occupancy that incorporated imperfect and variable detectability of spotted owls and allowed modeling of temporal variation in site occupancy, extinction, and colonization probabilities (at the site scale). The authors found that visit detection probabilities average less than 0.70 and were highly variable among study years and among their three study areas in Oregon. Pair site occupancy probabilities declined greatly on one study area and slightly on the other two areas. However, for all owls, including singles and pairs, site occupancy was mostly stable through time. Barred owl presence had a negative effect on these parameters (see barred owl discussion in the New Threats section below). However, there was enough temporal and spatial variability in detection rates to indicate that more visits would be needed in some years and in some areas, especially if establishing pair occupancy was the primary goal.

Threats

The spotted owl was listed as threatened throughout its range "due to loss and adverse modification of suitable habitat as a result of timber harvesting and exacerbated by catastrophic events such as fire, volcanic eruption, and wind storms" (USDI FWS 1990a, p. 26114). More specifically, threats to the spotted owl included low populations, declining populations, limited habitat, declining habitat, inadequate distribution of habitat or populations, isolation of provinces, predation and competition, lack of coordinated conservation measures, and vulnerability to natural disturbance (USDI FWS 1992a, pp. 33-41). These threats were characterized for each province as severe, moderate, low, or unknown (USDI FWS 1992a, pp. 33-41). Declining habitat was recognized as a severe or moderate threat to the spotted owl throughout its range, isolation of populations was identified as a severe or moderate threat in 11 provinces, and a decline in population was a severe or moderate threat in 10 provinces. Together, these three factors represented the greatest concerns about rangewide conservation of the spotted owl. Limited habitat was considered a severe or moderate threat in nine provinces, and low populations were a severe or moderate concern in eight provinces, suggesting that these factors were also a concern throughout the majority of the spotted owl's range. Vulnerability to natural disturbances was rated as low in five provinces.

The degree to which predation and competition might pose a threat to the spotted owl was unknown in more provinces than any of the other threats, indicating a need for additional information. Few empirical studies exist to confirm that habitat fragmentation contributes to increased levels of predation on spotted owls (Courtney et al. 2004, pp. 11-8 to 11-9). However, great horned owls (*Bubo virginianus*), an effective predator on spotted owls, are closely associated with fragmented forests, openings, and clearcuts (Johnson 1992, p. 84; Laidig and Dobkin 1995, p. 155). As mature forests are harvested, great horned owls may colonize fragmented forests, thereby increasing spotted owl vulnerability to predation.

The Service conducted a 5-year review of the spotted owl in 1994 (USDI FWS 2004), for which the Service prepared a scientific evaluation of the status of the spotted owl (Courtney et al. 2004). An analysis was conducted assessing how the threats described in 1990 might have changed by 2004. Some of the key threats identified in 2004 were:

- "Although we are certain that current harvest effects are reduced, and that past harvest is also probably having a reduced effect now as compared to 1990, we are still unable to fully evaluate the current levels of threat posed by harvest because of the potential for lag effects…In their questionnaire responses…6 of 8 panel member identified past habitat loss due to timber harvest as a current threat, but only 4 viewed current harvest as a present threat" (Courtney and Gutiérrez 2004, pp.11-7).

- "Currently the primary source of habitat loss is catastrophic wildfire, although the total amount of habitat affected by wildfires has been small (a total of 2.3 percent of the rangewide habitat base over a 10-year period)" (Courtney and Gutiérrez 2004, pp.11-8).

- "Although the panel had strong differences of opinion on the conclusiveness of some of the evidence suggesting [barred owl] displacement of [spotted owls], and the mechanisms by which this might be occurring, there was no disagreement that [barred owls] represented an operational threat. In the questionnaire, all 8 panel members identified [barred owls] as a current threat, and also expressed concern about future trends in [barred owl] populations" (Courtney and Gutiérrez 2004, pp. 11-8).

Threats, as identified in the 2011 Revised Recovery Plan for the Northern Spotted Owl, continue to emphasize that habitat loss and barred owls are the main threats to spotted owl recovery (USDI FWS 2011b, Appendix A), and that effects of high severity wildfires pose concern for habitat conservation in some portions of the range (Davis et al. 2016, p. 38).

Barred Owls (*Strix varia*)

Barred owls currently appear to be the primary threat to spotted owls. With its recent expansion to as far south as Marin County, California (Gutiérrez et al. 2004, pp. 7-12 to 7-13; Steger et al. 2006, p.226), the barred owl's range now completely overlaps that of the spotted owl. Evidence that barred owls are occurring in higher densities than spotted owls in many parts of the range (3–8 barred owl territories/northern spotted owl; Hamer et al. 2007; Singleton et al. 2010; Wiens et al. 2011, 2014), and, to a lesser extent, northern California spotted owls (Diller et al. 2016, Dugger et al. 2016). In a recent study, the highest densities found were in the Oregon Coast Range, with up to 20 barred owls per spotted owl territory reported (Wiens et al. 2017, p. 12).

The two species of owls share similar habitats and are likely competing for food resources (Hamer et al. 2001, p. 226, Gutiérrez et al. 2007, p. 187; Livezey and Fleming 2007, p. 319, Wiens et al., 2014, pp. 24 and 33). Hamer found a strong diet overlap (76 percent) between northern spotted and barred owl diets (pp. 221, 226). Barred owl diets are more diverse than spotted owl diets and include species associated with riparian and other moist habitats (e.g. fish, invertebrates, frogs, and crayfish), along with more terrestrial and diurnal species (Smith et al. 1983; Hamer et al. 2001; Gronau 2005, Wiens et al., 2014, p. 24). Even though barred owls may be taking spotted owls' primary prey only as a generalist, spotted owls may be affected by a sufficient reduction in the density of these prey items due to barred owls, leading to a depletion of prey to the extent that the spotted owl cannot find an adequate amount of food to sustain maintenance or reproduction (Gutiérrez et al. 2007, p. 187; Livezey and Fleming 2007, p. 319). These impacts are likely to have direct and indirect effects on ecosystem processes (Holm et al. 2017, p. 618)

In addition to completion for prey, barred owls are competing for habitats (Hamer et al. 1989, p.55; Dunbar et al. 1991, p. 467; Herter and Hicks 2000, p. 285; Pearson and Livezey 2003, p. 274; Wiens et al., 2014, pp. 24 and 33). Barred owls were initially thought to be more closely associated with early successional forests than spotted owls, based on studies conducted on the west slope of the Cascades in Washington (Hamer et al 1989, p. 34; Iverson 1993, p.39). However, more recent studies conducted in the Pacific Northwest show that barred owls frequently use mature and old-growth forests (Pearson and Livezey 2003, p. 270; Gremel 2005, Schmidt 2006, p. 1; Singleton et al. 2010, pp. 290-292). In the fire prone forests of eastern Washington, a telemetry study conducted on barred and spotted owls showed that barred owl home ranges were located on lower slopes or valley bottoms, in closed canopy, mature, Douglas-fir forest, while spotted owl sites were located on mid-elevation areas with southern or western exposure, characterized by closed canopy, mature, ponderosa pine or Douglas-fir forest (Singleton et al. 2005, p. 1).

In addition to resource competition, barred owls have been documented to physically attack spotted owls (Pearson and Livezey 2003, p. 274), and circumstantial evidence strongly indicated that a barred owl killed a spotted owl (Leskiw and Gutiérrez 1998, p. 226).

There is consensus in the literature on the negative influence barred owls are having on spotted owl site occupancy, fecundity, reproduction, apparent survival, and detectability, and that data indicates that over the last ten-fifteen years, they are contributing to declines in spotted owl populations (Olson et al. 2005, p. 924; Forsman et al. 2011, pp. 69-70), Dugger et al. 2011, pp. 2463-2467; Dugger et al. 2016, pp. 70-96). As barred owls have expanded, the occupancy of historical spotted owl territories appears to be declining. Over ten years ago, site occupancy of spotted owls in Washington and Oregon was significantly lower ($p < 0.001$) after barred owls were detected within 0.8 kilometer (0.5 miles) of the territory center but was "only marginally lower" ($p = 0.06$) if barred owls were located more than 0.8 kilometer (0.5 miles) from the spotted owl territory center (Kelly et al. 2003, p. 51). Pearson and Livezey (2003, p. 271) found that there were significantly more barred owl site-centers in unoccupied spotted owl circles than occupied spotted owl circles (centered on historical spotted owl site-centers) with radii of 0.8 kilometer (0.5 miles) ($p = 0.001$), 1.6 kilometer (1 mile) ($p = 0.049$), and 2.9 kilometer (1.8 miles) ($p = 0.005$) in Gifford Pinchot National Forest. In Olympic National Park, Gremel (2005, p. 11) found a significant decline ($p = 0.01$) in spotted owl pair occupancy at sites where barred owls had been detected, while pair occupancy remained stable at spotted owl sites without barred owls. Olson et al. (2005, p. 928) found that the annual probability that a spotted owl territory would be occupied by a pair of spotted owls after barred owls were detected at the site declined by 5 percent in the HJ Andrews study area, 12 percent in the Coast Range study area, and 15 percent in the Tyee study area. In contrast, Bailey et al. (2009, p. 2983), when using a two-species occupancy model, showed no evidence that barred owls excluded spotted owls from territories in Oregon. More recently, results from a barred owl and spotted owl radio-telemetry study in Washington reported two spotted owls fleeing their territories and traveling six and 15 miles, believed to be as a result of frequent direct encounters with barred owls; both spotted owls were subsequently found dead (Irwin et al. 2010, p. 3-4). Preliminary findings from an ongoing barred owl experimental control/treatment study, spotted owl pair occupancy was low, has declined in control sites; while (with the exception of one year in one study area), the occupancy by barred owls has increased (Wiens et al. 2017, tables 1 and 2). Authors also report that the probability of use by barred owls within 500 acre hexagons (1,235 acres) in the Oregon Coast Ranges study area was high in the two years of the study in the control area (>0.920) (p. 16).

Numerous studies suggest that barred owls are negatively affecting spotted owl survival and reproduction. Anthony et al. (2006, p. 32) found significant evidence for negative effects of barred owls on apparent survival of spotted owls in two of 14 study areas (Olympic and Wenatchee). They attributed the equivocal results for most of their study areas to the coarse nature of their barred owl covariate. Dugger et al. (2011, pp. 2463-2467) described synergistic effects associated with territory composition and presence of barred owls; some spotted owl pairs retained their territories and continued to survive and successfully reproduce during their study even when barred owls were present, but the effects of reduced old growth forest in the core habitat areas were compounded when barred owls were present - extinction rates of spotted owl territories nearly tripled when barred owls were detected. Yackulic and others documented similar findings; the effects of interspecific competition were likely to negatively affect spotted owls, both through its immediate effects on local extinction and by indirectly lowering colonization (Yackulic et al., 2014, pp. 271-273).

Most recently, apparent survival and local extinction rates were the key vital rates associated with barred owl presence in spotted owl populations (Dugger et al., 2016, p. 93-98). Dugger et al. (2016, pp. 98-99) suggested that barred owl densities may now be high enough across the range of the spotted owl that, despite the continued management and conservation of suitable owl habitat on Federal lands (Davis et al. 2011, 2015), the long-term prognosis for the persistence of spotted owls may be in question without additional management intervention. For example, Dugger et al. (2016) found that the removal of barred owls in the Green Diamond study area in northern California had rapid, positive effects on spotted owl survival and rates of population change, suggesting that, along with habitat conservation and management, barred owl removal may be able to slow or reverse spotted owl population declines on at least a localized scale (Diller et al. 2016).

Olson et al. (2004, p. 1048) found that the presence of barred owls had a significant negative effect on the reproduction of spotted owls in the central Coast Range of Oregon (in the Roseburg study area). The conclusion that barred owls had no significant effect on the reproduction of spotted owls in one study (Iverson 2004, p. 89) was unfounded because of small sample sizes (Livezey 2005, p. 102). It is likely that all of the above analyses underestimated the effects of barred owls on the reproduction of spotted owls because spotted owls often cannot be relocated after they are displaced by barred owls (Forsman, E. pers. comm. 2006, cited in USDI FWS 2011b, p. B-11). Anthony et al. (2006, p. 32) found significant evidence for negative effects of barred owls on apparent survival of spotted owls in two of 14 study areas (Olympic and Wenatchee). They attributed the equivocal results for most of their study areas to the coarse nature of their barred owl covariate. Dugger et al. (2011, pp. 2463-2467) confirmed the synergistic effects of barred owls and territory habitat characteristics on extinction and colonization rates of territories by spotted owls. Extinction rates of spotted owl territories nearly tripled when barred owls were detected (Dugger et al. 2011, p. 2464). The recent meta-analysis suggested weak relationships between fecundity and barred owls across all study areas; however, declines in the number of occupied spotted owl sites contributed to declines in the total number of young produced per study area (Dugger et al. 2016 p. 96).

Monitoring and management of spotted owls has become more complicated due to their possible reduced detectability when barred owls are present (Kelly et al. 2003, pp. 51-52; Courtney et al. 2004, p. 7-16 ; Olson et al. 2005, p. 929; Crozier et al. 2006, p.766-767). Evidence that spotted owls were responding less frequently during surveys led the Service and its many research partners to update the spotted owl survey protocol (USDI FWS 2012b). The recent changes to the spotted owl survey protocol were based on the probability of detecting spotted owls when barred owls are present (See USDI FWS Memorandum, revised January 9, 2012, “Northern Spotted Owl Survey Protocol” and attached “Protocol for Surveying Proposed Management Activities That May Impact Northern Spotted Owls” for guidance and methodology).

In an analysis of more than 9,000 banded spotted owls throughout their range, only 47 hybrids were detected (Kelly and Forsman 2004, p. 807). Consequently, hybridization with the barred owl is considered to be “an interesting biological phenomenon that is probably inconsequential, compared with the real threat—direct competition between the two species for food and space” (Kelly and Forsman 2004, p. 808).

There is no evidence that the increasing trend in barred owls has stabilized in any portion of the spotted owl's range in the western United States, and "there are no grounds for optimistic views suggesting that barred owl impacts on spotted owls have been already fully realized" (Gutiérrez et al. 2004, pp. 7-38). To date, this situation does not appear to have changed.

Wildfire

At the time of listing there was recognition that large-scale wildfire posed a threat to the spotted owl and its habitat (USDI FWS 1990a, p. 26183). New information suggests fire may be more of a threat than previously thought. In 2005 the overall total amount of habitat affected by wildfires was been relatively small (Lint 2005, p. v) but since then, there have been significant losses of nesting/roosting habitats reported, particularly in the reserved land allocations of the Klamath Province and parts of the Oregon Cascades (Davis et al. 2011, pp. 43-48; Davis et al. 2016, tables 5 and 7). Table A-2 below also summarizes habitat lost from natural disturbances, the majority of which has resulted from high severity fires. Silvicultural management of forest fuels are currently being implemented throughout the spotted owl's range, in an attempt to reduce the levels of fuels that have accumulated during nearly 100 years of effective fire suppression; however, the ability to protect spotted owl habitat and viable populations of spotted owls from large fires through risk-reduction endeavors is uncertain (Courtney et al. 2004, pp. 12-11). The NWFP recognized wildfire as an inherent part of managing spotted owl habitat in certain portions of the range. The distribution and size of reserve blocks as part of the NWFP design may help mitigate the risks associated with large-scale fire (Lint 2005, p. 77).

Studies indicate that the effects of wildfire on spotted owls and their habitat are variable, depending on fire intensity, severity, and size. Within the fire-adapted forests of the spotted owl's range, spotted owls likely have adapted to withstand fires of variable sizes and severities. However, fire is often considered a primary threat to spotted owls because of its potential to alter habitat rapidly (Bond et al. 2009, p. 1116) and is a major cause of habitat loss on Federal lands (Courtney et al. 2004, executive summary; Davis et al. 2011, pp. 43-48; Davis et al. 2016, tables 5 and 7).

Research results on spotted owl use of burned landscapes and their demographic variables following fires at localized scales has yielded variable results that were influenced by small sample sizes, varying impacts to habitat, existing forest management practices, the condition of pre- and post-fire landscapes, and the status of spotted owls that previously occupied the sites (Elliott 1985; Gaines et al. 1997, King et al. 1998; Bond et al. 2002; Jenness et al. 2004; Clark 2007; Seamans and Gutierrez 2007; Bond et al. 2009; Clark et al. 2011; Roberts et al. 2011; Clark et al. 2013; Comfort 2014; Lee and Bond 2015a; Lee and Bond 2015b; Bond et al. 2016; and Jones et al., 2016). Bond and others (2002) examined the demography of the three spotted owl subspecies after wildfires, in which wildfire burned through spotted owl nest and roost sites in varying degrees of severity. Post-fire demography parameters for the three subspecies were similar or better than long-term demographic parameters for each of the three subspecies in those same areas (Bond et al. 2002, p. 1025-1026). In a preliminary study conducted by Anthony and Andrews (2004, p. 8) in the Oregon Klamath Province, their sample of spotted owls appeared to be using a variety of habitats within the area of the Timbered Rock fire, including areas where burning had been moderate. Site fidelity can influence spotted owl use of burned areas that were previously suitable (Clark 2007, Bond et al. 2009, Lee et al. 2012). Also, the amount, extent, and location of high severity fires appear to be strong influences on spotted owl occupancy. One year following the extensive King Fire in the Sierra Nevada Mountains, Jones and others (2016) documented strong negative California spotted owl population impacts, with declines in occupancy and reproduction associated with severely burned sites; the probability of site extinction in that study was seven times higher one year after the fire where more than 50 percent of the site (approximately 0.7 mile radius area) burned at high severity (75–100 percent canopy mortality) (p. 303-304).

In southwest Oregon, lower occupancy and survival rates of spotted owl were found in burned areas compared to unburned, but the results were confounded by prior management and post-fire harvest (Clark 2007, Clark et al. 2011, Lee et al. 2012, Clark et al. 2013). Available data on the direct mortality of spotted owls from fire is limited. In one study, mortality was assumed to have occurred at one site, and spotted owls were present at only one of the six sites 1 year after a fire (Gaines et al. 1997, p. 126). In 1994, two wildfires burned in the Yakama Indian Reservation in Washington’s eastern Cascades, affecting the home ranges of two radio-tagged spotted owls (King et al. 1998, pp. 2-3). No direct mortality of spotted owls was observed, even though thick smoke covered several spotted owl site-centers for a week. Although the amount of home ranges burned was not quantified, spotted owls were observed using areas that burned at low and medium intensities. More research is needed to understand further the relationship between fire and spotted owl habitat use. Overall, we can conclude that fires are a change agent for spotted owl habitat, but there are still many unknowns regarding how much fire benefits or adversely affects spotted owl habitat (USDI FWS 2011b, p. III-31).

Additional impacts to spotted owls related to wildfire include forest management that occurs after fires. Post-fire salvage logging typically occurs on the majority of private timberlands, but also occurs on Federal lands to a smaller degree. This type of harvest can directly impact habitat potentially occupied by spotted owls and can negatively influence ecological processes, which can impair the long-term development of spotted owl habitat (reviewed in USDI FWS 2011b, p. III-48). Action agencies, working with the Service, are attempting to influence fire severity by designing projects to reduce fire-suppressed vegetation and mimic the effects of historical fire regimes. The effects of this type of management are uncertain and highly debated in the literature (Courtney et al. 2004, pp. 12-11, Omi and Martenson 2002, pp. 19-27; Irwin et al. 2004, p. 21; Spies et al. 2006 p. 359-361; Hanson et al. 2009, pp. 1316-1319; Spies et al. 2009, pp. 331-332; Ager et al. 2012, p. 282; Odion et al. 2014a pp. 10-12, Spies et al. 2012, pp. 10-12; Odion et al. 2014b, pp. 46-49; Gaines et al. 2010, Baker 2015, entire; Baker 2017, entire; Gallagher et al. 2018, pp. 10-13).

West Nile Virus

West Nile virus (WNV), caused by a virus in the family Flaviviridae, has killed millions of wild birds in North America since it arrived in 1999 (McLean et al. 2001; Caffrey 2003; Caffrey and Peterson 2003, pp. 7-8; Marra et al. 2004, p. 393). Mosquitoes are the primary carriers (vectors) of the virus that causes encephalitis in humans, horses, and birds. Mammalian prey may also play a role in spreading WNV among predators, like spotted owls. Owls and other predators of mice can contract the disease by eating infected prey (Garmendia et al. 2000, p. 3111; Komar et al. 2001). One captive spotted owl in Ontario, Canada, is known to have contracted WNV and died.

Human activities and landscape physiography appear to influence the occurrence of WNV (Dobson and Foufopoulos 2001, p. 1004; Gibbs et al. 2006, p. 80). Mountainous terrain typically associated with spotted owls may limit the widespread occurrence of WNV. The effect of how WNV will ultimately affect spotted owl populations is unknown but localized populations could be adversely affected (Blakesley and others 2004, *in* Courtney et al. 2004, p. 8-25-8-31). Susceptibility to infection and the mortality rates of infected individuals vary among bird species (Blakesley et al. 2004, pp. 8-33), but most owls appear to be quite susceptible. For example, breeding Eastern screech owls (*Megascops asio*) in Ohio experienced 100 percent mortality (Grubb, T. pers. comm. 2006 cited in Blakesley et al. 2004, pp. 8-33). Barred owls, in contrast, showed lower susceptibility (Hunter, B. pers. comm. no date cited in Blakesley et al. 2004, pp. 8-34). Some level of innate resistance may occur (Fitzgerald et al. 2003), which could explain observations in several species of markedly lower mortality in the second year of exposure to WNV (Caffrey and Peterson 2003). Wild birds also develop resistance to WNV through immune responses (Deubel et al. 2001). The effects of WNV on bird populations at a regional scale have not been large, even for susceptible species (Caffrey and Peterson 2003), perhaps due to the short-term and patchy distribution of mortality (McGowan, K. pers. comm. no date, cited in Courtney et al. 2004) or annual changes in vector abundance and distribution.

Blakesley et al. (2004, pp. 8-35) offer competing propositions for the likely outcome of spotted owl populations being infected by WNV. One scenario is that spotted owls can tolerate severe, short-term population reductions due to WNV, because spotted owl populations are widely distributed and number in the several hundreds to thousands. An alternative scenario is that WNV will cause unsustainable mortality, due to the frequency and/or magnitude of infection, thereby resulting in long-term population declines and extirpation from parts of the spotted owl's current range. Thus far, no mortality in wild, spotted owls has been recorded; however, WNV is a potential threat of uncertain magnitude and effect (Blakesley et al. 2004, pp. 8-34).

Sudden Oak Death

Sudden oak death was not listed as particular threat at the time of listing but was recognized as a potential threat to the spotted owl after it was discovered in Oregon (Courtney et al. 2004, USDI Fish and Wildlife 2011). This disease is caused by the fungus-like pathogen, *Phytopthora ramorum* that was recently introduced from Europe and is rapidly spreading as it is capable of infecting over 100 species of trees and shrubs (APHIS 2011, in Peterson et al. 2015, p. 937) . The disease has been found in several different forest types and at elevations from sea level to over 800 m and is now known to extend over 650 km from south of Big Sur, California to Curry County, Oregon (Rizzo and Garbelotto 2003, p. 198). In some areas it has reached epidemic proportions in oak (Quercus spp.) and tanoak (*Lithocarpus densiflorus*) forests along approximately 300 kilometers (186 miles) of the central and northern California coast (Rizzo et al. 2002, p. 733). Near Brookings, Oregon it has killed tanoak and causing dieback of closely associated wild rhododendron (*Rhododendron* spp.) and evergreen huckleberry (*Vaccinium ovatum*) (Goheen et al. 2002, p. 441), common components of spotted owl habitat. Despite treatments of infected sites that remove all infected trees and shrubs as well as those occurring within a 300 foot buffer, occurrences of infected sites have increased since 2001 (Peterson et al. 2015, p. 937). The majority of infected sites in Oregon are concentrated in the Chetco River drainage, but it has been located as far north as Cape Sebastian (Peterson et al. 2015, p. 238). The spores from this pathogen are transmitted through the coastal fog and rain or through contaminated surfaces. During a study completed between 2001 and 2003 in California, one-third to one-half of the hiker's present in the study area carried infected soil on their shoes (Davidson et al. 2005, p. 587), creating the potential for rapid spread of the disease. Sudden oak death poses a threat of uncertain proportion because of its potential impact on forest dynamics and alteration of key prey and spotted owl habitat components (e.g., hardwood trees, forest structure and nest tree mortality); especially in the southern portion of the spotted owl's range (Courtney et al. 2004, pp. 6-26 through 6-27, 11-8). Eradication treatments themselves have the potential to remove habitat at the stand level as all hardwoods and shrubs identified as carriers are removed. Because of the coastal influence on this pathogen, sudden oak death is not likely to be of consequence rangewide but could compound existing stressors in coastal provinces of the spotted owl range.

Inbreeding Depression, Genetic Isolation, and Reduced Genetic Diversity
Inbreeding and other genetic problems due to small population sizes were not considered an imminent threat to the spotted owl at the time of listing. Earlier studies showed no indication of reduced genetic variation and past bottlenecks in Washington, Oregon, or California (Barrowclough et al. 1999, p. 922; Haig et al. 2004, p. 36). A more recent study however, reported a significant bottleneck influence in the Washington Cascades, an area known to be experiencing a significant population decline, and that other areas with significant population bottlenecks were correlated with declines in population growth rate (Funk et al. 2010, as reviewed in Haig et al. 2016, p. 187). Canadian populations may be more adversely affected by issues related to small population size including inbreeding depression, genetic isolation, and reduced genetic diversity (Courtney et al. 2004, pp. 11-9). A 2004 study (Harestad et al. 2004, p. 13) indicates that the Canadian breeding population was estimated to be less than 33 pairs and annual population decline may be as high as 35 percent. In 2007, a recommendation was made by the Spotted Owl Population Enhancement Team to remove spotted owls from the wild in British Columbia (USDI FWS 2012a, p. 14078). This recommendation resulted in the eventual capture of the remaining 16 wild spotted owls in British Columbia for a captive breeding program (USDI FWS 2012a, p. 14078). Low and persistently declining populations throughout the northern portion of the species range (see "Population Trends" below) may be at increased risk of losing genetic diversity.
Hybridization of spotted owls with California spotted owls, Mexican spotted owls, and barred owls has been confirmed through genetic research (Funk et al. 2008, p. 1; Hamer et al. 1994, p. 487; Gutiérrez et al. 1995, p. 3; Dark et al. 1998, p. 50; Kelly 2001, pp. 33-35).

Climate Change

Global climate change has the potential to produce entirely new environmental conditions, making predictions about future ecological consequences a more daunting challenge. Recent forecasts indicate that climate change will have long-term and variable impacts on forest habitat at local and regional scales. Locally, this could involve shifts in tree species composition that influence habitat suitability. Frey et al. (2016, pp. 1, 6) concluded that old-growth will provide some buffer from impacts of regional warming and/or slow the rate at which some species relying on old-growth must adapt, based on their modeling of the fine-scale spatial distribution, under-canopy air temperatures in mountainous terrain of central Oregon. Similarly, Lesmeister et al. (2019, p. 16) concluded that older forest can serve as a buffer to climate change and associated increases in wildfire, as these areas have the highest probability of persisting through fire events even in weather conditions associated with high fire activity. Regionally, there could be losses of habitat availability caused by advances or retreats of entire vegetative communities, and perhaps prey communities as well. Effects of climate change, including fire and pest incidence, will not only affect currently suitable habitat for the spotted owl, they will also likely alter or interrupt forest growth and development processes (Karl et al. 2008, pp. 15 and 18; Dale et al. 2001, entire; Yospin et al. 2015, entire) that influence forest turnover rates and the emergence of suitable habitat attributes in new locations. These changes are predicted to be driven by changes in patterns of temperature and precipitation that are projected to occur under climate change scenarios (Mote et al. 2014, entire).

Glenn et al. (2010, p.2551) noted that the potential consequences of global climate change on Pacific Northwest forests remain somewhat unclear, though there is potential for changes in forest composition and disturbance patterns that could affect spotted owl populations. Most models predict warmer, wetter winters and hotter, drier summers for the Pacific Northwest in the first half of the 21st century (Mote et al., 2008, Mote et al. 2014, p. 489). This may result in a change in species composition or reduction in the acreage of existing low-elevation forests. The general predicted trend in North American forests is declining occupancy by conifers and displacement by hardwoods. Both the frequency and intensity of wildfires and insect outbreaks are expected to increase over the next century in the Pacific Northwest (Littell et al. 2010, p. 130). One of the largest projected effects on Pacific Northwest forests is likely to come from an increase in fire frequency, duration, and severity. Westerling et al. (2006, pp. 940-941) analyzed wildfires and found that since the mid-1980s, wildfire frequency in western forests has nearly quadrupled compared to the average of the period from 1970-1986. The total area burned is more than 6.5 times the previous level and the average length of the fire season during 1987-2003 was 78 days longer compared to 1978-1986 (Westerling et al. 2006, p. 941). The area burned annually by wildfires in the Pacific Northwest is expected to double or triple by the 2080s (Littell et al. 2010, p. 140). Wildfires are now the primary cause of spotted owl habitat loss on Federal lands, with about 505,800 acres of nesting/roosting habitat loss attributed to wildfires from 1993 to 2012 (Davis et al. 2016, table 7, p. 22).

In its review of the status of the spotted owl in California (CDFW 2016, p. 153-155), the California Department of Fish and Wildlife (CDFW) evaluated the possible effects of climate change upon spotted owl and the forested habitats on which it depends. In general, CDFW (2016, p. 153-155) determined that climate change is occurring within the spotted owl's entire range, including California, with many climate projections forecasting steady changes in the future. They reported that climate change studies predict future conditions that may negatively impact spotted owls, such as wet and cold springs, more frequent and severe summer heat waves, decreased fog along the coast, shifts in forest species composition, and increased frequency of severe wildfire events. However, CDFW (2016, p. 153-155) also reported that in some instances predicted future conditions, such as increased frequency of low to moderate severity fires and expansion of suitable owl habitat forest types, may be favorable to the spotted owl in the long-term. They further reported that in California, current rates of temperature and precipitation change predict hotter and drier conditions in some areas of the spotted owl's range, and wetter colder conditions in other areas of the range. They looked at past precipitation and temperature trends, and reported that drying trends across most of the spotted owl's range in California, coupled with warmer winters and cooler summers in the interior and cooler winters and warmer summers along the coast, may play a role in both owl and prey population dynamics. CDFW (2016, p. 153-155) recommended that further research is necessary to understand how climate change may be affecting spotted owls in California and throughout its range.

Potential changes in temperature and precipitation have important implications for spotted owl reproduction and survival. Wet, cold weather during the winter or nesting season, particularly the early nesting season, has been shown to negatively affect spotted owl reproduction (Olson et al. 2004, p. 1039, Dugger et al. 2005, p. 863), survival (Franklin et al. 2000 pp. 576-577, Olson et al. 2004, p. 1039, Glenn et al. 2011, p. 1279), and recruitment (Glenn et al. 2010, pp.2446-2547). Cold, wet weather may reduce reproduction and/or survival during the breeding season due to declines or decreased activity in small mammal populations so that less food is available during reproduction when metabolic demands are high (Glenn et al. 2011, pp. 1288-1289). Cold, wet nesting seasons may increase the mortality of nestlings due to chilling and reduce the number of young fledged per pair per year (Franklin et al. 2000, p.557, Glenn et al. 2011, p. 1286). Most recently, the relationships between spotted owl populations and climate was complex and variable, but rangewide, Dugger and others (2016, page 98) suggested that survival increased when winters were warmer and drier. This may become a factor in population numbers in the future; given climate change predictions for the Pacific Northwest include warmer, wetter winters.

Drought or hot temperatures during the summer have also been linked to reduced spotted owl recruitment (Glenn et al. 2010, p. 2549). Drier, warmer summers and drought conditions during the growing season strongly influence primary production in forests, food availability, and the population sizes of small mammals that spotted owls prey upon (Glenn et al. 2010, p. 2549).

Various types of changes in climate can have direct or indirect effects on species. These effects may be positive, neutral, or negative and they may change over time, depending on the species and other relevant considerations, such as the effects of interactions of climate with other variables (e.g., habitat fragmentation) (IPCC 2007, pp. 8–14, 18–19). For the more central portion of the spotted owl's range such as the location of the action area, climate models have provided a series of projections. For example, annual temperatures are likely to increase up to 3 degrees in the next couple of decades. Total precipitation may remain roughly similar to historic levels but likely increasing in the fall and winter months. Rising temperatures will cause snow to turn to rain in the lower elevations. As a result, the area is likely to experience more severe storm events, variable weather, higher and flashier winter and spring runoff events and increased flooding. Reduced snowpack and soil moisture along with hotter temperatures and longer fire seasons likely will increase significantly (Doppelt et al. 2008).

While a change in forest composition or extent is likely as a result of climate change, the rate of that change is uncertain. In forests with long-lived dominant tree species, mature individuals can survive these stresses, so direct effects of climate on forest composition and structure would most likely occur over a longer time scale (100 to 500 years) in some areas than disturbances such as wildfire or insect outbreaks (25 to 100 years) (McKenzie et al. 2009). The presence of high-quality habitat may buffer the negative effects of cold, wet, springs and winters on survival of spotted owls as well as ameliorate the effects of heat. This habitat might help maintain a stable prey base, thereby reducing the cost of foraging during the breeding season when energetic needs are high (Franklin et al. 2000).

Although the scientific literature has explored the link between climate change and the invasion by barred owls, changing climate alone is unlikely to have caused the invasion (Livezey 2009). In general, climate change can increase the success of introduced or invasive species in colonizing new territory. Invasive animal species are more likely to be generalists, such as the barred owl, than specialist, such as the spotted owl and adapt more successfully to a new climate than natives.

In summary, effects of climate change may vary across the range, but is likely to exacerbate some existing threats to the spotted owl such as the projected potential for increased habitat loss from drought-related fire, tree mortality, insects and disease, as well as affecting reproduction and survival during years of extreme weather.

Exposure to Toxicants

Toxicants were not identified as a threat when the spotted owl was listed, but a growing body of information suggests exposure to anti-coagulant rodenticides, fertilizers, other contaminants, as well as other factors associated with marijuana cultivation represent a growing concern for spotted owls. Recent accounts show that the scope and scale of exposure from illegal cultivation is increasing on federal and non-federal ownerships; these threats extend spotted owls and many other wildlife species and the resources they depend upon (Thompson et al. 2013, entire, Gabriel et al. 2013, entire; Wengert et al. 2015, p. 8; CDFW 2016 pp. 176-177, CEPA 2017b, p.1; Gabriel et al. 2018, entire; Higley et al. 2017 (abstracts). Known grow sites have been found to intersect with both subspecies of spotted owl ranges throughout California. On Forest Service lands in 2014, more than 620,000 marijuana plants on about 1,500 ac (607 ha) were removed from 167 different sites; about 90 percent of which were in California (US Senate press release 2015). Over 600 trespass grow sites were reported on mixed California ownerships in 2010 (Wengert et al. 2015, p. 8). Increases in mortalities from and exposure to pesticides in fishers in the Sierras and Northern California indicate that toxicants from marijuana cultivation suggest increasing trends (Gabriel et al. 2015, pp. 5-8, 14).

Illegal cultivation is a serious issue in the Klamath Physiographic Province, an area recognized as an important area for spotted owl populations (Schumaker et al. 2014). In Southwestern Oregon in Jackson and Josephine Counties alone, a multi-agency Drug Task force reported a total of 100 illegal marijuana cultivation sites containing approximately 294,090 plants between 2005-2014 (Caruthers, R. pers. comm. 2017). Many of these sites were located within known spotted owl home ranges, cores, or nest stands (Clayton, D. pers. comm. 2017).

Known exposure and recent data on impacts to barred owls suggest serious implications for spotted owls. In Hoopa Tribal lands in northwestern California, of 176 barred owls tested for exposure to anticoagulant rodenticides, 65 percent tested positive for one or more second generation ARs; many of these were collected from known spotted owl home ranges (Higley et al. 2017). From another data set in northwestern California, barred owls collected from 37 historical spotted owl territories have been tested for ARs (Gabriel et al. 2018, p. 4). In Oregon, 40 percent of barred owls sampled (n=10) tested positive for rodenticides.

Disturbance

Northern spotted owls may also respond physiologically to a disturbance without exhibiting a significant behavioral response. In response to environmental stressors, vertebrates secrete stress hormones called corticosteroids (Campbell 1990, p. 925). Although these hormones are essential for survival, extended periods with elevated stress hormone levels may have negative effects on reproductive function, disease resistance, or physical condition (Carsia and Harvey 2000, pp. 517-518; Saplosky et al. 2000, p. 1). In avian species, the secretion of corticosterone is the primary non-specific stress response (Carsia and Harvey 2000, p. 517). The quantity of this hormone in feces can be used as a measure of physiological stress (Wasser et al. 1997, p. 1019). Recent studies of fecal corticosterone levels of spotted owls indicate that low intensity noise of short duration and minimal repetition does not elicit a physiological stress response (Tempel and Gutiérrez 2003, p. 698; Tempel and Gutiérrez 2004, p. 538). However, prolonged activities, such as those associated with timber harvest, may increase fecal corticosterone levels depending on their proximity to spotted owl core areas (Wasser et al. 1997, p.1021; Tempel and Gutiérrez 2004, p. 544).

The effects of noise on spotted owls are largely unknown, and whether noise is a concern has been a controversial issue. The effect of noise on birds is extremely difficult to determine due to the inability of most studies to quantify one or more of the following variables: 1) timing of the disturbance in relation to nesting chronology; 2) type, frequency, and proximity of human disturbance; 3) clutch size; 4) health of individual birds; 5) food supply; and 6) outcome of previous interactions between birds and humans (Knight and Skagan 1988, pp. 355-358). Additional factors that confound the issue of disturbance include the individual bird’s tolerance level, ambient sound levels, physical parameters of sound, and how it reacts with topographic characteristics and vegetation, and differences in how species perceive noise.

Information specific to behavioral responses of spotted owls to disturbance is limited, research indicates that recreational activity can cause Mexican spotted owls (*S. o. lucida*) to vacate otherwise suitable habitat (Swarthout and Steidl 2001, p. 314) and helicopter overflights can reduce prey delivery rates to nests (Delaney et al. 1999, p. 70). Additional effects from disturbance, including altered foraging behavior and decreases in nest attendance and reproductive success, have been reported for other raptors (White and Thurow 1985, p. 14; Andersen et al. 1989, p. 296; McGarigal et al. 1991, p. 5).

Although it has not been conclusively demonstrated, it is anticipated that nesting spotted owls may be disturbed by heat and smoke as a result of burning activities during the breeding season.

Conservation Needs of the Spotted Owl

Based on the above assessment of threats, the spotted owl has the following habitat-specific and habitat-independent conservation (i.e., survival and recovery) needs:

Habitat-specific Needs

1. Large blocks of habitat capable of supporting clusters or local population centers of spotted owls (e.g., 15 to 20 breeding pairs) throughout the owl's range;
2. Suitable habitat conditions and spacing between local spotted owl populations throughout its range that facilitate survival and movement;
3. Suitable habitat distributed across a variety of ecological conditions within the spotted owl's range to reduce risk of local or widespread extirpation;
4. A coordinated, adaptive management effort to reduce the loss of habitat due to catastrophic wildfire throughout the spotted owl's range, and a monitoring program to clarify whether these risk reduction methods are effective and to determine how owls use habitat treated to reduce fuels; and
5. In areas of significant population decline, sustain the full range of survival and recovery options for this species in light of significant uncertainty.

Habitat-independent Needs

1. A coordinated research and adaptive management effort to better understand and manage competitive interactions between spotted and barred owls; and
2. Monitoring to understand better the risk that WNV and sudden oak death pose to spotted owls and, for WNV, research into methods that may reduce the likelihood or severity of outbreaks in spotted owl populations.

Conservation Strategy to Address Habitat Loss and Fragmentation

Since 1990, various efforts have addressed the conservation needs of the spotted owl and attempted to formulate conservation strategies based upon these needs. These efforts began with the ISC's Conservation Strategy (Thomas et al. 1990); they continued with the designation of critical habitat (USDI FWS 1992b), the Draft Recovery Plan (USDI FWS 1992a), and the Scientific Analysis Team report (Thomas et al. 1993), report of the Forest Ecosystem Management Assessment Team (Thomas and Raphael 1993); and they culminated with the NWFP (USDA FS/USDI BLM 1994a). Recently, the management strategy for portions of Bureau of Land Management lands in Oregon (2.5 million acres) was modified and is no longer following all measures described in the NWFP (USDI BLM 2016a, entire and USDI BLM 2016b, entire). In comparison to the NWFP land use allocations, the Late-Successional Reserve (LSR) designs of the revised Resource Management Plans (RMPs) make similar contributions to the development and spacing of the large habitat blocks needed for spotted owl conservation. The RMPs includes approximately 177,000 more acres (71,629 ha) of LSR and Riparian Reserves than in the NWFP. These land use allocations represent 36 and 27 percent of the RMP lands, respectively, and will be managed for the retention and development of large trees and complex forests across the RMP landscape (USDI FWS 2016, Table 1, p. 9). Two additional key provisions differ from previous strategies, including a mitigation that the BLM would participate in, cooperate with, and provide support for an interagency program for barred owl management to implement Recovery Action 30 when the Service determines the best manner in which barred owl management can contribute to the recovery of the spotted owl. Also, timber sales that would cause the incidental take of spotted owls from timber harvest would not be authorized until implementation of a barred owl management program has begun (USDI BLM 2016a, p 19 and USDI BLM 2016b, p. 19). Overall fundamentals of these large-scale conservation strategies have been based upon the reserve design principles first articulated in the ISC's report, which are summarized as follows:

- Species that are well distributed across their range are less prone to extinction than species confined to small portions of their range.
- Large blocks of habitat, containing multiple pairs of the species, are superior to small blocks of habitat with only one to a few pairs.
- Blocks of habitat that are close together are better than blocks far apart.
- Habitat that occurs in contiguous blocks is better than habitat that is more fragmented.
- Habitat between blocks is more effective as dispersal habitat if it resembles suitable habitat.

Federal Contribution to Recovery
Since it was signed on April 13, 1994, the NWFP has guided the management of Federal forest lands within the range of the spotted owl (USDA FS/USDI BLM 1994a, 1994b). The NWFP was designed to protect large blocks of old growth forest and provide habitat for species that depend on those forests including the spotted owl, as well as to produce a predictable and sustainable level of timber sales. The NWFP included land use allocations which would provide for population clusters of spotted owls (i.e., demographic support) and maintain connectivity between population clusters. Certain land use allocations in the plan contribute to supporting population clusters: LSRs, Managed Late-successional Areas, and Congressionally Reserved areas. Riparian Reserves, Adaptive Management Areas, and Administratively Withdrawn areas can provide both demographic support and connectivity/dispersal between the larger blocks, but were not necessarily designed for that purpose. Matrix areas were to support timber production while also retaining biological legacy components important to old-growth obligate species (in 100-acre owl cores, 15 percent late-successional provision, etc. (USDA FS/USDI BLM 1994a, USDI FWS 1994) which would persist into future managed timber stands.

The NWFP with its rangewide system of LSRs was based on work completed by three previous studies (Thomas et. al. 2006): the 1990 Interagency Scientific Committee (ISC) Report (Thomas et. al. 1990), the 1991 report for the Conservation of Late-successional Forests and Aquatic Ecosystems (Johnson et. al. 1991), and the 1993 report of the Scientific Assessment Team (Thomas et. al. 1993).

The Forest Ecosystem Management Assessment Team and the NWFP predicted, based on expert opinion, the spotted owl population would decline in the Matrix land use allocation over time, while the population would stabilize and eventually increase within LSRs as habitat conditions improved over the next 50 to 100 years (Thomas and Raphael 1993, p. II-31; USDA FS/USDI BLM 1994a, 1994b, p. 3&4-229). The results of the first decade of monitoring, Lint (2005, p. 18) did not yield conclusions whether implementation of the NWFP would reverse the spotted owl's declining population trend because not enough time had passed to provide the necessary measure of certainty. However, the results from the first decade of monitoring did not provide any reason to depart from the objective of habitat maintenance and restoration as described in the NWFP (Lint 2005, p. 18; Noon and Blakesley 2006, p. 288). Other stressors that occur in suitable habitat, such as the range expansion of the barred owl (already in action) and infection with WNV (which may or may not occur) may complicate the conservation of the spotted owl. Recent reports about the status of the spotted owl offer few management recommendations to deal with these emerging threats.

On June 28, 2011, the Service published the Revised Recovery Plan for the Northern Spotted

Owl (USDI FWS 2011b). The recovery plan identifies threats from competition with barred owls, ongoing loss of spotted owl habitat as a result of timber harvest, loss or modification of spotted owl habitat from uncharacteristic wildfire, and loss of amount and distribution of spotted owl habitat as a result of past activities and disturbances (USDI FWS 2011b, p. II-2 and Appendix A). To address these threats, the current recovery strategy identifies five main steps: 1) development of a rangewide habitat modeling framework; 2) barred owl management; 3) monitoring and research; 4) adaptive management; and 5) habitat conservation and active forest restoration (USDI FWS 2011b, p. II-2). The recovery plan lists recovery actions that address each of these items, some of which were retained from the 2008 recovery plan (USDI FWS 2008). The Managed Owl Conservation Areas and Conservation Support Areas recommended in the 2008 recovery plan are not a part of the recovery strategy outlined in the Revised Recovery Plan. The Service completed a rangewide, multi-step habitat modeling process to help evaluate and inform management decisions and critical habitat development (USDI FWS 2011b, Appendix C).

The Revised Recovery Plan recommended implementing a robust monitoring and research program for the spotted owl. The recovery plan encourages these efforts by laying out the following primary elements to evaluate progress toward meeting recovery criteria: monitoring spotted owl population trends, comprehensive barred owl research and monitoring, continued habitat monitoring; inventory of spotted owl distribution, and; explicit consideration for climate change mitigation goals consistent with recovery actions (USDI FWS 2011b, p. II-5). The Revised Recovery Plan also strongly encourages land managers to be aggressive in the implementation of recovery actions, including strategies that include active forest management. In other words, land managers should not be so conservative that, to avoid risk, they forego actions that are necessary to conserve the forest ecosystems that are necessary to the long-term conservation of the spotted owl. But they should also not be so aggressive that they subject spotted owls and their habitat to treatments where the long-term benefits do not clearly outweigh the short-term risks. Finding the appropriate balance to this dichotomy will remain an ongoing challenge for all who are engaged in spotted owl conservation (USDI FWS 2011b, p. II-12). The Revised Recovery Plan estimates that recovery of the spotted owl could be achieved in approximately 30 years (USDI FWS 2011b, p. II-3). The Revised Recovery Plan and the critical habitat designation build on the NWFP and recommends continued implementation of the NWFP and its standards and guides (USDI FWS 2011b, p. I-1).

Spotted Owl Recovery Units

The 2011 Final Revised Recovery Plan for the Northern Spotted Owl determined that the 12 existing physiographic provinces meet the criteria for use as recovery units (USDI FWS 2011b, p. III 1-2). Recovery criteria, as described in the 2011 Final Revised Recovery Plan (p. 11-3), are measurable and achievable goals that are believed to result through implementation of the recovery actions described in the recovery plan. Achievement of the recovery criteria will take time and are intended to be measured over the life of the plan, not on a short-term basis. The criteria are the same for all 12 identified recovery units. The four recovery criterion are: 1) stable population trend, 2) adequate population distribution, 3) continued maintenance and recruitment of spotted owl habitat, and 4) post-delisting monitoring (USDI FWS 2011b, p III-3).

The 2011 Revised Recovery Plan for the Northern Spotted Owl (USDI FWS 2011b) contains 14 recovery actions that specifically address spotted owl habitat loss and degradation. Two actions of primary importance are recovery actions 10 and 32:

- Recovery Action 10: Conserve spotted owl sites and high value spotted owl habitat to provide additional demographic support to the spotted owl population. This action addresses both nesting/roosting and foraging habitat.
- Recovery Action 32: Because spotted owl recovery requires well distributed, older and more structurally complex multi-layered conifer forests on Federal and non-Federal lands across its range, land managers should work with the Service…to maintain and restore such habitat while allowing for other threats, such as fire and insects, to be addressed by restoration management actions. These high-quality spotted owl habitat stands are characterized as having large diameter trees, high amounts of canopy cover, and decadence components such as broken-topped live trees, mistletoe, cavities, large snags, and fallen trees. This action addresses nesting/roosting habitat.

Recovery actions 10 and 32 are implemented on reserved areas by the USFS and BLM through the NWFP and the Resource Management Plans (RMPs); these two regulatory actions are discussed in more detail in Section 6. The large reserve network created under the NWFP and RMPs facilitates implementation of recovery actions 10 and 32 by protection of current nesting/roosting and foraging habitat, protection of spotted owl nest sites, and allowing for recruitment of new spotted owl habitat. Through the section 7 consultation process, the Service reviews the management activities implemented under the NWFP and RMPs and provides technical assistance to the USFS and BLM in making activities within or outside of reserves consistent with recovery actions 10 and 32 to the extent consistent with other land management priorities. Nesting/roosting and foraging habitat associated with both recovery actions 10 and 32 may decrease in local areas, but over the larger area and time, habitat that is associated with these recovery actions is increasing and will continue to increase under both the NWFP and RMPs.

Conservation Efforts on Non-Federal Lands

Non-Federal lands contributed 3,149,700 ac (1,274,638 ha) to the total 12,103,700 ac (4,898,193 ha) of nesting/roosting habitat available for breeding spotted owls in 2012 (Davis et al. 2016, pp. 21-22). There are portions of the range where habitat on Federal lands is lacking or of low quality, or where there is little Federal ownership; State and private lands may be important to provide demographic support (pair or cluster protection) and habitat connectivity for spotted owl in key areas such as southwestern Washington, northwestern Oregon (potentially including parts of the Tillamook and Clatsop State Forests), and northeastern California (USDI FWS 2011b, p. III-51). Timber harvest on State and private lands in Washington, Oregon, and California is regulated by each State's forest practice rules. The level of spotted owl conservation included in each State's regulations varies. Furthermore, while recovery efforts for the spotted owl are primarily focused on Federal land, Recovery actions 14 in the 2011 Revised Recovery Plan centered on seeking partnership with non-Federal landowners to supplement Federal conservation efforts, including voluntary actions like Habitat Conservation Plans (HCPs) and Safe Harbor Agreements (SHAs). There are a total of 21 current conservation plans in these states, including 7 HCPs and 3 SHAs located in Washington, 2 HCPs and 5 SHAs in Oregon, and 2 HCPs and one SHA in California, with an additional SHA occurring in both Washington and Oregon.

U.S. Fish and Wildlife Habitat Conservation Plans and Safe Harbor Agreements

The purpose of the HCP and SHA process is to provide for the conservation of endangered and threatened species while at the same time authorizing the incidental take of those species. HCPs are required as part of an application for an incidental take permit. They describe the anticipated effects of the proposed taking; how those impacts will be minimized and mitigated; and how the HCP is to be funded among other things. The Secretary must issue the permit if statutory issuance criteria are met, including that the applicant will minimize and mitigate the effects of the taking to the maximum extent practicable, the taking will not jeopardize the continued existence of the species, and funding to implement the plan is assured. 16 U.S.C. 1539(a)(2)(B). In developing HCPs, people applying for incidental take permits describe measures designed to minimize and mitigate the effects of their actions and receive formal assurances from the Service that if they fulfill the conditions of the HCP, the Service will not require any additional or different management activities by the participants without their consent. SHAs are voluntary agreements between non-Federal property owners and the Service; in exchange for actions that contribute to the recovery of listed species on non-Federal lands, participating property owners may return the enrolled property to the baseline conditions that existed at the beginning of the SHA. Incidental Take Permits that result from both HCPs and SHAs are intended to allow non-Federal entities to undertake actions that incidentally "take" species protected under the Act.

HCPs are not required to have a net benefit and SHAs are designed to have a temporary net gain for spotted owls. Under these plans, timber harvest has continued, resulting in the loss of nesting/roosting, foraging, and dispersal habitat; we do not currently have an analysis of habitat loss on lands without conservation plans compared to habitat loss on lands covered by HCPs and SHAs. Although the HCPs do not provide a net conservation benefit to spotted owl, they provide mitigation for habitat loss or slow down habitat loss through the required conservation measures. SHAs do provide a net conservation benefit to the spotted owl, and both conservation plans eliminate uncertainty with respect to landowners' actions in spotted owl habitat, and provide the Service an opportunity to provide technical assistance to landowners in the development of conservation measures included in the agreements. Therefore, in this context, both HCPs and SHAs have contributed to the overall conservation of spotted owls.

In Washington, there are seven spotted owl-related HCPs currently in effect covering 2 million ac (80,9371 ha) of non-Federal lands, one of which covers Washington Department of Natural Resources (DNR) lands. These HCPs still allow timber harvest but are designed to retain some nesting habitat and or connectivity over the next few decades. There are four spotted owl related SHAs in Washington, with one including some lands in Oregon. The primary intent of SHAs is to maintain or create potential spotted owl habitat. In addition, there is a long-term habitat management agreement covering 13,000 ac (5,261 ha) in which authorization of take was provided through an incidental take statement (section 7) associated with a Federal land exchange (USDI FWS 2011b, p. A-15). While timber harvest and habitat loss continue on lands covered by these agreements, the plans retain some nesting/roosting habitat throughout the area or in strategic locations, and provide habitat connectivity. Overall, HCPs, and SHAs in Washington provide some protection to spotted owls and their habitat. However, nesting/roosting and foraging habitat continue to decline due to timber harvest on non-Federal lands in Washington.

In Oregon, there are two spotted owl-related HCPs currently in effect covering 210,400 ac

(85,146 ha) of non-Federal lands. These HCPs still allow timber harvest but are designed to retain some nesting habitat and or connectivity over the next few decades. There are two spotted owl related SHAs occurring in Oregon. One SHA is a Washington SHA that covered some Oregon lands. The other SHA is a programmatic SHA with the Oregon Department of Forestry with 13 landowners with 3,484 acres enrolled. The primary intent of SHAs is to maintain or create potential spotted owl habitat. Strategies employed in the programmatic Oregon Department of Forestry SHA include, maintaining existing suitable habitat, increase time between harvests to allow for habitat development, and to lightly to moderately thin younger forestry stands that are currently not habitat (to increase tree diameter and stand diversity) (USDI FWS 2011b, p. A-16). There are 4 additional SHAs in Oregon related to the Barred Owl Removal Experiment explained below in the barred owl section. While timber harvest and habitat loss continue on lands covered by these HCPs and SHAs in Oregon, the plans retain some nesting/roosting habitat throughout the area or in strategic locations and provide habitat connectivity. Overall, HCPs, and SHAs in Oregon provide some protection to spotted owls and their habitat. However, nesting/roosting and foraging habitat continue to decline due to timber harvest on non-Federal lands in Oregon.

In California, there are two spotted owl-related HCPs currently in effect covering 211,765 ac (85,698ha) of non-Federal lands. These HCPs still allow timber harvest but are designed to retain some nesting habitat and or connectivity over the next few decades. There is one spotted owl-related SHA in California. The primary intent of SHAs is to maintain or create potential spotted owl habitat. While timber harvest and habitat loss continue on lands covered by these agreements, the plans retain some nesting/roosting habitat throughout the area or in strategic locations, and provide habitat connectivity. Overall, HCPs, and SHAs in California provide some protection to spotted owls and their habitat. However, nesting/roosting and foraging habitat continue to decline due to timber harvest on non-Federal lands in California.

State Forest Practice Rules

The majority of spotted owl conservation is expected from Federal lands, but the Service's primary expectations for private lands are for their contributions to demographic support (pair or cluster protection) to Federal lands, or their connectivity with Federal lands. Timber harvest on State and private lands in Washington, Oregon, and California is regulated by each State's forest practice rules. The level of spotted owl conservation included in each State's regulations varies Each State's rules are described below.

Washington

The spotted owl was listed as endangered species in Washington State by the Washington Fish and Wildlife Commission in 1988 to prioritize conservation for the subspecies (WDFW 2017). Timber harvest on State and private lands in Washington is guided by a number of State laws and policies, except for Washington Department of Natural Resources (WDNR) lands that are covered by an HCP. The Washington State Environmental Policy Act (SEPA) requires analysis of environmental impacts and consideration of reasonable alternatives for actions proposed by the State. State timber harvest activities must also comply with the State Forest Practices Act (Chapter 76.09 RCW), which regulates all forest management activities in Washington. The management of State trust lands, specifically, is guided by the Forest Resource Plan, which was adopted by the Board of Natural Resources in 1992. Among other things, the policies of the Plan require the Washington DNR analyze and potentially modify the impacts of its activities on watersheds, wildlife habitat, special ecological features, wetlands, and other natural resources to maintain healthy forests for future generations.

In 1996, the State Forest Practices Board adopted rules (Washington Forest Practices Board 1996) that would contribute to conserving the spotted owl and its habitats on non-Federal lands. Adoption of the rules was based in part on recommendations from a Science Advisory Group that identified important non-Federal lands and recommended roles for those lands in spotted owl conservation (Hanson et al. 1993, pp. 11-15; Buchanan et al. 1994, p. ii). The 1996 rule package was developed by a stakeholder policy group and then reviewed and approved by the Forest Practices Board (Buchanan and Swedeen 2005, p. 9). The 1996 rules identified 10 landscapes, or Spotted Owl Special Emphasis Areas (SOSEAs) where owl protections on non-Federal lands would be emphasized. Protections provided under the State Environmental Policy Act for those portions of owl sites located beyond the boundaries of the SOSEAs were largely eliminated (Buchanan and Swedeen 2005, p. 7). The overarching policy goal of the Washington Forest Practices Rules is to complement the conservation strategy on Federal lands, and as such the SOSEAs are adjacent to Federal lands. The SOSEAs are designed to provide a larger landscape for demographic and dispersal support for northern spotted owls with the long-term goal of supporting a viable population of northern spotted owls in Washington.

The Forest Practices Rules for northern spotted owls can be described as containing three basic types of provisions: 1) regulations that apply outside SOSEAs, 2) a circle-based protection scheme for northern spotted owl sites inside SOSEAs (retain all suitable habitat within 0.7 mi (1 km) of site center and retain 40 percent of suitable habitat within 1.8 to 2.7 mi (2.9 to 4.3 km) radius of home range), and 3) landscape-level planning options for inside SOSEAs. To avoid disturbance of nesting northern spotted owls inside SOSEAs, the rules also include timing restrictions from March 1 to August 31 within 0.25 miles of a site center for several potentially disruptive activities (e.g., road construction). Forest practices rules outside the SOSEAs are designed to protect the immediate vicinity of northern spotted owl site centers during the nesting season (March 1 to August 31) by restricting harvest within the best 70 ac (28 ha) of habitat around the site center and requiring additional environmental analysis for permitting (of harvesting, road construction, or aerial application of pesticides), but outside the nesting season there are no owl-related protections outside SOSEAs that constrain harvest of suitable northern spotted owl habitat in spotted owl management circles (Buchanan and Swedeen 2005, p. 14).

Within SOSEAs, the rules were intended to maintain the viability of each northern spotted owl site center by establishing that enough suitable habitat should be maintained to protect the viability of owls associated with each northern spotted owl site center, or to provide for the goals established in Spotted Owl Special Emphasis Areas. Due to extensive timber harvest activities in the decades leading up to listing of the northern spotted owl, most northern spotted owl management circles centered on non-Federal lands have far less habitat than the viability threshold identified (see below) when the rule went into effect. Because the rules do not include provisions for restoration of habitat to achieve the viability threshold at northern spotted owl sites these circles remain far below those thresholds. For individual site centers, the habitat considered necessary to maintain viability is as follows: (a) all suitable northern spotted owl habitat within 0.7 mi (1.1 km) of each northern spotted owl site center; (b) at least 5,863 ac (2,373 ha) of suitable northern spotted owl habitat within of 2.7 mi (4.3 km) of a site center in the Hoh-Clearwater Spotted Owl Special Emphasis Area on the western Olympic Peninsula, and

(c) at least 2,605 ac (1,054 ha) of suitable northern spotted owl habitat within 1.8 mi (2.9 km) of a site center in all other Spotted Owl Special Emphasis Areas. At all sites within SOSEAs, any proposed harvest of suitable northern spotted owl habitat within a territorial owl circle (status 1, 2, or 3 in the Washington Department of Fish and Wildlife database) would be considered a "Class-IV special" and would trigger State Environmental Policy Act review; such activities would require a Class IV special forest practices permit and an environmental impact statement per the State Environmental Policy Act (Buchanan and Swedeen 2005, p. 15-16).

The Forest Practices Board in Washington has a long-standing relationship with the Service and collaborates extensively on owl conservation. The Service provided extensive technical assistance in the development of the Board's existing owl rules. The Board was recognized in the Revised Recovery Plan for the Northern Spotted Owl (USDI FWS 2011b) for its ongoing owl conservation efforts in Recovery Action 18 encouraged to continue to use its existing processes "to identify areas on non-Federal lands in Washington that can make strategic contributions to northern spotted owl conservation over time. The Service encourages timely completion of the Board's efforts and will be available to assist as necessary." The Board convened the Northern Spotted Owl Implementation Team (NSOIT) in 2010 to develop incentives for landowners to achieve conservation goals for northern spotted owls and to identify the temporal and spatial allocation of conservation efforts on non-Federal lands; a draft product is due to be completed in 2017. The NSOIT conducted a pilot project testing different thinning prescriptions in northern spotted owl habitat but the project has since been discontinued. These efforts underway have evolved over years of collaboration and are designed to change the dynamic away from fear and resistance to partnership and participation. The Service has and is providing funding to support the work of the NSOIT. Overall, State forest practice rules in Washington provide some protection to northern spotted owls and their habitat. However, nesting/roosting and foraging habitat continue to decline due to timber harvest on non-Federal lands in Washington.

Oregon

The northern spotted owl is listed as a threatened species in Oregon (ODFW 2017). The Oregon Fish and Wildlife Commission's long-term goal for species listed as threatened or endangered under the Oregon Endangered Species Act is to manage the species and their habitats so that the status of the species improves to a point where listing is no longer necessary. Timber harvest on non-Federal lands in Oregon is guided by the Forest Practices Act and Forest Practices Rules (ODF 2014). The Oregon Forest Practices Act restricts timber harvest within 70 ac (28 ha) core areas around sites occupied by an adult pair of northern spotted owls capable of breeding (as determined by recent protocol surveys), but it does not provide for protection of northern spotted owl habitat beyond these areas (ODF 2014, pp. 61-62). In general, no large-scale northern spotted owl habitat protection strategy or mechanism currently exists for non-Federal lands in Oregon.

State forests in particular are managed to achieve "greatest permanent value," considering economics, environmental, and cultural goals. Each State Forest has a Forest Management Plan that seeks to implement these ideals. Ultimately, the State's goal is to produce timber revenue and also provide for a range of habitats across ownerships. Specific policies and procedures have been adopted on State lands to protect and conserve the northern spotted owl and its habitat. The State Forests Division has an extensive survey program across all districts as part of annual harvest planning (approximately $1.4 million spent in 2016) and conducts density surveys on two districts. Division policy directs districts to avoid any harvest activity on State lands which results in less than 40% suitable habitat within the provincial home range of an owl or pair (a 1.2 – 1.5-mi (1.9- 2.4 km) radius circle centered on a nest site or activity center). Division policy also directs districts to avoid any harvest activity which results in less than 500 ac (202 ha) of suitable habitat within a 0.7-mi (1.1 km) radius (1000 ac (405 ha)) of a nest site or activity center. In addition, 30 percent of Oregon State forests must be managed for the development of "complex forest structure" and late-seral tree species, which could provide some level of conservation benefit for a number of wildlife species of concern, including the northern spotted owl (IEc 2012). Thirty percent of Oregon State forests must be managed for "complex forest structures" and late seral tree species, for the benefit of a number of wildlife species. The locations of these managed lands are based in part on locations of northern spotted owl nest sites. Within these areas, a variety of treatments are employed to promote complex habitat and species diversity. Overall, State forest practice rules in Oregon provide some protection to northern spotted owls and their habitat. However, nesting/roosting and foraging habitat continue to decline due to timber harvest on non-Federal lands in Oregon.

California

The northern spotted owl was listed as an endangered species under the California Endangered Species Act (CESA) in early 2016 (CDFW 2017). The incidental take of state-listed species is prohibited under the California Code of Regulations (783-783.8 and the California Fish and Game Code 2080 (CDFW 2016), unless permitted by an HCP. Forest management and forest practices on private lands in California, including harvesting for forest products or converting land to another use are regulated by the State under Division 4 of the Public Resources Code, and in accordance with the California Forest Practice Rules (CFPR)(California Code of Regulations, (CCR) Title 14, Sections 895-1115; CFPR)(CFPR 2017). The CFPR require surveys for northern spotted owls in nesting/roosting and foraging habitat and restrict timber harvest within 0.7–1.3 mi (1-2 km) of a northern spotted owl activity center. Under this framework, the California Department of Forestry and Fire Protection (CALFIRE) is the designated authority on forest management and forest practices on private lands in California.

All private land timber harvesting in California must be conducted in accordance with a site-specific Timber Harvest Plan (THP, for industrial timberlands) or Nonindustrial Timber Management Plan (NTMP, for non-industrial private timberland owners) that is submitted by the owner and is subject to administrative approval by the CALFIRE. The THP/NTMP must be prepared by a State-registered professional forester and must contain site-specific details on the quantity of timber involved, where and how it will be harvested, and the steps that will be taken to mitigate potential environmental damage. The THP/NTMP and CALFIRE's review process are recognized as the functional equivalent to the environmental review processes required under the California Environmental Quality Act of 1970 (CEQA). The CFPRs require surveys for northern spotted owls in suitable habitat and to provide protection around activity centers. Under the CFPRs, no THP or NTMP can be approved if it is likely to result in incidental take of federally listed species, unless the take is authorized by a Federal incidental take permit.

For private timber lands in California not covered by a HCP or SHA, the policy of the State with regard to the northern spotted owl and timber harvest can be characterized as one of "take avoidance," for which the Service (Arcata and Yreka Fish and Wildlife Offices) has recommended measures to avoid take of northern spotted owls, primarily through recommendations for habitat retention, timing of timber operations and survey procedures for northern spotted owls (described briefly below). The Director of CALFIRE is not authorized to approve any proposed THP or NTMP that would result in take of a federally-listed species, including the northern spotted owl, unless that taking is authorized under a Federal Incidental Take Permit (review process is outlined in 14 CCR 919.9 and 919.10). This latter point creates an incentive for private landowners to enter into HCPs or SHAs, or to implement take avoidance measures recommended by the USFWS.

Prior to 2000, the California Department of Fish and Wildlife (then, California Department of Fish and Game; CDFW) reviewed THPs and NTMPs to ensure that take of northern spotted owls was not likely to occur. From about 2000 until 2010, the Service assumed this role and reviewed THPs and NTMPs (hundreds per year) for northern spotted owl "take avoidance." From 2010, the Service and CALFIRE shared duties for northern spotted owl take avoidance review of THPs and NTMPs. Beginning in 2014, the northern spotted owl was listed as a candidate species for potential listing under the California Endangered Species Act; consequently, in 2014, CDFW began reviewing a small number of THPs and NTMPs annually for northern spotted owl take avoidance. On August 25, 2016, the California Fish and Game Commission recommended that the northern spotted owl be added to the State list of threatened and endangered animals. Regarding timber harvest on private lands in California after 2016, the Service, CALFIRE and CDFW have not formally discussed how the agencies will share reviewing duties for northern spotted owl take avoidance associated with THPs and NTMPs, but recommended habitat retention standards (i.e., Attachments A and B) and survey recommendations remain in effect. California is currently engaged in discussions with the Service addressing northern spotted owl use of post-fire landscapes currently lacking in the California Forest Practice Rules.

For timber harvest activities that occur on non-Federal lands (excluding California State Parks and lands covered under a HCP) within CAL FIRE's Coast Forest District (generally, within the range of the coast redwood), the Service (Arcata Fish and Wildlife Office) provided to CAL FIRE and foresters a document titled, Northern Spotted Owl Take Avoidance Analysis and Guidance for California Coast Forest District ("Attachment A"), dated March 15, 2011. In general, recommended habitat retention guidelines around known active northern spotted owl activity centers in include: (1) delineation of a 100 ac (40 ha) "Core Area" comprised of "nesting/roosting" habitat (defined in Attachment A), in which timber harvest does not occur; (2) retention of at least an additional 100 ac (40 ha) of "nesting/roosting" habitat within 0.7 mi (1.1 km) of an activity center; and (3) retention of at least 300 ac (121 ha) of "foraging" habitat (defined in Attachment A) within 0.7 mi (1.1 km) of an activity center.

For timber harvest activities that occur on non-Federal lands within CAL FIRE's Interior Forest District, the Service (Arcata and Yreka Fish and Wildlife Offices) provided to CAL FIRE and foresters a document titled, Attachment B: Take Avoidance Analysis-Interior, dated February 27, 2008. In general, recommended habitat retention guidelines around known active northern spotted owl activity centers in include: (1) no harvest within 1,000 ft (305 m) of an activity center; (2) within 0.5 mi (0.8 km) radius (502 ac (203 ha) of an activity center, retention of four habitat types (as defined in Attachment B), including at least 100 ac (40 ha) "high quality nesting/roosting" habitat, 150 ac (61 ha) of "nesting/roosting" habitat, 100 ac (40 ha) of "foraging" habitat and 50 ac (20 ha) "low-quality foraging habitat"; and (3) between 0.5 mi (0.8 km) and 1.3 mi (2 km) radius circles on an activity center (2896 ac (1172 ha)), retention of greater than 935 ac (378 ha) of habitat, including at least 655 ac (265 ha) foraging habitat and at least 280 ac (113 ha) low-quality foraging habitat. Overall, State forest practice rules in California provide some protection to northern spotted owls and their habitat. However, nesting/roosting and foraging habitat continue to decline due to timber harvest on non-Federal lands in California.

Conservation Measures to Address Barred Owls

The 2011 Revised Recovery Plan for the Northern Spotted Owl contains ten recovery actions specific to addressing the barred owl threat. These include the establishment of protocols to detect barred owls and document barred owl site status and reproduction (Recovery Action 24), and the design and implementation of large-scale control experiments to assess effects of barred owl removal on spotted owl site occupancy, reproduction, and survival (Recovery Action 29). The manner in which this set of ten Recovery Actions is expected to contribute to northern spotted owl recovery is presented in Figure A-2.

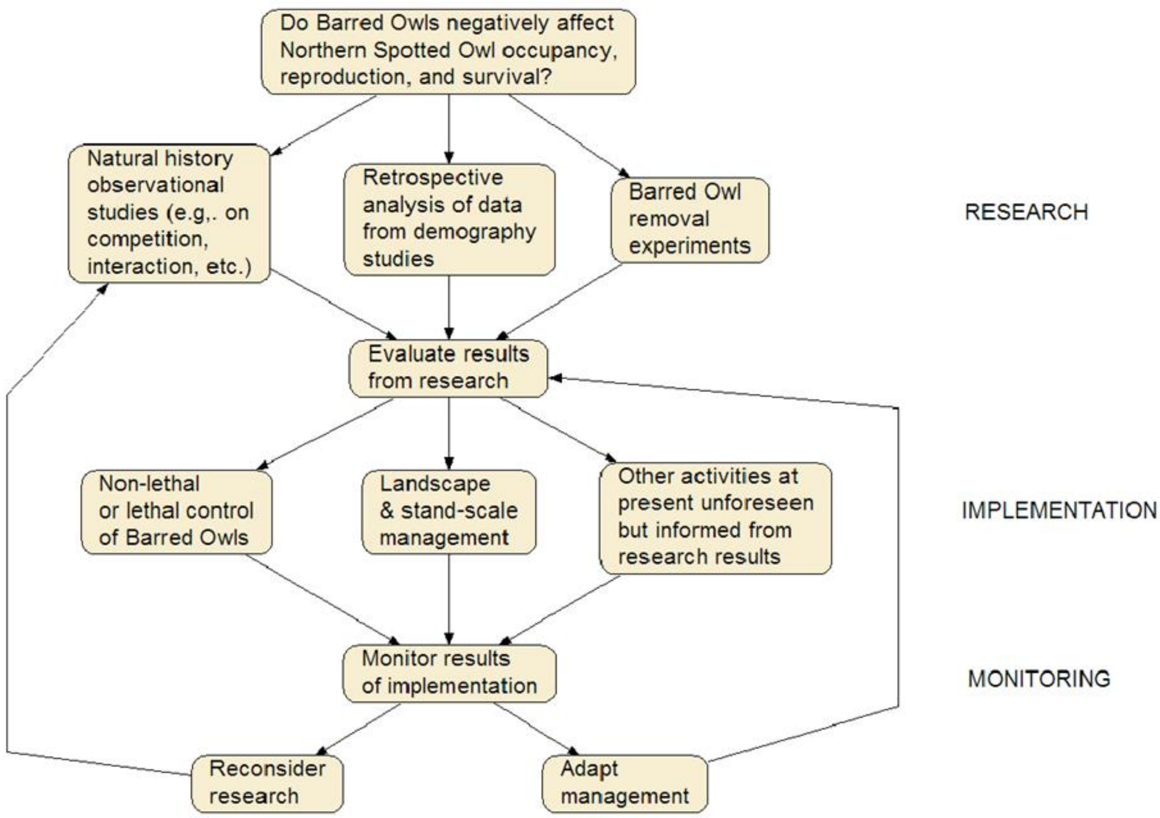

Figure A-2. Flowchart of barred owl Recovery Actions (USDI FWS 2011b, p. III-66, Figure III-1).

Several barred owl recovery actions have been completed, and recovery Action 29 is currently ongoing. The Barred Owl Removal Experiment (USDI FWS 2013 and 78 FR 57171) was developed based on a pilot project at Green Diamond Resources study area that demonstrated barred owl removal had rapid, positive effects on northern spotted owl survival and the rate of population change (Dugger et al. (2016, p. 58). This experiment is currently being implemented under the direction of USGS, the Hoopa Tribe, and APHIS in partnership with the Service. The research program is evaluating the effectiveness of barred owl removal as a potential recovery strategy for northern spotted owls on one study area in Washington, two study areas in Oregon, and one study area in northern California. Barred owl removal was implemented on the California study area in fall/winter 2013-2014, and on the Washington and one of the Oregon study areas in fall/winter 2015-2016. Barred owl removal on the final Oregon study area was initiated in fall of 2016. Removal was scheduled to occur for a minimum of four consecutive years at each study area, but could be extended if spotted owl population results from the initial removal are not definitive.

Under the BLM RMPs, the BLM will support barred owl management on their lands as informed by the outcome of the Barred Owl Removal Experiment. In the interim, the BLM is avoiding incidental take of northern spotted owls resulting from timber harvest on their lands. This support is intended to mitigate for the adverse effects associated with timber harvest and other resource programs, and result in a net positive impact on the recovery of northern spotted owls (USDI FWS 2016, p. 701).

Results from this experiment will provide future management guidance for the recovery of the northern spotted owl. Annual reports on study progress are provided each year, and a final report is anticipated in 2022. While results of the this experiment are not yet fully analyzed, removal has resulted in a substantial increase in the apparent survival of spotted owls on the Hoopa Reservation in California, the longest running of the study areas in the experiment, improving by nearly 10 percent over the apparent survival for the 5 years prior to the initiation of removal (Carlson et. al. 2019, p 9). On the three study areas in Oregon and Washington, the occupancy of spotted owl sites continues to decline on the control areas where no barred owls are removed, but appears to have stabilized or increased slightly on the treatment areas where barred owls are removed. However, the number of spotted owls on these areas is very low. Statistical analysis has not been completed on these areas yet (Wiens et. al. 2019, pp 12-13).

Safe Harbor Agreements in Oregon for Barred Owl Experiment

There are currently four SHAs specific to the Service's ongoing Barred Owl Removal Experiment in Oregon. The SHAs were limited to areas managed by landowners that were willing to work with the Service to provide access for survey and removal of barred owls on their lands within the study areas. Agreements were established with Roseburg Resources Company, Oxbow I LLC, Weyerhaeuser Company, and Oregon Department of Forestry to facilitate successful completion of this research project. The Barred Owl Removal Experiment implements Recovery Action 29 of the 2011 Revised Recovery Plan for the Northern Spotted Owl (USDI FWS 2011b, p. III-65). The Barred Owl Removal Experiment is being implemented on two study areas in Oregon, one in the Oregon Coast Ranges west of Eugene, Oregon, and one in the forest lands around Canyonville, Oregon. While the experiment is focused on Federal lands, the landscapes involved in the study areas include significant interspersed private and state lands. In the Oregon Coast Ranges study area, this includes lands owned by Roseburg Resources Company and Oxbow Timber I, LLC (SHA covers 9,400 ac (3,804 ha) of land total, 308 ac (125 ha) of currently unoccupied northern spotted owl habitat for which an incidental take permit was issued); Weyerhaeuser Company (SHA covers 1,072 ac (434 ha) total, 817 ac (331 ha) of currently unoccupied northern spotted owl habitat for which an incidental take permit was issued), and lands managed by Oregon Department of Forestry (SHA covers 20,000 ac (8,093 ha) total, 3,345 ac (1,354 ha) of currently unoccupied northern spotted owl habitat for which an incidental take permit was issued). In the Union/Myrtle (Klamath) study area in southern Oregon, this includes lands owned by Roseburg Resources Company (SHA covers 45,100 ac (18,251 ha) of land total, 7,080 ac (2865 ha) of currently unoccupied northern spotted owl habitat for which an incidental take permit was issued). Access on these non-Federal lands is important to the effective and efficient completion of the experiment.

Through these four SHAs, Roseburg Resources Company, Oxbow I LLC, Weyerhaeuser Company, and Oregon Department of Forestry will contribute to the conservation of the northern spotted owl by allowing the researchers to survey for barred owls on their lands throughout the Study Area, and remove barred owls from their lands within the removal portion of the experiment. The section 10 permit issued to them as part of the SHA provides these landowners with short-term incidental take authorization through habitat modification for spotted owls that may return to non-baseline northern spotted owl sites (unoccupied by resident spotted owls for the three years prior to the initiation of removal on the area) after the removal of barred owls. However, this information and access is crucial to efficient and effective implementation of this experiment. Information from this experiment is critical to the development of a long-term management strategy to address the barred owl threat to the northern spotted owl.

Rangewide Environmental Baseline

The environmental baseline of the species incorporates the effects of all past human activities and natural events that led to the present-day status of the species and its habitat, including all previously consulted on effects (USDI FWS/USDC NMFS 1998, pp. 4-19).

Habitat Trends

The Service has used information provided by the USFS, BLM, and National Park Service to update the habitat baseline conditions by tracking relative habitat changes over time on Federal lands for northern spotted owls on several occasions, since the northern spotted owl was listed in 1990 (USDA FS/USDI BLM 1994b, USDI FWS 2001, Lint 2005, Davis et al. 2011, Davis et al. 2016). These NWFP monitoring reports assess the status and trends of spotted owl habitat across 22.1 million acres of federally administered forest lands in addition to 23.8 million acres of nonfederal forest lands within the range in the United States. The estimate of 7.4 million acres used for the NWFP in 1994 (USDA FS/USDI BLM 1994b) was believed to be representative of the general amount of northern spotted owl habitat on NWFP lands at that time. These periodic rangewide evaluations of northern spotted owl habitat (Lint 2005, Davis et al. 2011, Davis et al. 2016) are used to determine if the rate of potential change to northern spotted owl habitat has been consistent with changes in amount of habitat anticipated under the NWFP and described in the Final Supplemental Environmental Impact Statement (FSEIS; USFS and USDI 1994b). Each analysis has used more up-to-date and higher quality data than the previous analyses and new analytical methods have been incorporated over time. While this improved the overall quality of the information provided, it also means that individual reports should not be compared directly without fully understanding the processes used to develop the results.

Trends for suitable habitat are largely declining rangewide, with rates of loss varying by province and land allocation. Approximately 9,089,700 acres of spotted owl nesting/roosting habitat existed on Federal lands and 3,436,000 acres existed on non-federal lands at the beginning of the NWFP in 1994/1996 Davis and others (2016, pp.23-24). Two decades into the

NWFP, Davis and others (2016, tables 6 and 7, pp. 21-22) reported a gross loss of about 650,200 acres of nesting/roosting habitat, representing about 7.2 percent of what was present in 1994/1996. Most of the losses (73 percent) occurred within the federally reserved LUAs, or a loss of about 7.5 percent of the habitat reserved by the NWFP; the majority of these losses were due to high severity fires within the Klamath Physiographic Provinces.

Some recruitment of nesting/roosting habitat was noted (Davis et al. 2016, p. 24). The recruitment of habitat in non-reserved areas led to a net increase in nesting/roosting habitat of 4.3 percent since 1993. Most of the gains occurred in the moister physiographic provinces (e.g., Coast Ranges and Western Cascades) however, there was also a large gain (13.5 percent) in the Oregon Eastern Cascades. Authors noted that habitat recruitment estimates have a higher level of uncertainty than estimates of habitat loss for reasons detailed in the NWFP 15-year monitoring report (Davis et al. 2011, pgs. 48 and 49). Although the spatial resolution of this new habitat map currently makes it unsuitable for tracking habitat effects at the scale of individual projects, the Service has evaluated the map for use in tracking provincial and rangewide habitat trends and now considers these data as the best available information on the distribution and abundance of extant spotted owl habitat within its range as of 2012 for Oregon and Washington, and California, when the base imagery was collected.

The Service also considers habitat effects that are documented through the section 7 consultation process since 1994. The analytical framework of these consultations focuses on the reserve and connectivity goals established by the NWFP land-use allocations (USDA FS/USDI BLM 1994a), with effects expressed in terms of changes in suitable northern spotted owl habitat within those land-use allocations.

In February 2013, the Service adopted the 2006/07 satellite imagery data on spotted owl habitat as the new rangewide habitat baseline for Federal lands which effectively resets the timeframe for establishing changes in the distribution and abundance of spotted owl habitat. These data were refreshed in May of 2017 to reflect the 2012 remotely sensed layer utilized in Davis et al., 2016. Until these data are refreshed, the assessment of local, provincial and rangewide spotted owl habitat status in this and future Opinions as well as Biological Assessments will rely on these habitat data associated with 2012 imagery to characterize changes in the status of spotted owl habitat.

<u>Service's Consultation Database</u>

To update information considered in 2001 (USDI FWS 2001), the Service designed the Consultation Effects Tracking System database in 2002, which recorded impacts to northern spotted owls and their habitat at different spatial and temporal scales. In 2011, the Service replaced the Consultation Effects Tracking System with the Consulted-on Effects Database located in the Service's Environmental Conservation Online System (ECOS). The ECOS Database corrected technical issues with the Consultation Effects Tracking System. Data are currently entered into the ECOS Database under various categories including; land management agency, land-use allocation, physiographic province, and type of habitat affected.

<u>Rangewide Consultation Effects: 1994 to May 16, 2017</u>

Between 1994 and May 16, 2017, the Service has consulted on the proposed removal/downgrade of approximately 212,940 acres of federal nesting/roosting habitats (Table A-1) or about 2.4 percent of the 9.09 million acres of northern spotted owl nesting/roosting habitat estimated by

Davis et al. (2016, p. 21) to have occurred on Federal lands in 1994. These changes in suitable northern spotted owl habitat are consistent with the expectations for implementation of the NWFP, which anticipated a rate of habitat harvested at 2.5 percent per decade (USDA FS/USDI BLM 1994a).

The Service also tracks habitat changes on non-NWFP lands through consultations including long-term Habitat Conservation Plans, Safe Harbor Agreements, or Tribal Forest Management Plans. Consultations conducted since 1994 have documented the eventual combined reduction of about 453,790 acres of habitat on non-NWFP lands. Most of the losses on non-NWFP lands have yet to be realized because they are part of long-term management plans.

In 2017, the Service updated the nesting /roosting habitat baseline which impacts are evaluated against, based on the 2012 habitat layer documented in Davis et al. (2016, p. 21) which is the most current evaluation of spotted owl habitat. The acre values for the Service's 2012 baseline in Table A-2 varies slightly from the acre values in Davis et al. (2016, p. 21), with the total acre variation being 0.09 percent. Davis et al. (2016, p. 21) rounded to the nearest 100 acres, but this does not explain all the variation. In 2016, the BLM in Oregon changed their land use allocations. Therefore, the 2012 base habitat layer was divided by different land use allocations representing reserves and non-reserved lands than was used to produce Davis et al. (2016, p. 21). Due to raster data (2012 habitat layer) overlaid on polygons (land use allocations representing reserves and non-reserved lands) there is some error in the identification of acres. The use of a different polygon layer, than used for the Davis et al. (2016, p. 21) land use allocations, resulted in different physiographic province reserves and non-reserved lands habitat acres. The combination of errors is extremely small and is still the best available information to use. This highlights that this data is to be used at a landscape level and may not be appropriate at the finer local scale. Since 2012, the acres reported as removed/downgraded are summarized by origin and by province (Table A-2).

Table A-1: Spotted owl Take/Effect Reports Table A - Rangewide summary of effects to northern spotted owl nesting/roosting habitat1 (acres) documented through ESA section 7 consultations or technical assistance reports; 1994 to Present.

May 16 11:33:42 MDT 2017

Land Ownership	Consulted On Habitat Changes[2]		Other Habitat Changes[3]	
	Removed/ Downgraded	Maintained/ Improved	Removed/ Downgraded	Maintained/ Improved
USFS, BLM, and NPS	212,941	565,037	276,009	97,181
Bureau of Indian Affairs / Tribes	114,099	28,372	2,398	0
Habitat Conservation Plans/Safe Harbor Agreements	339,692	14,539	N/A	N/A
Other Federal, State, County, Private Lands	68,813	28,447	2,392	0
Total Changes	**735,545**	**636,395**	**280,799**	**97,181**

Notes:

1. Northern spotted owl suitable habitat includes nesting/roosting habitat, and foraging habitat. Nesting/roosting habitat supports all life-history functions for spotted owls including foraging, and is sometimes referred to as nesting, roosting, and foraging habitat (NRF). Foraging-only habitat is a separate category that can include more open and fragmented forests, and does not provide structures for nesting/roosting. Habitat effects summarized in this table are all classified as impacts to nesting/roosting habitats. Impacts to foraging-only habitat are tracked separately.
2. Includes effects documented through ESA section 7 consultations for the period from 1994 to 6/26/2001 (USFWS 2001) and all subsequent effects reported in the USFWS Tracking and Integrated Logging System - Northern Spotted Owl Consultation Effects Database (web application and database).
3. Includes effects to spotted owl nesting/roosting habitat documented through technical assistance reports resulting from wildfires and other natural causes, private timber harvest, and/or land exchanges not associated with ESA section 7 consultations.

Table A-2. Spotted owl Take/Effect Reports Table B - Summary of northern spotted owl nesting/roosting1 habitat (acres) removed or downgraded as documented through ESA section 7 consultations on Federal lands. Environmental baseline and summary of effects by state, province, and land use function from 2012 to present. Tue May 16 11:37:48 MDT 2017

State	Physiographic Province2	Evaluation Baseline (2012)[3]			Nesting/Roosting Habitat Removed/Downgraded[4]							% Provincial Baseline Affected	% Range-wide Effects
					Land Management Effects			Habitat Loss from Natural Events			Total NR removed/ downgraded		
		NR Acres in Reserves	NR Acres in Non-Reserves	Total NR Acres	Reserves[5]	Non-Reserves[6]	Total	Reserves	Non-Reserves	Total			
WA	Eastern Cascades	554,786	224,876	779,662	276	2	278	3,895	0	3,895	4,173	0.54	5.62
	Olympic Peninsula	554,786	224,876	779,662	0	0	0	0	0	0	0	0	0
	Western Cascades	957,314	212,325	1,169,639	15	46	61	0	0	0	61	0.01	0.08
	Western Lowlands	12,964	3	12,967	0	0	0	0	0	0	0	0	0
OR	Cascades East	206,719	133,080	339,799	945	2,393	3,338	0	453	453	3,791	1.12	5.11
	Cascades West	1,425,026	949,045	2,374,071	639	6,781	7,420	761	1,775	2,536	9,956	0.42	13.41
	Coast Range	468,575	38,898	507,473	567	1,112	1,679	0	0	0	1,679	0.33	2.26
	Klamath Mountains	706,840	227,726	934,566	1,692	3,536	5,228	5,736	3,891	9,627	14,855	1.59	20.01
	Willamette Valley	3,688	3,938	7,626	0	0	0	0	0	0	0	0	0
CA	Cascades	120,067	89,316	209,383	0	67	67	0	0	0	67	0.03	0.09
	Coast	113,857	9,999	123,856	0	0	0	0	2,193	2,193	2,193	1.77	2.95
	Klamath	1,143,050	622,027	1,765,077	242	418	660	15,528	21,277	36,805	37,465	2.12	50.46
Total		**6,267,672**	**2,736,109**	**9,003,781**	**4,376**	**14,355**	**18,731**	**25,920**	**29,589**	**55,509**	**74,240**	**0.82**	**100**

Notes:

1. Northern spotted owl suitable habitat includes nesting/roosting habitat, and foraging habitat. Nesting/roosting habitat supports all life-history functions for spotted owls including foraging, and is sometimes referred to as nesting, roosting, and foraging habitat (NRF). Foraging-only habitat is a separate category that can include more open and fragmented forests and does not provide structures for nesting/roosting. Habitat effects summarized in this table are all classified as impacts to nesting/roosting habitat. Impacts to foraging-only habitat are tracked separately.
2. Defined in the Revised Recovery Plan for the Northern Spotted Owl (USFWS 2011) as Recovery Units as depicted on page A-3.
3. Spotted owl nesting/roosting (NR) habitat on Federal lands (includes USFS, BLM, NPS, DoD, USFWS) based on GIS data developed for the Northwest Forest Plan 20-year monitoring report for northern spotted owl habitat as reported by Davis et al. 2016 (PNW-GTR-929). Nesting/roosting habitat acres are approximate values based on 2012 satellite imagery. Values reported here may vary slightly from values reported in PNW-GTR-929.
4. Estimated nesting/roosting habitat removed or downgraded from land management (e.g., timber sales) or natural events (e.g., wildfires) as documented through section 7 consultation or technical assistance. Effects reported here include acres removed or downgraded from 2012 to present.
5. Reserve land use allocations intended to provide spotted owl demographic support include Late-Successional Reserves identified in the Northwest Forest Plan on National Forests, designated Wilderness, and other Congressionally reserved lands. Reserves on BLM lands in western Oregon managed under the 2016 revised Land and Resource Management Plans include Late-Successional Reserves, Congressionally reserved lands, National Landscape Conservation System lands, and some District Designated Reserves (e.g., Areas of Critical Environmental Concern).
6. Non-reserve lands intended to provide spotted owl dispersal connectivity between reserves include USFS and BLM designations for timber production (matrix and harvest land base designations), Adaptive Management Areas, and other non-reserved land use designations.

Recently, the Service modified the database input to account for effects to the habitats that could be used as foraging, but that lack the age or structural characteristics of habitats used for nesting and roosting (NR). This distinction may not be made in all consultations. These data represent effects as reported in individual consultations and likely do not represent the entirety of impacts to foraging habitat within critical habitat since 2012. For many projects, affected foraging likely is captured within the "NR" acres as foraging habitat was lumped into "nesting/roosting/foraging habitat" at the time of consultation. Table A-3 summarizes the acres of foraging habitat removed or downgraded.

Table A-3. Spotted owl Take/Effect Reports Table B2 - Summary of northern spotted owl foraging habitat1 (acres) removed or downgraded as documented through ESA section 7 consultations on Federal lands. Summary of effects by state, province, and land use function from 2012 to present.

Tue May 16 11:43:36 MDT 2017

State	Physiographic Province[2]	Foraging Habitat Removed/Downgraded[3]						
		Land Management Effects			Habitat Loss from Natural Events			Total Foraging Habitat removed/ downgraded
		Reserves[4]	Non-Reserves[5]	Total	Reserves	Non-Reserves	Total	
WA	Eastern Cascades	0	0	0	0	0	0	0
	Olympic Peninsula	0	0	0	0	0	0	0
	Western Cascades	0	0	0	0	0	0	0
	Western Lowlands	0	0	0	0	0	0	0
OR	Cascades East	0	0	0	0	62	62	62
	Cascades West	0	481	481	0	0	0	481
	Coast Range	0	1,772	1,772	0	0	0	1,772
	Klamath Mountains	0	1,586	1,586	0	0	0	1,586
	Willamette Valley	0	0	0	0	0	0	0
CA	Cascades	473	179	652	0	0	0	652
	Coast	0	1	1	0	1,034	1,034	1,035
	Klamath	1,454	286	1,740	8,558	8,480	17,038	18,778
Total		**1,927**	**4,305**	**6,232**	**8,558**	**9,576**	**18,134**	**24,366**

Notes:

1. Northern spotted owl suitable habitat includes nesting/roosting habitat, and foraging habitat. Nesting/roosting habitat supports all life-history functions for spotted owls including foraging, and is sometimes referred to as nesting, roosting, and foraging habitat (NRF). Foraging-only habitat is a separate category that can include more open and fragmented forests and does not provide structures for nesting/roosting. Habitat effects summarized in this table are all classified as impacts to nesting/roosting habitat. Impacts to foraging-only habitat are tracked separately.
2. Defined in the Revised Recovery Plan for the Northern Spotted Owl (USFWS 2011) as Recovery Units as depicted on page A-3.
3. Spotted owl nesting/roosting (NR) habitat on Federal lands (includes USFS, BLM, NPS, DoD, USFWS) based on GIS data developed for the Northwest Forest Plan 20-year monitoring report for northern spotted owl habitat as reported by Davis et al. 2016 (PNW-GTR-929). Nesting/roosting habitat acres are approximate values based on 2012 satellite imagery. Values reported here may vary slightly from values reported in PNW-GTR-929. Estimated nesting/roosting habitat removed or downgraded from land management (e.g., timber sales) or natural events (e.g., wildfires) as

documented through section 7 consultation or technical assistance. Effects reported here include acres removed or downgraded from 2012 to present.

4. Reserve land use allocations intended to provide spotted owl demographic support include Late-Successional Reserves identified in the Northwest Forest Plan on National Forests, designated Wilderness, and other Congressionally reserved lands. Reserves on BLM lands in western Oregon managed under the 2016 revised Land and Resource Management Plans include Late-Successional Reserves, Congressionally reserved lands, National Landscape Conservation System lands, and some District Designated Reserves (e.g., Areas of Critical Environmental Concern).
5. Non-reserve lands intended to provide spotted owl dispersal connectivity between reserves include USFS and BLM designations for timber production (matrix and harvest land base designations), Adaptive Management Areas, and other non-reserved land use designations.

<u>Other Past Habitat Trend Assessments</u>

In 2005, the Washington Department of Wildlife released the report, “An Assessment of Spotted Owl Habitat on Non-Federal Lands in Washington between 1996 and 2004” (Pierce et al. 2005). This study estimates the amount of spotted owl habitat in 2004 on lands affected by state and private forest practices. The study area is a subset of the total Washington forest practice lands, and statistically based estimates of existing habitat and habitat loss due to fire and timber harvest are provided. In the 3.2 million-acre study area, Pierce et al. (2005) estimated there was 816,000 acres of suitable spotted owl habitat in 2004, or about 25 percent of their study area. Based on their results, Pierce et al. (2005) estimated there were less than 2.8 million acres of spotted owl habitat in Washington on all ownerships in 2004. Most of the suitable owl habitat in 2004 (56%) occurred on Federal lands, and lesser amounts were present on state-local lands (21%), private lands (22%) and tribal lands (1%). Most of the harvested spotted owl habitat was on private (77%) and state-local (15%) lands. A total of 172,000 acres of timber harvest occurred in the 3.2 million-acre study area, including harvest of 56,400 acres of suitable spotted owl habitat. This represented a loss of about 6 percent of the owl habitat in the study area distributed across all ownerships (Pierce et al. 2005). Approximately 77 percent of the harvested habitat occurred on private lands and about 15 percent occurred on State lands. Pierce and others (2005) also evaluated suitable habitat levels in 450 spotted owl management circles (based on the provincial annual median spotted owl home range). Across their study area, they found that owl circles averaged about 26 percent suitable habitat in the circle across all landscapes. Values in the study ranged from an average of 7 percent in southwest Washington to an average of 31 percent in the east Cascades, suggesting that many owl territories in Washington are significantly below the 40 percent suitable habitat threshold used by the State as a viability indicator for spotted owl territories (Pierce et al. 2005).

Moeur et al. 2005 estimated an increase of approximately 1.25 to 1.5 million acres of medium and large older forest (greater than 20 inches dbh, single and multi-storied canopies) on Federal lands in the NWFP area between 1994 and 2003. The increase occurred primarily in the lower end of the diameter range for older forest. In the greater than 30-inch dbh size class, the net area increased by only an estimated 102,000 to 127,000 acres (Moeur et al. 2005). The estimates were based on change-detection layers for losses due to harvest and fire and re-measured inventory plot data for increases due to ingrowth. Transition into and out of medium and large older forest over the 10-year period was extrapolated from inventory plot data on a subpopulation of Forest Service land types and applied to all Federal lands. Because size class and general canopy layer descriptions do not necessarily account for the complex forest structure often associated with northern spotted owl habitat, the significance of these acres to northern spotted owl conservation remains unknown.

Population Trends

There are no estimates of the historical population size and distribution of spotted owls, although they are believed to have inhabited most old-growth forests throughout the Pacific Northwest prior to modern settlement (mid-1800s), including northwestern California (USDI FWS 1989, pp. 2-17).

The current range of the spotted owl extends from southwest British Columbia through the Cascade Mountains, coastal ranges, and intervening forested lands in Washington, Oregon, and California, as far south as Marin County (USDI FWS 1990a, p. 26114). The range of the spotted owl is partitioned into 12 physiographic provinces (Figure A-1) based on recognized landscape subdivisions exhibiting different physical and environmental features (USDI FWS 1992a, p. 31). The spotted owl has become rare in certain areas, such as British Columbia, southwestern Washington, and the northern coastal ranges of Oregon.

Because the existing survey coverage and effort are insufficient to produce reliable rangewide estimates of population size, demographic data are used to evaluate trends in spotted owl populations. Analysis of demographic data can provide an estimate of the finite rate of population change (λ), which provides information on the direction and magnitude of population change. A λ of 1.0 indicates a stationary population, meaning the population is neither increasing nor decreasing. A λ of less than 1.0 indicates a decreasing population, and a λ of greater than 1.0 indicates a growing population. Demographic data, derived from studies initiated as early as 1985, have been analyzed periodically to estimate trends in the populations of the spotted owl (Anderson and Burnham 1992; Burnham et al. 1994; Forsman et al. 1996; Anthony et al. 2006; Forsman et al. 2011; Dugger et al. 2016).

The most recent meta-analysis (Dugger et al. 2016) found continued declines in virtually all demographic parameters evaluated (Table A-4). Estimates of annual rates of population change, occupancy rates, and realized population change showed continuing declines across the range, and that the annual rate of decline was increasing in many areas, including southern Oregon and northern California. With the exception of treatment areas the Green Diamond Study Area (GDR-T) where removal of barred owls was initiated in 2009, Dugger et al. (2016, p. 70) reported that the populations in all study areas were declining, including those study areas that had been relatively stable in earlier analyses. Notably, the rate of realized population change for northern spotted owls in Cle Elum and the Olympic Peninsula demographic study areas in Washington showed a 60-70 percent decline over the past two decades. Lower rates were observed in the Oregon and California study areas where the realized rate of population change has shown a decline of 31-64 percent over the past two decades; the confidence intervals for some of the estimates of rate of population change slightly overlap zero, the results indicated a significant negative time trend at seven of the eleven study areas (Dugger et al. 2016, p. 70). These findings indicate that these populations are declining over time and the rate of decline is increasing.

The probability of occupancy has declined in all three states over the past two decades. Dugger et al. (2016, pp. 73-74); reported that occupancy rates in Washington declined from a range of 56 to100 percent in 1995, to a range of 11 to 26 percent in 2013. During this same time period, occupancy rates in Oregon declined from a range of 61 to 88 percent in 1995, to a range of 28 to

48 percent in 2013. In California, occupancy rates declined from a range of approximately 42 to 92 percent in 1993, to a range of 38 to 55 percent in 2013. This 2016 analysis was the first rangewide assessment of northern spotted owl population status to include estimates of occupancy dynamics (i.e. proportion of northern spotted owl territories occupied by a resident single or pair in a given year compared to the total number of territories surveyed), which revealed that territory occupancy of northern spotted owls has declined substantially in all 11 study areas since the early 1990s (Dugger et al. 2016, p. 79). The lowest occupancy rates were observed in 2013 (the final year included in this study) in the Oregon Coast Ranges Study Area (28 percent) and at the 3 study areas in Washington (Olympic, Cle Elum, Rainier).

Two methods of estimating populations have been described - records of known sites and population modeling. As of July 1, 1994, there were 5,431 known site-centers of spotted owl pairs or resident singles: 851 sites (16 percent) in Washington, 2,893 sites (53 percent) in Oregon, and 1,687 sites (31 percent) in California (USDI FWS 1995, p. 9495). The actual number of currently occupied spotted owl locations across the range is unknown because many areas remain unsurveyed (USDI FWS 2011b, p. A-2). In addition, many historical sites are no longer occupied because spotted owls have been displaced by barred owls, timber harvest, or severe fires, and it is possible that some new sites have been established due to reduced timber harvest on Federal lands since 1994. The totals above represent the cumulative number of locations recorded in the three states, not population estimates. Estimated populations were modeled during the 2012 critical habitat designation which projected a steady state, rangewide population size of roughly 3,400 female northern spotted owls. Population sizes varied regionally from low in the north, especially the northwest (e.g., about 100 in the North Coast Olympics and West Cascades North modeling regions), to high in parts of southern Oregon and northern California (e.g. about 750 each in the Inner California Coast, Klamath East, Klamath West, Redwood Coast, and West Cascades South modeling regions) (Dunk et al., 2012, p. 64). These estimates likely over represent the numbers of females as this modeling effort does not reflect rates of declines from 2008 - 2011 (as described in Dugger et al. 2016). Additionally, the actual number of currently occupied spotted owl locations across the range is unknown because many areas remain un-surveyed (USDI FWS 2011a, p. A-2) and many historical sites are no longer occupied because spotted owls have been displaced by barred owls, timber harvest, or severe fires. Other factors such as impacts of anticoagulant rodenticides have likely negatively affected localized spotted owl populations (Gabriel et al. 2018, p. 6). Another unmeasured factor might include the possibility that some new sites have been established due to reduced timber harvest on Federal lands since 1994.

Table A-4. Summary of most recent spotted owl population trends from in demographic study areas in Washington, Oregon, and California 1985-2013 (Derived from Dugger et al. 2016, Tables 2, 4 and 25).

Study Area [a]	Fecundity	Apparent Survival	Occupancy Rates	Lamda	Mean Lamda	% Pop Size
Washington						
CLE	Declining	Declining	Declining	No trend	0.916	–77%
RAI	No trend	Declining	Declining	No trend	0.953	–61%
OLY	No trend	No trend	Declining	No trend	0.961	–59%
Oregon						
COA	Declining	No trend	Declining	Declining	0.949	–64%
HJA	Declining	Declining	Declining	Declining	0.965	–47%
TYE	Declining	Declining	Declining	Declining	0.976	–31%
KLA	Declining	No trend	Declining	Declining	0.972	–34%
CAS	No trend	Declining	Declining	No trend	0.963	–44%
California						
NWC	Declining	Declining	Declining	Declining	0.970	–55%
HUP	Declining	Declining	Declining	Declining	0.977	–32%
GDR-CB	Declining	Declining	Declining	Declining	0.988	–31%
GDR-TB	Declining	Declining	Declining	Declining	0.961	–26%
GDR-CA	**	**	Declining	**	0.878	–41%
GDR-TA	**	**	N/A [c]	**	1.030	–9%

[c] Data used for occupancy modeling in the GDR study area excluded treatment areas after Barred Owl removals began in 2009.

** Too few years since Barred Owl removal to evaluate a trend.

In the northern-most portion of the range in British Columbia, few spotted owls are remaining. Chutter et al. (2004, p. v) suggested immediate action was required to improve the likelihood of recovering the spotted owl population in British Columbia. In 2007, personnel in British Columbia captured and brought into captivity the remaining 16 known wild spotted owls (USDI FWS 2011b, p. A-6). Prior to initiating the captive-breeding program, the population of spotted owls in Canada was declining by as much as 10.4 percent per year (Chutter et al. 2004, p. v). As of 2016, this program was comprised of 17 spotted owls, eight of which were born in captivity (British Columbia 2017, p. 1). The program is targeted produce annually up to 20 captive-born owls ready for release back into the wild until the population reaches 200; the first year of release expected to occur in the spring of 2018. The amount of previous interaction between spotted owls in Canada and the United States is unknown.

SPOTTED OWL CRITICAL HABITAT

Legal Status

The final rule designating critical habitat for the northern spotted owl was published on December 4, 2012 (USDI FWS 2012a) and became effective on January 3, 2013. Critical habitat for the northern spotted owl now includes approximately 9,577,969 acres in 11 units and 60 subunits in California, Oregon, and Washington.

Designation of critical habitat serves to identify those lands that are necessary for the conservation and recovery of the listed species. In this case, the Service's primary objective in designating critical habitat was to identify capable and existing essential northern spotted owl habitat and highlight specific areas where management of the northern spotted owl and its habitat should be given highest priority. The expectation of critical habitat is to ameliorate habitat-based threats. The recovery of the northern spotted owl requires habitat conservation in concert with the implementation of recovery actions that address other, non-habitat-based threats to the species, including the barred owl (USDI FWS 2012a, p. 71879). The conservation role of northern spotted owl critical habitat is to "adequately support the life-history needs of the species to the extent that well-distributed and inter-connected northern spotted owl nesting populations are likely to persist within properly functioning ecosystems at the critical habitat unit and range-wide scales" (USDI FWS 2012a, p. 71938). The specific conservation roles of the subunits included in the action area are described below in the Environmental Baseline.

Physical or Biological Features and Primary Biological Factors

When designating critical habitat, the Service considers "the physical or biological factors [PBFs] essential to the conservation of the species and which may require special management considerations or protection" (50 CFR §424.12; USDI FWS 2012a, p. 71897). "These include, but are not limited to: (1) space for individual and population growth and for normal behavior; (2) food, water, air, light, minerals, or other nutritional or physiological requirements; (3) cover or shelter; (4) sites for breeding, reproduction, or rearing (or development) of offspring; and (5) habitats that are protected from disturbance or are representative of the historical, geographical, and ecological distributions of a species" (USDI FWS 2012a, p. 71897). The final critical habitat rule states that "for the northern spotted owl, the physical or biological features essential to the conservation of the species are forested areas that are used or likely to be used for nesting, roosting, foraging, or dispersing" (USDI FWS 2012a, p. 71897). The final critical habitat rule for the northern spotted owl provides an in-depth discussion of the PBFs, which may be referenced for further detail (USDI FWS 2012a, pp. 71897-71906).

The final rule for critical habitat defines the PCEs (PBFs) as the specific elements of the critical habitat that are considered essential to the conservation of the northern spotted owl and are those elements that make areas suitable as nesting, roosting, foraging, and dispersal habitat (USDI FWS 2012a, p. 71904). The PPFs should be arranged spatially such that it is favorable to the persistence of populations, survival, and reproductive success of resident pairs, and survival of dispersing individuals until they are able to recruit into a breeding population (USDI FWS 2012a, p. 71904). Within areas essential for the conservation and recovery of the northern spotted owl, the Service has determined that the PBFs are:

- i) Forest types that may be in early-, mid-, or late-seral stages and that support the northern spotted owl across its geographic range;
- ii) Habitat that provides for nesting and roosting;
- iii) Habitat that provides for foraging;
- iv) Habitat to support the transience and colonization phases of dispersal, which in all cases would optimally be composed of nesting, roosting, or foraging habitat (PBFs 2 or 3), but which may also be composed of other forest types that occur between larger blocks of nesting, roosting, or foraging habitat (USDI FWS 2012, pp. 72051-72052).

In 2016, the Service returned to the use of statutory reference of PBFs when evaluating and discussing the availability and function of, as well as the effects to the attributes of critical habitat in the adverse modification analysis (USDI FWS and USDC NOAA 2016, p. 2716). Some critical habitat subunits may contain all of the PBFs and support multiple life history requirements of the northern spotted owl, while some subunits may contain only those PBFs necessary to support the species particular use of that habitat. All of the areas designated as critical habitat, however, do contain PCE 1, forest type. As described in the final rule, PCE 1 always occurs in concert with at least one other PCE (PCE 2, 3, or 4; USDI FWS 2012a, p. 72051). Northern spotted owl critical habitat does not include meadows, grasslands, oak woodlands, aspen woodlands, or manmade structures and the land upon which they are located (USDI FWS 2012a, p. 71918).

PBF 1: Forest Types

The primary forest types that support the northern spotted owl are: Sitka spruce, western hemlock, mixed conifer, mixed evergreen, grand fir, Pacific silver fir, Douglas-fir, white fir, Shasta red fir, redwood/Douglas-fir, and moister ponderosa pine (USDI FWS 2012a, p. 72051).

PBF 2: Nesting and Roosting Habitat

Nesting and roosting habitat habitats provide structural features for nesting, protection from adverse weather conditions, and cover to reduce predation risk for adults and young. Unlike foraging habitat, structural conditions of nesting roosting habitats do not vary much across the range. The final rule describes characteristics associated with nesting and roosting habitats sufficient for foraging by territorial pairs, moderate to high canopy cover (60 to over 80 percent), multilayered and multispecies canopies with large overstory trees (20 to 30 inches dbh), basal area greater than 240 square feet per acre, high diversity of tree diameters, high incidence of large live trees with various deformities (e.g., large cavities, broken tops, mistletoe infections, and other evidence of decadence), large snags and large accumulations of woody debris on the ground, and sufficient open space beneath the canopy for flight (USDI FWS 2012a, p. 72051). Nesting and roosting habitats will also function as foraging and dispersal habitat (FWS 2012a, p. 71884).

PBF 3: Foraging Habitat

Foraging habitat varies across the range, depending upon ecological conditions and disturbance regimes that influence vegetation structure and prey species distributions. Across most of the owl's range, nesting and roosting habitat is also foraging habitat, but in some regions (particularly in the southern portion of the range) northern spotted owls may additionally use other habitat types for foraging as well (differences in foraging habitats between ecological provinces are discussed below).

PBF 4: Dispersal Habitat

Northern spotted owl dispersal habitat is habitat that supports the transience and colonization phases of owl dispersal, and in all cases would optimally be composed of nesting, roosting, or foraging habitat (PCE 2 or 3), but which may also be composed of other forest types that occur between larger blocks of northern spotted owl nesting, roosting, or foraging habitat. In cases where nesting, roosting, or foraging habitats are insufficient to provide for dispersing or nonbreeding owls, the specific dispersal PCEs are: habitat supporting transience phase of dispersal (protection from avian predators, minimal foraging opportunities, younger and less diverse forests that provide some roosting structures and foraging opportunities) and habitat supporting the colonization phase of dispersal (nesting, roosting, and foraging habitat but in smaller amounts than needed to support a nesting pair) (USDI FWS 2012a, p. 72052).

Zones of Habitat Associations used by Northern Spotted Owls

Differences in patterns of habitat associations used by the northern spotted owl across its range suggest four different broad zones of habitat use, which we characterize as the (1) West Cascades/Coast Ranges of Oregon and Washington, (2) East Cascades, (3) Klamath and Northern California Interior Coast Ranges, and (4) Redwood Coast (Figure A-3). We configured these zones based on a qualitative assessment of similarity among ecological conditions and habitat associations within the 11 different regions analyzed during the critical habitat designation process (see USDI FWS 2012a). These four zones capture the range in variation of some of the PBFs essential to the conservation of the northern spotted owl. Habitat modeling indicates that vegetation structure has a dominant influence on owl population performance, with habitat pattern and topography also contributing. High canopy cover, high density of large trees, high numbers of sub-canopy vegetation layers, and low to moderate slope positions are all important features. Summarized below are the PBFs for each of these four zones, emphasizing zone-specific features that are distinctive within the context of general patterns that apply across the entire range of the northern spotted owl.

West Cascades/ Coast Range of Oregon and Washington - This zone includes five regions west of the Cascade crest in Washington and Oregon (Western Cascades North, Central and South; North Coast Ranges and Olympic Peninsula; and Oregon Coast Ranges; USDI FWS 2011b, p. C–13). Climate in this zone is characterized by high rainfall and cool to moderate temperatures. Variation in elevation between valley bottoms and ridges is relatively low in the Coast Ranges, creating conditions favorable for development of contiguous forests. In contrast, the Olympic and Cascade ranges have greater topographic variation with many high-elevation areas supporting permanent snowfields and glaciers. Douglas-fir and western hemlock dominate forests used by northern spotted owls in this zone. Root diseases and wind-throw are important natural disturbance mechanisms that form gaps in forested areas. Flying squirrels (*Glaucomys sabrinus*) are the dominant prey, with voles and mice also representing important items in the northern spotted owl's diet.

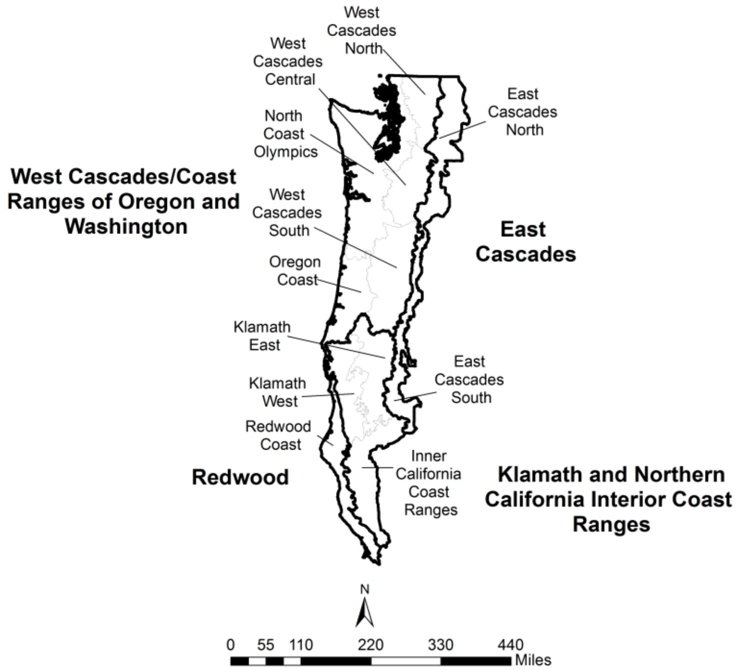

Figure A-3. Regions and zones of habitat associations used by northern spotted owls in Washington, Oregon, and California.

West Cascade/Coast Ranges of Oregon and Washington - Nesting habitat in this zone is mostly limited to areas with large trees with defects such as mistletoe brooms, cavities, or broken tops. The subset of foraging habitat that is not nesting/roosting habitat generally had slightly lower values than nesting habitat for canopy cover, tree size and density, and canopy layering. Prey species (primarily the northern flying squirrel) in this zone are associated with mature to late-successional forests, resulting in small differences between nesting, roosting, and foraging habitats.

East Cascades -This zone includes the Eastern Cascades North and Eastern Cascades South regions (USDI FWS 2011b, p. C–13). This zone is characterized by a continental climate (cold, snowy winters and dry summers) and a high frequency of natural disturbance due to fires and outbreaks of forest insects and pathogens. Flying squirrels are the dominant prey species, but the diet of northern spotted owls in this zone also includes relatively large proportions of bushy-tailed woodrats (*Neotoma cinerea*), snowshoe hare (*Lepus americanus*), pika (*Ochotona princeps*), and mice (*Microtus spp*. (Forsman et al. 2001, pp. 144–145).

Our modeling indicates that habitat associations in this zone do not show a pattern of dominant influence by one or a few variables (USDI FWS 2011b, Appendix C). Instead, habitat association models for this zone included a large number of variables, each making a relatively modest contribution (20 percent or less) to the predictive ability of the model. The features that were most useful in predicting northern spotted owl habitat quality were vegetation structure and composition, and topography, especially slope position in the north. Other efforts to model habitat associations in this zone have yielded similar results (e.g., Garm et al. 2010, pp. 2048–2050; Loehle et al. 2011, pp. 25–28).

Relative to other portions of the northern spotted owls' range, nesting and roosting habitat in this zone includes relatively younger and smaller trees, likely reflecting the common usage of dwarf mistletoe (*Arceuthobium douglasii*) brooms (dense growths) as nesting platforms (especially in the north). Forest composition that includes high proportions of Douglas-fir is also associated with this nesting structure. Additional foraging habitat in this zone generally resembles nesting and roosting habitat, with reduced canopy cover and tree size, and reduced canopy layering. High prey diversity suggests relatively diverse foraging habitats are used. Topographic position was an important variable, particularly in the north, possibly reflecting competition from barred owls (Singleton et al. 2010, pp. 289, 292). Barred owls, which have been present for over 30 years in the northern portions of this zone, preferentially occupy valley-bottom habitats, possibly compelling northern spotted owls to establish territories on less productive, mid-slope locations (Singleton et al. 2010, pp. 289, 292).

Klamath and Northern California Interior Coast Ranges - This zone includes the Klamath West, Klamath East, and Interior California Coast regions (USDI FWS 2011b, p. C–13). This region in southwestern Oregon and northwestern California is characterized by very high climatic and vegetative diversity resulting from steep gradients of elevation, dissected topography, and large differences in moisture from west to east. Summer temperatures are high, and northern spotted owls occur at elevations up to 5,800 feet. The western portions of this zone support a diverse mix of mesic forest communities interspersed with drier forest types. Forests of mixed conifers and evergreen hardwoods are typical of the zone. The eastern portions of this zone have a Mediterranean climate with increased occurrence of the ponderosa pine. Douglas-fir/dwarf mistletoe is rarely used for nesting platforms in the western part of the northern spotted owl's range, but is commonly used in the east.

The prey base for northern spotted owls in this zone is correspondingly diverse, but dominated by dusky-footed woodrats, bushy-tailed woodrats, and flying squirrels. Northern spotted owls have been well studied in the western Klamath portion of this zone (Forsman et al. 2004, p. 217), but relatively little is known about northern spotted owl habitat use in the eastern portion and the California Interior Coast Range portion of the zone.

Our habitat association models for this zone suggest that vegetation structure and topographic features are nearly equally important in influencing owl population performance, particularly in the Klamath. High canopy cover, high levels of canopy layering, and the presence of very large dominant trees were all important features of nesting and roosting habitat. Compared to other zones, additional foraging habitat for this zone showed greater divergence from nesting habitat, with much lower canopy cover and tree size. Low to intermediate slope positions were strongly favored. In the eastern Klamath, the presence of Douglas-fir was an important compositional variable in our habitat model (USDI FWS 2011b, Appendix C).

Redwood Zone - This zone is confined to the northern California coast, and is represented by the Redwood Coast region (USDI FWS 2011b, p. C–13). It is characterized by a maritime climate with moderate temperatures and generally mesic conditions. Near the coast, frequent fog delivers consistent moisture during the summer. Terrain is typically low-lying (0 to 3,000 feet). Forest communities are dominated by redwood, Douglas-fir–tanoak (*Lithocarpus densiflorus*) forest, coast live oak (*Quercus agrifolia*), and tanoak series. Dusky footed woodrats are the dominant prey items for northern spotted owls in this zone.

Habitat association models for this zone diverged strongly from models for other zones. Topographic variables (slope position and curvature) had a dominant influence with vegetation structure having a secondary role. Low position on slopes was strongly favored, along with concave landforms.

Several studies of northern spotted owl habitat relationships suggest that stump-sprouting and rapid growth of redwood trees, combined with high availability of woodrats in patchy, intensively managed forests, enables northern spotted owls to occupy a wide range of vegetation conditions within the redwood zone. Rapid growth rates enable young stands to develop structural characteristics typical of older stands in other regions. Thus, relatively small patches of large remnant trees can also provide nesting habitat structure in this zone.

Climate Change and Range-wide Spotted Owl Critical Habitat

There is growing evidence that recent climate change has impacted a wide range of ecological systems (Stenseth et al. 2002, entire; Walther et al. 2002, entire; Ådahl et al. 2006, entire; Karl et al. 2009, entire; Moritz et al. 2012, entire; Westerling et al. 2011, p. S459; Marlon et al. 2012, p. E541). Climate change, combined with effects from past management practices, is exacerbating changes in forest ecosystem processes and dynamics to a greater degree than originally anticipated under the NWFP. Environmental variation affects all wildlife populations; however, climate change presents new challenges as systems may change beyond historical ranges of variability. In some areas, changes in weather and climate may result in major shifts in vegetation communities that can persist in particular regions. (See expanded discussion in environmental baseline section above).

Climate change will present unique challenges to the future of northern spotted owl populations and their habitats. Northern spotted owl distributions (Carroll 2010, entire) and population dynamics (Franklin et al. 2000, entire; Glenn et al. 2010, entire; Glenn et al. 2011a, entire) may be directly influenced by changes in temperature and precipitation. In addition, changes in forest composition and structure as well as prey species distributions and abundance resulting from climate change may impact availability of habitat across the historical range of the subspecies. The *2011 Northern Spotted Owl Revised Recovery Plan* provides a detailed discussion of the possible environmental impacts to the habitat of the northern spotted owl from the projected effects of climate change (USDI FWS 2011b, pp. III-5 to III-11).

Because both northern spotted owl population dynamics and forest conditions are likely to be influenced by large-scale changes in climate in the future, we have attempted to account for these influences in our designation of critical habitat by recognizing that forest composition may change beyond the range of historical variation, and that climate changes may have unpredictable consequences for both Pacific Northwest forests and northern spotted owls. Our critical habitat designation also recognizes that forest management practices that promote ecosystem health under changing climate conditions will be important for northern spotted owl conservation.

Current Condition of Range-Wide Critical Habitat

The current condition of critical habitat incorporates the effects of all past human activities and natural events that led to the present-day status of the habitat (USDI FWS/USDC NMFS 1998, pg. 4-19). With the revision of spotted owl critical habitat, the rangewide condition has been "reset" as of December 4, 2012.

The Service updated the ECOS database to reflect the 2006/2007 habitat baseline developed for the NWFP 15-year monitoring report (Davis et al. 2011, Appendix D, Table D). Additional updates were made in May of 2017 to reflect 2012 imagery utilized in the 20-year NWFP monitoring report (Davis et al. 2016).

The Service's ECOS database indicates that as of May 16, 2017, approximately 4.89 million acres nesting/roosting (NR) habitat occur within the rangewide 9.577 million acres of spotted owl critical habitat (Table A-5, baseline data). Since the imagery date of 2012, an estimated 25,350 acres of NR habitat in critical habitat have been removed or downgraded range-wide (about .26 percent of the available nesting/roosting). The majority of these impacts originated in the Washington East Cascades, Oregon West Cascades and the Oregon and California Klamath Physiographic Provinces. Rangewide, about 15,080 acres were associated with natural disturbances, and about 10,300 were associated with land management actions.

Table A-5. Spotted owl Take/Effect Reports Table D - Designated northern spotted owl critical habitat. Summary of northern spotted owl nesting/roosting1 habitat (acres) removed or downgraded as documented through ESA section 7 consultations. Summary of effects by state, province, and land use function from 2012 to present.

Tue May 16 11:47:11 MDT 2017

Physiographic Province[2]		Evaluation Baseline		Nesting/Roosting Habitat Removed/Downgraded[5]							% Provincial Baseline Affected	% Range-wide Effects
				Land Management Effects			Habitat Loss from Natural Events			Total NR Acres Removed		
		Total Designated Critical Habitat Acres[3]	Nesting/Roosting Acres[4]	Reserves[6]	Non-Reserves[7]	Total	Reserves	Non-Reserves	Total			
WA	Eastern Cascades	1,022,960	467,221	265	2	267	3,895	0	3,895	4,162	0.89	16.42
	Olympic Peninsula	507,165	211,373	0	0	0	0	0	0	0	0.00	0.00
	Western Cascades	1,387,567	606,093	15	43	58	0	0	0	58	0.01	0.23
OR	Cascades East	529,652	187,798	893	1,460	2,353	0	0	0	2,353	1.25	9.28
	Cascades West	1,965,407	1,255,027	596	3,103	3,699	662	0	662	4,361	0.35	17.20
	Coast Range	1,151,874	483,846	1	695	696	0	0	0	696	0.14	2.75
	Klamath Mountains	911,681	542,119	1,324	1,152	2,476	1,476	1,535	3,011	5,487	1.01	21.64
CA	Cascades	243,205	97,248	0	67	67	0	0	0	67	0.07	0.26
	Coast	149,044	94,033	0	0	0	0	2,018	2,018	2,018	2.15	7.96
	Klamath	1,708,787	945,505	242	412	654	5,192	303	5,495	6,149	0.65	24.26
Total		**9,577,342**	**4,890,263**	**3,336**	**6,934**	**10,270**	**11,225**	**3,856**	**15,081**	**25,351**	**0.26%**	**100%**

Notes:

1. Northern spotted owl suitable habitat includes nesting/roosting habitat, and foraging-only habitat. Nesting/roosting habitat supports all life-history functions for spotted owls including foraging, and is sometimes referred to as nesting, roosting, and foraging habitat. Foraging-only habitat is a separate category that can include more open and fragmented forests and does not provide structures for nesting/roosting. Habitat effects summarized in this table are all classified as impacts to nesting/roosting habitats. Impacts to foraging-only habitat are tracked separately.
2. Defined in the Revised Recovery Plan for the Northern Spotted Owl (USFWS 2011a) as Recovery Units as depicted on page A-3.
3. Northern spotted owl critical habitat as designated December 4, 2012 (77 FR 71876). Total designated critical habitat acres listed here (9,577,342 acres) are derived from GIS data, and vary slightly from the total acres (9,577,969 acres) listed in the Federal Register (-627 acres).
4. Spotted owl nesting/roosting (NR) habitat based on GIS data developed for the Northwest Forest Plan 20-year monitoring report by Davis et al. 2016 (PNW-GTR-929). NR habitat acres are approximate values based on 2012 satellite imagery.
5. Estimated nesting/roosting habitat removed or downgraded from land management (e.g., timber sales) or natural events (e.g., wildfires) as documented through section 7 consultation or technical assistance. Effects reported here include acres removed or downgraded from 2012 to present.
6. Reserve land use allocations intended to provide spotted owl demographic support include Late-Successional Reserves identified in the Northwest Forest Plan on National Forests, designated Wilderness, and other Congressionally reserved lands. Reserves on BLM lands in western Oregon managed under the 2016 revised Land and Resource Management Plans include Late-Successional Reserves, Congressionally reserved lands, National Landscape Conservation System lands, and some District Designated Reserves (e.g., Areas of Critical Environmental Concern).
7. Non-reserve lands intended to provide spotted owl dispersal connectivity between reserves include USFS and BLM designations for timber production (matrix and harvest land base designations), Adaptive Management Areas, and other non-reserved land use designations.

Recently, the Service modified the ECOS database input to account for effects to the habitats that could be used as foraging, but that lack the age or structural characteristics of habitats used for nesting and roosting. This distinction may not be made in all consultations. These data represent effects as reported in individual consultations and likely do not represent the entirety of impacts to foraging habitat within critical habitat since 2012. For many projects, affected foraging likely is captured within the NR acres as foraging habitat was lumped into “nesting/roosting/foraging habitat” at the time of consultation. Trends to date mirror impacts reported by Davis et al. 2016, where habitat reductions are disproportionally affecting reserved lands and the Oregon and Klamath Province (Table A-6).

Table A-6: Spotted owl Take/Effect Reports Table D2 - Designated northern spotted owl critical habitat. Summary of northern spotted owl foraging habitat1 (acres) removed or downgraded as documented through ESA section 7 consultations. Summary of effects by state, province, and land use function from 2012 to present. Tue May 16 11:50:46 MDT 2017

	Physiographic Province[2]	Foraging Habitat Removed/Downgraded[4]							
		Total Designated Critical Habitat Acres[3]	Land Management Effects			Habitat Loss from Natural Events			Total Foraging Habitat removed/ downgraded
			Reserves[5]	Non-Reserves[6]	Total	Reserves[5]	Non-Reserves[6]	Total	
WA	Eastern Cascades	1,022,960	0	0	0	0	0	0	0
	Olympic Peninsula	507,165	0	0	0	0	0	0	0
	Western Cascades	1,387,567	0	0	0	0	0	0	0
OR	Cascades East	529,652	0	0	0	0	0	0	0
	Cascades West	1,965,407	0	63	63	0	0	0	63
	Coast Range	1,151,874	0	441	441	0	0	0	441
	Klamath Mountains	911,681	0	736	736	0	0	0	736
CA	Cascades	243,205	0	60	60	0	0	0	60
	Coast	149,044	0	1	1	0	870	870	871
	Klamath	1,708,787	1,449	272	1,721	5,996	259	6,255	7,976
Total		**9,577,342**	**1,449**	**1,573**	**3,022**	**5,996**	**1,129**	**7,125**	**10,147**

Notes:

1. Northern spotted owl suitable habitat includes nesting/roosting habitat, and foraging-only habitat. Nesting/roosting habitat supports all life-history functions for spotted owls including foraging, and is sometimes referred to as nesting, roosting, and foraging habitat. Foraging-only habitat is a separate category that can include more open and fragmented forests and does not provide structures for nesting/roosting. Habitat effects summarized in this table are all classified as impacts to foraging-only habitat. Impacts to nesting/roosting habitat are tracked separately. Environmental baseline information for foraging habitat as a separate habitat category is not available at a provincial scale.
2. Defined in the Revised Recovery Plan for the Northern Spotted Owl (USFWS 2011) as Recovery Units as depicted on page A-3.
3. Northern spotted owl critical habitat as designated December 4, 2012 (77 FR 71876). Total designated critical habitat acres listed here (9,577,342 acres) are derived from GIS data, and vary slightly from the total acres (9,577,969 acres) listed in the Federal Register (-627 acres).
4. Estimated foraging-only habitat removed or downgraded from land management (e.g., timber sales) or natural events (e.g., wildfires) as documented through ESA section 7 consultations or technical assistance. Effects reported here include acres removed or downgraded from 2012 to present.
5. Reserve land use allocations intended to provide spotted owl demographic support include Late-Successional Reserves identified in the Northwest Forest Plan on National Forests, designated Wilderness, and other Congressionally reserved lands. Reserves on BLM lands in western Oregon managed under the 2016 revised Land and Resource Management Plans include Late-Successional Reserves, Congressionally reserved lands, National Landscape Conservation System lands, and some District Designated Reserves (e.g., Areas of Critical Environmental Concern).
6. Non-reserve lands intended to provide spotted owl dispersal connectivity between reserves include USFS and BLM designations for timber production (matrix and harvest land base designations), Adaptive Management Areas, and other non-reserved land use designations.

Literature Cited

Ådahl, E., P. Lundberg, N.Jonzén et al. 2006. From climate change to population change: the need to consider annual life cycles. Global Change Biology. [Abstract] V. 12(9), pp. 1627-1633.

Ager, A., N. Vaillant, M. Finney, and H. Preisler. 2012. Analyzing wildfire exposure and source-sink relationships on a fire prone forest landscape. Forest Ecology and Management 267 (2012) 271-283.

Anderson, David E. and K.P. Burnham. 1992. Evidence that Northern Spotted Owl populations are declining, Part II. In USDI FWS 1992a, Draft Recovery Plan for the northern spotted owl, Appendix C.

Anthony, R.G., and L.S. Andrews. 2004. Summary Report – Winter habitat use by spotted owls on USDI Bureau of Land Management Medford District Lands within the boundaries of the Timbered Rock Fire. Unpublished report, OCWRU, OSU, Corvallis, Oregon. 29 pages.

Anthony, R.G., E.D. Forsman, A.B. Franklin, D.R. Anderson, K.P. Burnham, G.C. White, C.J. Schwarz, J. Nichols, J.E. Hines, G.S. Olson, S.H. Ackers, S. Andrews, B.L. Biswell, P.C. Carlson, L.V. Diller, K.M. Dugger, K.E. Fehring, T.L. Fleming, R.P. Gerhardt, S.A. Gremel, R.J. Gutiérrez, P.J. Happe, D.R. Herter, J.M. Higley, R.B. Horn, L.L. Irwin, P.J. Loschl, J.A. Reid, and S.G. Sovern. 2006. Status and trends in demography of northern spotted owls, 1985-2003. Wildlife Mongraph No. 163.

Bailey, L.L., J.A. Reid, E.D. Forsman, and J.D. Nichols. 2009. Modeling co-occurrence of northern spotted and barred owls: accounting for detection probability differences. Biological Conservation. 142: 2983-2989.

Baker, W.L. 2015. Historical Northern spotted owl habitat and old-growth dry forests maintained by mixed-severity wildfires Landscape Ecology (2015) 30:655–666.

Baker, W.L. 2017. Restoring and managing low-severity fire in dry-forest landscapes of the western USA. PLoS ONE 12(2): e0172288. 28 pp.

Barrowclough, G. F. and R. J. Gutiérrez. 1990. Genetic variation and differentiation in the spotted owl. Auk 107:737-744.

Barrowclough, G.F., R.J. Gutiérrez, and J.G. Groth. 1999. Phylogeography of spotted owl (Strix occidentalis) populations based on mitochondrial DNA sequences; gene flow, genetic structure, and a novel biogeographic pattern. Evolution 53(3):919-931.

Barrowclough, G.F., J.G. Groth, and R.J. Gutiérrez. 2005. Genetic structure, introgression and a narrow hybrid zone between northern and California spotted owls (Strix occidentalis). Molecular Ecology 14:1109–1120.

Barrows, C.W., and K. Barrows. 1978. Roost characteristics and behavioral thermoregulation in the spotted owl. Western Birds 9:1-8.

Barrows, C.W. 1981. Roost selection by Spotted Owls: an adaptation to heat stress. Condor 83: 302-309.

Bart, J. 1995. Amount of suitable habitat and viability of northern spotted owls. Conservation Biology 9 (4):943-946.

Bart J. and E. Forsman. 1992. Dependence of northern spotted owls (Strix occidentalis caurina) on old-growth forests in the western USA. Biological Conservation 1992: 95-100.

Bingham, B.B., and B.R. Noon. 1997. Mitigation of habitat "take": Application to habitat conservation planning. Conservation Biology 11 (1):127-138.

Blakesley, J.A., W. LaHaye, J.M.M. Marzluff, B.R. Noon, and S. Courtney. 2004. Scientific evaluation of the status of the northern spotted owl – demography. Chapter 8 In: Courtney, S.P., J.A. Blakesley, R.E. Bigley, M.L. Cody, J.P. Dumbacher, R.C. Fleischer, A.B. Franklin, J.F. Franklin, R.J. Gutiérrez, J.M. Marzluff, L. Sztukowski. *In* 2004. Scientific evaluation of the status of the northern spotted owl. Sustainable Ecosystems Institute. Portland, Oregon. September 2004.

Blakesley, J.A., D. R. Anderson, and B. R. Noon. 2006. Breeding dispersal in the California spotted owl. The Condor, Vol. 108, No. 1:71-81.

Bond, M.L., R.J. Gutierrez, A.B. Franklin, W.S. LaHaye, C.A. May, and M.E. Seamans. 2002. Short-term effects of wildfires on spotted owl survival, site fidelity, mate fidelity, and reproductive success. Wildlife Society Bulletin 30(4):1022-1028.

Bond, M.L., D.E. Lee, R.B. Siegel, and J.P. Ward, Jr. 2009. Habitat use and selection by spotted owls in a postfire landscape. Journal of Wildlife Management 73(7):1116-1124.

Bond, M.L., C. Bradley, and D.E. Lee. 2016. Foraging habitat selection by California spotted owls after Fire. The Journal of Wildlife Management; Vol. 80, Issue 7, pp. 1290–1300.

Buchanan, J.B., L.L. Irwin, and E.L. McCutchen. 1995. Within-stand nest site selection by spotted owls in the eastern Washington Cascades. Journal of Wildlife Management 59:301-310.

Buchanan, J.B. 2004. Managing habitat for dispersing northern spotted owls - are the current management strategies adequate? Wildlife Society Bulletin 32:1333–1345.

Buchanan, J.B. and P. Swedeen. 2005. Final briefing report to the Washington State Forest Practices Board regarding spotted owl status and forest practices rules. Washington Department of Fish and Wildlife, Olympia. 84 pp.

Burnham, K.P., D.R. Anderson, and G.C. White. 1994. Estimation of vital rates of the northern spotted owl. Colorado Cooperative Fish and Wildlife Research Unit, Colorado State University, Fort Collins, Colorado, USA.

Burt, W.H. 1943. Territoriality and home range concepts as applied to mammals. Journal of Mammalogy 24:346-352.

British Columbia. 2017. Northern Spotted Owl Recovery & Breeding Program. Website. http://www2.gov.bc.ca/gov/content/environment/plants-animals-ecosystems/species-ecosystems-at-risk/implementation/conservation-projects-partnerships/northern-spotted-owl. Accessed June 1, 2017.

Caffrey, C. 2003. Determining impacts of West Nile Virus on crows and other birds. American Birds (103rd Count) 57:14-21.

Caffrey, C. and C.C. Peterson. 2003. West Nile Virus may not be a conservation issue in northeastern United States. American Birds (103rd Count) 57:14-21.

CFPR (California Forest Practices Rules). 2017. Title 14, California Code of Regulations, Chapters 4, 4.5, and 10. Sacramento, CA. Available online: http://calfire.ca.gov/resource_mgt/downloads/2017%20Forest%20Practice%20Rules%20and%20Act.pdf

Campbell, N. A. 1990. Biology. The Benjamin/Cummings Publishing Company, Inc. Redwood City, California.

Carey, A.B., J.A. Reid, and S.P. Horton. 1990. Spotted owl home range and habitat use in southern Oregon coast ranges. Journal of Wildlife Management 54:11–17.

Carey, A. B., S. P. Horton, and B. L. Biswell. 1992. Northern spotted owls: influence of prey base and landscape character. Ecological Monographs 62: 223-250.

Carey, A.B. and K.C. Peeler. 1995. Spotted owls: resource and space use in mosaic landscapes. Journal of Raptor Research 29(4):223-229.

Carlson, P.C., J.M. Higley, and A.B. Franklin. 2019. Barred Owl Experimental Removal: Hoopa/Willow Creek Study Area NSO Demographic Report, 11 June 2019. Pp. 1-10.

Carroll, Carlos. 2010. Role of climatic niche models in focal-species-based conservation planning: assessing potential effects of climate change on Northern Spotted Owl in the Pacific. Biological Conservation. Volume 143, Issue 6, June 2010, Pp. 1432–1437.

Carsia, R. V., and S. Harvey. 2000. Adrenals. Chapter 19 in G. C. Whittow, editor. Sturkie's Avian Physiology. Academic Press, San Diego, California.

CEPA (California Environmental Protection Agency). 2017. Cannabis Cultivation Regulatory and Enforcement Unit. Environmental Harm from Cannabis Cultivation. http://www.waterboards.ca.gov/water_issues/programs/enforcement/cannabis_enforcement.shtml. Accessed February 16, 2017. 4 pp.

CDFW (California Department of Fish and Wildlife). 2016. Report to the Fish and Game Commission a status review of the northern spotted owl (Strix occidentalis caurina) in

California. Charlton H. Bonham, Director, California Department of Fish and Wildlife, January 27, 2016. i-229. 238 pp.

CDFW (California Department of Fish and Wildlife). 2017. Special Animals List- Natural Diversity Database. Periodic publication. 51 pp. Available online: https://www.wildlife.ca.gov/Conservation/SSC/Mammals

Chutter, M.J., I. Blackburn, D. Bonin, J. Buchanan, B. Costanzo, D. Cunnington, A. Harestad, T. Hayes, D. Heppner, L. Kiss, J. Surgenor, W. Wall, L. Waterhouse, and L. Williams. 2004. Recovery strategy for the northern spotted owl (Strix occidentalis caurina) in British Columbia. British Columbia Ministry of Environment, Victoria. 74 pp.

Clark D.A. 2007. Demography and habitat selection of northern spotted owls in post-fire landscapes of Southwestern Oregon. M.S. Thesis. Oregon State University. 218 pp.

Clark D.A., R.G. Anthony, and L.S. Andrews. 2011. Survival rates of northern spotted owls in post-fire landscapes of Southwest Oregon. Journal of Raptor Research, 45(1):38-47. 2011.

Clark D.A., R.G. Anthony, and L.S. Andrews. 2013. Relationship between wildfire, salvage logging, and occupancy of nesting territories by northern spotted owls. The Journal of Wildlife Management 77(4):672–688; 2013.

Comfort, E.J. 2014. Trade-offs between management for fire risk reduction and northern spotted owl habitat protection in the dry conifer forests of Southern Oregon. PhD. Dissertation; Oregon State University, Corvallis, OR.

Courtney, S.P. and R.J. Gutiérrez. 2004. Scientific evaluation of the status of the northern spotted owl – threats. In: Courtney, S.P., J.A. Blakesley, R.E. Bigley, M.L. Cody, J.P. Dumbacher, R.C. Fleischer, A.B. Franklin, J.F. Franklin, R.J. Gutiérrez, J.M. Marzluff, L. Sztukowski. 2004. Scientific evaluation of the status of the northern spotted owl. Sustainable Ecosystems Institute. Portland, Oregon. September 2004.

Crozier, Michelle L., Mark E. Seamans, R. J. Gutiérrez, Peter J. Loschl, Robert B. Horn, Stan G. Sovern and Eric D. Forsman. 2006. Does the presence of barred owls suppress the calling behavior of spotted owls? In The Condor 108: 260-269. The Cooper Ornithological Society 2006.

Dale, V.H, L.A. Joyce, S. McNulty, R.P. Neilson, M.P. Ayres, M.D. Flannigan, P.J. Hanson, L.C. Irland, A.E. Lugo, C.J. Peterson, D. Simberloff, F.J. Swanson, B.J. Stocks, and B.M. Wotton. 2001. Climate change and forest disturbances. BioScience 51: 723–734.

Dark, S.J., R.J. Gutiérrez, and G.I. Gould, Jr. 1998. The barred owl (*Strix varia*) invasion in California. The Auk. 115(1): 50-56.

Davis, R. J., K. M. Dugger, S. Mohoric, L. Evers, and W. C. Aney. 2011. Northwest Forest Plan—The first 15 years (1994–2008): Status and trends of Northern Spotted Owl populations and habitats. USDA Forest Service General Technical Report PNW-GTR-850.

Davis, Raymond J.; Hollen, Bruce; Hobson, Jeremy; Gower, Julia E.; Keenum, David. 2016. Northwest Forest Plan—the first 20 years (1994–2013): status and trends of northern spotted owl habitats. Gen. Tech. Rep. PNW-GTR-929. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 54 p.

Davidson, J.M., A.C. Wickland, H.A. Patterson, K.R. Falk, and D.M. Rizzo. 2005. Transmission of *Phytophthora ramorum* in mixed-evergreen forest in California. Ecology and Epidemiology. 95(5)587-596.

Delaney, D. K., T. G. Grubb, P. Beier, L. L. Pater, and M. H. Reiser. 1999. Effects of helicopter noise on Mexican spotted owls. Journal of Wildlife Management 63:60-76.

Deubel, V., L. Fiette, P. Gounon, M.T. Drouet, H. Khun, M. Huerre, C. Banet, M. Malkinson, and P. Despres. 2001. Variations in biological features of West Nile viruses. Annals of the New York Academy of Sciences 951:195-206.

Diller, L.V. and D.M. Thome. 1999. Population density of northern spotted owls in managed young-growth forests in coastal northern California. Journal of Raptor Research 33: 275–286.

Diller, L.V., K.A, Hamm, D.E. Early, D.W. Lamphear, K.M. Dugger, C.B. Yackulic, C.J. Schwarz, P.C. Carlson, and T.L. McDonald. 2016. Demographic response of northern spotted owls to barred owl removal. Journal of Wildlife Management 80: 691–707.

Dobson, A. P. and J. Foufopoulos. 2001. Emerging infectious pathogens of wildlife. Philosophical Transactions of The Royal Society B Biological Sciences 356(1411):1001-1012. Available online: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1088495/pdf/TB011001.pdf

Doppelt, B., R. Hamilton, C. Deacon, and M. Koopman. 2008. Preparing for climate change in the Rogue River Basin of southwest Oregon. Climate Change Leadership Initiative. University of Oregon, Eugene, Oregon. 43 pp.

Dugger, K.M., F. Wagner, R.G. Anthony, and G.S. Olson. 2005. The relationship between habitat characteristics and demographic performance of northern spotted owls in southern Oregon. The Condor 107:863-878.

Dugger, KM., R.G. Anthony, S. Andrews. 2011. Transient Dynamics of Invasive Competition: barred Owls, Spotted Owls, Habitat and the Demons of Competition Present. Ecological Applications (7). 2459-68.

Dugger KM, Forsman ED, Franklin AB, Davis RJ, White GC, Schwarz CJ, Burnham KP, Nichols JD, Hines JE, Yackulic CB, Doherty Jr PF. The effects of habitat, climate, and Barred Owls on long-term demography of Northern Spotted Owls. The Condor. 2015 Dec 10;118(1):57-116Dunbar, D. L., B. P. Booth, E. D. Forsman, A. E. Hetherington, and D. J. Wilson. 1991. Status of the spotted owl, Strix occidentalis, and barred owl, Strix varia, in southwestern British Columbia.

Frey, S.J.K, A.S. Hadley, S.L. Johnson, M. Schulze, J.A. Jones, and M.G. Betts. 2016. Spatial models reveal the microclimate buffering capacity of old-growth forests. Science Advances 2:e1501392, pp. 1-9.

Folliard, L. 1993. Nest site characteristics of northern spotted owls in managed forest of northwest California. M.S. Thesis. Univ. Idaho, Moscow, ID.

Forsman, E.D. 1975. A preliminary investigation of the spotted owl in Oregon. M.S. thesis, Oregon State University, Corvallis. 127 pp.

Forsman, E.D. 1981. Molt of the spotted owl. Auk 98:735-742

Forsman, E.D., Meslow, E.C., Wight, H.M. 1984. Distribution and biology of the spotted owl in Oregon. Wildlife Monographs, 87:1-64.

Forsman, E.D., S. DeStafano, M.G. Raphael, and R.G. Gutiérrez. 1996. Demography of the northern spotted owl. Studies in Avian Biology No. 17. 122 pp.

Forsman, E.D., I.A. Otto, S.G. Sovern, M. Taylor, D.W. Hays, H. Allen, S.L. Roberts, and D.E. Seaman. 2001. Spatial and temporal variation in diets of spotted owls in Washington. Journal of Raptor Research 35(2):141-150.

Forsman, E.D., Anthony, R. G., Reid, J. A., Loschl, P. J., Sovern, S. G., Taylor, M., Biswell, B. L., Ellingson, A., Meslow, E. C., Miller, G. S., Swindle, K. A., Thrailkill, J. A., Wagner, F. F., and D. E. Seaman. 2002. Natal and breeding dispersal of northern spotted owls. Wildlife Monographs, No. 149. 35 pp.

Forsman, E.D., R.G. Anthony, E.C. Meslow, and C.J. Zabel. 2004. Diets and foraging behavior of northern spotted owls in Oregon. Journal of Raptor Research 38(3):214-230.

Forsman, E.D., T.J. Kaminiski, J.C. Lewis, K.J. Maurice, and S.G. Sovern. 2005. Home range and habitat use of northern spotted owls on the Olympic Peninsula, Washington. J. Raptor Research 39(4):365-377.

Forsman, Eric D., Robert G. Anthony, Katie M. Dugger, Elizabeth M. Glenn, Alan B. Franklin, Gary C. White, Carl J. Schwarz, Kenneth P. Burnham, David R. Anderson, James D. Nichols, James E. Hines, Joseph B. Lint, Raymond J. Davis, Steven H. Ackers, Lawrence S. Andrews, Brian L. Biswell, Peter C. Carlson, Lowell V. Diller, Scott A.Gremel, Dale R. Herter, J. Mark Higley, Robert B. Horn, Janice A. Reid, Jeremy Rockweit, Jim Schaberel, Thomas J. Snetsinger, and Stan G. Sovern. 2011- POPULATION DEMOGRAPHY OF NORTHERN SPOTTED OWLS: 1985–2008.

Franklin, A.B. 1992. Population regulation in northern spotted owls: theoretical implications for management. Pages 815-827 in D. R. McCullough and R. H. Barrett (eds.)., Wildlife 2001: populations. Elsevier Applied Sciences, London, England.

Franklin, A. B., D. R. Anderson, R. J. Gutierrez, and K. P. Burnham. 2000. Climate, habitat quality, and fitness in northern spotted owl populations in northwestern California. Ecological Monographs 70: 539–590.

Funk, W.C., E.D. Forsman, T.D. Mullins, and S.M. Haig. 2008. Introregression and dispersal among spotted owl (Strix occidentalis) subspecies. Evolutionary Applications. 1: 161-171.

Gabriel., M. W., G. M. Wengert, J. M. Higley, S. Krogan, W. Sargent, and D L. Clifford. 2013. Silent Forests? Rodenticides on illegal marijuana crops harm wildlife. The Wildlife Society. The Wildlife Professional, Spring 2013. Pp. 46-50.

Gabriel, M.W., L. W. Woods, G. M. Wengert, N. Stephenson, J.M. Higley, C.Thompson, S. M. Matthews, R. A. Sweitzer, K. Purcell, R. H. Barrett, S.M. Keller, P. Gaffney, M.Jones,R. Poppenga, J. E. Foley, R. N. Brown,, D. L. Clifford, and B.N. Sacks. 2015. Patterns of Natural and Human-Caused Mortality Factors of a Rare Forest Carnivore,the Fisher (*Pekania pennanti*) in California. PLoS ONE 10(11):e0140640. doi:10.1371/journal.pone.0140640

Gabriel, M.W., L.V. Diller, J.P. Dumbacher, G.M. Wengert, J.M. Higley, R.H. Poppenga, and S. Mendia. 2018. Exposure to rodenticides in Northern Spotted and Barred Owls on remote forest lands in northwestern California: evidence of food web contamination. Avian Conservation and Ecology 13(1):2. https://doi.org/10.5751/ACE-01134-130102 Pp. 1-9.

Gaines, W.L., R.A. Strand, and S.D. Piper. 1997. Effects of the Hatchery Complex Fires on northern spotted owls in the eastern Washington Cascades. Pages 123-129 in Dr. J.M. Greenlee, ed. Proceedings of the First Conference on Fire Effects on Rare and Endangered Species and Habitats, November 13-16, 1995. International Association of Wildland Fire. Coeur d'Alene, ID.

Gaines, W. L., R.J. Harrod, J. Dickinson, A. L. Lyonsa, K.Halupka. 2010. Integration of northern spotted owl habitat and fuels treatments in the eastern Cascades, Washington, USA. Forest Ecology and Management 260 (2010) 2045–2052.

Gallagher, C.V., J.J. Keane, P.A. Shaklee, A.A. Kramer, and R. A. Gerrard. 2018 Note: Spotted Owl Foraging Patterns Following Fuels Treatments, Sierra Nevada, California. The Journal of Wildlife Management; DOI: 10.1002/jwmg.21586. Pp. 1-15.

Garmendia, A.E., H.J. Van Kruiningen, R.A. French, J.F. Anderson, T.G. Andreadis, A. Kumar, and A.B. West. 2000. Recovery and identification of West Nile virus from a hawk in winter. Journal of Clinical Microbiology 38:3110-3111.

Gibbs, SEJ, MC. Wiberly and M. Madden. 2006. Factors affecting the geographic distribution of West Nile virus in Georgia, USA: 2002–2004. Vector-borne and Zoonotic Diseases. Volume 6, Number 1, 2006. Pp. 73-82.

Glenn, E.M, M.C. Hansen, and R.G. Anthony. 2004. Spotted owl home-range and habitat use in young forests of western Oregon. Journal of Wildlife Management 68(1):33-50.

Glenn, E.M., R.G. Anthony, and E.D. Forsman. 2010. Population trends in northern spotted owls: associations with climate in the Pacific Northwest. Biological Conservation. 143(11): 2543-2552.

Glenn, E.M., R.G. Anthony, E.D. Forsman, and G.S. Olson. 2011a. Local Weather, Regional Climate, and Annual Survival of the Northern Spotted Owl. The Condor 113(1) 159-176, The Cooper Ornithological Society 2011

Glenn, E.M., R.G. Anthony, E.D. Forsman, and G.S. Olson. 2011b. Reproduction of Northern Spotted Owls: The Role of Local Weather and Regional Climate. The Journal of Wildlife Management 75(6): 1279-1294; 2011; DOI: 10.1002/jwmg.177.

Goheen, E.M., E.M. Hansen, A. Kanaskie, M.G. Williams, N. Oserbauer, and W. Sutton. 2002. Sudden oak death caused by Phytophthora ramorum in Oregon. Plant Disease 86:441.

Gremel, S. 2005. Factors controlling distribution and demography of Northern Spotted Owls in a reserved landscape. A thesis submitted in partial fulfillment for a Master of Science degree. University of Washington.

Gronau, Christian W. 2005. Evidence of an unusual prey item in a barrel owl pellet. In Wildlife Afield, 2:2, December 2005.

Gutiérrez, R.J., A.B. Franklin, and W.S. LaHaye. 1995. Spotted owl (Strix occidentalis) in: A. Poole and F. Gill, editors. The birds of North America, No. 179. The Academy of Natural Sciences and The American Ornithologists' Union, Washington, D.C. 28 pages.

Gutiérrez, R.J. 1996. Biology and distribution of the northern spotted owl. Pages 2-5 in E.D. Forsman, S. DeStefano, M.G. Raphael, and R.J. Guiterrez (Eds): Studies in Avian Biology No. 17.

Gutiérrez, R. J., M. Cody, S. Courtney, and D. Kennedy. 2004. Assessment of the potential threat of the northern barred owl. In: Courtney, S.P., J.A. Blakesley, R.E. Bigley, M.L. Cody, J.P. Dumbacher, R.C. Fleischer, A.B. Franklin, J.F. Franklin, R.J. Gutiérrez, J.M. Marzluff, L. Sztukowski. 2004. Scientific evaluation of the status of the northern spotted owl. Sustainable Ecosystems Institute. Portland, Oregon. September 2004.

Haig, S.M., R.S. Wagner, E.D. Forsman, and T.D. Mullins. 2001. Geographic variation and genetic structure in spotted owls. Conservation Genetics 2(1): 25-40.

Haig, S.M., T.D. Mullins, E.D. Forsman, P. Trail, and L. Wennerberg. 2004. Genetic identification of spotted owls, barred owls, and their hybrids: legal implications of hybrid identity. Conservation Biology 18:1347-1357.

Haig, S.M., M.P. Miller, R.Bellinger, H.M. Draheim, D.M. Mercer, and T.D. Mullins. 2016. The conservation genetics juggling act: integrating genetics and ecology, science and policy. Evolutionary Applications. VOL9 Pp. 181-195.

Hamer, T.E., S.G. Seim, and K.R. Dixon. 1989. Northern spotted owl and northern barred owl habitat use and home range size in Washington: preliminary report. Washington Department of Wildlife, Olympia, Washington.

Hamer, T.E., E.D. Forsman, A.D. Fuchs, and M.L. Walters. 1994. Hybridization between barred and spotted owls. Auk 111(2):487-492.

Hamer, T.E., D.L. Hays, C.M. Senger, and E.D. Forsman. 2001. Diets of northern barred owls and northern spotted owls in an area of sympatry. Journal of Raptor Research 35(3):221-227.

Hanson, E., D. Hays, L. Hicks, L. Young, and J. Buchanan. 1993. Spotted Owl habitat in Washington. Report to Washington Forest Practices Board, Olympia, Washington. i-116. 126 pp.

Harestad, A., J. Hobbs, and I. Blackburn. 2004. Précis of the Northern Spotted Owl in British Columbia. Pages. 12-14 in Zimmerman, K., K. Welstead, E. Williams, J. Turner, (editors). Northern Spotted Owl Workshop Proceedings. Forrex Series (online No. 14), Vancouver, British Columbia, Canada.

Henke, A.L., T.Y. Chi, J. Smith, C. Brinegar. Unpublished Draft. Microsatellite Analysis of Northern and California Spotted Owls in California. Conservation Genetics Laboratory, Department of Biological Sciences, San Jose State University, San Jose, California.

Hershey, K.T., E.C. Meslow, and F.L. Ramsey. 1998. Characteristics of forests at spotted owl nest sites in the Pacific Northwest. Journal of Wildlife Management 62(4):1398-1410.

Herter, D.R., and L.L. Hicks. 2000. Barred owl and spotted owl populations and habitat in the central Cascade Range of Washington. Journal of Raptor Research 34(4): 279-286.

Herter, D.R., L.L. Hicks, H.C. Stabins, J.J. Millspaugh, A.J. Stabins, and L.D. Melampy. 2002. Roost site characteristics of northern spotted owls in the nonbreeding season in central Washington. Forest Science 48(2):437-446.

Higley, J. M., M.W. Gabriel., G. M.Wengert; and B. Poppenga. Barred Owl Exposure to Anticoagulant Rodenticide on the Hoopa Valley Indian Reservation, Potential Implications for Northern Spotted Owls *In* abstracts of presentation to the Society of Northwest Vertebrate Biology. Arcata, California. February 2017. http://thesnvb.org/wp-content/uploads/2017/02/2017_all-MEETING-ABSTRACTS.pdf

Hoberg, E.P., G.S. Miller, E. Wallner-Pendleton, and O.R. Hedstrom. 1989. Helminth parasites of northern spotted owls (Strix occidentalis caurina). Journal of Wildlife Diseases 25:246–251.

IEc (Industrial Economics, Incorporated). 2012. Economic analysis of critical habitat for the northern spotted owl. Prepared for: U.S. Fish and Wildlife Service. Arlington, VA. November 20, 2012. Cambridge, MA. 244 pp.

IPCC (Intergovernmental Panel on Climate Change) 2007. Climate Change 2007: The Physical Science Basis. Summary for Policymakers. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, February 2007.

Irwin, L.L., D.F. Rock, and G.P. Miller. 2000. Stand structures used by northern spotted owls in managed forests. Journal of Raptor Research 34(3):175-186.

Irwin, Larry, Dennis Rock, and Suzanne Rock. 2010. Adaptive Management Monitoring of Spotted Owls. Annual Progress Report. National Council for Air and Stream Improvement, Inc.

Irwin, L.L., T.L. Fleming, and J. Beebe. 2004. Are spotted owl populations sustainable in fire-prone forests? Journal of Sustainable Forestry 18:1–28.

Iverson, W.F. 1993. Is the barred owl displacing the spotted owl in western Washington? M.S. Thesis, Western Washington University, Bellingham, Washington.

Jenness, J.S., P. Beier, and J.L. Ganey. 2004. Associations between forest fire and Mexican Spotted Owls. Forest Science 50(6) 2004.

Johnson, D. H., K. Norman, Jerry F. Franklin, Jack Ward Thomas, and John Gordon. 1991. Alternatives for Management of Late-Successional Forests of the Pacific Northwest. A report for the Conservation of Late-successional Forests and Aquatic Ecosystems.

Johnson, D.H. 1992. Spotted owls, great horned owls, and forest fragmentation in the central Oregon Cascades. M.S. Thesis, Oregon State University, Corvallis, Oregon.

Jones, G.M., R.J. Gutiérrez, D. J Tempel, S.A.Whitmore, W.J. Berigan, and M.Z. Peery. 2016. Megafires: an emerging threat to old-forest species. Front Ecol Environ 14(6): 300–306.

Karl, T.R. J.M. Melillo, and T.C. Peterson. 2009. Global Climate Change Impacts in the United States. Cambridge University Press.

Karl, T.R., G.A. Meehl, C.D. Miller, S.J. Hassol, A.M. Waple, and W.L. Murray, Eds., 2008: Weather and climate extremes in a changing climate. Regions of focus: North America, Hawaii, Caribbean, and U.S. Pacific islands. U.S. Climate Change Science Program Synthesis and Assessment Product 3.3, 180 pp.

Kelly, E.G. 2001. The Range Expansion of the Northern Barred Owl: An Evaluation of the Impact on Spotted Owls. M.S. Thesis. Oregon State University, Corvallis, Oregon. 92 pp.

Kelly, E.G., E.D. Forsman, and R.G. Anthony. 2003. Are barred owls replacing spotted owls? Condor 105:45-53.

Kelly, E.G. and E.D. Forsman. 2004. Recent records of hybridization between barred owls (Strix varia) and northern spotted owls (S. occidentalis caurina). Auk 121:806-810.

King, Gina M, K. R. Bevis, M. A. Rowe and E. E. Hanson. 1998. Spotted Owl Use of Habitat Impacted by 1994 Fires on the Yakama Indian Reservation: Three Years Post-Fire. Presentation at the Second Fore Effects on Rare and Endangered Species Conference; International Association of Wildland Fire, Coeur d'Alene. March 29-April 1, 1998.

Knight, R. L. and S. K. Skagen. 1988. Effects of recreational disturbance on birds of prey: a review. Pages 355-359 in R. L. Glinski et al., editors. Proceedings of the Southwest Raptor Management Symposium and Workshop, National Wildlife Federation, Washington, D. C.

Komar, N., N.A. Panella, J.E. Burns, S.W. Dusza, T.M. Mascarenhas, and T.O. Talbot. 2001. Serologic evidence for West Nile virus infection in birds in the New York City vicinity during an outbreak in 1999. Emerging Infectious Diseases 7(4):621-5.

Laidig, K.J., and D.S. Dobkin. 1995. Spatial overlap and habitat association of Barred Owls and Great Horned Owls in southern New Jersey. J. Raptor Res. 29:151–157.

LaHaye, W.S., R.J. Guiterrez, and J.R. Dunk. 2001. Natal dispersion of the spotted owl in southern California: dispersal profile of an insular population. Condor 103:691-700.

Layman, S.A. 1991. Diurnal foraging by spotted owls. Wilson Bulletin. 103(1): 138-140.

Lee, D.L., M.L. Bond, and R.B. Siegel. 2012. Dynamics of California Spotted Owl breeding-season site occupancy in burned forests. The Condor 114:792-802.

Lee, D.L., and M.L. Bond. 2015a. Occupancy of California spotted owl sites following a large fire in the Sierra Nevada. The Condor. Ornithological Applications. V. 117:228-236.

Lee, D.L., and M.L. Bond. 2015b. Previous year's reproductive state affects spotted owl site occupancy. The Condor. Ornithological Applications. V. 117:307-319.

Leskiw, T., and R.J. Gutiérrez. 1998. Possible predation of a Spotted Owl by a Barred Owl. Western Birds 29:225–226.

Lesmeister, D.B., S.G. Sovern, R.J. Davis, D.M. Bell, M.J. Gregory, and J.C. Vogeler. 2019. Mixed-severity wildfire and habitat of an old-forest obligate. Ecosphere. www.esajournals.org April 2019, Volume 10(4), Article e02696. Pp. 1-22.

Lint, J. 2005. Northwest Forest Plan – The first ten years (1994-2003): Status and trend of northern spotted owl populations and habitat. PNW Station Edit Draft (Lint, Technical Coordinator, 2005). USDA Forest Service, PNW Research Station, PNW-GTR-2005. Draft. Portland, OR 230pp

Littell, J. S., E. E. Oneil, D. McKenzie, J. A. Hicke, J. A. Lutz, R. A. Norheim, and M. M. Elsner. 2010. Forest ecosystems, disturbance, and climatic change in Washington State, USA. Climatic Change.

Livezey, K.B. 2005. Iverson (2004) on spotted owls and barred owls: comments on methods and conclusions. Journal of Raptor Research 39(1):102-103.

Livezey, K.B. and T.L. Fleming. 2007. Effects of barred owls on spotted owls: the need for more than incidental detections and correlational analyses. Journal of Raptor Research. 41(4): 319-325.

Livezey, K. B. 2009. Range Expansion of Barred Owls, Part II: Facilitating Ecological Changes. The American Midland Naturalist 161:323–349.

Loehle, Craig, Larry Irwin, John Beebe, and Tracy Fleming. 2011. Factors Influencing the Distribution of Northern Spotted Owls in the Eastern Cascades, Washington. Published by the Society for Northwestern Vertebrate Biology. http://www.bioone.org/doi/full/10.1898/09-33.1

Marlon, J.R., P. J. Bartleinb, D. G. Gavinb, C. J. Long, R. S. Anderson, C. E. Brilese, K. J. Brown, D. Colombaroli, D. J. Hallett, M. J. Power, E. A. Scharf, and M. K. Walsh. 2012. Long-term perspective on wildfires in the western USA. Proceedings of the National Academy of Sciences of the United States of America. 2012. Vol. 109 no. 9. Edited by B. L. Turner, Arizona State University, Tempe, AZ. Pp. E535-E543.

Marra, P. P., S. Griffing, C. Caffrey, A. M. Kilpatrick, R. McLean, C. Brand, E. Saito, A. P. Dupuis, L. Kramer, and R. Novak. 2004. West Nile virus and wildlife. BioScience 54: 393-402.

McGarigal, K., R.G. Anthony, and F.B. Isaacs. 1991. Interactions of humans and bald eagles on the Columbia River estuary. Wildl. Monogr. 115. 47 pp.McKenzie, D., D.L. Peterson, and J.J. Littell. 2009. Global warming and stress complexes in forests of western North America. Pages 319–338 In A. Bytnerowicz, M.J. Araugh, A.R. Riebau, and C. Andersen, editors. Developments in Environmental Science, Volume 8. Elsevier, The Netherlands.

McLean, R. G., S. R. Ubico, D. E. Docherty, W. R. Hansen, L. Sileo, and T. S. McNamara. 2001. West Nile virus transmission and ecology in birds: Annals of the New York Academy of Sciences 951: 54–57.

Meyer, J.S., Irwin, L.L., and M.S. Boyce. 1998. Influence of habitat abundance and fragmentation on northern spotted owls in western Oregon. Wildlife Monographs 139: 1-51.

Miller, G.S., S.K. Nelson, and W.C. Wright. 1985. Two-year-old female spotted owl breeds successfully. Western Birds 16:69-73.

Miller, G.S. 1989. Dispersal of juvenile northern spotted owls in western Oregon. M.S. Thesis. Oregon State University, Corvallis, Oregon. 139 pages.

Miller, G.S., R.J. Small, and E.C. Meslow. 1997. Habitat selection by spotted owls during natal dispersal in western Oregon. J. Wildl. Manage. 61(1):140-150.

Moen, C.A., A.B. Franklin, and R.J. Gutiérrez. 1991. Age determination of subadult northern spotted owls in northwest California. Wildlife Society Bulletin 19:489-493.

Moeur, Melinda; Spies, Thomas A.; Hemstrom, Miles; Martin, Jon R.; Alegria, James; Browning, Julie; Cissel, John; Cohen, Warren B.; Demeo, Thomas E.; Healey, Sean; Warbington, Ralph. 2005. Northwest Forest Plan–The first 10 years (1994-2003): status and trend of late-successional and old-growth forest. Gen. Tech. Rep. PNW-GTR-646. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 142 pp.

Moritz, M.A., M.A. Parisien, E. Batllori, M.A. Krawchuk, J. VanDorn, D.J. Ganz, and K.Hayhoe. 2012. Climate change and disruptions to global fire activity. 2012. Ecosphere. V. 3(6). Article 49, pp. 1-29.

Mote, P. W., A. Hamlet, and E. Salathé. 2008: Has spring snowpack declined in the Washington Cascades? Hydrology and Earth System Sciences, 12, 193-206, doi:10.5194/hess-12-93-2008. [Available online at http://www.hydrol-earth-syst-sci.net/12/193/2008/hess-12-193-2008.pdf]

Mote, P., A. K. Snover, S. Capalbo, S. D. Eigenbrode, P. Glick, J. Littell, R. Raymondi, and S. Reeder. 2014: Ch. 21: Northwest. Climate Change Impacts in the United States: The Third National Climate Assessment, J. M. Melillo, Terese (T.C.) Richmond, and G. W. Yohe, Eds., U.S. Global Change Research Program, 487-513. doi:10.7930/J04Q7RWX

Noon, B.R. and J.A. Blakesley. 2006. Conservation of the northern spotted owl under the Northwest Forest Plan. Conservation Biology 20:288–296.

North, Malcom P., J. F. Franklin, A. B. Carey, E. D Forsman and T. Hamer. 1999. Forest Stand Structure of the Northern Spotted Owl's Foraging Habitat. Journal of Forest Science 45(14).

North, M.P., G.Steger, R.Denton, G.Eberlein, T. Munton, and K. Johnson. 2000. Association of weather and nest-site structure with reproductive success in California spotted owls. Journal of Wildlife Management 64(3):797-807.

ODFW (Oregon Department of Fish and Wildlife). 2017. Threatened, Endangered, and Candidate Fish and Wildlife Species in Oregon. Revised June 2017. 2 pp.

Odion, D.C., C.T. Hanson, A. Arsenault, W.L. Baker, D.A. DellaSala, R.L. Hutto, W. Klenner, M.A. Moritz, R.L. Sherriff, T.T. Veblen, and M.A. Williams 2014a. Examining Historical and Current Mixed-Severity Fire Regimes in Ponderosa Pine and Mixed-Conifer Forests of Western North America. PLoS ONE 9(2): e87852. doi:10.1371/journal.pone.0087852 14 pp.

Odion, D.C., C.T. Hanson, D.A. DellaSala, W.L. Baker, and M.L.Bond. 2014b. Effects of Fire and Commercial Thinning on Future Habitat of the Northern Spotted Owl. The Open Ecology Journal, 2014, 7, 37-51.Olson, G.S., E.M. Glenn, R.G. Anthony, E.D. Forsman, J.A. Reid, P.J. Loschl, and W.J. Ripple. 2004. Modeling demographic performance of northern spotted owls relative to forest habitat in Oregon. Journal of Wildlife Management 68(4):1039-1053.

Olson, G.S., E. Glenn, R.G. Anthony, E.D. Forsman, J.A. Reid, P.J. Loschl, and W.J. Ripple. 2004. Modeling demographic performance of northern spotted owls relative to forest habitat in Oregon. Journal of Wildlife Management.

Olson, G.S., R.G. Anthony, E.D. Forsman, S.H. Ackers, P.J. Loschl, J.A. Reid, K.M Dugger, E.M. Glenn, and W.J. Ripple. 2005. Modeling of site occupancy dynamics for northern spotted owls, with emphasis on the effects of barred owls. Journal of Wildlife Management 69(3):918-932.

Omi, P.N., and E.J. Martinson. 2002. Effects of fuels treatment on wildfire severity. Final report submitted to the Joint Fire Science Program Governing Board. i-36. 40 pp.

Oregon Department of Forestry (ODF). 2014. Forest Practices Administrative Rules and Forest Practices Act. Salem, OR. Available online: https://www.oregon.gov/ODF/Documents/WorkingForests/FPARulebook.pdf

Pearson, R.R., and K.B. Livezey. 2003. Distribution, numbers, and site characteristics of spotted owls and barred owls in the Cascade Mountains of Washington. Journal of Raptor Research 37(4):265-276.

Peterson, E.K., E.M. Hansen, and A. Kanaski. 2015. Temporal epidemiology of sudden oak death in Oregon. Phytopathology. 105:937-946.

Pierce, D.J., J.B. Buchanan, B.L. Cosentino, and S. Snyder. 2005. An assessment of spotted owl habitat on non-federal lands in Washington between 1996 and 2004. Wildlife Department of Wildlife Research Report.

Rizzo, D.M., M. Garbeloto, J.M. Davidson, G.W. Slaughter, and S.T. Koike. 2002. Phytophthora ramorum as the cause of extensive mortality of Quercus spp. and Lithocarpus densiflorus in California. Plant Disease 86:205-214.

Rizzo, David and Matteo Garbelotto. 2003. Sudden oak death: endangering California and Oregon forest ecosystems1: 197–204. http://dx.doi.org/10.1890/1540-9295(2003)001[0197:SODECA]2.0.CO;2

Rosenburg, Daniel K., and R. G. Anthony. 1992. Characteristics of Northern Flying Squirrel Populations in Young Second and Old Growth Forests in Western Oregon. Canadian Journal of Zoology. Volume 70.

Rosenberg, D.K., K.A. Swindle, and R.G. Anthony. 2003. Influence of prey abundance on northern spotted owl reproductive success in western Oregon. Canadian Journal of Zoology 81:1715-1725.

Saplosky Robert, L. Michael Romero, and Allan U. Munck. 2000. How do Glucocorticoids affect stress responses? Integrating Permissive, Suppressive, Stimulatory and Preparatory Actions. Http://edrv/endojournals.org/cgi/content. 12-19-2000.

Schilling, J.W., K.M. Dugger, and R.G. Anthony. 2013. Survival and home range size of northern spotted owls in southwest Oregon. Journal of Raptor Research. 47(1):1-4.

Schmidt, K. 2006. Northern spotted owl monitoring and inventory, Redwood National and State Parks, 2005 annual report. Redwood National and State Parks, Orick, California.

Schumaker, N.H., A.Brookes, J.R. Dunk, B.Woodbridge, J.A. Heinrichs, J.J.Lawler, C.Carroll, and D.LaPlante. 2014. Mapping sources, sinks, and connectivity using a simulation model of northern spotted owls. Landscape Ecology, 29, 579–592.

Singleton, P, S. Graham, W. Gaines, and J. Lehmkuhl. 2005. The ecology of barred owls in fire-prone forests. USDA PNW December 2005 Progress Report; Wenatchee, Washington. Sisco, C.L. 1990. Seasonal home range and habitat ecology of spotted owls in northwestern California. M.S. Thesis. Humboldt State University, Arcata, California.

Singleton, P., J.F. Lehmkuhl, W.L. Gaines, and S.A. Graham. 2010. Barred owl space use and habitat selection in the eastern Cascades, Washington. Journal of Wildlife Management. 74(2): 285-294.

Sisco, C.L. 1990. Seasonal home range and habitat ecology of spotted owls in northwestern California. M.S. Thesis. Humboldt State University, Arcata, California.

Solis, D. M. and R. J. Gutierrez. 1990. Summer habitat ecology of northern spotted owls in northwestern California. The Condor 92:739-748.

Sovern, S.G., E.D. Forsman, B.L. Biswell, D.N. Rolph, and M. Taylor. 1994. Diurnal behavior of the spotted owl in Washington. Condor 96(1):200-202.

Sovern, S.G., E.D. Forsman, K.M.Dugger and M.Taylor. 2015. Roosting habitat use and selection by northern spotted owls during nataldispersal. The Journal of Wildlife Management 79(2):254–262; 2015.Steger, G. N., L. R. Werner, and T. E. Munton, 2006. USDAForest Service, Pacific Southwest Research Station, First Documented Record of the Barred Owl in the Southern Sierra Nevada. Pacific Southwest Research Station. Western Birds. 37:106-109. 2006.

Spies, T.A., M.A. Hemstrom, A. Youngblood, and S. Hummel. 2006. Conserving old-growth forest diversity in disturbance-prone landscapes. Conservation Biology. 20:351-362.

Spies, T.A., Miller, J.D., Buchanan, J.B., Lehmkuhl, J.F., Franklin, J.F., Healy, S.P.,Hessburg, P.F., Safford, H.D., Cohen, W.D., Kennedy, R.S.H., Knapp, E.K., Agee, J.K., Moeur, M., 2009. Underestimating risks to the Northern Spotted Owl in fireprone forests: response to Hanson et al. Conservation Biology 24 (1), 330–333.

Spies, T.A., D.B. Lindenmayer, A.M.Gill, S.L. Stephens, and J.K. Agree. 2012. Challenges and a checklist for biodiversity conservation in fire-prone forests: perspectives from the Pacific Northwest of USA and southeastern Australia. Biological Conservation 145: 5-14.

Stenseth, N.C, A. Mysterud, G. Ottersen, J.W. Hurrell, K. Chan, M. Lima. Ecological Effects of Climate Fluctuations. 2002. Science V. 23 August 2002. Pp.1292-1296. Vol. 297 no. 5585 pp. 1292-1296

Swarthout, E.C.H. and R.J. Steidl. 2001. Flush responses of Mexican spotted owls to recreationists. J. Wildlife Management 65(2):312-317.

Swindle, Keith A., William J. Ripple, and E. Charles Meslow. 1997. Landscape Composition around Northern Spotted Owl Nests, Central Cascade Mountains, Oregon. An Abstract of the Thesis for Master of Science degree. Oregon Cooperative Wildlife Research Unit, Oregon State University, Corvallis, Oregon.

Tempel D.J. and R. J. Gutiérrez. 2003. Fecal Corticosterone Levels in California Spotted Owls Exposed to Low-intensity Chainsaw Noise.

Tempel D.J. and R. J. Gutiérrez. 2004. Factors Relating to Fecal Corticosterone Levels in California Spotted Owls: Implications for Assessing Chronic Stress.

Thomas, J.W.; E.D. Forsman; J.B. Lint; E.C. Meslow; B.R. Noon; and J. Verner. 1990. A conservation strategy for the northern spotted owl: a report of the Interagency Scientific Committee to address the conservation of the northern spotted owl. Portland, Oregon.

U.S. Department of Agriculture, Forest Service; U.S. Department of Interior, Bureau of Land Management, U.S. Fish and Wildlife Service, National Park Service. 427 pp.

Thomas, J.W., M.G. Raphael, R.G. Anthony, E.D. Forsman, A.G. Gunderson, R.S. Holthausen, B.G. Marcot, G.H. Reeves, J.R. Sedell, and D.M. Solis. 1993. Viability assessments and management considerations for species associated with late-successional and old-growth forests of the Pacific Northwest. USDA Forest Service, Portland, Oregon.

Thomas, J.W., and M.G. Raphael (Eds.). 1993. Forest Ecosystem Management: An Ecological, Economic, and Social Assessment. Report of the Forest Ecosystem Management Assessment Team (FEMAT). July 1993. Portland, OR: USDA Forest Service and the USDI Bureau of Land Management.

Thome, Darrin M., C. J. Zabel and L. V. Diller. 1999. Forest Stand Characteristics and Reproduction of Nothern Spotted Owls in Managed North-Coastal California Forests. Journal Of Wildlife Management 63(1):44-59.

USDA FS/USDI BLM (Forest Service and Bureau of Land Management). 1994a. Record of Decision for amendments to Forest Service and Bureau of Land Management planning documents within the range of the northern spotted owl. U.S. Forest Service, Bureau of Land Management, Portland, OR. 2 vols. and appendices.

USDA FS/USDI BLM (Forest Service and Bureau of Land Management). 1994b. Final supplemental environmental impact statement on management of habitat for late-successional and old-growth forests related species within the range of the northern spotted owl. U.S. Forest Service, Bureau of Land Management, Portland, OR.

USDI BLM (Bureau of Land Management). 2016a. Northwestern & Coastal Oregon Record of Decision and Resource Management Plan. Oregon State Office, Portland, Oregon. i-308. 320 pp.

USDI BLM (Bureau of Land Management). 2016b. Southwestern Oregon Record of Decision and Resource Management Plan. Oregon State Office, Portland, Oregon. i-318. 332 pp.USDI BLM (Bureau of Land Management). 2016b. Proposed Resource Management Plan/Final Environmental Impact Statement for the Resource Management Plans for Western Oregon. Available online: https://www.blm.gov/or/plans/rmpswesternoregon/feis/

USDI FWS (U.S. Fish and Wildlife Service). 1983. Endangered and threatened species listing and recovery priority guidelines: correction. Federal Register 48:51985.

USDI FWS (U.S. Fish and Wildlife Service). 1989. The Northern Spotted Owl; a status review supplement. Portland, Oregon. 113 pp.

USDI FWS (U.S. Fish and Wildlife Service). 1990a. Endangered and threatened wildlife and plants; determination of threatened status for the northern spotted owl; final rule. Federal Register, 50 CFR 17: 26,114-26,194.

USDI FWS (U.S. Fish and Wildlife Service). 1990b. 1990 status review: northern spotted owl; Strix occidentalis caurina. Report to the U.S. Fish and Wildlife Service, Portland, OR.

USDI FWS (U.S. Fish and Wildlife Service). 1992a. Endangered and Threatened Wildlife and Plants; Draft Recovery Plan for the northern spotted owl.

USDI FWS (U.S. Fish and Wildlife Service). 1992b. Endangered and Threatened Wildlife and Plants; determination of critical habitat for the northern spotted owl. Federal Register 57: 1796-1838.

USDI FWS (U.S. Fish and Wildlife Service). 1994. Final biological opinion for the preferred alternative of the supplemental environmental impact statement on management of habitat for late-successional and old-growth forest related species within the range of the northern spotted owl. Fish and Wildlife Service, Portland, Oregon.

USDI FWS (U.S. Fish and Wildlife Service). 1995. Endangered and threatened wildlife and plants; proposed special rule for the conservation of the northern spotted owl on non-federal lands. Federal Register 60:9483–9527.

USDI FWS (U.S. Fish and Wildlife Service). 2001. A range wide baseline summary and evaluation of data collected through section 7 consultation for the northern spotted owl and its critical habitat: 1994-2001. Portland, OR. Unpublished document. 41 pages.

USDI FWS (U.S. Fish and Wildlife Service). 2004. Northern Spotted Owl Five Year Review: Summary and Evaluation, Portland, OR. 72pp.

USDI FWS (U.S. Fish and Wildlife Service). 2008. Recovery Plan for the Northern Spotted Owl. Region 1. U.S. Fish and Wildlife Service. Portland, Oregon.

USDI FWS (U.S. Fish and Wildlife Service). 2009. Regulatory and scientific basis for the U.S. Fish and Wildlife Service guidance for evaluation of take for northern spotted owls on private timberlands in California's northern interior region.

USDI FWS (U.S. Fish and Wildlife Service). 2011a. Northern Spotted Owl: Five Year Review Summary and Evaluation. USFWS, Portland, Oregon. 7 pp.

USDI FWS (U.S. Fish and Wildlife Service). 2011b. Revised Recovery Plan for the Northern Spotted Owl. Region 1. U.S. Fish and Wildlife Service. Portland, Oregon.

USDI FWS (U.S. Fish and Wildlife Service). 2012a. Revised Critical Habitat for the Northern Spotted Owl. Region 1. U.S. Fish and Wildlife Service. Portland, Oregon. Published in the Federal Register December 4, 2012.

USDI FWS (U.S. Fish and Wildlife Service). 2012b. Protocol for surveying proposed management activities that may impact northern spotted owls. Revised January 9, 2012. 42pp.

USDI FWS (U.S. Fish and Wildlife Service). 2013. Experimental removal of barred owls to benefit threatened northern spotted owls. Environmental Impact Statement. July, 2013. Oregon Fish and Wildlife Office, Portland, Oregon. 467 pp.

USDI FWS (U.S. Fish and Wildlife Service). 2015. Endangered and Threatened Wildlife and Plants; 90-Day Findings on 10 Petitions; Evaluation of a Petition To Reclassify the Northern Spotted Owl as an Endangered Species Under the Act Federal Register 80 (69): 19262

USDI FWS (U.S. Fish and Wildlife Service). 2016. Biological Opinion for the Western Oregon Resource Management Plan. August, 2016,

USDI FWS and USDC NOAA(U.S. Fish and Wildlife Service, U.S. National Oceanic and Atmospheric Administration). 2016. Interagency Cooperation—Endangered Species Act of 1973, as Amended; Definition of Destruction or Adverse Modification of Critical Habitat Federal Register. Vol. 81, No. 28 Thursday, February 11, 2016. Final Rule. Pp. 7214-7225. Available online: https://www.fws.gov/endangered/improving_ESA/pdf/Adverse%20Modification-2016-02675-02112015.pdf

USDI FWS/USDC NMFS (Fish and Wildlife Service, National Marine Fisheries Service). 1998. Procedures for Conducting Consultation and Conference Activities under Section 7 of the Endangered Species Act.

Wagner, F.F., E.C. Meslow, G.M. Bennett, C.J. Larson, S.M. Small, and S. DeStefano. 1996. Demography of northern spotted owls in the southern Cascades and Siskiyou, Mountains, Oregon. Pages: 67-76 In: Forsman, E.D., S. DeStefano, M.G. Raphael, and R.J. Gutierrez, (editors). 1996. Demography of the northern spotted owl. Studies in Avian Biology No. 17. Cooper Ornithology Society.

Walther, G.E., E. Post, P. Convey, A. Menzel, C. Parmesan. 2002. Ecological responses to recent climate change. Nature. V. 416. 28 March 2002. Pp. 389-395.

Ward, J. W. Jr. 1990. Spotted owl reproduction, diet and prey abundance in northwest California. M.S. Thesis. Humboldt State University, Arcata.

Washington Forest Practices Board. 1996. Permanent rules for the northern spotted owl. Washington Department of Natural Resources, Olympia, Washington.

Wasser, S. K., K. Bevis, G. King, and E. Hanson. 1997. Noninvasive physiological measures of disturbance in the northern spotted owl. Conservation Biology 11: 1019-1022.

WDFW (Washington Department of Fish and Wildlife). 2017. State Listed Species. Revised February 2017. 2 pp.

Weathers, W.W., Hodum, P.J., and J.A. Blakesley. 2001. Thermal ecology and ecological energetics of California spotted owls. The Condor 103: 678-690.

Wengert, G.M., M. Higley, M.W.Gabriel, H.R.Romsos, and W. Spencer. 2015. Modeling to predict the probability of trespass marijuana cultivation site presence in fisher, northern spotted owl, and Humboldt marten habitat. Powerpoint presentation to USFWS. November 2015.

Westerling, A. L., H. Hidalgo, D.R. Cayan, and T. Swetnam, 2006: Warming and Earlier Spring Increases Western US Forest Wildfire Activity, Science, 313: 940-943.

White, C. M., and T. L. Thurow. 1985. Reproduction of ferruginous hawks exposed to controlled disturbance. The Condor 87:14-22.

Wiens, J.D., R.G. Anthony, and E.D. Forsman. 2011. Barred Owl Occupancy Surveys Within the Range of the Northern Spotted Owl. The Journal of Wildlife Management 75(3):531–538.

Wiens, J.D., R.G. Anthony, and E.D. Forsman. 2014. Competitive interactions and resource partitioning between northern spotted owls and barred owls in western Oregon. Wildlife Monographs No. 185. 50 pp.

Wiens, J.D., Dugger, K.M., Lewicki, K.E., and Simon, D.C., 2017. Effects of experimental removal of barred owls on population demography of northern spotted owls in Washington and Oregon—2016 progress report: U.S. Geological Survey Open-File Report 2017-1040, 23 p., https://doi.org/10.3133/ofr20171040.

Wiens, J.D., Dugger, K.M., Lesmeister, D.B., Dilione, K.E., and Simon, D.C., 2019, Effects of Barred Owl (*Strix varia*) removal on population demography of Northern Spotted Owls (*Strix occidentalis caurina*) in Washington and Oregon, 2015–18: U.S. Geological Survey Open-File Report 2019-1074, 17 p., https://doi.org/10.3133/ofr20191074.Yackulic, C.B., J. Reid, J.D. Nichols, J.E. Hines, and R. Davis. 2014. The roles of competition and habitat in the dynamics of populations and species distributions. Ecology, 95(2), 2014, pp. 265–279.

Yospin, G.I., S.D. Bridgham, R.P. Neilson, J.P. Bolte, D.M. Bachelet, P.J. Gould, C.A. Harrington, J.A. Kertis, C. Evers, and B.R. Johnson. 2015. A new model to simulate climate-change impacts on forest succession for local land management. Ecological Applications, 25(1), 226-242. doi:10.1890/13-0906.

Zabel, C. J., K. M. McKelvey, and J. P. Ward, Jr. 1995. Influence of primary prey on home-range size and habitat-use patterns of northern spotted owls (Strix occidentalis caurina). Canadian Journal of Zoology 73:433-439.

Zabel C.J., S.E. Salmons, and M. Brown. 1996. Demography of northern spotted owls in southwestern Oregon. Studies in Avian Biology 17:77-82.

Zabel, C. J., J. R. Dunk, H. B. Stauffer, L. M. Roberts, B. S. Mulder, and A. Wright. 2003. Northern spotted owl habitat models for research and management application in California. Ecological Applications 13:1027–1040.

Personal Communications

Caruthers, Robert, USDA FS. 2017. April 7 telephone conversation with Jan Johnson. Documented in PDF file .

Clayton, David. USDA FS. 2017 May 5 email thread to Jan Johnson. Subject: FW: MjOwls in the 0.5-mile buffer group

Forsman, E. pers. comm. 2006. citation, p. B-11 in USDI FWS (U.S. Fish and Wildlife Service). 2011b. Revised Recovery Plan for the Northern Spotted Owl. Region 1. U.S. Fish and Wildlife Service. Portland, Oregon. 277 pp.

Grubb, T. pers. comm. No date. Pers. comm. citation on Ch 8 p. 33 in Blakesley, J.A., W. LaHaye, J.M.M. Marzluff, B.R. Noon, and S. Courtney. 2004. Scientific evaluation of the status of the northern spotted owl – demography. 1-46 pp. In: Courtney, S.P., J.A. Blakesley, R.E. Bigley, M.L. Cody, J.P. Dumbacher, R.C. Fleischer, A.B. Franklin, J.F. Franklin, R.J. Gutiérrez, J.M. Marzluff, L. Sztukowski. 2004. Scientific evaluation of the status of the northern spotted owl. Sustainable Ecosystems Institute. Portland, Oregon. September 2004. 508 pp.

Hunter B. pers. comm. No date. Pers. comm. citation on Ch 8 p. 34 in Blakesley, J.A., W. LaHaye, J.M.M. Marzluff, B.R. Noon, and S. Courtney. 2004. Scientific evaluation of the status of the northern spotted owl – demography. 1-46 pp. In: Courtney, S.P., J.A. Blakesley, R.E. Bigley, M.L. Cody, J.P. Dumbacher, R.C. Fleischer, A.B. Franklin, J.F. Franklin, R.J. Gutiérrez, J.M. Marzluff, L. Sztukowski. 2004. Scientific evaluation of the status of the northern spotted owl. Sustainable Ecosystems Institute. Portland, Oregon. September 2004. 508 pp.Loschl, P. and E. Forsman pers. comm.. 2006. Pers. comm. citation on p. A-1 in USDI FWS (U.S. Fish and Wildlife Service). 2011b. Northern Spotted Owl: Five Year Review Summary and Evaluation. USFWS, Portland, Oregon. 7 pp. 277 p.

Loschl, P. and E. Forsman. 2006. Pers. comm. citation, p. A-1 in USDI FWS (U.S. Fish and Wildlife Service). 2011b. Northern Spotted Owl: Five Year Review Summary and Evaluation. USFWS, Portland, Oregon. 7 pp. 277 p.

McGowan, K. pers. comm. No date. Pers. comm. citation on Ch 8 p. 33 in Blakesley, J.A., W. LaHaye, J.M.M. Marzluff, B.R. Noon, and S. Courtney. 2004. Scientific evaluation of the status of the northern spotted owl – demography. 1-46 pp. In: Courtney, S.P., J.A. Blakesley, R.E. Bigley, M.L. Cody, J.P. Dumbacher, R.C. Fleischer, A.B. Franklin, J.F.

Franklin, R.J. Gutiérrez, J.M. Marzluff, L. Sztukowski. 2004. Scientific evaluation of the status of the northern spotted owl. Sustainable Ecosystems Institute. Portland, Oregon. September 2004. 508 pp.

Associated Federal Register Documents

55 FR 26114: Determination of Threatened Status for the Northern Spotted Owl. Final Rule. Published in the Federal Register on January 26, 1990. 26114-26194.

57 FR 1796: Endangered and Threatened Wildlife and Plants; determination of critical habitat for the northern spotted owl. Final Rule. Published in the Federal Register on January 15, 1992. 1796-1838.

58 FR 14248: Final Rule To List the Mexican Spotted Owl as a Threatened Species. Final Rule. Published in the Federal Register on March 16, 1993. 14248-14271.

73 FR 29471: Proposed Revised Designation of Critical Habitat for the Northern Spotted Owl (*Strix occidentalis caurina*). Proposed rule. In addition, this document announced that the Final Recovery Plan for the Northern Spotted Owl is available. Published in the Federal Register on May 21, 2008. 29471-29477.

73 FR 47326: Revised Designation of Critical Habitat for the Northern Spotted Owl; Final Rule. Published in the Federal Register on Federal Register on August 13, 2008. 47326-47522.

76 FR 38575: Revised Recovery Plan for the Northern Spotted Owl (*Strix occidentalis caurina*). Notice of document availability: revised recovery plan. Published in the Federal Register on July 1, 2011. 38575-38576.

76 FR 63719: 12-Month Finding on a Petition To List a Distinct Population Segment of the Red Tree Vole as Endangered or Threatened. Proposed Rule. Published in the Federal Register on October 13, 2011. 63720-63762.

77 FR 71876: Designation of Revised Critical Habitat for the Northern Spotted Owl. Final Rule. Published in the Federal Register on December 4, 2012. 71876-72068.

78 FR 57171: Experimental Removal of Barred Owls To Benefit Threatened Northern Spotted Owls; Record of Decision for Final Environmental Impact Statement. Notice of availability September 17, 2013. 57171-57173.

80 FR 19259. 90-Day Findings on 10 Petitions. Notice of petition findings and initiation of status reviews. Published in the Federal Register on April 10, 2015. 19259-72068.

APPENDIX E

MARBLED MURRELET STATUS OF THE SPECIES

Species Description

The murrelet is a small diving seabird that nests mainly in coniferous forests and forages in near-shore marine habitats. Males and females have sooty-brown upperparts with dark bars. Underparts are light, mottled brown. Winter adults have brownish-gray upperparts and white scapulars. The plumage of fledged young is similar to that of adults in winter. Chicks are downy and tan colored with dark speckling.

Legal Status

The murrelet was listed as a threatened species on September 28, 1992, in Washington, Oregon, and northern California (Service 1992, entire). Since the species' listing, the Service has completed two 5-yr status reviews of the species: September 1, 2004 (Service 2004, entire) and June 12, 2009 (Service 2009, entire). The 2004 5-year review determined that the California, Oregon, and Washington distinct population segment of the murrelet did not meet the criteria outlined in the Service's 1996 Distinct Population Segment (DPS) policy (Service and NOAA 1996, entire; Service 2004, p. 6). However, the 2009 5-year review concluded the 2004 analysis of the DPS question was based on a flawed assumption regarding discreteness at the international border with Canada, and that the three-state population did, in fact, constitute a valid DPS (Service 2009, pp. 3-12). In 2010, the Service denied a petition to delist the marbled murrelet, and the U.S. Court of Appeals for the D.C. Circuit upheld the Service's decision. The legal status of the murrelet remains unchanged from the original designation.

Life History

Murrelets produce one egg per nest and usually only nest once a year, however re-nesting has been documented after nest failure. Nests are not built, but rather the egg is placed in a small depression or cup made in moss or other debris on the limb. Incubation lasts about 30 days, and chicks fledge after about 28 days after hatching. Both sexes incubate the egg in alternating 24-hour shifts. The chick is fed up to eight times daily and is usually fed only one fish at a time. The young are semi-precocial, capable of walking but not leaving the nest. Fledglings fly directly from the nest to the ocean. If a fledgling is grounded before reaching the ocean, they usually die from predation or dehydration, as murrelets need to take off from an elevated site to obtain flight.

Ecology and Habitat Characteristics

Murrelets spend most of their life in the marine environment but use old-growth forests for nesting. Courtship, foraging, loafing, molting, and preening occur in near-shore marine waters. Throughout their range, murrelets are opportunistic feeders and utilize prey of diverse sizes and species. They feed primarily on fish and invertebrates in near-shore marine waters although they have also been detected on rivers and inland lakes.

In their terrestrial environment, the presence of platforms (large branches or deformities) used for nesting is the most important characteristic of their nesting habitat. Murrelet habitat use during the breeding season is positively associated with the presence and abundance of mature and old-growth forests, large core areas of old-growth, low amounts of edge habitat, reduced habitat fragmentation, proximity to the marine environment, and forests that are increasing in stand age and height. Additional information on murrelet taxonomy, biology, and ecology can be found in Ralph et al. (1995, entire), McShane et al. (2004, entire), and Piatt et al. (2007, entire).

Aquatic Habitat Use

Birds occur offshore in Conservation Zones 1-6 year round and also occur in small numbers off southern California in the winter. Murrelets are usually found within five miles (eight km) from shore, and in water less than 60 meters deep (Ainley et al. 1995, entire; Burger 1995, entire; Strachan et al. 1995, entire; Nelson 1997, p. 3; Day and Nigro 2000, pp. 4,7; Raphael et al. 2007, p. 2). In general, birds occur closer to shore in exposed coastal areas and farther offshore in protected coastal areas (Nelson 1997, pp. 2-4). Courtship, foraging, loafing, molting, and preening occur in marine waters.

Murrelets are wing-propelled pursuit divers that forage both during the day and at night (Carter and Sealy 1986, p. 475; Henkel et al. 2003, p. 10; Kuletz 2005, pp. 47-48). Murrelets can make substantial changes in foraging sites within the breeding season, but many birds routinely forage in the same general areas and at productive foraging sites, as evidenced by repeated use over a period of time throughout the breeding season (Carter and Sealy 1990, entire, Whitworth et al. 2000, p. entire; Hull et al. 2001, entire; Mason et al. 2002, pp. 24-25; Piatt et al. 2007, pp. 13-14). Murrelets are also known to forage in freshwater lakes (Carter and Sealy 1986, entire; Nelson 1997, p. 8). Activity patterns and foraging locations are influenced by biological and physical processes that concentrate prey, such as weather, climate, time of day, season, light intensity, up-wellings, tidal rips, narrow passages between island, shallow banks, and kelp (Nereocystis spp.) beds (Ainley et al. 1995, entire; Burger 1995, entire; Strong et al. 1995, entire; Speckman 2003, entire; Nelson 1997, entire).

Juveniles are generally found closer to shore than adults (Beissinger 1995, pp. 387-388) and forage without the assistance of adults (Strachan et al. 1995, pp. 249-250). Kuletz and Piatt (1999, entire) found that in Alaska, juvenile murrelets congregated in kelp beds. Kelp beds are often associated with productive waters and may provide protection from avian predators (Kuletz and Piatt 1999, entire). McAllister (in Strachan et al. 1995, p. 250) found that juveniles were more common within 328 feet (100 m) of shorelines, particularly where bull kelp was present. Within the area of use, murrelets usually concentrate feedings in shallow, near-shore water less than 98 feet (30 m) deep (Huff et al. 2006, p. 19), but are thought to be able to dive up to depths of 157 feet (47 m) (Mathews and Burger 1998, p. 71). During the non-breeding season, murrelets disperse and can be found farther from shore (Strachan et al. 1995, p. 247). Although little information is available outside of the nesting season, limited information on winter distribution also suggests they do move further offshore (Strachan et al. 1995, p. 247). In areas with protective waters, there may be a general opportunistic shift from exposed outer coasts into more protected waters during the winter (Nelson 1997, p. 3); for example, many murrelets breeding on the exposed outer coast of Vancouver Island appear to congregate in the more sheltered waters within the Puget Sound and the Strait of Georgia in fall and winter (Burger 1995, p. 297). In many areas, murrelets also undertake occasional trips to inland nesting habitat during the winter months (Mendenhall 1992, p. 11). Throughout the listed range, murrelets do not appear to disperse long distances, indicating they are year-round residents (McShane et al. 2004, pp. 2-12, 2-13).

Throughout their range, murrelets are opportunistic feeders and utilize prey of diverse sizes and species. They feed primarily on fish and invertebrates in marine waters although they have also been detected on rivers and inland lakes (Carter and Sealy 1986, entire; Service 1992, p. 45328). In general, small schooling fish and large pelagic crustaceans are the main prey items. Pacific sand lance (*Ammodytes hexapterus*), northern anchovy (*Engraulis mordax*), immature Pacific herring (*Clupea harengus*), capelin (*Mallotus villosus*), Pacific sardine (*Sardinops sagax*), juvenile rockfishes (*Sebastas* spp.), and surf smelt (Osmeridae) are the most common fish species taken. Squid (*Loligo* spp.), euphausiids, mysid shrimp, and large pelagic amphipods are the main invertebrate prey. Murrelets are able to shift their diet throughout the year and over years in response to prey availability (Becker et al. 2007, entire). However, long-term adjustment to less energetically rich prey resources (such as invertebrates) appears to be partly responsible for poor murrelet reproduction in California (Becker and Beissinger 2006, pp. 475, 477).

Breeding adults exercise more specific foraging strategies when feeding chicks, usually carrying a single, relatively large (relative to body size) energy-rich fish to their chicks (Burkett 1995, p. 242; Nelson 1997, pp. 7-9), primarily around dawn and dusk (Nelson 1997, p. 18, Kuletz 2005, p. 35). Freshwater prey appears to be important to some individuals during several weeks in summer and may facilitate more frequent chick feedings, especially for those that nest far inland (Hobson 1990, p. 900). Becker et al. (2007, entire) found murrelet reproductive success in California was strongly correlated with the abundance of mid-trophic level prey (e.g., sand lance, juvenile rockfish) during the breeding and postbreeding seasons. Prey types are not equal in the energy they provide; for example, parents delivering fish other than age-1 herring may have to increase deliveries by up to 4.2 times to deliver the same energy value (Kuletz 2005, pp. 27-52). Therefore, nesting murrelets that are returning to their nest at least once per day must balance the energetic costs of foraging trips with the benefits for themselves and their young. This may result in murrelets preferring to forage in marine areas in close proximity to their nesting habitat. However, if adequate or appropriate foraging resources (i.e., “enough” prey, or prey with the optimum nutritional value for themselves or their young) are unavailable in close proximity to their nesting areas, murrelets may be forced to forage at greater distances or to abandon their nests (Huff et al. 2006, p. 20). Consequently, the distribution and abundance of prey Suitable for feeding chicks may greatly influence the overall foraging behavior and location(s) during the nesting season, may affect reproductive success (Becker et al. 2007, entire), and may significantly affect the energy demand on adults by influencing both the foraging time and number of trips inland required to feed nestlings (Kuletz 2005, pp. 43-51).

Nesting Biology

Incubation is shared by both sexes, and incubation shifts are generally one day, with nest exchanges occurring at dawn (Nelson 1997, p. 11, Bradley 2002, p. 36). Hatchlings appear to be brooded by a parent for one or two days and then left alone at the nest for the remainder of the chick period (from hatching until fledging) while both parents spend most of their time foraging at sea. Both parents feed the chick (usually a single fish carried in the bill) and the chick typically receives 1-8 meals per day (mean 3.2) (Nelson 1997, p. 18). About two-thirds of feedings occur early in the morning, usually before sunrise, and about one-third occur at dusk. Feedings are sometimes scattered throughout the day (Nelson 1997, p. 18). Chicks fledge 27-40 days after hatching, at 58-71 percent of adult mass (Nelson 1997, p. 19). Fledging has seldom been documented, but it typically appears to occur at dusk (Nelson 1997, p. 19).

Nest Tree Characteristics

Lank et al. (2003, p. 4) states that murrelets "occur during the breeding season in near-shore waters along the north Pacific coastline from Bristol Bay in Alaska to central California", nesting in single platform trees generally within 20 miles of the coast and older forest stands generally within 50 miles of the coast. Unlike most auks, murrelets nest solitarily on mossy platforms of large branches in old-forest trees (Lank et al. 2003, p. 4). Suitable murrelet habitat may include contiguous forested areas with conditions that contain potential nesting structure. These forests are generally characterized by large trees greater than 18 inches dbh, multi-storied canopies with moderate canopy closure, sufficient limb size and substrate (moss, duff, etc.) to support nest cups, flight accessibility, and protective cover from ambient conditions and potential avian predators (Burger 2002, pp. 39-43; Nelson and Wilson 2002, pp. 24-31). Over 95 percent of measured nest limbs were ≥15 cm diameter, with limb diameter ranges from 7-74 cm diameter (Burger 2002, 41-43). Nelson and Wilson (2002, p. 24) found that all 37 nest cups identified were in trees containing at least four platforms. All trees in their study were climbed, however, and ground-based estimates of platforms per tree in the study were not analyzed. Lank et al. (2003, p. 22) emphasizes that murrelets do not select nest sites based on tree species, but rather they select those individual trees that offer suitable nest platforms. Nest cups have been found in deciduous trees, albeit rarely and nest trees may be scattered or clumped throughout a forest stand.

A tree with potential nesting structure in Oregon typically has the following characteristics;

1) It occurs within 50 miles (81 km) of the coast (Service 1997, p. 32);
2) It is a conifer tree (Service 1997, p. 18, Burger 2002, p. 39);
3) It is ≥ 19.1 in. (49 cm) (dbh) in diameter and > 107 ft. (33 m) in height (Nelson and Wilson 2002, p. 32), although smaller trees have been documented in Alaska (Nelson 1997, p. 30);
4) It has ≥ one platform with the following characteristics:
    a. It is ≥ four in. (10 cm) wide (Nelson 1997, p. 30);
    b. It has nesting substrate (e.g., moss, epiphytes, duff) (Burger 2002, p. 42; Nelson and Wilson 2002, pp. 24, 100),
    c. It is in the live crown of the tree, either on the tree with nesting structure or on an adjacent tree (Nelson 1997, p. 16; Nelson and Wilson 2002, pp. 24, 98 & 99);
    d. It is located ≥ 32.5 ft. (9.9 m) above the ground (Nelson and Wilson 2002, p. 28); and

5) It has an access route through the canopy that a murrelet could use to approach and land on the platform (Nelson and Wilson 2002, p. 103). Because access should be viewed from above the canopy and we are assessing habitat from below the canopy, this aspect of nesting habitat may not be visible. Nelson and Wilson (2002, p. vii) suggests assessing access by looking for canopy layering, either natural (streams, gaps) or man-made edges and gaps as measures of access.

Nest Stand Characteristics

Nest stands are typically composed of low elevation conifer species. In California, nest sites have been located in stands containing old-growth redwood and Douglas-fir, while nests in Oregon and Washington have been located in stands dominated by Douglas-fir, western hemlock and Sitka spruce. Murrelets appear to select forest stands greater than 123.6 acres (50 ha) (Burger 2002, p. 108), but will use small patches of habitat surrounded by larger patches of unsuitable habitat (Nelson and Wilson 2002, p. 104). In surveys of mature or younger second-growth forests in California, murrelets were only found in forests where there were nearby old-growth stands or where residual older trees remained (Service 1992, p. 45329, Singer et al. 1995, p. 55).

At the stand level, vertical complexity is correlated with nest sites (Manley 1999, p. iii; Waterhouse et al. 2002, p. 12-13; Nelson and Wilson 2002, p. 97), and flight accessibility is probably a necessary component of Suitable habitat (Burger 2002, p. 80-86). Some studies have shown higher murrelet activity near stands of old-forest blocks over fragmented or unsuitable forest areas (Paton et al. 1992, entire; Rodway et al. 1993, entire; Burger 1995, entire; Deschesne and Smith 1997, entire; Rodway and Regehr 2002, entire), but this correlation may be confounded by ocean conditions, distance inland, elevation, survey bias and disproportionately available habitat. Nelson and Wilson (2002, p. 60) found that potential nest platforms per acre were a strong correlate for nest stand selection by murrelets in Oregon.

Adjacent forests can contribute to the conservation of the murrelet by reducing the potential for windthrow during storms by providing area buffers and creating a landscape with a higher probability of occupancy by murrelets (Service 1996, p. 26264; Meyer et al. 2002, p. 110; Service 2016, p. 51355). Trees surrounding and within the vicinity of a potential nest tree(s) may provide protection to the nest platform and potentially reduce gradations in microclimate (Chen et al. 1993, entire).

Landscape Characteristics

Studies have determined the characteristics of murrelet nesting habitat at a landscape-scale using a variety of methods, including predictive models, radio telemetry, audio-visual surveys (Evans Mack et al. 2003, entire), and radar. McShane et al. (2004, p. 4-103) reported, "At the landscape level, areas with evidence of occupancy tended to have higher proportions of large, old-growth forest, larger stands and greater habitat complexity, but distance to the ocean (up to about 37 miles [60 km]) did not seem important." Raphael et al. (2016a, p. 115, in Falxa and Raphael 2016) found that among the factors they investigated, nesting habitat factors (amounts and pattern, large contiguous patches) were the best predictors of murrelet population distribution and trends at sea. Elevation had a negative association in some studies with murrelet habitat occupancy (Burger 2002, entire). Hamer and Nelson (1995b, entire) sampled 45 nest trees in

British Columbia, Washington, Oregon, and California and found the mean elevation to be 1,089 feet (332 m).

Multiple radar studies (e.g., Burger 2001, entire; Cullen 2002, entire; Raphael et al. 2002, entire; Steventon and Holmes 2002, entire) in British Columbia and Washington have shown that radar counts of murrelets are positively associated with total watershed area, increasing amounts of late-seral forests, and with increasing age and height class of associated forests. Murrelet radar counts are also negatively associated with increasing forest edge and areas of logged and immature forests (McShane et al. 2004, pp. 4-40 to 4-41). Several studies have concluded that murrelets do not pack into higher densities within remaining habitat when nesting habitat is removed (Burger 2001, entire; Manley et al. 2001, entire; Cullen 2002, entire).

There is a relationship between proximity of human-modified habitat and increased avian predator abundance. However, increased numbers of avian predators do not always result in increased predation on murrelet nests. For example, Luginbuhl et al. (2001, p. 565) report, in a study using simulated murrelet nests, that “Corvid numbers were poorly correlated with the rate of predation within each forested plot”. Luginbuhl et al. (2001, p. 569), conclude, “that using measurements of corvid abundance to assess nest predation risk is not possible at the typical scale of homogenous plots (0.5-1.0 km2 in our study). Rather this approach should be considered useful only at a broader, landscape scale on the order of 5-50 km2 (based on the scale of our fragmentation and human-use measures).”

If the surrounding landscape has been permanently modified to change the predators’ numbers or densities through, for example, agriculture, urbanization, or recreation, and predators are causing unnaturally high nest failures, murrelet reproductive success may remain depressed. Because corvids account for the majority of depredations on murrelet nests and corvid density can increase with human development, corvid predation on murrelet habitat is a primary impact consideration. The threat of predation on murrelet populations (both nests and adults) appears to be greater than previously anticipated (McShane et al. 2004, pp. 2-15 to 2-19).

Population Dynamics

Current population and distribution of the listed species

Based on the results from the NWFP Effectiveness Monitoring Program, the 2017 murrelet population for Conservation Zones 1-5 is estimated at 23,000 birds, a slight increase from 2016 (Figure MAMU 1 and Figure MAMU 1. The six geographic areas identified as Conservation Zones in the recovery plan for the murrelet (Service 1997, p. 114). Critical habitat beyond these mapped areas is considered part of the conservation zone (Service 1997, p. 127).

Table MAMU 1). Recovery zones are the functional equivalent of recovery units as defined by Service policy (Service 1997, p. 115). Conservation Zone 3 and part of 4 occur in Oregon and cover the action area.

The data no longer demonstrate a significant murrelet population decline within the range of the NWFP, but the decline is still significant in WA (Table MAMU 2). This lack of a demonstrated NWFP-wide decline may be due to sample size or statistical power of the sampling design (see Figure MAMU 1. The six geographic areas identified as Conservation Zones in the recovery plan for the murrelet (Service 1997, p. 114). Critical habitat beyond these mapped areas is considered part of the conservation zone (Service 1997, p. 127).

Table MAMU 1 for confidence intervals). Conservation Zones 3 and 4 support 47 percent of the murrelet population within the U.S. (Table MAMU 3), and consistently have the highest – at-sea densities during the nesting season. Murrelets continue to occur in the lowest abundance in Conservation Zones 5 and 6.

At-sea surveys are also conducted in Conservation Zone 6, independent of the NWFP Effectiveness Monitoring Program, using similar survey methods. The 2018, marbled murrelet population for Conservation Zone 6 is estimated at about 370 birds (95 percent confidence limit [CL]: 250-546; Felis et al 2019, p. 7 Table 3, see Table MAMU 4).

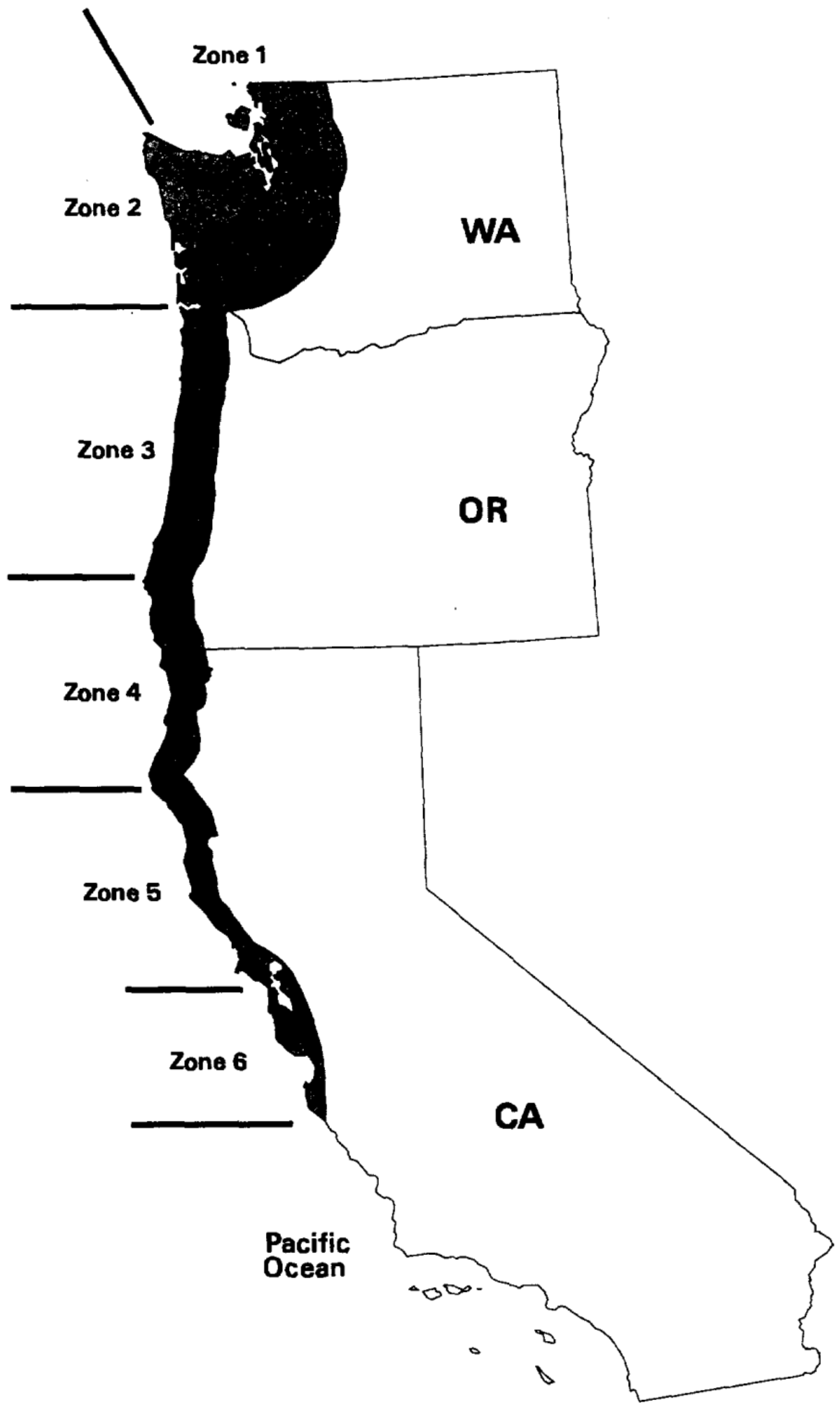

Figure MAMU 1. The six geographic areas identified as Conservation Zones in the recovery plan for the murrelet (Service 1997, p. 114). Critical habitat beyond these mapped areas is considered part of the conservation zone (Service 1997, p. 127).

Table MAMU 1. Summary of 2001-2017 marbled murrelet density and population size estimates (rounded to nearest 100 birds) for Conservation Zones 1-5 combined. Numbers in some years may differ slightly from those in previous summary reports (as indicated by an asterisk [*], as a result of additional data quality reviews performed in 2019. Note that the most recent range-wide estimate is always one year behind the current sampling year because it takes two years to derive estimates when sampling units every other year. (McIver et al. 2019, Table 1).

Year	Density (birds/km2)	Bootstrap Standard Error (birds/km2)	Coefficient of Variation of Density (%)	Birds	Birds Lower 95% CL	Birds Upper 95% CL
2001*	2.53	0.25	9.8%	22,300	18,000	26,600
2002*	2.58	0.30	11.8%	22,700	17,400	27,900
2003*	2.53	0.23	9.1%	22,200	18,300	26,200
2004	2.46	0.26	10.5%	21,600	17,100	26,000
2005	2.30	0.25	10.7%	20,200	16,000	24,400
2006	2.09	0.17	8.2%	18,300	15,400	21,300
2007	1.97	0.27	13.7%	17,300	12,700	22,000
2008	2.06	0.18	8.9%	18,100	15,000	21,300
2009	1.96	0.21	10.6%	17,200	13,700	20,800
2010	1.89	0.21	11.1%	16,600	13,000	20,200
2011	2.50	0.31	12.6%	22,000	16,600	27,400
2012	2.40	0.27	11.3%	21,100	16,400	25,800
2013	2.24	0.25	11.1%	19,700	15,400	23,900
2014*	2.42	0.22	9.2%	21,300	17,500	25,100
2015	2.75	0.26	9.5%	24,100	19,700	28,600
2016	2.58	0.26	10.0%	22,600	18,200	27,100
2017	2.62	0.26	10.0%	23,000	18,500	27,600

Table MAMU 2. Estimates of average annual rate of marbled murrelet population change based on at-sea population surveys. Confidence limits are for the estimates of percent annual change. The P-value is based on a 2-tailed test for whether the annual rate of change is less than zero, significant values are shaded in gray. Please note that the period of analysis extends to either 2017 or 2018 depending on which year sampling units were last surveyed. (McIver et al. 2019, Table 2).

Zone or State	Period of Analysis	Annual Rate of Change (%)	95% Conf. Limits		Adjusted R^2	P-value
			Lower	Upper		
Zone 1	2001-2018	-4.9	-7.3	-2.4	0.503	<0.001
Zone 2	2001-2017	-3.0	-6.8	0.9	0.105	0.119
Zone 3	2000-2018	1.4	-0.4	3.3	0.104	0.111
Zone 4	2000-2017	3.7	1.4	6.1	0.425	0.004
Zone 5	2000-2017	7.3	−4.4	20.3	0.085	0.199
WA	2001-2017	-3.9	-5.8	-2.0	0.523	<0.001
OR	2000-2017	2.0	0.5	3.6	0.279	0.014
CA	2000-2017	4.5	2.2	6.9	0.487	<0.001
All Zones	2001-2017	0.34	−0.9	1.6	0.000	0.569

Table MAMU 3. Summary of 2000 to 2017 marbled murrelet density and population size estimates within the NWFP area at the State scale. (From McIver et al. 2019, Table 4).

Year	State	Density (murrelets per km2)	Murrelets	Murrelets 95% CL Lower	Murrelets 95% CL Upper	Area (km2)
2001	WA	2.13	11,030	7,554	14,505	5,188
2002	WA	2.32	11,951	7,687	16,216	5,151
2003	WA	2.31	11,894	8,729	15,058	5,149
2004	WA	1.65	8,474	5,625	11,322	5,149
2005	WA	2.05	10,533	7,179	13,887	5,148
2006	WA	1.61	8,280	6,024	10,536	5,148
2007	WA	1.85	9,520	5,946	13,095	5,148
2008	WA	1.29	6,628	4,808	8,448	5,148
2009	WA	1.34	6,894	4,495	9,294	5,148
2010	WA	1.10	5,679	3,840	7,518	5,148
2011	WA	1.63	8,376	5,802	10,950	5,148
2012	WA	1.87	9,629	6,116	13,142	5,148
2013	WA	1.10	5,646	3,195	8,097	5,148
2014	WA	0.97	4,977	3,248	6,706	5,148
2015	WA	1.46	7,494	4,711	10,276	5,148
2016	WA	1.38	7,095	4,060	10,130	5,148
2017	WA	1.16	5,984	3,204	8,764	5,148
2000	OR	3.85	7,983	4,992	10,974	2,071
2001	OR	4.43	9,168	6,654	11,682	2,071
2002	OR	3.64	7,530	4,727	10,332	2,071
2003	OR	3.56	7,380	5,370	9,390	2,075
2004	OR	4.40	9,112	6,833	11,391	2,071
2005	OR	3.36	6,966	4,812	9,121	2,071
2006	OR	3.68	7,617	5,916	9,318	2,071
2007	OR	2.59	5,357	3,332	7,381	2,071
2008	OR	3.64	7,541	5,682	9,400	2,071
2009	OR	3.58	7,423	5,208	9,638	2,071
2010	OR	3.95	8,182	5,743	10,622	2,071
2011	OR	4.05	8,379	5,943	10,816	2,071
2012	OR	3.76	7,780	5,605	9,956	2,071
2013	OR	4.74	9,819	7,195	12,443	2,071
2014	OR	5.50	11,384	8,839	13,930	2,071
2015	OR	5.30	10,975	8,188	13,762	2,071
2016	OR	4.85	10,053	7,527	12,580	2,071
2017	OR	5.28	10,945	8,018	13,872	2,071
2000	CA	2.28	3,571	1,884	5,258	1,566
2001	CA	1.31	2,049	600	3,497	1,566
2002	CA	2.04	3,202	2,181	4,224	1,566
2003	CA	1.90	2,985	1,753	4,217	1,567

2004	CA	2.55	3,986	2,197	5,775	1,566
2005	CA	1.73	2,710	1,896	3,523	1,566
2006	CA	1.56	2,438	1,727	3,149	1,566
2007	CA	1.56	2,440	1,465	3,415	1,566
2008	CA	2.53	3,964	2,802	5,126	1,566
2009	CA	1.87	2,928	1,589	4,268	1,566
2010	CA	1.69	2,644	1,098	4,191	1,566
2011	CA	3.33	5,217	1,962	8,472	1,566
2012	CA	2.24	3,514	1,812	5,216	1,566
2013	CA	2.67	4,178	2,662	5,694	1,566
2014	CA	3.14	4,922	3,410	6,433	1,566
2015	CA	3.62	5,666	3,970	7,361	1,566
2016	CA	3.51	5,489	3,995	6,984	1,566
2017	CA	3.90	6,111	4,473	7,749	1,566

Table MAMU 4. Annual at-sea murrelet estimates for surveys drawn in both directions, surveys only drawn from the north, and surveys only drawn from the south, U.S. Fish and Wildlife Service Conservation Zone 6, central California, 1999–2018. (Felis et al 2019, p. 7 Table 3).

	Both directions			North			South		
Year	N	95% CI	n	N	95% CI	n	N	95% CI	n
1999	N/A			487	333–713	5	No surveys		
2000	N/A			496	338–728	8	No surveys		
2001	661	556–786	15	637	441–920	8	733	583–922	7
2002	683	561–832	15	628	487–809	9	729	494–1,075	6
2003	699	567–860	12	615	463–815	6	782	570–1,074	6
2004	No surveys			No surveys			No surveys		
2005	No surveys			No surveys			No surveys		
2006	No surveys			No surveys			No surveys		
2007	378	238–518	4	269	109–429	2	488	349–626	2
2008	174	91–256	4	122	61–184	1	225	131–319	3
2009	631	449–885	8	495	232–1,054	4	789	522–1193	4
2010	446	340–585	7	366	240–559	4	560	343–925	3
2011	433	339–553	6	320	225–454	2	452	331–618	4
2012	487	403–588	6	475	373–605	3	501	359–699	3
2013	628	386–1,022	6	439	233–827	3	556	126–2,456	3
2014	438	307–624	9	444	258–765	4	434	231–817	4
2015	243	152–386	9	225	136–370	4	296	159–549	5
2016	657	406–1,063	7	510	358–726	3	720	297–1,747	4
2017	530	384–732	9	413	247–689	4	790	487–1,280	5
2018	370	250–546	9	513	334–788	4	227	112–460	5

The at-sea distribution also exhibits discontinuity within Conservation Zones 1, 2, 5, and 6, where five areas of discontinuity are noted: a segment of the border region between British Columbia, Canada and Washington, southern Puget Sound, WA, Destruction Island, WA to Tillamook Head, OR, Humboldt County, CA to Half Moon Bay, CA, and the entire southern end of the breeding range in the vicinity of Santa Cruz and Monterey Counties, CA (McShane et al. 2004, p. 3-70).

Current Nesting Habitat

McShane et al. (2004, p. 4-2), reviewed and summarized habitat estimates from 16 sources and estimated the amount of murrelet nesting habitat at 2,223,048 acres distributed throughout Washington, Oregon, and California (McShane et al. 2004, p. 4-5). Washington State contains almost half of all remaining nesting habitat with an estimated 1,022,695 acres or 48 percent of the total. Approximately 93 percent (2,000,000 acres) are reported to occur on Federal lands (McShane et al. 2004, p. 4-10).

In another effort, Raphael et al. (2006, in Huff et al. 2006) produced two spatial models for the NWFP Effectiveness Monitoring program to predict the amount, location, and distribution of murrelet nesting habitat. Combining vegetation-based maps derived from satellite imagery and prior estimates of habitat on State and private lands from 1994 to 2003, (Raphael et al. 2006, p. 109 in Huff et al. 2006) used a panel of experts to reclassify 22 old-growth forest classes into four classes of murrelet habitat based upon nesting suitability. Referred to as the Expert Judgment Model, the model classifies existing forest structure, based upon percent conifer cover, canopy structure, quadratic mean diameter, and forest patch size, into four classes of suitability for nesting murrelets. Raphael et al. (2006, p. 116-123 in Huff et al. 2006) found that across the murrelet range, most habitat-capable land (52 percent) is unsuitable nesting habitat (Class 1) and 18 percent is classified as Class 4 habitat (highest suitability), with an estimated 41 percent of the Class 4 habitat (1,620,800 acres) occurring on non-Federal lands.

The second habitat model developed by Raphael et al. (2006 in Huff et al. 2006, p. 110-115, 130-143) used the Biomapper Ecological Niche-Factor Analysis methodology developed by Hirzel et al. (2002, entire). The resulting murrelet habitat suitability maps are based on both the physical and vegetative attributes adjacent to known murrelet occupied polygons or nest locations for each NWFP province. The maps provide a range of habitat suitability values, each with acreage estimates. In Washington, 2.1 million acres of habitat were rated with a habitat suitability (HS) greater than 60 and captured 82 percent of the stands documented as occupied, while 440,700 acres of habitat were rated as HS >80 habitat and captured 36 percent of the known occupied stands.

More recently, (Falxa and Raphael 2016, entire) used habitat modeling to estimate habitat within the NWFP. Because the modeling was improved (updated data, models, and methods) from the previous modeling effort, results, including the 1993 baseline, are different (Falxa and Raphael 2016, p. 85). Results are displayed in Table MAMU 5. Class 3 and 4 were classified as higher suitable murrelet habitat (Falxa and Raphael 2016, p. 77).

The Service believes the Raphael et al. (2016b, entire, in Falxa and Raphael 2016) model, which relates known (occupied) murrelet nest stands to habitat abundance, distribution, and quality, represents the best available information on the subject (Table MAMU 5). While not necessarily the best means to describe Suitable habitat at the site scale, the Service expects this model to have higher reliability for provincial-scale analysis compared to previous efforts.

Table MAMU 5. Distribution of murrelet nesting habitat on all lands, by habitat suitability class, for the baseline period (1993) and final year of analysis (2012). Table from Raphael et al. 2016b, p. 69, in Falxa and Raphael 2016.

All Lands – 1993 (1000s of acres)						All Lands – 2012 (1000s of acres)				
State or Province	Class 1	Class 2	Class 3	Class 4	Habitat Capable Total	Class 1	Class 2	Class 3	Class 4	Habitat Capable Total
Washington										
(Maxent score)	0–-0.06	0.06–0.21	0.21–0.53	0.53–1		0–-0.06	0.06–0.21	0.21–0.53	0.53–1	
Olympic Peninsula	902.9	960.5	623.3	235.4	2,722.1	971.2	994.0	549.7	207.2	2,722.1
Western Lowlands	2,817.7	1,173.3	236.0	32.9	4,259.9	3,182.9	889.2	167.4	20.4	4,259.9
Western Cascades	2,001.8	1,190.3	377.2	25.9	3,595.3	2,077.2	1,139.6	357.8	20.6	3,595.3
Eastern Cascades	158.6	97.0	16.7	1.5	273.8	141.1	112.7	18.5	1.5	273.8
Total	5,881.0	3,421.1	1,253.3	295.7	10,851.0	6,372.4	3,135.5	1,093.4	249.8	10,851.0
Oregon:										
(Maxent score)	0–0.04	0.04–0.18	0.18–0.51	0.51–1		0–0.04	0.04–0.18	0.18–0.51	0.51–1	
Coast Range	2,803.6	1,303.7	567.5	121.6	4,796.5	3,007.8	1,153.4	514.5	120.8	4,796.5
Willamette Valley	98.7	5.7	0.0	0.0	104.5	101.5	3.0	0.0	0.0	104.5
Western Cascades	4.2	0.6	0.0	0.0	4.8	4.4	0.4	0.0	0.0	4.8
Klamath	938.5	601.9	147.3	16.9	1,704.5	1,066.3	498.8	122.3	17.2	1,704.5
Total	3,845.0	1,912.0	714.8	138.6	6,610.4	4,180.0	1,655.6	636.8	137.9	6,610.4
California:										
(Maxent score)	0–0.01	0.01–0.17	0.17–0.57	0.57–1		0–0.01	0.01–0.17	0.17–0.57	0.57–1	
Coast Range	1,418.4	687.5	108.2	22.5	2,236.5	1,385.9	743.7	87.3	19.7	2,236.5
Klamath	961.6	50.2	1.8	0.1	1,013.6	959.7	51.9	1.9	0.1	1,013.6
Total	2,379.9	737.6	110.0	22.6	3,250.1	2,345.6	795.6	89.2	19.7	3,250.1
Plan area total	12,106.0	6,070.7	2,078.0	456.8	20,711.5	12,897.9	5,586.7	1,819.5	407.4	20,711.5

a Numbers rounded to nearest 100; total computed prior to rounding

Population structure

Murrelets are long-lived seabirds that spend most of their life in the marine environment, with breeding adult birds, usually age three or greater, annually nesting in the forest canopy of mature and old-growth forests from about March 24 through September 15. Murrelets have a naturally low reproductive rate, with pair's reproduction limited to one young per year.

Recovery Zones

The Recovery Plan identified six Conservation Zones (Figure 11) throughout the listed range of the species: Puget Sound (Conservation inland zone 1), Western Washington Coast Range (Conservation inland zone 2), Oregon Coast Range (Conservation Zone 3), Siskiyou Coast Range (Conservation Zone 4), Mendocino (Conservation Zone 5), and Santa Cruz Mountains (Conservation Zone 6). Recovery zones are the functional equivalent of recovery units as defined by Service policy (Service 1997, p. 115). Conservation Zones 3 and the northern part of 4 occur in Oregon and these conservation zones includes all lands within 35 miles of the coast and any lands designated as critical habitat beyond 35 miles of the coast (Service 1997, p. 127).

Reproductive estimates

Generally, estimates of murrelet fecundity are directed at measures of breeding success, either from direct assessments of nest success in the terrestrial environment, marine counts of hatch-year birds, or computer models. Telemetry estimates are typically preferred over marine counts for estimating breeding success due to fewer biases (McShane et al. 2004, p. 3-2). However, because of the challenges of conducting telemetry studies, estimating murrelet reproductive rates with an index of reproduction, referred to as the juvenile ratio (Ŕ), continues to be important, despite the debate over use of this index (see discussion in Beissinger and Peery 2007, p. 296).

Although difficult to obtain, nest success rates are available from telemetry studies conducted in California (Hebert and Golightly 2006, entire; Peery et al. 2004, entire) and Washington (Bloxton and Raphael 2006, entire). In northwestern Washington, Bloxton and Raphael (2005, p. 5) documented a nest success rate of 0.20 (2 chicks fledging from 10 nest starts). In central California, murrelet nest success is 0.16 (Peery et al. 2004, p. 1098) and in northern California it is 0.31 to 0.56 (Hebert and Golightly 2006, p. 95). No studies or published reports from Oregon are available.

Unadjusted and adjusted values for annual estimates of murrelet juvenile ratios at sea suggest extremely low breeding success in all parts of the listed range, including Conservation Zone 4 (mean ratio for 2000-2011 of 0.046, range 0.01 to 0.1, CCR 2012, p. 11), northern California (0.003 to 0.029 - Long et al. 2008, pp. 18-19; CCR 2012, p. 11), central California (0.035 and 0.032 - Beissinger and Peery 2007, pp. 299, 300), and in Oregon (0.0254 - 0.0598 - CCR 2008, p. 13).

These current estimates of Ŕ are assumed to be below the level necessary to maintain or increase the murrelet population within the listed range. Demographic modeling suggests murrelet population stability requires a minimum reproductive rate of 0.2 to 0.3 chicks per pair per year (Beissinger and Peery 2007, p. 302; Service 1997, p. B-35; Beissinger 1995, p. 390). The estimates for Ŕ discussed above from individual studies, as well as Ŕ estimates for the listed range (0.02 to 0.13) are all below the lowest estimated Ŕ value (0.2) identified as required for population stability (Beissinger and Peery 2007, p. 302).

The current estimates for Ŕ also appear to be well below what may have occurred prior to the murrelet population decline. Beissinger and Peery (2007, p. 298) performed a comparative analysis using historic data from 29 bird species to predict the historic Ŕ for murrelets in central California, resulting in an estimate of 0.27 (95 percent CI: 0.15 - 0.65). Therefore, the best available scientific information of current murrelet fecundity from model predictions, and from juvenile ratios and trend analyses based on population survey data appear to align well; both indicate that the murrelet reproductive rate is generally insufficient to maintain stable population numbers throughout all or portions of the species' listed range.

Status and Distribution

Historical status and distribution

Murrelet abundance during the early 1990s in Washington, Oregon, and California was estimated at 26,950 to 31,950 birds (Ralph et al. 1995, p. 10).

The historical breeding range of the murrelet extends from Bristol Bay, Alaska, south to the Aleutian Archipelago, northeast to Cook Inlet, Kodiak Island, Kenai Peninsula and Prince William Sound, south coastally throughout the Alexander Archipelago of Alaska, and through British Columbia, Washington, Oregon, to northern Monterey Bay in central California. Birds winter throughout the breeding range and also occur in small numbers off southern California. At the time of listing, the distribution of active nests in nesting habitat was described as non-continuous (Service 1997, p. 14). The at-sea extent of the species currently encompasses an area similar in size to the species' historic distribution, but with the extremely low density of murrelets in Conservation Zone 5, and the small population in Conservation Zone 6, the southern end of the murrelet distribution is sparsely populated compared to Conservation Zones 1-4.

Status of Nesting Habitat Lost Since 1992

The Service has determined that the rate of habitat loss has declined since listing, particularly on Federal lands due to implementation of the NWFP (Service 2004, pp. 11, 13). Between 1992 and 2003, the estimated loss of suitable murrelet habitat totaled 22,398 acres in Washington, Oregon, and California combined, of which 5,364 acres resulted from timber harvest and 17,034 acres resulted from natural events (McShane et al. 2004, pp. 4-64). Those data primarily represented losses on Federal lands and did not include data for most private or State lands within the murrelet's range.

More recently, (Falxa and Raphael 2016, p. 72) used habitat modeling to estimate losses of potential murrelet habitat for the period from 1993 to 2012 on both Federal and non-Federal lands within the five Conservation Zones in the NWFP area. They estimated there were 2.53 million acres of potential nesting habitat over all lands in the murrelet's range in Washington, Oregon, and California at the start of the NWFP (1993). Of this, 0.46 million acres were identified as the highest quality habitat. Ninety percent of the 1993 potential nesting habitat on federally administered lands occurred within reserved-land allocations. Forty one percent of potential nesting habitat occurred on non-Federal lands, including 44 percent of the highest quality habitat.

Raphael et al. (2016b, p. 72, in Falxa and Raphael 2016) found a net loss of 12 percent of potential nesting habitat from 1993 to 2012. Loss on Federal lands was about two percent of the potential nesting habitat from 1993 to 2012, and on non-Federal lands the loss was about 27 percent of the potential nesting habitat from 1993 to 2012. Fire was the major cause of nesting habitat loss on Federal lands since 1993; timber harvest was the primary cause of loss on non-Federal lands. Raphael et al. (2016b, p. 37, in Falxa and Raphael 2016) concluded that the NWFP has been successful in conserving murrelet habitat on Federal lands and that losses of habitat on Federal lands will continue due to fires and other disturbance events, but they expect those losses to be exceeded by recovery of currently unsuitable habitat within reserves as forests mature.

Consulted on effects that impact suitable habitat from October 1, 2003 to October 31, 2019 are summarized in
Table MAMU 6. An estimated 27,955 acres have been 'removed' in association with consultations to date, including technical assistance entries to update the baseline after a fire event.

Table MAMU 6. Aggregate results of all suitable habitat (acres) affected as determined by section 7 consultation for the marbled murrelet; summary of effects by Conservation Zone and habitat type from October 1, 2003 to Present (Service 2019).

Thu Oct 31 14:32:22 MDT 2019

Conservation Zone1	Authorized Habitat Effects2		Reported Habitat Effects2	
	Stands3	Remnants4	Stands3	Remnants4
Puget Sound	-114	0	-1	0
Western Washington	-3,051	0	-12	0
Outside CZ Area in WA	0	0	0	0
Oregon Coast Range	-5,748	-2,671	-2,924	-1,608
Siskiyou Coast Range	-16,061	-271	-5,184	-187
Outside CZ Area in OR	-36	-3	0	0
Mendocino	0	0	0	0
Santa Cruz Mountains	0	0	0	0
Outside CZ Area in CA	0	0	0	0
Total	-25,010	-2,945	-8,121	-1,795

Notes:

1. Conservation Zones (CZ) six zones were established by the 1997 Recovery Plan to guide terrestrial and marine management planning and monitoring for the Marbled Murrelet. Marbled Murrelet Recovery Plan, September, 1997
2. Habitat includes all known occupied sites, as well as other suitable habitat, though it is not necessarily occupied. Importantly, there is no single definition of suitable habitat, though the Marbled Murrelet Effectiveness Monitoring Section is in the process. Some useable working definitions include the Primary Constituent Elements as defined in the Critical Habitat Final Rule, or the criteria used for Washington State by Raphael et al. (Condor 104:331-342).
3. Stand: A patch of older forest in an area with potential platform trees.
4. Remnants: A residual or remnant stand is an area with scattered potential platform trees within a younger forest that lacks, overall, the structures for marbled murrelet nesting.

Range-wide Trend, Population

There are two general approaches that researchers use to assess murrelet population trend: at-sea surveys and population modeling based on demographic data. In general, the Service assigns greater weight to population trend and status information derived from at-sea surveys than estimates derived from population models because survey information generally provides more reliable estimates of trend and abundance.

The annual rate of population change for all NWFP zones between 2000 and 2017 was 0.34 percent, based on at-sea surveys (McIver et al. 2019, p. 9). However, these results are inconclusive because the confidence interval for the rate of population change overlap zero. The lack of a conclusive trend in murrelet populations described above is different from previous reports. Previously, Miller et al. (2012, entire) reported that the murrelet population was declining throughout its range (estimated at 29 percent decline for the listed population from 2001 to 2010). The annual population decline during 2001 to 2010 was 3.7 percent. It is unknown what is driving recent population levels. According to Falxa et al. (2016, p. 29, in Falxa and Raphael 2016), the increase in the murrelet population between 2011 and 2013 is too rapid to be attributable to habitat change, because nesting habitat takes many decades to several centuries to develop and is too slow a process to account for the rate of population change. Data does suggest that the habitat loss is likely contributing to variation in trends across the listed range of the murrelet (Falxa et al. 2016, p. 26, in Falxa and Raphael 2016).

Population Models

Prior to the use of survey data to estimate trend, demographic models were more heavily relied upon to generate predictions of trends and extinction probabilities for the murrelet population (Beissinger 1995, entire; Cam et al. 2003, entire; McShane et al. 2004, pp. 3-27 to 3-57; Service 1997, B-1 to B-19). However, murrelet population models remain useful because they provide insights into the demographic parameters and environmental factors that govern population stability and future extinction risk, including stochastic factors that may alter survival, reproductive, and immigration or emigration rates.

In a report developed for the 5-year Status Review of the Murrelet in Washington, Oregon, and California (McShane et al. 2004, pp. 3-27 to 3-60), computer models were used to forecast 40-year murrelet population trends. A series of female-only, multi-aged, discrete-time stochastic Leslie Matrix population models were developed for each conservation zone to forecast decadal population trends over a 40-year period and extinction probabilities beyond 40 years (to 2100). The authors incorporated available demographic parameters (
Table MAMU 7) for each conservation zone to describe population trends and evaluate extinction probabilities (McShane et al. 2004, p. 3-49).

McShane et al. (2004, p. 3-4) used mark-recapture studies conducted in British Columbia by Cam et al. (2003, entire) and Bradley et al. (2004, entire) to estimate annual adult survival and telemetry studies or at-sea survey data to estimate fecundity. Model outputs predicted 3.1 to 4.6 percent mean annual rates of population decline per decade the first 20 years of model simulations in murrelet Conservation Zones 1 through 5 (McShane et al. 2004, p. 3-52). Simulations for all zone populations predicted declines during the 20 to 40-year forecast, with mean annual rates of 2.1 to 6.2 percent decline per decade (McShane et al. 2004, p. 3-52). These reported rates of decline are similar to the estimates of four to seven percent per year decline reported in the Recovery Plan (Service 1997, p. 5).

Table MAMU 7. Murrelet demographic parameter values based on four studies all using Leslie Matrix models.

Demographic Parameter	Beissinger 1995	Beissinger and Nur 1997*	Beissinger and Peery (2007)	McShane et al. 2004
Juvenile Ratio (Ŕ)	0.10367	0.124 or 0.131	0.089	0.02 - 0.09
Annual Fecundity	0.11848	0.124 or 0.131	0.06-0.12	-
Nest Success	-	-	0.16-0.43	0.38 - 0.54
Maturation	3	3	3	2 - 5
Estimated Adult Survivorship	85 % – 90%	85 % – 88 %	82 % - 90 %	83 % – 92 %

*In Service (1997).

McShane et al. (2004, pp. 3-54 to 3-60) modeled population extinction probabilities beyond 40 years under different scenarios for immigration and mortality risk from oil spills and gill nets. Modeled results forecast different times and probabilities for local extirpations, with an extinction risk of 16 percent and mean population size of 45 individuals in 100 years in the listed range of the species (McShane et al. 2004, pp. 3-58).

Reason for Listing-Threats

When the murrelet was listed under the Endangered Species Act (Service 1992) and threats summarized in the Recovery Plan (Service 1997, pp. 43-76), several anthropogenic threats were identified as having caused the dramatic decline in the species:

1. habitat destruction and modification in the terrestrial environment from timber harvest and human development caused a severe reduction in the amount of nesting habitat;
2. unnaturally high levels of predation resulting from forest “edge effects”;
3. the existing regulatory mechanisms, such as land management plans (in 1992), were considered inadequate to ensure protection of the remaining nesting habitat and reestablishment of future nesting habitat; and
4. manmade factors such as mortality from oil spills and entanglement in fishing nets used in gill-net fisheries.

There have been changes in the levels of these threats since the 1992 listing (Service 2004, pp. 11-12; Service 2009, pp. 27-67). The regulatory mechanisms implemented since 1992 that affect land management in Washington, Oregon, and California (for example, the NWFP) and new gill-netting regulations in northern California and Washington have reduced the threats to murrelets (Service 2004, pp. 11-12). The levels for the other threats identified in 1992 listing (Service 1992) including the loss of nesting habitat, predation rates, and mortality risks from oil spills and gill net fisheries (despite the regulatory changes) remained unchanged following the Service's 2004, 5-year, range-wide status review for the murrelet (Service 2004, pp. 11-12).

New Threats

New threats were identified in the Service's 2009, 5-year review for the murrelet (Service 2009, pp. 27-67). These new stressors are due to several environmental factors affecting murrelets in the marine environment. These new stressors include:

1. Habitat destruction, modification, or curtailment of the marine environmental conditions necessary to support murrelets due to:
    a. elevated levels of polychlorinated biphenyls in murrelet prey species;
    b. changes in prey abundance and availability;
    c. changes in prey quality;
    d. harmful algal blooms that produce biotoxins leading to domoic acid and paralytic shellfish poisoning that have caused murrelet mortality; and
    e. climate change in the Pacific Northwest.

2. Manmade factors that affect the continued existence of the species include:
    a. derelict fishing gear leading to mortality from entanglement;
    b. energy development projects (wave, tidal, and on-shore wind energy projects) leading to mortality; and
    c. disturbance in the marine environment (from exposures to lethal and sub-lethal levels of high underwater sound pressures caused by pile-driving, underwater detonations, and potential disturbance from high vessel traffic; particularly a factor in Washington state).

There is growing evidence that recent climate change has impacted a wide range of ecological systems (Stenseth et al. 2002, entire; Walther et al. 2002, entire; Ådahl et al. 2006, entire; Karl et al. 2009, entire; Moritz et al. 2012, entire; Westerling et al. 2011, p. S459; Marlon et al. 2012, p. E541). Climate change, combined with effects from past management practices, is exacerbating changes in forest ecosystem processes and dynamics to a greater degree than originally anticipated under the NWFP. Environmental variation affects all wildlife populations; however, climate change presents new challenges as systems may change beyond historical ranges of variability. In some areas, changes in weather and climate may result in major shifts in vegetation communities that can persist in particular regions.

The Service believes climate change is likely to further exacerbate some existing threats such as the projected potential for increased habitat loss from drought-related fire, mortality, insects and disease in the short-term (10 to 30 years). These potential impacts will affect the environmental baseline for murrelets and other listed species, and we provide a general overview of these potential effects in Appendix D. Although it appears likely that the murrelet will be adversely affected by long-term consequences of climate change, we are not able to specifically quantify the magnitude of effects to the species (Service 2009, p. 34). However, the PRMP provides measures that will ameliorate these impacts and that should provide for the long-term persistence of the murrelet and other forest-dependent species. For example, the PRMP will result in a net increase in higher quality late-successional forest during the 50 years of the plan; the total area of protected forest reserves will increase; the district-mapped older, structurally complex, conifer forests were included in the LSRs; and the BLM will apply ecological forestry management principles that will better enable management of risk due to catastrophic wildfire. These measures, described in detail elsewhere in this BO, will increase the ability of the murrelet to persist and recover in the face of climate change effects by providing additional areas of habitat. Several threats to murrelets, present in both the marine and terrestrial environments, have been identified. These threats collectively comprise a suite of environmental stressors that, individually or through interaction, have significantly disrupted or impaired behaviors which are essential to the reproduction or survival of individuals. When combined with the species' naturally low reproductive rate, these stressors have led to declines in murrelet abundance, distribution, and reproduction at the population scale within the listed range.

Detailed discussions of the above-mentioned threats, life-history, biology, and status of the murrelet are presented in the Federal Register, listing the murrelet as a threatened species (Service 1992, entire); the Recovery Plan, Ecology and Conservation of the Murrelet (Ralph et al. 1995, entire); the final rule designating murrelet critical habitat (Service 1996, entire); the Evaluation Report in the 5-Year Status Review of the Murrelet in Washington, Oregon, and California (McShane et al. 2004, entire); the 2004 and 2009, 5-year Reviews for the Murrelet (Service 2004, entire; Service 2009, entire), and the final rule revising critical habitat for the murrelet (Service 2011, entire).

Conservation

Needs

Reestablishing an abundant supply of high-quality murrelet nesting habitat is a vital conservation need given the extensive habitat removal during the 20th century. However, there are other conservation imperatives. Foremost among the conservation needs are those in the marine and terrestrial environments to increase murrelet fecundity by increasing the number of breeding adults, improving murrelet nest success (due to low nestling survival and low fledging rates), and reducing anthropogenic stressors that reduce individual fitness or lead to mortality.

The overall reproductive success (fecundity) of murrelets is directly influenced by nest predation rates (reducing nestling survival rates) in the terrestrial environment and an abundant supply of high quality prey in the marine environment during the breeding season (improving potential nestling survival and fledging rates). Anthropogenic stressors affecting murrelet fitness and survival in the marine environment are associated with commercial and tribal gillnets, derelict fishing gear, oil spills, and high underwater sound pressure (energy) levels generated by pile-driving and underwater detonations (that can be lethal or reduce individual fitness).

General criteria for murrelet recovery (delisting) were established at the inception of the Plan and they have not been met. More specific delisting criteria are expected in the future to address population, demographic, and habitat-based recovery criteria (Service 1997, pp. 114-115). The general criteria include:

1. documenting stable or increasing population trends in population size, density, and productivity in four of the six Conservation Zones for a 10-year period; and

2. implementing management and monitoring strategies in the marine and terrestrial environments to ensure protection of murrelets for at least 50 years.

Thus, in addition to habitat protection, increasing murrelet reproductive success and reducing the frequency, magnitude, or duration of any anthropogenic stressor that affects murrelet fitness or survival in the marine and terrestrial environments are the priority conservation needs of the species. The Service estimates recovery of the murrelet will require at least 50 years (Service 1997, pp. vi 10).

Recovery Plan

The Marbled Murrelet Recovery Plan outlines the Comprehensive Mitigation Plan (CMP) with both short- and long-term objectives. The Plan places special emphasis on the terrestrial environment for habitat-based recovery actions due to nesting occurring in inland forests.

In the short-term, specific actions identified as necessary to stabilize the population include protecting occupied habitat and minimizing the loss of unoccupied but suitable habitat (Service 1997, p. 119). Specific actions include maintaining large blocks of suitable habitat, maintaining and enhancing buffer habitat, decreasing risks of nesting habitat loss due to fire and windthrow, reducing predation, and minimizing disturbance. The designation of critical habitat also contributes towards the initial objective of stabilizing the population size through the maintenance and protection of occupied habitat and minimizing the loss of unoccupied but suitable habitat.

Long-term conservation needs identified in the Plan include:
1. increasing productivity (abundance, the ratio of juveniles to adults, and nest success) and population size;
2. increasing the amount (stand size and number of stands), quality, and distribution of suitable nesting habitat;
3. protecting and improving the quality of the marine environment; and
4. reducing or eliminating threats to survivorship by reducing predation in the terrestrial environment and anthropogenic sources of mortality at sea.

Conservation Zone 3 Recovery Objectives: Murrelet occupied sites along the western portion of the Tillamook State Forest are especially important to maintaining well distributed murrelet populations. The murrelet recovery plan states that efforts should focus on maintaining these occupied sites, minimizing the loss of unoccupied but suitable habitat, and decreasing the time for development of new habitat. Relatively few known occupied sites occur north of the Tillamook State Forest. Recovery efforts should be directed at restoring some of the north-south distribution of murrelet populations and habitat in this Zone. Murrelet sites along the western portion of the Tillamook State Forest are especially important to maintaining well-distributed murrelet populations. Maintaining suitable and occupied murrelet habitat on the Elliot State Forest, Tillamook State Forest, Siuslaw NF, and BLM-administered forests is an essential component for the stabilization and recovery of murrelets (Service 1997, p. 127).

Conservation Zone 4 Recovery Objectives: Recovery actions in Zone 4 should be focused on preventing the loss of occupied nesting habitat, minimizing the loss of unoccupied but suitable habitat, and decreasing the time for development of new suitable habitat. Much murrelet nesting habitat is found in state and national parks that receive considerable recreational use. The need to maintain high quality murrelet terrestrial habitat should be considered in planning any modifications to state or national parks for recreational purposes. Both highway and Campground construction, including picnic areas, parking lots, and visitor centers, could present threats to the murrelet through loss of habitat, nest disturbance, or increasing potential predation from corvids associated with human activities such as Steller's jays and crows. Implementing appropriate trash disposal may help decrease potential predator populations in high human use areas such as county, state and national parks. Zone 4 has large blocks of suitable habitat critical to the three-state murrelet population recovery over the next 100 years. However, the amount of suitable habitat protected in parks is probably not sufficient by itself to guarantee long-term survival of murrelets in this Zone. On the other hand, a considerable amount of habitat is preserved in parks such that survival may be more likely in this Zone than in several other Zones. Private lands at the southern end of this Zone are important for maintaining the current distribution of the species. There is already a considerable gap in distribution between this area and the central California population in Zone 6. Efforts should be implemented to, at a minimum, not expand the current distribution gap (Service 1997, p. 128).

NWFP Protections

On Federal lands under the NWFP surveys are required for all timber sales that remove murrelet habitat. If habitat outside of mapped Late-Successional Reserves (LSRs) is found to be used by murrelets, then the habitat and recruitment habitat (within 25 years) within a 0.5-mile radius of the occupied behavior is designated as a new LSR. Timber harvest within LSRs is designed to benefit the development of late-successional conditions, which should improve future conditions of murrelet nesting habitat. Designated LSRs not only protect habitat currently suitable to murrelets (whether occupied or not) but will also develop future suitable habitat in large blocks.

Western Oregon RMP Protections

The Bureau of Land Management's (BLM) Wildlife Resource Program's Management Direction for murrelets provides some protection for murrelets. The extent to which the protective measures are applied within the action area is directed by the LUAs and distance from the ocean (inland zone 1 or 2). As described in its biological opinion for the RMP, the Service found that overall, the plan would provide for the survival and recovery of the murrelet. There was an expected immediate net gain of 79,500 acres to the reserve system including a gain of 48,182 acres of murrelet nesting habitat, about half of which was considered high-quality murrelet nesting habitat that would be added to the BLM's reserve system. An important provision required the incorporation of all occupied murrelet sites known at the time of implementation within the Late-successional Reserves (LSRs). Additionally, future sites discovered outside of LSRs in inland zone 1 and future sites discovered within Riparian Reserves within inland zone 2 will have the LUAs updated to LSR to protect the occupied stand. Proposed actions would significantly minimize habitat modification by applying protective measures to activities in all land allocations (LUAs) in inland zone 1 and to activities in the late-successional and riparian

LUAs in inland zone 2. Nest disturbance will be minimized by applying protective measures to activities in all LUAs in inland zone 1 and to activities in the reserve LUAs in inland zone 2 to allow for undisrupted murrelets nesting. Future activities are expected to impact murrelet nest sites in zone 2 (35- 50 miles from the coast) within the harvest land base and the district designated reserve LUAs (all of which will be subject to their own, future consultation), but the overall protections and management of murrelet habitat and sites are expected to result in an increase in the murrelet population within BLM lands and within the action area over time (Service 2016a, p. 284).

Tree Removal

Terrestrial habitat for murrelets has both a local and landscape aspect. At the local level a forest stand with branch platforms can provide nesting structure with minimal requirements for the murrelet, although we know murrelets are more likely to occur where there are large contiguous blocks of late-successional or old growth habitat on the landscape (Falxa and Raphael 2016, pp. 113-114). This patch of forested area can be either late-successional or old growth habitat with wide branches or younger trees with mistletoe infections or other deformities that form a platform wide enough for a nest. Murrelets use a wide variety of forest stands although they all must contain nesting structure.

There can be short or long-term potential effects associated with habitat modification. Thinning to increase growth rates and crowns by reducing competition for the retained trees can make currently unsuitable nest trees and trees of marginal habitat quality become nest trees sooner than without treatment. These types of thinning treatments also encourage currently suitable trees to maintain full crowns and branch development, and to create holes and gaps in the canopy that allow murrelets better access into tree crowns.

A 300-600-foot buffer from occupied or unsurveyed murrelet nesting habitat is recommended in the murrelet recovery plan as a short-term conservation action to stabilize and increase the population (Service 1997, p. 140). The part of an adjacent stand which lacks nesting structure but supports an adjacent stand or individual trees with murrelet nesting structure is referred to as buffer habitat. Thinning of buffer habitat may also affect murrelets by impacting the buffering habitat's ability to provide for windthrow during storms, provide a microclimate that supports moss growth, and provides a stand with low usage by murrelet nest predators. These effects are expected to be minimal if treatments are designed to: 1) minimize potential windthrow; 2) microclimate changes; and 3) minimize change that would increase stand usage by murrelet predators.

Predation by jays may increase when berry production and, potentially, insects increase in adjacent lands. The increase is likely due to the increased forage time spent by Steller's jays, (Cyanocitta stelleri) in the open areas. The following is from Zharikov et al. (2006, p. 117):

> "Populations of potential nest predators rarely increase in forest landscapes managed for timber, in contrast to forests adjacent to human settlements or agricultural fields (Henske et al. 2001). This is because local predator populations will increase only if fragmentation produces a concurrent increase in the amount of their staple food supply (e.g., berries) or

breeding habitat (Marzluff and Restani 1999, entire; Raphael et al. 2002, entire). In this study area clear-cutting is not associated with development of human habitation or agricultural fields. It is thus unlikely that recent forest fragmentation could create anthropogenic sources of food. At the same time, clear-cutting may have decreased the amount of nesting habitat for such known adult and nest predators of murrelets as the northern goshawk (Accipiter gentilis), common raven (Corvus corax) and gray jay (Perisores canadiensis) and thus lower their abundance in recently logged areas (Raphael et al. 2002, p. 339). However, clearcuts and the fragmented environment are used more often by another prominent nest predator, the Steller's jay, Cyanocitta stelleri, (Marzluff et al. 2004, p. 1422, possibly explaining the lower breeding success closer to old (fuzzy edge) clearcuts.

Disturbance

The effects to murrelets from disturbance are largely unknown, although effects such as increased energetic expenditure, elevated stress levels, and susceptibility to predation have been documented in other wildlife and are assumed to effect murrelets, as well. For these reasons, disturbance is considered a threat to the species (McShane et al. 2004, pp. 4-61 to 4-101, 5-12 to 5-39) although summary studies on effects of disturbance have not documented any nest failure, abandonment, or chick mortality directly attributed to noise disturbance (Singer et al. 1995, entire; Hamer and Nelson 1998, entire; Golightly et al. 2002, p. 29).

During the critical nesting period (
Table MAMU 8), noise and visual disturbance associated with habitat modification projects may disturb adult or juvenile murrelets. Murrelet reactions to noise, smoke or temporary increases in predation due to human presence at or in the immediate vicinity of murrelets could potentially include one or more of the following: a nesting adult flushes and leaves the eggs exposed to predation, an adult aborts a feeding attempt potentially reducing the fitness of the young, or a juvenile prematurely fledges potentially reducing the fitness due to having sub-optimal energy reserves or flight ability before leaving the nest. A murrelet that may be disturbed when it flies into the stands for other reasons than nest exchange or feeding young is presumably capable of moving away from disturbance without a significant disruption of its behavior. Murrelets feed at sea and only rely on forest habitat for nesting.

Table MAMU 8. Breeding period used to determine potential effects in this consultation.

Species	Breeding Period	Critical Breeding Period
Murrelet	April 1 – September 15	April 1 – August 5

Therefore, forest management or other forest activities during the murrelet breeding season (April 1 – September 15) may affect murrelets that are nesting. Current disturbance and disruption distances by common sources have been summarized in Table MAMU 9. Disruption is a subset of disturbance, to indicate the subset of disturbance that may adversely affect murrelets due to the greater impacts when closer to nesting murrelets.

In the late breeding period (August 6 – September 15), potential effects from disturbance decline because all breeding murrelets have establishing a nest, most are finished incubating and either have completed nesting (about half of the chicks have fledged) (Hamer et al. 2003, p. 1) or adult murrelets are still feeding the chick. Adults still tending their young in the late breeding period are heavily invested in chick-rearing, and it is during the crepuscular periods, which we define as two hours after sunrise and two hours before sunset, when most food deliveries to the young are made. When disruption events are limited to during the day and outside the crepuscular periods (which will be referred to as daily timing restrictions), the likelihood of nest abandonment or significant alteration of breeding success in the late breeding period is minimized because disruption will not occur during the periods of the majority of food deliveries to the chick plus the percent of young that have fledge is increasing every day. Therefore, the likelihood of injury by annoying the adult murrelets to such an extent as to significantly disrupt normal behavior patterns, which includes, but are not limited to, breeding, feeding or sheltering is not reasonably certain to occur in the late breeding period with daily timing restrictions and are considered insignificant effects (excluding activities that cause physical injury or mortality; e.g., blasting and helicopter hovering, Table MAMU 9).

Although disruption distances in Table MAMU 9 are based on the interpretation of the best available information, the exact distance where different types of noise, smoke or temporary increases in predation due to human presence may disrupt breeding, including feeding young, are difficult to predict and can be influenced by a multitude of factors. Site-specific information (e.g., topographic features, project length or frequency of disturbance to an area) could factor into the severity of anticipated effects. The potential for noise or human intrusion activities to create the likelihood of injury to murrelets is also dependent on the background or baseline levels in the environment. In areas that are continually exposed to higher ambient noise or human presence levels (e.g., areas near well-traveled roads, Campgrounds), murrelets are likely less susceptible to small potential increases in disturbances because they are acclimated to such activities. Murrelets do occur in areas near human activities and may habituate to certain levels of noise or human presence.

For disruption of murrelet behavior to occur as a result of disturbance (noise, smoke or temporary increases in predation due to human presence) caused by a proposed action, the effects and the murrelet(s) must be in proximity to one another during the murrelet nesting season (see Table MAMU 9).

Table MAMU 9. Disturbance and disruption distances for murrelets during the breeding period from the edge of unsurveyed or known occupied stand or nest structure in younger stands.

Disturbance Source	Disturbance Distances During the Breeding Period (Apr 1 – Sep 15)	Disruption Distances During the Breeding Period (Apr 1 – Sep 15)	Disruption Distances with daily timing restrictions *, unless noted otherwise (Aug 6 – Sep 15)
Light maintenance of roads, Campgrounds, and administrative facilities	≤ 0.25 mile	N/A1	N/A1 no daily timing restrictions required

Log hauling on open roads	≤ 0.25 mile	N/A1	N/A1 no daily timing restrictions required
Chainsaws (includes felling hazard/danger trees)	≤ 0.25 mile	≤ 110 yards2	N/A
Heavy equipment for road construction, road repairs, bridge construction, culvert replacements, etc.	≤ 0.25 mile	≤ 110 yards2	N/A
Pile-driving (steel H piles, pipe piles) Rock Crushing and Screening Equipment	≤ 0.25 mile	≤ 120 yards3	N/A
Blasting	≤ 1 mile	≤ 0.25 mile3	≤ 0.25 mile3
** Helicopter: Chinook 47d (described as a large helicopter in the rest of this document)	≤ 0.5 mile	≤ 265 yards5	≤ 100 yards6 (hovering only)
** Helicopter: Boeing Vertol 107, Sikorsky S-64 (SkyCrane)	≤ 0.25 mile	≤ 150 yards7	≤ 50 yards6 (hovering only)
** Helicopters: K-MAX, Bell 206 L4, Hughes 500	≤ 0.25 mile	≤ 110 yards8	≤ 50 yards6 (hovering only)
** Small fixed-wing aircraft (Cessna 185, etc.)	≤ 0.25 mile	≤ 110 yards	N/A
Tree Climbing	≤ 110 yards	≤ 110 yards9	N/A
Burning (prescribed fires, pile burning)	≤ 1 mile	≤ 0.25 mile10	N/A
Example: Chainsaws are being used adjacent to a murrelet occupied stand during the period of April 1 to September 15, less than 110 yards from the stand. In this scenario (within the disruption distance), murrelets could be disrupted to the point of likely adversely affecting the murrelets or their young. However, if the chainsaws were being used further than 110 yards away from the occupied stand during the same time period (within the .25 mile disturbance distance, but beyond the 110 yard disruption distance), this chainsaw use would only slightly disturb murrelets, not disrupt their normal behavior. In this case, the chainsaw use is not likely to adversely affect the murrelets because of the further distance the chainsaw use is away from them.			

Table MAMU 9 Footnotes:

1. N/A = not applicable. We anticipate that the few murrelets that select nest sites in close proximity to open roads either are undisturbed by or habituate to the normal range of sounds and activities associated with these roads (Hamer and Nelson 1998, p. 21).
2. Based on recommendations from murrelet researchers that advised buffers of greater than 100 meters to reduce potential noise and visual disturbance to murrelets (Hamer and Nelson 1998, p. 13, Service 2012, p. 10).
3. Impulsive sound associated with blasts and pile-driving is highly variable and potentially injurious at close distances. We selected a 0.25-mile radius around blast sites as a disruption distance based on observed prairie falcon flush responses to blasting noise at distances of 0.3 – 0.6 miles from blast sites (Holthuijzen et al. 1990, p. 273). We have conservatively chosen a distance threshold of 120 yards for impact pile-driving and rock-crushing operations to avoid potential hearing loss effects and to account for significant behavioral responses (e.g., flushing) from exposure to continuous sounds from impact pile driving.
4. Exposure to peak sound levels that are >140 dBA is likely to cause injury in the form of hearing loss in birds (Dooling and Popper 2007, pp. 23-24). We have conservatively selected 100 yards as an injury threshold distance **based** on sound levels from experimental blasts reported by Holthuijzen et al. (1990, p. 272), which documented peak sound levels from small blasts at 138 – 146 dBA at a distance of 100 m (110 yards).
5. Based on an estimated 92 dBA sound-contour (approximately 265 yards) for the Chinook 47d (Newman et al. 1984, Table D.1).

6. Because murrelet chicks are present at the nest until they fledge, they are vulnerable to direct injury or mortality from flying debris caused by intense rotor wash directly under a hovering helicopter. Rotor-wash from large helicopters is expected to be disruptive at any time during the nesting season due the potential for flying debris and shaking of trees located directly under a hovering helicopter. Hovering rotor-wash distance is based on a 300-ft radius rotor-wash zone for large helicopters hovering at < 500 above ground level (from WCB 2005, p. 2 – logging safety guidelines). We reduced the hovering helicopter rotor-wash zone to a 50-yard radius for all other helicopters based on the smaller rotor-span for all other ships.
7. Based on an estimated 92 dBA sound contour from sound data for the Boeing Vertol 107 the presented in the San Dimas Helicopter Logging Noise Report (USFS 2008, chapters 5, 6).
8. Based on Delaney et al. (1999, p. 74), which concluded that a buffer of 105 m (115) yards for helicopter overflights would eliminate flush responses from military helicopter overflights. The estimated 92 dBA sound contours for these helicopters is less than 110 yards (e.g., K-MAX (100 feet) (USFS 2008, chapters 5, 6), and Bell 206 (85-89 dBA at 100 m) (Grubb et al. 2010, p. 1277).
9. Based on recommendations from murrelet researchers that advised buffers of greater than 100 meters to reduce potential noise and visual disturbance to murrelets (Hamer and Nelson 1998, p. 13, Service 2012, p. 10).
10. Based on recommendations presented in Smoke Effects to Northern Spotted Owls (Service 2008, p. 4).
* Daily timing restrictions: Activities would not begin until two hours after sunrise and would end two hours before sunset.
**Aircraft normally use above ground level (AGL) as a unit of measure. For instance, to not cause a disruption by medium and small helicopters during the late breeding season, the AGL would be 350 feet. 350 feet AGL would account for 200-foot-tall trees that murrelets would be occupying plus the 50 yards disruption distance.

STATUS OF MARBLED MURRELET CRITICAL HABITAT

Description

Critical habitat consists of geographic areas essential to the conservation of a listed species. Under the Act, conservation means to use and the use of all methods and procedures that are necessary to bring an endangered species or threatened species to the point at which the measures provided pursuant to the Act are no longer necessary.

Critical habitat is provided protection under section 7 of the Act by ensuring that activities funded, authorized, or carried out by Federal agencies are not likely "to result in the destruction or adverse modification" such habitat. "Destruction or adverse modification means a direct or indirect alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of the listed species." (Service and NOAA 2019, p. 45016).

Legal Status

On May 24, 1996, the Service designated critical habitat for the murrelet within 104 CHUs encompassing approximately 3.9 million acres across Washington (1.6 million), Oregon (1.5 million), and California (0.7 million). The final rule became effective June 24, 1996. The final rule indicated that the scope of the section 7(a)(2) analysis should evaluate impacts of an action on critical habitat at the conservation zone(s) or even a major part of a conservation zone (Service 1996, p. 26271).

On October 5, 2011, the final rule revising critical habitat for the murrelet was published (Service, 2011). The Service reduced critical habitat in Northern California and Oregon. New information indicates that these areas do not meet the definition of critical habitat and 189,671 acres were removed from the network (Service 2011, p. 61599).

In 2012, the American Forest Resource Council (AFRC) and other parties filed suit against the Service, challenging the designation of critical habitat for the murrelet, among other things.

After this suit was filed, the Service concluded that the 1996 rule that first designated critical habitat for the murrelet, as well as the 2011 rule that revised that designation, did not comport with recent case law holding that the Service should specify which areas were occupied at the time of listing, and should further explain why unoccupied areas are essential for conservation of the species. Hence, the Service moved for a voluntary remand of the critical habitat rule, requesting until September 30, 2015, to issue a proposed rule, and until September 30, 2016, to issue a final rule. On September 5, 2013, the court granted the Service's motion, leaving the current critical habitat rule in effect pending completion of the remand. The final rule (Service 2016b) determined that all of the designated areas meet the statutory definition of critical habitat. Because the determination was that all areas currently designated as critical habitat meet the statutory definition, the Service did not change the boundaries of the specific areas identified as critical habitat.

Physical and Biological Features

The PBFs are physical and biological features the Service determines are essential to a species' conservation (i.e., recovery) and require special management considerations. For murrelets, the Service determined the PBF associated with the terrestrial environment that support nesting, roosting, and other normal behaviors are essential to the conservation of the murrelet and require special management considerations. The PBFs for the murrelet are: (1) individual trees with potential nesting platforms; and (2) forested lands of at least one half site potential tree height regardless of contiguity within 0.8 kilometers (0.5 miles) of individual trees with potential nesting platforms, and that are used or potentially used by murrelets for nesting or roosting (Service 1996, p. 26264). The site-potential tree height is the average maximum height for trees given the local growing conditions and is based on species-specific site index tables. These PBFs are intended to support terrestrial habitat for successful reproduction, roosting and other normal behaviors.

Conservation Strategy and Objectives

The Service's primary objective in designating critical habitat was to identify existing terrestrial murrelet habitat that supports nesting, roosting, and other normal behaviors that require special management considerations and to highlight specific areas where management should be given highest priority. The Service designated critical habitat to protect murrelets and their habitat in a well-distributed manner throughout the three states. Critical habitat is primarily based on the LSRs identified in the NWFP (approximately three million acres of critical habitat are located within the 3.9 million-acre LSR boundary designation). These LSRs were designed to respond to the problems of fragmentation of suitable murrelet habitat, potential increases in predation due to fragmentation, and reduced reproductive success of murrelets in fragmented habitat. The LSR system identifies large, contiguous blocks of late-successional forest that are to be managed for the conservation and development of the older forest features required by the murrelet, and as such, serve as an ideal basis for murrelet critical habitat. Where Federal lands were not sufficient to provide habitat considered crucial to retain distribution of the species, other lands were identified, including state, county, city and private lands (Service 1996, p. 26265).

Status and Distribution

The majority (77 percent) of designated critical habitat occurs on Federal lands in LSRs as identified in the NWFP. Because of this high degree of overlap with LSRs and LSR management guidelines, the condition of most of the range-wide network of murrelet critical habitat has experienced little modification of habitat since designation. Consultation data from October 1, 2003 – October 31, 2019 is displayed in Table MAMU 10. All consulted on acres impacted in the Oregon Coast Range occur on NWFP lands.

Climate Change

There is growing evidence that recent climate change has impacted a wide range of ecological systems (Stenseth et al. 2002, entire; Walther et al. 2002, entire; Ådahl et al. 2006, entire; Karl et al. 2009, entire; Moritz et al. 2012, entire; Westerling et al. 2011, p. S459; Marlon et al. 2012, p. E541). Climate change, combined with effects from past management practices, is exacerbating changes in forest ecosystem processes and dynamics to a greater degree than originally anticipated under the NWFP. Environmental variation affects all wildlife habitats; however, climate change presents new challenges as systems may change beyond historical ranges of variability. In some areas, changes in weather and climate may result in major shifts in vegetation communities that can persist in particular regions.

The Service believes climate change is likely to further exacerbate some existing threats to murrelet critical habitat such as the projected potential for increased habitat loss from drought-related fire, mortality, insects and disease in the short-term (10 to 30 years). Although it appears likely that murrelet critical habitat will be adversely affected by long-term consequences of climate change, we are not able to specifically quantify the magnitude of effects to the critical habitat network.

Current Condition of Range-Wide Critical Habitat

The current condition of critical habitat incorporates the effects of all past human activities and natural events that led to the present-day status of the habitat (Service and USDC NMFS 1998, p. 4-19). The existing ECOS database facilitates the tracking of impacts to habitat within designated critical habitat by conservation zone (

Table MAMU 10). As of October 31, 2019, approximately 5,422 acres of suitable habitat have been consulted on as removed from all lands (Fed and non-Federal); this includes acreage reported through technical assistance mechanisms that account for losses from wildfires. Habitats within the Siskiyou Coast Range represent the highest proportional losses. "Reported" habitat effects include acres reported by action agencies as implemented by actions.

Table MAMU 10. Aggregate Results of All Critical Habitat Removed by Section 7 Consultation for the Murrelet; Baseline and Summary of Effects By Conservation Zone and Habitat Type From October 1, 2003, to Present (Service 2019).
Thu Oct 31 14:33:16 MDT 2019

Conservation Zone1	Designated Acres2	Authorized Habitat Effects3			Reported Habitat Effects3		
	Total CHU Acres	Stands4	Remnants5	PCE26	Stands4	Remnants5	PCE26
Puget Sound	1,271,782	-16	0	-45	0	-1	0
Western Washington	414,050	-1	0	-1	0	0	0
Outside CZ Area in WA	0	0	0	0	0	0	0
Oregon Coast Range	1,024,122	-501	-4	-2,497	0	-1,186	0
Siskiyou Coast Range	1,055,788	-4,900	0	-3,176	0	-97	0
Outside CZ Area in OR	0	0	0	0	0	0	0
Mendocino	122,882	0	0	0	0	0	0
Santa Cruz Mountains	47,993	0	0	0	0	0	0
Outside CZ Area in CA	0	0	0	0	0	0	0
Total	3,936,617	-5,418	-4	-5,719	0	-1,284	0

Notes:

1. Conservation Zones (CZ) six zones were established by the 1997 Recovery Plan to guide terrestrial and marine management planning and monitoring for the Marbled Murrelet. Marbled Murrelet Recovery Plan, September, 1997
2. Critical Habitat Unit acres divided by Conservation zones, as presented in the Marbled Murrelet Recovery Plan Figure 8, page 114.
3. Habitat includes all known occupied sites, as well as other suitable habitat, though it is not necessarily occupied. Importantly, there is no single definition of suitable habitat, though the Marbled Murrelet Effectiveness Monitoring Section is in the process. Some useable working definitions include the Primary Constituent Elements as defined in the Critical Habitat Final Rule, or the criteria used for Washington State by Raphael et al. (Condor 104:331-342).
4. Stand: A patch of older forest in an area with potential platform trees.
5. Remnants: A residual or remnant stand is an area with scattered potential platform trees within a younger forest that lacks, overall, the structures for marbled murrelet nesting.
6. PCE2: trees with a ½ site-potential tree height within .5 mile of a potential nest tree.

Literature Cited

Ådahl, E., P. Lundberg, and N. Jonzen. 2006. From climate change to population change: the need to consider annual life cycles. Global Change Biology 12:1627-1633.

Ainley, D.G., S.G. Allen, and L.B. Spear. 1995. Offshore occurrence patterns of murrelets in central California. Pages 361-369 in C.J. Ralph, G.L. Hunt, M.G. Raphael, and J.F. Piatt, editors. Ecology and Conservation of the Marbled Murrelet. General Technical Report. PSW-GTR-152. Pacific Southwest Experimental Station, U.S. Forest Service, Albany, California. 10 pp.

Becker, B.H. 2001. Effects of oceanographic variation on marbled murrelet diet and habitat selection. Ph.D. dissertation, University of California, Berkeley.

Becker, B.H. and S.R. Beissinger. 2006. Centennial decline in the trophic level of an endangered seabird after fisheries decline. Conservation Biology 20(2):470-479.

Becker, B.H., M.Z. Peery, and S.R. Beissinger. 2007. Ocean climate and prey availability affect the trophic level and reproductive success of the marbled murrelet, an endangered seabird. Marine Ecology Progress Series 329:267-279.

Beever, E.A., J. O'Leary, C. Mengelt, J.M. West, S. Julius, N. Green, D. Magness, L. Petes, B. Stein, A.B. Nicotra, J.J. Hellmann, A.L. Robertson, M.D. Staudinger, A.A. Rosenberg, E. Babij, J. Brennan, G.W. Schuurman, and G.E. Hofmann. 2015. Improving conservation outcomes with a new paradigm for understanding species' fundamental and realized adaptive capacity. Conservation Letters, a journal of the Society of Conservation Biology 00(0):1-7. doi: 10.1111/conl.12190.

Beissinger, S.R. 1995. Population trends of the marbled murrelet projected from demographic analyses. Pages 385-393 in C.J. Ralph, G.L. Hunt, M.G. Raphael and J.F. Piatt, editors. Ecology and conservation of the marbled murrelet. U.S. Forest Service, Pacific Southwest Research Station, Albany, California.

Beissinger, S.R. and N. Nur. 1997. Appendix B: Population trends of the marbled murrelet projected from demographic analysis. Pages B1-B35 in Recovery plan for the threatened marbled murrelet (Brachyramphus marmoratus) in Washington, Oregon, and California. U.S. Fish and Wildlife Service, Pacific Region, Portland, Oregon.

Beissinger, S.R. and M.Z. Peery. 2007. Reconstructing the historic demography of an endangered seabird. Ecology 88(2):296-305.

Bloxton, T.D. and M.G. Raphael. 2005. Breeding ecology of the marbled murrelet in Washington State: 2004 season summary: a report to the U.S. Fish and Wildlife Service, Western Washington Fish and Wildlife Office, Lacey, Washington; U.S. Forest Service, Pacific Northwest Research Station, Olympia, Washington. 14 pp.

Bloxton, T.D. and M.G. Raphael. 2006. At-sea movements of radio-tagged marbled murrelets in Washington. Northwestern Naturalist 87(2):162-162.

Bradley, R.W. 2002. Breeding ecology of radio-marked marbled murrelets (Brachyramphus marmoratus) in Desolation Sound, British Columbia. Department of Biological Sciences. Simon Fraser University, Burnaby, British Columbia. 86 pp.

Bradley, R.W., F. Cooke, L.W. Lougheed, and W.S. Boyd. 2004. Inferring breeding success through radiotelemetry in the marbled murrelet. Journal of Wildlife Management 68(2):318-331.

Burger, A.E. 1995. Marine distribution, abundance, and habitats of marbled murrelets in British Columbia. Pages 295-312 in C.J. Ralph, G.L. Hunt, Jr., M.G. Raphael, and J.F. Piatt, editors. Ecology and conservation of the marbled murrelet. General Technical Report PSW-GTR-152. U.S. Forest Service, Pacific Southwest Research Station, Albany, California.

Burger, A.E. 2001. Using radar to estimate populations and assess habitat associations of marbled murrelets. Journal of Wildlife Management 65:696-715.

Burger, A. E. 2002. Conservation assessment of marbled murrelets in British Columbia, a review of biology, populations, habitat associations and conservation. Canadian Wildlife Service, Pacific and Yukon Region, Delta, British Columbia. 168 pp.

Burkett, E.E. 1995. Marbled murrelet food habits and prey ecology. Pages 223-246 in C.J. Ralph, G.L. Hunt, M.G. Raphael, and J.F. Piatt editors. Ecology and conservation of the marbled murrelet. General Technical Report PSW-GTW-152. U.S. Forest Service, Pacific Southwest Experimental Station, Albany, California. 420 pp.

Cam, E., L.W. Lougheed, R.W. Bradley, and F. Cooke. 2003. Demographic assessment of a marbled murrelet population from capture-recapture data. Conservation Biology 17(4):1118-1126.

Carter, H.R. and S.G. Sealy. 1986. Year-round use of coastal lakes by marbled murrelets. Condor 88:473-477.

Carter, H.R. and S.G. Sealy. 1990. Daily foraging behavior of marbled murrelets. Studies in Avian Biology 14:93-102.

CCR (Crescent Coastal Research). 2008. Population and productivity monitoring of marbled murrelets in Oregon during 2008. Final Report to U.S. Fish and Wildlife Service, Oregon Fish and Wildlife Office, Portland, Oregon. 13 pp.

CCR (Crescent Coastal Research). 2012. Marbled murrelet productivity measures at sea in northern California during 2011: an assessment relative to Redwood National and State Park lands. Final annual report to U.S. Fish and Wildlife Service, Arcata Fish and Wildlife Office, Arcata, California. 18 pp.

Chen, J., J.F. Franklin, and T.A. Spies. 1993. Contrasting microclimates among clearcut, edge and interior old-growth Douglas fir forest. Agricultural and Forest Meteorology 63:219-237.

Cullen, S.A. 2002. Using radar to monitor populations and assess habitat associations of marbled murrelets within the Sunshine Coast Forest District. British Columbia Ministry of Water, Land and Air Protection, Surrey, British Columbia. 25 pp.

Day, R.H. and D.A. Nigro. 2000. Feeding ecology of Kittlitz's and marbled murrelets in Prince William Sound, Alaska. Waterbirds 23(1):1-14.

Dechesne, S.B.C. and J.L. Smith. 1997. Wildlife inventory Queen Charlotte Islands/Haida Gwaii 1994-1996. Husby Group of Companies. 49 pages.

Delaney, D.K., T.G. Grubb, P. Beier, L.L Pater, and M.H. Reiser. 1999. Effects of helicopter noise on Mexican spotted owls. Journal of Wildlife Management 63(1):60-76.

Dooling, R.J. and A.N. Popper. 2007. Effects of highway noise on birds. Prepared for the California Department of Transportation, Division of Environmental Analysis, Sacramento, California. Prepared under contract 43A0139 Jones and Stokes Associates. 74 pp.

Evans Mack, D.E., W.P. Ritchie, S.K. Nelson, E. Kuo-Harrison, P. Harrison, and T.E. Hamer. 2003. Methods for surveying marbled murrelets in forests: a revised protocol for land management and research. Pacific Seabird Group Technical Publication Number 2. <https://pacificseabirdgroup.org/wp-content/uploads/2016/06/PSG_TechPub2_MAMU_ISP.pdf>.

Falxa, G.A. and M.G. Raphael, technical editors. 2016. Northwest Forest Plan – The first 20 years (1994-2013): status and trend of marbled murrelet populations and nesting habitat. General Technical Report PNW-GTR-933. U.S. Forest Service, Pacific Northwest Research Station, Portland, Oregon. x + 120 pp + appendices.

Falxa, G.A., M.G. Raphael, C. Strong, J. Baldwin, M. Lance, D. Lynch, S.F. Pearson, and R.D. Young. 2016. Chapter 1: status and trend of marbled murrelet populations in the Northwest Forest Plan Area. Pages 1-36 in G.A. Falxa and M.G., Raphael, technical editors. Northwest Forest Plan—The first 20 years (1994-2013): status and trends of marbled murrelet populations and nesting habitat. General Technical Report PNW-GTR-933. U.S. Forest Service, Pacific Northwest Research Station, Portland, Oregon. x + 120 pp + appendices.

Federal Energy Regulatory Commission (FERC). 2019. Biological Assessment and Essential Fish Habitat Assessment for the Jordan Cove Energy and Pacific Connector Gas Pipeline Project. Office of Energy Project, Washington, D.C. 1039 pp. + appendices.

Feely, R.A., T. Klinger, J.A. Newton, and M. Chadsey. 2012. Scientific summary of ocean acidification in Washington State marine waters. National Oceanic and Atmospheric Administration, Oceanic and Atmospheric Research Special Report. 176 pp.

Felis, J.J., Kelsey, E.C., and Adams, J. 2019. Abundance and productivity of marbled murrelets (Brachyramphus marmoratus) off central California during the 2018 breeding season. U.S. Geological Survey Data Series 1107. 10 pp. <https://doi.org/10.3133/ds1107>.

Glick, P., J. Clough, and B. Nunley. 2007. Sea-level rise and coastal habitats in the Pacific Northwest: an analysis for Puget Sound, southwestern Washington, and northwestern Oregon. National Wildlife Federation. 106 pp

Golightly, R.T., P.N. Hebert, and D.L. Orthmeyer. 2002. Evaluation of human-caused disturbance on the breeding success of marbled murrelets (Brachyramphus marmoratus) in Redwood National and State Parks, California. Bureau of Land Management, National Park Service, U.S. Fish and Wildlife Service, U.S. Geological Survey, California Department of Fish and Game, and California Department of Parks and Recreation. Arcata, California. 61 pp.

Grubb, T.G., D.K. Delaney, W.M. Bowerman, and M.R. Wierda. 2010. Golden eagle indifference to heli-skiing and military helicopters in northern Utah. Journal of Wildlife Management 74(6):1275-1285.

Hamer, T.E and S.K. Nelson. 1998. Effects of disturbance on nesting marbled murrelets: summary of preliminary results. US. Fish and Wildlife Service, Pacific Region, Portland, Oregon. 24 pp.

Hamer, T.E. and Nelson, S.K. 1995a. Nesting chronology of the marbled murrelet. Pages 49-56 in C.J. Ralph, G.L. Hunt Jr., M.G. Raphael, J.F. Piatt, editors. Ecology and conservation of the marbled murrelet. General Technical Report PSW-GTR-152. U.S. Forest Service, Pacific Southwest Research Station, Albany, California.

Hamer, T.E. and S.K. Nelson. 1995b. Characteristics of marbled murrelet nest trees and nesting stands. Pages 69-82 in C.J. Ralph, G.L. Hunt Jr., M.G. Raphael, J.F. Piatt, editors. Ecology and conservation of the marbled murrelet. General Technical Report PSW-GTR-152. U.S. Forest Service, Pacific Southwest Research Station, Albany, California.

Hamer, T.E., S.K. Nelson, and T.I. Mohagen II. 2003. Nesting chronology of the marbled murrelet in North America. Unpublished report prepared for U.S. Fish and Wildlife Service, Oregon Fish and Wildlife Office, Portland, Oregon. 23 pp.

Henkel, L.A., E.E. Burkett, and J.Y. Takekawa. 2003. At-sea activity and diving behavior of a radio-tagged marbled murrelet in central California. Waterbirds 26(4):9-12.

Hirzel, A.H., J. Hauser, D. Chessel, and N. Perrin. 2002. Ecological-niche factor analysis: how to compute habitat-suitability maps without absence data? Ecology 83(7):2027-2036.

Hobson, K.A. 1990. Stable isotope analysis of marbled murrelets: evidence for fresh water feeding and determination of trophic level. Condor 92:897-903.

Holthuijzen, A.M., W.G. Eastland, A.R. Ansell, M.N. Kochert, R.D. Williams, and L.S. Young. 1990. Effects of blasting on behavior and productivity of nesting prairie falcons. Wildlife Society Bulletin 18:270-281.

Huff, M.H., M.G. Raphael, S.L. Miller, K.S. Nelson, and J. Baldwin, technical editors. 2006. Northwest Forest Plan—The first 10 years (1994-2003): status and trends of populations and nesting habitat for the marbled murrelet. General Technical Report PNW-GTR-650. U.S. Forest Service, Pacific Northwest Research Station, Portland, OR. x + 151 pp.

Hull, C.L., G.W. Kaiser, C. Lougheed, L. Lougheed, S. Boyd, and F. Cooke. 2001. Intraspecific variation in commuting distance of marbled murrelets (Brachyramphus marmoratus): ecological and energetic consequences of nesting further inland. The Auk 118:1036-1046.

Jordan Cove Energy Project, LP and Pacific Connector Gas Pipeline, LP (JCEP). 2019. Comprehensive Mitigation Plan for Jordan Cove Energy Project L.P. and Pacific Connector Gas Pipeline, LP. Prepared for the Federal Energy Regulatory Commission. 107 pp + appendices.

Karl, T.R., J.M. Melillo, T.C. Peterson, editors. 2009. Global climate change impacts in the United States. Cambridge University Press, Cambridge, United Kingdom. 196 pp.

Kuletz, K.J. 2005. Foraging behavior and productivity of a non-colonial seabird, the marbled murrelet (Brachyramphus marmoratus), relative to prey and habitat. Ph.D. dissertation, University of Victoria, Victoria, British Columbia.

Kuletz, K.J. and J.F. Piatt. 1999. Juvenile marbled murrelet nurseries and the productivity index. Wilson Bulletin 111(2):257-261.

Lank, D.B., N. Parker, E.A. Krebs, and L. McFarlane Tranquilla. 2003. Geographic distribution, habitat selection, and population dynamics with respect to nesting habitat characteristics, of marbled murrelets Brachyramphus marmoratus. Centre for Wildlife Ecology, Simon Fraser University, Burnaby, British Columbia. 66 pages.

Littell, J.S., J.A. Hicke, S.L. Shafer, S.M. Capalbo, L.L. Houston, and P. Glick. 2013. Forest ecosystems: vegetation, disturbance and economics. Pages 110-135 in M.M. Dalton, P.W. Mote, and A.K. Snover, editors. Climate change in the Northwest: implications for our landscapes, waters and communities. Island Press, Washington, D.C. xl + 230 pp.

Long, L.L., S.L. Miller, C.J. Ralph, and E.A. Elias. 2008. Marbled murrelet abundance, distribution, and productivity along the coasts of northern California and southern Oregon, 2005-2007. Report to U.S. Fish and Wildlife Service and Bureau of Land Management, Arcata, California, 2008. 49 pp.

Luginbuhl, J.M., J.M. Marzluff, J.E. Bradley, M.G. Raphael, and D.E Varland. 2001. Corvid survey techniques and the relationship between corvid relative abundance and nest predation. Journal of Field Ornithology 72(4):556-572.

Manley, I.A. 1999. Behavior and habitat selection of marbled murrelets nesting on the Sunshine Coast. M.S. thesis. Simon Fraser University, Burnaby, British Columbia. xv + 163 pp.

Manley, I.A., A. Harfenist, and G. Kaiser. 2001. Marbled murrelet telemetry study on Queen Charlotte Islands/Haida Gwaii. Prepare for British Columbia Ministry of Environment, Lands and Parks, Smithers, British Columbia. iv + 26 pp + appendices.

Marlon, J.R., P.J. Bartlein, D.G. Gavin, C.J. Long, R.S. Anderson, C.E. Briles, K.J. Brown, D. Colombaroli, D.J. Hallett, M J. Power, E.A. Scarf, and M.K. Walsh. 2012. Long-term perspective on wildfires in the western USA. Proceedings of the National Academy of Sciences of the United States of America (PNAS) 109(9):3203-3204.

Marzluff, J.M. and M. Restani. 1999. The effects of forest fragmentation on avian nest predation and parasitism. Unpublished report prepared for U.S. Fish and Wildlife Service, Arcata Fish and Wildlife Office, Arcata, California. 30 pp.

Mason, A., A.E. Burger, and B. Hansen. 2002. At-sea surveys of marbled murrelets in Clayoquot Sound, 1996-2000. Pages 15-33 in A. Burger and T.A. Chatwin, editors. Multi-scale studies of populations, distribution and habitat associations of marbled murrelets in Clayoquot Sound, British Columbia. British Columbia Ministry of Water, Land and Air Protection, Victoria, British Columbia. 170 pp.

Mathews, N.J.C. and A.E. Burger. 1998. Diving depth of a marbled murrelet. Northwestern Naturalist 79:70-71.

McIver, W., S.F. Pearson, D. Lynch, N. Johnson, J. Baldwin, M.M. Lance, M.G. Raphael, C. Strong, and R. Young, T. Lorenz, and K. Nelson. 2019. Marbled murrelet effectiveness monitoring. Northwest Forest Plan: 2018 summary report. 22 pp.

McShane, C., T. Hamer, H. Carter, G. Swartzman, V. Friesen, D. Ainley, R. Tressler, K. Nelson, A. Burger, L. Spear, T. Mohagen, R. Martin, L. Henkel, K. Prindle, C. Strong, and J. Keany. 2004. Evaluation report for the 5-year status review of the marbled murrelet in Washington, Oregon, and California. Unpublished report prepared for the U.S. Fish and Wildlife Service, Pacific Region, Portland, Oregon. 362 pp + appendices.

Meekins, D.J. and T.E. Hamer. 1998. Use of radar to monitor marbled murrelets at inland sites in the North Cascades of Washington: preliminary report. Prepared for the U.S. Forest Service, Mount Baker-Snoqualmie National Forest, Darrington Ranger District, Darrington, Washington. 18 pp.

Mendenhall, V. 1992. Distribution, breeding records, and conservation problems of the marbled murrelet in Alaska. Pages 5-16 in: H.R. Carter and M.L. Morrison editors. Status and conservation of the marbled murrelet in North America. Western Foundation for Vertebrate Zoology 5(1). 117 pp.

Meyer, C.B., S.L. Miller, and C.J. Ralph. 2002. Multi-scale landscape and seascape patterns associated with marbled murrelet nesting areas on the U.S. west coast. Landscape Ecology 17: 95-115.

Miller, S., M. Raphael, G. Falxa, C. Strong, J. Baldwin, T. Bloxton, B. Galleher, M. Lance, D. Lynch, S. Pearson, C. Ralph, R. Young. 2012. Recent population decline of the marbled murrelet in the Pacific Northwest. Condor 114(4):771-781.

National Audubon Society. The Christmas Bird Count Historical Results [Online]. <http://www.christmasbirdcount.org>. Accessed 2017.

Nelson, S.K. 1997. Marbled murrelet (Brachyramphus marmoratus). Pages 1-32 in A. Poole and G. Gill, editors. Birds of North America, No. 276. Academy of Natural Sciences of Philadelphia and American Ornithologists' Union, Washington, DC.

Nelson, S.K. and A.K. Wilson. 2002. Marbled murrelet habitat characteristics on state lands in western Oregon. Oregon State University, Department of Fisheries and Wildlife, Oregon Cooperative Fish and Wildlife Research Unit, Corvallis. Submitted to Oregon Department of Forestry, Oregon Department of Fish and Wildlife, U.S. Fish and Wildlife Service, and National Council for Air and Stream Improvement. 151 pp.

Nielson, S.E., R.M. Munro, E.L. Bainbridge, G.B. Stenhouse, M.S. Boyce. 2004. Grizzly bears and forestry: ii. distribution of grizzly bear foods in clearcuts of west-central Alberta, Canada. Forest Ecology and Management 199(1):67-82.

Newman, J.S., E.J. Rickley, T.L. Bland, and K.R. Beattie. 1984. Noise measurement flight test for Boeing Vertol 234/Chinook 47-d. FAA-EE-84-7. Federal Aviation Administration, Washington D.C. 180 pp.

Oregon Department of Justice (ODOJ). 2019. Oregon State agency comments on FERC's draft environmental impact statement for docket nos. CP 17-494-000 and CP 17495-000

(Jordan Cove Energy Project LP and Pacific Connector Gas Pipeline Project LP). DOJ File No. 0ES456-ES456. 218 pp + appendices.

Paton, P. W.C., C.J. Ralph, and R.A. Erickson. 1992. Use of an inland site in northwestern California by marbled murrelets. Proceedings of the Western Foundation of Vertebrate Zoology 5(1):109-116.

Peery, M.Z., S.R. Beissinger, S.H. Newman, E.B. Burkett, and T.D. Williams. 2004. Applying the declining population paradigm: diagnosing causes of poor reproduction in the marbled murrelet. Conservation Biology 18(4):1088-1098.

Piatt, J.F., K.J. Kuletz, A.E. Burger, S.A. Hatch, V.L. Friesen, T.P. Birt, M.L. Arimitsu, G.S. Drew, A.M.A. Harding, and K.S. Bixler. 2007. Status review of the marbled murrelet (Brachyramphus marmoratus) in Alaska and British Columbia. Open-File Report 2006-1387. U.S. Geological Survey, Reston, Virginia. xiv + 164 pp + appendices.

Ralph, C.J., G.L. Hunt, Jr., M.G. Raphael, and J.F. Piatt. 1995. Chapter 1: Ecology and conservation of the marbled murrelet. Pages 3-22 in C.J. Ralph, G.L. Hunt Jr., M.G. Raphael, J.F. Piatt, editors. Ecology and conservation of the marbled murrelet. General Technical Report PSW-GTR-152. U.S. Forest Service, Pacific Southwest Research Station, Albany, California. 420 pp.

Raphael, M.G., D. Evans Mack, and B.A. Cooper. 2002. Landscape-scale relationships between abundance of marbled murrelets and distribution of nesting habitat. Condor 104(2):331-342.

Raphael, M.G., B. M. Galleher, M.H. Huff, S.L. Miller, S.K. Nelson, R.D. Young. 2006. Spatially explicit estimates of potential nesting habitat for the marbled murrelet. Pages 97-146 in M.H. Huff, M.G. Raphael, S.L. Miller, S.K. Nelson, and J. Baldwin, technical editors. Northwest Forest Plan—The first 10 years (1994-2003): status and trends of populations and nesting habitat for the marbled murrelet. General Technical Report PNW-GTR-650. U.S. Forest Service, Pacific Northwest Research Station, Portland, OR. x + 151 pp.

Raphael, M.G., J. Baldwin, G.A. Falxa, M.H. Huff, M. Lance, S.L. Miller, S.F. Pearson, C.J. Ralph, C. Strong, and C. Thompson. 2007a. Regional population monitoring of the marbled murrelet: field and analytical methods. General Technical Report NNW-GTR-716. U.S. Forest Service, Pacific Northwest Research Station, Portland, Oregon. 24 pp + appendices.

Raphael, M.G., J.M. Olson, and T. Bloxton. 2007b. Summary report of field observation of marbled murrelets in the San Juan Islands, Washington. U.S. Forest Service, Pacific Northwest Research Station, Portland, Oregon. 25 pp.

Raphael, M.G., A.J. Shirk, G.A. Falxa, D. Lynch, S.K. Nelson, S.F. Pearson, C. Strong, and R.D. Young. 2016a. Chapter 3: factors influencing status and trend of marbled murrelet populations: an integrated perspective. Pages 95-120 in G.A. Falxa and M.G., Raphael, technical editors. Northwest Forest Plan—The first 20 years (1994-2013): status and trend of marbled murrelet populations and nesting habitat. General Technical Report PNW-GTR-933. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. x + 120 pp + appendices.

Raphael, M G., G.A. Falxa, D. Lynch, S.K. Nelson, S.F. Pearson, A.J. Shirk, and R.D. Young. 2016b. Chapter 2: status and trend of nesting habitat for the marbled murrelet under the Northwest Forest Plan. Pages 37-94 in G.A. Falxa and M.G., Raphael, technical editors. Northwest Forest Plan—The first 20 years (1994-2013): status and trend of marbled murrelet populations and nesting habitat. General Technical Report PNW-GTR-933. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. x + 120 pp + appendices.

RIT 2011. Report on marbled murrelet recovery implementation team meeting and stakeholder workshop. Informal report. <https://www.fws.gov/wafwo/pdf/FinalReporMarbledMurrelerRITandStakeholderWorkshop.pdf>.

Rodway, M.S. and H.M. Regehr. 2002. Inland activity and forest structural characteristics as indicators of marbled murrelet nesting habitat in Clayoquot Sound. Pages 57-87 in A. Burger and T.A. Chatwin, editors. Multi-scale studies of populations, distribution and habitat associations of marbled murrelets in Clayoquot Sound, British Columbia. British Columbia Ministry of Water, Land and Air Protection, Victoria, British Columbia. 170 pp.

Rodway, M.S., H.M. Regehr, and J.P.L. Savard. 1993. Activity patterns of marbled murrelets in old-growth forest in the Queen Charlotte Islands, British Columbia. Condor 95:831-848.

Ruckelshaus, M.H., and M.M. McClure. 2007. Sound science: synthesizing ecological and socioeconomic information about the Puget Sound ecosystem. 102 pp.

Shafer, S.L., M.E. Harmon, R.P. Neilson, R. Seidl, B. St. Clair, and A. Yost. 2010. The potential effects of climate change on Oregon's vegetation. Pages 175-210 in K.D. Dello, and P.W. Mote. Oregon Climate Change Research Institute, Oregon State University, Corvallis. <http://occri.net/ocar/>.

Singer, S.W., D.L. Suddjian, and S.A. Singer. 1995. Fledging behavior, flight patterns, and forest characteristics at marbled murrelet tree nests in California. Northwestern Naturalist 76:54-62.

Speckman, S.G., J.F. Piatt, and A.M. Springer. 2003. Deciphering the social structure of marbled murrelets from behavioral observations at sea. Waterbirds 26(3):266-274.

Stenseth, N.C., A. Mysterud, G. Ottersen, J.W. Hurrell, K. Chan, and M. Lima. 2002. Ecological effects of climate fluctuations. Science 297(5585):1292-1296.

Steventon, J.D. and N.L. Holmes. 2002. A radar-based inventory of marbled murrelets (Brachyramphus marmoratus), northern mainland coast of British Columbia. British Columbia Ministry of Forests, Prince Rupert Forest Region, Prince Rupert, British Columbia. 40 pp.

Strachan, G., M. McAllister, and C.J. Ralph. 1995. Marbled murrelet at-sea foraging behavior. Pages 247-253 in C.J. Ralph, G.L. Hunt Jr., M.G. Raphael, J.F. Piatt, editors. Ecology and conservation of the marbled murrelet. General Technical Report PSW-GTR-152. U.S. Forest Service, Pacific Southwest Research Station, Albany, California. 420 pp.

Strong, C.S., B.K. Keitt, W.R. McIver, C.J. Palmer, and I. Gaffney. 1995. Distribution and population estimates of marbled murrelets at sea in Oregon during the summers of 1992 and 1993. Pages 339-352 in C.J. Ralph, G.L. Hunt Jr., M.G. Raphael, J.F. Piatt, editors. Ecology and conservation of the marbled murrelet. General Technical Report PSW-GTR-152. U.S. Forest Service, Pacific Southwest Research Station, Albany, California. 420 pp.

U.S. Fish and Wildlife Service (Service). 1992. Final rule: endangered and threatened wildlife and plants; determination of threatened status for the Washington, Oregon, and California population of the marbled murrelet. Federal Register 57(191):45328-45337.

U.S. Fish and Wildlife Service (Service). 1996. Final rule: endangered and threatened wildlife and plants; determination of critical habitat for the marbled murrelet. Federal Register 61(102):526256-26320.

U.S. Fish and Wildlife Service (Service). 1997. Recovery plan for the threatened marbled murrelet (Brachyramphus marmoratus) in Washington, Oregon, and California. U.S. Fish and Wildlife Service, Pacific Region, Portland, Oregon. 203 pp.

U.S. Fish and Wildlife Service (Service). 2004. Marbled murrelet 5-year review process: overview. U.S. Fish and Wildlife Service, Pacific Region, Portland, Oregon. 28 pp.

U.S. Fish and Wildlife Service (Service). 2008. Observations of smoke effects on northern spotted owls (draft). Compiled by J. Thrailkill, U.S. Fish and Wildlife Service, Oregon Fish and Wildlife Office, Portland, Oregon. 7pp.

U.S. Fish and Wildlife Service (Service). 2009. Marbled Murrelet (Brachyramphus marmoratus) 5 year review. U.S. Fish and Wildlife Service, Washington Fish and Wildlife Office, Lacey, WA, June 12, 2009. 108 pages.

U.S. Fish and Wildlife Service (Service). 2011. Final rule: endangered and threatened wildlife and plants; revised critical habitat for the marbled murrelet. Federal Register 76(193):61599-61621.

U.S. Fish and Wildlife Service (Service). 2012. Revised in-air disturbance analysis for marbled murrelets. Unpublished agency document prepared by E. Teachout, U.S. Fish and Wildlife Service, Washington Fish and Wildlife Office, Lacey, Washington. 12 pp.

U.S. Fish and Wildlife Service (Service). 2014a. Revised conservation framework for the northern spotted owl and marbled murrelet. Jordan Cove Energy and Pacific Connector Gas Pipeline Project. U.S. Fish and Wildlife Service, Ecological Services, Pacific Region with support from PC Trask & Associates, Inc. in collaboration with Mason, Bruce & Girard, Inc. 69 pp.

U.S. Fish and Wildlife Service (Service). 2014b. Draft species report: Fisher (Pekania pennanti), West Coast population. U.S. Fish and Wildlife Service. 243 pp. <http://www.fws.gov/yreka/20140911_WCFSR_finaldraft.pdf>.

U.S. Fish and Wildlife Service (Service). 2015. Proposed rule: endangered and threatened wildlife and plants; determination of critical habitat for the marbled murrelet. Federal Register 80(164):51506-51523.

U.S. Fish and Wildlife Service (Service). 2016a. Formal section 7 consultation on the Bureau of Land Management's approval of the proposed resource management plan for western Oregon. U.S. Fish and Wildlife Service, Pacific Region, Portland, Oregon. FWS Reference Number O1EOFWOO-2015-F-0279.

U.S. Fish and Wildlife Service (Service). 2016b. Final determination: endangered and threatened wildlife and plants; determination of critical habitat for the marbled murrelet. Federal Register 81(150):51348-51370.

U.S. Fish and Wildlife Service (Service). 2017. Formal section 7 consultation addressing manual maintenance, hazard tree removal and blowdown salvage activities proposed by the Coos Bay District of the Bureau of Land Management. U.S. Fish and Wildlife Service, Roseburg Field Office, Roseburg, Oregon. FWS Reference Number: 01EOFW00-2017-F-0074. 51 pp + appendices.

U.S. Fish and Wildlife Service (Service). 2019. Final rule: final regulatory revisions discussion of changes from proposed rule. Federal Register 50:44976-45018.

U.S. Fish and Wildlife Service and National Oceanic and Atmospheric Administration (Service and NOAA). 1996. Policy regarding the recognition of distinct vertebrate population segments under the endangered species act. Federal Register 61:4722-4725.

U.S. Fish and Wildlife Service and National Oceanic and Atmospheric Administration (Service and NOAA). 2019. Interagency cooperation—Endangered Species Act of 1973, as amended; definition of destruction or adverse modification of critical habitat. Federal Register 81(28):7214-7226.

U.S. Forest Service (USFS). 2008. Sound measurements of helicopters during logging operations. R.T. Harrison, R. Farve, and A. Horcher. USDA Forest Service San Dimas Technology & Development Center, San Dimas, CA. <http://www.fs.fed.us/eng/techdev/IM/sound_measure/helo_index.shtml>.

Walther, G., E. Post, P. Convey, A. Menzel, C. Parmesan, T. J. Beebee, J. Fromentin, O. Hoegh-Guldberg, F. Bairlein. 2002. Ecological responses to recent climate change. Nature 46: 389-395.

Waterhouse, F.L., R. Bradley, J. Markila, F. Cooke, and L. Lougheed. 2002. Use of air photos to identify, describe, and manage forest structure of marbled murrelet nesting habitat at a coastal British Columbia site. British Columbia Forest Service, Nanaimo, British Columbia. 19 pp.

WCB 2005. Safe work practices for helicopters in the forest industry. Workers Compensation Board of British Columbia. www.worksafebc.com. 34 pp.

Washington Department of Fish and Wildlife (WDFW). 2015. Washington State wildlife action plan. Washington Department of Fish and Wildlife. 1088 pp. <http://wdfw.wa.gov/conservation/cwcs/>.

Westerling, A.L., M.G. Turner, E.A. Smithwick, W.H. Romme, M.G. Ryan. 2011. Continued warming could transform Greater Yellowstone fire regimes by mid-21st century. Proceedings of the National Academy of Sciences (PNAS) 108(32):13165-13170.

Whitworth, D.L., S.K. Nelson, S.H. Newman, G.B. Van Vliet, and W.P. Smith. 2000. Foraging distances of radio-marked marbled murrelets from inland areas in southeast Alaska. Condor 102(2):452-456.

Varoujean II, D.H. and W.A. Williams. 1995. Chapter 31: Abundance and distribution of marbled murrelets in Oregon and Washington based on aerial survey. Pages 327-338 in C.J. Ralph, G.L. Hunt, M.G. Raphael, and J.F. Piatt, editors. Ecology and Conservation of the Marbled Murrelet. General Technical Report. PSW-GTR-152. Pacific Southwest Experimental Station, U.S. Forest Service, Albany, California. 10 pp.

Zharikov, Y., D.B. Lank, F. Huettmann, R.W. Bradley, N. Parker, P.P-W. Yen, L.A. Mcfarlane-Tranquilla, and F. Cooke. 2006. Habitat selection and breeding success in a forest-nesting Alcid, the marbled murrelet, in two landscapes with different degrees of forest fragmentation. Landscape Ecology 21(1):107-120.

References or Personal Communications

U.S. Fish and Wildlife Service and National Marine Fisheries Service (Service and NMFS). 1998. Endangered species act consultation handbook: procedures for conducting section 7 consultations and conferences. xxii + 165 pp + appendices.

Strong, C. and K. Nelson. MAMU biologists. Personal communication with Jan Johnson, U.S. Fish and Wildlife Service. May 3, 2019.

APPENDIX F

BULL TROUT STATUS OF THE SPECIES AND CRITICAL HABITAT

Rangewide Status of the Bull Trout

Listing Status and Current Range

The coterminous United States population of the bull trout (*Salvelinus confluentus*) was listed as threatened on November 1, 1999 (USFWS 1999, 64 FR 58910). The threatened bull trout occurs in the Klamath River Basin of south-central Oregon; the Jarbidge River in Nevada; the Willamette River Basin in Oregon; Pacific Coast drainages of Washington, including Puget Sound; major rivers in Idaho, Oregon, Washington, and Montana, within the Columbia River Basin; and the St. Mary-Belly River, east of the Continental Divide in northwestern Montana (Bond 1992, p. 2; Brewin and Brewin 1997, p. 215; Cavender 1978, pp. 165-166; Leary and Allendorf 1997, pp. 716-719; USFWS 1998, 63 FR 31647; USFWS 1999, 64 FR 58910; USFWS 2010, 75 FR 2269; USFWS 2015, pg. 1).

The final listing rule for the United States coterminous population of the bull trout discusses the consolidation of five DPSs into one listed taxon and the application of the jeopardy standard in accordance with the requirements of section 7 of the Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. 1531 et seq.), relative to this species, and established five interim recovery units for each of these DPSs for the purposes of Consultation and Recovery (USFWS 1999, 64 FR 58930).

Six draft recovery units were identified based on new information (USFWS 2010, 75 FR 63898) that confirmed they were needed to ensure a resilient, redundant, and representative distribution of bull trout populations throughout the range of the listed entity. The final Recovery Plan for the Coterminous Bull Trout Population (bull trout recovery plan) formalized these six recovery units (USFWS 2015, pg. 36-43) (see Figure 1). The final recovery units replace the previous five interim recovery units and will be used in the application of the jeopardy standard for Section 7 consultation proceedures.

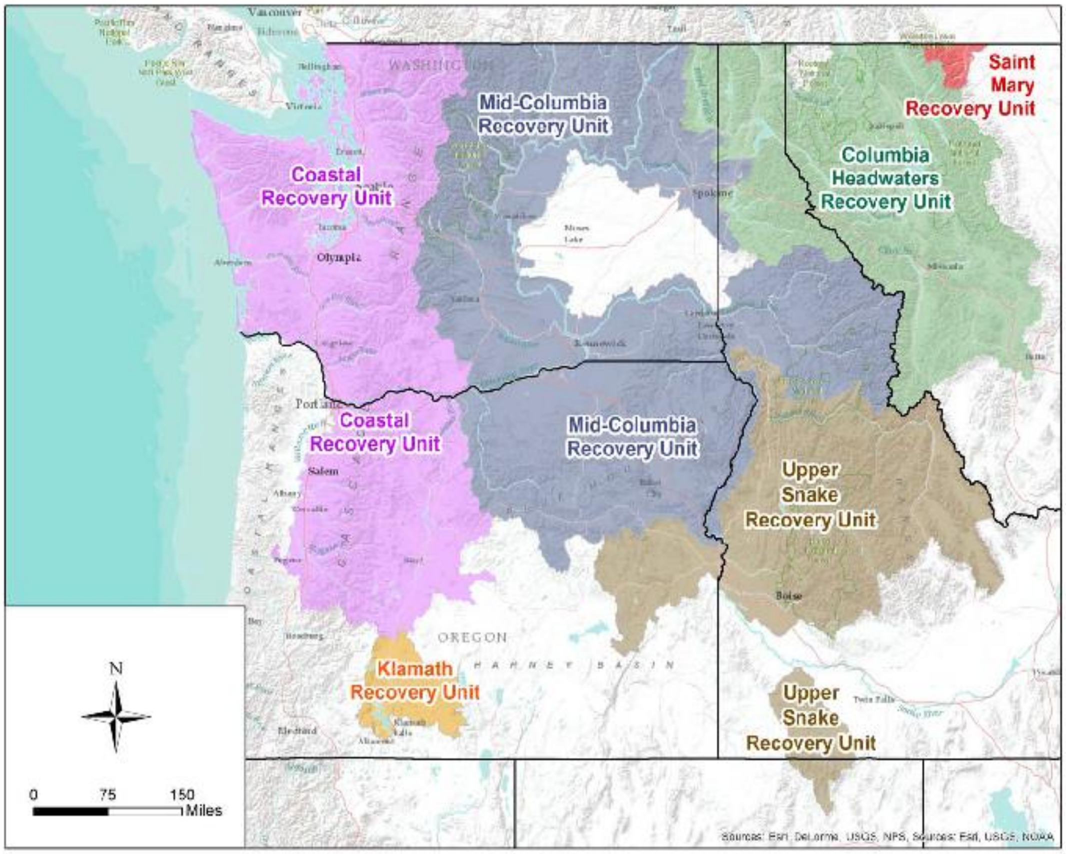

Figure 1. Locations of the six bull trout recovery units in the coterminous United States.

Reasons for Listing, Rangewide Trends and Threats

Throughout its range, the bull trout is threatened by the combined effects of habitat degradation, fragmentation, and alterations associated with dewatering, road construction and maintenance, mining, grazing, the blockage of migratory corridors by dams or other diversion structures, poor water quality; incidental angler harvest; entrainment (a process by which aquatic organisms are pulled through a diversion or other device) into diversion channels; and introduced non-native species (USFWS 1998, 63 FR 31647; USFWS 1999, 64 FR 58910). Poaching and incidental mortality of bull trout during other targeted fisheries are identified described in the bull trout recovery plan (see Threat Factors B and D) as additional threats (USFWS 2015, p. 150). Since the time of coterminous listing the species (USFWS 1999, 64 FR 58910) and designation of its critical habitat (USFWS 2004, 69 FR 59996; USFWS 2005b, 70 FR 56212; 2010, 75 FR 63898) a great deal of new information has been collected on the status of bull trout. The Service's Science Team Report (Whitesel et al 2004, entire), the bull trout core areas templates (USFWS 2005a, entire; USFWS 2009, entire), Conservation Status Assessment (USFWS 2005), and 5-year Reviews (USFWS 2008, entire; USFWS 2015g, entire) have provided additional information about threats and status. The final recovery plan lists other documents and meetings that compiled information about the status of bull trout (USFWS 2015, p. 3). As well, 2015 5-year review maintained the listing status as threatened based on the information compiled in the final bull trout recovery plan (USFWS 2015g, p.3) and the recovery unit implementation plans (RUIPs) (USFWS 2015a-f).

When first listed, the status of bull trout and its threats were reported by the Service at subpopulation scales. In 2002 and 2004, the draft recovery plans (USFWS 2002, entire; USFWS 2004, entire; USFWS 2004a, entire) included detailed information on threats at the recovery unit scale (i.e. similar to subbasin or regional watersheds), thus incorporating the metapopulation concept with core areas and local populations. In the 2008, 5-year Review, the Service established threats categories (i.e. dams, forest management, grazing, agricultural practices, transportation networks, mining, development and urbanization, fisheries management, small populations, limited habitat, and wildfire.) (USFWS 2008, entire). In the final recovery plan, threats and recovery actions are described for 109 core areas, forage/migration and overwintering areas, historical core areas, and research needs areas in each of the six recovery units (USFWS 2015, p 10-11). Primary threats are described in three broad categories: Habitat, Demographic, and Nonnative Fish for all recovery areas described in the listed range of the species. The 2015 5-year status review (USFWS 2015g, entire) references the final recovery plan and the recovery unit implementation plans and incorporates by reference the threats described therein. Although significant recovery actions have been implemented since the time of listing, the 5-year review concluded that bull trout still meets the definition of a "threatened" species (USFWS 2015g, entire).

New or Emerging Threats

The final Recovery Plan for the Coterminous Bull Trout Population (USFWS 2015, pg. 17) describes new or emerging threats, climate change, and other threats. Climate change was not addressed as a known threat when bull trout was listed. The 2015 bull trout recovery plan and RUIPs (USFWS 2015a-f) summarize the threat of climate change and acknowledge that some bull trout local populations and core areas may not persist into the future due to small populations, isolation, and effects of climate change (USFWS 2015, p. 48). The recovery plan further states that use of best available information will ensure future conservation efforts that offer the greatest long-term benefit to sustain bull trout and their required coldwater habitats (USFWS 2015, p. vii, and pp. 17-20). Mote et al. (2014) summarized climate change effects to include rising air temperature, changes in the timing of streamflow related to changing snowmelt, increases in extreme precipitation events, lower summer stream flows, and other changes. A warming trend in the mountains of western North America is expected to decrease snowpack, hasten spring runoff, reduce summer stream flows, and increase summer water temperatures (Poff et al. 2002, entire; Koopman et al. 2009, entire; PRBO Conservation Science 2011, entire). Lower flows as a result of smaller snowpack could reduce habitat, which might adversely affect bull trout reproduction and survival. Warmer water temperatures could lead to physiological stress and could also benefit nonnative fishes that prey on or compete with bull trout. Increases in the number and size of forest fires could also result from climate change (Westerling et al. 2006) and could adversely affect watershed function by resulting in faster runoff, lower base flows during the summer and fall, and increased sedimentation rates. Lower flows also may result in increased groundwater withdrawal for agricultural purposes and resultant reduced water availability in certain stream reaches occupied by bull trout (USFWS 2015b, p. B-10). Although all salmonids are likely to be affected by climate change, bull trout are especially vulnerable given that spawning and rearing are constrained by their location in upper watersheds and the requirement for cold water temperatures (Battin et al. 2007, pp. 6672-6673; Rieman et al. 2007, p. 1552). Climate change is expected to reduce the extent of cold-water habitat (Isaak et al. 2015), and increase competition with other fish species (lake trout, brown trout, brook trout, and northern pike) for resources in remaining suitable habitat. Several authors project that brook trout, a fish species that competes for resources with and predates on the bull trout, will continue increasing their range in several areas (an elevation shift in distribution) due to the effects from climate change (Wenger et al. 2011, Isaak et al. 2010, 2014; Peterson et al. 2013; Dunham 2015).

Life History and Population Dynamics

Distribution

The historical range of bull trout includes major river basins in the Pacific Northwest at about 41 to 60 degrees North latitude, from the southern limits in the McCloud River in northern California and the Jarbidge River in Nevada to the headwaters of the Yukon River in the Northwest Territories, Canada (Cavender 1978, pp. 165-166; Bond 1992, p. 2). To the west, the bull trout's range includes Puget Sound, various coastal rivers of British Columbia, Canada, and southeast Alaska (Bond 1992, p. 2). Bull trout occur in portions of the Columbia River and tributaries within the basin, including its headwaters in Montana and Canada. Bull trout also occur in the Klamath River basin of south-central Oregon. East of the Continental Divide, bull trout are found in the headwaters of the Saskatchewan River in Alberta and Montana and in the MacKenzie River system in Alberta and British Columbia, Canada (Cavender 1978, pp. 165-166; Brewin and Brewin 1997, entire).

Reproductive Biology

The iteroparous reproductive strategy (fishes that spawn multiple times, and therefore require safe two-way passage upstream and downstream) of bull trout has important repercussions for the management of this species. Bull trout require passage both upstream and downstream, not only for repeat spawning but also for foraging. Most fish ladders, however, were designed specifically for anadromous semelparous salmonids (fishes that spawn once and then die and require only one-way passage upstream). Therefore, even dams or other barriers with fish passage facilities may be a factor in isolating bull trout populations if they do not provide a safe downstream passage route. Additionally, in some core areas, bull trout that migrate to marine waters must pass both upstream and downstream through areas with net fisheries at river mouths. This can increase the likelihood of mortality to bull trout during these spawning and foraging migrations.

Growth varies depending upon life-history strategy. Resident adults range from 6 to 12 inches total length, and migratory adults commonly reach 24 inches or more (Goetz 1989, p. 30; Pratt 1985, pp. 28-34). The largest verified bull trout is a 32-pound specimen caught in Lake Pend Oreille, Idaho, in 1949 (Simpson and Wallace 1982, p. 95).

Bull trout typically spawn from August through November during periods of increasing flows and decreasing water temperatures. Preferred spawning habitat consists of low-gradient stream reaches with loose, clean gravel (Fraley and Shepard 1989, p. 141). Redds are often constructed in stream reaches fed by springs or near other sources of cold groundwater (Goetz 1989, pp. 15-16; Pratt 1992, pp. 6-7; Rieman and McIntyre 1996, p. 133). Depending on water temperature, incubation is normally 100 to 145 days (Pratt 1992, p. 1). After hatching, fry remain in the substrate, and time from egg deposition to emergence may surpass 220 days. Fry normally emerge from early April through May, depending on water temperatures and increasing stream flows (Pratt 1992, p. 1; Ratliff and Howell 1992, p. 10).

Early life stages of fish, specifically the developing embryo, require the highest inter-gravel dissolved oxygen (IGDO) levels, and are the most sensitive life stage to reduced oxygen levels. The oxygen demand of embryos depends on temperature and on stage of development, with the greatest IGDO required just prior to hatching.

A literature review conducted by the Washington Department of Ecology (WDOE 2002, p. 9) indicates that adverse effects of lower oxygen concentrations on embryo survival are magnified as temperatures increase above optimal (for incubation). Normal oxygen levels seen in rivers used by bull trout during spawning ranged from 8 to 12 mg/L (in the gravel), with corresponding instream levels of 10 to 11.5 mg/L (Stewart et al. 2007, p. 10). In addition, IGDO concentrations, water velocities in the water column, and especially the intergravel flow rate, are interrelated variables that affect the survival of incubating embryos (ODEQ 1995, Ch. 2 pp. 23-24). Due to a long incubation period of 220+ days, bull trout are particularly sensitive to adequate IGDO levels. An IGDO level below 8 mg/L is likely to result in mortality of eggs, embryos, and fry.

Population Structure

Bull trout exhibit both resident and migratory life history strategies. Both resident and migratory forms may be found together, and either form may produce offspring exhibiting either resident or migratory behavior (Rieman and McIntyre 1993, p. 2). Resident bull trout complete their entire life cycle in the tributary (or nearby) streams in which they spawn and rear. The resident form tends to be smaller than the migratory form at maturity and also produces fewer eggs (Goetz 1989, p. 15). Migratory bull trout spawn in tributary streams where juvenile fish rear 1 to 4 years before migrating to either a lake (adfluvial form), river (fluvial form) (Fraley and Shepard 1989, p. 138; Goetz 1989, p. 24), or saltwater (anadromous form) to rear as subadults and to live as adults (Brenkman and Corbett 2005, entire; McPhail and Baxter 1996, p. i; WDFW et al. 1997, p. 16). Bull trout normally reach sexual maturity in 4 to 7 years and may live longer than 12 years. They are iteroparous (they spawn more than once in a lifetime). Repeat- and alternate-year spawning has been reported, although repeat-spawning frequency and post-spawning mortality are not well documented (Fraley and Shepard 1989, p. 135; Leathe and Graham 1982, p. 95; Pratt 1992, p. 8; Rieman and McIntyre 1996, p. 133).

Bull trout are naturally migratory, which allows them to capitalize on temporally abundant food resources and larger downstream, and resident forms may develop where barriers (either natural or manmade) occur or where foraging, migrating, or overwintering habitats for migratory fish are minimized (Swanberg, 1997, entire; Brenkman and Corbett 2005, pp. 1075-1076; Goetz et al. 2004, p. 105, Starcevich et al 2012, entire; USFWS 2016, p. 170). For example, multiple life history forms (e.g., resident and fluvial) and multiple migration patterns have been noted in the Grande Ronde River (Baxter 2002, pp. 96, 98-106). Some river systems have retained habitat conditions that allow free movement between spawning and rearing areas and the mainstem Rivers. In these areas with connectivity bull trout can migrate between large rivers lakes, and spawning tributaries. Other migrations in Central Washington have shown that fluvial and adfluvial life forms travel long distances, migrate between core areas, and mix together in many locations where there is connectivity (Ringel et al 2014; Nelson and Nelle 2008). Such multiple life history strategies help to maintain the stability and persistence of bull trout populations to environmental changes. Benefits of connected habitat for migratory bull trout include greater growth in the more productive waters of larger streams, lakes, and marine waters; greater fecundity resulting in increased reproductive potential; and dispersing the population across space and time so that spawning streams may be recolonized should local populations suffer a catastrophic loss (Frissell 1999, pp. 861-863; MBTSG 1998, p. 13; Rieman and McIntyre 1993, pp. 2-3). In the absence of the migratory bull trout life form, isolated populations cannot be replenished when disturbances make local habitats temporarily unsuitable. Therefore, the range of the species is diminished, and the potential for a greater reproductive contribution from larger size fish with higher fecundity is lost (Rieman and McIntyre 1993, p. 2).

Whitesel et al. (2004, p. 2) noted that although there are multiple resources that contribute to the subject, Spruell et al. (2003, entire) best summarized genetic information on bull trout population structure. Spruell et al. (2003, entire) analyzed 1,847 bull trout from 65 sampling locations, four located in three coastal drainages (Klamath, Queets, and Skagit Rivers), one in the Saskatchewan River drainage (Belly River), and 60 scattered throughout the Columbia River Basin. They concluded that there is a consistent pattern among genetic studies of bull trout, regardless of whether examining allozymes, mitochondrial DNA, or most recently microsatellite loci. Typically, the genetic pattern shows relatively little genetic variation within populations, but substantial divergence among populations. Microsatellite loci analysis supports the existence of at least three major genetically differentiated groups (or evolutionary lineages) of bull trout (Spruell et al. 2003, p. 17). They were characterized as:

a) “Coastal”, including the Deschutes River and all of the Columbia River drainage downstream, as well as most coastal streams in Washington, Oregon, and British Columbia. A compelling case also exists that the Klamath Basin represents a unique evolutionary lineage within the coastal group.
b) “Snake River”, which also included the John Day, Umatilla, and Walla Walla rivers. Despite close proximity of the John Day and Deschutes Rivers, a striking level of divergence between bull trout in these two systems was observed.
c) “Upper Columbia River” which includes the entire basin in Montana and northern Idaho. A tentative assignment was made by Spruell et al. (2003, p. 25) of the Saskatchewan River drainage populations (east of the continental divide), grouping them with the upper Columbia River group.

Spruell et al. (2003, p. 17) noted that within the major assemblages, populations were further subdivided, primarily at the level of major river basins. Taylor et al. (1999, entire) surveyed bull trout populations, primarily from Canada, and found a major divergence between inland and coastal populations. Costello et al. (2003, p. 328) suggested the patterns reflected the existence of two glacial refugia, consistent with the conclusions of Taylor and Costello (2006, pg. 1165-1170), Spruell et al. (2003, p. 26) and the biogeographic analysis of Haas and McPhail (2001, entire). Both Taylor et al. (1999, p. 1166) and Spruell et al. (2003, p. 21) concluded that the Deschutes River represented the most upstream limit of the coastal lineage in the Columbia River Basin.

More recently, the USFWS identified additional genetic units within the coastal and interior lineages (Ardren et al. 2011, p. 18). Based on a recommendation in the USFWS's 5-year review of the species' status (USFWS 2008, p. 45), the USFWS reanalyzed the 27 recovery units identified in the 2002 draft bull trout recovery plan (USFWS 2002, p. 48) by utilizing, in part, information from previous genetic studies and new information from additional analysis (Ardren et al. 2011, entire). In this examination, the USFWS applied relevant factors from the joint USFWS and NMFS Distinct Population Segment (DPS) policy (USFWS 1996, entire) and subsequently identified six draft recovery units that contain assemblages of core areas that retain genetic and ecological integrity across the range of bull trout in the coterminous United States. These six draft recovery units were used to inform designation of critical habitat for bull trout by providing a context for deciding what habitats are essential for recovery (USFWS 2010, p. 63898). These six recovery units, adopted in the final bull trout recovery plan (USFWS 2015) and described further in the RUIPs (USFWS 2015a-f) include: Coastal, Klamath, Mid-Columbia, Columbia Headwaters, Saint Mary, and Upper Snake. A number of additional genetic analyses within core areas have been completed to understand uniqueness of local populations (Hawkins and Van Barren 2006, 2007; Small et al. 2009; DeHann and Neibauer 2012).

Population Dynamics

Although bull trout are widely distributed over a large geographic area, they exhibit a patchy distribution, even in pristine habitats (Rieman and McIntyre 1993, p. 4). Increased habitat fragmentation reduces the amount of available habitat and increases isolation from other populations of the same species (Saunders et al. 1991, entire). Burkey (1989, entire) concluded that when species are isolated by fragmented habitats, low rates of population growth are typical in local populations and their probability of extinction is directly related to the degree of isolation and fragmentation. Without sufficient immigration, growth for local populations may be low and probability of extinction high (Burkey 1989, entire; Burkey 1995, entire).

Metapopulation concepts of conservation biology theory has been suggested relative to the distribution and characteristics of bull trout, although empirical evidence is relatively scant (Rieman and McIntyre 1993, p. 15; Dunham and Rieman 1999, entire; Rieman and Dunham 2000, entire). A metapopulation is an interacting network of local populations with varying frequencies of migration and gene flow among them (Meffe and Carroll 1994, pp. 189-190). For inland bull trout, metapopulation theory is likely most applicable at the watershed scale where habitat consists of discrete patches or collections of habitat capable of supporting local populations; local populations are for the most part independent and represent discrete reproductive units; and long-term, low-rate dispersal patterns among component populations influences the persistence of at least some of the local populations (Rieman and Dunham 2000, entire). Ideally, multiple local populations distributed throughout a watershed provide a mechanism for spreading risk because the simultaneous loss of all local populations is unlikely. However, habitat alteration, primarily through the construction of impoundments, dams, and water diversions has fragmented habitats, eliminated migratory corridors, and in many cases isolated bull trout in the headwaters of tributaries (Rieman and Clayton 1997, pp. 10-12; Dunham and Rieman 1999, p. 645; Spruell et al. 1999, pp. 118-120; Rieman and Dunham 2000, p. 55).

Human-induced factors as well as natural factors affecting bull trout distribution have likely limited the expression of the metapopulation concept for bull trout to patches of habitat within the overall distribution of the species (Dunham and Rieman 1999, entire). However, despite the theoretical fit, the relatively recent and brief time period during which bull trout investigations have taken place does not provide certainty as to whether a metapopulation dynamic is occurring (e.g., a balance between local extirpations and recolonizations) across the range of the bull trout or whether the persistence of bull trout in large or closely interconnected habitat patches (Dunham and Rieman 1999, entire) is simply reflective of a general deterministic trend towards extinction of the species where the larger or interconnected patches are relics of historically wider distribution (Rieman and Dunham 2000, pp. 56-57). Research does, however, provide genetic evidence for the presence of a metapopulation process for bull trout, at least in the Boise River Basin of Idaho (Whiteley et al. 2003, entire), while Whitesel et al. identifies that bull trout fit the metapopulation theory in several ways (Whitesel et al, 2004, p. 18-21).

Habitat Characteristics

The habitat requirements of bull trout are often generally expressed as the four “Cs”: cold, clean, complex, and connected habitat. Cold stream temperatures, clean water quality that is relatively free of sediment and contaminants, complex channel characteristics (including abundant large wood and undercut banks), and large patches of such habitat that are well connected by unobstructed migratory pathways are all needed to promote conservation of bull trout throughout all hierarchical levels.

Bull trout have more specific habitat requirements than most other salmonids (Rieman and McIntyre 1993, p. 4). Habitat components that influence bull trout distribution and abundance include water temperature, cover, channel form and stability, valley form, spawning and rearing substrate, and migratory corridors (Fraley and Shepard 1989, entire; Goetz 1989, pp. 23, 25; Hoelscher and Bjornn 1989, pp. 19, 25; Howell and Buchanan 1992, pp. 30, 32; Pratt 1992, entire; Rich 1996, p. 17; Rieman and McIntyre 1993, pp. 4-6; Rieman and McIntyre 1995, entire; Sedell and Everest 1991, entire; Watson and Hillman 1997, entire). Watson and Hillman (1997, pp. 247-250) concluded that watersheds must have specific physical characteristics to provide the habitat requirements necessary for bull trout to successfully spawn and rear and that these specific characteristics are not necessarily present throughout these watersheds. Because bull trout exhibit a patchy distribution, even in pristine habitats (Rieman and McIntyre 1993, pp. 4-6), bull trout should not be expected to simultaneously occupy all available habitats.

Migratory corridors link seasonal habitats for all bull trout life histories. The ability to migrate is important to the persistence of bull trout (Rieman and McIntyre 1993, p. 2). Migrations facilitate gene flow among local populations when individuals from different local populations interbreed or stray to nonnatal streams. Local populations that are extirpated by catastrophic events may also become reestablished by bull trout migrants. However, it is important to note that the genetic structuring of bull trout indicates there is limited gene flow among bull trout populations, which may encourage local adaptation within individual populations, and that reestablishment of extirpated populations may take a long time (Rieman and McIntyre 1993, p. 2; Spruell et al. 1999, entire). Migration also allows bull trout to access more abundant or larger prey, which facilitates growth and reproduction. Additional benefits of migration and its relationship to foraging are discussed below under "Diet."

Cold water temperatures play an important role in determining bull trout habitat quality, as these fish are primarily found in colder streams, and spawning habitats are generally characterized by temperatures that drop below 9 °C in the fall (Fraley and Shepard 1989, p. 137; Pratt 1992, p. 5; Rieman and McIntyre 1993, p. 2).

Thermal requirements for bull trout appear to differ at different life stages. Spawning areas are often associated with cold-water springs, groundwater infiltration, and the coldest streams in a given watershed (Pratt 1992, pp 7-8; Rieman and McIntyre 1993, p. 7). Optimum incubation temperatures for bull trout eggs range from 2 °C to 6 °C whereas optimum water temperatures for rearing range from about 6 °C to 10 °C (Buchanan and Gregory 1997, p. 4; Goetz 1989, p. 22). In Granite Creek, Idaho, Bonneau and Scarnecchia (1996, entire) observed that juvenile bull trout selected the coldest water available in a plunge pool, 8 °C to 9 °C, within a temperature gradient of 8 °C to 15 °C. In a landscape study relating bull trout distribution to maximum water temperatures, Dunham et al. (2003, p. 900) found that the probability of juvenile bull trout occurrence does not become high (i.e., greater than 0.75) until maximum temperatures decline to 11 °C to 12 °C.

Although bull trout are found primarily in cold streams, occasionally these fish are found in larger, warmer river systems throughout the Columbia River basin (Buchanan and Gregory 1997, p. 2; Fraley and Shepard 1989, pp. 133, 135; Rieman and McIntyre 1993, pp. 3-4; Rieman and McIntyre 1995, p. 287). Availability and proximity of cold-water patches and food productivity can influence bull trout ability to survive in warmer rivers (Myrick 2002, pp. 6 and 13).

All life history stages of bull trout are associated with complex forms of cover, including large woody debris, undercut banks, boulders, and pools (Fraley and Shepard 1989, p. 137; Goetz 1989, p. 19; Hoelscher and Bjornn 1989, p. 38; Pratt 1992, entire; Rich 1996, pp. 4-5; Sedell and Everest 1991, entire; Sexauer and James 1997, entire; Thomas 1992, pp. 4-6; Watson and Hillman 1997, p. 238). Maintaining bull trout habitat requires stable and complex stream channels and stable stream flows (Rieman and McIntyre 1993, pp. 5-6). Juvenile and adult bull trout frequently inhabit side channels, stream margins, and pools with suitable cover (Sexauer and James 1997, p. 364). These areas are sensitive to activities that directly or indirectly affect stream channel stability and alter natural flow patterns. For example, altered stream flow in the fall may disrupt bull trout during the spawning period, and channel instability may decrease survival of eggs and young juveniles in the gravel from winter through spring (Fraley and

Shepard 1989, p. 141; Pratt 1992, p. 6; Pratt and Huston 1993, p. 70). Pratt (1992, p. 6) indicated that increases in fine sediment reduce egg survival and emergence.

Diet

Bull trout are opportunistic feeders, with food habits primarily a function of size and life-history strategy. Fish growth depends on the quantity and quality of food that is eaten, and as fish grow their foraging strategy changes as their food changes, in quantity, size, or other characteristics (Quinn 2005, pp. 195-200). Resident and juvenile migratory bull trout prey on terrestrial and aquatic insects, macrozooplankton, and small fish (Boag 1987, p. 58; Donald and Alger 1993, pp. 242-243; Goetz 1989, pp. 33-34). Subadult and adult migratory bull trout generally feed on various fish species (Donald and Alger 1993, pp. 241-243; Fraley and Shepard 1989, pp. 135, 138; Leathe and Graham 1982, pp. 13, 50-56). Bull trout of all sizes other than fry have been found to eat fish half their length (Beauchamp and VanTassell 2001, p. 204). In nearshore marine areas of western Washington, bull trout feed on Pacific herring (*Clupea pallasi*), Pacific sand lance (*Ammodytes hexapterus*), and surf smelt (*Hypomesus pretiosus*) (Goetz et al. 2004, p. 105; WDFW et al. 1997, p. 23).

Bull trout migration and life history strategies are closely related to their feeding and foraging strategies and their environment. Migration allows bull trout to access optimal foraging areas and exploit a wider variety of prey resources both within and between core areas. Connectivity between the spawning, rearing, overwintering, and forage areas maintains this diversity. There have been recent studies documenting movement patterns in the Columbia River basin that document long distance migrations (Borrows et al 2016, entire; Schaller et al 2014, entire; USFWS 2016, entire). For example, a data report documented a juvenile bull trout from the Entiat made over a 200-mile migration between spawning grounds in the Entiat River to foraging and overwintering areas in Columbia and Yakima River near Prosser Dam (PTAGIS 2015, Tag Code 3D9.1C2CCD42DD). As well, in the Skagit River system, anadromous bull trout make migrations as long as 121 miles between marine foraging areas in Puget Sound and headwater spawning grounds, foraging on salmon eggs and juvenile salmon along their migration route (WDFW et al. 1997, p. 25). Anadromous bull trout also use marine waters as migration corridors to reach seasonal habitats in non-natal watersheds to forage and possibly overwinter (Brenkman and Corbett 2005, pp. 1078-1079; Goetz et al. 2004, entire).

Conservation Needs

The 2015 recovery plan for bull trout established the primary strategy for recovery of bull trout in the coterminous United States: (1) conserve bull trout so that they are geographically widespread across representative habitats and demographically stable in six recovery units; (2) effectively manage and ameliorate the primary threats in each of six recovery units at the core area scale such that bull trout are not likely to become endangered in the foreseeable future; (3) build upon the numerous and ongoing conservation actions implemented on behalf of bull trout since their listing in 1999, and improve our understanding of how various threat factors potentially affect the species; (4) use that information to work cooperatively with our partners to design, fund, prioritize, and implement effective conservation actions in those areas that offer the greatest long-term benefit to sustain bull trout and where recovery can be achieved; and (5) apply adaptive management principles to implementing the bull trout recovery program to account for new information (USFWS 2015, p. 24.) .

Information presented in prior draft recovery plans published in 2002 and 2004 (USFWS 2002, 2004, 2004a) provided information that identified the original list of threats and recovery actions across the range of the species and provided a framework for implementing numerous recovery actions by our partner agencies, local working groups, and others with an interest in bull trout conservation. Many recovery actions were completed prior to finalizing the recovery plan in 2015.

The 2015 recovery plan (USFWS 2015, entire) integrates new information collected since the 1999 listing regarding bull trout life history, distribution, demographics, conservation successes, etc., and integrates and updates previous bull trout recovery planning efforts across the range of the coterminous bull trout listing

The Service has developed a recovery approach that: (1) focuses on the identification of and effective management of known and remaining threat factors to bull trout in each core area; (2) acknowledges that some extant bull trout core area habitats will likely change (and may be lost) over time; and (3) identifies and focuses recovery actions in those areas where success is likely to meet our goal of ensuring the certainty of conservation of genetic diversity, life history features, and broad geographical representation of remaining bull trout populations so that the protections of the ESA are no longer necessary (USFWS 2015, p. 45-46).

To implement the recovery strategy, the 2015 recovery plan establishes the recovery of bull trout will entail effectively managing threats to ensure the long-term persistence of populations and their habitats, ensuring the security of multiple interacting groups of bull trout, and providing habitat conditions and access to them that allow for the expression of various life history forms within each of six recovery units (USFWS 2015, p. 50-51).” The recovery plan defines four categories of recovery actions that, when implemented and effective, should:

1. Protect, restore, and maintain suitable habitat conditions for bull trout;
2. Minimize demographic threats to bull trout by restoring connectivity or populations where appropriate to promote diverse life history strategies and conserve genetic diversity;
3. Prevent and reduce negative effects of nonnative fishes and other nonnative taxa on bull trout;
4. and result in actively working with partners to conduct research and monitoring to implement and evaluate bull trout recovery activities, consistent with an adaptive management approach using feedback from implemented, site-specific recovery tasks, and considering the effects of climate change (USFWS 2015, p. 50-51).

Bull trout recovery is based on a geographical hierarchical approach. Bull trout are listed as a single DPS within the five-state area of the coterminous United States. The single DPS is subdivided into six biological-based recovery units: (1) Coastal Recovery Unit; (2) Klamath Recovery Unit; (3) Mid-Columbia Recovery Unit; (4) Upper Snake Recovery Unit; (5) Columbia Headwaters Recovery Unit; and (6) Saint Mary Recovery Unit (USFWS 2015, p. 23). A viable recovery unit should demonstrate that the three primary principles of biodiversity have been met: representation (conserving the genetic makeup of the species); resiliency (ensuring that each population is sufficiently large to withstand stochastic events); and redundancy (ensuring a sufficient number of populations to withstand catastrophic events) (USFWS 2015, p. 33).

Each of the six recovery units contain multiple bull trout recovery areas which are non-overlapping watershed-based polygons, and each core area includes one or more local population. Currently there are 109 occupied core areas, which comprise 611 local populations (USFWS 2015, p. 3, Appendix F). There are also six core areas where bull trout historically occurred but are now extirpated, and one research needs area where bull trout were known to occur historically, but their current presence and use of the area are uncertain (USFWS 2015, p. 3, Appendix F). Core areas can be further described as complex or simple (USFWS 2015, p. 3-4). Complex core areas contain multiple local bull trout populations, are found in large watersheds, have multiple life history forms, and have migratory connectivity between spawning and rearing habitat and foraging, migration, and overwintering habitats (FMO). Simple core areas are those that contain one bull trout local population. Simple core areas are small in scope, isolated from other core areas by natural barriers, and may contain unique genetic or life history adaptations.

A core area is a combination of core habitat (i.e., habitat that could supply all elements for the long-term security of bull trout) and a core population (a group of one or more local bull trout populations that exist within core habitat) and constitutes the basic unit on which to gauge recovery within a recovery unit. Core areas require both habitat and bull trout to function, and the number (replication) and characteristics of local populations inhabiting a core area provide a relative indication of the core area’s likelihood to persist. A core area represents the closest approximation of a biologically functioning unit for bull trout. Core areas are presumed to reflect the metapopulation structure of bull trout.

A local population is a group of bull trout that spawn within a particular stream or portion of a stream system (USFWS 2015, p. 73). A local population is considered to be the smallest group of fish that is known to represent an interacting reproductive unit. For most waters where specific information is lacking, a local population may be represented by a single headwater tributary or complex of headwater tributaries. Gene flow may occur between local populations (*e.g.*, those within a core population), but is assumed to be infrequent compared with that among individuals within a local population.

Population Units

The final recovery plan (USFWS 2015) designates six bull trout recovery units as described above. These units replace the 5 interim recovery units previously identified (USFWS 1999). The Service will address the conservation of these final recovery units in our section 7(a)(2) analysis for proposed Federal actions. The recovery plan (USFWS 2015), identified threats and factors affecting the bull trout within these units. A detailed description of recovery implementation for each recovery unit is provided in separate recovery unit implementation plans (RUIPs)(USFWS 2015a-f), which identify recovery actions and conservation recommendations needed for each core area, forage/ migration/ overwinter (FMO) areas, historical core areas, and research needs areas. Each of the following recovery units (below) is necessary to maintain the bull trout’s numbers and distribution, as well as its genetic and phenotypic diversity, all of which are important to ensure the species' resilience to changing environmental conditions. For more details on Federal, State, and tribal conservation actions in this unit see the actions since listing, contemporaneous actions, and environmental baseline discussions below.

Coastal Recovery Unit

The Coastal RUIP describes the threats to bull trout and the site-specific management actions necessary for recovery of the species within the unit (USFWS 2015a, entire). The Coastal Recovery Unit is divided into three Geographic Regions: Puget Sound, Olympic Peninsula, and the Lower Columbia River regions. This recovery unit contains 20 core areas comprising 84 local populations and a single potential local population in the historic Clackamas River core area where bull trout had been extirpated and were reintroduced in 2011. This recovery unit also has four historically occupied core areas that could be re-established (USFWS 2015, p. 47; USFWS 2015a, p. A-2).

Although population strongholds do exist across the three regions, populations in the Puget Sound region generally have better demographic status while the Lower Columbia River region exhibits the least robust demography (USFWS 2015a, p. A-6). Puget Sound and the Olympic Peninsula currently support the only anadromous local populations of bull trout. This recovery unit also contains ten shared FMO habitats which allow for the continued natural population dynamics in which the core areas have evolved (USFWS 2015a, p. A-5). There are four core areas within the Coastal Recovery Unit that have been identified as current population strongholds: Lower Skagit, Upper Skagit, Quinault River, and Lower Deschutes River (USFWS 2015, p.79; USFWS 2015a, p. A-3). These are the most stable and abundant bull trout populations in the recovery unit. The Puget Sound region supports at least two core areas containing a natural adfluvial life history.

The demographic status of the Puget Sound populations is better in northern areas. Barriers to migration in the Puget Sound region are few, and significant amounts of headwater habitat occur in protected areas (USFWS 2015a, p. A-7). The current condition of the bull trout in this recovery unit is attributed to the adverse effects of climate change, loss of functioning estuarine and nearshore marine habitats, development and related impacts (e.g., flood control, floodplain disconnection, bank armoring, channel straightening, loss of instream habitat complexity), agriculture (e.g., diking, water control structures, draining of wetlands, channelization, and the removal of riparian vegetation, livestock grazing), fish passage (e.g., dams, culverts, instream flows) residential development, urbanization, forest management practices (e.g., timber harvest and associated road building activities), connectivity impairment, mining, and the introduction of non-native species (USFWS 2015a, p. A-1 – A-25). Conservation measures or recovery actions implemented or ongoing include relicensing of major hydropower facilities that have provided upstream and downstream fish passage or complete removal of dams, land acquisition to conserve bull trout habitat, floodplain restoration, culvert removal, riparian revegetation, levee setbacks, road removal, and projects to protect and restore important nearshore marine habitats (USFWS 2015a, p. A-33 – A-34).

Klamath Recovery Unit

The Klamath recovery unit implementation plan describes the threats to bull trout and the site-specific management actions necessary for recovery of the species within the unit (USFWS 2015b, entire). The Klamath Recovery Unit is located in southern Oregon and northwestern California. The Klamath Recovery Unit is the most significantly imperiled recovery unit, having experienced considerable extirpation and geographic contraction of local populations and declining demographic condition, and natural re-colonization is constrained by dispersal barriers and presence of nonnative brook trout (USFWS 2015, p. 39). This recovery unit currently contains three core areas and eight local populations (USFWS 2015, p. 47; USFWS 2015b, p. B-1). Nine historic local populations of bull trout have become extirpated (USFWS 2015b, p. B-1). All three core areas have been isolated from other bull trout populations for the past 10,000 years (USFWS 2015b, p. B-3). The current condition of the bull trout in this recovery unit is attributed to the adverse effects of climate change, habitat degradation and fragmentation, past and present land use practices, agricultural water diversions, nonnative species, and past fisheries management practices (UFWS 2015b, p. B-13 – B-14). Conservation measures or recovery actions implemented or ongoing include removal of nonnative fish (e.g., brook trout, brown trout, and hybrids), acquiring water rights for instream flows, replacing diversion structures, installing fish screens, constructing bypass channels, installing riparian fencing, culver replacement, and habitat restoration (USFWS 2015b, p. B-10 – B-11).

Mid-Columbia Recovery Unit

The Mid-Columbia RUIP describes the threats to bull trout and the site-specific management actions necessary for recovery of the species within the unit (USFWS 2015c, entire). The Mid-Columbia Recovery Unit is located within eastern Washington, eastern Oregon, and portions of central Idaho. The Mid-Columbia Recovery Unit is divided into four geographic regions: Lower Mid-Columbia, Upper Mid-Columbia, Lower Snake, and Mid-Snake Geographic regions. This recovery unit contains 24 occupied core areas comprising 142 local populations, two historically occupied core areas, one research needs area, and seven FMO habitats (USFWS 2015, p. 47; USFWS 2015c, p. C-1 – C-4). The current condition of the bull trout in this recovery unit is attributed to the adverse effects of climate change, agricultural practices (e.g. irrigation, water withdrawals, livestock grazing), fish passage (e.g. dams, culverts), nonnative species, forest management practices, and mining (USFWS 2015c, p. C-9 – C-34). Conservation measures or recovery actions implemented or ongoing include road removal, channel restoration, mine reclamation, improved grazing management, removal of fish barriers, and instream flow requirements (USFWS 2015c, C-37 – C-40).

Columbia Headwaters Recovery Unit

The Columbia headwaters RUIP describes the threats to bull trout and the site-specific management actions necessary for recovery of the species within the unit (USFWS 2015d). The Columbia Headwaters Recovery Unit is located in western Montana, northern Idaho, and the northeastern corner of Washington. The Columbia Headwaters Recovery Unit is divided into five geographic regions: Upper Clark Fork, Lower Clark Fork, Flathead, Kootenai, and Coeur d'Alene geographic regions (USFWS 2015d, p. D-2 – D-4). This recovery unit contains 35 bull trout core areas; 15 of which are complex core areas as they represent larger interconnected habitats and 20 simple core areas as they are isolated headwater lakes with single local populations. The 20 simple core areas are each represented by a single local population, many of which may have persisted for thousands of years despite small populations and isolated existence (USFWS 2015d, p. D-1).

Fish passage improvements within the recovery unit have reconnected some previously fragmented habitats (USFWS 2015d, p. D-42), while others remain fragmented. Unlike other recovery units in Washington, Idaho and Oregon, the Columbia Headwaters Recovery Unit does not have any anadromous fish overlap (USFWS 2015d, p. D-42). Therefore, bull trout within the Columbia Headwaters Recovery Unit do not benefit from the recovery actions for salmon (USFWS 2015d, p. D-42). The current condition of the bull trout in this recovery unit is attributed to the adverse effects of climate change, mostly historical mining and contamination by heavy metals, expanding populations of nonnative fish predators and competitors, modified instream flows, migratory barriers (e.g., dams), habitat fragmentation, forest practices (e.g., logging, roads), agriculture practices (e.g. irrigation, livestock grazing), and residential development (USFWS 2015d, p. D-10 – D-25). Conservation measures or recovery actions implemented or ongoing include habitat improvement, fish passage, and removal of nonnative species (USFWS 2015d, p. D-42 – D-43).

Upper Snake Recovery Unit

The Upper Snake RUIP describes the threats to bull trout and the site-specific management actions necessary for recovery of the species within the unit (USFWS 2015e, entire). The Upper Snake Recovery Unit is located in central Idaho, northern Nevada, and eastern Oregon. The Upper Snake Recovery Unit is divided into seven geographic regions: Salmon River, Boise River, Payette River, Little Lost River, Malheur River, Jarbidge River, and Weiser River. This recovery unit contains 22 core areas and 207 local populations, with over 70 percent being present in the Salmon River Region (USFWS 2015, p. 47; USFWS 2015e, p. E-1 – E-2). The current condition of the bull trout in this recovery unit is attributed to the adverse effects of climate change, dams, mining, forest management practices, nonnative species, and agriculture (e.g., water diversions, grazing) (USFWS 2015e, p. E-15 – E-18). Conservation measures or recovery actions implemented or ongoing include instream habitat restoration, instream flow requirements, screening of irrigation diversions, and riparian restoration (USFWS 2015e, p. E-19 – E-20).

St. Mary Recovery Unit

The St. Mary RUIP describes the threats to bull trout and the site-specific management actions necessary for recovery of the species within the unit (USFWS 2015f). The Saint Mary Recovery Unit is located in Montana but is heavily linked to downstream resources in southern Alberta, Canada. Most of the Saskatchewan River watershed which the St. Mary flows into is located in Canada. The United States portion includes headwater spawning and rearing habitat and the upper reaches of FMO habitat. This recovery unit contains four core areas, and seven local populations (USFWS 2015f, p. F-1) in the U.S. Headwaters. The current condition of the bull trout in this recovery unit is attributed primarily to the outdated design and operations of the

Saint Mary Diversion operated by the Bureau of Reclamation (e.g., entrainment, fish passage, instream flows), and, to a lesser extent habitat impacts from development and nonnative species (USFWS 2015f, p. F-7 – F-8). The primary issue precluding bull trout recovery in this recovery unit relates to impacts of water diversions, specifically at the Bureau of Reclamations Milk River Project (USFWS 2015f, p. F-5). Conservation measures or recovery actions implemented or ongoing are not identified in the St. Mary RUIP; however, the USFWS is conducting interagency and tribal coordination to accomplish conservation goals for the bull trout (USFWS 2015f, p. F-9).

Federal, State and Tribal Actions Since Listing

Since our listing of bull trout in 1999, numerous conservation measures that contribute to the conservation and recovery of bull trout have been and continue to be implemented across its range in the coterminous United States. These measures are being undertaken by a wide variety of local and regional partnerships, including State fish and game agencies, State and Federal land management and water resource agencies, Tribal governments, power companies, watershed working groups, water users, ranchers, and landowners.
In many cases, these bull trout conservation measures incorporate or are closely interrelated with work being done for recovery of salmon and steelhead, which are limited by many of the same threats. These include removal of migration barriers (culvert removal or redesign at stream crossings, fish ladder construction, dam removal, etc.) to allow access to spawning or FMO habitat; screening of water diversions to prevent entrainment into unsuitable habitat in irrigation systems; habitat improvement (riparian revegetation or fencing, placement of coarse woody debris in streams) to improve spawning suitability, habitat complexity, and water temperature; instream flow enhancement to allow effective passage at appropriate seasonal times and prevent channel dewatering; and water quality improvement (decommissioning roads, implementing best management practices for grazing or logging, setting pesticide use guidelines) to minimize impacts from sedimentation, agricultural chemicals, or warm temperatures.

At sites that are vulnerable to development, protection of land through fee title acquisition or conservation easements is important to prevent adverse impacts or allow conservation actions to be implemented. In several bull trout core areas, it is necessary to continue ongoing fisheries management efforts to suppress the effects of non-native fish competition, predation, or hybridization; particularly brown trout, brook trout, lake trout, and northern pike (Fredenberg et al. 2007; DeHaan et al. 2010, entire; DeHaan and Godfrey 2009, entire; Fredericks and Dux 2014; Rosenthal and Fredenberg 2017). A more comprehensive overview of conservation successes from 1999-2013, described for each recovery unit, is found in the Summary of Bull Trout Conservation Successes and Actions since 1999 (Available at: (http://www.fws.gov/pacific/ecoservices/endangered/recovery/documents/USFWS_2013_summary_of_conservation_successes.pdf).

Projects that have undergone ESA section 7 consultation have occurred throughout the range of bull trout. Singly or in aggregate, these projects could affect the species' status. The Service has conducted periodic reviews of prior Federal "consulted-on" actions. A detailed discussion of consulted-on effects in the proposed action area is provided in the environmental baseline section below.

Literature Cited

Ardren, W.R., P.W. DeHaan, C.T. Smith , E.B. Taylor , R. Leary , C.C. Kozfkay , L. Godfrey , M. Diggs , W. Fredenberg , J. Chan, C.W. Kilpatrick , M.P. Small, and D.K. Hawkins. 2011. Genetic Structure, Evolutionary History, and Conservation Units of Bull Trout in the Coterminous United States, Transactions of the American Fisheries Society, 140:2, 506-525.

Battin, J., M.W. Wiley, M.H. Ruckelshaus, R.N. Palmer, E. Korb, K.K. Bartz, and H. Imaki. 2007. Projected impacts of climate change on salmon habitat restoration. Proceedings of the National Academy of Sciences of the United States of America. 104(16):6720-6725.

Baxter, C.V. 2002. Fish movement and assemblage dynamics in a Pacific Northwest riverscape. Doctor of Philosophy in Fisheries Science. Oregon State University, Corvallis, Oregon. 174 pp.

Baxter, J.S., E.B. Taylor, and R.H. Devlin. 1997. Evidence for natural hybridization between dolly varden (Salvelinus malma) and bull trout (Salvelinus confluentus) in a northcentral British Columbia watershed. Canadian Journal of Fisheries and Aquatic Sciences 54:421-429.

Beauchamp, D.A., and J.J. VanTassell. 2001. Modeling seasonal trophic interactions of adfluvial bull trout in Lake Billy Chinook, Oregon. Transactions of the American Fisheries Society 130:204-216.

Boag, T.D. 1987. Food habits of bull char (Salvelinus confluentus), and rainbow trout (Salmo gairdneri), coexisting in a foothills stream in northern Alberta. Canadian Field-Naturalist 101(1):56-62.

Bond, C.E. 1992. Notes on the nomenclature and distribution of the bull trout and the effects of human activity on the species. Pages 1-4 In P.J. Howell, and D.V. Buchanan, eds. Proceedings of the Gearhart Mountain bull trout workshop, Oregon Chapter of the American Fisheries Society, Corvallis, Oregon.

Bonneau, J.L., and D.L. Scarnecchia. 1996. Distribution of juvenile bull trout in a thermal gradient of a plunge pool in Granite Creek, Idaho. Transactions of the American Fisheries Society 125(4):628-630.

Barrows, M. G., B. Davis, J. Harris, E. Bailey, M. L. Koski and S. Starcevich. 2017. Clackamas River Bull Trout Reintroduction Project, 2016 Annual Report. U.S. Fish and Wildlife Service and Oregon Department of Fish and Wildlife. 66 pp.

Brenkman, S.J., and S.C. Corbett. 2005. Extent of anadromy in bull trout and implications for conservation of a threatened species. North American Journal of Fisheries Management 25:1073-1081.

Brewin, P.A., and M.K. Brewin. 1997. Distribution maps for bull trout in Alberta. Pages 209-216 In Mackay, W.C., M.K. Brewin and M. Monita eds. Friends of the Bull Trout, Bull Trout Task Force (Alberta), c/o Trout Unlimited, Calgary, Alberta T2P 2C8, Canada. 8 pp.

Buchanan, D.V., and S.V. Gregory. 1997. Development of water temperature standards to protect and restore habitat for bull trout and other cold water species in Oregon. Pages 119-126 In Mackay, W.C., M.K. Brewing and M. Monita eds. Friends of the Bull Trout, Alberta, Canada.

Cavender, T.M. 1978. Taxonomy and distribution of the bull trout, Salvelinus confluentus (Suckley), from the American Northwest. California Fish and Game 64(3):139-174.

Costello, A.B., T.E. Down, S.M. Pollard, C.J. Pacas, and E.B. Taylor. 2003. The influence of history and contemporary stream hydrology on the evolution of genetic diversity within species: an examination of microsatellite DNA variation in bull trout, Salvelinus confluentus (Pisces: Salmonidae). Evolution. 57(2):328-344.

DeHaan, P.W., and L.Godfrey. 2009. Bull trout population genetic structure and entrainment in Warm Springs Creek, Montana. U.S. Fish and Wildlife Service, Final Report June 2, 2009. Abernathy Fish Technology Center, Longview, Washington. 32 pp.

DeHaan, P.W., L.T. Schwabe, and W.R. Ardren. 2010. Spatial patterns of hybridization between bull trout, Salvelinus confluentus, and brook trout Salvelinus fontinalis, in an Oregon stream network. Conservation Genetics 11: 935-949.

Donald, D.B., and D.J. Alger. 1993. Geographic distribution, species displacement, and niche overlap for lake trout and bull trout in mountain lakes. Canadian Journal of Zoology 71:238-247.

Dunham, J. B. 2015. Final report for rangewide climate vulnerability assessment for threatened bull trout. Report submitted to Northwest Climate Science Center. U.S. Geological Survey, Forest and Rangeleand Ecosystem Science Center, Corvallis, Oregon. 47 pp.

Dunham, J.B. and B.E. Rieman. 1999. Metapopulation structure of bull trout: Influences of physical, biotic, and geometrical landscape characteristics. Ecological Applications 9:642-655.

Dunham, J., B. Rieman, and G. Chandler. 2003. Influences of temperature and environmental variables on the distribution of bull trout within streams at the southern margin of its range. North American Journal of Fisheries Management 23:894-905.

Fraley, J.J., and B.B. Shepard. 1989. Life history, ecology and population status of migratory bull trout (Salvelinus confluentus) in the Flathead Lake and river system, Montana. Northwest Science 63(4):133-143.

Fredericks, J., and A. Dux. 2014. Lake Pend Oreille Fishery Recovery Program. Idaho Department of Fish and Game Presentation. 30 pp.

Fredenberg, W., P. DeHaan, and W. Ardren. 2007. Genetic Analysis and photo documentation of hybridization between bull trout and brook trout in the Swan River basin, Montana. Report prepared forth the Swan Valley Bull Trout Working Group. 34 pp.

Frissell, C.A. 1999. An ecosystem approach to habitat conservation for bull trout: groundwater and surface water protection. Flathead Lake Biological Station, University of Montana, Open File Report Number 156-99, Polson, MT, January 07, 1999. 46 pp.

Goetz, F., E.D. Jeanes, and E.M. Beamer. 2004. Bull trout in the nearshore. U.S. Army Corps of Engineers, Preliminary draft, Seattle, Washington, June 2004. 396 pp.

Goetz, F. 1989. Biology of the bull trout, Salvelinus confluentus, a literature review. Willamette National Forest, Eugene, Oregon, February 1989. 53 pp.

Haas, G.R., and J.D. McPhail. 2001. The post-Wisconsin glacial biogeography of bull trout (Salvelinus confluentus): a multivariate morphometric approach for conservation biology and management. Canadian Journal of Fisheries and Aquatic Sciences 58:2189-2203.

Hoelscher, B., and T.C. Bjornn. 1989. Habitat, density, and potential production of trout and char in Pend Oreille Lake tributaries. Idaho Department of Fish and Game, Project F-710R-10, Subproject III, Job No. 8., Boise, Idaho, January 1989. 60 pp.

Howell P.J., J.B. Dunham, P.M. Sankovich 2009. Relationships between water temperatures and upstream migration, cold water refuge use, and spawning of adult bull trout from the Lostine River, Oregon, USA. Ecology of Freshwater Fish 2009, John Wiley & Sons A/S. 11 pp.

Howell, P.J., and D.V. Buchanan. 1992. Proceedings of the Gearhart Mountain bull trout workshop. Oregon Chapter of the American Fisheries Society, Corvallis, Oregon. 67 pp.

Isaak, D.J., M.K. Young, D. Nagel, and D. Horan. 2014. Coldwater as a climate shield to preserve native trout through the 21st century. Pages 110-116 in: R.F. Carline and C. LoSapio (editors). Looking back and moving forward. Proceedings of the Wild Trout Symposium XI, Bozeman, Montana.

Isaak, D.J., C.H. Luce, B.E. Rieman, D.E. Nagel, B.E. Peterson, D.L. Horan, S. Parkes, and G.L. Chandler. 2010. Effects of climate change and wildfire on stream temperatures and salmonid thermal habitat in a mountain river network. Ecological Applications 20:1350-1371.

Ringel, K., B. M., J. Neibauer, K. Fulmer, and M. C. Nelson. 2014. Migration patterns of adult bull trout in the Wenatchee River, Washington 2000-2004. U.S. Fish and Wildlife Service, Leavenworth, Washington. 81pp with separate appendices.

Koopman, M. E., R. S. Nauman, B. R. Barr, S. J. Vynne, and G. R. Hamilton. 2009. Projected future conditions in the Klamath basin of southern Oregon and northern California. National Center for Conservation Science and Policy, Ashland, Oregon.

Leary, R.F., and F.W. Allendorf. 1997. Genetic confirmation of sympatric bull trout and Dolly Varden in western Washington. Transactions of the American Fisheries Society 126:715-720.

Leathe, S.A., and P.J. Graham. 1982. Flathead Lake fish food habits study. US EPA, Region VIII, Water Division, Contract R008224-01-4, Denver, Colorado, October, 1982. 209 pp.

MBTSG (The Montana Bull Trout Scientific Group). 1998. The relationship between land management activities and habitat requirements of bull trout. Montana Fish, Wildlife, and Parks, Helena, MT, May 1998. 77 pp.

McPhail, J.D., and J.S. Baxter. 1996. A review of bull trout (Salvelinus confluentus) life-history and habitat use in relation to compensation and improvement opportunities. Department of Zoology, University of British Columbia, Fisheries Management Report Number 104, Vancouver, British Columbia. 36 pp.

Mote, P., A.K. Snover, S. Capalbo, S.D. Eigenbrode, P. Glick, J. Littell, R. Raymondi, and S. Reeder. 2014. Chapter 21: Northwest. Pages 487-513 in Climate Change Impacts in the United States: The Third National Climate Assessment, J.M. Melillo, Terese (T.C.) Richmond, and G.W. Yohe, Eds., U.S. Global Change Research Program doi:10.7930/J04Q7RWX.

Myrick, C.A., F.T. Barrow, J.B. Dunham, B.L. Gamett, G.R. Haas, J.T. Peterson, B. Rieman, L.A. Weber, and A.V. Zale. 2002. Bull trout temperature thresholds:peer review summary. USFWS, Lacey, Washington, September 19, 2002. 14 pp.

Nelson, M. C., and R. D. Nelle. 2008. Seasonal movements of adult fluvial bull trout in the Entiat River, WA 2003-2006. U.S. Fish and Wildlife Service, Leavenworth, Washington.

ODEQ (Oregon Department of Environmental Quality). 1995. 1992-1994 water quality standards review: dissolved oxygen - final issue paper. Oregon Department of Environmental Quality, Portland, OR.

Peterson, D.P., S.J. Wenger, B.E. Rieman, and D.J. Isaak. 2013. Linking climate change and fish conservation efforts using spatially explicit decision support tools. Fisheries 38:112-127.

Poff, N. L., M. M. Brinson, and J. W. Day, Jr. 2002. Aquatic ecosystems & global climate change: Potential impacts on inland freshwater and coastal wetland ecosystems in the United States. Pew Center on Global Climate Change.

Pratt, K.L. 1984. Habitat use and species interactions of juvenile cutthroat, Salmo clarki, and bull trout, Salvelinus confluentus, in the upper Flathead River basin. Master's Thesis. University of Idaho, Moscow, ID.

Pratt, K.L. 1985. Pend Oreille trout and char life history study. Idaho Department of Fish and Game in cooperation with the Pend Oreille Idaho Club

Pratt, K.L. 1992. A review of bull trout life history. Pages 5-9 In Howell, P.J. and D.V. Buchanan eds. Proceedings of the Gearhart Mountain bull trout workshop, Oregon Chapter of the American Fisheries Society, Corvallis, Oregon. 5 pp.

Pratt, K.L., and J.E. Huston. 1993. Status of bull trout (Salvelinus confluentus) in Lake Pend Oreille and the lower Clark Fork River. The Washington Water Power Company, Draft, Spokane, Washington, December 1, 1993. 200 pp.

PRBO Conservation Science. 2011. Projected effects of climate change in California ecoregional summaries emphasizing consequences for wildlife. Version 1.0.

[PTAGIS] PIT Tag Information System. 2015. Queries/reports for PIT tagged bull trout. Movements observed between core areas. http://www.ptagis.org/home.

Ratliff, D.E., and P.J. Howell. 1992. The status of bull trout populations in Oregon. Pages 10-17 in: P.J. Howell and D.V. Buchanan (eds). Proceedings of the Gearhart Mountain bull trout workshop. Oregon Chapter of the American Fisheries Society, Corvallis.

Rich, C.F. 1996. Influence of abiotic and biotic factors on occurrence of resident bull trout in fragmented habitats, Western Montana. Master's Thesis. Montana State University, Bozeman, MT. 54 pp.

Rieman, B., and J. Clayton. 1997a. Wildfire and native fish: Issues of forest health and conservation of sensitive species. Fisheries 22:6-14.

Rieman, B.E., and J.B. Dunham. 2000. Metapopulations and salmonids: a synthesis of life history patterns and empirical observations. Ecology of Freshwater Fish 9:51-64.

Rieman, B.E., D. Isaak, S. Adams, D. Horan, D. Nagel, C.H. Luce, and D. Myers. 2007. Anticipated climate warming effects on bull trout habitats and populations across the interior Columbia River Basin. Transactions of the American Fisheries Society 136(6):1552-1565.

Rieman, B.E., D.C. Lee, and R.F. Thurow. 1997. Distribution, status, and likely future trends of bull trout within the Columbia River and Klamath River basins. North American Journal of Fisheries Management 7:1111-1125.

Rieman, B.E., and J.D. McIntyre. 1996. Spatial and temporal variability in bull trout redd counts. North American Journal of Fisheries Management 16:132-141.

Rieman, B.E., and J.D. McIntyre. 1995. Occurrence of bull trout in naturally fragmented habitat patches of varied size. Transactions of the American Fisheries Society 124(3):285-296.

Rieman, B.E., and J.D. McIntyre. 1993. Demographic and habitat requirements for conservation of Bull Trout. USDA, Forest Service, Intermountain Research Station, General Technical Report INT-302, Ogden, Utah, September 1993. 38 pp.

Rosenthal, L., and W. Fredenberg. 2017. Experimental removal of Lake Trout in Swan Lake, Montana: 2016 Annual Report. Prepared for the Swan Valley Bull Trout Working Group. 23 pages.

Schaller, H., P. Budy, C. Newlon, S. Haeseker, J. Harris, M. Barrows, D. Gallion, R. Koch, T. Bowerman, M. Connor, R. Al-Chokhachy, J. Skalicky, and D. Anglin. 2014. Walla Walla River bull trout ten year retrospective analysis and implications for recovery planning. U.S. Fish and Wildlife Service, Columbia River Fisheries Program Office, Vancouver, WA, and Utah State University, Cooperative Fish and Wildlife Research Unit, U.S. Geological Survey, Logan, UT. 520 pp.

Sedell, J.R., and F.H. Everest. 1991. Historic changes in pool habitat for Columbia River Basin salmon under study for TES listing. Pacific Northwest Research Station, Draft U.S. Department of Agriculture Report, Corvallis, Oregon. 6 pp.

Sexauer, H.M., and P.W. James. 1997. Microhabitat use by juvenile bull trout in four streams located in the eastern Cascades, Washington. Pages 361-370 In W.C. McKay, M.K. Brewin, and M. Monita, eds. Friends of the Bull Trout Conference Proceedings, Bull Trout Task Force (Alberta), c/o Trout Unlimited, Calgary, Alberta, Canada.

Simpson, J.C., and R.L. Wallace. 1982. Fishes of Idaho. University of Idaho Press, Moscow, ID. 93 pp.

Spruell, P., B.E. Rieman, K.L. Knudsen, F.M. Utter, and F.W. Allendorf. 1999. Genetic population structure within streams: microsatellite analysis of bull trout populations. Ecology of Freshwater Fish 8:114-121.

Spruell, P., A.R. Hemmingsen, P.J. Howell, N. Kanda, and F.W. Allendorf. 2003. Conservation genetics of bull trout: Geographic distribution of variation at microsatellite loci. Conservation Genetics 4:17-29

Stewart, D.B., N.J. Mochnacz, C.D. Sawatzky, T.J. Carmichael, and J.D. Reist. 2007. Fish life history and habitat use in the Northwest territories: Bull trout (Salvelinus confluentus). Department of Fisheries and Oceans, Canadian Manuscript Report of Fisheries and Aquatic Sciences 2801, Winnipeg, MB, Canada, 2007. 54 pp.

Swanberg, T.R. 1997. Movements of and Habitat Use by Fluvial Bull Trout in the Blackfoot River, Montana. Transactions of the American Fisheries Society. 126:735-746, 1997.

Taylor, B.E., S. Pollard, and D. Louie. 1999. Mitochondrial DNA variation in bull trout (Salvelinus confluentus) from northwestern North America: implications for zoogeography and conservation. Molecular Ecology 8:1155-1170.

Taylor, E. B., and A. B. Costello. 2006. Microsatellite DNA analysis of coastal populations of bull trout (Salvelinus confluentus) in British Columbia: zoogeographic implications and its application to recreational fishery management. Canadian Journal of Fisheries and Aquatic Sciences 63:1157– 1171.Thomas, G. 1992. Status of bull trout in Montana. Montana Department of Fish, Wildlife and Parks, Helena, MT, August 1992. 83 pp.

USFWS and NOAA. 1996. Policy Regarding the Recognition of Distinct Vertebrate Population Segments Under the Endangered Species Act. Fish and Wildlife Service, Department of the Interior, National Oceanic and Atmospheric Administration, Department of Commerce. 61 FR 4722.

USFWS. 1999. Endangered and Threatened Wildlife and Plants; Determination of Threatened Status for Bull Trout in the Coterminous United States. Fish and Wildlife Service, Department of the Interior. 50 CFR 17, Vol. 64, No. 210, p. 58910-58933.

USFWS. 2002. Bull trout (Salvelinus confluentus) draft recovery plan (Klamath River, Columbia River, and St. Mary-Belly River distinct population segments). U.S. Fish and Wildlife Service, Portland, Oregon.

USFWS. 2003. Bull trout consulted-on effects from the time of listing to August 2003. J. Nuss ed. November 24, 2003, Draft Report. 23 pp.

USFWS. 2004. Draft Recovery Plan for the Coastal-Puget Sound distinct population segment of bull trout (Salvelinus confluentus). Volume I: Puget Sound Management Unit, 389 + xvii p., and Volume II: Olympic Peninsula Management Unit, 277 + xvi p., Portland, Oregon.

USFWS. 2004a. Draft recovery plan for the Jarbidge River distinct population segment of the bull trout (Salvelinus confluentus). U.S. Fish and Wildlife Service, Portland, Oregon. 132 + xiii p.

USFWS. 2005. Bull trout core area conservation status assessment. W. Fredenberg, J. Chan, eds.

U.S. Fish and Wildlife Service, Portland, OR. 399 pp.

USFWS. 2005a. Bull trout core area templates - complete core area by core area analysis. W. Fredenberg, J. Chan, eds. U.S. Fish and Wildlife Service, Portland, Oregon. 668 pp.

USFWS. 2005b. Endangered and threatened wildlife and plants; designation of critical habitat for the bull trout. September 26, 2005. 70 FR 56212-56311.USFWS. 2008. Bull trout (Salvelinus confluentus) 5-year review: Summary and evaluation. U.S. Fish and Wildlife Service, Portland, Oregon.

USFWS. 2008b. Bull trout recovery monitoring and evaluation. U.S. Fish and Wildlife Service.

USFWS. 2009. Bull trout core area templates - complete core area by core area re-analysis. W. Fredenberg and J. Chan, editors. U. S. Fish and Wildlife Service. Portland, Oregon. 1895 pp.

USFWS. 2010. Endangered and threatened wildlife and plants; revised designation of critical habitat for bull trout in the coterminous United States; proposed rule. January 14, 2010. Federal Register 75 FR 2269.

USFWS. 2010a. Endangered and threatened wildlife and plants; revised designation of critical habitat for bull trout in the coterminous United States; final rule. October 18, 2010. Federal Register 75:63898-64070.

USFWS. 2014. Revised draft recovery plan for the coterminous United States population of bull trout (Salvelinus confluentus). U.S. Fish and Wildlife Service, Portland, Oregon. xiii + 151 pp.

USFWS. 2015. Recovery plan for the coterminous United States population of bull trout (Salvelinus confluentus). U.S. Fish and Wildlife Service, Portland, Oregon. xii + 179 pp.

USFWS. 2015a. Coastal recovery unit implementation plan for bull trout (Salvelinus confluentus). U.S. Fish and Wildlife Service, Lacey, Washington, and Portland, Oregon. 155 pp.

USFWS. 2015b. Klamath recovery unit implementation plan for bull trout (Salvelinus confluentus). U.S. Fish and Wildlife Service, Klamath Falls, Oregon. 35 pp.

USFWS. 2015c. Mid-Columbia recovery unit implementation plan for bull trout (Salvelinus confluentus). U.S. Fish and Wildlife Service, Portland, Oregon. 345 pp.

USFWS. 2015d. Columbia headwaters recovery unit implementation plan for bull trout (Salvelinus confluentus). U.S. Fish and Wildlife Service, Kalispell, Montana, and Spokane, Washington. 179 pp.

USFWS. 2015e. Upper Snake recovery unit implementation plan for bull trout (Salvelinus confluentus). U.S. Fish and Wildlife Service, Boise, Idaho. 113 pp.

USFWS. 2015f. St. Mary recovery unit implementation plan for bull trout (Salvelinus confluentus). U.S. Fish and Wildlife Service, Kalispell, Montana. 30 pp.

USFWS, 2015g. Bull Trout 5-Year Review, Short Form Summary. U.S. Fish and Wildlife Service, Boise, Idaho. 7pp.

USFWS. 2016. Use of the Mainstem Columbia and Lower Snake Rivers by Migratory Bull Trout. Data Synthesis and Analyses. Final Report. U.S. Fish and Wildlife Service, Columbia River Fisheries Program Office, Vancouver, WA. 276 pp.

Watson, G., and T.W. Hillman. 1997. Factors affecting the distribution and abundance of bull trout: an investigation at hierarchical scales. North American Journal of Fisheries Management 17(2):237-252.

Wegner, S.J., et al. 2011. Flow regime, temperature, and biotic interactions, drive differential declines of trout species under climate change. PNAS August 23, 2011. 108 (34) 14175-14180.

Westerling, A.L., H.G. Hidalgo, D.R. Cayan, and T.W. Swetnam. 2006. Warming and earlier spring increase western U.S. forest wildfire activity. Science. 18 Aug 2006: Vol. 313, Issue 5789, pp. 940-943.

Whiteley, A., P. Spruell and F.W. Allendorf. 2003. Population genetics of Boise Basin bull trout (Salvelinus confluentus). Final Report to Bruce Rieman, Rocky Mountain Research Station. University of Montana Wild Trout and Salmon Genetics Lab, Missoula, Montana.

Whitesel, T.A. and 7 coauthors. 2004. Bull trout recovery planning: A review of the science associated with population structure and size. Science Team Report #2004-01, U.S. Fish and Wildlife Service, Region 1, Portland, Oregon.

WDFW, FishPro Inc., and Beak Consultants. 1997. Grandy Creek trout hatchery biological assessment. Washington Department of Fish and Wildlife, Olympia, WA, March 1997. 47 pp.

WDOE. 2002. Evaluating criteria for the protection of freshwater aquatic life in Washington's surface water quality standards - dissolved oyxgen: Draft discussion paper and literature summary. Washington Department of Ecology, Publication Number 00-10-071, Olympia, WA, December 2002.
90 pp.

Status of Bull Trout Critical Habitat

Legal Status

Current Designation

The Service published a final critical habitat designation for the coterminous United States population of the bull trout on October 18, 2010 (70 FR 63898); the rule became effective on November 17, 2010. Critical habitat is defined as the specific geographic area(s) that contains features essential for the conservation of a threatened or endangered species and that may require special management and protection. Critical habitat may include an area that is not currently occupied by the species but that will be needed for its recovery. Designated critical CHUs for the bull trout are described in Figure 1. A justification document describes occupancy and the rationale for why these habitat areas are essential for the conservation of bull trout was developed to support the rule and is available on our website (https://www.fws.gov/pacific/bulltrout/crithab/Jusitfication%20Docs.html).

The scope of the designation involved the species' coterminous range. Rangewide, the Service designated reservoirs/lakes and stream/shoreline miles as bull trout critical habitat (Table B-1). Designated bull trout critical habitat is of two primary use types: 1) spawning and rearing, and 2) foraging, migration, and overwintering (FMO).

Table B-1. Stream/shoreline distance and reservoir/lake area designated as bull trout critical habitat by state.

State	Stream/Shoreline Miles	Stream/Shoreline Kilometers	Reservoir /Lake Acres	Reservoir/ Lake Hectares
Idaho	8,771.6	14,116.5	170,217.5	68,884.9
Montana	3,056.5	4,918.9	221,470.7	89,626.4
Nevada	71.8	115.6	-	-
Oregon	2,835.9	4,563.9	30,255.5	12,244.0
Oregon/Idaho	107.7	173.3	-	-
Washington	3,793.3	6,104.8	66,308.1	26,834.0
Washington (marine)	753.8	1,213.2	-	-
Washington/Idaho	37.2	59.9	-	-
Washington/Oregon	301.3	484.8	-	-
Total	19,729.0	31,750.8	488,251.7	197,589.2

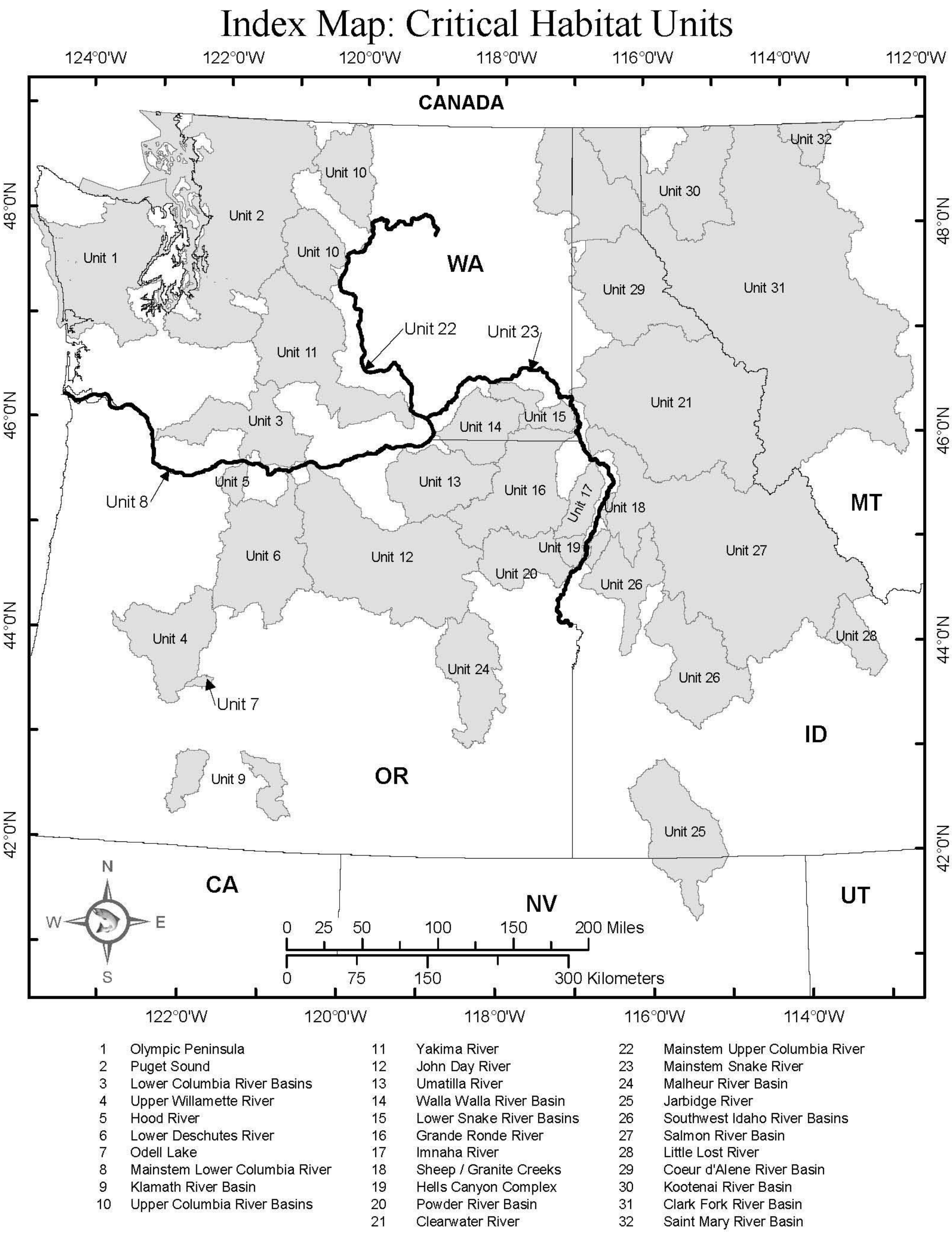

Figure 1. Index map of bull trout designated critical habitat units.

This rule also identifies and designates as critical habitat approximately 1,323.7 km (822.5 miles) of streams/shorelines and 6,758.8 ha (16,701.3 acres) of lakes/reservoirs of unoccupied habitat to address bull trout conservation needs in specific geographic areas in several areas not occupied at the time of listing. These unoccupied areas were determined by the Service to be essential for restoring functioning migratory bull trout populations based on currently available scientific information. These unoccupied areas often include lower main stem river environments that can provide seasonally important migration habitat for bull trout. This type of habitat is essential in areas where bull trout habitat and population loss over time necessitates reestablishing bull trout in currently unoccupied habitat areas to achieve recovery.

The final rule continues to exclude some critical habitat segments based on a careful balancing of the benefits of inclusion versus the benefits of exclusion. Critical habitat does not include: 1) waters adjacent to non-Federal lands covered by legally operative incidental take permits for habitat conservation plans (HCPs) issued under section 10(a)(1)(B) of the Endangered Species Act of 1973, as amended (Act), in which bull trout is a covered species on or before the publication of this final rule; 2) waters within or adjacent to Tribal lands subject to certain commitments to conserve bull trout or a conservation program that provides aquatic resource protection and restoration through collaborative efforts, and where the Tribes indicated that inclusion would impair their relationship with the Service; or 3) waters where impacts to national security have been identified (75 FR 63898). Excluded areas are approximately 10 percent of the stream/shoreline miles and 4 percent of the lakes and reservoir acreage of designated critical habitat. Each excluded area is identified in the relevant CHU text, as identified in paragraphs (e)(8) through (e)(41) of the final rule. Fewer than 2,000 stream miles and 20,000 acres of lake and reservoir surface area were excluded from the designation of critical habitat. It is important to note that the exclusion of waterbodies from designated critical habitat does not negate or diminish their importance for bull trout conservation, nor reduce authorities that protect the species under the ESA. Because exclusions reflect the often complex pattern of land ownership, designated critical habitat is often fragmented and interspersed with excluded stream segments.

Conservation Role and Description of Critical Habitat

The conservation role of bull trout critical habitat is to support viable core area populations (75 FR 63898:63943 [October 18, 2010]). The core areas reflect the metapopulation structure of bull trout and are the closest approximation of a biologically functioning unit for the purposes of recovery planning and risk analyses. CHUs generally encompass one or more core areas and may include FMO areas, outside of core areas, that are important to the survival and recovery of bull trout.

As shown in Figure 1, thirty-two CHUs within the geographical area occupied by the species at the time of listing are designated under the final critical habitat rule. Twenty-nine of the CHUs contain all of the physical or biological features identified in this final rule and support multiple life-history requirements. Three of the mainstem river units in the Columbia and Snake River basins contain most of the physical or biological features necessary to support the bull trout's particular use of that habitat, other than those physical biological features associated with Primary Constituent Elements (PCEs) 5 and 6, which relate to breeding habitat.

The primary function of individual CHUs is to maintain and support core areas, which 1) contain bull trout populations with the demographic characteristics needed to ensure their persistence and contain the habitat needed to sustain those characteristics (Rieman and McIntyre 1993, p. 19); 2) provide for persistence of strong local populations, in part, by providing habitat conditions that encourage movement of migratory fish (MBTSG 1998, pp. 48-49; Rieman and McIntyre 1993, pp. 22-23); 3) are large enough to incorporate genetic and phenotypic diversity, but small enough to ensure connectivity between populations (Hard 1995, pp. 314-315; Healey and Prince 1995, p. 182; MBTSG 1998, pp. 48-49; Rieman and McIntyre 1993, pp. 22-23); and 4) are distributed throughout the historic range of the species to preserve both genetic and phenotypic adaptations (Hard 1995, pp. 321-322; MBTSG 1998, pp. 13-16; Rieman and Allendorf 2001, p. 763; Rieman and McIntyre 1993, p. 23).

The Olympic Peninsula and Puget Sound CHUs are essential to the conservation of amphidromous bull trout, which are unique to the Coastal-Puget Sound population segment. These CHUs contain marine nearshore and freshwater habitats, outside of core areas, that are used by bull trout from one or more core areas. These habitats, outside of core areas, contain PCEs that are critical to adult and subadult foraging, overwintering, and migration.

Primary Constituent Elements for Bull Trout Critical Habitat

Within the designated critical habitat areas, the PCEs for bull trout are those habitat components that are essential for the primary biological needs of foraging, reproducing, rearing of young, dispersal, genetic exchange, or sheltering. Based on our current knowledge of the life history, biology, and ecology of the bull trout and the characteristics of the habitat necessary to sustain its essential life-history functions, we determined in our final designation that the following PCEs are essential for the conservation of bull trout.

1. Springs, seeps, groundwater sources, and subsurface water connectivity (hyporheic flows) to contribute to water quality and quantity and provide thermal refugia.

2. Migration habitats with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and freshwater and marine foraging habitats, including but not limited to permanent, partial, intermittent, or seasonal barriers.

3. An abundant food base, including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.

4. Complex river, stream, lake, reservoir, and marine shoreline aquatic environments, and processes that establish and maintain these aquatic environments, with features such as large wood, side channels, pools, undercut banks and unembedded substrates, to provide a variety of depths, gradients, velocities, and structure.

5. Water temperatures ranging from 2 °C to 15 °C (36 °F to 59 °F), with adequate thermal refugia available for temperatures that exceed the upper end of this range. Specific temperatures within this range will depend on bull trout life-history stage and form;

geography; elevation; diurnal and seasonal variation; shading, such as that provided by riparian habitat; streamflow; and local groundwater influence.

6. In spawning and rearing areas, substrate of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. A minimal amount of fine sediment, generally ranging in size from silt to coarse sand, embedded in larger substrates, is characteristic of these conditions. The size and amounts of fine sediment suitable to bull trout will likely vary from system to system.

7. A natural hydrograph, including peak, high, low, and base flows within historic and seasonal ranges or, if flows are controlled, minimal flow departure from a natural hydrograph.

8. Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited.

9. Sufficiently low levels of occurrence of non-native predatory (e.g., lake trout, walleye, northern pike, smallmouth bass); interbreeding (e.g., brook trout); or competing (e.g., brown trout) species that, if present, are adequately temporally and spatially isolated from bull trout.

PCE 9 addresses the presence of nonnative predatory or competitive fish species. Although this PCE applies to both the freshwater and marine environments, currently no non-native fish species are of concern in the marine environment, though this could change in the future.

Note that only PCEs 2, 3, 4, 5, and 8 apply to marine nearshore waters identified as critical habitat. Also, lakes and reservoirs within the CHUs also contain most of the physical or biological features necessary to support bull trout, with the exception of those associated with PCEs 1 and 6. Additionally, all except PCE 6 apply to FMO habitat designated as critical habitat.

Critical habitat designated within each CHU includes the stream channels within the designated stream reaches and has a lateral extent as defined by the bankfull elevation on one bank to the bankfull elevation on the opposite bank. Bankfull elevation is the level at which water begins to leave the channel and move into the floodplain and is reached at a discharge that generally has a recurrence interval of 1 to 2 years on the annual flood series. If bankfull elevation is not evident on either bank, the ordinary high-water line must be used to determine the lateral extent of critical habitat. The lateral extent of designated lakes is defined by the perimeter of the waterbody as mapped on standard 1:24,000 scale topographic maps. The Service assumes in many cases this is the full-pool level of the waterbody. In areas where only one side of the waterbody is designated (where only one side is excluded), the mid-line of the waterbody represents the lateral extent of critical habitat.

In marine nearshore areas, the inshore extent of critical habitat is the mean higher high-water (MHHW) line, including the uppermost reach of the saltwater wedge within tidally influenced freshwater heads of estuaries. The MHHW line refers to the average of all the higher high-water heights of the two daily tidal levels. Marine critical habitat extends offshore to the depth of 10 meters (m) (33 ft) relative to the mean low low-water (MLLW) line (zero tidal level or average of all the lower low-water heights of the two daily tidal levels). This area between the MHHW line and minus 10 m MLLW line (the average extent of the photic zone) is considered the habitat most consistently used by bull trout in marine waters based on known use, forage fish availability, and ongoing migration studies and captures geological and ecological processes important to maintaining these habitats. This area contains essential foraging habitat and migration corridors such as estuaries, bays, inlets, shallow subtidal areas, and intertidal flats.

Adjacent shoreline riparian areas, bluffs, and uplands within CHUs are not designated as critical habitat. However, it should be recognized that the quality of marine and freshwater habitat along streams, lakes, and shorelines is intrinsically related to the character of these adjacent features, and that human activities that occur outside of the designated critical habitat within the CHUs can have significant effects on physical and biological features of the aquatic environment.

Activities that are likely to cause adverse effects to critical habitat are evaluated to determine if they are likely to “destroy or adversely modify” critical habitat such that the critical habitat will no longer serve the intended conservation role for the species or retain those PCEs that relate to the ability of the area to at least periodically support the species. Activities that may destroy or adversely modify critical habitat are those that alter the PCEs to such an extent that the conservation value of critical habitat is appreciably reduced (75 FR 63898:63943). The Service’s evaluation must be conducted at the scale of the entire critical habitat area designated, unless otherwise stated in the final critical habitat rule (USFWS and NMFS 1998, pp. 4-39). Thus, adverse modification of bull trout critical habitat is evaluated at the scale of the final designation, which includes the critical habitat designated for the Klamath River, Jarbidge River, Columbia River, Coastal-Puget Sound, and Saint Mary-Belly River population segments. However, we consider all 32 CHUs to contain features or areas essential to the conservation of the bull trout (75 FR 63898:63901, 63944). Therefore, if a proposed action would alter the physical or biological features of critical habitat to an extent that appreciably reduces the conservation function of one or more critical habitat units for bull trout, a finding of adverse modification of the entire designated critical habitat area may be warranted (75 FR 63898:63943).

Current Critical Habitat Condition Rangewide

The condition of bull trout critical habitat varies across its range from poor to good. Although still relatively widely distributed across its historic range, the bull trout occurs in low numbers in many areas, and populations are considered depressed or declining across much of its range (67 FR 71240). This condition reflects the condition of bull trout habitat. The decline of bull trout is primarily due to habitat degradation and fragmentation, blockage of migratory corridors, poor water quality, past fisheries management practices, impoundments, dams, water diversions, and the introduction of nonnative species (63 FR 31647, June 10 1998; 64 FR 17112, April 8, 1999).

There is widespread agreement in the scientific literature that many factors related to human activities have impacted bull trout habitat function, and continue to do so. Among the many factors that contribute to degraded PCEs, those which appear to be particularly significant and have resulted in a legacy of degraded habitat conditions are as follows: 1) fragmentation and isolation of local populations due to the proliferation of dams and water diversions that have eliminated habitat, altered water flow and temperature regimes, and impeded migratory movements (Dunham and Rieman 1999, p. 652; Rieman and McIntyre 1993, p. 7); 2) degradation of spawning and rearing habitat and upper watershed areas, particularly alterations in sedimentation rates and water temperature, resulting from forest and rangeland practices and intensive development of roads (Fraley and Shepard 1989, p. 141; MBTSG 1998, pp. ii - v, 20-45); 3) the introduction and spread of nonnative fish species, particularly brook trout and lake trout, as a result of fish stocking and degraded habitat conditions, which compete with bull trout for limited resources and, in the case of brook trout, hybridize with bull trout (Leary et al. 1993, p. 857; Rieman et al. 2006, pp. 73-76); 4) in the Coastal-Puget Sound region where amphidromous bull trout occur, degradation of mainstem river FMO habitat, and the degradation and loss of marine nearshore foraging and migration habitat due to urban and residential development; and 5) degradation of FMO habitat resulting from reduced prey base, roads, agriculture, development, and dams.

Effects of Climate Change on Bull Trout Critical Habitat

One objective of the final rule was to identify and protect those habitats that provide resiliency for bull trout use in the face of climate change. Over a period of decades, climate change may directly threaten the integrity of the essential physical or biological features described in PCEs 1, 2, 3, 5, 7, 8, and 9. Protecting bull trout strongholds and cold water refugia from disturbance and ensuring connectivity among populations were important considerations in addressing this potential impact. Additionally, climate change may exacerbate habitat degradation impacts both physically (e.g., decreased base flows, increased water temperatures) and biologically (e.g., increased competition with non-native fishes). For more discussion regarding impacts of climate change, see the status of the species and environmental baseline sections.

Consulted on Effects to Critical Habitat

The Service has formally consulted on the effects to bull trout critical habitat throughout its range. Section 7 consultations include actions that continue to degrade the environmental baseline in many cases. However, long-term restoration efforts are also proposed and have been implemented, which provides some stability or improvement in the existing functions within some of the critical habitat units. For about a detailed analysis of prior consulted-on effects in the action area, see the environmental baseline section.

Literature Cited for Bull Trout Status of Critical Habitat

Dunham, J.B. and B.E. Rieman. 1999. Metapopulation structure of bull trout: influences of physical, biotic, and geometrical landscape characteristics. Ecological Applications 9(2):642-55.

Fraley, J.J. and B.B. Shepard. 1989. Life history, ecology and population status of migratory bull trout (*Salvelinus confluentus*) in the Flathead Lake and River system, Montana. Northwest Science 63:133-43.

Hard, J. 1995. A quantitative genetic perspective on the conservation of intraspecific diversity. American Fisheries Society Symposium 17:304-26.

Healey, M.C. and A. Prince. 1995. Scales of variation in life history tactics of Pacific salmon and the conservation of phenotype and genotype. American Fisheries Society Symposium 17:176-84.

Leary, R.F., F.W. Allendorf, and S.H. Forbes. 1993. Conservation genetics of bull trout in the Columbia and Klamath River drainages. Conservation Biology 7(4):856-65.

MBTSG (The Montana Bull Trout Scientific Group). 1998. The relationship between land management activities and habitat requirements of bull trout. Montana Fish, Wildlife, and Parks, Helena, MT, May 1998, 77 pp.

Rieman, B.E. and F.W. Allendorf. 2001. Effective population size and genetic conservation criteria for bull trout. North American Journal of Fisheries Management 21:756-64.

Rieman, B.E. and J.D. McIntyre. 1993. Demographic and habitat requirements for conservation of bull trout. General Technical Report INT-302. U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Ogden, Utah, 38 pp.

Rieman, B.E., J.T. Peterson, and D.E. Myers. 2006. Have brook trout (*Salvelinus fontinalis*) displaced bull trout (*Salvelinus confluentus*) along longitudinal gradients in central Idaho streams? Canadian Journal of Fish and Aquatic Sciences 63:63-78.

USFWS (U.S. Fish and Wildlife Service) and NMFS (National Marine Fisheries Service). 1998. Endangered Species Consultation Handbook: Procedures for conducting consultation and conference activities under Section 7 of the Endangered Species Act. U.S. GPO:2004-690-278. March 1998.

Bull Trout Environmental Baseline

Recovery Unit	Core Area	Local Pops	# of Primary Threats	Primary Threats Described in 2015 Recovery Plan	2008 5-Year Review Core Area Rank	Summary of Most Recent Status, Trend, Distribution Data	Sources of Data
Mid-Columbia	North Fk. JohnDay	7	4	1) Upland/Riparian Land Management - Legacy and current mining activities, livestock grazing, forest management, and agricultural impacts have resulted in high water temperatures, sedimentation, degraded channel networks and loss of instream complexity 2) Instream Impacts - Current and legacy mining activity has disconnect3d streams from floodplain and interrupted natural hydrology, impacting water quality and stream temperature in FMO habitats. 3)	At Risk	Based upon inventories conducted in 1992, bull trout distribution in the North Fork John Day River and tributaries was limited to 18 percent of the previously known range. Resident bull trout are the predominant life history form in the North Fork with a few fluvial migratory individuals documented in recent years. There is limited data available for the local populations in this core area. Redd counts have been conducted in the upper mainstem North Fork and Baldy Creek. Recent redd counts in Baldy Creek show a downward trend in redd abundance. The North Fork has been described as the most challenging area to identify bull trout redds in Oregon based on the decomposing granite gravel substrate and extensive hybridization with brook trout. One priority for the John Day Basin is to develop a system to monitor bull trout presence and population trends. In addition to the limited redd count data, researchers from Utah State University initiated bull trout research in the North Fork John Day River in 2005. Population estimates for the North Fork John Day River showed low abundances of bull trout in the mainstem of the North Fork and in Baldy Creek (1,000 each for both). Due to limited	USFWS 2015b; Budy et al. 2005; Budy et al. 2006; Claire and Gray 1993

Recovery Unit	Core Area	Local Pops	# of Primary Threats	Primary Threats Described in 2015 Recovery Plan	2008 5-Year Review Core Area Rank	Summary of Most Recent Status, Trend, Distribution Data	Sources of Data
				Connectivity Impairment - Fish passage issues at culverts, temperature barriers, and entrainment impact bull trout migratory behavior. 4) Non-Native Fishes - Hybridization and competition with brook trout pose a serious risk to bull trout. Brook trout are present in all populations except Trail Creek.		distribution of bull trout below the confluence with Baldy Creek, in 2006 researchers focused population surveys above the Baldy Creek confluence. In 2006, researchers from Utah State University estimated the population of bull trout greater than 120 mm (5 inches) in the upper North Fork John Day above the Baldy Creek confluence at 432 individuals (95 percent confidence interval = 274 to 752) and 1,193 individuals in Baldy Creek (95 percent confidence interval = 825 to 2509). Bull Trout abundance measures or descriptors of species status were not presented in the listing document. Recent (2015-17) redd surveys and occupancy work in the all three core areas do not provide sufficient information to generate abundance estimates at the core area or population scales. However bull trout were detected in most populations in all core areas indicating continued a presence. Sub-adult and adult bull trout are regularly captured in low numbers while sampling spring Chinook during March and April in the mainstem John Day River near Spray indicating movement into and use of FMO habitat.	
	Upper Mainstem John Day	2	4	1) Upland/Riparian Land Management - Legacy and current livestock grazing	At Risk	The bull trout in this core area express both a resident and fluvial life history strategy. There is little information on bull trout abundance in the Upper Mainstem John Day River, although	USFWS 2015b; Hemmin

Recovery Unit	Core Area	Local Pops	# of Primary Threats	Primary Threats Described in 2015 Recovery Plan	2008 5-Year Review Core Area Rank	Summary of Most Recent Status, Trend, Distribution Data	Sources of Data
				and agricultural practices have degraded riparian and instream habitat quality. 2) Water Quality - Agriculture practices and livestock grazing (current and legacy) have resulted in increases in instream water temperatures and low flows due to irrigation activities, altered channel conditions, and lack of shade. 3) Connectivity Impairment - Fish passage issues and entrainment at diversions and push up dams, as well as low flow conditions and temperature barriers created by irrigation activities reduce connectivity		this core area may be a bull trout stronghold in the John Day River Basin due to the absence of brook trout and presence of good habitat conditions. Habitat improvement projects in the Upper Mainstem John Day River should result in increased bull trout distribution. Population trends have not been documented in the Upper Mainstem John Day River. Call and Reynolds Creeks have been used for index redd counts. The redd counts in Call Creek have ranged from 2 to 15 redds during annual redd surveys although surveyors have reported seeing an abundance of bull trout when conducting field work. Restoration work conducted in Reynolds Creek has re-established fish passage so Reynolds Creek may be a good indicator of redd trends in future years. Bull Trout abundance measures or descriptors of species status were not presented in the listing document. Recent (2015-17) redd surveys and occupancy work in the all three core areas do not provide sufficient information to generate abundance estimates at the core area or population scales. However bull trout were detected in most populations in all core areas indicating continued a presence. Sub-adult and adult bull trout are regularly captured in low numbers while sampling spring Chinook during March and April in the mainstem John Day	gsen et al. 2001

Recovery Unit	Core Area	Local Pops	# of Primary Threats	Primary Threats Described in 2015 Recovery Plan	2008 5-Year Review Core Area Rank	Summary of Most Recent Status, Trend, Distribution Data	Sources of Data
				within and among populations. 4) <u>Small Population Size -</u> Critically low abundance and decline in lfuvial life history component limits recovery potential and may have deleterious genetic effects.		River near Spray indicating movement into and use of FMO habitat(ODFW, unpublished data).	
	Middle Fk John Day	3	4	1) <u>Upland/Riparian Land Management -</u> Legacy timber harvest, mining and livestock grazing have resulted in warm water temperatures, loss of cold water storage, degraded channel networks and a lack of structural integrity. 2) <u>Water Quality -</u> Forest management practices, livestock grazing, and mining have resulted in	At Risk	Bull trout in the Middle Fork John Day River persist at low abundance levels. Resident bull trout are the predominant life history form. In 1999, population surveys were conducted in Clear, Big, Deadwood, and Granite Boulder Creeks to estimate abundance. Total numbers of bull trout consisting of primarily juvenile and subadult fish were estimated to be 1,950 individuals in Big Creek, 640 individuals in Clear Creek, and 368 individuals in Granite Boulder Creek. In 1999 and 2000, redd surveys were conducted on Clear Creek and eight redds were observed each year. Bull Trout abundance measures or descriptors of species status were not presented in the listing document. Recent (2015-17) redd surveys and occupancy work in the all three core areas do not provide sufficient information to generate abundance	USFWS 2015b; Hemmingsen 1999; Malheur National Forest 2001

Recovery Unit	Core Area	Local Pops	# of Primary Threats	Primary Threats Described in 2015 Recovery Plan	2008 5-Year Review Core Area Rank	Summary of Most Recent Status, Trend, Distribution Data	Sources of Data
				warm water temperatures and low flows in rearing areas and FMO habitat limiting movement and distribution. 3) <u>Connectivity Impairment -</u> Temperature barriers in the Middle Fork John Day River, as well as passage issues at diversions, old log weirs and road culverts in the tributaries impair connectivity between populations. 4) <u>Small Population Size -</u> Putative declines in recent years have put populations in the core area at higher risk of genetic and		estimates at the core area or population scales. However bull trout were detected in most populations in all core areas indicating continued a presence. Sub-adult and adult bull trout are regularly captured in low numbers while sampling spring Chinook during March and April in the mainstem John Day River near Spray indicating movement into and use of FMO habitat(ODFW, unpublished data).	

Recovery Unit	Core Area	Local Pops	# of Primary Threats	Primary Threats Described in 2015 Recovery Plan	2008 5-Year Review Core Area Rank	Summary of Most Recent Status, Trend, Distribution Data	Sources of Data
				demographic stochasticity.			
	Umatilla	1	5	1) Upland/Riparian Land Management - Livestock grazing, agricultural practices, and transportation networks have eliminated or reduced riparian cover, resulting in a loss of habitat complexity and warm water temperatures. 2) Instream Impacts - Transportation networks and agricultural practices have channelized and oversimplified the river channel, eliminating important wetlands and floodplain	At Risk	Both resident and fluvial bull trout are known to occur in the Umatilla River watershed. Redd counts have been done each year since 1998 on the North Fork Umatilla River, and periodically in the South Fork Umatilla River and North Fork Meacham Creek. In 2003 and 2004, the North Fork Umatilla River appeared to support the core area's entire bull trout spawning population, with no redds detected in the South Fork Umatilla or in North Fork Meacham Creek. Redd totals on the North Fork Umatilla River have fluctuated considerably, and have averaged about 50 redds since 1998; however, the last 5-year average (2009 to 2013) was only 19 redds, suggesting this population is declining.	USFWS unpublished data 2015; USFWS 2015b

Recovery Unit	Core Area	Local Pops	# of Primary Threats	Primary Threats Described in 2015 Recovery Plan	2008 5-Year Review Core Area Rank	Summary of Most Recent Status, Trend, Distribution Data	Sources of Data
				interaction, decreasing instream flows and increasing water temperatures. 3) Water Quality - High instream water temperatures as a result of intense land use activities mentioned above significantly limit summer rearing habitat for migratory fish, the predominant life history type. Increased water temperatures and loss of available habitat due to climate change are predicted as a high risk to this core area. 4) Connectivity Impairment - Passage barriers in the lower Umatilla River and warm			

Recovery Unit	Core Area	Local Pops	# of Primary Threats	Primary Threats Described in 2015 Recovery Plan	2008 5-Year Review Core Area Rank	Summary of Most Recent Status, Trend, Distribution Data	Sources of Data
				water temperature barriers impede free movement of bull trout between spawning and rearing areas and FMO habitat. 5) Small Population Size - Critically low abundance and an apparent reduction in the resident life history type put the core area at high risk of genetic and demographic stochasticity.			
	Walla Walla	3	5	1) Upland/Riparian Land Management - Agricultural practices, transportation networks, rural and urban developments and other land management actions have eliminated or	At Risk	The South Fork Walla Walla and Mill Creek support sizeable bull trout populations, however redd counts in both populations have been declining since 2001. In the South Fork Walla Walla redd counts peaked in 2001 at over 400 and have steadily declined to just above 100 in 2012. Although the total number of bull trout, including juveniles, appears to be stable, the number of large adults is declining as are total adults, as reflected in the redd counts. Likewise, adult abundance in Mill Creek	USFWS 2008; Schaller et al 2014; Howell & Sankovich 2012, Howell et al. 2016

Recovery Unit	Core Area	Local Pops	# of Primary Threats	Primary Threats Described in 2015 Recovery Plan	2008 5-Year Review Core Area Rank	Summary of Most Recent Status, Trend, Distribution Data	Sources of Data
				reduced riparian cover and protective buffers, resulting in the loss of habitat complexity, increased input of pollutants and storm-water runoff, and increased water temperatures. 2) <u>Instream Impacts -</u> Flood control and water Management activities have eliminated complex channels and floodplain interaction, altered and reduced flows, and increased water temperatures particularly in FMO habitats. 3) <u>Water Quality -</u> High instream water temperatures as a result of intense land use activities mentioned above		declined 63 percent during 2006 to 2010 with even greater declines in subadult survival.	

Recovery Unit	Core Area	Local Pops	# of Primary Threats	Primary Threats Described in 2015 Recovery Plan	2008 5-Year Review Core Area Rank	Summary of Most Recent Status, Trend, Distribution Data	Sources of Data
				significantly limit FMO for migratory fish. Increased water temperatures and loss of available habitat due to climate change are predicted as a high risk to this core area. 4) Connectivity Impairment - Entrainment at diversions and passage barriers, as well as temperature barriers and low flows, prevent bull trout from moving freely and easily between FMO and spawning habitats. 5) Non-Native Fishes - Predatory species, such as small mouth bass and walleye, in FMO areas of the mainstem Walla Walla and Columbia Rivers. Competing			

Recovery Unit	Core Area	Local Pops	# of Primary Threats	Primary Threats Described in 2015 Recovery Plan	2008 5-Year Review Core Area Rank	Summary of Most Recent Status, Trend, Distribution Data	Sources of Data
				species, including hatchery origin rainbow and brown trout, in FMO.			
	Pine, Indian, Wildhorse	3	3	1) Instream Impacts - Dewatering caused by numerous diversions has resulted in significantly reduced stream flow and elevated stream temperatures directly impacting the migratory life history. 2) Connectivity Impairment - Dewatering, entrainment and passage barriers caused by water diversions and impeded connectivity. Oxbow and Hells Canyon Dams isolate Wildhorse Creek from other	High Risk	Idaho Power Company (IPC) has implemented extensive habitat and flow restoration actions in Pine Creek and its tributaries in recent years. IPC also conducted a population estimate for Pine Creek, Clear Creek, North Pine Creek and East Pine Creek during the years 2013-2016. The total basin population estimate of fish over 70mm was 6,315 bull trout. The total basin population estimate of fish over 150mm was 2,716). IPC's surveys confirmed that bull trout were largely isolated in headwater streams in the basin. Distribution was compared to distribution surveys conducted in 1994 and found not to have changed significantly. Fall trapping using weirs suggests there's no fluvial component to the bull trout populations in Pine, Clear, North and East Pine creeks. No brook trout or hybrids were found in Pine or East Fork Pine although brook trout and hybrids were detected in Clear Creek. The proportion of hybrids in Clear Creek approximately doubled from rates observed in the 1994 survey.	IPC 2017;

Recovery Unit	**Core Area**	**Local Pops**	**# of Primary Threats**	**Primary Threats Described in 2015 Recovery Plan**	**2008 5-Year Review Core Area Rank**	**Summary of Most Recent Status, Trend, Distribution Data**	**Sources of Data**
				populations in the core area and prevent connection to other core areas. 3) Non-native fishes - Hybridization and competition with brook trout are serious threats to bull trout. Brook trout are widespread throughout the core area.			
	Powder	10	6	1) Upland/Riparian Land Management - Agricultural practices, legacy forest management practices (including roads) and livestock grazing have resulted in high water temperatures, sedimentation, and loss of floodplain connection and instream complexity	High Risk	Tributaries known to be inhabited by bull trout in this core area include: Big Creek, Wolf Creek, Indian Creek, Anthony Creek, North Powder River, Rock Creek, Cracker Creek, Lake Creek, Salmon Creek, and McCully Fork Creek. During 2013-2015, the distribution, relative abundance, and extent of hybridization of bull trout and brook trout populations in the Powder River Basin were extensively sampled in most of the streams where bull trout were previously documented or thought to occur and compared with similar surveys conducted during the 1990s. No extirpations have occurred; however, in most streams the bull trout distribution is limited to a few kilometers	Howell 2017

Recovery Unit	Core Area	Local Pops	# of Primary Threats	Primary Threats Described in 2015 Recovery Plan	2008 5-Year Review Core Area Rank	Summary of Most Recent Status, Trend, Distribution Data	Sources of Data
				in bull trout habitats. 2) Instream Impacts - Agricultural practices and mining activities have degraded the stream channel and pose a risk of chemical contamination. 3) Water Quality - Dewatering and high water temperatures as a result of intense land use activities mentioned above create inhospitable conditions for bull trout in FMO habitats during summer months. Increased water temperatures and loss of available habitat due to climate change are predicted as a high		at the upper limits of fish distribution. Only three populations occur in streams where brook trout are not present.	

Recovery Unit	Core Area	Local Pops	# of Primary Threats	Primary Threats Described in 2015 Recovery Plan	2008 5-Year Review Core Area Rank	Summary of Most Recent Status, Trend, Distribution Data	Sources of Data
				risk to this core area. 4) Connectivity Impairment - Fish passage issues and entrainment at dams, diversions, and culverts, as well as dewatering and temperature barriers impair connectivity between spawning populations and FMO habitats. 5) Small Population Size - Small populations isolated in headwater streams are at high risk of genetic and demographic stochasticity and the loss of the migratory life history threatens persistence. 6) Non-Native Fishes - Hybridization and competition with			

Recovery Unit	Core Area	Local Pops	# of Primary Threats	Primary Threats Described in 2015 Recovery Plan	2008 5-Year Review Core Area Rank	Summary of Most Recent Status, Trend, Distribution Data	Sources of Data
				brook trout are serious threats to bull trout. Brook trout are widespread and abundant throughout the core area.			
	Imnaha	8	0	No Primary Threats Identified.	Potential Risk	The Imnaha River Core Area populations are generally stable; especially the Imnaha River population. Little Sheep was rated at high risk of extinction and there is limited abundance data available for these populations. The Service sampled bull trout in Upper Little Sheep Creek in 2010 and captured very few fish between the 3920 Forest Road and the forks, and captured no fish above the forks (a large portion of which was affected by the 1989 Canal Fire). Distribution and abundance appears to be extremely limited in the Upper Little Sheep population . The 10-year average from 2001 to 2010 was 193 redds for the Imnaha River (Upper Imnaha River and tributaries). Total redds numbers on the Imnaha ranged from 101 to 262 within that period for 28.2 km (17.5 miles) of stream. The 11-year average from 2000 to 2010 was 18 redds for the Big Sheep system for 14.8 km (9.6 miles) (includes Big Sheep and Lick Creek).	Buchanan et al 1997; M. Hudson, USFWS, pers. comm. 2011; Sausen 2011; Cook and Hudson 2008

Recovery Unit	Core Area	Local Pops	# of Primary Threats	Primary Threats Described in 2015 Recovery Plan	2008 5-Year Review Core Area Rank	Summary of Most Recent Status, Trend, Distribution Data	Sources of Data
						Total redd numbers within the Big Sheep system ranged from 8 to 34 for that period. Current abundance data (redd count and/or electrofishing data) are available for the Imnaha River, Big Sheep Creek, and McCully Creek local populations and they suggest relatively high abundance and/or stable trends.	
	Upper Grande Ronde	6	3	1) Upland/Riparian Land Management - Livestock Grazing and Forest Management Practices, including forest roads, have resulted in a lack of large wood recruitment, loss of pools, sedimentation, warm water temperatures and low flows. 2) Instream Impacts - Legacy Forest Management Practices, including splash damming, and Agricultural Practices,	High Risk	The Upper Grand Ronde core area consists of six local populations including: Upper Grand Ronde; Limber Jim; Chicken and Indiana; Clear; Catherine; and, Indian creeks. The six populations in this core area are spread over a large geographical area with multiple age classes, containing both resident and fluvial fish. Distribution for this core area includes a total of approximately 231.4 stream miles. There is a high level of uncertainty in the status of the populations in this core area. The NF Catherine Creek is the only location that has some trend data (total redds for 1.3 miles of survey ranged 2-33 redds from 1998-2006, and 2008, and 2009, average number redds was 14, or 10.8 redds/mile). This population to date is estimated to be stable (with a downward trend in recent years). Ratliff and Howell (1992) estimated the Upper Grande Ronde, Catherine and Indian Creek populations as being at moderate risk of extinction.There has been very little monitoring of other local populations	Ratliff and Howell 1992; USFWS Unpublished Data 2011;

Recovery Unit	Core Area	Local Pops	# of Primary Threats	Primary Threats Described in 2015 Recovery Plan	2008 5-Year Review Core Area Rank	Summary of Most Recent Status, Trend, Distribution Data	Sources of Data
				construction of the State Ditch, have channelized the river channel, reduced instream complexity, and increased water temperature and sedimentation in FMO habitats. 3) Connectivity Impairment - Temperature Barriers and Low Flows impede movement of bull trout between populations and in FMO habitats.		of bull trout within this core area over the last decade thus current status and trends are largely unknown.	
	Wallowa/Minam	6	1	1) Water Quality - Agricultural Practices and other land use activities resulted in high water temperatures and low flows that degrade habitat quality and impede connectivity,	At Risk	The Wallowa/Minam core area consists of six local populations including: Minam River; Deer Creek; Lostine River; Bear Creek; Wallowa Lake; and, Upper Hurricane Creek. There has been very little monitoring of bull trout within this core area over the last decade thus the current status and trend of the local populations are largely unknown.Recently 600 bull trout were re-introduced to Wallowa Lake which had been salvaged from a decommissioned hydropower	USFWS Unpublished data 2015;

Recovery Unit	Core Area	Local Pops	# of Primary Threats	Primary Threats Described in 2015 Recovery Plan	2008 5-Year Review Core Area Rank	Summary of Most Recent Status, Trend, Distribution Data	Sources of Data
				particularly in FMO habitats.		project on Big Sheep (Imnaha Basin) in 1997. Limited data are available on their abundance; however, some recent observations suggest they have persisted. A PacifiCorp fisheries biologist caught one fluvial size bull trout in the West Fork Wallowa River in June 2010. Two fluvial bull trout were captured in the Wallowa Falls tailrace on July 12, 2010 while electrofishing. One fluvial bull trout was reported in the tailrace on September 15, 2010 while snorkeling. The bypassed East Fork Wallowa River near the confluence with the West Fork Wallowa River, two bull trout were observed paired up, with the female constructing a redd. A brook trout was observed paired up with the fish. The male bull trout was reported to be the same fish captured during the tailrace fish salvage in July 12, 2010 (Doyle 2011). Due to low population abundance, potential hybridization with brook trout, competition with introduced lake trout, and potential incidental catch of bull trout at Wallowa Lake, there is a high level of uncertainty about the status of the Wallowa Lake and upstream tributaries population of bull trout. The Lostine River and Bear Creek have several years of trend data. Total redds for 8.5 miles of	

Recovery Unit	Core Area	Local Pops	# of Primary Threats	Primary Threats Described in 2015 Recovery Plan	2008 5-Year Review Core Area Rank	Summary of Most Recent Status, Trend, Distribution Data	Sources of Data
						survey on the Lostine River averaged 38 (range 22-70) redds or 4.6 redds/mile from 1999-2010. Bear Creek averaged 9 redds (range 5-12) redds or 4.7 redds/mile from 1999-2010. The Lostine River and Bear Creek populations appear to be stable for the survey period 1999-2008, with some recent downward trend in 2009 and 2010. The Lostine River was rated as a moderate risk of extinction by Buchanan et al. (1997). Data for the Deer Creek population is limited to observations of 12 resident size bull trout redds in 0.8 miles of stream (15 redds/mile), upstream of a newly installed culvert, that replaced a former passage barrier (Sausen 2011). The Deer Creek population was listed in Buchanan et.al (1997) as "of special concern." Sampling of bull trout in Hurricane Creek in 2002 by ODFW (using electrofishing) suggests a small population of approximately 200 resident bull trout which is potentially substantially hybridized with introduced brook trout. No abundance data are available for the Minam River.	
	Lookingglass/ Wenaha	4	0	No Primary Threats Identified.	At Risk	In general, there is a high level of uncertainty about the trend of the four local populations, especially for the populations within the Wenaha River. The Lookingglass Creek redd counts have had a range of 15 to 69 (average of 44.5) redds for approximately 6 km (4 miles) of	G. Mendel, WDFW, pers. comm., 2008;

Recovery Unit	Core Area	Local Pops	# of Primary Threats	Primary Threats Described in 2015 Recovery Plan	2008 5-Year Review Core Area Rank	Summary of Most Recent Status, Trend, Distribution Data	Sources of Data
						survey from 1994 to 2010. The Lookingglass local population is estimated to be stable based on the trend of redd counts. There are insufficient data available to make inferences about abundance of bull trout and to conclude population stability or trend in the entire Wenaha River system . Information is available regarding the relative abundance of bull trout in northern tributaries of the Wenaha River within Washington State. The North Fork Wenaha River within Washington has bull trout redd counts of 82 and 86 (both partial counts) in 2006 and 2007 respectively, and 153 redds in 2005, and 112 in 2010. Butte Creek and the West Fork of Butte Creek also have bull trout redd counts (of 31 and 32 redds, respectively) in 2005 and 2006, although the survey areas were not exactly the same during the 2 years.	and B. Knox, ODFW, pers. comm. 2011; Mendel et al. 2006, Mendel et al. 2008; G. Mendel, pers. comm. 2011;
	Little Minam	1	0	No Primary Threats Identified.	Potential Risk	The Little Minam River core area contains a healthy resident population (an average of 306 redds from 1997 to 2004, or 27 redds/mile) distributed in excellent habitat protected within the Eagle Cap Wilderness. While there is no recent survey information, the population is considered stable with no primary threats.	USFWS 2015b
Coastal	Odell	1	4	1) <u>Instream Impacts - </u>Transportation Networks – legacy effects related to	High Risk	Bull trout in the Odell Core Area represent one of the most imperiled populations in Oregon. In 2012, ODFW observed 21 adult females and 22 adult males migrating through the video weir	Starcevich et al. 2017

Recovery Unit	Core Area	Local Pops	# of Primary Threats	Primary Threats Described in 2015 Recovery Plan	2008 5-Year Review Core Area Rank	Summary of Most Recent Status, Trend, Distribution Data	Sources of Data
				transportation networks (railroad grade) degraded and limited spawning habitat in Odell Lake tributaries. 2) Fisheries Management - Angling – a significant portion of the estimated bull trout population is handled through incidental catch in the kokanee and lake trout fisheries 3) Small Population Size - Genetic and Demographic Stochasticity – available spawner abundance data indicates Odell Lake bull trout are at risk of genetic and demographic stochasticity. Redd		on Trapper Creek, the primary spawning tributary for the single local population in the Odell core area. None were hybrids based on physical characteristics. In 2016, 15 females and 10 males were detected migrating past the video weir in Trapper Creek, 2 of which were identified as hybrids by physical characteristics. Of these 3 males and 3 females were not detected migrating downstream past the weir post-spawning suggesting possible mortalities. Beginning in spring 2018, ODFW begain translocating juvenile bull trout from the Metolius to various tributaries of Odell Lake in an effort to study the habitat suitabilty of these streams and whether bull trout will rear and utilize these habitats. In 2017, 5 or less redds were observed in Trapper Creek, the primary and perhaps only spawning stream for this Core Area.	

Recovery Unit	Core Area	Local Pops	# of Primary Threats	Primary Threats Described in 2015 Recovery Plan	2008 5-Year Review Core Area Rank	Summary of Most Recent Status, Trend, Distribution Data	Sources of Data
				counts over the last generation average less than 12 redds. 4) Non-Native Fishes - Predation/Species Competition – nonnative lake trout likely negatively impact bull trout. Hybridization/Species Competition – nonnative brook trout hybridize with bull trout and compete for food and space			
	Clackamas River	1	0	No Primary Threats Identified. Potential Local Population. Reintroduced beginning in 2011.	NA	Translocations of bull trout to the Clackamas River from the Metolius River began in 2011 and occurred annually until 2016. A total of 2,868 bull trout of various ages were introduced (juveniles age 1 and 2, subadults and adults. Spawning was documented for the first time Fall 2011 and has been documented annually since that time. Redd counts have been increasing annually since 2013 with a high of 89 redds recorded in 2017. The majority of spawning occurs in a single tributary, Pinhead Creek and its tributary Last Creek, though	Starcevich et al. 2018; USFWS 2016

Recovery Unit	Core Area	Local Pops	# of Primary Threats	Primary Threats Described in 2015 Recovery Plan	2008 5-Year Review Core Area Rank	Summary of Most Recent Status, Trend, Distribution Data	Sources of Data
						limited spawning has been documented in other tributaries.	
	Upper Willamette	4	6	1) Upland/Riparian Land Management - Forest Management Practices – legacy forest management practices have degraded instream and riparian habitats. 2) Instream Impacts - Altered Flows and Geomorphic Processes – operation of the major dams alters the natural flow regime and geomorphic processes, eliminating pools and complex habitat suitable for juvenile and adult rearing. 3) Connectivity Impairment -	High Risk	The Upper Willamette Core Area is comprised of 3 local populations in the McKenzie River subbasin and a single local population in the Middle Fork Willamette River. Populations in the McKenzie River are partially isolated from each other by dams. Total redd counts for the entire basin were relatively consistent over the period 2010–2016. Aside from a distinct increase in 2009, total redd counts were also relatively consistent from 2007–2016 (including data for tributaries upstream from Trail Bridge Dam). The mean annual total redd count for 2010–2016 was 176.5 ± 26.4 (mean ± SD) and varied from 143–183 redds, whereas total redd counts in 1999–2006 ranged from 96–141 redds (mean ± SD = 114.6 ± 13.7). Despite this relative consistency in total counts in 2010–2016, the redd counts in individual local spawning populations varied considerably. The overall number of adult spawners in the McKenzie River subbasin (all 3 local populations) is thought to be approximately 300 individuals. The number of adult spawners in the Middle Fork Willamette River local population, which is the result of a	Zymonas et al. 2017;

Recovery Unit	Core Area	Local Pops	# of Primary Threats	Primary Threats Described in 2015 Recovery Plan	2008 5-Year Review Core Area Rank	Summary of Most Recent Status, Trend, Distribution Data	Sources of Data
				Entrainment and Fish Passage Issues – dams entrain fish, impede passage, cause passage related mortality and isolate what was once one population into four small populations 4) Fisheries Management - Illegal Harvest – illegal harvest and incidental angling-related mortality are significant sources of take in the McKenzie River and Middle Fork Willamette River [Hills Creek Reservoir]. 5) Forage Fish Availability - Preybase – loss of anadromous fish due to fish passage issues at dams		reintroduction initiated in 1997, is estimated to be 20-30 individuals.	

Recovery Unit	Core Area	Local Pops	# of Primary Threats	Primary Threats Described in 2015 Recovery Plan	2008 5-Year Review Core Area Rank	Summary of Most Recent Status, Trend, Distribution Data	Sources of Data
				impact forage base and productivity of bull trout. 6) Non-Native Fishes - Hybridization and Competition - Brook trout are present in spawning and rearing habitats; Predation - Nonnative warm water species are abundant in the Middle Fork Willamette Basin and beginning to show up in the McKenzie River and Cougar Reservoir			
	North Santiam (historic)	0		No bull trout present. Reintroduction feasibility currently underway.	NA	NA	
	South Santiam (historic)	0		No bull trout present. No reintroduction feasibility underway at this time.	NA	NA	

Recovery Unit	**Core Area**	**Local Pops**	**# of Primary Threats**	**Primary Threats Described in 2015 Recovery Plan**	**2008 5-Year Review Core Area Rank**	**Summary of Most Recent Status, Trend, Distribution Data**	**Sources of Data**
	Hood River	1	4	1) Upland/Riparian Land Management - Legacy Forest Management and Agriculture Practices – impacts from these activities have resulted in channelization and habitat degradation. 2) Instream Impacts - Water Management – water withdrawal at irrigation dams and diversions decrease flow, and alter sediment and wood routing). 3) Water Quality - Water Management - operations at Clear Branch Dam increase downstream water temperatures. 4) Connectivity Impairment - Fish Passage Issues –	High Risk	The Hood River Core Area contains a single local population that resides in Lawrence Lake (reservoir) and spawns in the lake's two tributaries; Clear Branch Creek and Pinnacle Creek. The lowest number of total redds counted in Clear Branch above and below the dam and in Pinnacle during surveys conducted from 2006 – 2017 was 12 in 2017 and the highest number counted was 66 in 2014. The average number of total redds counted per year from 2006 – 2017 (Clear Branch and Pinnacle creeks) was 30. The majority of spawning activity was in Clear Branch above the dam until 2016, when 69% of the redds were found in Pinnacle Creek instead. Half of the total redds counted in 2017 were in Pinnacle Creek. The shift in spawning to Pinnacle Creek may be due to the difficulty of passing multiple beaver dams at the mouths of Clear Branch Creek. Very little spawning has occurred in Clear Branch below the dam and few bull trout have been observed in the Hood River Basin below the dam in general. In their study results, ODFW calculated adult:redd ratios of 3.92 in 2007 and 3.96 in 2008 (Stacevich and Jacobs 2010). If this ratio is applied to redd counts, the number of adult bull trout above Clear Branch dam is estimated to be 259 – 261 adults in 2014 (the year the	USFS 2017; Stacevich and Jacobs 2010

Recovery Unit	Core Area	Local Pops	# of Primary Threats	Primary Threats Described in 2015 Recovery Plan	2008 5-Year Review Core Area Rank	Summary of Most Recent Status, Trend, Distribution Data	Sources of Data
				impeded fish passage at Clear Branch Dam isolates a population of bull trout above the dam; Low flow conditions prevent migration during summer and fall		highest number of redds were counted), and 47 – 48 adults in 2017 (the year of the lowest redd count).	
	Upper Deschutes (historic)	0		No bull trout present. No reintroduction feasibility underway at this time.	NA	NA	
	Lower Deschutes	5	0	No Primary Threats Identified	Potential Risk	The Lower Deschutes Core Area is comprised of 3 local populations (Metolius River) above Portland General Electric's Hydropower Project and 2 local populations below the project (Shitike Creek and Warm Springs River). Together, the bull trout local populations in the Metolius River represent some of the healthiest in Oregon. In conglomerate, census redd counts in the Metolius River have averaged 520 annually over the last decade. Several studies have demonstrated approximately 2.3 fish per redd suggesting an average population of spawning adults over the last decade of 1,196 fish. Bull trout redd counts in Warm Springs River have ranged from 4 to 8 redds each year	CTWSR 2017; USFS 2018

Recovery Unit	Core Area	Local Pops	# of Primary Threats	Primary Threats Described in 2015 Recovery Plan	2008 5-Year Review Core Area Rank	Summary of Most Recent Status, Trend, Distribution Data	Sources of Data
						2012-2014 but increased to 26 redds in both 2015 and 2016. Redd survey effort in Shitike Creek has been inconsistent over time. However, consistent surveys in reach 1 of Shitike Creek suggest the population is relatively stable (avg 19.2 redds per year 1998-2009 and 19.7 redds per year 2010-2016).	
Klamath	Upper Klamath Lake	2	4	1) Upland/Riparian Land Management - Legacy forest management and agricultural practices – channelization and habitat degradation. 2) Connectivity Impairment - Lack of connectivity to FMO habitat (Wood River, Agency Lake); unscreened irrigation diversions (entrainment, dewatering); fish passage issues. 3) Small Population Size - The two local populations have small population	At Risk	Bull trout in the Upper Klamath Lake core area formerly occupied Annie Creek, Sevenmile Creek, Cherry Creek, and Fort Creek, but are now extirpated from these locations. The last remaining local populations, Sun Creek and Threemile Creek, have received focused attention. Brook trout have been removed from bull trout occupied reaches, and these reaches have been intentionally isolated to prevent brook trout reinvasion. As such, over the past few generations these populations have become stable and have increased in distribution and abundance. In 1996, the Threemile Creek population had approximately 50 fish that occupied a 1.4-km (0.9-mile) reach (USFWS 2002b). In 2012, a mark-resight population estimate was completed in Threemile Creek, which indicated an abundance of 577 (95 percent confidence interval = 475 to 679) age-1+ fish (ODFW 2012). In addition, the length of the distribution of bull trout in Threemile Creek had increased to 2.7	USFWS 2015d

Recovery Unit	Core Area	Local Pops	# of Primary Threats	Primary Threats Described in 2015 Recovery Plan	2008 5-Year Review Core Area Rank	Summary of Most Recent Status, Trend, Distribution Data	Sources of Data
				sizes, particularly Threemile Creek, and are isolated from one another, which may confer genetic risks and reduce the likelihood of population persistence over time; lack of migratory life history. 4) <u>Non-Native Fishes -</u> Brook trout, and to some extent, brown trout, are numerous in all historically occupied and suitable spawning/rearing and FMO habitat.		km (1.7 miles) by 2012 (USFWS unpublished data). Between 1989 and 2010, bull trout abundance in Sun Creek increased approximately tenfold (from approximately 133 to 1,606 age-1+ fish) and distribution increased from approximately 1.9 km (1.2 miles) to 11.2 km (7.0 miles) (Buktenica et al. 2013).	
	Sycan River	1	4	1) <u>Upland/Riparian Land Management -</u> Legacy forest management and agricultural practices – channelization and	High Risk	The Sycan River core area is comprised of one local population, Long Creek. Bull trout previously occupied Calahan Creek, Coyote Creek, and the Sycan River, but are now extirpated from these locations (Light et al. 1996). The last remaining population (Long Creek) has received focused attention in an	Light et al. 1996; USFWS 2015d; USFWS 2002b

Recovery Unit	Core Area	Local Pops	# of Primary Threats	Primary Threats Described in 2015 Recovery Plan	2008 5-Year Review Core Area Rank	Summary of Most Recent Status, Trend, Distribution Data	Sources of Data
				habitat degradation. 2) Connectivity Impairment - Lack of connectivity to FMO habitat (mainstem Sycan River); unscreened irrigation diversions (entrainment, dewatering); fish passage issues. 3) Small Population Size - Long Creek is the only remaining local population, which may confer genetic risks and reduce the likelihood of population persistence over time. 4) Non-Native Fishes - Brook trout are numerous in all historically occupied and suitable spawning/rearing and FMO habitat. Hybridization and		effort to ensure it is not also extirpated. In 2006, two weirs were removed from Long Creek, which increased the amount of occupied foraging, migratory, and overwintering (FMO) habitat by 3.2 km (2.0 miles). Bull trout currently occupy approximately 3.5 km (2.2 mi) of spawning/rearing habitat, including a portion of an unnamed tributary to upper Long Creek, and seasonally use 25.9 km (16.1 mi) of FMO habitat. Brook trout also inhabit Long Creek and have been the focus of periodic removal efforts. No recent statistically rigorous population estimate has been completed for Long Creek; however, the 2002 Draft Bull Trout Recovery Plan reported a population estimate of 842 individuals . Currently unoccupied habitat is needed to establish additional local populations, although brook trout are widespread in this core area and their management will need to be considered in future recovery efforts. In 2014, the Klamath Falls Fish and Wildlife Office of the U.S. Fish and Wildlife Service (Service) established an agreement with the U.S. Geological Survey to undertake a structured decision making process to assist with recovery planning of bull trout populations in the Sycan River core area.	

Recovery Unit	Core Area	Local Pops	# of Primary Threats	Primary Threats Described in 2015 Recovery Plan	2008 5-Year Review Core Area Rank	Summary of Most Recent Status, Trend, Distribution Data	Sources of Data
				competition presently occurs in Long Creek.			
	Upper Sprague River	5	4	1) Upland/Riparian Land Management - Legacy forest management and agricultural practices – channelization and habitat degradation. 2) Connectivity Impairment - Lack of connectivity to FMO habitat (between North Fork and South Fork Sprague River); unscreened irrigation diversions (entrainment, dewatering); fish passage issues. 3) Small Population Size - The local populations have small population sizes, particularly Boulder, Dixon, and	At Risk	The Upper Sprague River core area comprises five bull trout local populations, placing the core area at an intermediate risk of extinction. The five local populations include Boulder Creek, Dixon Creek, Deming Creek, Leonard Creek, and Brownsworth Creek. The Upper Sprague River core area population of bull trout has experienced a decline from historic levels, although less is known about historic occupancy in this core area. Bull trout are reported to have historically occupied the South Fork Sprague River, but are now extirpated from this location. The remaining five populations have received focused attention. Although brown trout (Salmo trutta) co-occur with bull trout and exist in adjacent habitats, brook trout do not overlap with existing bull trout populations. Efforts have been made to increase connectivity of existing bull trout populations by replacing culverts that create barriers. Thus, over the past few generations, these populations have likely been stable and increased in distribution. Population abundance has been estimated recently for Boulder Creek (372 + 62 percent), Dixon Creek	Buchanan et al. 1997; Hartill and Jacobs 2007; Moore 2006; USFWS 2002b

Recovery Unit	Core Area	Local Pops	# of Primary Threats	Primary Threats Described in 2015 Recovery Plan	2008 5-Year Review Core Area Rank	Summary of Most Recent Status, Trend, Distribution Data	Sources of Data
				Leonard creeks, and nearly all are isolated from one another, which may confer genetic risks and reduce the likelihood of population persistence over time; lack of migratory life history. 4) Non-Native Fishes - Brook trout, and to some extent, brown trout, are numerous in all historically occupied and suitable spawning/rearing and FMO habitat. Brown trout presently occur with bull trout in Boulder, Dixon, Leonard, and Brownsworth creeks.		(20 + 60 percent), Deming Creek (1,316 + 342), and Leonard Creek (363 + 37 percent). No statistically rigorous population estimate has been completed for the Brownsworth Creek local population; however, the 2002 Draft Bull Trout Recovery Plan reported a population estimate of 964 individuals. Additional local populations need to be established in currently unoccupied habitat within the Upper Sprague River core area, although brook trout are widespread in this core area and will need to be considered in future recovery efforts.	

Recovery Unit	Core Area	Local Pops	# of Primary Threats	Primary Threats Described in 2015 Recovery Plan	2008 5-Year Review Core Area Rank	Summary of Most Recent Status, Trend, Distribution Data	Sources of Data
Upper Snake	Upper Malheur	3	5	1) Upland/Riparian Land Mangement - Forest Management Practices (legacy and current), Livestock Grazing. 2) Water Quality - Forest Management Practices (legacy and current), Livestock Grazing. 3) Connectivity Impairment - Entrainment, Fish Passage Issues, Dewatering, Temperature Barriers. 4) Small Population Size - Genetic, Demographic Stochasticity. 5) Non-Native Fishes - Competition, Hybridization	High Risk	The three local bull trout populations in this core area include: 1) Lake Creek, 2) Meadow Fork Creek, and 3) Big Creek. The Upper Malheur River subpopulation was isolated by Warm Springs Dam in 1919 (Buchanan and Gregory 1997). Buchanan and Gregory (1997) classified bull trout in the Upper Malheur River as "high risk" of extinction. The three populations in this core area are spread over a large geographical area with multiple age classes, containing both resident and fluvial fish. Recent information indicates that there is a high proportion of brook trout in the Upper Malheur River, resulting in impacts through hybridization and competition for resources. Brook trout have displaced bull trout from several historic tributaries (i.e., Summit, Bosonberg, McCoy and Corral Basin creeks) and affect over 60 percent of the bull trout population. An estimate of adult abundance for the Upper Malheur River local population is not available because of the inability to distinguish between bull trout and brook trout redds when not occupied. The Burns Paiute Tribe has worked with a number of partners to develop the Malheur Bull Trout Conservation Plan which focuses on eradication and suppression of brook trout in the Upper Malheur River via implementation of rotenone	Buchanan and Gregory 1997; USFWS 2015

Recovery Unit	Core Area	Local Pops	# of Primary Threats	Primary Threats Described in 2015 Recovery Plan	2008 5-Year Review Core Area Rank	Summary of Most Recent Status, Trend, Distribution Data	Sources of Data
						actions combined with installation, operation and maintenance of artificial barriers to prevent reestablishment of brook trout basin tributaries.	
	North Fk. Malheur	5	1	1) Upland/Riparian Land Management - Forest Management Practices, Livestock Grazing. 2) Instream Impacts - Water Management. 3) Water Quality - Forest Management Practices, Livestock Grazing. 4) Connectivity Impairment - Entrainment, Dewatering, Temperature Barriers. 5) Nonnative fishes - Potential for Invasion.	High Risk	The five bull trout populations in this core area include: 1) Elk Creek, 2) Little Crane Creek, 3) Swamp Creek, 4) Sheep Creek, and 5) Horseshoe Creek. The North Fork Malheur River subpopulation was isolated by Agency Dam in 1934 (Buchanan and Gregory 1997). Buchanan and Gregory (1997) classified bull trout in the North Fork Malheur River as “of special concern”, which falls between a “low” and “moderate” risk level. The five populations in this core area are spread over an isolated, large geographical area with multiple age classes, containing both resident and migratory (fluvial) fish. Bull trout were known to exist in the North Fork Malheur River watershed prior to 1992. Distribution in the North Fork Malheur River above Agency Dam has remained unchanged since the species was first documented there.	Buchanan and Gregory 1997; BPT 2017

APPENDIX G

SHORTNOSE AND LOST RIVER SUCKER STATUS OF THE SPECIES, CRITICAL HABITAT AND ENVIRONMENTAL BASELINE

Status of the Species – Lost River and Shortnose Sucker

This section provides information about both suckers' life history, habitat preferences, geographic distribution, population trends, threats, and conservation needs. This includes description of the effects of past human activities and natural events that have led to the current status of the Lost River sucker (LRS) and shortnose sucker (SNS). The final listing rule contains a physical description of the species (53 FR 27130). Additional information can be found at: https://ecos.fws.gov/ecp0/profile/speciesProfile?spcode=E052 and https://ecos.fws.gov/ecp0/profile/speciesProfile?spcode=E055.

Regulatory History

The LRS and the SNS were federally listed as endangered throughout their entire ranges on July 18, 1988 (53 FR 27130). They are also listed as endangered by the States of California (1974) and Oregon (1991). In 2007 and 2013, the status of each of these species was reviewed by the USFWS (USFWS 2007a, b; 2013). A new 5-year status review of the LRS and the SNS has been initiated by the USFWS, and this review will be completed in 2019. A draft revision of the 1993 recovery plan for these species was published by the USFWS in 2011, and a final revised plan published in 2013 (USFWS 2013). The USFWS proposed critical habitat for the LRS and the SNS on December 1, 1994 (59 FR 61744), but the proposal was not finalized. On December 7, 2011, a revised proposal was published that included critical habitat in Klamath and Lake Counties, Oregon, and Modoc County, California (76 FR 76337). The final designation of critical habitat for the LRS and the SNS was published on December 11, 2012 (77 FR 73740).

Reasons for Listing

Although not explicitly stated in the final listing rule, the LRS and the SNS were listed because of the loss of populations of both species, a decline in numbers within both species' populations, and loss of habitat all of which resulted in a critical lack of resiliency and redundancy for each species (USFWS 2013). In this context, resiliency is the ability of a population or species to rebound after stressful environmental conditions, such as adverse water quality, increased predation, disease, drought, or climate change. Redundancy, in this context, involves multiple populations spread over the landscape to reduce the likelihood of simultaneous extirpation from catastrophic events, such as adverse water quality, drought, or disease.

Of the few populations of the LRS and the SNS that remain, most are very restricted in distribution and many lack the ability to successfully reproduce. This condition was caused by several factors, including habitat loss, construction of barriers, overharvesting of adults, and entrainment of young individuals.

Suitable habitat for the LRS and the SNS was drastically reduced in extent and functionality due to the historical conversion of wetlands to agricultural use and construction of irrigation and hydroelectric facilities, which drained lakes and wetlands, created barriers to spawning habitat, and caused mortality by entraining fish. Chiloquin Dam on the Sprague River was cited as the most influential barrier at the time of listing because it blocked access to approximately 95 percent of potential river spawning habitat for Upper Klamath Lake (UKL) populations of the LRS and the SNS (53 FR 274130); the dam was removed in 2008. Nevertheless, many other significant physical barriers persist throughout the range of these species, limiting the ability of populations to reproduce or disperse, such as the Tule Lake populations (NRC 2004).

Overharvesting of adult LRSs and SNSs potentially contributed to declining population levels in UKL, especially for the LRS, but harvest has not been authorized since 1987 (USFWS 2007a, b). Entrainment of larval and juvenile suckers into irrigation and hydroelectric structures was also cited as a threat at listing, and this loss of young fish continues to threaten these species even though several major improvements to key structures (*e.g.*, the A Canal fish screen) have been implemented.

Nonnative fishes were identified as a potential threat to the LRS and the SNS at the time of their listing because of potential competition and predation.

Lastly, mass mortality events in UKL are not new, but it is believed that as *Aphanizomenon flos-aquae* (AFA), a nitrogen-fixing blue-green alga or "cyanobacterium," has increasingly dominated the system, the frequency of extreme fish die-off events has also increased (NRC 2004). Although conditions are most severe in UKL and Keno Reservoir, listed suckers throughout the Klamath Basin are vulnerable to water quality-related mortality (USFWS 2007a, b).

New Threats Identified Since Listing

<u>Climate Change</u>

Since the 1950s, western North America has experienced changes in the timing and amount of precipitation, including decreased snowfall, earlier snowmelt, and earlier peak spring runoff, which appear inconsistent with historically normal fluctuations, suggesting effects from anthropogenic sources (Hamlet *et al*. 2005, Stewart *et al*. 2005, Knowles *et al*. 2006). Climate models indicate that these trends are likely to continue (Barnett *et al*. 2008). In the upper Klamath Basin, eight of the 10 lowest total annual inflows into UKL in the past 50 years occurred between 1991 and 2009, and, over the past decade, inflows to the lake have been about 9 percent less than over the previous 31 years. Additionally, the July through September inflows to UKL have declined by over 50 percent during the past 50 years (Mayer 2008, Mayer and Naman 2011).

The LRS and the SNS evolved in a region with highly variable precipitation, often with extended and severe droughts (Negrini 2002); however, given the current lack of recruitment into the adult population of each species, the absence of population connectivity (even in wet years), poor habitat conditions, and diminished abundance, LRS and SNS populations are highly vulnerable to negative impacts from climate change, especially increased drought. Threats from climate change not only include reduction in amounts of spring runoff and its timing, but are likely to also result in increasingly reduced water quantity, the spread of disease and parasites, and proliferation of invasive and nonnative species that could prey on or compete with suckers.

Disease, Predation, and Parasitism

Emerging information suggests that other natural factors may also be adversely affecting the suckers more than previously thought. For example, fish-eating birds, such as the American white pelican (*Pelecanus erythrorhynchus*), could have substantial negative impacts on adult sucker populations, especially those in Clear Lake where they could be exposed to pelican predation during the spawning migration in Willow Creek. Early data indicate that American white pelican predation rates on sub-adult or adult suckers in Clear Lake Reservoir may be as high as 20 percent in some years; however, additional research is needed to clarify the magnitude of this threat (Roby and Collis 2011; D. Hewitt, USGS, pers. comm. 2012). Additional, recently identified threats include algal toxins, which may have affected nearly 50 percent of 47 juvenile

LRSs assayed from UKL (Vanderkooi *et al*. 2010); and parasites, including Neascus spp., a trematode flatworm (Simon *et al*. 2012, Markle *et al*. 2013), anchor worm (*Lernaea cyprinacea*), a parasitic copepod (Simon *et al*. 2012), *Trichodina* sp., an external ciliate protozoan; and the bacterium *Flavobacterium columnare*, which causes gill rot (Holt 1997, Foott 2004, Foott *et al*. 2010). Markle *et al*. (2013) recently estimated an additional 3.7 percent daily mortality for juvenile SNSs that were infected with *Neascus* spp. (black spot disease) compared to uninfected individuals. There is new information concerning the bacterial flora on the skin of juvenile suckers (Burdick *et al*. 2009b), but it is unknown if this negatively affects the fish.

The LRS and the SNS are known to have at least two groups of multicellular, invertebrate parasites: *Neascus* and *Lernaea*. *Neascus*, or “black-spot disease,” is a catch-all term for a group of trematode flatworms that cause similar infections in fish (Kirse 2010). The larval trematodes (a parasitic flat worm) burrow under the skin of the fish, resulting in a black cyst. The *Neascus* life cycle progresses through snails, then fish, and finally a fish-eating bird, all of which are seasonally numerous at UKL. Parasitic infections can cause physiological stress, blood loss, decreased growth rates, reduced swimming performance, lower overwinter fitness, and mortality, especially in small fish (Marcogliese 2004, Kirse 2010, Ferguson *et al*. 2011). In some instances, parasites can also make hosts more vulnerable to predators by affecting their morphology and/or behavior (Marcogliese 2004). Limited evidence is beginning to emerge concerning the effects of these parasites on listed Klamath suckers and it shows that parasites are likely an important source of mortality for age-0 SNS (Markle *et al*. 2013).

LRS and SNS Life History

The LRS and the SNS are adapted to lake environments. The LRS is the only extant member of the genus Deltistes (Miller and Smith 1967), and the SNS is one of three recognized species in the genus Chasmistes (Moyle 2002). Both species are relatively large, with a maximum size between 24 to 31 inches. The LRS and the SNS feed on zooplankton and small benthic invertebrates taken from or near soft substrates (Scoppettone and Vinyard 1991).

Both species spawn from February through May over rocky substrates in habitats less than 4 feet deep in rivers and at shoreline springs (Buettner and Scoppettone 1990). In UKL, it appears that more than 95 percent of adults spawn every year (Hewitt *et al*. 2012). Females are highly fecund, producing from 44,000 to over 200,000 eggs per LRS female and 18,000 to 72,000 per SNS female per year, of which only a very small percentage survive to become juveniles (NRC 2004). Females typically broadcast their eggs in the company of two males (Buettner and Scoppettone 1990), and the fertilized eggs settle within the top few inches of the substrate until hatching 1 week later.

Approximately 10 days after hatching, larvae emerge out of the substrate (Buettner and Scoppettone 1990). Most larvae spawned in streams quickly drift downstream into lake habitat. Larval movement away from the spawning grounds begins in April and is typically completed by July (Klamath Tribes 1996, Tyler *et al*. 2004, Ellsworth *et al*. 2010). Once in lake habitats, SNS larvae predominantly use nearshore areas adjacent to and within emergent vegetation (Klamath Tribes 1996, Cooperman and Markle 2004, Crandall *et al*. 2008), but LRS larvae tend to occur more often in open water habitat (Burdick and Brown 2010) than near vegetated areas.

Sucker larvae transform into age-0 juveniles at about 1 inch total length by mid-July. Age-0, which are individuals younger than 1 year, juvenile SNS primarily use relatively shallow (<4 feet) vegetated areas, but may also begin to move into deeper, unvegetated offshore habitats before the end of their first year (Terwilliger *et al*. 2004, Hendrixson *et al*. 2007a, Hendrixson *et al*. 2007b, Bottcher and Burdick 2010, Burdick and Brown 2010). Age-0 LRS juveniles also tend to be less associated with shallow vegetated habitat than SNS juveniles. Little is known about the ecology of older juvenile suckers (ages 1–4). SNSs and LRSs juveniles begin recruiting into the adult population at 4 to 7 years of age, with LRSs taking longer than SNSs and females of both species taking longer than males to reach sexual maturity (Buettner and Scoppettone 1990, Perkins *et al*. 2000a).

Adult LRSs and SNSs inhabit lake environments with water depths of 3 to 15 feet, but appear to prefer depths from 5 to 11 feet (Peck 2000, Reiser *et al*. 2001), with LRSs typically inhabiting slightly deeper habitats than SNS (Banish *et al*. 2009). Adult LRSs and SNSs in UKL primarily occur in the northern half of UKL during the summer (Peck 2000, Banish *et al*. 2009), but become concentrated near and within Pelican Bay when water quality is adverse in the remainder of the lake (Perkins *et al*. 2000b, Banish *et al*. 2009). In the spring, congregations also form near tributaries or shoreline areas prior to spawning (Janney *et al*. 2008).

The LRS and the SNS exhibit many adaptations characteristic of long-lived species. Juveniles grow rapidly until reaching sexual maturity. Under favorable conditions, adults can have high survival rates, which enable populations to outlive adverse periods, such as droughts. Once achieving sexual maturity, LRSs live an average of 12.5 years under current conditions in UKL (D. Hewitt, USGS, pers. comm. 2010). Similarly, SNS adults are estimated to live an average of 7.4 years after joining the adult population. Thus, for those individuals that survive to adulthood, we expect an average total life span of 20 years for the LRS and 12 years for the SNS, based on the average time to maturity and average adult life spans, with maximum ages of up to 57 and 33 years, respectively (Scoppettone 1988, Buettner and Scoppettone 1990, Terwilliger *et al*. 2010).

LRS and SNS Distribution

The LRS and the SNS are endemic to the upper Klamath River Basin, including the Lost River and Lower Klamath sub-basins (Moyle 2002). Populations of both species currently exist in UKL, its tributaries, and downstream in the Klamath River reservoirs; although SNS dominates in Keno Reservoir and the hydropower reservoirs in the Klamath River (Desjardins and Markle 2000, Kyger and Wilkens 2012a). Both species also occur in Tule Lake, Clear Lake, and the Lost River. Only the SNS occurs in Gerber Reservoir, but, based on genetic evidence, this population appear to be intercrosses between the SNS and the Klamath largescale sucker (*Catostomus snyderi*, KLS; Tranah and May 2006).

Prior to listing, populations of the LRS were extirpated from Lower Klamath (including Sheepy Lake; Coots 1965), and a population of the SNS was extirpated from Lake of the Woods (Andreasen 1975). Subpopulations of the LRS or the SNS that were spawning at Barkley, Harriman, other springs, and smaller tributaries to UKL have also been extirpated (USFWS 2013). Other than populations in UKL, Clear Lake, and Gerber Reservoir, all other populations of both species are believed to be population sinks, populations that result from dispersal from a producing population, but cannot maintain themselves through larval production. Suckers are suspected by some to spawn in the Link River (Smith and Tinniswood 2007), the Lost River below Anderson-Rose Dam (Hodge and Buettner 2009), in the upper reach of Copco Reservoir (Beak Consultants Inc. 1988), and above Malone Dam (Sutton and Morris 2005); however, due to small numbers, the lack of suitable habitat, and presence of predators, it is unlikely these attempts lead to substantial larval production.

LRS and SNS Recovery Units

The 2013 revised recovery plan for the LRS and the SNS identifies recovery units for both of these species, based on the limited information on genetic and ecological distinction between sub-basins (USFWS 2013). The UKL Recovery Unit is subdivided into four management units: (1) UKL river-spawning individuals; (2) UKL spring-spawning individuals (LRS only); (3) the Keno Reservoir Unit, including the area from Link River Dam to Keno Dam; and (4) the reservoirs along the Klamath River downstream of Keno Dam, known as the Klamath River Management Unit. The Lost River Recovery Unit is also subdivided into four management units: (1) Clear Lake; (2) Tule Lake; (3) Gerber Reservoir (SNS only), and (4) the Lost River proper (mostly SNS). By specifying recovery units, USFWS indicates that recovery cannot occur without viable populations in each recovery unit; however, this does not mean that each management unit has equivalent conservation value or is even necessary for species recovery to be achieved. Viable populations are ones that are able to complete their life cycle regularly with recruitment and diverse age composition of the adult population.

In the 2013 recovery plan for the LRS and the SNS (USFWS 2013), the criteria to assess whether each species has been recovered are focused on reduction or elimination of threats, and demographic evidence that sucker populations are healthy. The threats-based criteria for down-listing include: (1) restoring and enhancing habitats, including water quality; (2) reducing adverse effects from nonnative species; and (3) reducing losses from entrainment. To meet the population-based criteria for delisting each species must exhibit an increase in spawning population abundances over a sufficiently long period to indicate resilience, as well as establish spawning subpopulations within UKL.

LRS and SNS Genetics

In an assessment of mitochondrial DNA (mtDNA), Dowling (2005) reported that the LRS is relatively distinct genetically from the other sucker species in the Klamath Basin. Similarly, microsatellite markers indicate that LRSs do not regularly interbreed with the other catostomids in the Klamath Basin (Tranah and May 2006). In addition, differences in mtDNA of LRS populations in the upper Klamath Basin compared to those in the Lost River sub-basin suggest that these should be treated as separate LRS units (Dowling 2005) for purposes of maintaining genetic diversity.

Conversely, little distinction between SNS and KLS mtDNA and microsatellite markers has been found (Dowling 2005, Tranah and May 2006), suggesting that interbreeding has occurred in the past and likely continues to occur between these species. This is especially true in the Lost River sub-basin; although morphological, behavioral, and ecological distinctions are maintained in most populations (Markle *et al*. 2005). Increased hybridization resulting from human intervention can be cause for concern for imperiled species, and may even lead to extinction (Rhymer and Simberloff 1996). However, data suggest that intercrossing among Klamath Basin suckers is consistent with a pattern of historical intercrossing, which is not uncommon for the sucker family Catostomidae (Dowling and Secor 1997, Dowling 2005, Tranah and May 2006). Further studies are needed to determine the extent, causes, and effects of this intercrossing, but based on the historical pattern of intercrossing of these species and the fact that many individuals retain much of the SNS phenotype we consider these SNSs to be protected under the ESA. A genetic distinction among SNS populations between basins is weakly defined. Currently, there is no opportunity for gene flow between the populations of both species because of many significant physical barriers.

LRS and SNS Range-wide Population Trends

Starting in the late 1800s, large areas of sucker habitat were converted to agriculture and barriers were created that isolated populations from spawning grounds. Although there are no survey records until the 1900s, it is likely that these once superabundant species began to decline in numbers around the turn of the 20th century concurrent with significant destruction and degradation of sucker habitat. Later, from the 1960s to the early 1980s, recreational harvests of suckers in UKL progressively decreased (Markle and Cooperman 2002), which reflected further declines in the LRS and SNS populations and led to their listing under the ESA in 1988. From 1995 to 1997, water quality-related die-offs killed thousands of adult suckers in UKL (Perkins *et al*. 2000b). Over that three-year period, more than 7,000 dead suckers were collected and many other dead suckers were likely present but not detected.

More recently (between 2002 and 2010), the abundance of LRS males in the lakeshore-spawning subpopulation in UKL decreased by 50 to 60 percent, and the abundance of females in UKL decreased by 29 to 44 percent (Hewitt *et al*. 2012). It is not clear if the river-spawning subpopulation of the LRS in UKL has increased or decreased between 2002 and 2010 because of improvements in sampling methodology part way through the study that give the appearance of a large influx of individuals, but it is likely that this population decreased proportionately similar to the spring-spawning population (Hewitt *et al*. 2012).

Capture-recapture data indicate that the UKL SNS adult population decreased in abundance by 64 to 82 percent for males and 62 to 76 percent for females between 2001 and 2010 (Hewitt *et al*. 2012). Although the adult populations of both species in UKL have declined substantially, the SNS adult population is at a greater risk of extirpation from UKL than LRS because it had declined to a greater degree and there are approximately 10 times LRS in UKL than SNS (Hewitt *et al*. 2012). If the trend from 2001 through 2010 continues for the SNS in UKL we may expect that roughly 1,000 will remain by the end of 2023 in this water body. However, the risk of extirpation becomes even more likely given that the relatively advanced age of most individuals in UKL will likely result in an acceleration of declining trends until then as individuals begin to succumb to old age.

Recent LRS and SNS size distribution trends reveal that the adult spawning populations within UKL are comprised mostly of similar age, relatively old individuals. Since the late 1990s, median lengths of populations of SNS have increased by approximately 0.16 inches per year and 0.35 to 0.47 inches per year for the LRS (Hewitt *et al*. 2012). If younger individuals (which are typically smaller) were frequently joining the population the median length would remain stable, suggesting that recruitment of new adults is minimal to nonexistent. Most adult suckers currently in UKL are believed to be the result of spawning that occurred in the early 1990s (Janney *et al*. 2008). These fish are now approximately 20 years of age, and are well beyond the average life span of 12 years for the SNS and equal to that of 20 years for the LRS. Even though viable eggs and larvae are produced each year, a bottleneck during subsequent life stages causes a lack of recruitment of new adults into UKL sucker populations, which continue to exist only because of their long life. However, this trend is especially untenable for the SNS, and, without substantial recruitment in the next decade, the population will be so small that it is unlikely to persist.

Insufficient monitoring data are available to determine trends for other LRS and SNS populations, but since the declining populations in UKL are the source of most of the LRS and SNS populations elsewhere, we expect the trends in those populations to be similar to those in UKL. Loss of the UKL LRS and SNS populations would put both species at a high risk of extinction because the UKL populations represent approximately 40 to 80 percent of the total rangewide population of the SNS and the LRS, respectively, and would reduce the number of self-sustaining populations from two to one for the LRS, and from three to two for the SNS. If these losses occurred it would significantly reduce both the resiliency and the redundancy of the LRS and SNS populations range-wide. Resiliency and redundancy are very important factors for survival and recovery of these species (USFWS 2013).

LRS and SNS Population Dynamics

Adult Population Sizes

Because of the wide-ranging behavior, expansive habitat, and rarity of these species, obtaining accurate population estimates is impracticable. However, long-term monitoring using capture-recapture methods provide accurate information on relative changes in abundance (Hewitt *et al*. 2010, 2012). For example, in 2011, UKL monitoring detected or captured approximately 22,000 tagged LRS (Hewitt *et al*. 2012). Approximately 37 percent of these individuals were spawning at the springs along the eastern shoreline of the lake. The proportion of tagged individuals in the total UKL population is unknown. If that were known, it would allow for the calculation of a relatively accurate estimate of overall numbers in UKL. However, the proportions of tagged to untagged individuals in direct captures suggest that the LRS population in UKL likely numbers between 50,000 and 100,000 adults (Hewitt *et al*. 2012). The number of adult SNSs in UKL is likely to be fewer than 25,000, given that only approximately 10,000 individual SNSs were detected or captured during the 2011 spawning season (Hewitt *et al*. 2012).

In Clear Lake, SNSs are more abundant than LRSs. Approximately 2,500 tagged SNSs were detected during the spawning run up Willow Creek in 2011 (B. Hayes, USGS, pers. comm. 2011); slightly less than 500 tagged LRSs were detected during the same period at this location. Although reliable estimates of total population numbers are unavailable, but data suggest that fewer than 25,000 adult SNSs and fewer than 10,000 adult LRSs occur in Clear Lake.

Data on LRS and SNS populations in Keno Reservoir, Klamath River reservoirs, Tule Lake, Gerber Reservoir, and the Lost River are limited, but the monitoring efforts completed for these populations indicate low numbers of each species, with perhaps fewer than 5,000 individuals total for the LRS and the SNS in Tule Lake (Hodge and Buettner 2009), Keno Reservoir (Kyger and Wilkens 2010a), and the Klamath River reservoirs below Keno (Desjardins and Markle 2000). In 2010, 413 suckers (187 LRS + 227 SNS and 3 unknowns were captured and relocated to UKL (Courter *et al*. 2010). SNS dominate in the Keno Reservoir and downstream in the hydropower reservoirs (Desjardins and Markle 2000, Kyger and Wilkens 2012b). Gerber Reservoir may be an exception to this because spawning surveys in 2006 detected approximately 1,700 of the nearly 2,400 SNSs that had been tagged the previous year (Barry *et al*. 2007c). Based on limited data, we estimate that the approximate total range-wide adult population of the LRS is 65,000 to 115,000 individuals, and less than 60,000 individuals for the SNS.

Vital rates (*e.g*., survival and recruitment) of SNS and LRS adults in UKL have varied little over the past decade. Annual adult survival rates of the SNS in UKL appear to vary more than the LRS, but adults of both species in UKL appear to be relatively stable (Hewitt *et al*. 2012), excluding years of large fish die-offs as in 1995, 1996, and 1997. Modeling of LRS and SNS adult populations since 2001 suggests a low rate of recruitment (Hewitt *et al*. 2012), which has resulted in adult populations for both species that are homogenous in size and age. If this lack of recruitment continues, it will cause instability and eventually lead to extirpation of these species from UKL. It is generally accepted that the last substantial recruitment for both the LRS and the SNS in UKL occurred in the late 1990s, from fish that were spawned earlier in the decade (e.g., 1991). Although it is difficult to verify this finding using standard fish-ageing techniques (given the long life of these species, annual growth rings are often difficult to differentiate), the size distribution of spawning adults appears to corroborate this view. Between 2000 and 2011, the length distribution of both species in UKL steadily shifted upwards, with few smaller (and presumably younger) individuals being present (Hewitt *et al*. 2012).

Given the scarcity of juvenile suckers in UKL and based on the time it takes for these species to become sexually mature, it likely will be at least 4 years before substantial recruitment into the adult age class occurs because there are no known cohorts in the queue. Although we do not know specifically how this current uniform age distribution compares to historical conditions, healthy adult populations of long-lived species should generally possess multiple reproducing year-classes.
In Clear Lake, SNS vital rates appear to be fairly consistent, given the normal distribution of size classes of captured individuals since 2004 (Hewitt and Janney 2011; based on the assumption that size is generally related to age). During the same period, annual size distribution surveys indicated a group of sub-adult LRS was progressing towards sexual maturity, but this cohort inexplicably disappeared from samples taken in 2008 (E. Janney, USGS, pers. comm. 2011).

Environmental Baseline for Lost River Suckers and Shortnose Suckers

Endangered Species Act regulations define the environmental baseline as "…the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process" (50 CFR 402.02). The environmental baseline analysis provides a reference point for the Service assess the potential effects of the proposed action on listed species.

Habitat

Loss and alteration of habitats (including spawning and rearing habitats) were major factors leading to the listing of both species (USFWS 1988 pp. 27131–27132) and continue to be significant challenges to recovery. Both species utilize a spectrum of aquatic habitats during some stage of the life cycle, including river or stream habitats, open-water lake habitats, and the wetlands areas along banks and shores. However, alterations or total loss of habitats have occurred throughout the species' range. The most dramatic examples of wholesale habitat loss include Tule Lake (roughly 36,000 hectares [89,000 acres] lost) and Lower Klamath Lake (roughly 40,700 hectares [100,500 acres] lost) (National Research Council 2004 p. 53). These two lakes were both terminal bodies with a single major tributary, which were dammed in 1910 or diked in 1917 (respectively) to completely block inflows (National Research Council 2004 pp. 55–56). This resulted in a loss of approximately 392 km^2 (151 mi^2) or 88 percent of Tule Lake and 362 km^2 (140 mi^2) or 95 percent of Lower Klamath Lake (National Research Council 2004 p. 96). As the lake levels receded, the exposed lake bottoms were converted to agricultural uses.

Prior to damming, Tule Lake hosted what was probably the largest population of LRS (Bendire 1889 p. 444). Anecdotal reports suggest that populations of LRS also occurred in Lower Klamath Lake (Cope 1879 p. 72), although we are not aware of any pre-1917 reports on scientific fish surveys of the Lower Klamath Lake. Notable habitat loss also occurred in UKL. Approximately 70 percent of the original 20,400 hectares (50,400 acres) of wetlands surrounding the lake, including the Wood River Valley (Figure 6-4), was diked, drained, or significantly altered between 1889 and 1971 (Gearhart et al. 1995 p. 7). Conversely, additional habitat that is suitable for suckers was created when reservoirs were created behind Gerber Dam and enlarged behind Clear Lake Dam.

Barriers that limit or prevent access to spawning habitat were also identified as threats when the species were listed. Chiloquin Dam was cited as the most influential barrier because it restricted access to potentially 95 percent of historic river spawning habitat in the Sprague River for the populations in UKL (USFWS 1988 p. 27131). However, this dam was removed in 2008, improving access to approximately 120 km (75 mi) of river for spawning. Both species have been detected upstream of the dam site during the spawning season, albeit in very small numbers (Martin et al. 2013 p. 8). Additionally, several dams or water control structures hinder or completely impede movements of the species throughout their historic range. These include Gerber Dam, Clear Lake Dam, Anderson Rose Dam, Harpold Dam, Lost River Diversion Dam, Malone Dam, as well as numerous smaller check dams and the like (USBR 2000b, entire). All of the more substantial dams (i.e., the named ones above) were installed approximately 100 years ago, and none of them, except Link River Dam, have structures that would permit volitional fish passage. For example, suckers attempting to run up the Lost River from Tule Lake Sump 1A are only able to travel 12 km (7.5 mi) before the Anderson-Rose Dam blocks migration. The connection between UKL and downstream environments was questionable for many decades because of a dilapidated fish passage ladder on the Link River Dam. This condition improved with the completion of a sucker-friendly fish ladder in 2005.

Another equally important type of barrier is limited hydrologic connection to spawning or rearing habitat. This can be due to natural climatic patterns or result from human actions, such as water management for agricultural irrigation. For example, low lake levels in Clear Lake Reservoir can limit adult sucker access to Willow Creek (Hewitt and Hayes 2013, entire), the only known spawning tributary (Buettner and Scoppettone 1991 p. 8). When conditions permit access, adults ascend Willow Creek, the single major tributary flowing into Clear Lake Reservoir, spawn successfully, and produce juvenile cohorts in Clear Lake Reservoir (Buettner and Scoppettone 1991 pp. 47–48, Sutphin and Tyler 2016 p. 10). The amount of suitable shoreline spawning habitat in UKL is also affected by changes in lake elevation (Burdick et al. 2015b p. 483). Several spring-spawning populations, including Tecumseh Springs, Big Springs, and Barkley Springs, have been extirpated, in part due to reduced connectivity.

Historically, wetlands comprised hundreds of thousands of hectares throughout the range of the species (Akins 1970 pp. 42–50, Bottorff 1989 p. ii, Gearhart et al. 1995 p. 16), some of which likely functioned as crucial habitat for larvae and juveniles. Other wetlands may have played vital roles in the quality and quantity of water. Loss of ecosystem functions such as these, due to alteration or separation of the habitat, is as detrimental as physical loss of the habitat. For example, increases in sediment input to the lake and occurrence of *Aphanizomenon flos-aquae* (AFA) coincide with loss of riparian and wetland areas associated with agricultural development above UKL (Bradbury et al. 2004 p. 164). Higher inundation of fringe wetland habitats have been associated with higher larval survival in UKL (Cooperman et al. 2010 p. 34). Of the approximately 102 km^2 (39.3 mi^2) of wetlands still connected to UKL, relatively little functions as rearing habitat for larvae and juveniles, partly due to lack of connectivity with current spawning areas and habitat alterations.

The volume of water available in the action area at any one time depends on a variety of weather and climate factors including the amount and timing of precipitation, the percentage of precipitation occurring as snow versus rain, snow–water equivalent, air temperature, wind speed and direction, relative humidity, and other factors. Water quantity can affect the amount of available LRS and SNS habitat and the connectivity among habitats used in different seasons. In UKL, anthropogenic actions such as groundwater pumping and surface water diversions in areas tributary to the lake, or from the lake itself, also affect the available volume of water. For the purposes of this BiOp, these factors are not described individually because they are expressed jointly as the net inflow of water to UKL. Direct measurement of flow into UKL is not possible; therefore, net inflow is calculated based on the change in storage in the lake (change in the volume of water in the lake) and measured outflow.

Net Inflow = Change in lake storage + measured outflow

Annual net inflow to UKL during the period of record ranged from a low of 592,932 acre-feet (1992) to a high of 1,977,714 acre-feet (1983). The average and median annual net inflows during the period of record are 1,202,011 and 1,051,059 acre-feet, respectively. Approximately 48 percent of the annual inflow occurs between October and February, 44 percent between March and June, and 8 percent between July and September.

The change in storage is calculated based on a weighted average of lake surface elevation at three widely spaced gages and an elevation-capacity relationship (USBR 2018a Appendix 4, p. 4–23). Outflow from the lake is measured on the Klamath River below the Link River Dam and at the A Canal diversion. Losses from evaporation and gains from direct precipitation and groundwater discharge into the lake are not measured; however, these losses and gains are manifested in the change in storage. The primary subbasins draining into UKL are the Sprague, Williamson, and Wood River basins. The Sprague River flows into the Williamson River near Chiloquin, Oregon, several miles above the point where the Williamson River flows into UKL. There is a very strong relationship between flow in the Williamson River below its confluence with the Sprague River and net inflow to UKL (Garen et al. 2011 p. 11). Therefore, evaluation of trends in net inflow is enhanced by understanding trends in flow in the Williamson River. Additionally, because the Williamson is largely disconnected from the primary snowmelt-runoff production of the Cascade mountain range, Williamson River flows are a reasonable indicator of hydrology in the Upper Klamath Basin.

Evaluation of baseline hydrology involved the analyses of flow data for the Williamson River (used as a proxy for total UKL inflow) and surface elevation data for Clear Lake and Gerber Reservoir. Though the proposed action was based upon a period of record spanning water years 1981 to 2016, consideration of baseline hydrology extends to the broadest period of reliable data available for these sites. Williamson River flow data extend from water years 1918 through 2017; Clear Lake data encompass water years 1905 through 2018; and Gerber Reservoir data run from water year 1926 through water year 2018.

Flow volumes were at their lowest in the last century during the 1917 to 1937 period, with annual flow volume hovering around 600 TAF. A marked increase in flow volume occurred during the 1940s and peak Williamson flow volumes for the observed period occurred in the mid-1950s. Since this time, a general downward trend has been observed. In the last decade, flow volume has trended toward levels not seen since the driest period on record. Also of note is the persistence of hydrologic trends across the period of record. Flow trends do not alter rapidly.

The most rapid change observed was the ascendant arc of flows from lows in the 1930s to peak values in the mid-1950s; this change manifested over the course of 20 years. The current downward trend has lasted approximately 50 years. The Williamson River, which includes flows from the Sprague and Sycan Rivers, constitutes approximately half of the total inflow to UKL, making it a reasonable proxy for UKL inflow (Perry et al. 2005 pp. 24, 32, Stannard et al. 2013 pp. 3, 21). Additional inflow sources are the Wood River, Cascade Mountain snowmelt runoff via streams and subsurface through flow, and numerous springs and groundwater seeps. These additional sources of inflow have short or nonexistent periods of recorded flow and are unlikely to increase in magnitude by enough to make up for any shortfall in Williamson River contribution. Figure 2 illustrates the past 100 years of recorded Williamson flows and points to several trends. Currently, Williamson River flow volume indicates an ongoing 50 year decreasing trend. This trend is unlikely to alter significantly in the next 5-10 years. Assuming that Williamson River flow volume is indicative of overall UKL inflow, this suggests that UKL inflow is also likely to trend downward for the next decade.

In addition to indicating trends in UKL inflow, the Williamson River flow volume may also be a bellwether for overall hydrology across the Upper Klamath Basin. The downward trend in Williamson River flow volume may be a symptom of drier hydrology: less precipitation, lesser and more ephemeral snowpack, and less interannual groundwater recharge. Data from Clear Lake and Gerber Reservoir show similar trends. Though these are water surface elevations from reservoirs, they also point to a recent period of interannual decline in basin-wide hydrology. Clear Lake is a large, shallow lake situated south and east of UKL, within the closed Lost River basin. It was dammed and enlarged beyond its historic footprint by the Bureau of Reclamation in order to act as an evaporative lake and reservoir, removing water from the Lost River system in times of high flows and providing irrigation water in the spring and summer. Clear Lake has a single major tributary, Willow Creek, with a short period of recorded flow (since 2012). Likewise, Gerber Reservoir, the only true reservoir managed by the Klamath Project, is utilized for storage and delivery of irrigation water. Gerber Reservoir was created by impounding Miller Creek, an ungaged stream. Both of these reservoirs, though very different from the Williamson River, show signs of drier hydrology in recent years.

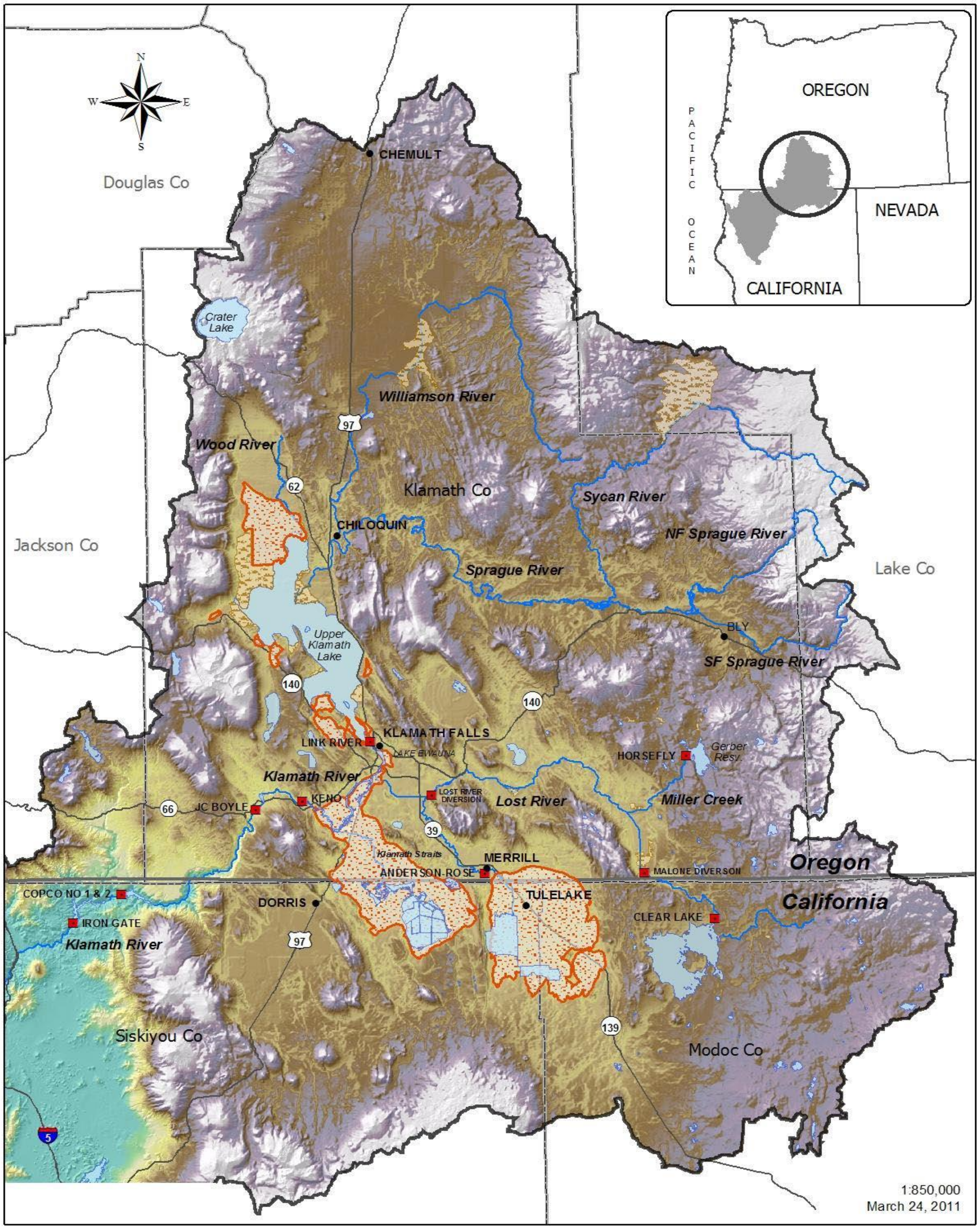

Figure 1. The upper Klamath Basin indicating areas of lost aquatic and wetland habitat that have been lost since 1900 with current conditions overlain. The lost areas are outlined in orange.

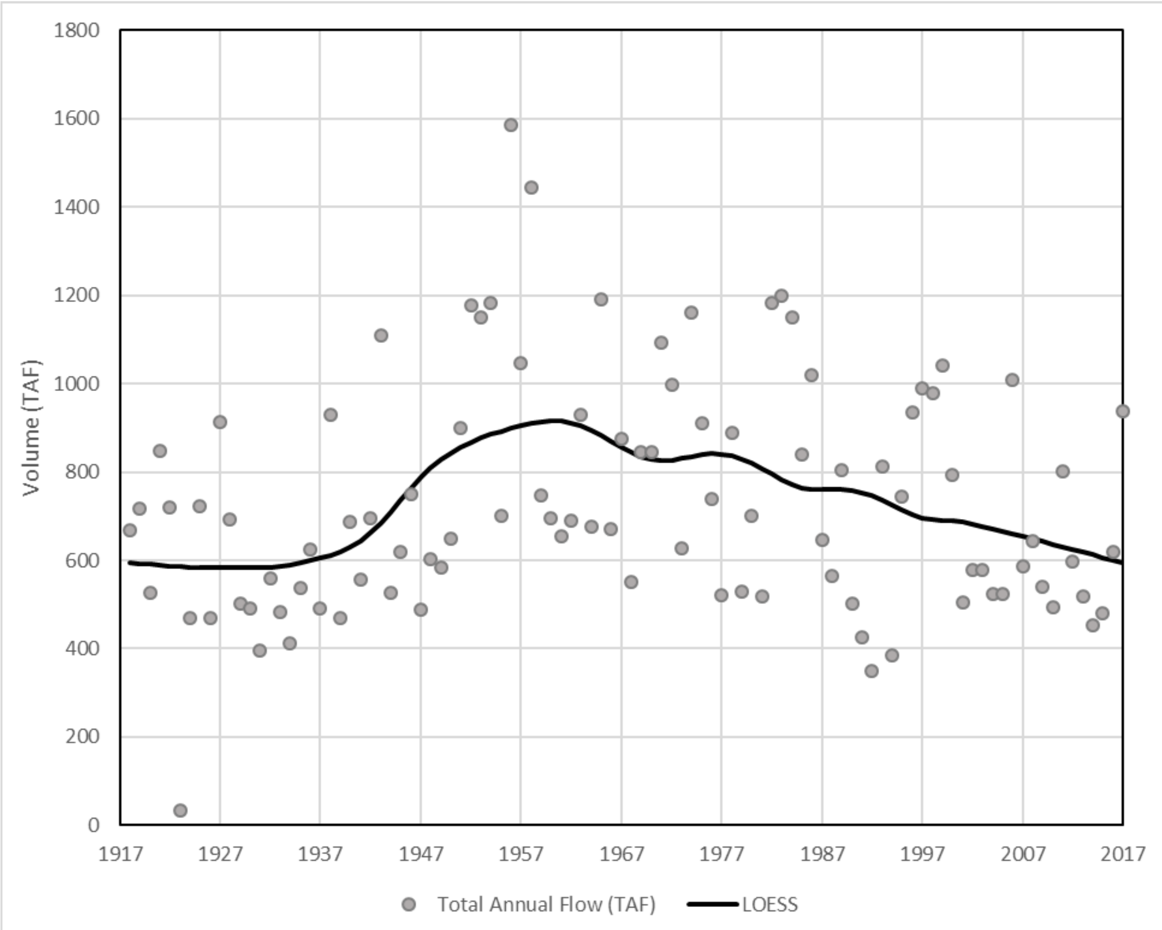

Figure 2. Total volume recorded annually at USGS gage 11502500 Williamson River below Sprague River near Chiloquin, OR for water years 1918 -2017 and a LOESS smooth of these data. Note the outlier year of 1923; a gage malfunction resulted in the loss of flow data from 10/1/1922 through 8/30/1923.

Gerber Reservoir surface elevations show less obvious similarity to the Williamson River, though this is likely due to it being a true reservoir and being operated as such (Figure 4). The hydrologically dry period during the 1920s and 1930s show a steady increase in reservoir storage, as might be expected during drought. A decline in the 1950s indicates less need for stored water and the need to maintain freeboard for additional flood storage. Surface elevation then increases through the 1970s and stabilizes through the 1990s. However, there is a marked and steep decrease in annual surface elevations beginning in 2003 and continuing through the present. Though this decline in Gerber Reservoir surface elevations differs in timing and duration from those observed in Clear Lake and the Williamson River, it nonetheless indicates a current period of drier hydrology and declining water storage.

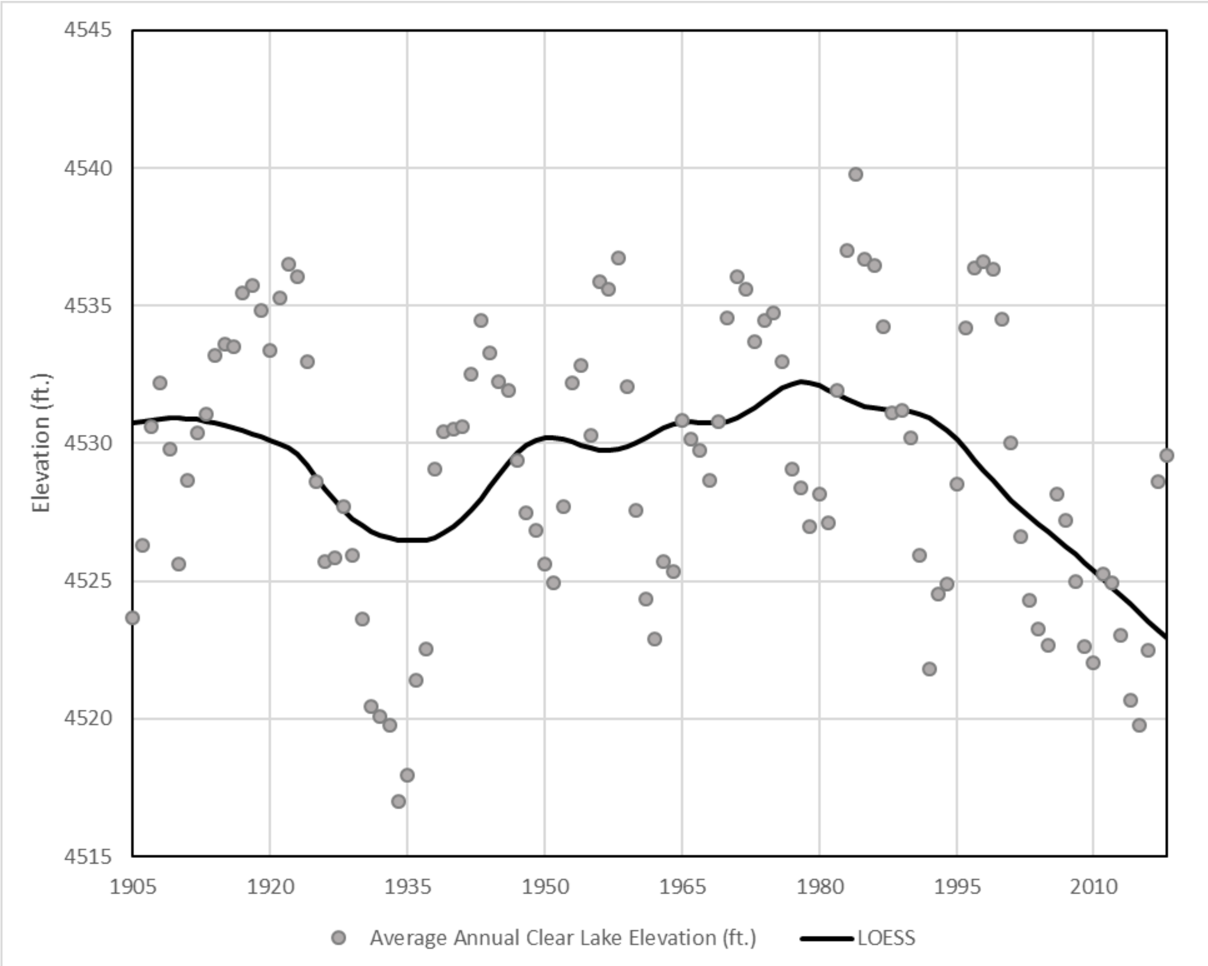

Figure 3. Average annual Clear Lake surface elevations for water years 1905 – 2018.

Consideration of data from across the Upper Klamath Basin for the last century or more points to the likelihood of a continuing trend of drier hydrology for the next 5-10-year period. The Williamson River, Clear Lake, and Gerber Reservoir have all experienced the effects of declining flows for at least the past decade, if not longer. Even if these trends begin to alter in the near term, hydrologic evidence suggests that this alteration will not occur rapidly enough to have a significant impact on hydrology in the next decade. The data indicate that planning for continued dry hydrology, with the possibility of increasingly dry conditions, is warranted.

Of note for this discussion is the impact of climate change on future hydrology. Climate change and its impacts are very difficult to predict, with models returning widely varying results as to the timing and magnitude of precipitation and runoff and the changes in temperature. However, there is general agreement that temperatures will increase, particularly in summer months (Barr et al. 2010 p. ii, 20, 24). This is likely to result in increased evapotranspiration and greater demand on water supplies during irrigation seasons. It also appears likely that there will be a shift in the ratio of winter precipitation types, with a greater proportion of precipitation falling as rain rather than snow (USBR 2016 p. 6).

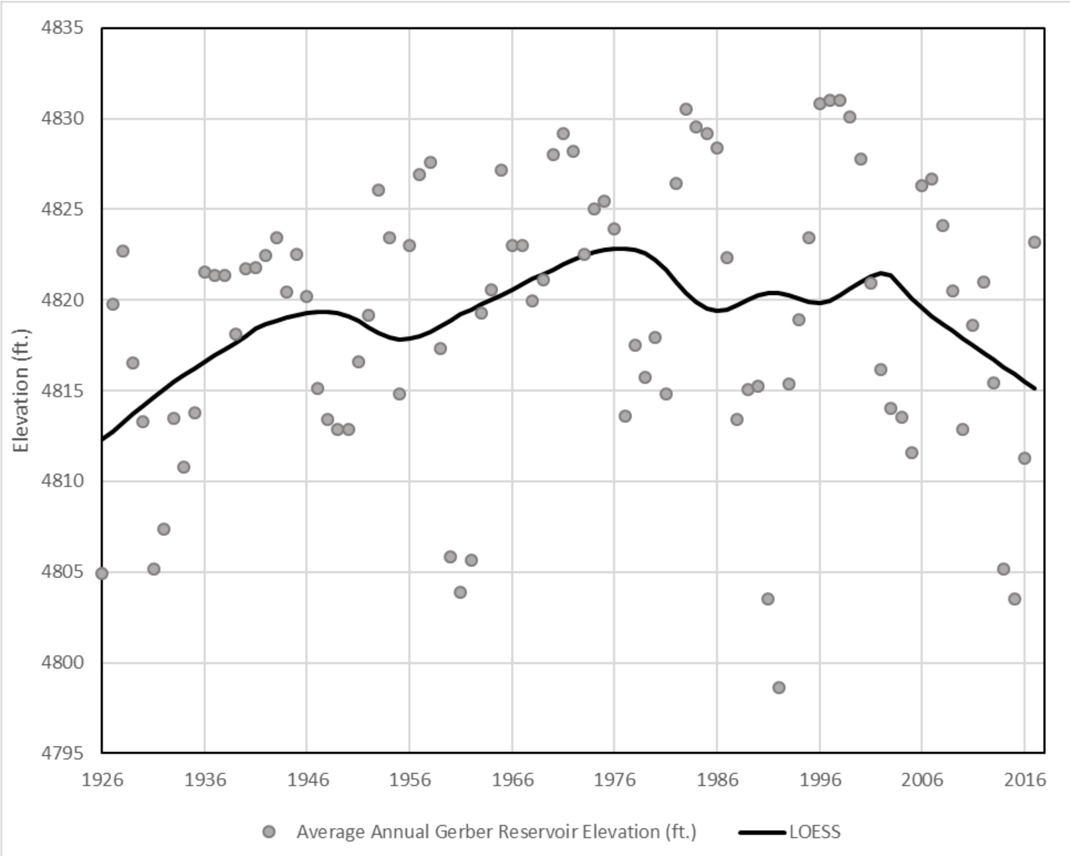

Figure 4. Annual average Gerber Reservoir surface elevations for water years 1926 – 2018.

This is likely to increase winter runoff and decrease snowmelt percolation through the system into the spring months, further stressing water supplies in a basin with limited interannual storage. These impacts are likely to be felt over the next 20 – 50 years, though it is unclear how quickly these changes will manifest. While the full effect of climate change may be unknowable at this time, climate modelling suggests that it would be prudent to plan for a system with hydrology that may be significantly altered from what has been observed in the past.

Water Quality

Water quality is a complex and important factor for sucker survival and vigor. Many elements contribute to water quality including temperature, dissolved oxygen, ammonia toxicity, pH, algae, and nutrient loading. Varied levels of detail are available on the ways in which these parameters may affect suckers. To date, no analysis of empirical data has detected a strong correlation between lake elevation and the relevant water quality parameters (e.g., Morace 2007, entire, see section 8.3.1.6 for a more thorough discussion). To provide a general understanding of how these water quality elements and suckers interact, we summarize the elements and provide sources for additional information, as appropriate.

Blue-green Algae

Blue-green algae, such as AFA, are relevant to the sucker environmental baseline because the massive annual bloom and subsequent crash dynamics are the primary driver of most water quality dynamics in UKL and Keno Reservoir during the high stress period of the summer months. Summertime blooms of AFA dominate Upper Klamath Lake phytoplankton communities due to excessive phosphorus loading linked to watershed development. Similar phytoplankton dynamics in Keno Reservoir/Lake Ewauna are due to large populations and associated nutrients of blue-green algae imported into the system from UKL in summer. Nutrient and algae exports also influence downstream reservoirs, particularly two largest reservoirs (i.e., Copco 1 and Iron Gate) in the Klamath Hydroelectric Reach where algal concentrations increase capitalizing on the imported nutrients.

Algal toxins represent a potentially direct effect from blue-green algae to suckers in UKL, in particular microcystin, a liver toxin produced by the cyanobacterium *Microcystis aeruginosa*. Microcystin may enter suckers through the gut as they consume midge larvae containing the toxin. Due to the limited capacity of fish to detoxify microcystins, fish suffer from sub-lethal effects or succumb to the toxic effects of elevated microcystin concentrations. Because microcystin is relatively stable, persisting *in situ* for months, it potentially could accumulate in fish tissues and in aquatic biota. However, direct consumption of *Microcystis* in the laboratory did not have measurable effects on survival or fish health (B. Martin, USGS, personal communication November 15, 2017). Suggested references for additional information include, but are not limited to Boyd et al. (2002), Butler et al. (2009), Caldwell Eldridge et al. (2012), Gilroy et al. (2000), Kent (1990), Malbrouck and Kestemont (2006), National Research Council (2004), Sullivan et al. (2008), Roy-Lachapelle et al. (2017), and VanderKooi et al. (2010).

Dissolved Oxygen

Dissolved oxygen (DO) concentrations within water depend on several factors, including water temperature (colder water absorbs more oxygen), water depth and volume, atmospheric pressure, salinity, and the activity of organisms that depend upon dissolved oxygen for respiration. Dissolved oxygen available for respiratory consumption by suckers is strongly influenced by the bloom and crash dynamics of algal communities, which in turn depend largely on availability of nitrogen and phosphorus. Within UKL, low DO concentrations occur most frequently in August, the period of declining algal blooms with associated decomposition and warm water temperatures in the lake. Downstream in Keno Reservoir, DO typically reaches very low levels from July through October as algae transported from UKL settle out of the water and decay; these low-DO events can last for extended periods. Organic matter and nutrient inputs, which promote primary productivity, from the Lost River basin via the Klamath Straits Drain and the Lost River Diversion Channel also contribute to low DO levels in this reach. Low DO does not appear to be a major threat in Clear Lake and Gerber Reservoir. Suggested references for additional information include but are not limited to Boyd et al. (2002), Jassby and Kann (2010), Kirk et al (2010), Martin and Saiki (1999), Morace (2007), Sullivan et al. (2009, 2011), and Walker (2001).

Ammonia Toxicity

Low DO events are often associated with high levels of un-ionized ammonia, which can be toxic to fish. Ammonia toxicity is complex because it is a function of total ammonia nitrogen concentration, pH, and temperature. The toxic form, ammonia, is most prevalent at higher pH.

Ammonia concentrations in UKL can be high enough to threaten suckers (Burdick et al. 2015a p. 6). Total ammonia nitrogen concentrations in the Keno Reservoir frequently exceed Oregon's chronic criteria from June to September and can exceed the acute criteria in both June and July. These degraded conditions can occur throughout much of the 20-mile long reservoir, with better conditions only in the uppermost and lowermost reaches. Suggested references for additional information include Deas and Vaughn (2006), Kirk et al. (2010), Lease et al. (2003), Martin and Saiki (1999), Meyer and Hansen (2002), Saiki et al. (1999), Sullivan et al. (2011), and USEPA (2013).

pH

In the Upper Klamath Basin, summertime pH levels are elevated above neutral. Extended periods of higher pH are associated with large summer algal blooms in UKL. Generally, pH in the reach from Link River Dam through the Keno Reservoir increases from spring to early summer and decreases in the fall; however, there are site-dependent variations in the observed trend. Suggested references for additional information include, but are not limited to Aquatic Science Resources (2005), Boyd et al. (2002), Jassby and Kann (2010), Kann (2017), Lease et al. (2003), Martin and Saiki (1999), Morace (2007), Saiki et al. (1999).

Water Temperature

Water temperatures in the Klamath Basin vary seasonally and by location. In the Upper Klamath Basin, water temperatures are typically very warm in summer months as ambient air temperatures heat surface waters. Both UKL and Keno Reservoir/Lake Ewauna may undergo periods of intermittent, weak summertime stratification, but water temperatures in these water bodies are predominantly similar throughout the water column. Clear Lake typically exhibits slightly higher temperatures than UKL. Although maximum water temperatures do not typically exceed the acute thermal tolerance of endangered suckers in either lake, they may cause stress to suckers in the hottest months leading to reduced growth and/or increased susceptibility to other stressors. Increasing temperature has many potential indirect effects, including reducing DO concentrations, increasing total ammonia-nitrogen, increasing growth rates of pathogens, and requiring greater energy demands from fish, and thus is an exacerbating factor. Suggested references for additional information include but are not limited to Jassby and Kann (2010), Kirk et al. (2010), Flint and Flint (2012), Martin and Saiki (1999), Morace (2007), and Kann (2017).

Nutrients

Concentrations of primary plant nutrients, including nitrogen and phosphorus, in lakes are affected by the geology of the surrounding watershed, upland land uses, and physical processes within the lake and its tributaries. The ability of riparian and floodplain habitats to retain or alter nutrients throughout the system is degraded as a result of ditches, dikes, and levees that promote drainage or prevent overbank flows. UKL was eutrophic prior to settlement by Anglo-Americans but is now hypereutrophic due in large part to human modifications to the environment. The relatively high levels of phosphorus present in the Upper Klamath Basin's young volcanic rocks and soils are a major contributor to phosphorus loading to the lake. Land use within the watershed increases inputs through soil erosion, pasture runoff, and irrigation return flows. UKL is a major source of nitrogen and phosphorus loading to the Klamath River, primarily due to nitrogen fixation by AFA. Nutrient and organic matter inputs from the Lost River Basin via Klamath Straits Drain and the Lost River Diversion Channel are also an important source of nutrients to the Keno Reservoir and Klamath River below. Suggested references for additional information include, but are not limited to Boyd et al. (2002), Bradbury et al. (2004), Colman et al. (2004), Eilers et al. (2004), Kann and Walker (1999), Kirk et al. (2010), Kuwabara et al. (2007), National Research Council (2004), Snyder and Morace (1997), and Sullivan et al. (2009).

Die-off Events

Large fish die-off events, although uncommon, can have a pronounced effect on population resiliency by killing numerous individuals. Typically, adults have been the only life stage encountered during sucker die-offs in UKL, but it is likely any juveniles present would also be impacted but remain undetected because of their smaller body size. For example, three consecutive fish die-offs in UKL (1995–1997) possibly involved tens of thousands of adult suckers (Perkins et al. 2000a p. 10). Multiple factors were likely to blame, but low DO concentrations and perhaps high total ammonia-nitrogen concentrations were implicated in the die-offs (Perkins et al. 2000a pp. 16–19, 24–29). During the die-off period in 1996 there was concurrently a *Microcystis aeruginosa* bloom, which may have also been a contributing factor.

Other reported die-offs in UKL include 1986 (Coleman et al. 1988 p. 5). Since the die-offs of the late 1990s, such events have been relatively rare with observations of sucker die-offs in 2003 and 2017. During August and September of 2017, 490 LRS and 9 SNS carcasses were observed, predominantly in the northwest area of UKL (M. Buettner, The Klamath Tribes, personal communication, January 2, 2018). The data are not sufficient to conclusively implicate low DO concentrations as the primary factor, but the highest numbers of carcass detections were coincident with the lowest DO levels of the summer, as occurred in each of the late-1990s events. It is possible that other die-off events went undetected or are underreported in the literature. Nevertheless, it seems that widespread die-offs in UKL have occurred in roughly 1 out of 10 years.

Genetic Introgression

Hybridization is a single interbreeding event between individuals of two species. Introgression is the subsequent incorporation of genetic materials into the genome of the species as a result of numerous hybridization events (i.e., back crossing). Introgression is common among suckers in general and well documented among the Klamath Catostomids, particularly between SNS and Klamath largescale sucker (KLS; *Catostomus snyderi*) (Dowling et al. 2016 p. 3).

Hybridization and introgression between shortnose sucker and Klamath largescale sucker are well documented and evidenced by phenotypic intermediates in morphology (Markle et al. 2005 p. 476) and lack of discrimination among molecular markers (Dowling et al. 2016 p. 19). However, morphological distinctiveness of the species varies by location (Markle et al. 2005 p. 476), and the two species’ spawning is partially isolated temporally and spatially (Markle et al. 2005 p. 480). In UKL, morphological attributes of both species are more or less maintained, while other populations such as Gerber and Clear Lake reservoirs show a spectrum of morphological intermediates (Dowling 2005 pp. 21–22).

Genetic diversity is lower for both species in Clear Lake Reservoir as compared to conspecifics in UKL. In this reservoir, both species have lower heterozygosity and allelic richness compared to conspecifics in UKL (Smith and VonBargen 2015 p. 24). Lower genetic diversity could be due to the population being derived from a limited number of individuals trapped when the dam was installed (i.e., founder effects) or simply due to genetic drift associated with small population size. Additionally, lack of connectivity with other populations also further depresses genetic diversity via reduced gene flow. Of more importance, the shortnose sucker population in Clear Lake Reservoir is highly introgressed with Klamath largescale sucker (Tranah and May 2006 p. 313, Dowling et al. 2016, entire). Shortnose sucker are more genetically similar to Klamath largescale within the same subbasin than they are to conspecifics from the other subbasin (Smith and VonBargen 2015 p. 14), in the Lost River subbasin, shortnose sucker and Klamath largescale sucker can be difficult to distinguish morphologically. This can potentially erode species distinctiveness (genetic representation) within the population as well as reduce the abundance of phenotypic shortnose sucker (i.e., abundance of individuals that possess the morphology associated with shortnose sucker) and thereby reduce population resilience. Genetic representation within the Gerber Reservoir population is very similar to that of Clear Lake Reservoir. The shortnose sucker are highly introgressed with Klamath largescale, and the population is completely disconnected from other populations.

Unlike the shortnose sucker, hybridization and introgression involving the endangered Lost River sucker does not appear to be extensive (Dowling et al. 2016 p. 18). At present, both endangered suckers in UKL are characterized by population sizes large enough to maintain genetic diversity and prevent the negative effects of inbreeding. We cannot make similar conclusions about other populations because we lack accurate estimates of population sizes.

The draining of Tule Lake and Lower Klamath Lake and the construction of dams and irrigation structures has isolated the populations such that there is no exchange of individuals between the major remaining populations in UKL, Gerber Reservoir, and Clear Lake, and the system no longer functions as a metapopulation. This reduction of redundancy and connectivity could also have negative impacts on representation of diversity within the species.

Maintenance of ecological and phenotypic distinction between shortnose sucker and Klamath largescale in UKL suggests that introgression between these species does not threaten the resiliency of that shortnose sucker population. However, the resiliency of the shortnose sucker populations in Clear Lake Reservoir and Gerber Reservoir may be compromised by dilution of the distinct genetics and ecology of the species through hybridization and introgression.

Harvest

Migrating suckers were a historically important food source for the Klamath Tribes and were harvested in large numbers during the spring months (Bendire 1889 p. 444, Evermann and Meek 1897 p. 60). Settlers of European descent also utilized sucker migrations as a source of food and fish oil, including some commercial harvest. Historical accounts of sucker harvest from the late 19th century describe a large fishery on the Lost River for fish migrating upstream from Tule Lake (Bendire 1889 p. 444, Gilbert 1897 p. 6). The construction of dams on the Lost River and the draining of Tule Lake for agricultural purposes eliminated this fishery. However, a large recreational fishery for suckers developed in the Williamson and Sprague Rivers. In 1967, the Klamath Falls fisheries agent for the Oregon Fish and Game Commission was quoted in the newspaper as stating, “we’ve estimated that about 100,000 pounds—that’s 50 tons—of mullet [suckers] were snagged out of the two rivers in a three-week period” (Cornacchia 1967, entire). This snag fishery, which targeted primarily LRS but included SNS (Bienz and Ziller 1987), existed in the Williamson and Sprague Rivers up to 1987 when the Oregon Fish and Game Commission outlawed harvest of both species.

Until 1987, fishing pressure during the spawning migration likely contributed to population declines in Lost River and SNS in the Williamson and Sprague Rivers, but the magnitude of the effect is difficult to discern due to a lack of data on population sizes and harvest quantities during most of the 20th century. At present, some Lost River and SNS are inadvertently captured while anglers target other species in UKL; however, the numbers are likely small, and anglers are required by law to immediately release the fish.

Climate

The climate of the Klamath basin is classified by the Köppen-Geiger system as temperate with dry, warm summers, also known as a warm-summer Mediterranean climate (Peel et al. 2007 p. 1639). With this climate most of the precipitation falls in the form of snow during the winter. The climate of the Klamath Basin naturally fluctuates between wet and drought periods over a scale of years to decades. Droughts are of particular interest because of their influence on lake and reservoir elevations, which can affect suckers in a variety of ways (see section 8).
The years 1992, 2001, and 2011 rank among the driest single years and 1990-1992 ranks among the driest 3-year periods in the past 120 years (Malevich et al. 2013 p. 17). For longer-term droughts (6-20 years), the decade of the 1930s ranks among the driest in nearly 500 years (Malevich et al. 2013 p. 17). It is unclear how longer-term droughts affect the species, but these have the potential of affecting population-level dynamics such as persistent reduction in spawning production or other broad habitat modifications.

Environmental Contaminants

Contaminants from agricultural application of pesticides or other industrial practices could have affected sucker populations. Some of these compounds can remain bioavailable in the environment for decades. However, specific data regarding the historic or modern effects of contaminants on individuals and populations of these species are very sparse and inadequate to draw any definitive conclusions.
Organochlorine pesticides, such as DDT, were used extensively in the Klamath Basin (particularly the Tule Lake Basin) from 1940 through 1960 (Eagles-Smith and Johnson 2011 p. 19). Acute mortality to fish from DDT usually occurs at very low levels of concentration (U.S. Environmental Protection Agency 1975 p. 41). Eggs are especially vulnerable because the compound tends to accumulate in fatty areas, such as egg yolks (U.S. Environmental Protection Agency 1975 p. 43). In 1988, 15 years after DDT was banned, the sediments near the mouth of the Link River possessed the highest concentrations of various organochlorine pesticides of a broad survey of 25 aquatic sites in the Upper Klamath basin (Sorenson and Schwarzbach 1991 p. 62). Similarly, samples of suckers at the Link River mouth and in UKL all contained

organochlorines (Sorenson and Schwarzbach 1991 p. 64). We are unaware of data regarding subsequent trends of concentrations in suckers, but significant declining trends in concentrations in birds of the Klamath Basin suggest these lingering compounds are less prevalent since the 1980s (Eagles-Smith and Johnson 2011 pp. 1–20). An evaluation of modern pesticide use on Tule Lake National Wildlife Refuge concluded that the type and concentration of chemical applications were unlikely to harm suckers in Tule Lake (Haas 2007 p. 3). The processing of lumber products also provided a potential source of relevant environmental contaminants over the last century. For example, a mill located at the confluence of the Williamson and Sprague Rivers operated for 70 years – closing in 1988 (Parker 2008 p. 9).

Contamination of the site included numerous petroleum-based chemicals, pentachlorophenal, metals, and dioxins (Parker 2008 p. 10), all of which are toxic to fish under certain conditions. Its location near the upstream terminus of the only sucker river spawning habitat for both species presented a possible risk if harmful chemicals leached into the hydrological system. Dioxins are especially harmful to eggs since they bind with fat and oils, such as the yolk. The site has been "cleaned" and remediated for human health objectives by removing most of the petroleum-based chemicals, pentachlorophenal, and decaying wood that was mobilizing toxic metals. The dioxins were buried under a layer of protective soil. A minimal survey for dioxins in the nearby rivers during the spawning season indicated that current levels were likely not harmful (S. Burdick, USGS, pers comm, October 25, 2018). Nevertheless, it is not clear whether what impacts this and other similar sites have affected sucker populations.

Mercury deposited from the atmosphere can be highly toxic to fish and wildlife when it is converted into methylmercury. Methylation is stimulated by repeated inundation and drying, which occurs in the wetlands around Upper Basin Lakes as well as on the lands of Tule Lake and Lower Klamath National Wildlife Refuges where lands are rotated between agricultural use and wetland habitat for waterfowl (Eagles-Smith and Johnson 2011 pp. 27–28). However, mercury concentrations measured in suckers and other fish from the Upper Klamath Basin in 1988-1989 were below the national average for all fish (Sorenson and Schwarzbach 1991 p. 41). Overall, there is not strong evidence that contaminants have contributed substantially to the decline of sucker populations in the Upper Klamath Basin.

Predation

LRS and SNS evolved with substantial predation pressure on larvae and juveniles from native fish species, including redband trout (*Oncorhynchus mykiss newberrii*), blue chub (*Gila coerulea*), and Tui chub (*Gila bicolor*), as well as predation pressure on all life stages from numerous bird species. Non-native fishes introduced to the system also potentially impact suckers through predation. Approximately 20 fish species were introduced accidentally or deliberately into the upper Klamath Basin. These comprised about 85 percent of fish biomass in UKL when the suckers were listed (Scoppettone and Vinyard 1991 p. 375, National Research Council 2004 pp. 188–189). The introduced fish species most likely to affect LRS and SNS are the fathead minnow (*Pimephales promelas*) and yellow perch (*Perca flavescens*). Additional exotic, predatory fishes found in sucker habitats, although typically in relatively low numbers, include bullheads (*Ameiurus* species), largemouth bass (*Micropterus salmoides*), crappie (*Pomoxis* species), green sunfish (*Lepomis cyanellus*), pumpkinseed (*Lepomis gibbosus*), and

Sacramento perch (*Archoplites interruptus*) (Koch et al. 1975 p. 17, Logan and Markle 1993 pp. 27–29). These fish may prey on young suckers as well as compete with them for food or space (Markle and Dunsmoor 2007 pp. 573–577).

Fathead minnows were first documented in the Klamath Basin in the 1970s and are now the most numerous fish species in UKL (Simon and Markle 1997 p. 146). Laboratory experiments have demonstrated that adult fathead minnows' prey on sucker larvae (Markle and Dunsmoor 2007 pp. 573, 576). In UKL, higher fathead minnow abundances were associated with lower sucker survival rates (Markle and Dunsmoor 2007 p. 576). Likewise, as indirect evidence, higher larval sucker survival rates were also associated with greater water depth and shoreline vegetative cover, habitat that helps larvae avoid predation (Markle and Dunsmoor 2007 p. 575). Nonetheless, suckers outgrow fathead minnow's gape limitation quickly, and spatial and temporal overlap with other non-native predators (such as yellow perch) may be limited.

Several species of birds can prey on LRS and SNS. Bald eagles frequent sucker spawning sites, such as Ouxy Springs and the Sprague River near the Chiloquin Dam site, during the spawning season. Pelicans (*Pelecanus erythrorhynchus*) and double-crested cormorants (*Phalacrocorax auritus*) can also target juveniles and adults. There are also numerous other species of piscivorous birds, including terns, grebes, and mergansers, that may prey on juvenile and larval suckers throughout their range. Avian predation can be responsible for mortality of at least 8.4 percent of juveniles and 4.2 percent of adults annually in Clear Lake (Evans et al. 2016a pp. 1261–1262). Predation on spawning adults may increase mortality rates of this life stage and alter behavior during this critical period. For example, predation on adults, or the threat of predation, at spawning sites may limit the amount of time spent on the spawning ground, affecting overall reproductive outputs. It is difficult to determine whether avian predation has increased or decreased relative to historic levels, but bird populations in general in the Klamath Basin have certainly declined from historic numbers. Overall, it is more likely that the absolute amount of predation has also diminished.

Disease and Parasites

Numerous types of diseases and parasites infect LRS and SNS, some of which are associated with morbidity and mortality. Infections can cause physiological stress, blood loss, decreased growth rates, reduced swimming performance, lower overwinter fitness, and mortality, especially in small fish (Marcogliese 2004, entire, Kirse 2010, entire). Additionally, parasites may provide a route for other infectious pathogens by creating a wound in the skin, or they can make fish more susceptible to predation by modifying their behavior (Robinson et al. 1998 pp. 605–606, Marcogliese 2004, entire).

The LRS and the SNS are hosts to various species of bacteria, protozoa, myxozoa, trematodes, nematodes, leeches, and copepods (Foott 2004 pp. 3–4, Janik 2017 pp. 6–7). These can infect the eye, gills, kidney, blood, heart, muscle, skin, and gut. Many of these are pathogenic and can be associated at times with morbidity in suckers (Foott 2004 pp. 3–5, Foott and Stone 2005 pp. 7–9, Foott et al. 2010 pp. 5–13, Burdick et al. 2015a pp. 36–39, Hereford et al. 2016 pp. 35–39).

It is likely that most of the parasites currently able to infect Klamath suckers share an evolutionary history with suckers, suggesting that it is unlikely that native parasites cause the annual loss of juvenile cohorts. It is possible that the advent of a hyper-abundant introduced species has also increased the number of parasite hosts in the system. This could then theoretically increase the total number of parasites in the system, which could increase the infection rates of suckers. Furthermore, *Lernaea cyrpinacae* (anchor worms) are likely introduced and consistently parasitize sucker juveniles (Janik et al. 2018 pp. 1678 & 1683). While it is clear that parasites and disease affect individual survival, we currently do not have enough information to assess accurately the degree to which these negatively affect sucker population survival and viability.

Consulted on Effects

Here we describe the effects of past and ongoing actions known to occur within the action area and which affected or are affecting LRS and SNS. The Service reviewed records of past and ongoing consultations and provides summaries of formal consultations that are most relevant in describing the environmental baseline for the subject action. In essence, those actions that did not affect or that resulted in discountable or insignificant effects are not included as part of this discussion, as those actions did not rise to the level of take. This does not mean that we did not consider the other actions as part of the environmental baseline, rather we opted to focus our written summary on those actions with higher potential to significantly affect the environmental baseline for LRS and SNS.

The Klamath Project

The Bureau of Reclamation manages several reservoirs in the upper Klamath Basin to provide water for the 250,000-acre Klamath Project, which was established in 1905 as the second federal water project in the nation. The Bureau of Reclamation consulted with the Service multiple times on the Klamath Project since 1991, including the current proposed action. As the proposed action is an ongoing action for water management in the Klamath Basin, the potential for effects from water management activities and its associated infrastructure to listed suckers is not entirely different between past and current consultations.

The Service has authorized lethal and non-lethal take for all life stages of LRS and SNS as a result of past and ongoing activities associated with the Klamath Project. The creation of physical structures that are part of the Klamath Project (e.g., dams, canals, diversion points, etc.) altered the nature of the habitat both upstream and downstream. For example, habitat below Clear Lake Dam no longer functions as a migration corridor for spawning individuals because of impassable barriers and does not provide optimal habitat for out-migrating larvae given the unnatural flow patterns through the system. Conversely, the habitat above the dam has changed from a system with a large vegetated wetland associated with open water prior to the dam to a nearly homogenous open-water system with few emergent plants in most years.

A number of conservation actions have been undertaken as part of Reclamation's project operations such as screening of irrigation diversions, installation of a fish ladder at Link River

Dam, and assisted rearing of LRS and SNS. These actions and their effects are described below in the Conservation Efforts section.

PacifiCorps HCP

PacifiCorp finalized a Habitat Conservation Plan (HCP) for LRS and SNS in November 2013 (PacifiCorp 2013, entire) in accordance with section 10(a)(1)(B) of the ESA. In response to this plan, the Service conducted an intra-service consultation (08EKLA00-2013-F-0043) on the effects to suckers of the authorization of the plan.

The HCP addressed direct effects to suckers, including entrainment at project diversions, false attraction at Project tailraces, ramp rates, lake level fluctuations, migration barriers, loss of habitat, and water quality, as well as effects to sucker critical habitat (PacifiCorp 2013 pp. 43–58). Additionally, the Plan proposed the shutdown of the East Side and West Side facilities to reduce sucker mortality resulting from entrainment into the canals (PacifiCorp 2013 pp. 64–66). PacifiCorp established a Sucker Conservation Fund to support sucker conservation goals and objectives and committed to continue support of the Nature Conservancy's Williamson River Delta Restoration Project (PacifiCorp 2013 p. 67). These commitments included $100,000 to the fund and annual funding of about $20,000 to the Nature Conservancy over the next 10 years, as well as in-kind costs to implement management actions and monitoring (PacifiCorp 2013 pp. 79–80).

Implementation of the HCP required an Incidental Take Permit from the Service under the ESA. PacifiCorp operations at numerous facilities along the Link and Klamath Rivers were covered. The permit called for authorization of lethal take of both species over the next 10 years, including 10,000 eggs, 66,000 larvae, 500 juveniles, and five adults. Additionally, disruption of 1,400,000 larvae, 6,700 juveniles, and 25 adults was included. However, much of the take was eliminated when PacifiCorp ceased operation of the East Side and West Side facilities. The Service determined that issuance of the Incidental Take Permit for the HCP was not likely to jeopardize the continued existence of the LRS or SNS and was not likely to destroy or adversely modify critical habitat for the species.

Grazing

The Bureau of Land Management and U.S. Forest Service consulted with the Service on the effects of grazing related actions to LRS and SNS. These grazing actions are outside the action area for the current proposed action, but they could have effects to the same individuals or populations because suckers migrate from the current action area into the action areas for these grazing actions during spawning. The most recent consultations on these actions are summarized below.

The Klamath Falls Resource Area of the Lakeview District Bureau of Land Management completed formal consultation with the Service in 2014 on the effects of grazing related actions to shortnose suckers (08EKLA00-2013-F-0023). The action described lethal and non-lethal adverse effects from changes to habitat suitability and displacement of individuals. The allotments and pastures consulted on are hydrologically connected to Gerber Reservoir and Clear Lake.

The Fremont-Winema National Forest completed formal consultation with the Service in 2017 on the effects of grazing related actions to shortnose suckers (08EKLA00-2017-F-0099). The action described lethal and non-lethal adverse effects from trampling and displacement of individuals. The allotments and pastures consulted on are hydrologically connected to Gerber Reservoir and Clear Lake Reservoir.

The Modoc National Forest completed formal consultation with the Service in 1996 on the effects of grazing related actions to Lost River suckers (1-1-96-F-57 and 1-10-96-F-35). The action described adverse effects from changes to various habitat attributes. The action area for this consultation is hydrologically connected to Clear Lake Reservoir.

Highway 140 Widening Project

The Western Federal Land Highway Division of the Federal Highway Administration, in cooperation with the Oregon Department of Transportation, has consulted on but not yet completed, the widening of a 5.6-mile section of Oregon State Route 140 (OR-140) between mile post 57 and mile post 63, located northwest of the city of Klamath Falls. Consultation will be completed in early spring 2019. Approximately 2 miles of the action area is located along the western edge of Howard Bay in Upper Klamath Lake and approximately 4 miles are upland of the lake. In addition, the Federal Highway Administration will construct a 10.4-acre wetland site located approximately 3 miles east (across the lake) from the southern end of the action area.

Widening OR-140 will include expanding existing travel lanes from 11-feet to 12-feet, widening road shoulder to 6-feet, realigning roadway, constructing new embankment along Howard Bay, constructing stormwater treatment features, and clearing and grubbing upland areas. Highway widening along Howard Bay requires adding fill material to the lake to construct new embankments and create minor realignments to the roadway. Fill material will alter approximately 9.7 acres of Lost River and shortnose sucker habitat. However, upon completion of the project the current shoreline will have a net increase of 60 linear feet of shallow water habitat. Effects to LRS and SNS are anticipated from to alteration to habitat structure, function, and diversity as well as exposure to construction-related disturbance, turbidity, and sedimentation. The wetland construction component of the project has the potential to restore natural wetland habitat functions and connectivity over the long-term by slowing down water currents and decreasing wave action. Best management practices and minimization measures will be implemented to reduce impacts to LRS and SNS.

Scientific Research

In 2018, the Service consulted (08EKLA00-2018-F-0065) on the effects to LRS and SNS of issuing scientific permits for the purpose of promoting recovery of the species under section 10(a)(1)(A) of the ESA. The consultation addressed purposeful take of the species using a variety of scientific collection techniques, marking, transport and relocation, and biological sampling. Take authorized as part of scientific research includes purposeful lethal take of 15 adults, 30 juveniles, 1,000 larvae, and 2,000 eggs. Additionally, non-lethal harm of 20 adults, 40 juveniles, 500 larvae, and 1,000 eggs was authorized. The Service considered the effects of the issuance of scientific permits (as currently proposed) on the reproduction, abundance, and distribution of the species, as well as how the aggregation of these effects will affect the overall survival and recovery of the species. The Service determined that the action was not likely to jeopardize the continued existence of the LRS and SNS, nor adversely modify the designated critical habitat of the species.

Klamath Tribes Sucker Rearing

Included in the programmatic consultation on the issuance of recovery permits for actions involving LRS and SNS (08EKLA00-2018-F-0065) is assisted rearing, which allows for the collection of up to 75,000 wild-hatched larvae from the UKL system. The Klamath Tribes established a rearing program in 2018, and the first collections under the program were performed in spring 2018. A total of 20,000 larvae from the UKL system were brought into captivity. This first cohort is currently in captivity with an anticipated release date in spring 2020. The current permit allows for collection of up to 20,000 larvae per year. Although the scale of releases and the specific of effects of this action are unknown at present, it may result in additional recruitment to populations of LRS and SNS in UKL.

Conservation Efforts

Klamath Basin Sucker Rearing Program

The Service started an assisted rearing program for Lost River and SNS in 2015 to supplement populations in UKL through augmentation. The primary target of the effort is SNS, but the lack of an effective way to identify live larvae and juveniles means that both species are collected and reared. In 2013, the Bureau of Reclamation agreed to fund such a program as a way to improve the environmental baseline of the species to minimize impacts to suckers that may result from Klamath Project operations with a 10-year target of releasing a total of 8,000 to 10,000 suckers with lengths of at least 200 mm. The Service funded expansion of the program and aims to collect around 20,000 larval suckers for assisted rearing in spring of 2019.

The program was designed to maximize retention of genetic diversity and maintain natural behaviors post-release as much as possible (Day et al. 2017 pp. 306–307). Larvae are collected as they drift downstream in the Williamson River, so no brood stock are maintained, and the effects of artificial breeding are avoided. Collection efforts are currently spread across the drift season to maximize the genetic variability. Juveniles are stocked into semi-natural ponds and growth depends on a combination of natural and artificial feed.

The first release of reared suckers into UKL occurred in spring 2018, and the proportion of released individuals that will join the spawning population is unknown. Thus, the assisted rearing program is likely to be a source of recruitment for both SNS and LRS in UKL, but the specific impact on population trajectories will be uncertain until information on survival and recruitment probabilities of released individuals is available. Support for the ongoing operation of this program is a component of the current proposed action.

Habitat Restoration Program

Numerous agencies and organizations have restored important components of habitat to reduce threats to these species over the last 20 years. In most instances, considerable time is necessary to determine the efficacy of such recovery actions because of the time needed for the habitat to achieve full functioning and the subsequent time needed for a long-lived species to respond with improved demographics. For example, actions to increase reproduction and recruitment into adult populations require at least 5 years for SNS and 9 years for LRS to achieve minimal functioning.
Hundreds of on-the-ground restoration projects, wetland, riparian, in-stream, upland, and fish passage projects have been implemented in the Upper Klamath Basin that directly or indirectly benefit suckers. Many of the projects included elements of more than one category of restoration project type taking a holistic or ecosystem approach based on the assumption that restoration of natural ecosystem functioning will ultimately benefit multiple species, including listed suckers.

Major sucker recovery-oriented projects completed include screening of irrigation diversions, eliminating barriers to fish passage, and restoration of rearing and spawning habitat (Table 1). For example, restoration of the Williamson River Delta by The Nature Conservancy, with substantial support from PacifiCorp and other organizations, has provided approximately 2,500 hectares (~6, 000 acres) that can serve as rearing habitat for the largest spawning populations of both species despite much of the area being deeper than it was historically due to subsidence. The removal of Chiloquin dam in 2008 opened approximately 120 kilometers (75 miles) of potential spawning and migration corridor. Additionally, screening the A-canal in 2002 reduced entrainment of fish greater than 30 millimeters (1.2 inches) into the irrigation systems of the Klamath Project canal system. Prior to placement of the screen, up to hundreds of thousands of juveniles were estimated to be entrained into the irrigation canals at this point each year (Gutermuth et al. 2000a p. 14). In addition to these major accomplishments, private landowners, the Oregon Department of Fish and Wildlife, Bureau of Reclamation, Natural Resources Conservation Service, the U.S. Fish and Wildlife Service, have realized countless other smaller projects that can benefit LRS and SNS populations.

Table 1. Summary of some recent major restoration projects benefitting Lost River sucker and shortnose sucker populations. Many of these projects were cooperative efforts of state and federal agencies, non-profit organizations, and private landowners.

Project	Year Completed	Potential Benefits
Reducing Entrainment		
A-Canal Screen	2002	Retain more larvae and juveniles in Upper Klamath Lake by limiting entrainment into the canal
Clear Lake Dam Screen	2003	Retain more larvae, juveniles, and adults in Clear Lake Reservoir by limiting entrainment into the canal
Modoc Irr. Dis. Williamson River Div. Screen	2007	Reduce larval mortality due to entrainment

Geary Canal Screen	2009	Retain more larvae and juveniles in Upper Klamath Lake by limiting entrainment into the canal
Eliminating Barriers		
Link River Dam fish ladder	2004	Restore connectivity of sucker populations in Upper Klamath Lake and Lake Ewauna by allowing for adult passage upstream, which may then contribute to spawning populations.
Chiloquin Dam removal	2008	Opening 120 km (75 mi) of historic migration, rearing, and spawning habitats in the Sprague River
Providing Habitat		
Williamson River Delta restoration	2008	Provide ~2,500 hectares (6,000 acres) of potential rearing habitat for larvae and juvenile suckers in Upper Klamath Lake

Literature Cited

Akins, G. J. 1970. The effects of land use and land management on the wetlands of the upper Klamath Basin. Western Washington State College, Bellingham.

Anderson, J. G. T. 1991. Foraging behavior of the American White Pelican (*Pelecanus erythrorhyncos*) in western Nevada. Colonial Waterbirds 14:166–172.

Banish, N. P., B. J. Adams, and R. S. Shively. 2007. Distribution and habitat associations of radio-tagged adult Lost River and shortnose suckers in Upper Klamath Lake, Oregon: 2005-2006 report. U.S. Geological Survey, Western Fisheries Research Center, Klamath Falls Field Station.

Banish, N. P., B. J. Adams, R. S. Shively, M. M. Mazur, D. A. Beauchamp, and T. M. Wood. 2009. Distribution and habitat associations of radio-tagged adult Lost River suckers and shortnose suckers in Upper Klamath Lake, Oregon. Transactions of the American Fisheries Society 138:153–168.

Barnett, T. P., D. W. Pierce, H. G. Hidalgo, C. Bonfils, B. D. Santer, T. Das, G. Bala, A. W. Wood, T. Nozawa, A. A. Mirin, D. R. Cayan, and M. D. L. B.-2. P. L. Dettinger. 2008. Human-induced changes in the hydrology of the western United States. Science 319:1080–1083.

Barr, B. R., M. E. Koopman, C. A. Williams, S. J. Vynne, G. R. Hamilton, and R. E. Doppelt. 2010. Preparing for climate change in the Klamath Basin. National Center for Conservation Science and Policy and Climate Leadership Initiative.

Barry, P. M., B. S. Hayes, E. C. Janney, R. S. Shively, A. C. Scott, and C. D. Luton. 2007. Monitoring of Lost River (*Deltistes luxatus*) and shortnose (*Chasmistes brevirostris*) suckers in Gerber and Clear Lakes, 2005-2006. Page (W. F. R. S. Klamath Falls Field

Station U.S. Geological Survey, U.S. Department of Interior, Ed.). Klamath Falls, Oregon.

Barry, P. M., E. C. Janney, D. A. Hewitt, B. S. Hayes, and A. C. Scott. 2009. Population dynamics of adult Lost River (*Deltistes luxatus*) and shortnose (*Chasmistes brevirostris*) suckers in Clear Lake, California, 2006-2008: Open File Report 2009-1109. U.S. Geological Survey, Reston, Virginia.

Bendire, C. E. 1889. The Lost River sucker. Forest and Stream 32:444–445.

Bienz, C. S., and J. S. Ziller. 1987. Status of three lacustrine sucker species (catostomidae). The Klamath Tribes and Oregon Department of Fish and Wildlife, Klamath Falls, Oregon.

Billman, E. J., J. E. Rasmussen, and J. Watson. 2011. Evaluation of release strategies for captive-reared June sucker based on poststocking survival. Western North American Naturalist 71:481–489.

Bottcher, J. L., and S. M. Burdick. 2010. Temporal and spatial distribution of endangered juvenile Lost River and shortnose suckers in relation to environmental variables in Upper Klamath Lake, Oregon: 2009 annual data summary, Open File Report 2010-1261. U.S. Geological Survey, Reston, Virginia.

Bottorff, J. 1989. Concept plan for waterfowl habitat protection, Klamath Basin, Oregon and California: North American waterfowl management plan category 28. Portland, Oregon.

Boyd, M., S. Kirk, M. Wiltsey, and B. Kasper. 2002. Upper Klamath Lake drainage total maximum daily load (TMDL) and water quality managment plan (WQMP). Portland, Oregon.

Bradbury, J. P., S. M. Colman, and R. Reynolds. 2004. The history of recent limnological changes and human impact on Upper Klamath Lake, Oregon. Journal of Paleolimnology 31:151–165.

Buchanan, D., M. Buettner, T. Dunne, and G. Ruggerone. 2011. Klamath River expert panel report: Scientific assessment of two dam removal alternatives on resident fish.

Buettner, M., and G. Scoppettone. 1990. Life history and status of Catostomids in Upper Klamath Lake, Oregon: Completion report. Reno Field Station, National Fisheries Research Center, U.S. Fish and Wildlife Service, U.S. Department of Interior, Reno, Nevada.

Buettner, M., and G. Scoppettone. 1991. Distribution and information on the taxonomic status of shortnose sucker, *Chasmistes brevirostris*, and Lost River sucker, *Deltistes luxatus*, in the Klamath River Basin, California. Reno, Nevada.

Burdick, S. M., and D. T. Brown. 2010. Distribution and condition of larval and juvenile Lost River and shortnose suckers in the Williamson River Delta Restoration Project and

Upper Klamath Lake, Oregon: 2009 Annual Data Summary: U.S. Geological Survey Open-File Report 2010-1216. Klamath Falls, Oregon.

Burdick, S. M., D. G. Elliott, C. O. Ostberg, C. M. Conway, A. Dolan-Caret, M. S. Hoy, K. P. Feltz, and K. R. Echols. 2015a. Health and condition of endangered juvenile Lost River and shortnose suckers relative to water quality and fish assemblages in Upper Klamath Lake, Oregon, and Clear Lake Reservoir, California. U.S. Geological Survey Open-File Report 2015-1217.

Burdick, S. M., H. A. Hendrixson, and S. P. VanderKooi. 2008. Age-0 Lost River sucker and shortnose sucker nearshore habitat use in Upper Klamath Lake, Oregon: A patch occupancy approach. Transactions of the American Fisheries Society 137:417–430.

Burdick, S. M., D. A. Hewitt, J. E. Rasmussen, B. Hayes, E. Janney, and A. C. Harris. 2015b. Effects of lake surface elevation on shoreline-spawning Lost River Suckers. North American Journal of Fisheries Management 35:478–490.

Burdick, S. M., and B. A. Martin. 2017. Inter-annual variability in apparent relative production, survival, and growth of juvenile Lost River and shortnose suckers in Upper Klamath Lake, Oregon, 2001-2015. U.S. Geological Survey Open-File Report 2017-1069. U.S. Geological Survey, Klamath Falls, Oregon.

Burdick, S. M., C. O. Ostberg, and M. S. Hoy. 2018. Juvenile Lost River and shortnose sucker year class strength, survival, and growth in Upper Klamath Lake, Oregon, and Clear Lake Reservoir, California: 2016 monitoring report. U.S. Geological Survey Open-File report 2018-1066. Reston, Virginia.

Burdick, S. M., and J. E. Rasmussen. 2013. Age and condition of juvenile Catostomids in Clear Lake California, Open-File Report 2013-1188. U.S. Geological Survey, Reston.

Burdick, S. M., and S. P. Vanderkooi. 2010. Temporal and spatial distribution of endangered juvenile Lost River and shortnose suckers in relation to environmental variables in Upper Klamath Lake, Oregon, 2008 annual data summary, U.S. Geological Survey Open-File Report 2010-1051. U.S. Geological Survey, Klamath Falls, Oregon.

Burdick, S. M., S. P. VanderKooi, and G. O. Anderson. 2009. Spring and summer spatial distribution of endangered juvenile Lost River and shortnose suckers in relation to environmental variables in Upper Klamath Lake, Oregon: 2007 annual report. U.S. Geological Survey Open-File Report 2009-1043. U.S. Geological Survey, Klamath Falls, Oregon.

Caldwell Eldridge, S. L., T. M. Wood, and K. R. Echols. 2012. Spatial and temporal dynamics of cyanotoxins and their relation to other water quality variables in Upper Klamath Lake, Oregon, 2007-2009. USGS Sceintific Investigations Report 2012-5069. U.S. Geological

Survey, Reston, VA.

Caldwell Eldridge, S. L., T. M. Wood, K. R. Echols, and B. R. Topping. 2013. Microcystins, nutrient dynamics, and other environmental factors during blooms of non-microcystin producing Aphanizomenon flos-aquae in Upper Klamath Lake, Oregon, 2009. Lake and Reservoir Management 29:68–81.

California Department of Fish and Game. 2004. State and federally listed endangered and threatened animals of California. California Department of fish and game.

Cameron, J. M. 2008. Pesticide monitoring results for Tule Lake, California, 2007. Klamath Falls, Oregon.

Coleman, M. E., J. Kahn, and G. Scoppettone. 1988. Life history and ecological investigations of catostomids from the Upper Klamath Lake Basin, Oregon. Seattle, Washington.

Colman, S. M., J. P. Bradbury, J. P. McGeehin, C. W. Holmes, D. Edginton, and A. M. Sarna-Wojcicki. 2004. Chronology of sediment deposition in Upper Klamath Lake, Oregon. Journal of Paleolimnology 31:139–149.

Connor, M. L. 2017. Priority Water Right for the Klamath Refuge [Memorandum]. Washington, D.C.

Cooperman, M. S., and D. F. Markle. 2003. Rapid out-migration of Lost River and shortnose sucker larvae from in-river spawning beds to in-lake rearing grounds. Transactions of the American Fisheries Society 132:1138–1153.

Cooperman, M. S., and D. F. Markle. 2004. Abundance, size, and feeding success of larval shortnose suckers and Lost River suckers from different habitats of the littoral zone of Upper Klamath Lake. Environmental Biology of Fishes 71:365–377.

Cooperman, M. S., D. F. Markle, M. Terwilliger, and D. C. Simon. 2010. A production estimate approach to analyze habitat and weather effects on recruitment of two endangered freshwater fish. Canadian Journal of Fisheries and Aquatic Sciences 67:28–41.

Cope, E. D. 1879. Fishes of Klamath Lake, Oregon. American Naturalist 13:784–785.

Cornacchia, P. 1967. Mullet homely, but popular. Eugene, OR.

Courter, I., J. Vaughn, and S. Duery. 2010. 2010 Tule Lake sucker relocation report: Project summary. Cramer Fish Sciences.

Crandall, J. 2004. Williamson River Delta restoration Project Catostomid technical report. The Nature Conservancy, Portland, Oregon and Klamath Falls, Oregon.

Day, J. L., J. L. Jacobs, and J. Rasmussen. 2017. Considerations for the propagation and conservation of endangered lake suckers of the western United States. Journal of Fish and Wildlife Management 8:301–312.

Deas, M., and J. Vaughn. 2006. Characterization of organic matter fate and transport in the Klamath River below Link Dam to assess treatment/reduction potential: Completion report.

Desjardins, M., and D. F. Markle. 2000. Distribution and biology of suckers in lower Klamath Reservoirs. Department of Fisheries and Wildlife, Oregon State University, Portland, Oregon.

Dowling, T. 2005. Conservation genetics of endangered Lost River and shortnose suckers.

Dowling, T. E., D. F. Markle, G. J. Tranah, E. W. Carson, D. W. Wagman, and B. P. May. 2016. Introgressive Hybridization and the Evolution of Lake-Adapted Catostomid Fishes. PLoS ONE 11.

Doyle, M. C., and D. D. Lynch. 2005. Sediment Oxygen Demand in Lake Ewauna and the Klamath River.

Dunsmoor, L., L. Basdekas, B. Wood, and B. Peck. 2000. Quality, composition, and distribution of emergent vegetation along the Lower River and Upper Klamath Lake shorelines of the Williamson River Delta, Oregon. Completion Report. Klamath Tribes and Bureau of Reclamation.

Eagles-Smith, C. A., and B. L. Johnson. 2011. Contaminants in the Klamath Basin: historical patterns, current distribution, and data gap identification. Draft Administrative Report, U.S. Geological Survey, Forest and Rangeland Ecosystem Science Center, Corvallis, OR.

Eigenmann, R. S. 1891. Description of a new species of *Catostomus* (*C. rex*) from Oregon. American Naturalist 25:667–668.

Eilers, J. M., and B. J. Eilers. 2005. Fish habitat analysis of Upper Klamath Lake and Agency Lake, Oregon. Klamath Falls, Oregon.

Eilers, J. M., J. Kann, J. Cornett, K. Moser, and A. St. Amand. 2004. Paleolimnological evidence of change in a shallow, hypereutrophic lake: Upper Klamath Lake, Oregon. Hydrobiologia 520:7–18.

Ellsworth, C. M., and B. A. Martin. 2012. Patterns of larval sucker emigration from the Sprague and lower Williamson Rivers of the Upper Klamath Basin, Oregon after the removal of Chiloquin Dam--2009-10 annual report. U.S. Geological Survey Open-File Report 2012-1037.

Ellsworth, C. M., T. J. Tyler, and S. P. Vanderkooi. 2010. Using spatial, seasonal, and diel drift patterns of larval Lost River suckers *Deltistes luxatus* (Cypriniformes:Catostomidae) and shortnose suckers *Chasmistes brevirostris* (Cypriniformes:Catostomidae) to help identify a site for a water withdrawl structure. Environmental Biology of Fishes 89:47–57.

Erdman, C. S., H. A. Hendrixson, and N. T. Rudd. 2011. Larval sucker distribution and condition before and after large-scale restoration at the Williamson River delta, Upper Klamath Lake, Oregon. Western North American Naturalist 71:472–480.

Evans, A. F., D. A. Hewitt, Q. Payton, B. M. Cramer, K. Collis, and D. D. Roby. 2016a. Colonial waterbird predation on Lost River and Shortnose suckers in the Upper Klamath Basin. North American Journal of Fisheries Management 36:1254–1268.

Evans, D. M., J. P. Che-Castaldo, D. Crouse, F. W. Davis, R. Epanchin-Niell, C. H. Flather, R. K. Frohlich, D. D. Goble, Y.-W. Li, and T. D. Male. 2016b. Species recovery in the United States: Increasing the effectiveness of the Endangered Species Act. Issues in Ecology 20:1–28.

Evermann, B. W., and S. E. Meek. 1897. A report upon salmon investigations in the Columbia River Basin and elsewhere on the Pacific Coast in 1896. Bulletin of the United States Fish Commission 17:15–84.

Findholt, S. L., and S. H. Anderson. 1995a. Diet and prey use patterns of the American white pelican (*Pelecanus erythrorhynchos*) nesting at Pathfinder Reservoir , Wyoming. Colonial Waterbirds 18:58–68.

Findholt, S. L., and S. H. Anderson. 1995b. Foraging Areas and Feeding Habitat Selection of American White Pelicans (*Pelecanus erythrorhynchos*) Nesting at Pathfinder Reservoir, Wyoming. Colonial Waterbirds 18:47–57.

Flint, L., and A. Flint. 2012. Estimation of stream temperature in support of fish production modeling under future climates in the Klamath River Basin: U.S. Geological Survey Scientific Investigations Report 2011-5171.

Foott, J. S. 2004. Health monitoring of adult Lost River sucker (*Deltistes luxatus*) and shortnose sucker (*Chasmistes brevirostris*) in Upper Klamath Lake, Oregon, April – September 2003. U.S. Fish & Wildlife Service, Anderson, California.

Foott, J. S., and R. Stone. 2005. Bio-energetic and histological evaluation of juvenile (0+) sucker fry from Upper Klamath Lake collected in August and September 2004. Anderson, California.

Foott, J. S., R. Stone, and R. Fogerty. 2010. FY2009 Technical Report: Health and energy evaluation of juvenile fish from Link R. trap and haul project and J-canal salvage. United

States Fish and Wildlife Service California-Nevada Fish Health Center, Anderson, California.

Foster, K., and D. Bennetts. 2006. Entrainment monitoring report for the Lost River Diversion Channel in 2005. Klamath Falls, Oregon.

Freitas, S. E., D. M. Mauser, and J. Beckstrand. 2007. Ecology of shortnose and Lost River suckers in Tule Lake National Wildlife Refuge, California. Progress report April through September 2007. Tulelake, California.

Garen, D., R. Tama, M. Gannett, J. Risley, and T. Mayer. 2011. Upper Klamath Basin water supply forecasting : Status, issues, and outlook. USDA-NRCS, Portland, Oregon.

Gearhart, R. A., J. K. Anderson, M. G. Forbes, M. Osburn, and D. Oros. 1995. Watershed strategies for improving water quality in Upper Klamath Lake, Oregon. Volume I: Use of wetlands for improving water quality in Upper Klamath Lake, Oregon. Humboldt State University, Arcata, California.

Gearhart, R., E. Henry, J. Rueter, and Y. Pan. 2005. Preliminary research on *Aphanizomenon flos-aquae* in Upper Klamath Lake, Oregon. Portland, Oregon.

Gilbert, C. H. 1897. The fishes of the Klamath Basin. Bulletin of the United States Fish Commission 17:1–13.

Gilroy, D. J., K. W. Kauffman, R. A. Hall, X. Huang, and F. S. Chu. 2000. Assessing potential health risks from microcystin toxins in blue-green algae dietary supplements. Environmental Health Perspectives 108:435–439.

Grabowski, T. B., and C. A. Jennings. 2009. Post-release movements and habitat use of robust redhorse transplanted to the Ocmulgee River, Georgia. Aquatic Conservation: Marine and Freshwater Ecosystems 19:170–177.

Gutermuth, B., E. Pinkston, and D. Vogel. 2000a. A-canal fish entrainment during 1997 and 1998 with emphasis on endangered suckers. Klamath Falls, Oregon.

Gutermuth, B., C. Watson, and J. Kelly. 2000b. Link River hydroelectric project (east and westside powerhouses) final entrainment study report. Cell Tech and PacificCorp Environmental Services.

Haas, J. 2007. A toxicological unit analysis of risk to listed suckers in the Tule Lake sumps of pesticide use on the federal lease lands on Tule Lake National Wildlife Refuge. Division of Ecological Contaminants. U.S. Fish and Wildlife Service, Sacramento, CA.

Hamilton, A., R. Piaskowski, and S. Snedaker. 2003. 2003 progress report: Evaluation of fish entrainment and fish habitat use along Miller Creek, Lost River Basin, Oregon. Bureau of Land Management, Klamath Falls Area Office.

Hendrix, N. 2010. Testimony and exhibits submitted in the matter of the determination of the relative rights of the waters of the Klamath River, a tributary of the Pacific Ocean.

Hendrixson, H. A., S. M. Burdick, B. L. Herring, and S. P. Vanderkooi. 2007. Nearshore and offshore habitat use by endangered, juvenile Lost River and shortnose suckers in Upper Klamath Lake, Oregon. Klamath Falls, Oregon.

Hereford, D. M., S. M. Burdick, D. G. Elliott, A. Dolan-Caret, C. M. Conway, and A. C. Harris. 2016. Survival, movement, and health of hatchery-raised juvenile Lost River suckers within a mesocosm in Upper Klamath Lake, Oregon. U.S. Geological Survey Open-File Report 2016-1012.

Hereford, D. M., and J. Roberts. 2019. Assessment of wetland habitat for larval and young of the year suckers at various lake elevations in Upper Klamath Lake, Oregon. Klamath Falls, Oregon

Hewitt, D. A., and B. S. Hayes. 2013. Monitoring of adult Lost River and shornose suckers in Clear Lake Reservoir, California, 2008-2010. U.S. Geological Survey Open-File Report 2013-1301. U.S. Geological Survey, Reston, VA.

Hewitt, D. A., E. C. Janney, B. S. Hayes, and A. C. Harris. 2014. Demographics and run timing of adult Lost River (*Deltistes luxatus*) and shortnose (*Chasmistes brevirostris*) suckers in Upper Klamath Lake, Oregon, 2012. Klamath Falls Field Station, Western Fisheries Research Station, U.S. Geological Survey, U.S. Department of Interior, Reston, Virginia.

Hewitt, D. A., E. C. Janney, B. S. Hayes, and A. C. Harris. 2017. Status and trends of adult Lost River (*Delistes luxatus*) and shortnose (*Chasmistes brevirostris*) sucker populations in Upper Klamath Lake, Oregon, 2015: USGS Open-File Report 2017-1059. U.S. Geological Survey, Reston, Virginia.

Hewitt, D. A., E. C. Janney, B. S. Hayes, and A. C. Harris. 2018. Status and trends of adult Lost River (*Delistes luxatus*) and shortnose (*Chasmistes brevirostris*) sucker populations in Upper Klamath Lake, Oregon, 2017: USGS Open-File Report 2018-1064. U.S. Geological Survey, Reston, Virginia.

Hillemeier, D., Y. Tribe, M. Belchik, S. Water, P. Analyst, Y. Tribe, T. Soto, S. F. Biologist, K. Tribe, S. C. Tucker, N. Resources, P. Advocate, K. Tribe, S. Ledwin, S. F. Biologist, H. V. Tribe, and N. Marine. 2017. Measures to Reduce Infection of Klamath River Salmonids : A Guidance Document.

Hodge, J., and M. Buettner. 2009. Sucker population monitoring in Tule Lake and lower Lost River, 2006 -2008. Completion Report. Klamath Falls, Oregon.

Hoenig, J. M. 1983. Empirical use of longevity data to estimate mortality rates. Fishery Bulletin 82:898–903.

Horn, M. J., and D. Lieberman. 2005. A risk assessment for low dissolved oxygen in Klamath Lake, Oregon.

Houde, E. D. 1989. Comparative growth, mortality, and energetics of marine fish larvae: temperature and implied latitudinal effects. Fishery Bulletin 87:471–495.

Houde, E. D., and J. Bartsch. 2009. Mortality. Pages 27–42 *in* E. W. North, A. Gallego, and P. Petitgas, editors. Manual of recommnded practices for modelling physical-biological interactions during fish early life. ICES Cooperative Research Report No. 295, Copenhagen.

Janik, A. J. 2017. Aspects of the parasite fauna and related diseases in juveniles fishes in Upper Klamath Lake, OR. Oregon State University.

Janik, A. J., D. F. Markle, J. R. Heidel, and M. L. Kent. 2018. Histopathology and external examination of heavily parasitized Lost River sucker *Deltistes luxatus* (Cope 1879) and shortnose sucker *Chasmistes brevirostris* (Cope 1879) from Upper Klamath Lake, Oregon. Journal of Fish Diseases 2018:1–13.

Janney, E. C., B. S. Hayes, D. A. Hewitt, P. M. Barry, A. Scott, J. Koller, M. Johnson, and G. Blackwood. 2009. Demographics and 2008 run timing of adult Lost River (*Deltistes luxatus*) and shortnose (*Chasmistes brevirostris*) suckers in Upper Klamath Lake, Oregon, 2008. U.S. Geological Survey, Reston, Virginia.

Jassby, A., and J. Kann. 2010. Upper Klamath Lake monitoring program: preliminary analysis of status and trends for 1990-2009. Technical Memorandum prepared by Aquatic Ecosystem Sciences LLC for Klamath Tribes Natural Resources Department, Chiloquin, Oregon.

Kann, J. 1997. Ecology and water quality dynamics of a shallow hypereutrophic lake dominated by cyanobacteria. University of North Carolina, Chapel Hill.

Kann, J. 2010. Testimony and exhibits submitted in the matter of the determination of the relative rights of the waters of the Klamath River, a tributary of the Pacific Ocean.

Kann, J. 2017. Upper Klamath Lake 2016 data summary report. Ashland, Oregon.

Kann J., W. W. 1999. Nutrient and hydrologic loading to Upper Klamath Lake, Oregon, 1991-1998. Aquatic Ecosystem Science LLC, Ashland, Oregon.

Kann, J., and E. B. Welch. 2005. Wind control on water quality in shallow, hypereutrophic Upper Klamath Lake, Oregon. Lake and Reservoir Management 21:149–158.

Kent, M. L. 1990. Netpen liver disease (NLD) of salmonid fishes reared in sea water: Species susceptibility, recovery, and probable cause. Diseases of Aquatic Organisms 8:21–28.

Kirk, S., D. Turner, and J. Crown. 2010. Upper Klamath and Lost River subbasins total maximum daily loads (TMDL) and water quality management plan. Portland, Oregon.

Kirse, S. C. 2010. Parasite ecology of fish with black spot disease.

Koch, D. L., J. J. Cooper, G. P. Contreras, and V. King. 1975. Survey of the fishes of the Clear Lake Reservoir Drainage. Reno, Nevada.

Korson, C., T. J. Tyler, and C. A. Williams. 2008. Link River Dam fish ladder fish passage results, 2005-2007. Klamath Falls, Oregon.

Korson, C., A. Wilkens, and D. Taylor. 2010. Klamath Project: A canal endangered sucker monitoring, 2010. Klamath Falls, Oregon.

Kuwabara, J. S., D. D. Lynch, B. R. Topping, F. Murphy, J. L. Carter, N. S. Simon, F. Parchaso,T. M. Wood, M. K. Lindenberg, K. Wiese, and R. J. Avanzino. 2007. Quantifying the benthic source of nutrients to the water column of Upper Klamath Lake, Oregon: Open File Report 2007-1276. U.S. Geological Survey, Reston.

Kyger, C., and A. Wilkens. 2011a. Endangered Lost River and shortnose sucker distribution and relative abundance in Lake Ewauna, and use of the Link River dam fish ladder, Oregon: Annual Report 2010. Klamath County, Oregon.

Kyger, C., and A. Wilkens. 2011b. Klamath Project: Endangered sucker salvage activities, 2008 -2010. United States Bureau of Reclamation, Klamath Falls, Oregon.

Laeder, J., and A. Wilkens. 2010. Klamath Project: A canal endangered sucker monitoring, 2006-2009. Klamath Falls, Oregon.

Lease, H. M., J. A. Hansen, H. L. Bergman, and J. S. Meyer. 2003. Structural changes in gills of Lost River suckers exposed to elevated pH and ammonia concentrations. Comparative Biochemistry and Physiology 134:491–500.

Leeseberg, C. A., P. A. Barry, G. Whisler, and E. C. Janney. 2007. Monitoring of Lost River (*Deltistes luxatus*) and shortnose (*Chasmistes brevirostris*) suckers in Gerber and Clear Lake Reservoirs: Annual Report 2004. Klamath Falls, Oregon.

Loftus, M. E. 2001. Assessment of potential water quality stress to fish: supplement to Effects of water quality and lake levle on the biology and habitat of selected fish species in Upper Klamath Lake. Portland, Oregon.

Logan, D. J., and D. F. Markle. 1993. Fish faunal survey of Agency Lake and northern Upper Klamath Lake, Oregon. Klamath Falls, Oregon.

Malbrouck, C., and P. Kestemont. 2006. Effects of microcystins on fish. Environmental Toxicology and Chemistry 25:72–86.

Malevich, S. B., C. A. Woodhouse, and D. M. Meko. 2013. Tree-ring reconstructed hydroclimate of the Upper Klamath basin. Journal of hydrology 495:13–22.

Marcogliese, D. J. 2004. Parasites: Small Players with Crucial Roles in the Ecological Theater. EcoHealth 1:151–164.

Marine, K. R., and M. Gorman. 2005. Monitoring and evaluation of the A-canal fish screen and bypass facility. Klamath Falls, Oregon.

Markle, D. F., M. R. Cavalluzzi, and D. C. Simon. 2005. Morphology and taxonomy of Klamath Basin suckers (Catostomidae). Western North American Naturalist 65:473–489.

Markle, D. F., and K. Clauson. 2006. Ontogenetic and habitat-related changes in diet of late larval and juvenile suckers (Catostomidae) in Upper Klamath Lake, Oregon. Western North American Naturalist 66:492–501.

Markle, D. F., and M. S. Cooperman. 2001. Relationships between Lost River and Shortnose Sucker Biology and Management of Upper Klamath Lake BT -Water Allocation in the Klamath Reclamation Project, 2001: An Assessment of Natural Resource, Economic, Social, and Institutional Issues with a Focus . Water Allocation in the Klamath Reclamation Project, 2001: An Assessment of Natural Resource, Economic, Social, and Institutional Issues with a Focus on the Upper Klamath Basin:93–117.

Markle, D. F., and L. K. Dunsmoor. 2007. Effects of Habitat Volume and Fathead Minnow Introduction on Larval Survival of Two Endangered Sucker Species in Upper Klamath Lake, Oregon. Transactions of the American Fisheries Society 136:567–579.

Marsh, P. C., B. R. Kesner, and C. A. Pacey. 2005. Repatriation as a Management Strategy to Conserve a Critically Imperiled Fish Species. North American Journal of Fisheries Management 25:547–556.

Martin, B. A., D. A. Hewitt, and C. M. Ellsworth. 2013. Effects of Chiloquin Dam on spawning distribution and larval emigration of Lost River, shortnose, and Klamath largescale suckers in the Williamson and Sprague Rivers, Oregon. Klamath Falls Field Station, Western Fisheries Research Station, U.S. Geological Survey, U.S. Department of Interior.

Martin, B. A., and M. K. Saiki. 1999. Effects of ambient water quality on the endangered Lost River sucker in Upper Klamath Lake, Oregon. Transactions of the American Fisheries Society 128:953–961.

McMahon, B. F., and R. M. Evans. 1992a. Foraging strategies of American white pelicans. Behaviour 120:69–89.

McMahon, B. F., and R. M. Evans. 1992b. Nocturnal Foraging in the American White Pelican. American Ornithological Society 94:101–109.

Mefford, B., and J. Higgs. 2006. Link River Falls fish passage investigation -flow velocity simulation.

Meyer, J. S., and J. A. Hansen. 2002. Subchronic toxicity of low dissolved oxygen concentrations, elevated pH, and elevated ammonia concentrations to Lost River suckers. Transactions of the American Fisheries Society 131:656–666.

Middleton, B. 1999. Wetland restoration, flood pulsing, and disturbance dynamics. John Wiley & Sons, Inc., New York.

Miller, R. R., and G. R. Smith. 1981. Distribution and evolution of *Chasmistes* (Pisces: Catostomidae) in western North America. Occasional Papers of the Museum of Zoology, University of Michigan 696:1–48.

Modde, T., Z. H. Bowen, and D. C. Kitcheyan. 2005. Spatial and Temporal Use of a Spawning Site in the Middle Green River by Wild and Hatchery-Reared Razorback Suckers. Transactions of the American Fisheries Society 134:937–944.

Morace, J. L. 2007. Relation between selected water-quality variables, climatic factors, and lake levels in Upper Klamath and Agency Lakes, Oregon, 1990-2006: Scientific Investigations Report 2007-5117. U.S. Geological Survey, Reston.

Muir, W. D., S. G. Smith, J. G. Williams, and B. P. Sandford. 2001. Survival of juvenile salmonids passing through bypass systems, turbines, and spillways with and without flow deflectors at Snake River dams. North American Journal of Fisheries Management 21:135– 146.

National Research Council. 2004. Endangered and threatened fishes in the Klamath River Basin: Causes of decline and strategies for recovery. The National Academies Press, Washington, D.C.

PacifiCorp. 2000. Klamath Hydroelectric Project, First Stage Consultation Document, FERC [Federal Energy Regulatory Commission] Project No. 2082. Portland, Oregon.

PacifiCorp. 2013. PacifiCorp Klamath hydroelectric project interim operation habitat conservation plan for Lost River and Shortnose Suckers. Prepared by PacifiCorp Energy Inc., Portland, OR. Submitted to the U.S. Fish and Wildlife Service, Klamath Falls Fish and Wildlife Office, Klamath Falls, Oregon.

Parker, K. 2008. Final removal action and OSC report for Chiloquin Forest Products site. Seattle, Washington.

Peck, B. 2000. Radio telemetry studies of adult shortnose and Lost River suckers in Upper Klamath Lake and tributaries. Klamath Falls, Oregon.

Peel, M. C., B. L. Finlayson, and T. A. McMahon. 2007. Updated world map of the Köppen-Geiger climate classification. Hydrology and earth system sciences discussions 4:439–473.

Perkins, D. L., J. Kann, and G. G. Scoppettone. 2000a. The role of poor water quality and fish kills in the decline of endangered Lost River and shortnose suckers in Upper Klamath Lake. Page (U. S. G. Survey, Ed.). U.S. Geological Survey, Reno, Nevada.

Perkins, D. L., G. G. Scoppettone, and M. Buettner. 2000b. Reproductive biology and demographics of endangered Lost River and shortnose suckers in Upper Klamath Lake, Oregon. U.S. Geological Survey, Reno, Nevada.

Perry, T., A. Lieb, A. Harrison, M. Spears, T. Mull, E. Cohen, J. Rasmussen, J. Hicks, D. Holz, and J. Lyons. 2005. Natural Flow of the Upper Klamath River:93.

Phillips, B., J. Ross, and A. Wilkens. 2011. Klamath Project: Endangered sucker distribution and relative abundance in reconnected wetlands and open water areas adjacent to the Klamath River, Oregon; 2010 report. Klamath Falls, Oregon.

Piaskowski, R. 2003. Movements and habitat use of adult Lost River and shortnose suckers in Link River and Keno Impoundment, Klamath River Basin, Oregon. Klamath Falls, Oregon.

Piaskowski, R., and M. Buettner. 2003. Review of water quality and fisheries sampling conducted in Gerber Reservoir, OR with emphasis on the shortnose sucker and its habitat needs.

Rasmussen, J. E., M. C. Belk, and S. L. Peck. 2009. Endangered species augmentation: a case study of alternative rearing methods. Endangered Species Research 8:225–232.

Rasmussen, J. E., and E. S. Childress. 2018. Population Viability of Endangered Lost River Sucker and Shortnose Sucker and the Effects of Assisted Rearing. Journal of Fish and Wildlife Management 9:582–592.

Reiser, D. W. 2010. Testimony and exhibits submitted in the matter of the determination of the relative rights of the waters of the Klamath River, a tributary of the Pacific Ocean.

Reiser, D. W., M. Loftus, D. Chapman, E. Jeanes, and K. Oliver. 2001. Effects of water quality and lake level on the biology and habitat of selected fish species in Upper Klamath Lake. Klamath Falls, Oregon.

Rhymer, J. M., and D. Simberloff. 1996. Extinction by hybridization and introgression. Annual Review of Ecology and Systematics 27:83–109.

Risley, J. C., M. W. Gannett, J. K. Lea, and E. A. Roehl Jr. 2005. An analysis of statistical methods for seasonal flow forecasting in the upper Klamath Basin of Oregon and California: Scientific Investigations Report 2005-5177. U.S. Geological Survey, Reston.

Risley, J., L. E. Hay, and S. . Markstrom. 2012. Watershed scale response to climate change--Sprague River Basin, Oregon: U.S. Geological Survey Fact Sheet 2011-3120. U.S. Geological Survey.

Robinson, A. T., P. P. Hines, J. A. Sorensen, and S. D. Bryan. 1998. Parasites and fish health in a desert stream, and management implications for two endangered fishes. North American Journal of Fisheries Management 18:599–608.

Roy-Lachapelle, A., M. Solliec, M. F. Bouchard, and S. Sauvé. 2017. Detection of cyanotoxins in algae dietary supplements. Toxins 9:76.

Saiki, M. K., D. P. Monda, and B. L. Bellerud. 1999. Lethal levels of selected water quality variables to larval and juvenile Lost River and shortnose suckers. Environmental Pollution 105:37–44.

Scoppettone, G. G., P. H. Rissler, M. C. Fabes, and D. Withers. 2014. American White Pelican Predation on Cui-ui in Pyramid Lake, Nevada. North American Journal of Fisheries Management:57–67.

Scoppettone, G. G., and G. L. Vinyard. 1991. Life history and management of four endangered lacustrine Suckers. Pages 359–377 *in* W. L. Minckley and J. E. Deacon, editors. Battle Against Extinction. The University of Arizona Press, Tuscon.

Scoppettone, G., S. Shea, and M. Buettner. 1995. Information on population dynamics and life history of shortnose suckers (*Chasmistes brevirostris*) and Lost River suckers (*Deltistes luxatus*) in Tule and Clear Lakes. Reno, Nevada.

Shelly, A., J. Zablotney, D. Reiser, B. Eakins, and N. Hendrix. 2019. Upper Klamath Lake bathymetry model development. Redmond, WA.

Shively, R. S., E. B. Neuman, A. E. Kohler, and B. J. Peck. 2000. Species composition and distribution of fishes in the Lost River, Oregon. Klamath Falls, Oregon.

Simon, D. C., and D. F. Markle. 1997. Interannual abundance of nonnative fathead minnows (*Pimephales promelas*) in Upper Klamath Lake, Oregon. Western North American Naturalist 57:142–148.

Simon, D. C., D. F. Markle, and G. R. Hoff. 1995. Larval and juvenile ecology of Upper Klamath Lake suckers. Corvallis, Oregon.

Simon, D. C., M. R. Terwilliger, and D. F. Markle. 2014. Larval and juvenile ecology of Upper Klamath Lake suckers: 2009-2013. Final Report. Corvallis, Oregon.

Smith, M., and J. VonBargen. 2015. Genetic information needs assessment for Lost River suckers (*Deltistes luxatus*) and shortnose sucker (*Chasmistes brevirostris*) of the Klamath River basin. Longview, WA.

Smith, R., and W. Tinniswood. 2007. Monthly Report: May 2007. Klamath Falls, Oregon.

Snyder, D. E. 2003. Electrofishing and its harmful effects on fish, USGS Information and Technology Report USGS/BRD/ITR-2003-0002. Denver, CO.

Snyder, D. T., and J. L. Morace. 1997. Nitrogen and phosphorus loading from drained wetlands adjacent to Upper Klamath and Agency Lakes, Oregon: Water Resources Investigations Report 97-4059. U.S. Geological Survey, Portland, Oregon.

Sorenson, S. K., and S. E. Schwarzbach. 1991. Reconnaissance investigation of water quality, bottom sediment, and biota associated with irrigation drainage in the Klamath Basin, California nd Oregon, 1988-89. U.S. Geological Survey Water Resources Investigations Report 90-4203.

Stannard, D. I., M. W. Gannett, D. J. Polette, J. M. Cameron, M. S. Waibel, and and J. M. Spears. 2013. Evapotranspiration from wetland and open-water sites at Upper Klamath Lake , Oregon , 2008 – 2010 Scientific Investigations Report 2013 – 5014.

Stauffer-Olsen, N. J., J. L. Carter, and S. V Fend. 2017. Spatial and Temporal Variability in Benthic Invertebrate Assemblages in Upper Klamath Lake, Oregon. Northwest Science 91:257–271.

Strayer, D. L., and D. Dudgeon. 2010. Freshwater biodiversity conservation: recent progress and future challenges. Journal of the North American Benthological Society 29:344–358.

Strayer, D. L., and S. E. G. Findlay. 2010. Ecology of freshwater shore zones. Aquatic Sciences 72:127–163.

Sullivan, A., M. Deas, J. Asbill, J. Kirshtein, K. Butler, J. V. 2009. Klamath River Water Quality Data from Link River Dam to Keno Dam , Oregon , 2008. Quality.

Sullivan, A. B., M. L. Asbill, J. D. Kirshtein, K. Butler, R. W. Wellman, M. A. Stewart, and J.

Vaughn. 2008. Klamath River water quality and acoustic doppler current profiler data from Link River Dam to Keno Dam, 2007: Open File Report 2008-1185. Reston, Virginia.

Sullivan, A. B., and S. A. Rounds. 2011. Modeling hydrodynamics, water temperature, and water quality in the Klamath River upstream of Keno Dam, Oregon, 2006-09: Scientific Investigations Report 2011-5105. U.S. Geological Survey, Reston, Virginia.

Sullivan, A. B., S. A. Rounds, M. L. Deas, J. R. Asbill, R. E. Wellman, M. A. Stewart, M. W. Johnston, and I. E. Sogutlugil. 2011. Modeling hydrodynamics, water temperature, and water quality in the Klamath River upstream of Keno Dam, Oregon, 2006-09. Page U.S. Geological Survey Scientific Investigations Report.

Sutphin, Z., and T. J. Tyler. 2016. Entrainment of early life-stages of fish from Clear Lake Reservoir into Lost River. U.S. Bureau of Reclamation, Denver, CO.

Sutton, R., and C. Morris. 2005. Instream flow assessment of sucker spawning habitat in Lost River upstream from Malone Reservoir. Klamath Falls, Oregon.

Taylor, D., and A. Wilkens. 2013. Klamath Project endangered sucker salvage activities, 2008-2012. Klamath Falls, Oregon.

Terwilliger, M. 2006. Physical habitat requirements for Lost River and shortnose suckers in the Klamath Basin of oregon and California: Literature review. Klamath Falls, Oregon.

Terwilliger, M., T. Reece, and D. F. Markle. 2010. Historic and recent age structure and growth of endangered Lost River and shortnose suckers in Upper Klamath Lake, Oregon. Environmental Biology of Fishes 89:239–252.

Terwilliger, M., D. C. Simon, and D. F. Markle. 2004. Larval and juvenile ecology of Upper Klamath Lake: 1998-2003. Klamath Falls, Oregon.

Tranah, G. J., and B. May. 2006. Patterns of intra-and interspecies genetic diversity in Klamath River Basin suckers. Transactions of the American Fisheries Society 135:306–316.

Tribes, K. 1996. A synopsis of the early life history and ecology of Catostomids, with a focus on the Williamson River Delta. Chiloquin, Oregon. Environmental Protection Agency. 1975. DDT: A review of scientific and economic aspects of the decision to ban its use as a pesticide. United States Environmental Protection Agency Washington, DC.Environmental Protection Agency. 2013. Aquatic life ambient water quality criteria for ammonia - freshwater. Washington, DC.

USBR. 1994. Biological assessment on long-term operations of the Klamath Project, with special emphasis on Clear Lake operations. USBR. 2000a. Klamath irrigation project sucker salvage and Langell Valley fish survey report. 1999. Klamath Falls, Oregon.

USBR. 2000b. Klamath Project historic operation. Klamath Falls, Oregon.

USBR. 2001a. Biological assessment of the Klamath Project's continuing operations on the endangered Lost River sucker and shortnose sucker. Klamath Falls, Oregon.

USBR. 2001b. Inventory of water diversions in the Klamath Project Service Area that potentially entrain endangered Lost River and shortnose suckers. Klamath Falls, Oregon.

USBR. 2007. Biological assessment: the effects of the proposed action to operate the Klamath Project from April 1, 2008 to March 31, 2018 on federally listed threatened and endangered species. Klamath Falls, Oregon.

USBR. 2009. Lost River water quality and fisheries habitat assessment. Klamath Falls, Oregon.

USBR. 2012. The effects of the proposed action to operate the Klamath Project from April 1, 2013 through March 31, 2023 on federally listed threatened and endangered species. Klamath Falls, Oregon.

USBR. 2016. Chapter 5: Klamath River Basin. Page Secure Water Act Section 9503(c) Reclamation Climate Change and Water 2016.

USBR. 2017. The 2016 annual monitoring report for the May 31, 2013, joint biological opinions on Klamath Project operations effects to federally listed Lost River and shortnose suckers and coho salmon. Klamath Falls, Oregon.

USBR. 2018a. Final biological assessment. The effects of the proposed action to operate the Klamath Project from April 1, 2019 through March 31, 2029 on federally listed threatened and endangered species. Mid-Pacific Region.

USBR. 2018b. The 2017 annual monitoring report for the May 31, 2013, joint biological opinions on Klamath Project operations effects to federally listed Lost River and shortnose suckers and coho salmon. Klamath Falls, Oregon.

USFWS. 1988. Endangered and threatened wildlife and plants: determination of endangered status for the shortnose sucker and Lost River sucker, Final Rule. Federal Register 53:27130–27134.

USFWS. 1993. Lost River and shortnose recovery plan. Page (U. S. D. of Interior, Ed.). U.S. Fish and Wildlife Service, U.S. Department of Interior, Portland, Oregon.

USFWS. 2002. Biological/conference opinion regarding the effects of the U.S. Bureau of Reclamation's proposed 10-year operation plan for the Klamath Project and its effect on the endangered Lost River sucker (*Deltistes luxatus*), endangered shortnose sucker (*Chasmistes brevirostris*. Klamath Falls, Oregon.

USFWS. 2007a. Shortnose sucker (*Chasmistes brevirostris*) 5-year review: Summary and evaluation. Klamath Falls, Oregon.

USFWS. 2007b. Lost River sucker (*Deltistes luxatus*) 5-year review: Summary and evaluation. Klamath Falls, Oregon.

USFWS. 2007c. Formal consultation on the proposed relicensing of the Klamath Hydroelectric Project, FERC Project No. 2082, Klamath River, Klamath County, Oregon, and Siskiyou County, California. Yreka, California.

USFWS. 2008. Biological/conference opinion regarding the effects of the U.S. Bureau of Reclamation's proposed 10-year operation plan (April 1, 2008 -March 31, 2018) for the Klamath Project and its effects on the endangered Lost River and shortnose suckers. Klamath Falls, Oregon.

USFWS. 2012. Endangered and threatened wildlife and plants: designation of critical habitat for Lost River sucker and shortnose sucker. Federal Register 77:73740–73768.

USFWS. 2013a. Revised recovery plan for the Lost River sucker (*Deltistes luxatus*) and shortnose sucker (*Chasmistes brevirostris*). U.S. Fish and Wildlife Service, Pacific Southwest Region, Sacramento, California.

USFWS. 2013b. Shortnose sucker (*Chasmistes brevirostris*) 5-year review: Summary and evaluation. Klamath Falls, Oregon.

USFWS. 2013c. Lost River sucker (*Deltistes luxatus*) 5-year review: Summary and evaluation. Klamath Falls, Oregon.

USFWS. 2018. Endangered and threatened wildlife and plants: Initiation of 5-year status reviews of 50 species in California, Nevada, and the Klamath Basin of Oregon. Federal Register 83:28251–28254.

USFWS. 2019. Species status assessment for the endangered Lost River sucker and shortnose sucker. Klamath Falls, Oregon.

USFWS, N. 2013d. Effects of proposed Klamath project operations from May 31, 2013, through March 31, 2023, on five federally listed threatened and endangered species.

VanderKooi, S. P., S. M. Burdick, K. R. Echols, C. A. Ottinger, B. H. Rosen, and T. M. Wood. 2010. Algal toxins in upper Klamath Lake, Oregon: Linking water quality to juvenile sucker health: U.S. Geological Survey Fact Sheet 2009-3111, 2 p.

Walker, W. W. 2001. Developmetn of Phosphorus TMDL for Upper Klamath Lake, Oregon. Bend, Oregon.

Walker, W. W. 2010. Testimony and exhibits submitted in the matter of the determination of the relative rights of the waters of the Klamath River, a tributary of the Pacific Ocean.

Weddell, B. J. 2000. Relationship between flows in the Klamath River and Lower Klamath Lake prior to 1910. Pullman, WA.

Welch, E. B., and T. Burke. 2001. Interim summary report: Relationship between lake elevation and water quality in Upper Klamath Lake, Oregon. Portland, Oregon.

Whitney, R. R., M. W. Erho, and C. C. Coutant. 1997. Downstream passage for salmon at hydroelectric projects in the Columbia River Basin: development, installation, and evaluation. Portland, Oregon.

Wood, T. M. 2001. Sediment oxygen deman in Upper Klamath and Agency Lakes, Oregon, 1999. Water-Resources Investigations Report 01-4080. Portland, Oregon.

Wood, T. M., G. J. Fuhrer, and J. L. Morace. 1996. Relation between selected water-quality variables and lake level in Upper Klamath and Agency Lakes, Oregon. U.S. Geological Survey Water-Resources Investigations Report 96-4079. Portland, Oregon.

Wood, T. M., G. R. Hoilman, and M. K. Lindenberg. 2006. Water-quality conditions in Upper Klamath Lake, Oregon, 2002-04: Scientific Investigations Report 2006-5209. U.S. Geological Survey, Reston.

Wood, T. M., S. A. Wherry, D. C. Simon, and D. F. Markle. 2014. Particle-tracking investigation of the retention of sucker larvae emerging from spawning grounds in Upper Klamath Lake, Oregon: U.S. Geological Survey Open-File Report 2014-1061

APPENDIX H

STATUS OF THE SPECIES AND CRITICAL HABITAT-OREGON SPOTTED FROG

Listing Status

The Oregon spotted frog was listed as threatened under the Endangered Species Act (ESA) on August 29, 2014 (79 FR 51658).

Taxonomy

The scientific name *Rana pretiosa* (order Anura; family Ranidae) was first applied to a series of five specimens collected in 1841 by Baird and Girard (1853, p. 378) from the vicinity of Puget Sound. Subsequently, the "spotted frog" was separated into two species, *Rana pretiosa* (Oregon spotted frog) and *Rana luteiventris* (Columbia spotted frog) based on genetic analyses (Green *et al.* 1996, 1997).

Phylogenetic analyses conducted on samples of Oregon spotted frogs collected from 3 locations in Washington and 13 locations in Oregon indicate that there are two well-supported clades (a group of biological taxa, as species, that includes all descendants of one common ancestor) nested within the Oregon spotted frog: the Columbia clade (Trout Lake Natural Area Preserve (NAP) and Camas Prairie) and the southern Oregon clade (Wood River and Buck Lake in the Klamath River basin) (Funk *et al.* 2008, p. 202).

Blouin *et al.* (2010) performed genetic analyses on Oregon spotted frogs from 23 locations in British Columbia, Washington, and Oregon for variation at 13 microsatellite loci and 298 base pairs of mitochondrial DNA. Their results indicate that *Rana pretiosa* is comprised of six major genetic groups: (1) British Columbia; (2) the Chehalis River drainage in Washington; (3) the Columbia River drainage in Washington; (4) Camas Prairie in northern Oregon; (5) the central Cascades of Oregon; and (6) the Klamath River basin (Blouin *et al.* 2010, pp. 2184–2185). Within the northern genetic groups, the British Columbia (Lower Fraser River) and Chehalis (Black River) populations form the next natural grouping (Blouin *et al.* 2010, p. 2189). Recently discovered locales in the Sumas, South Fork Nooksack, and Samish Rivers occur in-between these two groups. While no genetic testing has been done on these newly found populations, it is reasonable to assume that they are likely to be closely related to either the British Columbia or Chehalis group, or both, given their proximity and use of similar lowland marsh habitats (79 FR 51659).

Physical Description

The Oregon spotted frog is named for the black spots that cover the head, back, sides, and legs. The dark spots are characterized by ragged edges and light centers that grow and darken with age (Hayes 1994, p. 14). Body color also varies with age. Juveniles are usually brown or, occasionally, olive green on the back and white, cream, or flesh-colored with reddish pigments on the underlegs and abdomen developing with age (McAllister and Leonard 1997, pp. 1–2).

Adults range from brown to reddish brown but tend to become redder with age. The Oregon spotted frog is a medium-sized frog, ranging from 44 to 100 millimeters (mm; 1.74 to 4 inches (in)) in body length. Females are typically larger than males and can reach up to 100 mm or more (4 in) (Rombough et al. 2006, p. 210).

Life History

Adult Oregon spotted frogs begin to breed by one to three years of age, depending on sex, elevation, and latitude. Male Oregon spotted frogs are not territorial and often gather in large groups of 25 or more individuals at specific locations (Leonard *et al.* 1993, p. 132). Breeding occurs in February or March at lower elevations and between early April and early June at higher elevations (Leonard *et al.* 1993, p. 132). The majority of egg masses are laid communally in groups of a few to several hundred (Licht 1971, p. 119; Nussbaum *et al.* 1983, p. 186; Cook 1984, p. 87; Hayes *et al.* 1997 p. 3; Engler and Friesz 1998, p. 3). Females may deposit their egg masses at the same locations in successive years, in shallow, often temporary, pools of water; gradually receding shorelines; on benches of seasonal lakes and marshes; and in wet meadows. These sites are usually associated with the previous year's emergent vegetation, are generally no more than 14 inches (35 centimeters (cm)) deep (Pearl and Hayes 2004, pp. 19–20). Breeding micro-environments are often located in seasonally inundated shallows and are usually hydrologically connected to permanently-wetted areas, such as creeks, wetlands, and springs (Licht 1971, p. Licht, 1974, p. 614). Shallow water is easily warmed by the sun, and warmth hastens egg development (McAllister and Leonard 1997, p. 8). However, laying eggs in shallow water can result in high mortality rates for eggs and hatchling larvae due to desiccation or freezing (Licht 1971, p.112, Licht1974, p 618).

Eggs usually hatch within three weeks after oviposition. Tadpoles metamorphose into froglets during their first summer. Tadpoles are grazers, having rough tooth rows for scraping plant surfaces and ingesting plant tissue and bacteria. They also consume algae, detritus, and probably carrion. Post-metamorphic spotted frogs feed on live animals, primarily insects.

Similar to many North American pond-breeding anurans (belonging to the Order Anura, which contains all frogs), predators can strongly affect the abundance of larval and post-metamorphic spotted frogs. The heaviest losses to predation are thought to occur shortly after tadpoles emerge from eggs, when they are relatively exposed and poor swimmers (Licht 1974, p. 624). However, the odds of survival appear to increase as tadpoles grow in size and aquatic vegetation matures, thus affording cover (Licht 1974, p. 624).

Licht (1974, pp. 617–625) documented the highly variable mortality rates for spotted frog life-history stages in marsh areas in the lower Fraser Valley, BC: embryos (30 percent), tadpoles (99 percent), and post-metamorphic (after the change from tadpole to adult, or "metamorphosis") frogs (95 percent). Licht (1974, p. 625) estimated mortality of each life stage and predicted only a 1 percent chance of survival of eggs to metamorphosis, a 67 percent chance of juvenile survival for the first year, and a 64 percent adult annual survival with males having a higher mortality rate than females. An average adult between-year survival of 37 percent was estimated by a mark-recapture study at Dempsey Creek in Washington between 1997 and 1999 (Watson *et al.* 2000, p. 19).

Habitat

The Oregon spotted frog is highly aquatic; it is almost always found in or near a perennial body of water that includes zones of shallow water and abundant emergent or floating aquatic plants, which the frogs use for basking and cover. Watson *et al.* (2003, p. 298) summarized the conditions required for completion of the Oregon spotted frog life cycle as shallow water areas for egg and tadpole survival, perennially deep, moderately vegetated pools for adult and juvenile survival in the dry season, and perennial water for protecting all age classes during cold wet weather. Characteristic vegetation includes grasses, sedges, and rushes, although eggs are laid where the vegetation is low or sparse, such that vegetation structure does not shade the eggs (McAllister and Leonard 1997, p. 17). While native vegetation is the preferred substrate, the frog may also use short, manipulated reed canarygrass/native vegetation mix (J. Engler, pers. comm. 1999) a high level of insolation, or solar exposure, seems to be a significant factor in breeding habitat selection (McAllister and White 2001, p. 12; Pearl and Hayes 2004, p. 18). The availability of the unique characteristics of traditional egg-laying sites is limited at many sites, and adults may have limited flexibility to switch sites (Hayes 1994, p. 19). This may make the spotted frog particularly vulnerable to modification of egg-laying sites (Hayes 1994, p. 19).

After breeding, during the dry season, spotted frogs move to deeper, permanent pools or creeks (Watson *et al.* 2003, p. 295). They are often observed near the water surface basking and feeding in beds of floating and submerged vegetation (Watson *et al.* 2003, pp. 292–298; Pearl *et al.* 2005, pp. 36–37).

Known overwintering sites are associated with flowing systems, such as springs and creeks, that provide well-oxygenated water (Hallock and Pearson 2001, p. 15; Hayes *et al.* 2001, pp. 20–23, Tattersall and Ultsch 2008, pp. 123, 129, 136) and sheltering locations protected from predators and freezing (Risenhoover *et al.* 2001; Watson *et al.* 2003, p. 295). Oregon spotted frogs burrow in mud, silty substrate, clumps of emergent vegetation, woody accumulations within the creek, and holes in creek banks when inactive during periods of prolonged or severe cold (Watson *et al.* 2003, p. 295; Hallock and Pearson 2001, p. 16; McAllister and Leonard 1997, p. 17); however, they are intolerant of anoxic (absence of dissolved oxygen) conditions and are unlikely to burrow into the mud for more than a day or two (Tattersall and Ultsch 2008, p. 136) because survival under anoxic conditions is only a matter of 4–7 days (Tattersall and Ultsch 2008, p. 126). This species can remain active during the winter and selects microhabitats that can support aerobic metabolism and minimize exposure to predators (Hallock and Pearson 2001, p. 15; Hayes *et al.* 2001, pp. 20–23; Tattersall and Ultsch 2008, p. 136). In central Oregon, where winters generally result in ice cover over ponds, spotted frogs follow a fairly reliable routine of considerable activity and movement beneath the ice during the first month following freeze-up. Little movement is observed under the ice in January and February, but activity steadily increases in mid-March, even when ice cover persists (Bowerman 2006, pers. comm.; Hallock 2009, pers comm.; Hayes *et al.* 2001, pp. 16–19). Oregon spotted frogs have been observed using "semi-terrestrial" overwintering habitats such as interstices in lava rock, beaver channels, and flooded beaver lodges along the Deschutes River in central Oregon (Pearl *et al.* 2018, p 545). Overwintering sites may contain multiple frogs, underscoring the importance of these habitat features for spotted frogs (Pearl *et al.* 2018, p 548).

Movement studies specific to Oregon spotted frogs are limited in number and scope. Results of a habitat utilization and movement study at Dempsey Creek in Washington indicate that adult frogs made infrequent movements between widely separated pools and more frequent movements between pools in closer proximity (Watson *et al.* 2003, p. 294), but remained within the study area throughout the year. Home ranges averaged 5.4 ac (2.2 ha), and daily movement was 16–23 ft (5–7 m) throughout the year (Watson *et al.* 2003, p. 295). During the breeding season (February–May), frogs used about half the area used during the rest of the year. During the dry season (June–August), frogs moved to deeper, permanent pools, and occupied the smallest range of any season, then moved back toward their former breeding range during the wet season (September–January) (Watson *et al.* 2003, p. 295). Individuals equipped with radio transmitters stayed within 2,600 ft (800 m) of capture locations at the Dempsey Creek site (Watson *et al.* 1998, p. 10) and within about 1,312 ft (400 m) at the Trout Lake NAP (Hallock and Pearson 2001, p. 16). A late season movement and habitat use study of four spotted frog populations in the upper Willamette (1 population), Klamath River basin (1 population) and upper Deschutes (2 populations) showed that 84.5% (49/58) of frogs moved less than 250 m between late summer and winter tracking locations (Pearl et al. 2018, p. 543). The Pearl et al. (2018, p. 543) study also showed that frogs associated with ditches in the Klamath Marsh National Wildlife Refuge, traveled significantly longer distances (i.e., ranging up to 1145 m) than frogs not utilizing ditches. Whether ditches facilitate movement of spotted frogs or frogs are moving longer distances to locate more suitable overwintering habitat is unknown (Pearl et al, 2018 p. 548).

Long travel distances, while infrequent, have been observed between years and within a single year between seasons. Recaptures of spotted frogs at breeding locations in the Buck Lake population in Oregon indicated that adults often move less than 300 ft (100 m) between years (Hayes 1998, p. 9). Three adult spotted frogs (one male and two females) marked in a study at Dempsey Creek and the Black River in Washington moved a distance of 1.5 mi (2.4 km) between seasons along lower Dempsey Creek to the creek's mouth from the point where they were marked (McAllister and Walker 2003, p. 6). An adult female spotted frog traveled 1,434 ft (437 m) between seasons from its original capture location at the Trout Lake Wetland NAP (Hallock and Pearson 2001, p. 8). Two juvenile frogs at the Jack Creek site in Oregon were recaptured the next summer 4,084 ft (1,245 m) and 4,511 ft (1,375 m) downstream from where they were initially marked, and one adult female moved 1.7 miles (2.7 km) downstream (Cushman and Pearl 2007, p. 13). Spotted frogs at a Sunriver site routinely make annual migrations of 1,640 to 4,265 ft (500 to 1,300 m) between the major egg-laying complex and an overwintering site (Bowerman 2006, pers. comm.).

Although these movement studies are specific to Oregon spotted frogs, the number of studies and size of the study areas are limited. Few studies have been conducted over multiple seasons or years. In addition, the ability to detect frogs is challenging because of the difficult terrain and the need for the receiver and transmitter to be in close proximity. Hammerson (2005) recommends that a 3.1-mile (5-km) dispersal distance be applied to all ranid frog species, because the movement data for ranids are consistent. The preponderance of data indicates that a separation distance of several kilometers may be appropriate and practical for delineation of occupancy, despite occasional movements that are longer or that may allow some genetic interchange between distant populations (for example, the 6.2-mi (10-km) distance noted by Blouin *et al.* 2010, pp. 2186, 2188). Based on the best available scientific information, the Service considers that spotted frog habitats are connected for purposes of genetic exchange when occupied/suitable habitats fall within a maximum movement distance of 3.1 mi (5 km) (79 FR 51663, p. 51662).

Distribution

Historically, the Oregon spotted frog ranged from British Columbia to the Pit River basin in northeastern California (Hayes 1997; p. 40; McAllister and Leonard 1997, p. 7). Oregon spotted frogs have been documented at 61 historical localities in 48 watersheds (3 in British Columbia, 13 in Washington, 29 in Oregon, and 3 in California) in 31 sub-basins (McAllister *et al.* 1993, pp. 11–12; Hayes 1997, p. 41; McAllister and Leonard 1997, pp. 18–20; COSEWIC 2011, pp. 12–13).

Currently, the spotted frog is found within 16 sub-basins ranging from extreme southwestern British Columbia south through the Puget Trough, and the Cascades Range from south-central Washington at least to the Klamath River basin in southern Oregon (Table 1 79 FR 51662-51663)(Figure 1). Oregon spotted frogs occur in lower elevations in British Columbia and Washington and are restricted to high elevations in Oregon (Pearl et al. 2010 p. 7). In addition, spotted frogs currently have a very limited distribution west of the Cascade crest in Oregon, are considered to be extirpated from the Willamette Valley in Oregon (Cushman and Pearl 2007, p. 14), and may be extirpated in the Klamath and Pit River basins of California (Hayes 1997, p. 1; Service (Klamath Falls Fish and Wildlife Office), unpublished data).

In British Columbia, spotted frogs no longer occupy the locations documented historically, but they currently are known to occupy six locations in a single sub-basin and 3 unconfirmed eDNA detections in, the Lower Fraser River (Canadian Oregon Spotted Frog Recovery Team 2012, p. 6, Kendra Morgan, BC Ministry of Environment, pers. comm., 2018).

In Washington, spotted frogs are known to occur only within seven sub-basins/watersheds: the Sumas River, a tributary to the Lower Chilliwack River watershed and Fraser River sub-basin; the lower South Fork Nooksack River, a tributary of the Nooksack River; Samish River; Chambers Creek, which drains to the Puget Sounds, Black River, a tributary of the Chehalis River; Outlet Creek (Conboy Lake), a tributary to the Middle Klickitat River; and Trout Lake Creek, a tributary of the White Salmon River. The Klickitat and White Salmon Rivers are tributaries to the Columbia River. The spotted frogs in each of these sub-basins/watersheds, with the exception of perhaps the South Fork Nooksack and Samish, are isolated from frogs in other sub-basins (79 FR 51663).

In Oregon, Oregon spotted frogs are known to occur only within eight sub-basins (scale equivalent to Hydrologic Unit Code 8): (1) Lower Deschutes River; (2) Upper Deschutes River; (3) Little Deschutes River; (4) McKenzie River; (5) Middle Fork Willamette; (6) Upper Klamath; (7) Upper Klamath Lake; and (8) the Williamson River. Oregon spotted frogs in most of these sub-basins are isolated from spotted frogs in other sub-basins. However, Oregon spotted frogs in the lower Little Deschutes River are aquatically connected with those in the Deschutes

River downstream of the confluence of the rivers in the Upper Deschutes River sub-basin. Oregon spotted frog distribution west of the Cascade Mountains in Oregon is restricted to a few lakes in the upper watersheds of the McKenzie River and Middle Fork Willamette River sub-basins, which represent the remaining 2 out of 12 historically occupied sub-basins west of the Cascades in Oregon (79 FR 51663).

In California, this species has not been detected since 1918 (California Academy of Science Museum Record 44291) at historical sites and may be extirpated (Hayes 1997 pp. 135). However, there has been little survey effort of potential habitat since 1996, so this species may still occur in California (79 FR 51663).

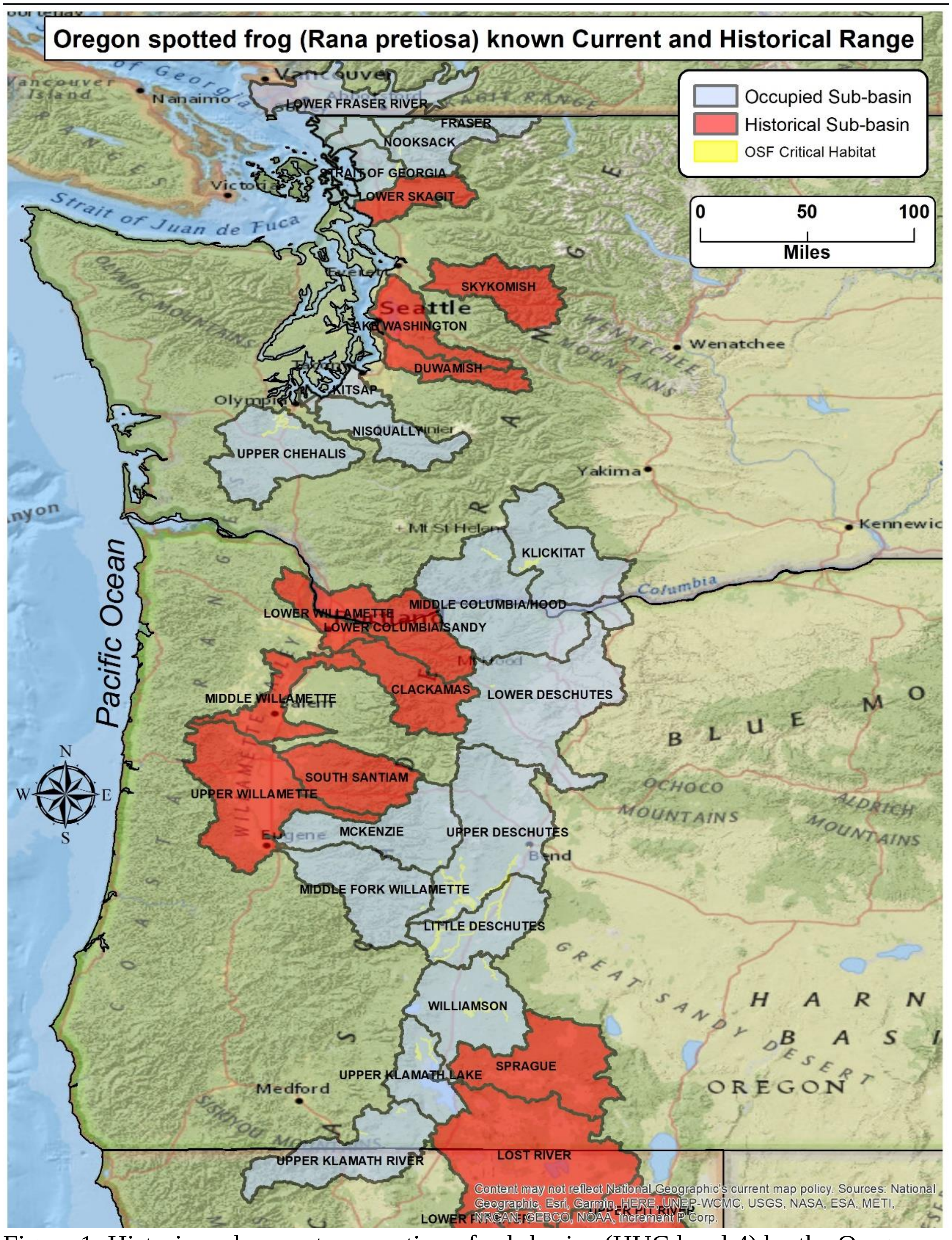

Figure 1: Historic and current occupation of sub-basins (HUC level 4) by the Oregon spotted frog (Table 1 79 FR 51662 -51663, with addition of a single extant population in Chamber Creek found in 2018)

Population Dynamics

The Services' final rule to list the Oregon spotted frog estimated the total minimum breeding adult populations within each of the 15 occupied sub-basins using egg mass counts from known breeding locations (79 FR 51663-51667). Although there are limitations with using egg mass data to evaluate population size and status at the site level and sub-basin scale, egg mass counts do indicate that many breeding locations within sub-basins have small numbers of breeding adults. Adams et al. (2013, p. 1 and 4 and 2014 p. 1 - 2) recommends assessing trends in amphibian populations by documenting the change in the number of populations using occupancy modeling rather than a change in abundance at individual sites. However, long-term spotted frog population trends using occupancy modeling are not yet available.

Modeling across a variety of amphibian taxa suggests that pond-breeding frogs have high temporal variances of population abundances and high local extinction rates relative to other groups of amphibians, with smaller frog populations undergoing disproportionately large fluctuations in abundance (Green 2003, pp. 339–341). The vulnerability of spotted frog egg masses to fluctuating water levels (Hayes *et al.* 2000, pp. 10–12; Pearl and Bury 2000, p. 10), the vulnerability of post-metamorphic stages to predation (Hayes 1994, p. 25), and low overwintering survival (Hallock and Pearson 2001, p. 8) can contribute to relatively rapid population turnovers, suggesting spotted frogs are particularly vulnerable to local extirpations from stochastic events and chronic sources of mortality (Pearl and Hayes 2004, p. 11). The term "rapid population turnovers" refers to disproportionately large fluctuations in abundance.

Oregon spotted frogs concentrate breeding efforts in relatively few locations (Hayes *et al.* 2000, pp. 5–6; McAllister and White 2001, p. 11). For example, Hayes *et al.* (2000, pp. 5–6) found that 2 percent of breeding sites accounted for 19 percent of the egg masses at the Conboy Lake NWR. Similar breeding concentrations have been found elsewhere in Washington and in Oregon. Moreover, spotted frogs exhibit relatively high fidelity to breeding locations, using the same seasonal pools every year and often using the same egg-laying sites. In years of extremely high or low water, the frogs may use alternative sites. For example, the Trout Lake Creek and Conboy Lake frogs return to traditional breeding areas every year, but the egg-laying sites change based on water depth at the time of breeding. A stochastic event that impacts any one of these breeding locations could significantly reduce the Oregon spotted frog population associated with that sub-basin.

Egg mass count data suggests a positive correlation and significant link between site size and spotted frog breeding population size (Pearl and Hayes 2004, p. 12). Larger sites are more likely to provide the seasonal microhabitats required by spotted frogs, have a more reliable prey base, and include overwintering habitat. The observation that extant spotted frog populations tend to occur in larger wetlands led Hayes (1994, Part II pp. 5, 7) to hypothesize that a minimum size of 9 acres (ac) (4 hectares (ha)) may be necessary to reach suitably warm temperatures and support a large enough population to persist despite high predation rates. However, spotted frogs also occupy smaller sites and are known to occur at sites as small as 2.5 ac (1 ha) and as large as 4,915 ac (1,989 ha) (Pearl and Hayes 2004, p. 11). Smaller sites generally have a small number of frogs and, as described above, are more vulnerable to extirpation. Pearl and Hayes (2004, p. 14) believe that these smaller sites were historically subpopulations within a larger breeding complex and spotted frogs may only be persisting in these small sites because the sites exchange migrants or seasonal habitat needs are provided nearby.

Egg mass counts are believed to be the best available metric of adult reproductive population size and are the most time-efficient way to estimate population size (Phillipsen *et al.* 2010, p. 743). Adult females are believed to lay one egg mass per year (Phillipsen *et al*. 2010, p. 743), and the breeding period occurs within a reliable and predictable timeframe each year (McAllister 2006, pers. comm.). If egg mass numbers are collected in a single survey timed to coincide with the end of the breeding season, when egg laying should be complete, then the egg mass count should represent a reliable estimate of total egg masses. Because one egg mass is approximately equivalent to one breeding female plus one to two adult males, a rough estimate of adult population size can be made if a thorough egg mass census is completed (Phillipsen *et al.* 2010, p. 743). A minimum adult population estimate can be derived from the total egg mass count multiplied by two (one egg mass equals two adult frogs). However, using egg mass counts to estimate population size has some weaknesses. For example, researchers have uncertainties about whether adult females breed every year, only lay one egg mass per year, and find difficulty in distinguishing individual egg masses in large communal clusters. Furthermore, access to high elevation or remotely located sites during the breeding period can be difficult or unsafe due to snow and other hazards.

Egg mass counts, as currently conducted at most sites, do not allow for evaluation of trends within a site nor between sites because surveys are not standardized. Survey effort, area coverage, and timing can differ between years at individual sites. In addition, method of survey can differ between years at individual sites and differ between sites. Because of the weaknesses associated with the egg mass counts, site estimates derived from egg mass counts are considered to be a minimum estimate and generally should not be compared across years or with other sites. However, some breeding locations have been surveyed in a consistent manner (in some cases by the same researcher) and for enough years that trend data are available and considered to be reliable (e.g., Big Marsh or Sunriver).

Most species' populations fluctuate naturally in response to weather events, disease, predation, or other factors. However, these factors have less impact on a species with a wide and continuous distribution. Small, isolated populations are generally more likely to be extirpated by stochastic events and genetic drift (Lande 1988, pp. 1456–1458).

Funk *et al.* (2008, p. 205) found low genetic variation in Oregon spotted frogs, which likely reflects small effective population sizes, historical or current genetic bottlenecks, and/or low gene flow among populations. Genetic work by Blouin *et al.* (2010) indicates low genetic diversity within and high genetic differentiation among each of the six Oregon spotted frog groups (British Columbia, Chehalis and Columbia drainages, Camas Prairie, central Oregon Cascades, and the Klamath River basin). This pattern of genetic fragmentation is likely caused by low connectivity between sites and naturally small populations sizes. Gene flow is very limited between locations, especially if separated by 6 mi (10 km) or more, and at the larger scale, genetic groups have the signature of complete isolation (Blouin *et al.* 2010, p. 2187). At least two of the locations sampled by Blouin *et al.* (2010) (Camas Prairie and Trout Lake) show indications of recent genetic drift.

Movement studies suggest spotted frogs are limited in their overland dispersal and potential to recolonize sites. Oregon spotted frog movements are associated with aquatic connections (Watson *et al.* 2003, p. 295; Pearl and Hayes 2004, p. 15). Oregon spotted frogs rely on an aquatic connection between breeding sites to maintain population viability.

Rangewide Threats

Large historical losses of wetland habitat have occurred across the range of the Oregon spotted frog. Wetland losses are estimated from between 30 to 85 percent across the species range with the greatest percentage lost having occurred in British Columbia. These wetland losses have directly influenced the current fragmentation and isolation of remaining spotted frog populations. Loss of natural wetland and riverine disturbance processes as a result of human activities has and continues to result in degradation of spotted frog habitat. Historically, a number of disturbance processes created early successional wetlands favorable to spotted frogs throughout the Pacific Northwest: (1) Rivers freely meandered over their floodplains, removing trees and shrubs and baring patches of mineral soil; (2) beavers created a complex mosaic of aquatic habitat types for year-round use; and (3) summer fires burned areas that would be shallow water wetlands during the spotted frog breeding season the following spring. Today, all of these natural processes are greatly reduced, impaired, or have been permanently altered as a result of human activities, including stream bank, channel, and wetland modifications; operation of water control structures (e.g., dams and diversions); beaver removal; and fire suppression.

The historical loss of Oregon spotted frog habitats and lasting anthropogenic changes in natural disturbance processes are exacerbated by the introduction of reed canarygrass, nonnative predators, and potentially climate change. In addition, current regulatory mechanisms and voluntary incentive programs designed to benefit fish species have inadvertently led to the continuing decline in quality of Oregon spotted frog habitats in some locations in Washington. The current wetland and stream vegetation management paradigm is generally a no-management or restoration approach that often results in succession to a tree- and shrub-dominated community that unintentionally degrades or eliminates remaining or potential suitable habitat for Oregon spotted frog breeding. Furthermore, incremental wetland loss or degradation continues under the current regulatory mechanisms. If left unmanaged, these factors are anticipated to result in the eventual elimination of remaining suitable Oregon spotted frog habitats or populations. The persistence of habitats required by the species is now largely management dependent.

In the Final Rule to list the frog as threatened (79 FR 51658), the Service determined that the Oregon spotted frog is impacted by one or more of the following factors to the extent that the species meets the definition of a threatened species under the ESA:

- Habitat necessary to support all life stages is continuing to be impacted and/or destroyed by human activities that result in the loss of wetlands to land conversions; hydrologic changes resulting from operation of existing water diversions/manipulation structures, new and existing residential and road developments, drought, and removal of beavers; changes in water temperature and vegetation structure resulting from reed canarygrass invasions, plant succession, and restoration plantings; and increased sedimentation, increased water temperatures, reduced water quality, and vegetation changes resulting from the timing and intensity of livestock grazing (or in some instances, removal of livestock grazing at locations where it maintains early seral stage habitat essential for breeding);

- Predation by nonnative species, including nonnative trout and bullfrogs;
- Inadequate existing regulatory mechanisms that result in significant negative impacts such as habitat loss and modification; and
- Other natural or manmade factors including small and isolated breeding locations, low connectivity, low genetic diversity within occupied sub-basins, and genetic differentiation between sub-basins.

Also, there are cumulative effects of the several threats that the Oregon spotted frog faces. All occupied sub-basins are subjected to multiple threats, which cumulatively pose a risk to individual populations. Many of these threats are intermingled, and the magnitude of the combined threats to the species is greater than the individual threats (79 FR 51658).

Consulted-on Effects

Consulted-on effects are those effects that have been analyzed through section 7 consultation as reported in a Biological Opinion. These effects are an important component of objectively characterizing the current condition of the species.

Formal Consultations have been completed for Oregon spotted frog habitat restoration activities in the Middle Klickitat River sub-basin in Washington and within the Little and Upper Deschutes River sub-basins in Oregon (Table 1). These restoration activities, described briefly below, were designed to improve habitat for Oregon spotted frog and will have short-term adverse but long-term beneficial effects to spotted frog habitat.

Conboy Lake National Wildlife Refuge (NWR), located within the Middle Klickitat River sub-basin in Klickitat County, WA, will improve habitat conditions for Oregon spotted frogs through decommissioning and cleaning approximately 0.75 miles of ditches and other management actions. Ditch decommissioning reduces the amount of habitat used by non-native predatory and competitive species (ex: bullfrogs and brown bullhead). Ditch cleaning is essential for maintaining water flow into the wetlands that are used by Oregon spotted frogs for breeding and rearing. These conservation actions paired with continued removal of predatory and competitive species and reed canarygrass management support recovery of this large and isolated population of spotted frogs.

The Ryan Ranch Restoration Project, located downstream of Wickiup Dam within the Upper Deschutes River sub-basin on the Deschutes National Forest, has restored approximately 65 acres of emergent marsh habitat and reconnects the Deschutes River with its floodplain. The wetland restoration area had been historically (circa 1949) occupied by Oregon spotted frog prior to the construction of a berm that disconnected the wetland from the Deschutes River. Restoration work was completed in the spring of 2019.

The Marsh Project, located within the Little Deschutes River sub-basin on the Deschutes National Forest in Klamath County, OR, implemented in 2018, improves habitat conditions for Oregon spotted frog through hydrological restoration and lodgepole pine removal. The Big Marsh project area represents approximately 80 percent of the adult breeding population in the Little Deschutes River sub-basin at the time of the ESA Listing. The Big Marsh Oregon spotted frog population is essential to the conservation of the spotted frog because it is the source population for downstream habitats within Big Marsh Crescent, Crescent Creek, and the Little Deschutes River. Therefore, the Big Marsh Restoration Project supports the recovery of Oregon spotted frogs within the Little Deschutes River sub-basin.

The Deschutes Project consultation with the Bureau of Reclamation analyzed impacts to spotted frogs as a result of water management and the implementation of early conservation measures within the Deschutes Basin Habitat Conservation Plan (OSF Proposal) within the Upper and Little Deschutes River sub-basins within an approximate xx acres of spotted frog habitat.

The current condition of the Oregon spotted frog and its critical habitat within the Deschutes Project action area is highly degraded due to the impacts of past and ongoing irrigation water storage and delivery activities conducted by the Districts, in coordination with Reclamation, that have radically altered the natural hydrology of this portion of the Deschutes River Basin. Synchronizing and modifying, as needed, water management activities within the action area to ensure the proper function of habitats that support all spotted frog life stages and to ensure connectivity within suitable habitat areas and between spotted frog populations are vital to the survival and recovery of this species. Implementation of the OSF Proposal over a two-year period is a first step in that direction and should help inform the development of the Deschutes River Basin HCP by the Districts. That HCP effort represents a highly significant opportunity to conserve the Oregon spotted frog by aligning irrigation water management in the Basin to closely conform to and support the life history requirements of the spotted frog and the proper function of its critical habitat.

The Thurston Country Beaver Creek Culvert Replacement Project installed a bridge that allowed better connectivity between two known Oregon spotted frog sites on Beaver Creek. Most of the construction activities occurred outside the wetted channel and incorporated several conservation measures such as having experience frog biologist on site to oversee seining the dewater area and minimize effects to Oregon spotted frogs if found in the area. Take in the form of harm is estimated at two adult spotted frogs along 50 feet of Beaver Creek.

The overall goal of the Chehalis-Olympia No. 1 Transmission Line Right-of-Way Maintenance project is to establish low-growing plant communities along the ROW and control the development of trees that could interfere with transmission lines. The right-of-way easement is 75 to 615 feet in width through the project area and approximately 80 miles long. The action area contains known occupied sites and contains habitat for the full life history of the Oregon spotted frog. The vegetation maintenance includes conservation measures to avoid or minimize effects of the activities to Oregon spotted frogs and suitable habitat. Although there may be short-term impacts to frogs, maintaining the right-of-way and avoiding activities in wetted areas at known occupied sites and in areas with suitable habitat will benefit Oregon spotted frogs in the

long term. The action area may also act as a dispersal corridor that is necessary for gene flow and demographic support of populations within the Black River watershed.
The Preserve Habitat Conservation Plan includes managing 25 acres of wetland habitat to benefit Oregon spotted frog by reducing the occurrence of invasive or non-native plants. The mitigation site is degraded due to reed canarygrass and other invasive plant species. Reed canarygrass mechanical control, mowing, management of livestock access in wetted areas of OSF suitable habitat will improve the suitability of the habitat at the mitigation site. Conservation measures include avoiding mechanical management activities in the water or immediately next to the water's edge on the mitigation site, and no in-water vegetation management work in OSF suitable habitat during OSF breeding season. Take in the form of harm is estimated as one adult spotted frog and one egg mass annually for 10 years

The WFWO Monroe-Custer No. 2 Transmission Right-of-Way Vegetation Management Project includes maintaining vegetation and performing routine inspections on the existing right-of-way under the transmission lines. The right-of-way easement is 150 to 575 feet in width and crosses approximately 20 miles of potentially suitable habitat for Oregon spotted frogs. Within that area, the right-of-way crosses 16 to 18 acres of designated critical habitat for the Oregon spotted frog. Vegetation control methods include hand cutting, mowing, and managed herbicidal treatments to remove tall-growing trees and shrubs and to maintain low-growing vegetation. The proposed vegetation maintenance may affect a small number of individual spotted frogs on a total of 210 acres suitable habitat spread over a period of 15 years. In the long term, maintaining the vegetation in the right-of-way and avoiding activities in wetted areas at known occupied sites and in areas with potentially suitable habitat will benefit Oregon spotted frogs.

The Gifford Pinchot National Forest Beaver Pond restoration project will restore 12 acres of Oregon spotted frog wetland habitat through removal of invasive plant species via manual and herbicide treatment over a five-year period (2018-2023). Annual Oregon spotted frog egg mass surveys will occur to complement the restoration activities. Reed canarygrass and Canada thistle will be treated through mowing beginning in June and application of aquatic-labeled imazapyr beginning August 1. Take associated with activities conducted in suitable occupied habitat will include a small proportion of the total number of individuals in all life stages of Oregon spotted frogs within 12 acres.

Each year WDFW staff conducts surveys for Oregon spotted frogs in Washington State under the WDFW Section 6 Cooperative Agreement. When new breeding sites are located 1 to 3 eggs are collected for genetic confirmation to ensure species identification as they can easily confused with red-legged frog (Rana aurora).

Table 1. Completed formal consultations or conferences involving effects of Federal actions on the Oregon spotted frog.

Project/Consultation/Conference Name	Sub-basin Affected	Type of Take (Harm or Harass)	Amount of Take (eggs, tadpoles, frogs, or habitat surrogate)
Colorado Avenue Dam Paddle Trail Improvements Project Biological Opinion	Upper Deschutes	Harm	2.72 acres overwintering habitat permanent loss
		Harass	3.44 acres of disturbance
Ryan Ranch Restoration Conference Opinion and Amended Biological Opinion (2018)	Upper Deschutes	Harm	2,940 tadpoles
		Harass	14 adults, 7 egg masses (avg. of 600 eggs per mass) and 7 juveniles
Old Mill CCAA 20-year Permit Conference Opinion	Upper Deschutes	Harm	12 adult/juvenile spotted frogs and 20 egg masses or up to 8,400 tadpoles
Antelope Grazing Allotments Project Biological Opinion	Williamson River	Harm	2 adults, 4 juveniles, 2 metamorphs, and 237 tadpoles
Marsh Biological Opinion	Little Deschutes	Harm	29 adults, 29 sub adults and 216 juveniles – mortality within 0.10 acre
		Harass	adults, sub-adults, and juveniles with 153 acres
		Harass	294 adult spotted frogs, 294 sub-adult and 2,157 juveniles via capture and handling
Conboy Lake NWR Habitat Management Activities Opinion	Middle Klickitat River	Harm	13 tadpoles
		Harass	109 adults
Wickiup Hydro Opinion	Upper Deschutes	Harm	≤ 5% increase in brown trout
Deschutes Project	Upper Deschutes	Harm and harass	All life stages within 4,661 acres of wetlands.
		Harm	All spotted frogs within 7 acres of wetlands.
		Harass	All spotted frogs within 8 acres of wetlands.
	Little Deschutes	Harm and harass	All spotted frogs within 1,182 acres of wetlands.
Thurston Country PW Beaver Creek Culvert Replacement	Black River	Harm	2 adult spotted frogs along 50 ft of Beaver Creek
Nationwide Aerial Application of Fire Retardant on National Forest System Land	All sub-basins on USFS lands		No take
Chehalis-Olympia No. 1 Transmission Line Right-of-Way Maintenance	Black River	Harm and harass	All spotted frogs occurring on a total of

			268 acres of suitable habitat
The Preserve Habitat Conservation Plan	Black River	Harm and harass	A total of 47 acres over ten years
		Harm	1 adult spotted frog and 1 egg mass annually for 10 years
Monroe-Custer No. 2 Transmission Right-of-Way Vegetation Management Project	South Fork Nooksack & Samish Rivers	Harm and harass	All spotted frogs on a total of 210 acres suitable habitat spread over a period of 15 yrs,
GPNF Beaver Pond	White Salmon River	Harm and harass	Oregon spotted frogs, all life stages, on 12 acres
Section 6	All sub-basins in Washington	Harm and harass	1 to 3 eggs at newly found sites

Rangewide Conservation Needs

The overall reproductive success of the Oregon spotted frog is directly influenced by the timing and availability of water in habitats that support all life stages and maintaining aquatic connectivity within suitable habitat areas and between populations. Synchronizing and modifying, as needed, water management activities within Oregon spotted frog habitat to ensure the proper function of habitats that support all spotted frog life stages and to ensure connectivity within suitable habitat areas and between spotted frog populations are vital to the survival and recovery of this species. Of equal importance is maintaining low emergent wetland vegetative structure with a high level of solar exposure (low canopy closure) during breeding and the early stages of rearing. Maintaining and restoring complex wetland habitats of variable water depths and native vegetation structure and diversity will provide quality habitat that is suitable for all life stage of spotted frogs. These habitats should be without non-native predators such as bull frogs.

Currently, Oregon spotted frogs are mostly found in small isolated sites occupied by a small number of individuals in a very small portion of its historic range. Therefore, re-establishing and maintaining adequate areas of high quality, connected wetland and aquatic habitat for the spotted frog is a vital conservation need. Conservation efforts focused on improving water management to create habitats that are suitable for all life stages and reducing or removing non-native plant and animal species that reduce the suitability of habitat or result in direct predation of spotted frog are necessary.

In most watersheds across the range of the Oregon spotted frog there is some level of population resilience in the form of multiple occupied sites or sufficient extent of suitable habitat for the species. However in three watersheds, the Lower Chilliwack River, the White River, and Keene Creek the entire reproductive population of Oregon spotted frogs is likely represented by less than 10 females or its status is completely unknown and the habitat is only marginally functional for species life history needs. Immediate, planned and coordinated conservation and recovery actions are needed for the species in those watersheds of they are likely to become locally extinct in the near future.

General criteria for Oregon spotted frog recovery (delisting) are currently being developed by the Service. A draft recovery plan is anticipated to be completed in 2020. Recovery will require removing and reducing threats to the species coupled with building self-sustaining populations of spotted frogs across their current and possibly historical range by maintaining, restoring, and expanding the habitat on which they depend. Portions of the historical range, including the Pit River Basin of California, Willamette Valley lowlands of Oregon and Central Puget Lowlands of Washington, will require further evaluation to determine if populations can be re-established within the current highly modified habitat condition. Development of recovery metrics may vary geographically in order to create discrete recovery goals across the range of the species. The Service does not have an estimated recovery time for this species.

Long and short-term spotted frog conservation and recovery needs include managing hydrology, reducing or removing invasive animals and plants, and improving connectivity among sites and populations. Conservation efforts will focus on maintaining and increasing population numbers and expanding distribution into suitable habitat within the current and historical range to allow for adequate genetic interchange and re-population of areas following stochastic events.

Status of Oregon Spotted Frog Critical Habitat

The Fish and Wildlife Service designated critical habitat for Oregon spotted frog on 65,038 acres and 20.3 stream miles in Washington and Oregon on May 11, 2016 (81 FR 29336). Critical habitat for Oregon spotted frog was designated within 14 units, delineated by river sub-basins where spotted frogs are extant: (1) Lower Chilliwack River; (2) South Fork Nooksack River; (3) Samish River; (4) Black River; (5) White Salmon River; (6) Middle Klickitat River; (7) Lower Deschutes River; (8) Upper Deschutes River; (9) Little Deschutes River; (10) McKenzie River; (11) Middle Fork Willamette River; (12) Williamson River; (13) Upper Klamath Lake; and (14) Upper Klamath. The final rule for critical habitat provides descriptions of ownership, acreages and threats for each Unit (pp. 29356 – 29360). A summary of area or length and ownership can be found in Tables 7 and 8 below. In Washington State Oregon spotted frogs are known to occur outside of Critical Habitat in units 2, 4, and 6 and have the potential to occur in other areas not designated as Critical Habitat.

Table 8. Approximate area and landownership in designated critical habitat units for the Oregon spotted frog in Oregon and Washington.

	Critical Habitat Unit	Federal Ac (Ha)	State Ac (Ha)	County Ac (Ha)	Private/local municipalities Ac (Ha)	Total
Washington	1. Lower Chilliwack River	0	0	0	143 (58)	143 (58)
	2. South Fork Nooksack River	0	0	0	111 (45)	111 (45)
	3. Samish River	0	1 (<1)	7 (3)	976 (395)	984 (398)
	4. Black River	877 (355)	375 (152)	485 (196)	3,143 (1,272)	4,880 (1,975)
	5. White Salmon River	108 (44)	1,084	0	33 (13)	1,225 (496)
	6. Middle Klickitat River	4,069 (1,647)	0	0	151 (61)	4,220 (1,708)
Oregon	7. Lower Deschutes River	90 (36)	0	0	0	90 (36)
	8. Upper Deschutes River	23,213	185 (75)	45 (18)	589 (238)	24,032 (9,726)
	8A. Upper Deschutes River, Below Wickiup Dam	1,182 (479)	185 (75)	45 (18)	589 (238)	2,001 (810)
	8B. Upper Deschutes River, Above Wickiup Dam	22,031	0	0	0 (<1)	22,031 (8,916)
	9. Little Deschutes River	5,288 (2,140)	14 (6)	80 (32)	5,651 (2,287)	11,033 (4,465)
	10. McKenzie River	98 (40)	0	0	0	98 (40)
	11. Middle Fork Willamette River ...	292 (118)	0	0	0	292 (118)
	12. Williamson River	10,418	0	0	4,913 (1,988)	15,331 (6,204)
	13. Upper Klamath Lake	1,259 (510)	9 (4)	1 (<1)	1,068 (432)	2,337 (946)
	14. Upper Klamath	103 (42)	0	0	159 (64)	262 (106)
	Total	**45,815**	**1,668**	**618 (250)**	**16,937 (6,854)**	**65,038 (26,320)**

Note: Area sizes may not sum due to rounding. Area estimates reflect all land and stream miles within critical habitat unit boundaries.

Table 9. Approximate river mileage and ownership within proposed critical habitat units for the Oregon spotted frog in Washington State only. No river miles were designated in Oregon.

Critical habitat unit	Federal river mile (km)	Federal/ private * river mile (km)	State river mile (km)	State/private river mile (km)	County river mile (km)	County/ private river mile (km)	Private/local municipalities river mile (km)	Total
1. Lower Chilliwack River	0	0	0	0	0	0	4.38 (7.05)	4.38 (7.05)
2. South Fork Nooksack River	0	0	0	0	0	0	3.56 (5.73)	3.56 (5.73)
3. Samish River	0	0	0	0	0	0	1.73 (2.78)	1.73 (2.78)
4. Black River	0.06 (0.10)	0.06 (0.10)	0.49 (0.79)	0.05 (0.07)	0.64 (1.02)	0.26 (0.42)	5.90 (9.49)	7.46 (11.98)
5. White Salmon River	0.91 (1.46)	0	0	0	0	0	2.30 (3.70)	3.21 (5.16)
Total	**0.97 (1.56)**	**0.06 (0.09)**	**0.49 (0.79)**	**0.05 (0.07)**	**0.64 (1.02)**	**0.26 (0.42)**	**17.87 (28.75)**	**20.34 (32.7)**

* Ownership—multi-ownership (such as Federal/Private) indicates different ownership on each side of the river/stream/creek.
Note: River miles (km) may not sum due to rounding. Mileage estimates reflect stream miles within critical habitat unit boundaries that are not included in area estimates in Table 8.

Physical or Biological Features and Primary Constituent Elements

When designating critical habitat, the Service identifies "the physical or biological features [PBFs] essential to the conservation of the species and which may require special management considerations or protection" (50 CFR §424.12; 81 FR 29351). "These include, but are not limited to: 1) space for individual and population growth and for normal behavior; 2) food, water, air, light, minerals, or other nutritional or physiological requirements; 3) cover or shelter; 4) sites for breeding, reproduction, or rearing (or development) of offspring; and 5) habitats that are protected from disturbance or are representative of the historical, geographical, and ecological distributions of a species" (81 FR 29351). The final rule for critical habitat identifies the physical or biological features that are essential to the conservation of Oregon spotted frog (USDI FWS 2016, pp. 29351 – 29354). Primary Constituent Elements (PCEs) are those specific elements of the physical and biological features that provide for a species' life history processes and are essential to the conservation of the species.

The following PCEs of critical habitat were identified for the Oregon spotted frog:

1. Nonbreeding (N), Breeding (B), Rearing (R), and Overwintering Habitat (O) - Ephemeral or permanent bodies of fresh water, including, but not limited to natural or manmade ponds, springs, lakes, slow-moving streams, or pools within oxbows adjacent to streams, canals, and ditches that have one of more of the following characteristics:
    - Inundated for a minimum of 4 months per year (B, R) – timing varies by elevation but may begin as early as February and last as long as September. Inundated from October through March (O).
    - If ephemeral, areas are hydrologically connected by surface water flow to a permanent water body (e.g., pools, springs, ponds, lakes, streams, canals, or ditches) (B, R).
    - Shallow water areas (less than or equal to 30 cm (12 inches), or water of this depth over vegetation in deeper water (B, R).
    - Total surface area with less than 50% vegetative cover (N).
    - Gradual topographic gradient (<3% slope) from shallow water toward deeper, permanent water (B, R).
    - Herbaceous wetland vegetation (i.e. emergent, submergent, and floating-leaved aquatic plants), or vegetation that can structurally mimic emergent wetland vegetation through manipulation (B, R).
    - Shallow water areas with high solar exposure or low (short) canopy cover (B, R)
    - An absence or low density of nonnative predators (B, R, N).
2. Aquatic movement corridors - Ephemeral or permanent bodies of fresh water that have one or more of the following characteristics:
    - Less than or equal to 5 km (3.1 miles) linear distance from breeding areas;
    - Impediment free (including, but not limited to, hard barriers such as dams, impassable culverts, lack of water, or biological barriers such as abundant predators, or lack of refugia from predators).
3. Refugia habitat – Nonbreeding, breeding, rearing, or overwintering habitat or aquatic movement corridors with habitat characteristics (e.g., dense vegetation and/or an abundance of woody debris) that provide refugia from predators (e.g., nonnative fish or bullfrogs).

Special Management Considerations

Threats to the physical or biological features that are essential to the conservation of this species and that may warrant special management considerations or protection include, but are not limited to: 1) habitat modifications brought on by nonnative plant invasions or native vegetation encroachment (trees and shrubs); 2) loss of habitat from conversion to other uses; 3) hydrologic manipulation; 4) removal of beavers and features created by beavers; 5) livestock grazing; and 6) predation by invasive fish and bullfrogs. These threats also have the potential to affect the PCEs if conducted within or adjacent to designated units.

Consulted-on Effects to Oregon Spotted Frog Critical Habitat

Consulted-on effects are those effects that have been analyzed through section 7 consultation as reported in a biological opinion. These effects are an important component of objectively characterizing the current condition of the Critical Habitat designated for Oregon spotted frog.

Formal Consultations have been completed for Oregon spotted frog habitat restoration activities in Critical Habitat Units 6, 8 (subunit 8A) and 9. All actions have had short-term adverse but long-term beneficial effects to critical habitat. All consulted on activities to date, briefly described below, are designed to improve habitat conditions within Oregon spotted frog designated critical habitat.

Conboy Lake National Wildlife Refuge (NWR) in Klickitat County, WA, comprises the majority of the critical habitat in Unit 6. The Service determined that actions at Conboy NWR long-term beneficial effects to PCEs of the critical habitat, but in improving overall conditions there would be some loss of PCEs 1 and 2 through the decommissioning of 0.75 miles of ditches and a short term loss of PCE 3 through 0.75 miles of ditch cleaning.

The Ryan Ranch Restoration Project, located within CHU 8 (subunit 8A) on the Deschutes National Forest, in Deschutes County, OR, has resulted in the restoration of approximately 65 acres of critical habitat for the Oregon spotted frog. PCE 1 will be improved by increasing the extent and duration of inundation within a floodplain wetland that was historically occupied by spotted frogs. PCE 2 will be improved by re-establishing an aquatic movement corridor between this wetland and the Deschutes River.

The Marsh Project, located within CHU 9 on the Deschutes National Forest in Klamath County, OR, was implemented in 2018 and will improve all PCEs through hydrological restoration and lodgepole pine removal. The Big Marsh project area represents approximately 25% or 2,847 acres of critical habitat in CHU 9. Implementation of the Marsh Project is likely to enhance the recovery support function of CHU 9 by improving the physical and biological features of critical habitat that will support life history processes that are essential for the conservation of the spotted frog.

The Wickiup Hydro Project, located within CHU 8B, on the Deschutes National Forest, in Deschutes County, OR, will increase the number of non-native fish species, adversely affecting PCE 1 and PCE 2.

The Deschutes Project occurs within CHU 8 (Upper Deschutes River) and 9 (Little Deschutes River). These CHUs combined encompass approximately 35,065 acres of critical habitat for the Oregon spotted frog and represent 54 percent of the range-wide acreage of designated critical habitat (65,038 acres).[24] Of these 35,065 acres, approximately 22,688 acres of critical habitat (35 percent of critical habitat acreage range-wide) are within the geographic area influenced by the Deschutes Project, including private irrigation district actions that store and release water for irrigation. The conservation function of critical habitat within the large area affected by Deschutes Project operations has been significantly altered due to past and ongoing water management associated with the Deschutes Project and other threats. Improving the conservation function of critical habitat within this area is essential to meeting the recovery needs of the Oregon spotted frog.

The Thurston Country Beaver Creek Culvert Replacement Project occurred in Critical Habitat Unit 4: Black River and incorporated several conservation measures to minimize effects to the habitat. The project will result in a short-term loss in PCE 2 for one week due to dewatering of a 50-ft section (400 ft^2) of the creek. However, there will be an improvement to the overall condition of PCE 2. Additionally, there will be a small loss of refugia and nonbreeding habitat where the culvert and bank vegetation is removed. The replanting will result in the reestablishment of bank over at the project site and that physical instream processes will result in a heterogeneous instream habitat over the course of several years. Therefore, we expect insignificant effects to PCE 1 and 3 and a short-term adverse effect to PCE 2 to result from this project. Overall, this project will be a long-term improvement in the condition of critical habitat in the Beaver Creek Drainage. Upon completion of the project the area of the creek available as a movement corridor will double and aid in recovery of the species in the watershed.

The Nationwide Aerial Application of Fire Retardant on National Forest System Land consultation evaluates effects to Oregon spotted frog designated critical habitat from misapplication of fire retardants on National Forest lands. It is reasonable to assume that Oregon spotted frog and its designated critical habitat will likely be adversely affected by one misapplication, with potential for subsequent intrusion, over the next four years. We expect that the degradation of water quality due to retardant in aquatic areas will act as impediments, barriers, or reduced-function habitat. The low probability (0.093) of a misapplication, the lower probability of intrusion in designated critical habitat, and the incorporation of an expanded avoidance buffer reduces the risk of intrusion substantially.

All three PCEs are present within designated critical habitat for Oregon spotted frogs in the project area for the BPA Chehalis-Olympia No. 1 Transmission Line Right-of-Way Maintenance project. The action is likely to improve PCE 1 where the right-of-way crosses designated critical habitat by increasing the amount of habitat with less than 50 percent vegetation cover. The action will not impact PCEs 2 and 3 within the Black River Critical Habitat Unit.

Some of the Monroe-Custer No. 2 Transmission Right-of-Way Vegetation Management Project vegetation maintenance will occur within Critical Habitat Unit 3: Samish River. The transmission line right-of-way overlaps designated critical habitat in two areas. The right-of-way on the Monroe-Custer No. 1 line overlaps an estimated 5 to 6 acres of critical habitat. The

[24] Critical habitat acres and percentages of critical habitat do not include the approximately 30 miles of Oregon spotted frog critical habitat designated in Washington State.

Monroe-Custer No. 2 line overlaps an estimated 10 to 12 acres of critical habitat. We expect insignificant effects to PCE 3 and benefits to critical habitat PCEs 1 and 2 to result from this project. Overall, this project will maintain designated suitable critical habitat by keeping the right-of-way in low vegetation benefiting the long-term condition of critical habitat in the Samish River watershed.

The Gifford Pinchot National Forest Beaver Pond restoration project will occur on 12 acres of designated critical habitat for Oregon spotted frog in Critical Habitat Unit 5 (White Salmon River Unit). Removal of invasive plant species via manual and herbicide treatment over a five-year period (2018-2023) may have short-term adverse effects to breeding and rearing habitat (PCE 1) and reduction in refugia habitat (PCE 3) for Oregon spotted frog; however, the long-term effects of invasive plant species removal and restoring more native species is expected to result in long-term benefits of suitable habitat. The action will not create permanent physical or biological barriers to movement of individuals (PCE 2).

Climate Change

Our analyses under the Endangered Species Act include consideration of ongoing and projected changes in climate. The terms “climate” and “climate change” are defined by the Intergovernmental Panel on Climate Change (IPCC). The term “climate” refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2007a, p. 78). The term “climate change” thus refers to a change in the mean or variability of one or more measures of climate (e.g., temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2007a, p. 78).

Global climate projections are informative, and, in some cases, the only or the best scientific information available for us to use. However, projected changes in climate and related impacts can vary substantially across and within different regions of the world (e.g., IPCC 2007a, pp. 8–12). Therefore, we use “downscaled” projections when they are available and have been developed through appropriate scientific procedures, because such projections provide higher resolution information that is more relevant to spatial scales used for analyses of a given species (see Glick *et al.* 2011, pp. 58–61, for a discussion of downscaling). With regard to our analysis for the Oregon spotted frog, downscaled projections are available.

The climate in the Pacific Northwest (PNW) has already experienced a warming of 0.8 degrees Celsius (C) (1.4 degrees Fahrenheit (F)) during the 20th century (Mote *et al.* 2008, p.3). Using output from eight climate models the PNW is projected to warm further by 0.6 to 1.9 degrees C (1.1 to 3.4 degrees F) by the 2020s, and 0.9 to 2.9 degrees C (1.6 to 5.2 degrees F) by the 2040s (Mote *et al.* 2008, pp. 5–6). Additionally, the majority of models project wetter winters and drier summers (Mote *et al.* 2008, p.7), and of greatest consequence, a reduction in regional snowpack, which supplies water for ecosystems during the dry summer (Mote *et al.* 2003). The small summertime precipitation increases projected by a minority of models do not change the fundamentally dry summers of the PNW and do not lessen the increased drying of the soil column brought by higher temperatures (Mote *et al.* 2003, p. 8).

Snowmelt-dominated watersheds, such as White Salmon in Washington and the Upper Deschutes, Little Deschutes, and Klamath River sub-basins in Oregon, will likely become transient, resulting in reduced peak spring streamflow, increased winter streamflow, and reduced late summer flow (Littell *et al.* 2009, p. 8). In snowmelt-dominated watersheds that prevail in the higher altitude catchments and in much of the interior Columbia Basin, flood risk will likely decrease, and summer low flows will decrease in most rivers under most scenarios (Littell *et al.* 2009, p. 13).

Climate change models predict that water temperatures will rise throughout Oregon as air temperatures increase into the 21st century. A decline in summer stream flow may exacerbate water temperature increases as the lower volume of water absorbs solar radiation (Chang and Jones, p. 134).

Analyses of the hydrologic responses of the upper Deschutes basin (including the Upper and Little Deschutes River sub-basins) and the Klamath River basin to climate change scenarios indicates that the form of precipitation will shift from predominately snow to rain and cause decreasing spring recharge and runoff and increasing winter recharge and runoff (Waibel 2011, pp., 57–60; Mayer and Naman 2011, p. 3). However, there is spatial variation within the Deschutes sub-basins as to where the greatest increases in recharge and runoff will occur (Waibel 2011, pp., 57–60). Changes in seasonality of stream flows may be less affected by climate change along the crest of the Cascades in the upper watersheds of the Deschutes, Klamath, and Willamette River basins in Oregon, where many rivers receive groundwater recharge from subterranean aquifers and springs (Chang and Jones 2010, p. 107). Summer stream flows may thus be sustained in High Cascade basins that are groundwater fed (Chang and Jones 2010, p. 134). Conversely, Mayer and Naman (2011 p. 1) indicate that streamflow into Upper Klamath Lake will display absolute decreases in July-September base flows in groundwater basins as compared to surface-dominated basins. This earlier discharge of water in the spring will result in less streamflow in the summer (Mayer and Naman 2011, p. 12).

Although predictions of climate change impacts do not specifically address Oregon spotted frogs, short- and long-term changes in precipitation patterns and temperature regimes will likely affect wet periods, winter snowpack, and flooding events (Chang and Jones 2010). These changes are likely to affect amphibians through a variety of direct and indirect pathways, such as range shifts, breeding success, survival, dispersal, breeding phenology, aquatic habitats availability and quality, food webs, competition, spread of diseases, and the interplay among these factors (Blaustein *et al.* 2010 entire; Hixon *et al.* 2010, p. 274; Corn 2003 entire). Amphibians have species-specific temperature tolerances, and exceeding these thermal thresholds is expected to reduce survival (Blaustein *et al.* 2010, pp. 286–287). Earlier spring thaws and warmer ambient temperatures may result in earlier breeding, especially at lower elevations in the mountains where breeding phenology is driven more by snowpack than by air temperature (Corn 2003, p. 624). Shifts in breeding phenology may also result in sharing breeding habitat with species not previously encountered and/or new competitive interactions and predator/prey dynamics (Blaustein *et al.* 2010. pp. 288, 294). Oregon spotted frogs are highly aquatic and reductions in summer flows may result in summer habitat going dry, potentially resulting in increased mortality or forcing frogs to seek shelter in lower quality wetted areas where they are more susceptible to predation.

Amphibians are susceptible to many types of pathogens including trematodes, copepods, fungi, oomycetes, bacteria, and viruses. Changes in temperature and precipitation could alter host-pathogen interactions and/or result in range shifts resulting in either beneficial or detrimental impacts on the amphibian host (Blaustein *et al.* 2010, p. 296). Kiesecker *et al.* (2001a, p. 682) indicate climate change events, such as El Nino/Southern Oscillation, that result in less precipitation and reduced water depths at egg-laying sites results in high mortality of embryos because their exposure to UV-B and vulnerability to infection (such as Saprolegnia) is increased. Warmer temperatures and less freezing in areas occupied by bullfrogs is likely to increase bullfrog winter survivorship, thereby increasing the threat from predation. Uncertainty about climate change impacts does not mean that impacts may or may not occur; it means that the risks of a given impact are difficult to quantify (Schneider and Kuntz-Duriseti 2002, p. 54; Congressional Budget Office 2005, entire; Halsnaes *et al.* 2007, p. 129). Oregon spotted frogs occupy habitats at a wide range of elevations, and all of the occupied sub-basins are likely to experience precipitation regime shifts; therefore, the Oregon spotted frog’s response to climate change is likely to vary across the range and the population-level impacts are uncertain. The interplay between Oregon spotted frogs and their aquatic habitat will ultimately determine their population response to climate change. Despite the potential for future climate change throughout the range of the species, as discussed above, we have not identified, nor are we aware of any data on, an appropriate scale to evaluate habitat or population trends for the Oregon spotted frog or to make predictions about future trends and whether the species will be significantly impacted.

Literature Cited for Osf Status of the Species and Critical Habitat

Adams, M.J., D. W. Miller, E. Muths, P. S. Corn, E.H. C. Grant, L. L. Bailey, G. M. Fellers, R. N. Fisher, W. J. Sadinski, H. Waddle, and S. C. Walls. 2013. Trends in Amphibian Occupancy in the United States. PLoS ONE 8(5): e64347.

Adams, M.J., C.A. Pearl, B. McCreary, and S.K. Galvan. 2014. Short-term occupancy and abundance dynamics of the Oregon spotted frog (*Rana pretiosa*) across its core range. U.S. Geological Survey, Reston, Virginia. 18 pp.

Baird, S.F., and C. Girard. 1853. Communication regarding *Rana pretiosa* and *Bufo columbiensis*. Proceedings of the Academy of Natural Sciences Philadelphia 6: 378–379.

Blouin, M., I.C. Phillipsen, and K.J. Monsen. 2010. Population structure and conservation genetics of the Oregon spotted frog, *Rana pretiosa*. Conservation Genetics 11: 2179-2194.

Blaustein, A.R., S.C. Walls, B.A. Bancroft, J.J. Lawler, C.L. Searle, S.S. Gervasi. 2010. Direct and indirect effects of climate change on amphibian populations. Diversity 2: 281-313.

Canadian Oregon Spotted Frog Recovery Team (COSFRT). 2012. Recovery strategy for the Oregon Spotted Frog (*Rana pretiosa*) in British Columbia. Prepared for the B.C. Ministry of Environment, Victoria, BC. 59 pp.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2011. COSEWIC assessment and status report on the Oregon spotted frog *Rana pretiosa* in Canada. COSEWIC. Ottawa. xi + 47 pp. (www. sararegistry.gc.ca/status/status_e.cfm).

Cook, F.R. 1984. Introduction to Canadian amphibians and reptiles. National Museums of Canada, Ottowa. 200pp.

Corn, P.S. 2003. Amphibian breeding and climate change: importance of snow in the mountains. Conservation Biology 17: 622-625.

Cushman, K.A. and C.A. Pearl. 2007. A conservation assessment for the Oregon spotted frog (*Rana pretiosa*). U.S. Department of Agriculture Forest Service Region 6, U.S. Department of Interior Bureau of Land Management Oregon and Washington. 46 pp.

Engler, J., and D.C. Friesz. 1998. Draft 1998 Oregon spotted frog breeding surveys, Conboy Lake National Wildlife Refuge, Klickitat County, Washington. Unpublished Report. 5 pp.

Funk, W.C., C.A. Pearl, H.M. Draheim, M.J. Adams, T.D. Mullins, and S.M. Haig. 2008. Range-wide phylogeographic analysis of the spotted frog complex (*Rana luteiventris* and *Rana pretiosa*) in the northwestern North America. Molecular Phylogenetics and Evolution 46:198-210.

Glick, P., B.A. Stein, and N.A. Edelson (eds.). 2011. Scanning the conservation horizon: a guide to climate change vulnerability assessment. National Wildlife Federation, Washington, DC. 168 pp.

Green, D.M., T.F. Sharbel, J. Kearsley, and H. Kaiser. 1996. Postglacial range fluctuation, genetic subdivision and speciation in the western North American spotted frog complex, *Rana pretiosa*. Evolution 50:374–390.

Green, D.M., H. Kaiser, T.F. Sharbel, J. Kearsley, and K.R. McAllister. 1997. Cryptic species of spotted frogs, *Rana pretiosa* complex in western North America. Copeia 1997:1–8.

Green, D.M. 2003. The ecology of extinction: population fluctuation and decline in amphibians, Biological Conservation 111: 331-343.

Hallock, L., and S. Pearson. 2001. Telemetry study of fall and winter Oregon spotted frog (*Rana pretiosa*) movement and habitat use at Trout Lake, Klickitat County, Washington. Unpublished report to Washington State Department of Transportation and Washington Department of Natural Resources Natural Areas Program. 20 pp.

Halsnaes, K., P. Shukla, D. Ahuja, G. Akumu, R. Beale, J. Edmonds, C. Gollier, A. Grübler, M. Ha Duong, A. Markandya, M. McFarland, E. Nikitina, T. Sugiyama, A. Villavicencio, and J. Zou. 2007. Framing issues. In Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [B. Metz, O. R. Davidson, P. R. Bosch, R. Dave, L. A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Hammerson, G.A. 2005. Population/Occurrence delineation for ranid frogs. Available on-line at NatureServe Explorer http://www.natureserve.org. [Accessed 6 March 2012].

Hayes, M.P. 1994. The spotted frog (*Rana pretiosa*) in western Oregon. Part I. Background. Part II. Current status. Oregon Department of Fish and Wildlife Technical Report 94–1–01. Unpublished Report.

Hayes, M.P. 1997. Status of the Oregon spotted frog (*Rana pretiosa* sensu stricto) in the Deschutes basin and selected other systems in Oregon and northeastern California with a rangewide synopsis of the species' status. Final report prepared for The Nature Conservancy under contract to the U.S. Fish and Wildlife Service, Portland, Oregon. Unpublished Report. 57 pp.

Hayes, M.P., J.D. Engler, R.D. Haycock, D.H. Knopp, W.P. Leonard, K.R. McAllister, and L.L. Todd. 1997. Status of the Oregon spotted frog (*Rana pretiosa*) across its geographic range. Oregon Chapter of the Wildlife Society, Corvallis, Oregon

Hayes, M.P. 1998. The Buck Lake Oregon spotted frog (*Rana pretiosa*) population (Spencer

Creek System, Klamath County, Oregon). Final report prepared for the Bureau of Land Management and The Nature Conservancy under contract to Winema National Forest. Unpublished Report. 22 pp.

Hayes, M.P., J.D. Engler, D.C. Friesz, and K. Hans. 2000. Oregon spotted frog (*Rana pretiosa*) oviposition at Conboy National Wildlife Refuge (Klickitat County, Washington): management implications of embryonic mortality. Final report to U.S. Fish and Wildlife Service. Lacey, Washington. 14 pp.

Hayes, M.P., J.D. Engler, S.Van Leuven, D.C. Friesz, T. Quinn, and D.J. Pierce. 2001. Overwintering of the Oregon spotted frog (*Rana pretiosa*) at Conboy Lake National Wildlife Refuge, Klickitat County, Washington, 2000-2001. Final Report to Washington Department of Transportation. June 2001. 86 pp.

Hixon, M.A., S.V. Gregory, W.D. 2010. Oregon's Fish and Wildlife in a Changing Climate. Chapter 7, Oregon Climate Change Research Institute (2010), Oregon Climate Assessment Report, K.D. Dello and P.W. Mote (eds). College of Oceanic and Atmospheric Sciences, Oregon State University, Corvallis, OR.

Intergovernmental Panel on Climate Change (IPCC). 2007. Regional climate projections. Chapter 11 In: Climate Change 2007: the physical science basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Christensen, J.H., B. Hewitson, A. Busuioc, A. Chen, X. Gao, I. Held, R. Jones, R.K. Kolli, W.-T. Kwon, R. Laprise, V. Magaña Rueda, L. Mearns, C.G. Menéndez, J. Räisänen, A. Rinke, A. Sarr and P. Whetton. (Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller, editors.) Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. 94 pp.

Kiesecker, J.M., A.R. Blaustein, and C.L. Miller. 2001. Potential mechanisms underlying the displacement of native red-legged frogs by introduced bullfrogs. Ecology 82: 1964-1970.

Lande, R. 1988. Genetics and demography in biological conservation. Science 241:1455-1460.

Leonard, W. P., H.A. Brown, L.L.C. Jones, K.R. McAllister, and R.M. Storm. 1993. Amphibians of Washington and Oregon. Seattle Audubon Society, Seattle, Washington. 168 pp.

Licht, L.E. 1971. Breeding habits and embryonic thermal requirements of the frogs *Rana aurora aurora* and *Rana pretiosa pretiosa* in the Pacific Northwest. Ecology 52:116–124.

Licht, L.E. 1974. Survival of embryos, tadpoles, and adults of the frogs *Rana aurora aurora* and *Rana pretiosa pretiosa* sympatric in southwestern British Columbia. Canadian Journal of Zoology 52:613–627.

Littell, J.S., M. McGuire Elsner, L.C. Whitely Binder, and A.K. Snover (eds). 2009. The Washington Climate Change Impacts Assessment: Evaluating Washington's Future in a Changing Climate - Executive Summary. In: The Washington Climate Change Impacts Assessment: Evaluating Washington's Future in a Changing Climate, Climate Impacts Group, University of Washington, Seattle, Washington.

Mayer, T.D. and S.W. Naman. 2011. Streamflow response to climate as influenced by geology and elevation. Journal of the American Water Resources Association 47: 724-738.

McAllister, K.R., W.P. Leonard. And R. M. Storm. 1993. Spotted frog (Rana pretiosa) surveys in the Puget trough of Washingtone, 1989-1991. Northwestern Naturalist, Vol 74, No 1, pp. 10-15.

McAllister, K.R., and W.P. Leonard. 1997. Washington State status report for the Oregon spotted frog. Washington Department of Fish and Wildlife, Olympia. 38 pp.

McAllister, K.R. and M. Walker. 2003. An inventory of Oregon spotted frogs (*Rana pretiosa*) in the upper Black River drainage, Thurston County, Washington. Unpublished report. Washington Department of Fish and Wildlife, Olympia. 12 pp.

McAllister, K.R. and H.Q. White. 2001. Oviposition ecology of the Oregon spotted frog at Beaver Creek, Washington. Unpublished report. Washington Department of Fish and Wildlife, Olympia. 24 pp.

Mote, P.W., E.A. Parson, A.F. Hamlet, W.S.Keeton, D. Lettenmaier, N. Mantua, E.L. Miles, D.W. Peterson, D.L. Peterson, R. Slaughter, and A.K. Snover. 2003. Preparing for climate change: The water, salmon, and forests of the Pacific Northwest. Climate Change 61: 45-88.

Mote, P., E. Salathe, V. Duliere, and E. Jump. 2008. Scenarios of future climate for the Pacific Northwest. A report for the Climate Impacts Group, University of Washington, Seattle, Washington. 12pp.

Nussbaum, R.A., E.D. Brodie, Jr., and R.M. Storm. 1983. Amphibians and reptiles of the Pacific Northwest. University of Idaho Press, Moscow.

Pearl, C.A. and R.B. Bury. 2000. The Oregon spotted frog (*Rana pretiosa*) in the Three Sisters Wilderness Area, Oregon: 1999 findings. Unpublished report to U.S. Fish and Wildlife Service, Portland, Oregon. 14 pp.

Pearl, C.A. and M.P. Hayes. 2004. Habitat associations of the Oregon spotted frog (*Rana pretiosa*): A literature review. Final Report. Washington Department of Fish and Wildlife, Olympia, Washington, USA.

Pearl, C.A., J. Bowerman and D. Knight. 2005. Feeding behavior and aquatic habitat use by Oregon spotted frogs (*Rana pretiosa*) in central Oregon. Northwestern Naturalist 86: 36-38.

Pearl, C., D. Clayton, and L. Turner. 2010. Surveys for presence of Oregon spotted frog (*Rana pretiosa*): background information and field methods. Unpublished report. 49 pp.

Pearl, C. A., B. McCreary, J.C. Rowe and M. Adams. 2018. Late-Season Movement and Habitat Use by Oregon Spotted Frog (Rana Pretiosa) in Oregon, USA. Copeia, 106(3): 539-549.

Phillipsen, I.C., J. Bowerman, and M. Blouin. 2010. Effective number of breeding adults in Oregon spotted frogs (*Rana pretiosa*): genetic estimates at two life stages. Conservation Genetics 11:737-745.

Risenhoover, K.L., T.C. McBride, K. McAllister and M. Golliet. 2001. Overwintering behavior of the Oregon Spotted Frog (*Rana pretiosa*) along Dempsey Creek, Thurston County, Washington. Unpublished report submitted to Washington Department of Transportation, Olympia. 26 pp. + appendices.

Rombough, C.R., M.P. Hayes, and J.D. Engler. 2006. *Rana pretiosa* (Oregon Spotted Frog) maximum size. Herpetological Review 37: 210.

Schneider, S.H., and K. Kuntz-Duriseti. 2002. Uncertainty and climate change policy in Climate Change Policy: A Survey. (Schneider, S.H., A. Rosencranz, and J.O. Niles, editors). Island Press, Washington D.C. 584 pp.

Tattersall, G.J. and G.R. Ultsch. 2008. Physiological ecology of aquatic overwintering in ranid frogs. Biological Reviews 83:119-140.

U.S. Fish and Wildlife Service (USFWS). 2014. Endangered and Threatened Wildlife and Plants: Threatened Status for Oregon spotted frog Final Rule. Federal Register 79 (168): 51658 - 51710.

U.S. Fish and Wildlife Service (USFWS). 2016. Endangered and Threatened Wildlife and Plants: Designation of Critical Habitat for the Oregon spotted frog; Final Rule. Federal Register 81 (91): 29336-29396.

Waibel, M.S. 2011. Model analysis of the hydrologic response to climate change in the Upper Deschutes Basin, Oregon. Thesis. Portland State University.

Watson, J.W., K.R. McAllister, D.J. Pierce, and A. Alvarado. 1998. Movements, habitat selection, and population characteristics of a remnant population of Oregon spotted frogs (*Rana pretiosa*). Annual Progress Report. Washington Department of Fish and Wildlife, Olympia, Washington. 19 pp.

Watson, J.W., K.R. McAllister, D.J. Pierce, and A. Alvarado. 2000. Ecology of a remnant population of Oregon spotted frogs (*Rana pretiosa*) in Thurston County, Washington. Final Report. Washington Department of Fish and Wildlife, Olympia, Washington. 84 pp.

Watson, J.W., K.R. McAllister, and D.J. Pierce. 2003. Home ranges, movements, and habitat selection of Oregon spotted frogs (*Rana pretiosa*). Journal of Herpetology 37:292−300.

Personal Communications

Bowerman, Jay. Sunriver Nature Center, October 4, 2006, email communications with Deanna Lynch, USFWS Western Washington Fish and Wildlife Office, regarding Oregon spotted frog – update on activities.

Engler, Joe. USFWS Conboy Lake National Wildlife Refuge, July 22, 1999, written communication with Dr. L. Karolee Owens, USFWS Western Washington Fish and Wildlife Office, regarding comments on Oregon spotted frog proposed rule.

Hallock, Lisa. Washington Department of Natural Resources, February 11, 2009, email communications with Deanna Lynch, USFWS Western Washington Fish and Wildlife Office, regarding Annual update of Oregon spotted frog species assessment.

McAllister, Kelly. Washington Department of Fish and Wildlife, January 9, 2006 email communications with Deanna Lynch, USFWS Western Washington Fish and Wildlife Office, regarding Oregon spotted frog egg mass surveys.

Morgan, Kendra. British Columbia Ministry of the Environment, April 16, 2019, Minutes from the Washington Oregon spotted frog Workgroup recorded by F Teal Waterstrat, USFWS Washington Field Office, regarding Canadian Survey results in 2019.

APPENDIX I

STATUS OF THE SPECIES AND STATUS OF CRITICAL HABITAT-FENDERS BLUE BUTTERFLY

Prairie Environments

Prairies are open native grasslands with little tree cover or the grassland understories of savanna habitats (USFWS 2010). Native prairies are among the most endangered ecosystems in the United States (Noss et al. 1995). Although once widespread in the region, today prairies "… are invariably small, moderately to heavily disturbed, and geographically disjunct" (Altman et al. 2001). Moist winters, dry summers and gentle topography are necessary to produce a prairie, but prairies will generally only persist when regular fire, flooding or other disturbance prevents succession to woody vegetation (USFWS 2010). Disturbances can be natural, such as wildfire, although most present-day disturbances are anthropogenic (e.g., prescribed fire or mowing). In the absence of regular disturbance, the prairies may be overtaken by shrubs and trees, which shade and crowd out the open grasslands and the species that depend on them, ultimately allowing succession to forest habitat.

The quantity and quality of prairies habitats across the Pacific Northwest has declined substantially (Crawford and Hall 1997, Noss et al. 1995). For example, prairies that once covered over 145,000 acres of the south Puget Sound region have largely been lost over the past 150 years (Crawford and Hall 1997). The primary causes of prairie habitat loss in the region are attributed to the conversion of prairie habitat to urban development and agricultural uses (over 60% of losses), and succession to Douglas-fir forest (32%) (Crawford and Hall 1997). Today approximately 8% of the original prairies in the south Puget Sound area remain, but only about 3% contain native prairie vegetation (Crawford and Hall 1997, p.11). In the remaining prairies, many of the native bunchgrass communities have been replaced by nonnative pasture grasses. In the Willamette Valley, Oregon, native grassland has been reduced from the most common vegetation type to scattered parcels intermingled with rural residential development and farmland. It is estimated that less than 1% of the native grassland and savanna remains in Oregon (Altman et al. 2001).

Historically, the prairies in the Northwest are thought to have been actively maintained by the native peoples of the region, who lived here for at least 10,000 years before the arrival of Euro-American settlers (Boag 1992). Prairies were burned to increase growth of favored food plants and to improve conditions for hunting game (Boyd 1986). Frequent burning reduced the abundance of shrubs and trees, favoring open prairies or savannas with a rich variety of native plants and animals. After Euro-American settlement, regular burning of prairies ceased, and most of the grasslands were gradually developed for agricultural or urban uses (Altman et al. 2001). Woody species and non-native weeds encroached on the remaining prairie habitats. The decline in prairies and their increased fragmentation has led to the decline of many native prairie plants and animals (Altman et al. 2001). Even so, remnants of these highly diverse, complex, and poorly understood ecosystems provide necessary habitat for many rare species.
Today, the major factors in the decline of prairie species have been: 1) alteration of natural and human-mediated disturbance processes (e.g., fire and flooding) that maintained the early seral stage of the plant communities; 2) habitat conversion to agricultural landscapes through livestock

grazing and croplands; 3) urbanization, which results in the permanent loss of native prairies; and 4) invasion by non-native plants (Altman et al. 2001, Wilson et al. 2003). The loss, degradation and fragmentation of prairies have had cascading effects to species dependent on those habitats, resulting in fewer and smaller population sizes, loss of genetic diversity, reduced gene flow among populations, destruction of population structure, and increased susceptibility to local population extirpation caused by environmental catastrophes.

Legal Status

Fender's blue butterfly was listed as endangered, without CH, on January 25, 2000 (USFWS 2000). Critical habitat for the butterfly was designated on October 6, 2006 (USFWS 2006a). A final recovery plan that includes the Fender's blue butterfly (Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington) was published by the Service in May 2010 (USFWS 2010). Critical habitat units for the Fender's blue butterfly have been designated in Benton, Lane, Polk and Yamhill Counties, Oregon.

Species Description

The Fender's blue butterfly belongs to the group of blue butterflies in the family Lycaenidae. The Fender's blue butterfly is one of about a dozen subspecies of Boisduval's blue butterfly (*Icaricia icarioides*) found only in western North America. Fender's blue butterfly is small, with a wingspan of approximately 25 mm (1 inch). The upper wings of the males are brilliant blue in color and the borders and basal areas are black. The upper wings of the females are completely brown. The undersides of the wings of both sexes are creamish tan with black spots surrounded by a fine white border or halo. The dark spots on the underwings of male butterflies are small. In contrast, the dark spots on the underwings of the pembina blue butterfly (*Icaricia icariodes pembina*) are surrounded with wide white haloes, and the underside of the hindwings of Boisduval's blue butterfly (*Icaricia icariodes*) is very pale whitish gray with broad haloes around the black spots (Schultz et al. 2003).

Life History

Fender's blue butterfly populations occur on upland prairies characterized by native fescue spp. (bunch grasses). The association of Fender's blue butterfly with upland prairie is mostly a result of its dependence on lupine host plants, although the butterfly also uses wet prairies for nectaring and dispersal habitat. Sites occupied by the Fender's blue butterfly are predominantly located on the western side of the Willamette Valley, within 33 km (21 miles) of the Willamette River. Adult Fender's blue butterfly live approximately 10-15 days and are estimated to travel approximately 2 km (1.2 miles) over their life span (Schultz 1998). Although only limited observations have been made of the early life stages of the butterfly, the life cycle of the species likely is similar to other subspecies of *Icaricia icarioides* (Hammond and Wilson 1993). The life cycle of Fender's blue butterfly may be completed in one year. An adult female butterfly may lay approximately 350 eggs over her 10-15 day lifespan, of which perhaps fewer than two will survive to adulthood (Schultz 1998, Schultz et al. 2003). Females lay their eggs on Kincaid's lupine (*Lupinus sulphureus* ssp. *kincaidii*), longspur lupine, (*Lupinus arbustus*) or sickle-keeled lupine (*Lupinus albicaulis*), which are the larval food plants, during May and June (Ballmer and Pratt 1988). Newly hatched larvae feed for a short time, reaching their second instar in the early summer, at which point they enter an extended diapause. Diapausing larvae remain in the leaf litter at or near the base of the host plant through the fall and winter when the lupine plant senesces. Larvae become active again in March or April of the following year. Some larvae may be able to extend diapause for more than one season depending upon the individual and environmental conditions. Once diapause is broken, the larvae feed and grow through three to four additional instars, enter their pupa stage, and after about two weeks emerge as adult butterflies in May and June (Schultz et al. 2003).

Fender's blue butterfly is believed to have limited dispersal ability, potentially remaining within 2 km (1.2 miles) of their natal lupine patch (Schultz 1998). However, anecdotal evidence exists of adult butterflies dispersing as far as 5 to 6 km (3.1 to 3.7 miles) (Hammond and Wilson 1993, Schultz 1998). Habitat fragmentation makes dispersal of this magnitude less likely to occur so recovery strategies focus on establishing "functioning networks" to ensure connectivity between habitat patches (USFWS 2010). A study at the main area of Willow Creek in Lane County, showed 95% of adult Fender's blue butterfly are found within 10 m (33 feet) of large lupine patches (Schultz 1998).

Habitat requirements for Fender's blue butterfly include lupine host plants (Kincaid's lupine, longspur lupine, and sickle-keeled lupine) for larval food and oviposition sites and wildflowers for adult nectar food sources. Documented native nectar sources include species such as: narrowleaved onion (*Allium amplectens*), Tolmie star-tulip (*Calochortus tolmiei*), rose checker-mallow (*Sidalcea malviflora* ssp. *virgata*), common woolly sunflower (*Eriophyllum lanatum*), and Oregon geranium (*Geranium oreganum*) (Wilson et al. 1997, York 2002, Schultz et al. 2003). Non-native vetches and other flowers are also frequently used as nectar sources, although they are considered inferior to the native nectar sources (Schultz et al. 2003). An estimated 5 to 15 acres of high density lupine habitat are necessary to support a population of Fender's blue butterfly (Crone and Schultz 2003, Schultz and Hammond 2003). However, most prairie remnants are degraded areas, with very patchy distribution of lupine resources. Therefore, larger prairie patches, with on-going management to improve and maintain habitat quality, are necessary to support a viable Fender's blue butterfly populations.

Kincaid's lupine is the larval host plant at most known Fender's blue butterfly population sites. At two sites, Coburg Ridge and Baskett Butte, the butterfly feeds primarily on longspur lupine, although small amounts of Kincaid's lupine is present (Schultz et al. 2003). Sickle-keeled lupine is used by the butterfly where it occurs in poorer quality habitats (Schultz et al. 2003). It is interesting to note that Fender's blue butterfly has not been found to use broadleaf lupine (*Lupinus latifolius*), a plant commonly used as a food source by other subspecies of *Icaricia icarioides*, even though it occurs in habitats occupied by the butterfly (Schultz et al. 2003).

Population Status

The historic distribution of Fender's blue butterfly is not precisely known due to the limited information collected on this species prior to its description in 1931. Although the type specimen for this butterfly was collected in 1929, few collections were made between the time of the subspecies' discovery and Macy's last observation of the butterfly on May 23, 1937, in Benton County, Oregon (Hammond and Wilson 1992). Uncertainty regarding the butterfly's host plant caused researchers to focus their survey efforts on common lupine species known to occur in the vicinity of Macy's collections. Fifty years passed before the Fender's blue butterfly was found again.

Fender's blue butterfly was rediscovered in 1989 at the McDonald Research Forest, Benton County, Oregon. The species was found to be associated primarily with Kincaid's lupine and occasionally longspur and sickle-keeled lupine (Hammond and Wilson 1993). Past survey efforts have determined that Fender's blue butterfly is endemic to the Willamette Valley and persists at about thirty sites on remnant prairies in Linn, Yamhill, Polk, Benton, and Lane counties (Hammond and Wilson 1993, Schultz 1996, Schultz et al. 2003). Extensive survey efforts have resulted in the discovery of several subpopulations and populations that were not known when Fender's blue butterfly was listed as endangered. Most significantly, in 2011, a large Fender's blue butterfly population was found at Hagg Lake in Washington County, Oregon (Hammond 2011). In 2014, the Service introduced Fender's blue butterfly to the William Finley National Wildlife Refuge and intend to augment the population in 2015-2016 (Severns and Fitzpatrick 2015). The status of Fender's blue butterfly has improved since the species was listed as endangered, primarily due to the number of sites that are now actively managed to improve habitat conditions and the discovery of several subpopulations and populations that were not previously known. As of 2014, Fender's blue butterfly was found at an estimated 67 sites in Oregon with a total species abundance estimate of approximately 16,664 adults (Fitzpatrick 2014). A summary of annual, range-wide species abundance is provided in **Error! Reference source not found.** (Fitzpatrick 2014).

Table 11. Annual Range-wide Fender's Blue Butterfly Population Estimates (Fitzpatrick 2014).

Year	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Estimate	3,391	1,713	3,843	4,490	5,996	2,017	3,525	5,355	2,309	6,064	4,531	3,761	13,011	15,029	16,644

It is difficult and costly to assess Fender's blue butterfly annual population abundance due to the short flight season of adults, variable weather conditions, species distribution, and the presence of other blue butterflies (Collins et al. 2011). In order to improve the accuracy of range-wide annual population estimates, more intensive and costly monitoring efforts were initiated in 2012 (Collins et al. 2011, Hicks 2012). Specifically, distance sampling is now being implemented at the largest habitat areas supporting the largest Fender's blue butterfly populations and peak count assessments are being conducted at smaller sites. Peak count estimates are less expensive because they only involve a single site visit. However, these surveys have limited accuracy since it is difficult to predict when peak flight will occur and the method assumes 100% detection of the individuals which is impossible to obtain. Distance sampling is a method for estimating abundance that takes into account the probability of detection, and is implemented by recording the distance from the observer to each observation (Buckland 2001). Distance sampling transect counts are collected several times throughout the flight season and are processed with Insect Count Analyzer (INCA) to provide a population estimate (Hicks 2011). In 2012, there was significant increase in Fender's blue butterfly abundance estimates (Table 23). The magnitude of this increase is actually a reflection of the change in abundance estimate methodologies implemented in that year.

Threats, Reasons for Listing
Habitat loss, encroachment of shrubs and trees into prairie habitats due to fire suppression, fragmentation, invasion by non-native plants, and elimination of natural disturbance regimes all threaten the survival of Fender's blue butterfly. Few populations occur on protected lands. Most occur on private lands which are not managed to maintain native prairie habitats. These populations are at high risk of loss to development or continuing habitat degradation (USFWS 2000).

The prairies of western Oregon and southwestern Washington have been overtaken by non-native plants that shade-out or crowd-out important native species. Fast growing non-native shrubs Himalayan blackberry (*Rubus armeniacus*) and Scotch broom (*Cytisus scoparius*), non-native grasses such as tall oatgrass (*Arrhenatherum elatius*), and non-native forb, such as meadow knapweed (*Centaurea debeauxii*), can virtually take over the prairies, inhibiting the growth of the lupine host plants and native nectar sources (Hammond 1996, Schultz et al. 2003). When these highly invasive non-native plants become dominant, they can effectively preclude Fender's blue butterfly from using the native plant species the butterfly needs to survive and reproduce (Hammond 1996). In the absence of a regular disturbance regime, succession of native trees and shrubs also threaten to alter prairie habitats. Common native species found to encroach on undisturbed prairies include Douglas-fir (*Pseudotsuga menziesii*), Oregon white oak (*Quercus garryana*), Oregon ash (*Fraxinus latifolia*), Douglas' hawthorn (*Crataegus douglasii*) and Pacific poison oak (*Toxicodendron diversilobum*).

Habitat fragmentation has isolated some Fender's blue butterfly populations to such an extent that butterfly movement among suitable habitat patches may now occur only rarely. This reduction in movement is not expected to maintain the population over time (Schultz 1998). The rarity of host lupine patches and fragmentation of habitat are thought to be the major ecological factors limiting reproduction, dispersal, and subsequent colonization of new habitat (Hammond and Wilson 1993, Hammond 1994, Schultz 1997, Schultz and Dlugosch 1999). Extirpation of remaining small populations as a result of localized events and/or probable low genetic diversity associated with small populations is expected (Schultz and Hammond 2003).

Previous population viability analyses determined that the Fender's blue butterfly is at high risk of extinction throughout most of its range (Schultz and Hammond 2003). However, several relatively large populations have been found that were not previously known to occur and methodologies for population estimates have been improved (Collins et al. 2011, Hicks 2012) data quality. Therefore, the Service is currently evaluating options for completing another population viability analysis with more current and improved data.

Recovery Measures
Biologists from Federal and state agencies and private conservation organizations are engaged in active research and monitoring programs to improve the status of Fender's blue butterfly. Recent research has focused on population viability analyses (Schultz and Hammond 2003), metapopulation dynamics and the effects of habitat fragmentation (Schultz 1998), population response to habitat restoration (Wilson and Clark 1997, Kaye and Cramer 2003, Schultz et al. 2003), and developing protocols for captive rearing.

Recent studies have shown that Fender's blue butterfly populations respond positively to habitat restoration. Mowing, burning and mechanical removal of weeds have all resulted in increasing butterfly populations. At two sites in the West Eugene Wetlands, The Nature Conservancy's (TNC's) Willow Creek Natural Area and the BLM's Fir Butte site), both adults and larval Fender's blue butterflies have increased in number following mowing to reduce the stature of herbaceous non-native vegetation, although the response to habitat restoration is often complicated by other confounding factors, such as weather fluctuations (Schultz and Dlugosch 1999, Fitzpatrick 2005). Wilson and Clark (1997) conducted a study on the effects of fire and mowing on Fender's blue butterfly and its native upland prairie at Baskett Slough National Wildlife Refuge in the Willamette Valley. Although fire killed all larvae in burned patches, female butterflies from the nearby unburned source patch were able to colonize the entire burned area, including lupine patches that were 107 m (350 feet) from the unburned source plants. They found that Fender's blue butterfly eggs were 10-14 times more abundant in plots that were mowed or burned compared to undisturbed, control plots. Woody plants were reduced 45% with burning and 66% with mowing.

Fender's blue butterfly population trends have been correlated with lupine vigor. High leaf growth appears to produce larger butterfly populations. At the USACE's Fern Ridge Reservoir, the Fender's blue butterfly population has increased dramatically since fall mowing of lupine patches has been implemented. The abundance of Fender's blue butterfly eggs was found to be correlated with the abundance of Kincaid's lupine leaves at a number of study sites (Kaye and Cramer 2003); egg abundance increased substantially at sites which had been treated to control non-native weeds (Schultz et al. 2003).

Fender's blue butterfly populations occur on public lands or lands that are managed by a conservation organization at the Service's Baskett Slough National Wildlife Refuge, the USACE's Fern Ridge Reservoir, the BLM's West Eugene Wetlands, TNC's Willow Creek Preserve and Coburg Ridge easement, and on a small portion of Oregon State University's Butterfly Meadows in the McDonald State Forest. All of these parcels have some level of management for native prairie habitat values. The Partners for Fish and Wildlife Program works with private landowners to restore wildlife habitats. Native prairie restoration and Fender's blue butterfly recovery are key focus areas of the program in the Willamette Valley.

Critical Habitat

Critical habitat for the Fender's blue butterfly was designated November 2, 2005 (70 FR 66492). The PBFs for Fender's Blue butterfly include:

1. Early seral upland prairie, oak savanna habitat with undisturbed subsoils that provides a mosaic of low growing grasses and forbs, and an absence of dense canopy vegetation allowing access to sunlight needed to seek nectar and search for mates.
2. Larval hostplants; *Lupinus sulphureus* ssp. *kincaidii*, *L. arbustus*, and *L. albicaulis.*
3. Adult nectar sources.
4. Steppingstone habitat. Undeveloped open areas with the physical characteristics appropriate for supporting the short-stature prairie, oak/savanna plant community.

APPENDIX J

STATUS OF THE SPECIES AND STATUS OF CRITICAL HABITAT-KINCAID'S LUPINE

Kincaid's lupine is found in dry upland prairies from Lewis County, Washington, in the north, south to the foothills of Douglas County, Oregon; however, most of the known and historical populations are found in the Willamette Valley (USFWS 2010a). Historically, the species was documented from Vancouver Island, British Columbia, Canada (Dunn and Gillet 1966), but has not been located in that region since the 1920s (Kaye 2000). Before Euro-American settlement of the region, Kincaid's lupine was likely well distributed throughout the prairies of western Oregon and southwestern Washington; today, habitat fragmentation has resulted in existing populations that are widely separated by expanses of unsuitable habitat.

Range-wide, Kincaid's lupine is known at about 164 sites, comprising about 608 acres of total coverage (USFWS 2010a). In Oregon, the ONHIC (2014) reported Kincaid's lupine over 100 sites. From these locations, at least 43 populations are considered potential populations that could contribute to recovery; and 25 of those populations have protection in place for Kincaid's lupine.

Until the summer of 2004, Kincaid's lupine was known from just two extant populations in Washington, in the Boistfort Valley in Lewis County, more than 160 km (100 miles) from the nearest population in the Willamette Valley (USFWS 2010a). Arnett (2014) reported a total of 5 populations across 9 sites of Kincaid's lupine in 2014. At two sites, Kincaid's lupine covered more than 1,000 m^2 (1,196 square yards) each (Boistfort and Cowlitz Prairie); only one plant was observed at Drew's Prairie in 2013. Only one location (Lozier Preserve within the Cowlitz Prairie population) has protection for Kincaid's lupine; all other locations are privately owned with no formal protections.

Monitoring the size of Kincaid's lupine populations is challenging because its pattern of vegetative growth renders it difficult to distinguish individuals (Wilson et al. 2003). Instead of counting plants, most monitoring for this species relies on counting the number of leaves per unit area, partly because there is a strong correlation between Fender's blue butterfly egg numbers and lupine leaf density (Schultz 1998, Kaye and Thorpe 2006). Leaf counts are time consuming, however, and recent evaluations have shown that lupine cover estimates are highly correlated with leaf counts, much faster to perform, and useful for detecting population trends (Kaye and Benfield 2005).

Life History and Ecology for Kincaid's Lupine

Kincaid's lupine is a long-lived perennial species that can survive for several decades (Wilson et al. 2003). Individual plants are capable of spreading by rhizomes, producing clumps of plants exceeding 20 m (33 feet) in diameter. Population counts are thus unreliable, and apparently large populations may consist of few genetic individuals. Leaves are oval-palmate, with very narrow leaflets. The small, purplish-blue pea flowers grow in loose racemes that are 15.2 to 20.3 cm (6 to 8 inches) tall.

Flowering begins in April and extends through June (USFWS 2010a). As the summer dry season arrives, Kincaid's lupine becomes dormant, and is completely senescent by mid-August (Wilson et al. 2003). Pollination is largely accomplished by small native bumblebees (*Bombus mixtus* and *B. californicus*), solitary bees (*Osmia lignaria*, *Anthophora furcata*, *Habropoda* sp., *Andrena* spp., *Dialictus* sp.) and occasionally, European honeybees (*Apis mellifera*) (Wilson et al. 2003). Insect pollination appears to be critical for successful seed production (Wilson et al. 2003).

Kincaid's lupine reproduces by seed and vegetative spread. It is able to spread extensively through underground growth. Individual clones can be several centuries old (Wilson et al. 2003), and become quite large with age, producing many flowering stems. As part of a genetic evaluation, collections taken from small populations of Kincaid's lupine at the Baskett Slough National Wildlife Refuge were found to be genetically identical, indicating that the population consists of one or a few large clones (Liston et al. 1995). Reproduction by seed is common in large populations where inbreeding depression is minimized and ample numbers of seeds are produced. In small populations, seed production is reduced and this appears to be due, at least in part, to inbreeding depression (Severns 2003).

Kincaid's lupine is vulnerable to seed, fruit and flower predation by insects, which may limit the production of seeds. Seed predation by bruchid beetles and weevils and larvae of other insects has been documented and may result in substantially reduced production of viable seed (Kaye and Kuykendall 1993, Kuykendall and Kaye 1993). Floral and fruit herbivory by larvae of the silvery blue butterfly (*Glaucopsyche lygdamus columbia*) has also been reported (Kuykendall and Kaye 1993). The vegetative structures of Kincaid's lupine support a variety of insect herbivores, including root borers, sap suckers and defoliators (Wilson et al. 2003).
Kincaid's lupine is the primary larval host plant of the endangered Fender's blue butterfly (Wilson et al. 2003). Female Fender's blue butterflies lay their eggs on the underside of Kincaid's lupine leaves in May and June; the larvae hatch several weeks later and feed on the plant for a short time before entering an extended diapause, which lasts until the following spring (Schultz et al. 2003). Kincaid's lupine, like other members of the genus *Lupinus,* is unpalatable to vertebrate grazers.

Habitat Characteristics for Kincaid's Lupine

In the Willamette Valley and southwestern Washington, Kincaid's lupine is found on upland prairie remnants where the species occurs in small populations at widely scattered sites (USFWS 2010a). A number of populations are found in road rights-of-way, between the road shoulder and adjacent fence line, where they have survived because of a lack of agricultural disturbance. Some of the populations in Washington occur in pastures and appear to benefit from light grazing by livestock, which reduces the cover of competing shrubs and grasses (Arnett 2008). Common native species typically associated with Kincaid's lupine include: *Festuca idahoensis* ssp. *roemeri*, *Danthonia californica*, *Calochortus tolmiei*, *Eriophyllum lanatum*, and *Fragaria virginiana.* The species appears to prefer heavier, generally well-drained soils and has been found on 48 soil types, typically Ultic Haploxerolls, Ultic Argixerolls, and Xeric Palehumults (Wilson et al. 2003).

In Douglas County, Oregon, Kincaid's lupine appears to tolerate more shaded conditions, where it occurs at sites with canopy cover of 50 to 80% (Barnes 2004). In contrast to the open prairie habitats of the more northerly populations, in Douglas County, tree and shrub species dominate the sites, including *Pseudotsuga menziesii* (Douglas-fir), *Quercus kelloggii* (California black oak), *Arbutus menziesii* (Pacific madrone), *Pinus ponderosa* (ponderosa pine), *Calocedrus decurrens* (incense cedar), *Arctostaphylos columbiana* (hairy manzanita) and *Toxicodendron diversilobum*.

In contrast to historical ecosystem composition, invasive non-native species are a significant component of Kincaid's lupine habitat today (USFWS 2010a). Common invasives include: *Arrhenatherum elatius, Brachypodium sylvaticum*, *Dactylis glomerata*, *Festuca arundinacea*, *Rubus armeniacus* and *Cytisus scoparius* (Wilson et al. 2003). In the absence of fire, some native species, such as *Toxicodendron diversilobum* and *Pteridium aquilinum*, invade prairies and compete with Kincaid's lupine.

Threats/ Reasons for Listing for Kincaid's Lupine
A serious long-term threat to all Willamette Valley prairie species is the change in community structure due to plant succession. The vast majority of Willamette Valley prairies would likely be forested if left undisturbed. The natural transition of prairie to forest in the absence of disturbance such as fire will lead to the eventual loss of these prairie sites unless they are actively managed (Johannessen et al. 1971; Kuykendall and Kaye 1993).

The three major threats to *Lupinus sulphureu*s ssp. *kincaidii* populations are habitat loss, competition from non-native plants and elimination of historical disturbance regimes (Wilson et al. 2003, USFWS 2010a). Habitat loss from a wide variety of causes (*e.g.*, urbanization, agriculture, silvicultural practices and roadside maintenance) has been the single largest factor in the decline of *Lupinus sulphureu*s ssp. *kincaidii* (USFWS 2000a). Land development and alteration in the prairies of western Oregon and southwestern Washington have been so extensive that the remaining populations are essentially relegated to small, isolated patches of habitat. Habitat loss is likely to continue as private lands are developed; at least 49 of 54 sites occupied by *Lupinus sulphureu*s ssp. *kincaidii* in 2000 at the time of listing were on private lands and are at risk of being lost unless conservation actions are implemented (USFWS 2000a).

Habitat fragmentation and isolation of small populations may be causing inbreeding depression in *Lupinus sulphureu*s ssp. *kincaidii*. The subspecies was likely widespread historically, frequently outcrossing throughout much of its range, until habitat destruction and fragmentation severely isolated the remaining populations (Liston et al. 1995). There is some evidence of inbreeding depression, which may result in lower seed set (Severns 2003). Hybridization between *Lupinus sulphureu*s ssp. *kincaidii* and *Lupinus arbustus* has been detected at Baskett Slough National Wildlife Refuge (Liston et al. 1995).

Before settlement by Euro-Americans, the regular occurrence of fire maintained the open prairie habitats essential to *Lupinus sulphureu*s ssp. *kincaidii* (USFWS 2010a). The loss of a regular disturbance regime, primarily fire, has resulted in the decline of prairie habitats through succession by native trees and shrubs, and has allowed the establishment of numerous non-native grasses and forbs. Some aggressive non-native plants form dense monocultures, which compete for space, water and nutrients with the native prairie species, and ultimately inhibit the growth and reproduction of *Lupinus sulphureu*s ssp. *kincaidii* by shading out the plants (Wilson et al. 2003). When *Lupinus sulphureu*s ssp. *kincaidii* was listed, we estimated that 83% of upland prairie sites within its range were succeeding to forest (USFWS 2000a).

Recovery Measures for Kincaid's Lupine

Active research efforts have focused on restoring the essential components of Kincaid's lupine habitat by mimicking the historical disturbance regime with the application of prescribed fire, mowing and manual removal of weeds (USFWS 2010a). Research and habitat management programs for Kincaid's lupine have been implemented at several sites, including Baskett Slough National Wildlife Refuge, Bureau of Land Management's Fir Butte site and TNC's Willow Creek Preserve (Wilson et al. 2003, Kaye and Benfield 2005). Prescribed fire and mowing before or after the growing season have been effective in reducing the cover of invasive non-native plants; following treatments, Kincaid's lupine has responded with increased leaf and flower production (Wilson et al. 2003). Research has also been conducted on seed germination, propagation and reintroduction of Kincaid's lupine (Kaye and Kuykendall 2001, Kaye and Cramer 2003, Kaye et al. 2003). Seeds of this species have been banked at the Rae Selling Berry Seed Bank in Portland, Oregon (Portland State Environmental Science and Management 2015). The Bureau of Land Management, Umpqua NF and the Service completed a programmatic conservation agreement for Kincaid's lupine in Douglas County, Oregon, in April 2006 (Roseburg Bureau of Land Management et al. 2006). The objectives of the agreement are: 1) to maintain stable populations of the species in Douglas County by protecting and restoring habitats, 2) to reduce threats to the species on BLM and USFS lands, 3) to promote larger functioning metapopulations, with increased population size and genetic diversity, and 4) to meet the recovery criteria in the Recovery Outline for the species (USFWS 2006b).

Populations of Kincaid's lupine occur on public lands or lands that are managed by a conservation organization at the Service's William L. Finley National Wildlife Refuge and Baskett Slough National Wildlife Refuge, the USACE's Fern Ridge Reservoir, Bureau of Land Management units in Lane and Douglas Counties, the Umpqua NF, TNC's Willow Creek Preserve, and at a small portion of Oregon State University's Butterfly Meadows in the McDonald State Forest (USFWS 2010a). All of these parcels have some level of management for native prairie habitat values.

For additional information on recovery goals, objectives, and criteria, see *Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington (USFWS 2010a)*: http://www.USFWS.gov/oregonfwo/Species/PrairieSpecies/Documents/PrairieSpeciesFinalRecoveryPlan.pdf.

Kincades Lupine Critical Habitat

Critical Habitat. Critical habitat for the Kincaid's lupine was designated November 2, 2005 (70 FR 66492). The PBFs for include:

1. Early seral upland prairie, oak savanna habitat with undisturbed subsoils that provides a mosaic of low growing grasses and forbs, and an absence of dense canopy vegetation allowing access to sunlight needed to seek nectar and search for mates.
2. Larval host-plants; *Lupinus sulphureus* ssp. *kincaidii*, *L. arbustus*, and *L. albicaulis.*
3. Adult nectar sources.
4. Stepping stone habitat. Undeveloped open areas with the physical characteristics appropriate for supporting the short-stature prairie, oak/savanna plant community.

APPENDIX K

STATUS OF THE SPECIES- NELSON'S CHECKERMALLOW

Nelson's checkermallow was listed as Threatened on February 12, 1993 (USFWS 1993) without designated CH. A recovery plan for the species was finalized on May 20, 2010 (USFWS 2010a). This species is on the state of Oregon's Threatened Plant list, and in Washington it is classified by the WNHP as endangered. Nelson's checkermallow occurs in Oregon (Benton, Linn, Marion, Polk, Tillamook, Yamhill, and Washington counties) and Washington (Cowlitz and Lewis counties).

Population Trends and Distribution for Nelson's Checkermallow Nelson's checkermallow primarily occurs in Oregon's Willamette Valley, but is also found at several sites in Oregon's Coast Range and at two sites in the Puget Trough of southwestern Washington. The plant's range extends from southern Benton County, Oregon, north to Cowlitz County, Washington, and from central Linn County, Oregon, west to the crest of the Coast Range. In the late 1990s, the species was known to occur in 65 occurrences within five relict population centers in Oregon and Washington and occupy approximately 273 acres (USFWS 1998).

The 2010 Recovery Plan states that Nelson's checkermallow was known from about 90 sites, comprising about 1,277 acres of total cover (USFWS 2010a). Data collection for a range-wide inventory of Nelson's checkermallow was completed in 2014 (Currin, Institute for Applied Ecology, *pers. comm.* 2015). Results indicated that 71 populations composed of 214,111 individual plants in Oregon that have potential to contribute towards achieving recovery goals. Other smaller populations exist but are unlikely to contribute to recovery. Of the 71 populations, 21 populations were less than 100 plants; 36 populations had 100 to 2,499 plants; and 14 populations had more than 2500 plants. Of those 14 populations, five contained over 10,000 plants.

Life History and Ecology for Nelson's Checkermallow
Nelson's checkermallow is a perennial herb in the mallow family (*Malvaceae*). It has tall, lavender to deep pink flowers that are borne in somewhat open clusters 50 to 150 cm (19.2 to 48 inches) tall at the end of short stalks (USFWS 1993). Plants are partially dioecious, in that they have either perfect flowers (male and female) or pistillate flowers (female only). The plant can reproduce vegetatively, by rhizomes, and by seeds, which drop near the parent plant. Flowering typically occurs from late May to mid-July but may extend into September in the Willamette Valley. Fruits have been observed as early as mid-June and as late as mid-October. Coast Range populations generally flower later and produce seed earlier, probably because of the shorter growing season. Seed production for a Nelson's checkermallow plant is typically high. An average plant may produce between 300 and 3000 seeds but could potentially exceed 10,000 seed. The limiting factor of Nelson's checkermallow seed production is weevil damage. Weevils typically associated with the plants in the wild often infest flowers and eat flowers. Early in seed production, weevils often consume developing embryos and may account for 80 to 100% loss of pre-dispersal seed.

In the Willamette Valley, Nelson's checkermallow begins flowering as early as mid-May, and continues through August to early September, depending upon the moisture and climatic conditions of each site. Coast Range populations experience a shorter growing season and generally flower later and senesce earlier. Nelson's checkermallow inflorescences are indeterminate, and often simultaneously exhibit fruits, open flowers, and unopened buds. Seeds are deposited locally at or near the base of the parent plant and may be shed immediately or persist into winter within the dry flower parts that remain attached to the dead stems. Above-ground portions of the plant die back in the fall, usually followed by some degree of regrowth at the base, with the emergence of small, new leaves that persist through the winter directly above the root crown. It is not uncommon for some plants to continue producing some flowers into the fall and early winter, although this is usually limited to one or two small stems per plant, consequently with little seed production (USFWS 1998).

Perfect-flowered Nelson's checkermallow are protandrous, with complete temporal separation of male and female phases in individual flowers (Gisler and Meinke 1998). This prevents self-fertilization. The bottom-to-top foraging observed among most bee visitors also encourages outcrossing because pollinators leave male-phase flowers at the top of one raceme and then fly to female phase flowers on the bottom of the next raceme. Nelson's checkermallow is pollinated by a variety of insects, including at least 17 species of bees, 3 species of wasps, 9 species of flies, 6 species of beetles, and 5 species of butterflies/moths (Gisler 2003).

Pre-dispersal seed predation by weevils (*Macrorhoptus sidalceae*) is extremely high in many populations, and may severely curtail, if not virtually eliminate, seed survival in many populations (Gisler and Meinke 1998). The weevils appear to be restricted to Willamette Valley, southwestern Washington and lower Coast Range populations (around Grand Ronde), but do not infest the Coast Range populations in Yamhill, Tillamook, and Washington counties. The weevils are native, host-specific, and are themselves parasitized by tiny undescribed wasps (Gisler and Meinke 1998).

Habitat Characteristics for Nelson’s Checkermallow

In the Willamette Valley, Nelson’s checkermallow is known from wet prairies and stream sides (USFWS 2010a). Nelson’s checkermallow populations occur at low elevations (below 200 m (650 feet)) within a mosaic of urban and agricultural areas, with concentrations around the cities of Corvallis and Salem. Although occasionally occurring in the understory of *Fraxinus latifolia* (Oregon ash) woodlands or among woody shrubs, Willamette Valley populations usually occupy open habitats supporting early seral plant species. These native prairie remnants are frequently found at the margins of sloughs, ditches, and streams; roadsides; fence rows; drainage swales; and fallow fields. Soil textures of the occupied sites vary from gravelly, well drained loams to poorly drained, hydric clay soils (CH2MHill 1986, Glad et al. 1994).

Some of the native plants commonly associated with *Sidalcea nelsoniana* in the Willamette Valley include: *Achillea millefolium* (yarrow), *Juncus effusus* (common rush), *Carex* spp. (sedge), *Spiraea douglasii* (western spiraea), *Crataegus douglasii* (Douglas’ hawthorn), *Geum macrophyllum* (large-leaved avens), and *Fraxinus latifolia* (Oregon Department of Agriculture 1995). Most sites have been densely colonized by invasive weeds, especially introduced forage grasses. Common non-native species found with Nelson’s checkermallow include *Festuca* *arundinacea*, *Rosa* spp. (rose), *Cirsium arvense* (Canada thistle), *Hypericum perforatum* (common St. John's wort), *Rubus* spp. (blackberry), *Phleum pratense* (timothy), *Holcus lanatus* (velvet grass), *Vicia* spp., *Chrysanthemum leucanthemum* (oxeye-daisy), *Agrostis capillaris*, *Alopecurus pratensis*, *Phalaris arundinacea*, *Geranium* spp. (geranium), *Lotus corniculatus* (bird's-foot trefoil) and *Daucus carota* (Oregon Department of Agriculture 1995).

Coast Range Nelson's checkermallow populations typically occur in open, wet to dry grassy meadows, intermittent stream channels, and along margins of coniferous forests, with clay to loam soil textures (Glad et al. 1987) at elevation ranging from 490 to 600 m (1,610 to 1,970 feet). These areas generally support more native vegetation than Willamette Valley sites. Native plants commonly associated with Nelson's checkermallow in the Coast Range include *Senecio triangularis* (spear-head senecio), *Fragaria Virginiana*, *Juncus* spp., *Carex* spp., and *Achillea millefolium*; non-native associated species often include *Senecio jacobaea* (tansy ragwort), *Holcus lanatus*, and *Phleum pratense.*

A variety of animal species are associated with Nelson's checkermallow. Stems and inflorescences are commonly eaten by deer and elk. Nelson's checkermallow flowers are visited by a diverse assemblage of insects, including leafcutter bees (Megachilidae), honeybees (Apidae), bumble bees (Bombidae), hover flies (Syrphidae), butterflies (Hesperiidae), and pollen-foraging beetles (Cerambycidae and Meloidae). The species is also a host for various phytophagous insects such as aphids (Aphididae), stinkbugs (Pentatomidae), scentless plant bugs (Rhopalidae), spotted cucumber beetles (Chrysomelidae), plant bugs (Miridae), milkweed bugs (Lygaeidae), spittlebugs (Cercopidae), butterfly larvae (Lycaenidae: *Strymon melinus*; Nymphalidae: *Vanessa anabella*), and in the Willamette Valley, weevils (Curculionidae: *Macrohoptus sidalcae*).

Recovery Measures for Nelson's Checkermallow

Extensive research has been conducted on the ecology and population biology of Nelson's checkermallow, methods of seed predator control, and propagation and reintroduction techniques (Gisler and Meinke 1998; Bartels and Wilson 2001; Gisler 2003; Wilson 2004). The results of these studies have been used to direct the management of the species at sites managed for wet prairies (USFWS 2010a).

Nelson's checkermallow has a highly complex breeding system that facilitates both outcrossing and selfing (USFWS 2010a). Control of seed predation by native weevils may be needed to enhance reproductive success at some populations which are heavily infested with weevils (Gisler and Meinke 1998). Research into habitat management techniques indicates that burning may not be directly beneficial to Nelson's checkermallow, and that caution should be used in management of native prairie fragments with populations of Nelson's checkermallow (Bartels and Wilson 2001, Wilson 2004). The species has proved to be readily grown in controlled environments, and several approaches have successfully cultivated healthy plants for augmentation of existing populations (Gisler 2003). Seeds of this species have been banked at the Rae Selling Berry Seed Bank in Portland, Oregon (Portland State Environmental Science and Management 2015) and the University of Washington Botanic Garden.

Populations of Nelson's checkermallow are protected on lands managed by the Service at William L. Finley and Baskett Slough National Wildlife Refuges, the Confederated Tribes of the Grand Ronde in Polk County, and by the Bureau of Land Management at Walker Flat in Yamhill County, Oregon (USFWS 2010a). In December 2007, Ridgefield National Wildlife Refuge, in Clark County, Washington, outplanted 2,530 seedlings to establish a new population at the refuge; monitoring and management of the new population is ongoing. A habitat conservation plan that addresses conservation of Nelson's checkermallow within Benton County was completed in 2010 (Benton County 2010).

Threats/ Reasons for Listing for Nelson's Checkermallow

Habitats occupied by Nelson's checker-mallow contain native grassland species and numerous introduced taxa (USFWS 2010a). In some areas, habitats occupied by Nelson's checker-mallow are undergoing an active transition towards a later seral stage of vegetative development, often due to the encroachment of non-native, invasive species (i.e., brush competition). Invasive woody species of concern include non-native plants such as Himalayan blackberry (*Rubus discolor*), multiflora rose (*Rosa multiflora*), European hawthorn (*Crataegus monogyna*), and Scot's broom (*Cytisus scoparius*). Invasive native species include Oregon ash, Douglas hawthorn (*Crataegus douglasii*), Nootka rose (*Rosa nutkana*) and Douglas spiraea (*Spiraea douglasii*).

Due to this rapid invasion by woody vegetation (especially Scot's broom) in some areas and the suppression of natural fire regimes, secondary successional pressures on these plant populations are expected to increase over time. Habitat conversion via succession and/or agricultural activities poses measurable threats to the long-term stability of Nelson's checker-mallow populations.

Agricultural and urban development have modified and destroyed habitats, fragmenting populations into small, widely scattered patches (USFWS 2010a). In the Willamette Valley, extirpation is an ongoing threat to many Nelson's checker-mallow occurrences on private lands, roadsides, and undeveloped lots zoned for industrial and residential development. Within the genus Sidalcea, the actual sex ratio (the number of functionally pistellate to perfect flowers) of a population may be a strong contributing factor to its genetic vigor or vulnerability such that the ratio of pistellate to perfect flowers may ultimately control the amount and quality of seeds produced regardless of habitat quality. Likewise, seed predation by weevils prior to seed dispersal may also be a factor controlling seed production.

Prior to European colonization of the Willamette Valley, naturally occurring fires and fires set by Native Americans maintained suitable Nelson's checkermallow habitat (USFWS 2010a). Current fire suppression practices allow succession of trees and shrubs in Nelson's checkermallow habitat. Remnant prairie patches in the Willamette Valley have been modified by livestock grazing, fire suppression, or agricultural land conversion. Stream channel alterations, such as straightening, splash dam installation, and rip-rapping cause accelerated drainage and reduce the amount of water that is diverted naturally into adjacent meadow areas. As a result, areas that would support Nelson's checkermallow are lost.

The most serious management threat related to land use faced by several populations on private lands that are not subject to state and Federal laws governing listed plant species (USFWS 2010a). Seventeen years of population observation has documented the ongoing disturbance or complete extirpation of populations on private land due to non-industrial timber harvest operations, development, herbicide application, agricultural activities, and other land-use practices (CH2MHill 1997). Although numerous checkermallow occurrences are on public lands, many are threatened by inadvertent disturbance from roadside maintenance, herbicide application and mowing, soil cultivation, ditching, and other habitat modification. For additional information on recovery goals, objectives, and criteria, see *Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington (USFWS 2010a)*: http://www.USFWS.gov/oregonfwo/Species/PrairieSpecies/Documents/PrairieSpeciesFinalRecoveryPlan.pdf