Final
PROJECTS
Biological Opinion

May 2015

Endangered Species Act – Section 7 Consultation

Programmatic Biological Opinion

Programmatic Restoration Opinion for Joint Ecosystem Conservation by the Services (PROJECTS) program
"PROJECTS Biological Opinion"
for
[FWS *reference*: 01EOFW00-2014-F-0222]

Prepared by the Oregon Fish and Wildlife Office
U.S. Fish and Wildlife Service
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Date

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Federal Action Agencies: National Oceanic and Atmospheric Administration's Restoration Center and the restoration programs funded or implemented by the U.S. Fish and Wildlife Service

Affected Species and Determinations for PROJECTS:

ESA-Listed Species	ESA Status	Determination Species	Determination Critical Habitat
MAMMALS			
Canada lynx (*Lynx canadensis*)	T	NLAA	NLAA
Columbian white-tailed deer (*Odocoileus virginianus leucurus)*	E	NLAA	NE
Gray wolf *(Canis lupus)*	E	NLAA	NE
Grizzly bear *(Ursus arctos horribilis)*	T	NLAA	NE
Mazama pocket gopher (*Thomomys mazama spp*.)	T	LAA	NLAA
Northern Idaho ground squirrel (*Spermophilus brunneus brunneus)*	T	NLAA	NE
Pygmy rabbit (*Brachylagus idahoensis*)	T	NLAA	NE
Woodland caribou *(Rangifer tarandus caribou)*	E	NLAA	NE
FISH			
Bull trout (*Salvelinus confluentus*)	T	LAA	LAA
Lahontan cutthroat trout (*Oncorhynchus clarkii henshawi*)	T	LAA	NE
Warner sucker (*Catostomus warnerensis*)	T	LAA	LAA
BIRDS			
Marbled murrelet *(Brachyramphus marmoratus)*	T	LAA	NLAA
Northern spotted owl *(Strix occidentalis caurina)*	T	LAA	NLAA
Streaked horned lark (*Eremophila alpestris strigata*)	T	LAA	NLAA
Western snowy plover (*Charadrius nivosus nivosus*)	T	NLAA	NLAA
AMPHIBIANS			
Oregon spotted frog (*Rana pretiosa*)	T	NLAA	NLAA
INVERTEBRATES			
Fender's blue butterfly (*Icaricia icarioides fender*)	E	LAA	NLAA
Oregon silverspot butterfly (*Speyeria zerene hippolyta)*	T	LAA	LAA
Taylor's checkerspot butterfly *(Euphydryas editha taylori)*	E	LAA	NLAA
Vernal pool fairy shrimp (*Branchinecta lynchi*)	T	LAA	LAA
PLANTS			
Bradshaw's lomatium (*Lomatium bradshawii*)	E	LAA	NE
Cook's desert-parsley (*Lomatium cookii*)	E	LAA	LAA
Gentner's fritillary (*Fritillaria gentneri*)	E	LAA	NE
Golden paintbrush (*Castilleja levisecta*)	T	LAA	NE
Howell's spectacular thelypody (*Thelypodium howellii spectabilis*)	T	LAA	NE
Kincaid's lupine (*Lupinus sulphureus ssp. kincaidii*)	T	LAA	NLAA
Large-flowered woolly meadowfoam (*Limnanthes floccosa ssp. grandiflora*)	E	LAA	LAA
Nelson's checker-mallow (*Sidalcea nelsoniana*)	T	LAA	NE
Rough popcornflower (*Plagiobothrys hirtus*)	E	LAA	NE
Spalding's catchfly (*Silene spaldingii*)	T	LAA	NE
Ute ladies'-tresses (*Spiranthes diluvialis*)	T	LAA	NE
Water howellia (*Howellia aquatilis*)	T	LAA	NE
Wenatchee mountains checkermallow (*Sidalcea oregana var. calva*)	E	LAA	LAA
Western lily (*Lilium occidentale*)	E	LAA	NE
Willamette daisy (*Erigeron decumbens var. decumbens*)	E	LAA	NLAA

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LIST OF ACRONYMS

ARBO II – Aquatic Restoration Biological Opinion (version 2)
BA – Biological Assessment
BIA – Bureau of Indian Affairs
BLM – Bureau of Land Management
BMP – Best management practices
BPA – Bonneville Power Administration
CFR – Code of Federal Regulations
cfs – cubic feet per second
CHU – Critical Habitat Unit
CI – confidence interval
CNLM – Center for Natural Lands Management
dbh – diameter at breast height
DPS – Distinct Population Segment
EIS – Environmental Impact Statement
ELJ – Engineered Log Jam
EPA – U.S. Environmental Protection Agency
ESA – Endangered Species Act
FR – Federal Register
HCP – Habitat conservation plan
HIP III – Habitat Improvement Program Biological Opinion (version 3)
HWM – High Water Mark
IC – Interior Columbia
IDFG – Idaho Department of Fish and Game
IGDO – Inter-gravel dissolved oxygen
IRU – Individual recovery unit
ITS – Incidental Take Statement
JBLM –Joint Base Lewis-McChord
LAA – Likely to Adversely Affect
LSR – Late successional reserve
LW – Large Wood
MHHW – mean higher high-water line
MLLW – mean lower low-water line
NEPA – National Environmental Policy Act
NF – National Forest
NWR – National Wildlife Refuge
NLAA – Not Likely to Adversely Affect
NMFS – National Marine Fisheries Service
NOAA – National Oceanic and Atmospheric Administration
NOAA RC – National Oceanic and Atmospheric Administration Restoration Center
NPS – National Park Service
NR – Nesting and Roosting
NRF – Nesting, Roosting and Foraging

LIST OF ACRONYMS (continued)

NWR – National Wildlife Refuge
NWFP – Northwest Forest Plan
OAR – Oregon Administrative Rules
ODEQ – Oregon Department of Environmental Quality
ODFW – Oregon Department of Fish and Wildlife
OHW – Ordinary High Watermark
OSF – Oregon Spotted Frog
PAH – Polycyclic Aromatic Hydrocarbons
PBF – Primary Biological Feature
PCE – Primary Constituent Element
PDC – Project Design Criteria
PFW – Partners for Fish and Wildlife Program
PROJECTS – Programmatic Restoration Opinion for Joint Ecosystem Conservation by the Services
PVA – Population Viability Analysis
RC – Restoration Center (NOAA)
RHCA – Riparian habitat conservation areas
RRT – Restoration Review Team
SAV – Submerged Aquatic Vegetation
Service – United States Fish and Wildlife Service
T&E – Threatened and endangered
TNC – The Nature Conservancy
TCB – Taylor's checkerspot butterfly
USACE – United States Army Corps of Engineers
USFS – United States Forest Service
USFWS – United States Fish and Wildlife Service

1 INTRODUCTION

This document is the U.S. Fish and Wildlife Service's (Service) biological opinion (Opinion) based on our review of the biological assessment for Programmatic Restoration Opinion for Joint Ecosystem Conservation by the Services (PROJECTS BA) (USFWS 2014) and its revision (USFWS 2015). The PROJECTS BA was developed by the Service and the National Oceanic and Atmospheric Administration's Restoration Center (NOAA RC) (collectively, the Action Agencies). This document was prepared in accordance with regulations on interagency cooperation (50 CFR 402) pursuant to Section 7 of the Endangered Species Act of 1973 (16 U.S.C. 1531 *et seq*.), (as amended) (ESA), for species under the jurisdiction of the Service. The request for formal consultation, signed by all administrative units, was received by the Service on May 5, 2014.

This Opinion describes the proposed action and the anticipated effects of the proposed action as implemented under the Action Agencies' programs that fund or carry out habitat restoration actions on all lands in the States of Idaho, Oregon and Washington, within USFWS Pacific Region (Region 1); and excludes the southwestern portion of Oregon within Region 8. This is the third large, multi-state programmatic biological opinion recently completed by the Service on Federal restoration programs in the Pacific Northwest. The purpose of this consultation is to provide regional Section 7 consultation coverage, for multiple ESA-listed species under the Service's jurisdiction, for a range of proposed restoration actions funded by any one of the several restoration programs administered by the the Action Agencies in Idaho, Oregon and Washington in the Service's Pacific Region (Region 1). These proposed restoration actions are described in the PROJECTS BA, and represent the integration, consolidation and expansion of prior restoration programmatic consultations in the Pacific Northwest. All NOAA RC restoration funding is included in this PROJECTS consultation. Service programs included in this PROJECTS consultation are the Coastal Program, Partners for Wildlife Program (PFW), National Fish Passage Program, Western Native Trout Initiative, Chehalis Fisheries Restoration Program and the Endangered Species Recovery Program (*i.e.,* recovery actions taken by or in partnership with the Service that benefit federally listed, proposed, candidate, and other at-risk species), and traditional Section 6 Grants to states where the Action Agencies have significant involvement. In addition to the programs listed above, this programmatic consultation is also intended to provide Section 7 consultation coverage to entities that partner with or are a division of the Service and which conduct restoration activities, provided certain conditions are met, which is further described in the Section entitled "Action Area and Requirements for Coverage."

The intent of completing this programmatic restoration consultation across the three Pacific Northwest states was to:

- promote regional consistency in design criteria for similar project types,
- provide consistency in the conservation measures to be implemented to minimize impacts to ESA-listed species,
- ensure species-specific conservation measures as applied as needed to minimize impacts to ESA-listed species,
- create a review process for more complex restoration actions to ensure good project design and consistency with the terms, conditions and incidental take statement in this Opinion, and

- to develop a required reporting process in which any effects to ESA-listed species are documented.

This documentation will allow the Service to annually review implementation of this Opinion and determine if the design criteria, conservation measures and terms and conditions are adequate to protect listed species, and develop alternatives if any are found necessary.

This Opinion is based on the following major sources of information: the 2014 PROJECTS BA and supporting reference information; the National Marine Fisheries Service's (NMFS) Programmatic Restoration Opinion for Joint Ecosystem Conservation by the Services Biological Opinion (December 3, 2013) (NMFS 2013); the Service's 2013 Aquatic Restoration Biological Opinion (ARBO II)(USFWS 2013a) with the U.S, Forest Service (USFS), Bureau of Reclamation (BOR), and the Bureau of Indian Affairs (BIA) (July 1, 2013); the Service's Biological Opinion on Habitat Improvement Program (HIP III) with the Bonneville Power Administration (BPA) (November 8, 2013; USFWS 2013b); the Service's 2008 Programmatic Formal Consultation on Western Oregon Prairie Restoration Activities (USFWS 2008); the Service's Biological Opinion on the Oregon Fish and Wildlife Office's Restoration and Recovery Programs (USFWS 2010), Biological Opinion for the Programmatic Biological Assessment for Habitat Restoration Activities of the Western Washington Fish and Wildlife Office (USFWS 2005); many internal discussions between Service restoration practitioners, consultation biologists, and species experts, and numerous Federal listings and critical habitat designations published in the Federal Register.

Overview of the Proposed Action

The proposed action consists of three main sections, which combined total 53 project design criteria (PDC). These sections are:

- Program Administration (PDC 1-12)
- General Design Criteria (PDC 13-32)
- Restoration Actions (or "Categories of Actions;" PDC 33-53)

Program administration PDC contain the process that all restoration projects must follow, including notification and reporting requirements. The general design criteria apply to all projects. These criteria are largely BMPs that must be applied to each restoration project, as appropriate, and included in the project design plan. As examples, general design criteria include, but are not limited to, measures dealing with cite access, site contamination, inwater work area isolation, surveys, and herbicide use. The Restoration Actions PDC list the specific types of restoration projects that are covered under this Opinion and the criteria specific each type of restoration action that must be followed in order to be covered under this Opinion. The Restoration Actions include:

- Fish Passage Restoration (Stream Simulation Culvert and Bridge Projects; Headcut and Grade Stabilization; Fish Ladders; Irrigation Diversion Replacement/Relocation and Screen Installation/Replacement) (PDC 33)
- Stream Channel Enhancement (Large Wood (LW), Boulder, and Gravel Placement; Engineered Logjams (ELJ); Constructed Riffles, Porous Boulder Step Structures and Vanes; Gravel Augmentation; Tree Removal for LW Projects) (PDC 34)

- Dam and Legacy Structure Removal (PDC 35)
- Channel Reconstruction/Relocation (PDC 36)
- Off- and Side-Channel Habitat Restoration (PDC 37)
- Streambank Restoration (PDC 38)
- Set-Back or Removal of Existing Berms, Dikes, and Levees (PDC 39)
- Reduction/Relocation of Recreation Impacts (PDC 40)
- Livestock Fencing, Stream Crossings and Off-Channel Livestock Watering (PDC 41)
- Piling, Marine Debris and other Structure Removal (PDC 42)
- Shellfish Bed/Nearshore Habitat Restoration (PDC 43)
- In-channel Nutrient Enhancement (PDC 44)
- Road and Trail Erosion Control and Decommissioning (PDC 45)
- Juniper Removal (PDC 46)
- Native Fish Protection (PDC 47)
- Beaver Habitat Restoration (PDC 48)
- Wetland Restoration (PDC 49)
- Tide/Flood Gate Removal, Replacement, or Retrofit (PDC 50)
- Native Vegetation Restoration and Management (PDC 51)
- Upland Silvicultural Treatments (PDC 52)
- Install Wildlife Structures (PDC 53)

Timeframe of Proposed Action
The Action Agencies' proposed action has no expiration date. The Service agreed to this proposal provided that any new listings of species or critical habitat within the action area that would be affected by the action will be cause for reinitiation. Such reinitiation would likely occur by amendment as new listings occur, species by species, and would not necessarily require the revisiting the entire Opinion. We note that the proposed action includes reporting requirements and coordination meetings of the Restoration Review Team (RRT) that will result in annual updates of the PROJECTS Handbook (see PDC 5 of the proposed action for more information). These ongoing annual updates will ensure that the restoration programs under PROJECTS will use on-the-ground experience to best direct restoration actions, and adjust these actions as more knowledge is acquired.

Action Area and Requirements for Coverage
"Action area" means 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). For this consultation, the overall program action area consists of the combined action areas for each action to be authorized or carried out under this Opinion within the range of multiple listed species and their designated critical habitat in Idaho, Oregon, and Washington within the Service's Pacific Region (Region 1). This includes all upland, prairie, coastal, riparian and aquatic areas affected by site preparation, construction, and site restoration at each action site.

The Action Agencies annually fund or carry out multiple restoration actions in aquatic, upland, nearshore, prairie, and coastal habitats on all lands in the states of Oregon, Washington, and Idaho. This Opinion covers restoration actions in the following programs: Service recovery grants, traditional section 6 grants in which the Service has substantial involvement, Partners for

Fish and Wildlife Program, Coastal Program, National Fish Passage Program, Western Native Trout Initiative, Chehalis Fisheries Restoration Program and all NOAA RC restoration funding. The Action Area for this consultation includes all lands in the states of Idaho, Washington, and Oregon in the Service's Pacific Region (Region 1).

To be eligible for coverage under this Biological Opinion, the proposed restoration action:
1) must provide long-term benefits to listed species and their native habitats;
2) must comply with the required process outlined in Steps 1-12 of the proposed action, which includes project review, reporting, monitoring, and all relevant approvals;
3) must be consistent with the proposed actions, PDC and conservation measures contained in this Opinion, or receive approval for a minor variance through the RRT;
4) must be supported (with funding or technical assistance) by the NOAA RC or one of the Service programs listed above, and the link between the project, agency, and program must be described in a signed mechanism (e.g., a cooperative agreement or conservation agreement);
5) For restoration actions that meet the above criteria on Federal lands (including Service properties), the proposed restoration must be consistent with the Federal agency's ESA-conservation plan for the affected listed species on their lands.

In addition to multiple programs listed above, this programmatic consultation is also intended to provide Section 7 consultation coverage to other entities to conduct restoration activities, provided these projects will be implemented in accordance with this PROJECTS programmatic consultation and that the Action Agencies' programs listed above are involved in the habitat restoration project. Other funding programs/entities include, but not limited to, the following:

1. Other Federal funding programs benefitting listed species; and
2. Private, state and local government conservation, restoration and management actions.

To ensure compliance with the programmatic approach to restoration activities addressed in this Opinion, the Action Agencies will coordinate with the project lead (i.e., the individual funding recipient, private landowner, or conservation partner) to ensure pre-project completion of a project-specific agreement such as a Cooperative Agreement, Conservation Agreement, Restoration Plan, or similar document. These agreements and associated documents in the project file will, at a minimum, provide the following details about the project: project description, location, objectives, timeframe for completion, applicable project design criteria, monitoring and reporting objectives, and relevant best management practices (BMPs) and conservation measures from the Service's Opinion. These other entities can only be covered for restoration projects provided the local Service office determines the proposed action will not exceed the level of effects described in this Opinion.

1.1 Background and Consultation History

This Opinion covers multiple restoration programs under the Action Agencies. These programs are briefly described below.

Partners for Fish and Wildlife Program

In 1987, the Service established the Partners for Fish and Wildlife Program. The program provides technical and financial assistance statewide to private landowners interested in restoring or otherwise improving native habitats for fish and wildlife. The program's objective is to develop partnerships with internal Service programs and external agencies to engage private landowners and stakeholders in collaborative, proactive habitat restoration activities to strategically address limiting factors for our priority listed, candidate, and species of concern, as well as anadromous fish and migratory birds. Our philosophy is to work proactively with private landowners for the mutual benefit of declining Federal trust species and participating landowner interests.

Coastal Program

The Service established a Coastal Program along the Oregon Coast in 2002. It is a non-regulatory program that relies on voluntary partnerships. The program goals and objectives include promoting coastal ecosystem conservation and restoration. The intent is to cover restoration activities that the Service directs in Oregon and Washington. The program promotes species recovery, developing assessment and planning tools, conserving coastal habitats through conservation easements and locally-initiated land acquisition, and restoring degraded coastal habitats through site specific projects. The program is administered along the Oregon and Washington coast depending upon the participating entities and specific species or habitats involved.

Fish Habitat and Fish Passage Programs

The National Fish Passage Program was enacted by the Service in 1999. This program provides funding and technical assistance to resolve barriers to fish migration and passage. The National Fish Habitat Action Plan implements assessments and habitat restoration projects through approved partnerships. Idaho, Oregon and Washington have, at present, four approved partnerships,(the Western Native Trout Initiative, the Desert Fish Habitat Partnership, the Pacific Marine and Estuarine Fish Habitat Partnership, and the Reservoir Fish Habitat Partnership) and one candidate partnership (North American Salmon Stronghold Partnership).

Recovery Program

The Recovery Program involves actions taken by or in partnership with the Service that benefit listed, proposed, and candidate species. The program provides technical and financial assistance (1113 recovery funding) in a broad variety of actions that may occur on all types of land ownership. Other related grant programs (e.g. Western Native Trout Initiative) may provide funding used to contribute to recovery of species or ecosystems. The Service's Recovery program supports on-the-ground conservation actions and other actions that support project design and development. Many of these restoration projects come from, or are consistent with, final published Recovery Plans for ESA-listed species. Examples of the types of projects that may be funded include surveys, habitat restoration, providing fish passage, managing non-native competitors, restoring streams that support imperiled species, erecting fencing to exclude animals from sensitive habitats, planting native vegetation to restore a rare plant community, or project monitoring.

Cooperative Endangered Species Conservation Fund (Traditional Section 6 Grants)
The Service recognizes that success in conserving species will ultimately depend on working cooperatively with landowners, communities, and Tribes to foster voluntary stewardship efforts on private lands, as many listed species spend at least part of their life cycle on privately owned lands. Section 6 of the ESA is one tool the Service can use to to help States and landowners plan and implement projects to conserve species. This fund provides grants to States and Territories to participate in a wide array of voluntary conservation projects for listed, proposed, and candidate species. The program provides funding to states and territories for species and habitat conservation actions on non-Federal lands, provided the state/ territory contribute matching funds and enter into a cooperative agreement with the Secretary of the Interior (http://www.fws.gov/endangered/grants/).

NOAA Restoration Center
The NOAA RC is the only office within NOAA solely devoted to restoring the nation's coastal, marine, and migratory fish habitat. Their efforts focus on four priority habitat restoration approaches to improve fishery production: opening rivers, reconnecting coastal wetlands, restoring corals, and rebuilding shellfish populations. Since 1996, the NOAA RC has supported nearly 500 community restoration projects in the Northwest Region, benefiting more than 4,500 acres of estuarine and riparian habitat and opening approximately 1,288 km (800 miles) of in-stream salmon habitat. Their mission statement is "We work with hundreds of partners and local citizens to collaboratively provide the science, communications, and policy expertise needed to restore our coastal and marine environment" (http://www.habitat.noaa.gov/restoration/aboutrc/index.html).

Funding for NOAA RC's actions is provided by the Damage Assessment, Remediation and Restoration Program and the Community-Based Restoration Program, often in combination with resources provided by Service restoration programs. The Damage Assessment, Remediation and Restoration Program is cooperatively implemented by the NOAA RC, NOAA's National Ocean Service's Office of Response and Restoration, and the Office of General Counsel. These programs are authorized by the Comprehensive Environmental Response, Compensation, and Liability Act (also known as CERCLA or Superfund), the Oil Pollution Act, the Clean Water Act, and the Marine Protection, Research and Sanctuaries Act. The Community-Based Restoration Program, which involves communities in the restoration of local marine and estuarine habitats, is authorized by the Fish and Wildlife Coordination Act. Depending on the action, other cooperating entities may include Federal agencies, state agencies, tribal governments, local governments, non-governmental and nonprofit organizations, businesses, schools, and private landowners.

1.1.1 Consultation History

This programmatic Opinion is the first three-state consultation done for Service restoration programs and the NOAA RC. However, it is the third large scale Programmatic biological opinion for restoration activities for areas in the Pacific Northwest in recent years. ARBO II is the current biological opinion for aquatic restoration activities conducted and/or funded by the USFS, BOR, and the BIA (USFWS 2013a). HIP III is the current biological opinion for restoration activities conducted and/or funded by BPA (USFWS 2013b).

Prior to the issuance of this Opinion, Service restoration programs were either covered by other statewide programmatic biological opinions or individual biological opinions for a specific project. In Oregon and Washington, programmatic consultations for Service restorations programs include the following:

- Programmatic Formal Consultation for the PFW Program in Oregon (November 16, 1998)
- Programmatic Formal Consultation on Western Oregon Prairie Restoration Activities (August 14, 2008)
- Biological Opinion on the Oregon Fish and Wildlife Office's Restoration and Recovery Programs (April 27, 2010)
- Biological Opinion for the Programmatic Biological Assessment for Habitat Restoration Activities of the Western Washington Fish and Wildlife Office (May 15, 2006)

Restoration activities under the Action Agencies' programs that required consultation but did not fall under the programmatic biological opinions were consulted on individually.

On April 28, 2014, the Action Agencies requested initiation of formal consultation, based on a 2014 programmatic PROJECTS BA, prepared by the WWO PFW staff. This request was provided to the Service's Endangered Species Division at the OFWO. Based on internal discussions within the Service, proposed changes for an updated PROJECTS BA were provided to the WFWO PFW staff on September 26, 2014. A meeting was held internally with the Service to discuss the proposed action in the draft PROJECTS BA on October 1, 2014. A final programmatic PROJECTS BA (USFWS 2015) was submitted to the OFWO's Endangered Species Division on February 2, 2015.

The Action Agencies requested to initiate formal consultation, based on the final programmatic PROJECTS BA, for their restoration/recovery activities in accordance with section 7 of the Endangered Species Act (ESA) for their "may affect, likely to adversely affect" determinations for the following federally listed species:

- Mazama pocket gopher, marbled murrelet, Northern spotted owl, streaked horned lark, bull trout, Lahontan cutthroat trout, Warner sucker, Fender's blue butterfly, Oregon silverspot butterfly, Taylor's checkerspot butterfly, vernal pool fairy shrimp, Bradshaw's lomatium, Cook's desert-parsley, golden paintbrush, Gentner's fritillary, Howell's spectacular thelypody, Kincaid's lupine, large-flowered meadowfoam, Nelson's checker-mallow, rough popcornflower, Spalding's catchfly, Ute ladies'-tresses, water howellia, Wenatchee Mountains checkermallow, western lily, and Willamette daisy.

1.2 Concurrences on other Listed Species

The Action Agencies requested concurrence for their determinations for the following species and critical habitats resulting in informal consultation:

- "May affect, not likely to adversely affect" (NLAA) Cananda lynx, Columbian white-tailed deer, gray wolf, grizzly bear, Northern Idaho ground squirrel, Oregon spotted frog, pygmy rabbit, woodland caribou, and western snowy plover.

- "May affect, not likely to adversely affect" (NLAA) the designated critical habitats for Canada lynx, Mazama pocket gopher, marbled murrelet, Northern spotted owl, streaked horned lark, western snowy plover, Oregon spotted frog, Fender's blue butterfly, Taylor's checkerspot butterfly, Kincaid's lupine and Willamette daisy.

We considered this request for our concurrence that the PROJECTS proposed action may affect, but is not likely to adversely affect the above listed species and designated critical habitats. Additional analysis is further detailed in Appendix A. We agree that with implementation of the proposed action, including PDC and the proposed species-specific conservation measures described in Appendix A to this document, adverse effects to these species and their habitats are either 1) discountable because they are unlikely to occur or 2) insignificant because the scale and extent of the negative effects will not result in take of a listed animal or reduction in the value of critical habitats through impacts to PCEs or PBFs. Thus, we concur with the determination of effects on the above listed species and designated critical habitats from restoration activities described in the PROJECTS proposed action. The above concurrences are based on the following points:

- The goals of the Action Agencies' programs addressed in the programmatic PROJECTS BA are to restore native habitats to benefit native fish, wildlife, and plant species, including federally listed species.
- By following the PDC, short-term impacts to habitats (including designated and proposed critical habitats that support the above federally listed species) are limited to those that are insignificant, discountable or wholly beneficial. Long-term adverse effects to these habitats are not anticipated.
- By following the species specific conservation measures, the proposed action is not likely to result in harm or harassment to the above federally listed species during their critical reproduction, rearing, and growth periods.
- By consulting with the appropriate Service species' leads when listed plants and animals are present at a project site, each restoration project will incorporate the best appropriate conservation measures to protect listed species at a project site.
- No PCEs or primary biological features, as appropriate, in designated critical habitat for species above will be adversely affected by the proposed action across the range of any species. The PDC and species specific conservation measures have been designed to substantially minimize or eliminate the amount and severity of potential effects to the physical and biological habitat components represented by PCEs or primary biological features of critical habitat for the above-mentioned species. The PDC and proposed restoration project categories will minimize or eliminate potential negative effects to such an extent that these effects will be insignificant or discountable, and, in the long-term, improve proper functioning conditions in riparian, wetland, estuarine, stream, and upland habitats necessary to support the species listed above.

Any project that is determined to likely to adversely affect the above species or their critical habitat is not covered by this programmatic consultation, and must go through an individual section 7 consultation.

1.3 Proposed Action

"Action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies. Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration.

Habitat restoration projects are generally designed and implemented to restore or enhance natural processes that promote native species. Aquatic restoration projects generally restore or enhance stream and riparian area function and fish habitat. The aquatic restoration projects included under this programmatic consultation will improve channel dimensions and stability, sediment transport and deposition, riparian, wetland, and floodplain functions, hydrologic function, as well as water quality. Furthermore, such improvements will help address limiting factors related to spawning, rearing, migration, and more for ESA-listed and other native fish species.

Terrestrial restoration projects (upland, prairie, coastal and forest-land) promote and enhance conditions for native plant species composition, forage base, and habitat structure which in turn benefits other native faunal species. Prarie restoration projects typically increase native plant density and promote native plant growth and reproduction. The prairie restoration projects included under this programmatic consultation will maintain and improve prairie plant conditions. Such improvements will help address limiting factors for species dependent on prairies, such as Mazama pocket gopher and listed butterflies.
Similarly, silviculture treatments can be used to create habitat diversity and complexity in forested stands that is important to sustaining a diverse number of species and supporting predator/prey relationships, such as those of the northern spotted owl.

The Action Agencies propose to fund or carry out 21 categories of aquatic and upland restoration actions under the Programmatic Restoration Opinion for Joint Ecosystem Conservation by the Services (PROJECTS) program. The 21 project categories of action include:

1.3.1 Project Categories

1. Fish Passage Restoration (Stream Simulation Culvert and Bridge Projects; Headcut and Grade Stabilization; Fish Ladders; Irrigation Diversion Replacement/Relocation and Screen Installation/Replacement) (PDC 33)
2. Stream Channel Enhancement (Large Wood (LW), Boulder, and Gravel Placement; Engineered Logjams (ELJ); Constructed Riffles, Porous Boulder Step Structures and Vanes; Gravel Augmentation; Tree Removal for LW Projects) (PDC 34)
3. Dam and Legacy Structure Removal (PDC 35)
4. Fluvial Channel Reconstruction/Relocation (PDC 36)
5. Off- and Side-Channel Habitat Restoration (PDC 37)
6. Streambank Restoration (PDC 38)
7. Set-Back or Removal of Existing Berms, Dikes, and Levees (PDC 39)
8. Reduction/Relocation of Recreation Impacts (PDC 40)
9. Livestock Fencing, Stream Crossings and Off-Channel Livestock Watering (PDC 41)
10. Piling, Marine Debris, and other Structure Removal (PDC 42)
11. Shellfish Bed/Nearshore Habitat Restoration (PDC 43)

12. In-channel Nutrient Enhancement (PDC 44)
13. Road and Trail Erosion Control and Decommissioning (PDC 45)
14. Juniper Removal (PDC 46)
15. Native Fish Protection (PDC 47)
16. Beaver Habitat Restoration (PDC 48)
17. Wetland Restoration (PDC 49)
18. Tide/Flood Gate Removal, Replacement, or Retrofit (PDC 50)
19. Native Vegetation Restoration and Management (PDC 51)
20. Upland Silvicultural Treatments (PDC 52)
21. Install Wildlife Structures (PDC 53)
22.

These categories of actions that are anticipated to receive funding by the Action Agencies are described in more detail later in this Opinion. As previously noted, these restoration activity categories represent the integration, consolidation and expansion of prior restoration programmatic consultations in the Pacific Northwest to take advantage of successful approaches and to promote regional consistency in design criteria for similar project types. The Service relied on the following description of the proposed action, including all proposed PDC and species-specific conservation measures, to complete this consultation.

1.3.2 Project Design Criteria

The Action Agencies propose to apply the following PDC, in the relevant sections, to every action authorized under this Opinion. Measures described under "Administration" apply to the Action Agencies as they manage the PROJECTS program for habitat restoration activities which may impact listed species under the Service's jurisdiction. PDC described under "General Construction" apply to actions that involve construction. PDC described under "Types of Action" are measures that apply to specific types of actions.

1.3.2.1 Program Administration

1. **Initial Rollout.** The Action Agencies will provide an initial training of this programmatic consultation for restoration program staff to ensure that these PDC and species-specific conservations measures are considered at the onset of each project, incorporated into all phases of project design, and that any constraints, such as the need for fish passage or hydraulic engineering, are resolved early during project design.
2. **Failure to Report May Trigger Re-initiation.** The Service may require re-initiation of this consultation if the Action Agencies fail to provide full reports or host the joint-annual coordination meeting (See 11 and 12 below).
3. **Full Implementation Required.** Failure to comply with all applicable conditions for a specific project will invalidate protective coverage of ESA section 7(o)(2) regarding "take" of listed species, and may lead the Service to a different conclusion regarding the effects of that project.
4. **Integration of PDC, Conservation Measures, and Terms and Conditions into Project Design and Contract Language.** The Action Agencies shall incorporate appropriate aquatic and terrestrial conservation measures and PDC, along with any terms and conditions, into contract language, force-account implementation plans, cooperative agreements, or other agency-specific means of ensuring compliance.

5. **Restoration Review Team (RRT).** Depending on the listed species, the following types of projects require RRT review prior to submission to NMFS, for approval under the NMFS December 2, 2013, programmatic opinion (NMFS 2013), and/or the Service for approval under this Opinion:
    a. Dam Removal
    b. Fluvial Channel Reconstruction/Relocation, which includes side channel projects when the proposed side channel will contain greater than 20% of the bankfull flow.
    c. Tide/Flood Gate Replacement/Retrofit/Removal
    d. Precedent or policy setting actions, such as the application of new technology.

    The RRT will be comprised of a core group, including program managers from the Service restoration programs (PFW, Coastal, Fisheries, and Recovery programs), and the NOAA RC, plus a representative from NMFS West Coast Region, and a NMFS fish passage engineer, if applicable. Additional technical experts (fisheries biologists, botanist, wildlife biologist, hydrologists, geomorphologists, soil scientists, or engineers) from these agencies will be recruited depending on the project to be reviewed.

    The reviews will help ensure that the above four project types: 1) utilize best available science and technology in development of an appropriate restoration plan; 2) are consistent with similar projects; 3) maximize ecological benefits of restoration and recovery projects; and 4) ensure consistent use and implementation of this Opinion throughout the action area. RRT review may be delayed if an incomplete or substandard design is submitted for review and significant revision is necessary.[1]

    In addition to project specific review, the RRT will periodically review and recommend revisions as appropriate to BMPs and conservation measures and other specific implementation guidelines of the Opinion. The RRT will keep a record of clarifications and changes that are agreed to and approved by NMFS and/or the Service by maintaining a **PROJECTS Handbook** that will be reviewed and updated annually. This record will be stored at the Service's OFWO in Portland, Oregon. A complete description of the proposed action, PDC for native vegetation restoration and species-specific conservations measures will be maintained in this PROJECTS Handbook, which will be amended through annual updates. All additions/amendments to the PROJECTS Handbook will not result in any additional negative effects beyond those considered in the Biological Opinion issued for PROJECTS. The RRT does not replace any existing review process, nor shall it delay project implementation unless significant technical, policy, or program concerns with a particular restoration approach are identified. For those projects listed in 5a. through 5d. above, NMFS and the Service will not issue approval for inclusion under this Opinion unless the RRT has reviewed and approved its design.

[1] NMFS completed the effects analysis for this consultation for aquatic species under its jurisdiction (NMFS2013). This analysis is similar to that for actions described in this Opinion for resident aquatic species under USFWS jurisdiction. NMFS's review considered the application of all relevant general and activity-specific conservation measures, and on our review of the best available scientific information, and past experience with similar types of actions. It was not assumed that the RRT review process would result in a further reduction of the short-term adverse effects of any particular project.

6. **Review and Approval.** Various levels of review and approval are required for projects covered under this Opinion.
    a. Action Agencies Project Supervisors will review each project to be covered under this Opinion prior to submission to ensure that projects:
        i. Are within the present or historic range of one of the 26 endangered or threatened species considered in this Opinion, or their designated critical habitat.
        ii. May affect one of the 26 endangered or threatened species considered in this Opinion, or their designated critical habitat.
        iii. Are coordinated with each Service "state species lead" for each species potentially affected by the project when one or more of the following circumstances occurs:
            - Project is in occupied habitat as documented in a note to the project file;
            - Project will reintroduce a species into currently unoccupied habitat;
            - Project cannot meet all required PDC measures (e.g. see Minor Variance Process (PDC 7).
            - Project will affect a species or PCEs with limited consultation history (See PDC 6.c below).
        iv. Have impacts that are likely to be within the range of effects considered in this Opinion.
        v. Have used PDC and conservation measures defined in this Opinion, and the most recent PROJECTS Handbook requirements.
        vi. Do not involve the following activities:
            - Use of pesticide-treated wood, including pilings.
            - Installation of a new tide gate (not replacement in a setback dike).
            - Conducting in-water work in the Willamette River downstream of Willamette Falls between Dec 1 and Jan 31.
            - Any action that requires an environmental impact statement (EIS) under the National Environmental Policy Act (NEPA) regulations if the EIS evaluates alternatives affecting listed species. This does not apply if it is agency or office policy to prepare an EIS for each project, but not specifically required by NEPA.
            - Any action that requires any earthwork at an U.S. Environmental Protection Agency (EPA)-designated Superfund Site, a state-designated clean-up area, or in the likely impact zone of a significant contaminant source, as identified by historical information or best professional judgment.
            - Any action that would result in an overall net loss of designated critical habitat (on either public or private land).
            - Use of cable to anchor in-stream structures.
            - Use of blanket rock riprap to armor streambanks.

- Development of springs that currently have ESA listed species present, or adversely affect critical habitat long term.
- Any action with the primary purpose of protecting private property, or capping environmental contaminants.
- Any action covered under Section 10(a)(1)(A) permits.

b. For aquatic species under the Service's jurisdiction, the Service State Supervisor or designee for the affected state, in consultation with NMFS engineering staff, will review and approve any project with any of the following elements, including any additional conservation measures necessary to ensure that the effects of those projects are within range of effects considered in this Opinion:
   i. Modifications or variances of any PROJECTS requirement (PDC 7)
   ii. Fish screen for pump intake(s) to dewater at rate >3 cubic feet per second (cfs)(PDC 27)
   iii. Installation of pilings (PDC 30)
   iv. Culverts and bridges that do not meet width standards (PDC 33c)
   v. Grade control, stream stability, or headcut countermeasures (PDC 33d.ii)
   vi. Fish ladders and channel-spanning non-porous structures (PDC 33e)
   vii. Irrigation diversion replacement/relocation (PDC 33f)
   viii. Fish screen installation/replacement (PDC 33f)
   ix. ELJs that occupy >25% of the bankfull area (PDC 34b)
   x. Constructed or engineered riffles (PDC 34c)
   xi. Dam removal projects (PDC 35a)
   xii. Fluvial channel reconstruction/relocation (PDC 36)
   xiii. Off- and side-channel reconstruction >20% of the bankfull flow (PDC 37)
   xiv. Alluvium placement that occupies >25% of the channel bed or >25% of the bank full cross sectional area (PDC 38d)
   xv. LW placement that occupies >25% of the bankfull cross section (PDC 38e)
   xvi. Beach nourishment projects (PDC 43c)
   xvii. Tide/flood gate removal, replacement or retrofit projects (PDC 50)

c. Because several species were recently listed and there is limited consultation history for these species, the Service Supervisor or designee for the affected state will review and approve projects that may affect the following species or their designated critical habitats, including any additional conservation measures beyond those contained in this Opinion necessary to ensure that the effects of those projects are within range of effects considered in this Opinion:
   i. Oregon spotted frog.
   ii. Streaked horned lark
   iii. Taylor's checkerspot butterfly
   iv. Mazama pocket gopher

d. For terrestrial animal species and plant species under the Service's jurisdiction, the Service Supervisor or designee for the affected state will review and approve any project with any of the following elements, including any additional conservation measures necessary to ensure that the effects of those projects are within range of effects considered in this Opinion:

   i. Modifications or variances of any PROJECTS requirement (PDC 7)
   ii. Native Vegetation Restoration and Management (PDC 51 for spring mowing; grazing in some instances).

e. Projects that follow the PDC and conservation measures in this Opinion and do not require approval, include:
   i. Culverts and bridges that meet width standards (PDC 33a-c)
   ii. LW, boulder, and gravel placement projects (PDC 34a&e)
   iii. ELJs that occupy less than 25% of the bankfull area (PDC 34b)
   iv. Porous boulder step structures and vanes (PDC 34d)
   v. Tree removal for LW projects (PDC 34f)
   vi. Removal of legacy structures (PDC 35b)
   vii. Off and side channel reconstruction projects when the proposed side channel will contain less than 20% of the bankfull flow (PDC 37)
   viii. Streambank restoration (PDC 38)
   ix. Set-back or removal of existing berms, dikes, and levees (PDC 39)
   x. Estuary restoration (PDC 39b)
   xi. Reduction/relocation of recreation impacts (PDC 40)
   xii. Livestock fencing, stream crossings and off-channel livestock watering facilities (PDC 41)
   xiii. Piling, marine debris and other structure removal (PDC 42)
   xiv. Shellfish bed restoration (PDC 43a)
   xv. Replacing shoreline armoring (PDC 43b)
   xvi. In-channel nutrient enhancement (PDC 44)
   xvii. Road and trail erosion control and decommissioning (PDC 45)
   xviii. Juniper tree removal (PDC 46)
   xix. Native fish protection measures (PDC 47)
   xx. Beaver in-channel structures and habitat restoration (PDC 48)
   xxi. Tide/flood gate removal (PDC 50)
   xxii. Native Vegetation Restoration and Management (PDC 51; except for those actions listed under PDC 6.d)
   xxiii. Upland Silviculture Treatments (PDC 52)
   xxiv. Installation of wildlife structures (PDC 53)

7. **Minor Variance Process.** Because of the wide range of proposed activities and the natural variability within and between ecosystems, some projects may necessitate minor variations from criteria specified herein. NMFS Branch Chiefs and/or Service State Supervisors or designees may grant minor variances, including exceptions to in-water work windows or other timing windows proposed in this Opinion, when there is a clear conservation benefit and there are no additional adverse effects beyond those covered by this Opinion. Minor variances may be requested as part of the above notification process and will:
   a. Cite the BA and Opinion identifying number
   b. Cite the relevant criterion by page number
   c. Define the requested variance
   d. Explain why the variance is necessary

   e. Provide a rationale for why the variance will provide a conservation benefit and will not cause additional adverse effects
   f. Include as attachments any necessary approvals by state agencies.
8. **Site Access.** The Action Agencies will retain the right of reasonable access to each project site to monitor the use and effectiveness of these conditions.
9. **On-Site Documentation.** The following documentation will be posted at the project site or accessible in the area of work if not feasible to post:
   a. Name(s), phone number(s), and address(es) of the person(s) responsible for oversight will be posted at the work site.
   b. A description of hazardous materials that will be used, including inventory, storage, and handling procedures will be available on-site.
   c. Procedures to contain and control a spill of any hazardous material generated, used or stored on-site, including notification of proper authorities, will be readily available on-site.
   d. A standing order to cease work in the event of high flows (above those addressed in the design and implementation plans) or exceedance of water quality limits will be posted on-site.
10. **Monitoring and Reporting.** The Action Agencies will ensure that the following notifications and reports (Appendix B) are submitted to NMFS and the Service for each project to be completed under this Opinion. All project notifications and reports are to be submitted electronically to the Service at PROJECTS@fws.gov *and* to NMFS at usfws.biop.nwr@noaa.gov (from Service project managers) and noaarc.biop.nwr@noaa.gov (from NOAA RC project managers), including:
    a. Project notification 30 days or more before start of construction (Part 1).
    b. Project completion within 60-days of end of construction (Part 1 with Part 2 completed).
    c. Fish salvage within 60-days of work area isolation with fish capture (Part 1 with Part 3 completed).
11. **Annual Program Report.** The Action Agencies will each submit monitoring reports to NMFS and the Service by March 31each year that describe efforts to carry out this Opinion in the preceding calendar year. The reports will include assessments of overall PROJECTS program activity, maps showing the locations and types of actions authorized and carried out under this Opinion, and any other data or analyses the Action Agencies deem necessary or helpful to assess habitat trends as a result of actions authorized under this Opinion. The Action Agencies will each submit reports to the Service and NMFS, by email, at these addresses: PROJECTS@fws.gov and/or noaarc.biop.nwr@noaa.gov or usfws.biop.nwr@noaa.gov. The Action Agencies will review the tracking information for all projects implemented in a given year to ensure the accuracy and completeness of the tracking record within 60 days of provision by NMFS. The Action Agencies will also provide a record of the addendum to this Opinion for the previous year, including a summary of RRT quarterly and annual meetings.
12. **Annual Coordination Meeting.** The Action Agencies will attend a joint annual coordination meeting with the Service and NMFS by March 31 each year to discuss annual reports and any actions that can improve conservation under this Opinion, or make the PROJECTS program more efficient or accountable. Meeting will be jointly arranged by the Action Agencies, the Service and NMFS.

1.3.2.2 General Design Considerations

13. Project Design Process

In addition to specific conservation measures below, it is expected that project managers will use the best available scientific information regarding the likely effects of climate change on resources in the project area, including projections of local stream flow and water temperature, and/or sea level rise and sediment transport processes, to ensure that the project will be adaptable to those changes.

The following general design considerations will be applied for all actions completed under the PROJECTS program:

a. Obtain all applicable regulatory permits and official project authorizations before beginning construction.
b. Design the project to minimize the extent and duration of earthwork, *e.g.*, compacting, dredging, drilling, excavation, noise, and filling, including the following concerns:
    i. Minimize use of heavy equipment, vehicles or power tools below bankfull elevation to the extent possible project specialists determine such work is necessary, or will result in less risk of sedimentation or other ecological damage than work above that elevation.
    ii. Complete earthwork in wetlands, riparian areas, and stream channels as quickly as possible.
    iii. Specify that the construction contractor is to cease project operations when high flows or high tides may inundate the project area, except for efforts to avoid or minimize resource damage.
c. Project designs for a specific species should include review/input from a biologist at the local Service office with appropriate knowledge of the particular species, such as the Service state species lead for affected species. The biologist has the discretion to adjust disturbance and disruption distances, based on site-specific conditions and known biology of the species.
d. Hollow pipes, such as those used for signs, fences and gates, will be capped to prevent trapping small birds and mammals.

14. Site Contamination Assessment

Pursuant to Service policy, project managers will conduct a site contamination assessment as part of the design process to determine whether there is a likelihood of hazardous materials being present at the site, and include measures in the design to prevent release of such materials as a result of the project and to handle and dispose of them according to applicable regulations.

a. The level of detail and resources committed to such an assessment will be commensurate with the level and type of past or current development at the site. Assessments may include the following:
    i. Review available records, such as former site use, building plans, and records of any prior contamination events.

   ii. If the project site was used for industrial processes (*i.e.*, mining or manufacturing with chemicals), inspect to determine the environmental condition of the property.
   iii. Interview people who are knowledgeable about the site, *e.g.*, site owners, operators, and occupants, neighbors, or local government officials.

b. Retain contaminant survey information in the project file. Discuss with NMFS and the Service if ground disturbance or other activities to accomplish the proposed project has substantial potential to release contaminants into habitats that support listed fish and wildlife species to determine if additional consultation is needed.

1.3.2.3 Construction Considerations

Make the following construction considerations part of the construction contract bid package so that the construction contractor can plan and cost the work accordingly.

15. Site Layout and Flagging

a. Before any significant ground disturbance or entry of mechanized equipment or vehicles into the construction area, clearly flag, mark with survey paint, or other obvious boundary marker, the following areas as appropriate:
   i. Sensitive areas, *e.g.*, wetlands, water bodies, ordinary high water, spawning areas, appropriate buffer zones for listed plant and animal species and their habitats, as identified in the proposed conservation measures.
   ii. Equipment entry and exit points.
   iii. Road and stream crossing alignments.
   iv. Staging, storage, and stockpile areas.

b. Before the use of herbicides, clearly flag no-application buffer zones if possible.

16. Staging, Storage, and Stockpile Areas

a. Designate and use staging areas to store hazardous materials, or to store, fuel, or service heavy equipment, vehicles and other power equipment with tanks larger than 18.9 l (5 gallons), that are at least 45.7 m (150 feet) from any natural water body or wetland, or on an established paved area, such that sediment and other contaminants from the staging area cannot be deposited in the floodplain or stream.
b. Natural materials that are displaced by construction and reserved for restoration, *e.g.*, LW, gravel, and boulders, may be stockpiled within the 100-year floodplain.
c. Dispose of any material not used in restoration and not native to the floodplain outside of the functional floodplain.
d. After construction is complete, obliterate all staging, storage, or stockpile areas, stabilize the soil, and revegetate the area.[2]

[2] Road and path obliteration refers to the most comprehensive degree of decommissioning and involves decompacting the surface and ditch, pulling the fill material onto the running surface, and reshaping to match the original contour.

17. Erosion Control

a. Use site planning and site erosion control measures commensurate with the scope of the project to prevent erosion and sediment discharge from the project site.
b. Before significant earthwork begins, install appropriate, temporary erosion controls downslope to prevent sediment deposition in the riparian area, wetlands, or water body.
c. During construction, if eroded sediment appears likely to be deposited in the stream, install additional sediment barriers as necessary.
d. Temporary erosion control measures may include fiber wattles, silt fences, jute matting, wood fiber mulch and soil binder, or geotextiles and geosynthetic fabric.
e. Soil stabilization utilizing wood fiber mulch and tackifier (hydro-applied) may be used to reduce erosion of bare soil if the materials are noxious weed-free and nontoxic to aquatic and terrestrial animals, soil microorganisms, and vegetation.
f. Remove sediment from erosion controls if it reaches 1/3 of the exposed height of the control.
g. Whenever surface water is present, maintain a supply of sediment control materials and an oil-absorbing floating boom at the project site.
h. Stabilize all disturbed soils following any break in work unless construction will resume within four days.
i. Remove temporary erosion controls after construction is complete and the site is fully stabilized.

18. Hazardous Material Spill Prevention and Control

a. At the project site:
    i. Post or have available on site, written procedures for notifying environmental response agencies, including an inventory and description of all hazardous materials present, and the storage and handling procedures for their use.
    ii. Maintain a spill containment kit, with supplies and instructions for cleanup and disposal, adequate for the types and quantity of hazardous materials present.
    iii. Train workers in spill containment procedures, including the location and use of the spill containment kits.
b. Temporarily contain any waste liquids under an impervious cover, such as a tarpaulin, in the staging area until the wastes can be properly transported to, and disposed of, at an approved receiving facility.

19. Equipment, Vehicles, and Power Tools

a. Select, operate and maintain all heavy equipment, vehicles, and power tools to minimize adverse effects on the environment and noise disturbance to listed species, *e.g.*, low pressure tires, minimal hard-turn paths for track vehicles, use of temporary mats or plates to protect wet soils.
b. Before entering wetlands or working within 150 feet of a waterbody, replace all petroleum-based hydraulic fluids with biodegradable products.[3]

[3] For additional information and suppliers of biodegradable hydraulic fluids, motor oil, lubricant, or grease, see

c. Take appropriate measures necessary for invasive species prevention and control:
    i. Before entering and leaving the project site, power wash all heavy equipment, vehicles and power tools, allow them to fully dry, and inspect them to make certain no plants, soil, or other organic material is adhering to their surface.
    ii. Before entering and leaving the water, inspect any watercraft, waders, boots, or other gear to be used in or near water and remove any plants, soil, or other organic material adhering to the surface.
    iii. Ensure all vehicles, equipment, and tools are as clean as possible and free from any seeds or vegetative matter.
d. Inspect all equipment, vehicles, and power tools for fluid leaks before they leave the staging area.
e. Before operation within 150 feet of any waterbody, and as often as necessary during operation, thoroughly clean all equipment, vehicles, and power tools to keep them free of external fluids and grease and to prevent leaks and spills from entering the water.
f. Generators, cranes or other stationary heavy equipment operated within 150 feet of any waterbody will be maintained and protected as necessary to prevent leaks and spills from entering the water.

20. Temporary Access Roads and Paths

a. Whenever reasonable, preferentially use existing access roads and paths.
b. Minimize the number and length of temporary access roads and paths through riparian areas and floodplains.
c. Minimize removal of riparian vegetation.
d. When it is necessary to remove vegetation, cut at ground level (no grubbing).
e. Do not build temporary access roads or paths where grade, soil, or other features suggest slope instability.
f. Any road on a slope steeper than 30% will be designed by a civil engineer with experience in steep road design.
g. After construction is complete, obliterate all temporary access roads and paths, stabilize the soil, and revegetate the area.
h. Temporary roads and paths in wet areas or areas prone to flooding will be obliterated by the end of the in-water work window. Decompact road surfaces and drainage areas, pull fill material onto the running surface, and reshape to match the original contours.

Environmentally Acceptable Lubricants by the U.S. EPA (2011); *e.g.*, mineral oil, polyglycol, vegetable oil, synthetic ester; Mobil® biodegradable hydraulic oils, Total® hydraulic fluid, Terresolve Technologies Ltd.® bio-based biodegradable lubricants, Cougar Lubrication® 2XT Bio engine oil, Series 4300 Synthetic Bio-degradable Hydraulic Oil, 8060-2 Synthetic Bio-Degradable Grease No. 2, *etc*. The use of trade, firm, or corporation names in this Opinion is for the information and convenience of the action agency and applicants and does not constitute an official endorsement or approval by the U.S. Department of Interior or USFWS of any product or service to the exclusion of others that may be suitable.

21. Dust Abatement

a. Employ dust abatement measures commensurate with soil type, equipment use, wind conditions, and the effects of other erosion control measures.
b. Sequence and schedule work to reduce the exposure of bare soil to wind erosion.
c. Maintain spill containment supplies on-site whenever dust abatement chemicals are applied.
d. Do not use petroleum-based products.
e. Do not apply dust-abatement chemicals, *e.g.*, magnesium chloride, calcium chloride salts, ligninsulfonate, within 25 feet of water body, or in other areas where there may be runoff into a wetland or water body.
f. Do not apply ligninsulfonate at rates exceeding 2.26 l/m^2 (0.5 gallons per square yard) of road surface, assuming a 50:50 solution of ligninsulfonate to water.

22. Temporary Stream Crossings

a. No stream crossing may occur where listed amphibians are present.
b. No stream crossing may occur at active spawning sites when holding adult listed fish are present, or when eggs or alveins are in the gravel.
c. Do not place temporary crossings in areas that may increase the risk of channel re-routing or avulsion, or in potential spawning habitat, *e.g.*, pools and pool tailouts.
d. Minimize the number of temporary stream crossings; use existing stream crossings whenever reasonable.
e. Install temporary bridges and culverts to allow for equipment and vehicle crossing over perennial streams to access construction areas.
f. Wherever possible, vehicles and machinery will cross streams at right angles to the main channel.
g. Equipment and vehicles may cross the stream in the wet only where the streambed is bedrock, where the streambed is naturally stable, or where mats or off-site logs are placed in the stream and used as a crossing.
h. Obliterate all temporary stream crossings as soon as they are no longer needed, and restore any damage to affected stream banks or channel.

23. Surface Water Withdrawal and Construction Discharge Water

a. Surface water may be diverted to meet construction needs, but only if developed sources are unavailable or inadequate.
b. Diversions may not exceed 10% of the available flow and will have a juvenile fish exclusion device that is consistent with NMFS's criteria (NMFS 2011 or the most recent version).[4]
c. Treat all construction discharge water using BMPs to remove debris, sediment, petroleum products, and any other pollutants likely to be present (*e.g.*, green concrete, contaminated water, silt, welding slag, sandblasting abrasive, grout cured less than 24 hours, drilling fluids), to ensure that no pollutants are discharged to any perennial or intermittent waterbody.

[4] National Marine Fisheries Service. 2011. Anadromous salmonid passage facility design. Northwest Region.

24. Temporary Fish Passage

a. Provide fish passage for any adult or juvenile listed fish likely to be present in the action area during construction, unless passage did not exist before construction. Stream isolation and dewatering is required during project implementation, unless the stream is naturally impassable at the time of construction.

b. After construction, provide fish passage that meets NMFS's fish passage criteria for any adult or juvenile listed fish (NMFS 2011 or the most recent version), for the life of the action.

25. Timing of In-Water Work

a. The in-water work window will limit in-water construction to the times specified in the project notification form. The construction schedule will conform to the most up-to-date guidelines on in-water work windows established in Oregon, Washington, and Idaho by the Oregon Department of Fish and Wildlife, Washington Department of Fish and Wildlife, and Idaho Department of Fish and Game, respectively, and the Service for bull trout. For nearshore projects in Puget Sound, no in-water work is allowed in bull trout foraging, migration and overwintering habitat from February 16 to July 15, and near the Duwamish River from February 16 to September 30. Any exceptions to in-water work windows recommended by ODFW, WDFW, or IDFG will be approved by NMFS and the Service, as appropriate.

b. Hydraulic and topographic measurements and placement of LW, boulders, or gravel may be completed anytime, provided there is no excavation in areas occupied by adult fish congregating for spawning, or in areas where redds are occupied by eggs or pre-emergent alevins.

26. Fisheries, Hydrology, Geomorphology, Wildlife, Botany, and Cultural Surveys in Support of Habitat Restoration

This includes assessments and monitoring projects that are associated with planning, implementation, and monitoring of restoration projects covered by this Opinion. Such support projects may include surveys to document the following aquatic, riparian, coastal and upland attributes: habitat, hydrology, channel geomorphology, water quality, fish spawning, species presence[5], macroinvertebrates, riparian vegetation, wildlife, and cultural resources (including excavating test pits less than 1 m^2 (~1.2 square yard) in size). This also includes effectiveness monitoring associated with projects implemented under this Opinion, provided the effectiveness monitoring is limited to the same survey techniques described in this section.

a. Project sites will be surveyed for presence of any listed plant or animal species that may occur within the project area. Surveys will take place prior to initiation of the project and during the appropriate time frames. If no surveys occur or are available, occupancy for listed animal species will be assumed in all suitable habitat in proximity to known occupied habitat (distance is defined on a species by species basis within the conservation measures), and listed plant occupancy

[5] Enumeration by non-lethal techniques that do not require handling, *i.e.,* snorkeling, ocular surveys, *etc.*; not hooking or electrofishing for fish species.

will be assumed in all suitable habitat where the species is known to occur, unless absence can be confirmed by a Service species lead.

b. Train personnel in survey methods to prevent or minimize disturbance of fish and wildlife and plants. Contract specifications should include these methods where appropriate.
c. Avoid impacts to fish redds. When possible, avoid sampling during spawning periods.
d. Avoid trampling and/or stepping on listed species, their nests and their forage plants when completing surveys, assessments, and monitoring activities.
e. Do not walk through vernal pool habitats, especially during the wet season, unless absolutely necessary to complete required surveys, assessments, and monitoring activities.
f. Complete surveys, assessments, and monitoring activities during non-critical life history periods for a listed species (e.g., not during spawning and breeding periods), unless the activity objective(s) requires this level of timing.
g. Coordinate with other local agencies to prevent redundant surveys.
h. Locate excavated material from cultural resource test pits away from stream channels. Replace all material in test pits when survey is completed and stabilize the surface.

27. Work Area Isolation

a. Isolate any work area within the wetted channel from the active stream whenever listed fish are reasonably certain to be present, or if the work area is less than 91.44 m (300 feet) upstream from known spawning habitats. However, work area isolation may not always be necessary or practical in certain settings; e.g., dry streambeds and tidal zones, respectively.
b. Engineering design plans for work area isolation will include all isolation elements. Final site specific plans by contractors will be approved by project sponsor and biologist.
c. Dewater the shortest linear extent of work area practicable, unless wetted in-stream work is deemed to be minimally harmful to fish, and is beneficial to other aquatic species.[6]
    i. Use a coffer dam and a by-pass culvert or pipe, or a lined, non-erodible diversion ditch to divert flow around the dewatered area. Dissipate flow energy to prevent damage to riparian vegetation or stream channel and provide safe downstream re-entry for fish, preferably into pool habitat with cover.
    ii. Where gravity feed is not possible, pump water from the work site to avoid re-watering. Maintain a fish screen on the pump intake to avoid juvenile fish entrainment (NMFS 2011 or the most recent version).
    iii. Pump seepage water to a temporary storage and treatment site, or into upland areas, to allow water to percolate through soil or to filter through vegetation before reentering the stream channel. The water treatment site

[6] For instructions on how to dewater areas occupied by lamprey, see *Best management practices to minimize adverse effects to Pacific lamprey* (*Entosphenus tridentatus*) (USFWS 2010).

should have a treatment system comprised of either a hay bale basin or other sediment control device.

iv. Monitor water levels below the construction site to prevent stranding of aquatic organisms.

v. When construction is complete, re-water the construction site slowly to prevent loss of surface flow downstream, and to prevent a release of suspended sediment.

d. Whenever a pump is used to dewater the isolation area and listed fish may be present, a fish screen will be used that meets NMFS's fish screen criteria (NMFS 2011 or the most recent version). NMFS approval is required for pumping that exceeds 3 cfs.

28. Fish Capture and Release

a. If practicable, allow listed fish species to migrate out of the work area or remove fish before dewatering; otherwise remove fish from an exclusion area as it is slowly dewatered with methods such as hand or dip-nets, seining, and trapping with minnow traps (or gee-minnow traps).

b. Fish capture will be supervised by a qualified fisheries biologist with experience in work area isolation and competence to ensure the safe handling of fish.

c. Conduct fish capture activities during periods of the day with the coolest air and water temperatures possible, normally early in the morning to minimize stress and injury of species present.

d. Monitor the nets frequently enough to ensure they stay secured to the banks and free of organic accumulation.

e. Electrofish during the coolest time of day, and only after other means of fish capture are determined to be not feasible or ineffective.

i. Follow the most recent version of NMFS (2000) electrofishing guidelines.

ii. Do not electrofish when the water appears turbid, *e.g.*, when objects are not visible at depth of 30 cm (12 inches).

iii. Do not intentionally contact fish with the anode.

iv. Use direct current or pulsed direct current within the following ranges:

- If conductivity is less than 100 microsecond (µs), use 900 to 1100 volts.
- If conductivity is between 100 and 300 µs, use 500 to 800 volts.
- If conductivity greater than 300 µs, use less than 400 volts.

v. Begin electrofishing with a minimum pulse width and recommended voltage, then gradually increase to the point where fish are immobilized.

vi. Immediately discontinue electrofishing if fish are killed or injured, *i.e.*, dark bands visible on the body, spinal deformations, significant de-scaling, fish are torpid or not able to maintain upright attitude after sufficient recovery time. Recheck machine settings, water temperature and conductivity, and adjust or postpone procedures as necessary to reduce injuries.

f. If buckets are used to transport fish:

i. Minimize the time fish are in a transport bucket.

ii. Keep buckets in shaded areas or, if no shade is available, covered by a canopy.
iii. Limit the number of fish within a bucket; fish will be of relatively comparable size to minimize predation.
iv. Use aerators or replace the water in the buckets at least every 15 minutes with cold clear water.
v. Release fish in an area upstream with adequate cover and flow refuge; downstream release is acceptable provided the release site is below the influence of construction.
vi. Be careful to avoid mortality counting errors.

g. Monitor and record fish presence, handling, and injury during all phases of fish capture and submit a fish salvage report to NMFS and the Service for any listed fish species that may be present, within 60 days of capture. The report must, document the date, time of day, fish handling procedures, air and water temperatures, and total numbers of each fish species handled, and numbers of listed fish injured or killed.

29. Invasive species and non-native plant control

Invasive species impacts are of concern to the Service and NMFS. Invasive species degrade, change, or displace native habitats and compete with native wildlife and are thus harmful to fish, wildlife, and plant resources. Preventing the introduction or spread of invasive and non-target species is the most effective strategy to avoid impacts to native species and ecosystems. Preventive measures typically offer the most cost-effective means to minimize or eliminate environmental and economic impacts due to invasive species.

Invasive Species Prevention Measures

a. Each project must clearly identify and implement invasive species prevention measures, including:
    i. Generating a list of invasive species of concern for importing or exporting from the project site.
    ii. Specifying methods to be used to reduce the risk of spreading invasive species.
    iii. Monitoring that will occur to detect invasive species and;
    iv. Identifying actions that will be implemented to control invasive species if identified and it is deemed necessary to take action.
b. Control or removal of invasive and non-native vegetation must be completed in a manner that minimizes the accidental dispersal of seeds or reproductive plant parts to other locations. Project personnel should complete the following tasks.
    i. Shake out all work clothes worn before leaving a project site.
    ii. Change work clothes (e.g., coveralls, gloves, and hats) and clean boots if workers will be going to a new location.
    iii. Launder work clothes frequently.
    iv. Properly dispose of all invasive and non-native plant materials removed during a treatment in a timely manner.

v. Clean all equipment, vehicles, and tools used at a project site before going to a new location.

Invasive Plant Treatment Measures

a. Herbicide methods.
   - For herbicide use in prairie restoration sites, see PDC 51 for additional information and restrictions on prairie, coastal and oak habitat restoration.
   - Herbicide Label. Herbicide applicators will comply with all label instructions.
   - Power equipment. Refuel gas-powered equipment with tanks larger than 19 liters (5 gallons) in a vehicle staging area placed 45.72 m (150 feet) or more from any natural waterbody, or in an isolated hazard zone such as a paved parking lot.
   - Maximum herbicide treatment area. In riparian habitat: Do not treat more than 10% of the acres of riparian habitat within a 6^{th-}field HUC with herbicides per year.
   - Herbicide applicator qualifications. Herbicides may only be applied by an appropriately licensed applicator, or under the direct supervision of a licensed applicator. Only use an herbicide specifically targeted for a particular plant species that will cause the least impact.
   - 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, take remedial actions in the event of spills, and fully report the event. The following measures will be used to reduce the risk of a spill during water transport: a) No more than 9.5 l (2.5 gallons) of herbicide concentrate will be transported per person or raft, and typically it will be 3.8 l (1 gallon) or less; b) glyphosate will be carried in 3.8 l (1 gallon) or smaller plastic containers. The containers will be wrapped in plastic bags and then sealed in a secondary watertight container. If transported by raft, the container will be secured to the watercraft.
   - Before applying herbicide, applicators must thoroughly review the site to identify and mark any required buffer areas.

b. All reasonable efforts will be made to determine adverse impacts to listed species following herbicide applications.
c. Notify the Service within 24 hours of any spill or misapplication.
d. Permitted Herbicides. The only herbicides allowed for use under this Opinion are divided into “Aquatic and Upland” and “Upland Use Only”. Herbicides and adjutants identified for "Upland Use Only," must not be used within 30.5 m (100 feet) (except Oryzalin which has a 297 m (975 feet) buffer) of aquatic habitats or where there is a reasonable likelihood that it will drift or leach into aquatic habitats. All BMPs for herbicide use and species specific conservation measures must be observed. The use of dyes is strongly encouraged when spraying near the 30 m (100 feet) buffer. Vegetation control closer than 30 m (100 feet) may use “Aquatic” herbicides with associated buffers, or other control techiques removal.

e. Permitted herbicides, common trade names[7], and allowable uses under this Opinion are as follows:

Aquatic and Upland Herbicides

- aquatic imazapyr (e.g., Habitat) – Aquatic and Upland, no T&E plants and butterflies
- aquatic glyphosate (e.g., AquaMaster, AquaPro, Rodeo) – Aquatic and Upland
- aquatic triclopyr-TEA (e.g., Renovate 3) – Aquatic and Upland, no T&E plants and butterflies
- chlorsulfuron (e.g., Telar, Glean, Corsair) – Aquatic and Upland
- clopyralid (e.g., Transline) – Aquatic and Upland
- imazapic (e.g., Plateau) – Aquatic and Upland
- imazapyr (e.g., Arsenal, Chopper) – Aquatic and Upland, no T&E plants and butterflies
- metsulfuron-methyl (e.g., Escort) – Aquatic and Upland
- picloram (e.g., Tordon) – Aquatic and Upland
- sethoxydim (e.g., Poast, Vantage) – Aquatic and Upland
- sulfometuron-methyl (e.g., Oust, Oust XP) - Aquatic and Upland
- glyphosate (nonaquatic formulation) – Upland Use Only, no vernal pool use.
- triclopyr (e.g., Garlon4Ultra) – Upland Use Only, no vernal pool use.
- fluazifop-p-butyl (e.g., Fusilade) – Upland Use Only, no vernal pool use.
- clethodim (e.g., Envoy) – Upland Use Only, no vernal pool use
- triclopyr +2,4-D ester (e.g., Crossbow) – Upland Use Only, no vernal pool use.
- diquat dibromide (e.g., Reward) – Upland Use Only, no vernal pool use
- 2,4-D amine, Cannot use on T&E plants and butterflies, no vernal pool use.
- oryzalin, Cannot use on T&E plants and butterflies, no vernal pool use.
- aminopyralid – Upland Use Only, no vernal pool use.

f. Permitted Herbicide adjuvants. When recommended by the label, an approved aquatic surfactant or drift retardant can be used to improve herbicidal activity or application characteristics. Adjuvants that contain alky amine etholoxylates, i.e., polyethoxylated tallow amine (POEA), alkylphenol ethoxylate (including alkyl phenol ethoxylate phosphate esters), or herbicides that contain these compounds are not covered by this Opinion. The following product names are covered by this Opinion:

- Agri-Dex
- AquaSurf
- Bond

[7] The use of trade, firm, or corporation names in this Opinion is for the information and convenience of the action agency and applicants and does not constitute an official endorsement or approval by the U.S. Department of Interior or USFWS of any product or service to the exclusion of others that may be suitable.

- Bronc Max
- Bronc Plus Dry-EDT
- Class Act NG
- Competitor
- Cut Rate
- Cygnet Plus
- Destiny HC
- Exciter Fraction
- InterLock
- Kinetic
- Level 7
- Liberate
- Magnify
- One-AP XL
- Pro AMS Plus
- Spray-Rite
- Superb HC
- Tactic
- Tronic
- Activeate Plus – Upland use only
- Nufilm – Upland use only
- Other vegetable-based surfactants for which there is a demonstrated track record for use with Service ESA-listed species – Upland use only

g. Measures for handling herbicides are as follows.
    i. During transport, the applicator must secure herbicides containers to prevent movement within the vehicle or loss from the vehicle.
    ii. When spray equipment is not being used, the applicator must ensure that all valves and tanks covers are closed during movement of the vehicle.
h. The applicator must firmly secure any filled portable tanks used for herbicide applications to the frame of the vehicle.
i. Herbicide carriers. Herbicide carriers (solvents) are limited to water or specifically labeled vegetable oil. Use of diesel oil as an herbicide carrier is not covered by this Opinion.
j. Dyes. The presence of dye makes it easier to see where the herbicide has or has not been applied, as well as enabling applicator to immediately see if there are drift issues, spills, leaks or drips (SERA 1997).
    i. Dyes should be used for all applications to ensure complete and uniform treatment of invasive plants.
    ii. Use a non-hazardous indicator dye (e.g., Hi-Light or Dynamark) with herbicides within 30.5 m (100 feet) of water.
k. Measures for herbicide mixing.
    i. Mix herbicides and adjuvants, carriers, and/or dyes more than 45.7 m (150 feet) from any perennial or intermittent waterbody to minimize the risk of an accidental discharge.

   ii. Applicators must prepare spray mixtures in accordance with the label instructions and not exceed the amount of herbicide per acre as specified in the instructions.
   iii. Applicators must mix and load herbicides at least 45.7 m (150 feet) from any surface waters and residential wells and only in locations where accidental spills cannot flow into surface waters or contaminate groundwater. Required buffer distances to listed species and sensitive resources must also be adhered to as addressed in the species conservation measures.

l. Tank Mixtures. The potential interactive relationships that exist among most active ingredient combinations have not been defined and are uncertain. Therefore, combinations of herbicides in a tank mix are not covered by this Opinion.
m. Spill Cleanup Kit. Provide a spill cleanup kit 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.
n. Herbicide application rates. Apply herbicides at the lowest effective label rates.
o. Herbicide application methods. Herbicides will only be applied by an appropriately licensed applicator or under the direct supervision of a licensed applicator, and application methods must comply with all label instructions. Apply liquid or granular forms of herbicides as follows:
   i. Broadcast spraying – hand held nozzles attached to back pack tanks or vehicles, or by using vehicle mounted booms.
   ii. Spot spraying – hand held nozzles attached to back pack 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.
n. Measures for spot spraying
   i. Keep the spray nozzle within 1.2 m (4 feet) of the ground when applying herbicide less than 4.6 m (15 feet) from high water mark (HWM). If spot or patch spraying tall vegetation more than 4.6 m (15 feet) away from the HWM, keep the spray nozzle within 1.8 m (6 feet) of the ground.
   ii. 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.
o. Measures for wick and wipe applications
   i. The appropriate type and size of equipment will be used to apply herbicides onto the target foliage and stems.
   ii. Herbicide applications will be made in a manner that prevents herbicide runoff onto the ground.
p. Measures for basal bark applications
   i. Applicators will avoid unnecessary run-off when applying herbicide to stems of target vegetation. A dryer is recommended to establish coverage and prevent runoff.

   ii. Herbicide applications will be applied using the lowest nozzle pressure that will allow adequate coverage.

q. Measures for spot and patch applications
   i. Herbicides applications may be used with hand applicators or an all-terrain vehicle with low mounted boom sprayers.
   ii. Herbicide will be applied in a manner where the spray is directed towards the application area and away from listed plants.

r. Measures for cut surface and hack and squirt/injection applications
   i. Herbicide applications will be made in a manner that prevents herbicide runoff onto the ground.

s. Measures for spot applications of dry granules, pellets, and dust
   i. A 3 m (10 feet) buffer will be maintained between listed plants and application areas to prevent exposure to listed plants.

t. Measures for tractor-based broadcast applications
   i. Nozzles and pressures will be adjusted to minimize fine particle size so that the spray does not drift off the application area, while still providing for reasonable herbicide coverage.
   ii. Drift control agents will be used if necessary to prevent any spray from drifting off the application area.

u. Washing spray tanks. Wash spray tanks 91.4 m (300 feet) or more away from any surface water.

v. Avoid the use of any irrigation waters that are contaminated with herbicides. Do not use these waters in any area that contains a listed plant species.

w. Minimization of herbicide drift and as follows:
   i. Do not broadcast spray when wind speeds exceed 16.1 km (10 miles) per hour, or are less than 3.2 km (2 miles) per hour. Do not spot spray when wind speeds exceed 16.1 km (10 miles) per hour. Winds less than 3.2 km (2 miles) per hour are acceptible for spot spraying.
   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. Use minimum effective nozzle height recommended by nozzle manufacturer.
   v. Increase spray droplet size whenever possible by decreasing spray pressure to lowest effective nozzle pressure recommended by nozzle manufacturer, using high flow rate nozzles, using water diluents instead of oil, and adding thickening agents.
   vi. Do not apply herbicides during temperature inversions, or when air temperature exceeds 27 ºC (81 ºF). Do not apply herbicides when the soil is saturated or when a precipitation event likely to produce direct runoff to salmon/bull trout 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 may follow label instructions. Do not conduct hack-squirt/injection applications during periods of heavy rainfall. For all other cases: Herbicide applications will be delayed if precipitation is forecast to occur

within 24 hours, except for pellet based applications. At upland prairie sites, chemical applications will not occur within 24 hours of predicted precipitation. At wet prairie sites, chemical applications will only be conducted if the 7-day weather forecast indicates no significant rainfall.

vii. Wind and other weather data will be monitored and reported for all broadcast applications.

A. Herbicide buffer distances. Table 1 outlines required no-application buffer-widths, measured in feet, as map distance perpendicular to the bankfull elevation for streams, the upland boundary for wetlands, or the upper bank for roadside ditches. Widths are based on herbicide formula, stream type, and application method during herbicide applications. Before herbicide application begins, flag or mark the upland boundary of each applicable herbicide buffer to ensure that all buffers are in place and functional during treatment.

30. Piling Installation

a. Pilings may be concrete, steel round pile 60 cm (24 inches) in diameter or smaller, steel H-pile designated as HP24 or smaller, or untreated wood.[8]
b. When possible, use a vibratory hammer for piling installation.
c. When using an impact hammer to drive or proof steel piles, use one of the following sound attenuation methods to effectively dampen sound pressure waves in all areas to a single strike peak threshold of 206 decibels. For cumulative strikes, a 187 decibel sound exposure level (SEL) is allowed in areas and times where fish are larger than 2 grams; and a 183 decibel SEL is allowed in areas and times when fish are smaller than 2 grams.
d. Completely isolate the pile from flowing water by dewatering the area around the pile if dewatering is practicable.
e. If area cannot be dewatered, and water velocity is 0.5 m/s (1.6 feet per second) or less, surround the piling being driven by a confined or unconfined bubble curtain that will distribute small air bubbles around 100% of the piling perimeter for the full depth of the water column, as described in National Marine Fisheries Service and USFWS (2006).[9]
f. If water velocity is greater than 0.5 m/s (1.6 feet per second), surround the piling being driven by a confined bubble curtain (*e.g.,* a bubble ring surrounded by a fabric or non-metallic sleeve) that will distribute air bubbles around 100% of the piling perimeter for the full depth of the water column.
g. NMFS/Service review and approval. Provide NMFS/Service the following information: the timing of in-water work, the number of impact hammer strikes per pile and the estimated time required to drive piles; the hours per day pile

[8] An individual consultation and site-specific risk assessment are required for actions that propose the use of pilings made of treated wood, including chromated copper arsenate (CCA), ammoniacal copper zinc arsenate (ACZA), alkaline copper quaternary (ACQ-B and ACQ-D), ammoniacal copper citrate (CC), copper azole (CBA-A), copper dimethyldithiocarbamate (CDDC), borate preservatives, and oil-type wood preservatives, such as creosote, pentachlorophenol, and copper naphthenate.

[9] See also Wursig *et al*. (2000) and Longmuir and Lively (2001) for additional information on how to deploy an effective, economical bubble curtain.

driving will occur, the depth of water, the type of substrate, the hydroacoustic assumptions; and the pile type, diameter, and spacing of the piles.

Table 1. Herbicide buffer distances by herbicide formula, stream type, and application method for aquatic habitat restoration projects. Upland Use Only herbicides must be used at least 30.5 m (100 feet) from any aquatic habitat, except for Oryzalin, which requires a 297 m (975 feet) buffer from aquatic habitats. Check species-specific conservation measures for additional restrictions for each listed species at each project site.

Herbicide	**No Application Buffer Width (feet)**					
	Streams and Roadside Ditches with flowing or standing water present and Wetlands			Dry Streams, Roadside Ditches, and Wetlands (no standing water present)		
	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	bankfull elevation	50	None	None
Clopyralid	100	15	bankfull elevation	50	None	None
Metsulfuron-methyl	100	15	bankfull elevation	50	None	None
Moderate Risk to Aquatic Organisms						
Imazapyr	100	50	bankfull elevation	50	15	bankfull elevation
Sulfometuron-methyl	100	50	50	50	15	bankfull elevation
Chlorsulfuron	100	50	bankfull elevation	50	15	bankfull elevation
High Risk to Aquatic Organisms						
Picloram	100	50	50	100	50	50
Sethoxydim	100	50	50	100	50	50
Upland Use Only Herbicides						
Triclopyr - BEE	100	100	100	100	100	100
Glyphosate	100	100	100	100	100	100
2, 4-D amine	100	100	100	100	100	100
Clethodim	100	100	100	100	100	100
Fluazifop-P-butyl	100	100	100	100	100	100
Oryzalin	**Not Allowed**	975	975	**Not Allowed**	975	975
Aminopyralid	100	100	100	100	100	100
diquat dibromide (e.g., Reward)	100	100	100	100	100	100
triclopyr +2,4-D ester (e.g., Crossbow)	100	100	100	100	100	100

31. Site Restoration

a. Restore any significant disturbance of riparian, wetland or upland vegetation, soils, stream banks or stream channel.
b. Remove all project related waste; *e.g.*, pick up trash, sweep roadways in the project area to avoid runoff-containing sediment and trash.
c. Obliterate all temporary access roads, crossings, and staging areas.
d. Loosen soil in compacted areas when necessary for revegetation or infiltration.
e. Although no single criterion is sufficient to measure restoration success, the intent is that the following features should be present in the upland parts of the project area, within reasonable limits of natural and management variation:
    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 microsites, are present and well distributed across the site; invasive plants are minimal or absent.
    v. Plants have normal, vigorous growth form, and a high probability of remaining vigorous, healthy and dominant over undesired competing vegetation.
    vi. 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").
    vii. A continuous corridor of shrubs and trees appropriate to the site are present to provide shade and other habitat functions for the entire streambank/shoreline.

32. Revegetation

a. Plant and seed disturbed areas before or at the beginning of the first growing season after construction.
b. Native vegetation will planted on disturbed project sites and sites protected from further disturbance until new growth is well established. Do not use non-native species for site restoration with the exception of sterile seed for stabilization if native seed is not available.
c. Use an assemblage of vegetation species appropriate for long-term productivity of the site, including native trees, shrubs, and herbaceous species. Vegetation, such as willow (*Salix* spp.), sedge (*Carex* spp.) and rush (*Juncus* spp.) mats, may be gathered from abandoned floodplains, stream channels, and wetlands.
d. Planting techniques must not cause major soil disturbance at project sites.
e. Native vegetation should be salvaged, as appropriate, from areas where soil disturbance will be occurring on a project site and replanted later at the site. When feasible, use vegetation salvaged from other local areas scheduled for clearing due to development.

f. Use species that will achieve shade and erosion control objectives, including forb, grass, shrub, or tree species that are appropriate for the site and native to the project area or region. Short-term stabilization measures may include use of non-native sterile seed mix if native seeds are not available, weed-free certified straw, jute matting, and similar methods.
g. Do not apply surface fertilizer within 15.4 m (50 feet) of any wetland or water body.
h. Install fencing as necessary to prevent access to revegetated sites by livestock or unauthorized persons.
i. Conduct post-construction monitoring and treatment to remove or control invasive plants until native plant species are well established.

1.3.2.4 Restoration Actions

Projects within the 21 restoration activity categories will be designed and implemented to help restore watershed, coastal, and upland processes. As such, these improvements may help address limiting factors of listed species. Aquatic habitat restoration and enhancement projects are conducted within stream channels, adjacent riparian/floodplain areas, wetlands, nearshore, coastal areas, and uplands. Upland projects will address habitat requirements of prairie, oak, forest, and dune species. The 21 types of Restoration Actions are listed in the beginning of Section 1.3.1 above.

33. Fish Passage Restoration

Typical projects include the following: total removal, replacement, or resetting of culverts or bridges; stabilizing headcuts and other channel instabilities; removing, relocating, constructing, repairing, or maintaining fish ladders; and replacing, relocating, or constructing fish screens and irrigation diversions. Such projects will take place where fish passage has been partially or completely eliminated.

a. Stream simulation culvert and bridge projects. All road-stream crossing structures shall adhere to the most recent version of NMFS fish passage criteria (NMFS 2011 or most recent version) located under at: http://www.westcoast.fisheries.noaa.gov/publications/hydropower/fish_passage_design_criteria.pdf. The Service in consultation with NMFS engineering review, if required, shall occur at the conceptual, post-modeling, and final design phases, which is approximated by 30%, 60%, and 90% designs.
b. All road-stream crossing structures shall simulate stream channel conditions per industry design standards found in any one of the following:
    i. Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organisms at Road-Stream Crossings (USDA-Forest Service 2008) or the most recent version, located at: http://stream.fs.fed.us/fishxing/aop_pdfs.html
    ii. Part XII Fish Passage Design and Implementation, Salmonid Stream Habitat Restoration Manual (California Department of Fish and Game 2009) or the most recent version, located at: https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=12512
    iii. Water Crossings Design Guidelines (Barnard *et al.* 2013) or the most recent version), located at: http://wdfw.wa.gov/publications/01501/

c. General road-stream crossing criteria
    i. Span
        1. Span is determined by the bankfull channel width at crossing location.
        2. Single span structures shall maintain a clear, unobstructed opening above the general scour elevation that is at least as wide as 1.5 times the bankfull width for alluvial channels.
        3. Multi-span structures shall maintain clear, unobstructed openings above the general scour elevation (except for piers or interior bents) that are at least as wide as 2.2 times the bank full width for alluvial channels.
        4. Entrenched streams: If a stream is entrenched (entrenchment ratio of less than 1.4), the crossing span shall accommodate the flood prone width. Flood prone width is the channel width measured at twice the maximum bankfull depth (Rosgen 1996).
        5. Minimum structure span is 1.8 m (6 feet).
    ii. Scour Prism
        1. Designs shall maintain the general scour prism, as a clear, unobstructed opening (*i.e.,* native streambed material can move freely without countermeasures, or structural material to include abutments, footings, and culvert inverts).
        2. When bridge abutments are set back beyond the applicable criteria span they may be located above the general scour elevation.
    iii. Embedment
        1. All culvert footings and inverts shall be placed below the thalweg at a depth of 0.91 m (3 feet), or the Lower Vertical Adjustment Potential (LVAP) line, whichever is deeper.
        2. LVAP, as calculated in *Stream Simulation: An ecological approach to providing passage for aquatic organisms at road crossings* (USDA-Forest Service 2008)
        3. In addition to embedment depth, embedment of closed bottom culverts shall be between 30% and 50% of the culvert height.
    iv. Bridges
        1. Primary bridge structural elements will be concrete, metal, fiberglass, or untreated timber. The use of treated wood for bridge construction or replacement is not allowed under this Opinion. Old railroad cars, which are commonly used as bridges, may have treated wood decking. Replace treated elements with untreated wood.
        2. All concrete will be poured in the dry, or within confined waters not connected to surface waters, and will be allowed to cure a minimum of 7 days before contact with surface water as recommended by Washington State Department of Transportation (2010).
        3. Riprap will not be placed within the bankfull area of the stream. Riprap may only be placed below bankfull height when necessary

for protection of abutments and pilings. The amount and placement of riprap will not constrict the bankfull flow.

4. Temporary work bridges will also meet NMFS fish passage criteria[10] (2011) (or the most recent version).
5. Bridge designs should allow for terrestrial wildlife movement over or under bridges whenever possible.
6. Service fish passage review and approval. The Service in consultation with NMFS engineering will review crossing structure designs if the span width is determined to be less than the criteria established above or if the design is inconsistent with criteria in *Anadromous Salmonid Passage Facility Design* (NMFS 2011) or the most recent version.

d. Headcut and grade stabilization. Headcuts (vertical off-sets in the streambed) often occur in meadow areas, where floodplain soils are fine textured. Headcuts may develop because of channel straightening, channel avulsion, culvert replacement or removal, or loss of riparian vegetation. Grade (streambed elevation) stabilization measures minimize the migration of headcuts upstream.

i. Methods

1. In streams with current or historical fish presence, provide fish passage over a headcut through use of morphologically appropriate grade stabilization. This includes constructed riffles for riffle-pool morphologies, rough constructed riffles/ramps for plane bed morphologies, wood jams, rock sills, and boulder weirs for step-pool morphologies, and roughened channels for cascade morphologies as described in part ii below.
2. Grade control materials can include both rock and LW. Material shall not in any part consist of gabion baskets, sheet piles, concrete, articulated concrete blocks, or cable anchors.
3. Rock for structures shall be durable and of suitable quality to assure permanence in the climate in which it is to be used. Gravel sizing depends on the size of the stream, size of bed material upstream, maximum depth of flow, plan form, entrenchment, and ice and debris loading.
4. Short-term headcut stabilization (including emergency stabilization projects) may occur without associated fish passage measures. However, fish passage will be incorporated into the final headcut stabilization action and be completed during the first subsequent in-water work period.

ii. Grade Stabilization to Promote Fish Passage

1. Service fish passage review and approval. The Service (in aquatic habitats) will review all projects containing grade control, stream bed stability, or headcut countermeasures that are proposed to promote fish passage.

[10] http://www.habitat.noaa.gov/pdf/salmon_passage_facility_design.pdf

2. Provide fish passage over grade control structures through use of constructed riffles for pool/riffle streams or a series of log or rock weirs for step/pool channels. If LW and boulder placement is used for headcut stabilization, refer to LW, Boulder, and Gravel Placement (PDC 34) below.
3. Construct structures in a "V" or "U" shape in plan view, oriented with the apex upstream, lower in the center to direct flows to the middle of channel.
4. Key structures into the stream bed to minimize structure undermining due to scour, preferably at least 2.5 times their exposure height. The structures should also be keyed into both banks.
5. If several structures will be used in series, space them at the appropriate distances to promote fish passage of all life stages of native fish. Incorporate NMFS (2011) fish passage criteria (jump height, pool depth, *etc.*) in the design of step structures. Recommended spacing should be no closer than the net drop divided by the channel slope (for example, a 30 cm (1 foot) high step structure in a stream with a two-percent gradient will have a minimum spacing of 15.3 m (50 feet) [1/0.02]).
6. Include gradated (cobble to fine) material in the rock structure material mix to help seal the structure/channel bed, thereby preventing subsurface flow and ensuring fish passage immediately following construction if natural flows are sufficient.
7. If a project involves the removal of multiple barriers on one stream or in one watershed over the course of a work season, remove the most upstream barrier first if possible.

e. Fish Ladders
   i. Service fish passage review and approval. The Service will review fishways designs for consistency with criteria in *Anadromous Salmonid Passage Facility Design* (NMFS 2011 or the most recent version).
   ii. Design preference is based on project type, level of maintenance, and required monitoring essential for reliable fish passage. Typical fishway designs include: a) roughened channels/boulder step structures, b) channel spanning concrete sills, c) pool and chute, and d) pool and weir fishways. Roughened channel and boulder step structure fishways consist of a properly sized mix of rock and sediment in an open channel that creates enough roughness and diversity to facilitate fish passage. Our review will include any appurtenant facilities (*i.e.*, fish counting equipment, pit tag detectors, lighting, trash racks, attraction water) that may be included with the fish ladder design. See *Anadromous Salmonid Passage Facility Design* (NMFS 2011 or the most recent version) for guidelines and PDC.
   iii. If a project involves the removal of multiple barriers on one stream or in one watershed over the course of a work season, remove the most upstream barrier first if possible.

f. Irrigation diversion replacement/relocation and screen installation/ replacement

i. Service fish passage review and approval. The Service in consultation with NMFS engineering will review irrigation diversion replacement/relocation and screen installation/replacement projects for consistency with criteria in *Anadromous Salmonid Passage Facility Design* (NMFS 2011 or the most recent version).
ii. Diversion structures—associated with points of diversion and future fish screens—will pass all life stages of threatened and endangered aquatic species that historically used the affected aquatic habitat.
iii. Water diversion intake and return points will be designed (to the greatest degree possible) to prevent all native fish life stages from swimming or being entrained into the diversion.
iv. NMFS fish screen criteria (NMFS 2011 or the most recent version) applies to salmonid species but generally may be applied to other aquatic fish species. This includes screens in temporary and permanent pump intakes.
v. All fish screens will be sized to match the irrigator's state water right or estimated historical water use, whichever is less.
vi. Size of bypass structure should be big enough to pass adult fish back to the stream.
vii. Abandoned ditches and other similar structures will be plugged or backfilled, as appropriate, to prevent fish from swimming or being entrained into them.
viii. When making improvements to pressurized diversions, install a totalizing flow meter capable of measuring rate and duty of water use. For non-pressurized systems, install a staff gage or other measuring device capable of measuring instantaneous rate of water flow.
ix. Conversion of instream diversions to groundwater wells will only be used in circumstances where there is an agreement to ensure that any surface water made available for instream flows is protected from surface withdrawal by another water user.
x. For the removal of diversion structures constructed of local rock and dirt, the project sponsor will dispose of the removed material in the following manner:
    1. Material more than 60% silt or clay will be disposed in uplands, outside of the active floodplain.
    2. Material with more than 40% gravel will be deposited within the active floodplain, but not in wetlands.
    3. Material with more than 50% gravel and less than 30% fines (silt or clay) may be deposited below the bankfull elevation.

34. Stream Channel Enhancement (Large Wood, Boulder, and Gravel Placement)
Typical projects include LW and boulder placement, ELJs, constructed riffles, porous boulder structures and vanes, gravel placement, and tree removal for LW projects. ELJs are a type of LW placement that employs an engineered anchoring system such as ballast, pinning, or vertical piles. Such activities will occur in areas where channel structure is lacking due to past stream cleaning (LW removal), riparian timber harvest, and in areas where alluvial gravel supplies are low due to anthropogenic disruptions. These projects

will occur in stream channels and adjacent floodplains to increase channel stability, rearing habitat, pool formation, spawning gravel deposition, channel complexity, hiding cover, low velocity areas, and floodplain function.

a. Large wood and boulder projects
    i. Place LW and boulders in areas where they would naturally occur, and in a manner that closely mimics natural accumulations for that particular stream type. For example, boulder placement may not be appropriate in low-gradient meadow streams.
    ii. Structure types shall simulate disturbance events to the greatest degree possible and include, but are not limited to, log jams, debris flows, wind-throw, and tree breakage.
    iii. No limits are to be placed on the size or shape of structures as long as such structures are within the range of natural variability of a given location and do not block fish passage.
    iv. Projects can include grade control and streambank stabilization structures, as long as the size and configuration of such structures will be commensurate with scale of project site and hydraulic forces, and provided that streambank stabilization, if any, is not the principal objective of the restoration action.
    v. The partial burial of LW and boulders is permitted and may constitute the dominant means of placement. This applies to all stream systems but more so for larger stream systems where use of adjacent riparian trees or channel features is not feasible or does not provide the full stability desired.
    vi. LW includes whole conifer and hardwood trees, logs, and rootwads. LW size (diameter and length) should account for bankfull width and stream discharge rates, and the geomorphic function of the LW in that stream type. An example is, in stream reaches where LW forms immobile steps or channel-spanning jams. When available, trees with rootwads should be a minimum of 1.5x bankfull channel width, while logs without rootwads should be a minimum of 2.0x bankfull widths. In larger, wider streams, where LW is readily transported and forms complex log jams along the channel margins, bar apexes, or side channel junctions, LW should be of sufficient diameter to avoid breakage due to hydraulic forces, and of sufficient length to be fitted into a structure that can be stabilized through gravity, placement orientation, or keying the structure into the streambank.
    vii. Structures may partially or completely span stream channels or be positioned along stream banks.
    viii. Stabilizing or key pieces of LW will be intact, hard, with little decay, and if possible have root wads (untrimmed) to provide functional refugia habitat for fish. Consider orienting key pieces such that the hydraulic forces upon the LW increase stability.
    ix. Anchoring LW. Anchoring alternatives may be used in preferential order:
        1. Use of adequate sized wood sufficient for stability due to gravity and placement orientation.
        2. Orient and place wood in such a way that movement is limited.

3. Ballast the wood using gravel or rock to increase the mass of the structure to resist movement.
4. Vertical pilings to reduce lateral shifting.
5. Use large boulders as anchor points for the LW.
6. Pin LW with rebar to large rock to increase its weight.
7. Anchoring LW by cable is not allowed under this Opinion.

b. Engineered Logjams (ELJs) are structures designed to redirect flow, change scour and deposition patterns, and retain mobile LW that might otherwise be exported by the flow.[11] While providing valuable fish and wildlife habitat, they are also designed to redirect flow and can provide stability to a streambank or downstream gravel bar. To the extent practical, ELJs are designed to simulate stable natural log jams and can be either naturally stable due to LW size and/or stream width or anchored in place using rebar, rock, or piles (driven into a dewatered area or the streambank, but not in water). They are also designed to create a hydraulic shadow, a low-velocity zone downstream that allows sediment to settle out, and allows scour holes to form adjacent to the structure.
   i. Service fish passage review and approval. For ELJs that occupy greater than 25% of the bankfull cross sectional area, the Service, in consultation with NMFS engineering, will review the action for consistency with criteria in *Anadromous Salmonid Passage Facility Design* (NMFS 2011 or the most recent version).
   ii. ELJs will be patterned, to the greatest degree possible, after stable natural log jams.
   iii. Grade control ELJs are designed to arrest channel down-cutting or incision by providing a grade control that retains sediment, lowers stream energy, and increases water elevations to reconnect floodplain habitat and diffuse downstream flood peaks.
   iv. Stabilizing or key pieces of LW that will be relied on to provide streambank stability or redirect flows will be intact and solid (little decay). If possible, acquire LW with untrimmed rootwads to provide functional refugia habitat for fish.
   v. When available, key pieces with rootwads attached should be a minimum length of 1.5 times the bankfull channel width, while logs without rootwads should be a minimum of 2.0 times the bankfull width.
   vi. The partial burial of LW may constitute the dominant means of placement, and LW can be buried into the streambank or channel.
   vii. Angle and offset. The LW portions of ELJ structures should be oriented such that the force of water upon the LW increases stability. If a rootwad is left exposed to the flow, the bole placed into the streambank should be oriented downstream parallel to the flow direction so the pressure on the rootwad pushes the bole into the streambank and bed.
   viii. If LW anchoring is required, a variety of methods may be used. These include buttressing the wood between riparian trees, vertical pilings to

[11] ELJs are defined as structures composed of LW with at least three key members incorporating the use of an anchoring system as defined in PDC 33.a.ix.

reduce lateral shifting, or the use of manila, sisal, or other biodegradable ropes for lashing connections. If hydraulic conditions warrant use of structural connections, rebar pinning, chains, or bolted connections may be used. Rock may be used for ballast but is limited to that needed to anchor the LW.

c. Constructed riffles
   i. Service fish passage review and approval. The Service, in consultation with NMFS engineering, will review all constructed or engineered riffles for consistency with criteria in *Anadromous Salmonid Passage Facility Design* (NMFS 2011 or the most recent version).
   ii. Constructed riffles are to be constructed to allow upstream and downstream passage of all native fish species and life stages that occur in the stream. A low flow notch shall be constructed to concentrate flows in channels where minimum flows may restrict fish passage.
   iii. Constructed riffles will be constructed out of an appropriately sized gravel mix, including the appropriate level of fines, to allow for compaction for stability and sealing to ensure minimal loss of surface flow through the newly placed material.
   iv. Gravel sizing depends on the size of the stream, maximum depth of flow, planform, entrenchment, and ice and debris loading.
   v. The project designer or an inspector experienced in these structures should be present during installation.
   vi. Ensure that the structure is appropriately sealed according to project objectives before equipment leaves the site.
   vii. For projects where hyporheic flow is a project objective, levels of compaction must be adjusted to allow appropriate balance of surface and sub-surface flow.

d. Porous boulder step structures and vanes
   i. Full channel spanning boulder structures are to be installed only in highly uniform, incised, bedrock-dominated channels, with the goal to enhance or provide fish habitat in stream reaches where log placements are not practicable due to channel conditions (not feasible to place logs of sufficient length, bedrock dominated channels, deeply incised channels, artificially constrained reaches, *etc.*), or where damage to infrastructure on public or private lands is of concern, or where private landowners will not allow log placements due to concerns about damage to their streambanks or property.
   ii. Install boulder structures low in relation to channel dimensions so that they are completely overtopped during bankfull channel events.
   iii. Boulder step structures are to be placed diagonally across the channel or in more traditional upstream pointing "V" or "U" configurations with the apex oriented upstream.
   iv. Boulder step structures are to be constructed to allow upstream and downstream passage of all native fish species and life stages that occur in the stream.

v. The use of gabions, cable, or other means to prevent the movement of individual boulders in a boulder step structure is not allowed.
vi. Rock for boulder step structures shall be durable and of suitable quality to assure long-term stability in the climate in which it is to be used. Rock sizing depends on the size of the stream, maximum depth of flow, planform, entrenchment, and ice and debris loading.
vii. The project designer or an inspector experienced in these structures should be present during installation.
viii. Full spanning boulder step structure placement should be coupled with measures to improve habitat complexity and protection of riparian areas to provide long-term inputs of LW.

e. Gravel augmentation
i. Gravel can be placed directly into the stream channel, at tributary junctions, or other areas in a manner that mimics natural debris flows and erosion.
ii. Augmentation will only occur in areas where the natural supply has been eliminated, significantly reduced through anthropogenic disruptions, or used to initiate gravel accumulations in conjunction with other projects, such as simulated log jams and debris flows. Most importantly, gravel augmentation should only be used in streams that are geomorphically appropriate for gravel bed features such as bars, pool-riffle sequences, etc., to persist. That is, where the stream morphology and hydraulics are such that gravel cannot be stable or retained, augmentation will not be effective.
iii. Gravel to be placed in streams shall be a sized for that stream, and clean alluvium with similar angularity as the natural bed material. When possible use gravel of the same lithology as found in the watershed. Reference *Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organisms at Road-Stream Crossings* (USDA-Forest Service 2008) to determine gravel sizes appropriate for the stream.
iv. Gravel can be mined from the floodplain at elevations above bankfull, but not in a manner that will cause stranding during future flood events.
v. Crushed rock is not permitted, unless sediment in the stream reach is sub-angular to angular.
vi. After gravel placement in areas accessible to higher stream flow, allow the stream to naturally sort and distribute the material.
vii. Do not place gravel directly on bars and riffles that are known spawning areas, which may cause fish to spawn on the unsorted and unstable gravel, thus potentially resulting in redd destruction.
viii. Imported gravel will be free of invasive species and non-native seeds. If necessary, wash gravel prior to placement.

f. Tree removal for LW projects
i. Live conifers and other trees can be felled or pulled/pushed over for in-channel LW placement only when riparian zone tree stands are fully stocked[12] or over-stocked.[13] Tree felling shall not create excessive

[12] Fully stocked stands – Stands in which all the growing space is effectively occupied but which still have ample

streambank erosion or increase the likelihood of channel avulsion during high flows.

ii. Trees may be removed by cable, ground-based equipment, horses or helicopters.

iii. Trees may be felled or pushed/pulled directly into a stream or floodplain.

iv. Trees may be stock-piled for future instream restoration projects.

v. The project manager for an aquatic restoration action will coordinate with a Service wildlife biologist in tree-removal planning efforts to ensure no listed species or critical habitat is impacted.

35. Dam and Legacy Structure Removal

Typical projects include removal of dams, channel-spanning weirs, legacy habitat structures, earthen embankments, subsurface drainage features, spillway systems, outfalls, pipes, instream flow redirection structures (e.g., drop structure, gabion, groin), or similar devices used to control, discharge, or maintain water levels. Legacy structures include past projects, such as LW, boulder, rock gabions, and other in-channel and floodplain structures. Removal projects will be implemented to reconnect stream corridors, floodplains, and estuaries, reestablish wetlands, improve aquatic organism passage, and restore more natural channel and flow conditions. Instream water control structures that impound contaminated sediment are not covered by this Opinion.

a. Dam removal

i. Design Review

1. Service fish passage review and approval. The Service in consultation with NMFS engineering will review the action for consistency with criteria in Anadromous Salmonid Passage Facility Design (NMFS 2011 or the most recent version).

2. RRT. The action will be reviewed by the RRT prior to submission to Service for approval.

ii. Project Documentation – At a minimum, the following information will be necessary for review:

1. A longitudinal profile of the stream channel thalweg for 20 channel widths downstream of the structure and 20 channel widths upstream of the reservoir area (outside of the influence of the structure) shall be used to determine the potential for channel degradation.

2. A minimum of three riffle cross-sections – one downstream of the structure, one through the reservoir area upstream of the structure, and one upstream of the reservoir area (outside of the influence of the structure) to characterize the channel morphology and quantify the stored sediment.

3. Sediment characterization to determine the proportion of coarse sediment (greater than 2 mm) in the reservoir area.

room for development of the crop trees.

[13] Overstocked stands – Stands in which the growing space is so completely utilized that growth has slowed down and many trees, including dominants, are being suppressed.

4. A survey of any downstream spawning areas that may be affected by sediment released by removal of the water control structure or dam. Dams with reservoirs with sediments having a d35 greater than 2 mm (i.e., 65% of the sediment by weight exceeds 2 mm in diameter) may be removed without excavation of stored material, if the sediment contains no contaminants; sediments with a d35 less than 2 mm (i.e., 65% of the sediment by weight is less than 2 mm in diameter) will require partial removal of the fine sediment to create a pilot channel, in conjunction with stabilization of the newly exposed streambanks with native vegetation.

iii. Design Guidance. If a project involves the removal of multiple barriers on one stream or in one watershed over the course of a work season, remove the most upstream barrier first if possible.

iv. Monitoring and adaptive management. Dams greater than 3 m (10 feet) in height (measured at the upstream side of the structure at the approximate centerline of the stream) require a long-term monitoring and adaptive management plan that will be developed between the Action Agencies. Develop a monitoring and adaptive management plan that has been reviewed and approved by the RRT that includes the following:
   1. Introduction
   2. Existing monitoring protocols
   3. Project effectiveness monitoring plan
   4. Project review team triggering conditions
   5. Monitoring frequency, timing, and duration
   6. Monitoring technique protocols
   7. Data storage and analysis
   8. Monitoring quality assurance plan
   9. Literature cited

b. Removal of legacy structures

   i. Remove material not typically found within the stream or floodplain at project sites (i.e., boulders, concrete, etc.) from the 100-year floodplain.

   ii. Materials (i.e., LW and boulders.) typically found within the stream or floodplain at that site can be reused to implement habitat improvements described under the LW, Boulder, and Gravel Placement (PDC 34) activity category in this Opinion.

   iii. If the structure being removed is keyed into the bank, fill in “key” holes with native materials to restore contours of streambank and floodplain. Compact the fill material adequately to prevent washing out of the soil during over-bank flooding. Do not mine material from the stream channel bed to fill in “key” holes.

   iv. When removal of buried log structures may result in significant disruption to riparian vegetation or the floodplain, consider using a chainsaw to extract the portion of log within the channel and leaving the buried sections within the streambank.

v. If a project involves the removal of multiple barriers on one stream or in one watershed over the course of a work season, remove the most upstream barrier first if possible.
vi. If the legacy structures (log, rock, or gabion weirs) were placed to provide grade control, evaluate the site for potential headcutting and incision due to structure removal. This will require surveying a streambed longitudinal profile. If headcutting and channel incision are likely to occur due to structure removal, additional measures will be taken to reduce these impacts.
vii. If the structure is being removed because it has caused an over-widening of the channel, consider implementing other restoration categories to decrease the width to depth ratio of the stream to a level commensurate with the geomorphic setting.

36. Fluvial Channel Reconstruction/Relocation

Typical projects include reconstruction of existing alluvial stream channels through excavation and structure placement (LW and boulders) or relocation (rerouting of flow) into historical or newly constructed channels that are typically more sinuous and complex. This proposed action applies to stream systems that have been straightened, channelized, dredged, or otherwise modified for the purpose of flood control, increasing arable land, realignment, or other land use management goals, or for streams that are incised or otherwise disconnected from their floodplains due to watershed disturbances. For tidal wetland and estuarine projects, refer to PDC 39b and 49.

a. General project design criteria
    i. Design Review
        1. Service fish passage review and approval. The Service, in consultation with NMFS engineering, will review the action for consistency with criteria in Anadromous Salmonid Passage Facility Design (NMFS 2011 or the most recent version).
        2. Restoration Review Team (RRT). The action will be individually reviewed by the RRT prior to submission to the Service for approval.
    ii. Design Guidance
        1. Construct geomorphically appropriate stream channels and floodplains within a watershed and reach context.
        2. Design actions to restore floodplain characteristics—elevation, width, gradient, length, and roughness—in a manner that closely mimics, to the extent possible, those that will naturally occur at that stream and valley type.
        3. To the greatest degree possible, remove non-native fill material from the channel and floodplain to an upland site.
        4. When necessary, loosen compacted soils once overburden material is removed. Overburden or fill comprised of native materials, which originated from the project area, may be used within the floodplain where appropriate to support the project goals and objectives.

5. Structural elements shall fit within the geomorphic context of the stream system. For bed stabilization and hydraulic control structures, constructed riffles shall be preferentially used in pool-riffle stream types, while roughened channels and boulder step structures shall be preferentially used in step-pool and cascade stream types.
6. Material selection (LW, rock, gravel) shall also mimic natural stream system materials.
7. Construction of the streambed should be based on Stream Simulation Design principles as described in section 6.2 of *Stream Simulation:An Ecological Approach to Providing Passage for Aquatic Organisms at Road-Stream Crossings* (USDA-Forest Service 2008) or other appropriate design guidance documents (see PDC 33b).

b. Project documentation. Provide the Service and the RRT with the following documentation:
   i. Background and problem statement
      1. Site history
      2. Environmental baseline
      3. Problem description
      4. Cause of problem
   ii. Project description
      1. Goals/objectives
      2. Project elements
      3. Sequencing, implementation
      4. Recovery trajectory: how does it develop and evolve?
   iii. Design analysis
      1. Technical analyses
      2. Computations relating design to analysis
      3. References
   iv. River Restoration Analysis Tool. The River Restoration Analysis Tool (www.restorationreview.com) was created to assist the Service with design and monitoring of aquatic restoration projects. The following questions taken from the tool will be used by the RRT to evaluate the project, and should therefore be addressed in the project documentation:
      1. Problem Identification
         a. Is the problem identified?
         b. Are causes identified at appropriate scales?
      2. Project Context
         a. Is the project identified as part of a plan, such as a watershed action plan or recovery plan?
         b. Does the project consider ecological, geomorphic, and socioeconomic context?
      3. Goals & Objectives
         a. Do goals and objectives address problem, causes, and context?

   b. Are objectives measurable?
4. Alternatives/Options Evaluation
   a. Were alternatives/options considered?
   b. Are uncertainties and risk associated with selected alternative acceptable?
5. Project Design
   a. Do project elements collectively support project objectives?
   b. Are PDC defined for all project elements?
   c. Do project elements work with stream processes to create and maintain habitat?
   d. Is the technical basis of design sound for each project element?
6. Implementation
   a. Are plans and specifications sufficient in scope and detail to execute the project?
   b. Does plan address potential implementation impacts and risks?
7. Monitoring & Management
   a. Does monitoring plan address project compliance?
   b. Does monitoring plan directly measure project effectiveness?

c. Monitoring. Develop a monitoring and adaptive plan that has been reviewed and approved by the RRT and the Service 30 days prior to the planned start of construction. The plan will include the following:
   i. Introduction
   ii. Existing Monitoring Protocols
   iii. Project Effectiveness Monitoring Plan
      1. Immediately upon completion of the new channel construction, the contractor shall survey the project and provide as-built monitoring data, which will be supplied to the Service and the RRT for review. This survey will compare as-built metrics to proposed design metrics on channel length, substrate size, residual pool depth, pieces of LW, etc.
   iv. Project Review Team Triggers
   v. Monitoring Frequency, Timing, and Duration
   vi. Monitoring Technique Protocols
   vii. Data Storage and Analysis
   viii. Monitoring Quality Assurance Plan
   ix. Literature cited

37. Off- and Side-Channel Habitat Restoration

These projects will be implemented to reconnect historical side-channels with floodplains by removing off-channel fill and plugs. Furthermore, new side-channels and alcoves can be constructed in geomorphic settings that will accommodate such features. This activity category typically applies to areas where side channels, alcoves, and other backwater habitats have been filled or blocked from the main channel, disconnecting them from most if not all flow events.

a. Service fish passage review and approval. When a proposed side channel will contain greater than 20% of the bankfull flow[14], the action will be reviewed by the RRT and reviewed and approved by the Service in consultation with NMFS engineering for consistency with NMFS (2011b) Anadromous Salmonid Passage Facility Design criteria.
b. Data requirements. Data requirements and analysis for off- and side-channel habitat restoration include evidence of historical channel location, such as land use surveys, historical photographs, topographic maps, remote sensing information, or personal observation.
c. Allowable excavation. Off- and side-channel improvements can include minor excavation (less than or equal to 10% of volume) of naturally accumulated sediment within historical channels, i.e., based on the ordinary high water (OHW) level as the elevation datum. The calculation of the 10% excavation volume does not include manually placed fill, such as dikes, berms, or earthen plugs (see PDC 39). There is no limit as to the amount of excavation of anthropogenic fill within historical side channels as long as such channels can be clearly identified through field or aerial photographs. Excavation depth will not exceed the maximum thalweg depth in the main channel. Excavated material removed from off- or side-channels shall be hauled to an upland site or spread across the adjacent floodplain in a manner that does not restrict floodplain capacity.

38. Streambank Restoration

Streambank restoration as defined in this Opinion is an action used in conjunction with other techniques such as dam removal, bridge placement, channel reconstruction, etc. It is not a stand-alone restoration action.

a. The following streambank restoration methods may be used individually or in combination:
    i. Alluvium placement
    ii. LW placement
    iii. Roughened toe
    iv. Woody plantings
    v. Herbaceous cover, in areas where the native vegetation does not include trees or shrubs
    vi. Bank reshaping and slope grading
    vii. Coir logs
    viii. Deformable soil reinforcement
    ix. Engineered log jams
    x. Floodplain flow spreaders
    xi. Floodplain roughness
b. For more information on the above methods see Federal Emergency Management Agency (2009)[15] or Cramer *et al.* (2003)[16]. Other than those methods relying

[14] Large side channels projects are essentially channel construction projects if they contain more than 20% of flow.
[15] http://www.fema.gov/pdf/about/regions/regionx/Engineering_With_Nature_Web.pdf

solely upon woody and herbaceous plantings, streambank stabilization projects should be designed by a qualified engineer that is appropriately registered in the state where the work is performed.

c. Rock will not be used for streambank restoration, except as ballast to stabilize LW. Stream barbs and full-spanning weirs are not allowed for stream bank stabilization under this Opinion.

d. Alluvium Placement can be used as a method for providing bank stabilization using imported gravel/cobble/boulder-sized material of the same composition and size as that in the channel bed and banks to halt or attenuate streambank erosion, stabilize riffles, and provide critical spawning substrate for native fish. This method is predominately for use in small to moderately sized channels and is not appropriate for application in mainstem systems. These structures are designed to provide roughness, redirect flow, and provide stability to adjacent streambed and banks or downstream reaches, while providing valuable fish and wildlife habitat.

    i. Service fish passage review and approval. The Service in consultation with NMFS engineering will review alluvium placement projects that occupy more than 25% of the channel bed or more than 25% of the bankfull cross sectional area.
    ii. This design method is only approved in those areas where the natural sediment supply has been eliminated, significantly reduced through anthropogenic disruptions, or used to initiate or simulate sediment accumulations in conjunction with other structures, such as LW placements and ELJs.
    iii. Material used to construct the toe should be placed in a manner that mimics attached longitudinal bars or point bars.
    iv. Size distribution of toe material will be diverse and predominately comprised of D_{84} to D_{max} size class material based on measurements for sediments in similar segments of the streambed.
    v. Spawning gravels will constitute at least one-third of the total alluvial material used in the design except where the reach does not support spawning or velocities are sufficient to scour out spawning gravels.
    vi. Spawning gravels are to be placed at or below an elevation consistent with the water surface elevation of a bankfull event.
    vii. Spawning size gravel can be used to fill the voids within toe and bank material and placed directly onto stream banks in a manner that mimics natural debris flows and erosion.
    viii. All material will be clean alluvium with similar angularity as the natural bed material. When possible use material of the same lithology as found in the watershed. Reference *Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organisms at Road-Stream Crossings* (USDA-Forest Service 2008) to determine gravel sizes appropriate for the stream.
    ix. Material can be mined from the floodplain at elevations above bankfull, but not in a manner that will cause stranding during future flood events.

[16] http://wdfw.wa.gov/publications/00046/wdfw00046.pdf

x. Crushed rock is not permitted unless natural bed material is sub-angular to angular.
xi. After placement in areas accessible to higher stream flow, allow the stream to naturally sort and distribute the material.
xii. Do not place material directly on bars and riffles that are known spawning areas, which may cause fish to spawn on the unsorted and unstable gravel, thus potentially resulting in redd destruction.
xiii. Imported material will be free of invasive species and non-native seeds. If necessary, wash prior to placement.

e. LW Placements are defined as structures composed of LW that do not use mechanical methods as the means of providing structure stability (i.e., large rock, rebar, rope, cable, etc.). The use of native soil, run of alluvium, wood, or buttressing with adjacent trees as methods for providing structure stability are authorized. This method is predominately for use in small to moderately sized channels and is not appropriate for application in mainstem systems. These structures are designed to provide roughness, redirect flow, and provide stability to adjacent streambed and banks or downstream reaches, while providing valuable fish and wildlife habitat.
  i. Service Review and Approval. The Service will review LW placement projects that would occupy greater than 25% of the bankfull cross section area.
  ii. Structure shall simulate disturbance events to the greatest degree possible and include, but are not limited to, log jams, debris flows, wind-throw, and tree breakage.
  iii. Structures may partially or completely span stream channels or be positioned along stream banks.
  iv. Where structures partially or completely span the stream channel LW should be comprised of whole conifer and hardwood trees, logs, and rootwads. LW size (diameter and length) should account for bankfull width and stream discharge rates. See Section 34.a.vi
  v. Structures will incorporate a diverse size (diameter and length) distribution of rootwad or non-rootwad, trimmed or untrimmed, whole trees, logs, snags, slash, etc.
  vi. For individual logs that are completely exposed, or embedded less than half their length, logs with rootwads should be a minimum of 1.5 times bankfull channel width, while logs without rootwads should be a minimum of 2.0 times bankfull widths where appropriate.
  vii. Consider orienting key pieces such that the hydraulic forces upon the LW increase stability.

f. Engineered Log Jams
  i. See PDC 34b.
  ii. If LW mechanical anchoring is required, a variety of methods may be used. These include large angular rock, buttressing the wood between adjacent trees, vertical pilings to reduce lateral shifting, or the use of manila, sisal or other biodegradable ropes for lashing connections. If hydraulic conditions warrant use of structural connections, rebar pinning

or bolted connections may be used. Use of cable is not covered by this Opinion.

iii. Use a diverse assemblage of vegetation species native to the action area or region, including trees, shrubs, and herbaceous species. Vegetation, such as willow, sedge and rush mats, may be gathered from abandoned floodplains and stream channels.

iv. Do not apply surface fertilizer within 15.3 m (50 feet) of any stream channel.

v. Install fencing as necessary to prevent access to revegetated sites by livestock or unauthorized persons.

vi. Conduct post-construction monitoring and treatment or removal of invasive plants until native plant species are well established.

39. Set-Back or Removal of Existing Berms, Dikes, and Levees

These projects will be conducted to reconnect historical fresh-water deltas to inundation, stream channels with floodplains, and historical estuaries to tidal influence. Such projects will take place where estuaries and floodplains have been disconnected from adjacent rivers or estuaries through drain pipes and anthropogenic fill.

a. Floodplains and freshwater deltas

i. Design actions to restore floodplain characteristics—elevation, width, gradient, length, and roughness—in a manner that closely mimics, to the extent possible, those that would naturally occur at that stream and valley type.

ii. Remove drain pipes, fences, and other anthropogenic features to the extent possible.

iii. To the extent possible, remove non-native fill material from the floodplain to an upland site.

iv. Where it is not possible to remove or set-back all portions of dikes and berms, or in areas where existing berms, dikes, and levees support abundant riparian vegetation, breaches will be created. Breaches shall be equal to or greater than the bankfull channel width to reduce the potential for scour during flood events. In addition to other breaches, the berm, dike, or levee shall always be breached at the downstream end of the project or at the lowest elevation of the floodplain to ensure the flows will naturally recede back into the main channel, thus minimizing fish entrapment.

v. When necessary, loosen compacted soils once overburden material is removed. Overburden or fill comprised of native materials, which originated from the project area, may be used within the floodplain to create set-back dikes and fill anthropogenic holes provided that floodplain function is not impeded.

b. Estuary restoration

i. Culverts and tide gates will be removed using the PDC and conservation measures, where appropriate, as described in Work Area Isolation (PDC 27), Surface Water Withdrawals (PDC 23), and Fish Capture and Release (PDC 28) and Fish Passage Restoration (PDC 33) above.

ii. Temporary roads within the project area should be removed to allow free flow of water. Material either will be placed in a stable area above the ordinary high water line or highest measured tide or be used to restore topographic variation in wetlands.
iii. To the extent possible, remove segmented drain tiles placed to drain wetlands. Fill generated by drain tile removal will be compacted back into the ditch created by removal of the drain tile.
iv. Channel construction may be done to recreate channel morphology based on aerial photograph interpretation, literature, topographic surveys, and nearby undisturbed channels. Channel dimensions (width and depth) are based on measurements of similar types of channels and the drainage area. In some instances, channel construction is simply breaching the levee. For these sites, further channel development will occur through natural processes. Fill ditches constructed and maintained to drain wetlands. Some points in an open ditch may be over-filled, while other points may be left as low spots to enhance topography and encourage sinuosity of the developing channel.
v. In areas that may be prone to mosquito infestations, ensure that the site is not likely to provide ponded, stagnate, water that would support significant populations of mosquito larvae.

40. Reduction/Relocation of Recreation Impacts

These projects are intended to close, better control, or relocate recreation infrastructure and use along streams, shorelines, estuaries, and within riparian areas. This includes removal, improvement, or relocation of infrastructure associated with designated campgrounds, dispersed camp sites, day-use sites, foot trails, and off-road vehicle roads/trails in riparian areas.

a. Design remedial actions to restore floodplain characteristics—elevation, width, gradient, length, and roughness—in a manner that closely mimics, to the extent possible, those that would naturally occur at that stream and valley type.
b. To the extent possible, non-native fill material shall be removed from the floodplain to an upland site.
c. Overburden or fill comprised of native materials, which originated from the project area, can be used to reshape the floodplain, placed in small mounds on the floodplain, used to fill anthropogenic holes, buried on site, or disposed into upland areas.
d. For recreation relocation projects—such as campgrounds, horse corrals, off-road vehicle trails—move current facilities out of the riparian area or as far away from the stream/shoreline as possible.
e. Consider de-compaction of soils and vegetation planting once overburden material is removed.
f. Place barriers—boulders, fences, gates, etc.—outside of the bankfull width and across traffic routes to prevent off-road vehicle access into and across streams.
g. For work conducted on off-road vehicle roads and trails, follow relevant PDC in Road and Trail Erosion Control and Decommissioning (PDC 45) below.

41. Livestock Fencing, Stream Crossings and Off-Channel Livestock Watering

Projects will be implemented by constructing fences to exclude riparian grazing, providing controlled access for walkways that livestock use to transit across streams and through riparian areas, and reducing livestock use in riparian areas and stream channels by providing upslope water facilities.

a. Livestock fencing
   i. To the extent possible, fences will be placed outside the channel migration zone and allow for lateral stream movement.
   ii. Minimize vegetation removal, especially potential LW recruitment sources, when constructing fence lines.
   iii. Where appropriate, construct fences at water gaps in a manner that allows passage of LW and other debris.
   iv. Hollow fence post will be capped to prevent trapping small birds and mammals.

b. Livestock stream crossings
   i. The number of crossings will be minimized.
   ii. Locate crossings or water gaps where streambanks are naturally low. Livestock crossings or water gaps will not be located in areas where compaction or other damage can occur to sensitive soils and vegetation (e.g., wetlands) due to congregating livestock.
   iii. To the extent possible, crossings will not be placed in areas where listed species spawn or are suspected of spawning (e.g., pool tailouts where spawning may occur), or within 91.5 m (300 feet) upstream of such areas.
   iv. Existing access roads and stream crossings will be used whenever possible, unless new construction will result in less habitat disturbance and the old trail or crossing is retired.
   v. Access roads or trails will be provided with a vegetated buffer that is adequate to avoid or minimize runoff of sediment and other pollutants to surface waters.
   vi. Essential crossings will be designed and constructed or improved to handle reasonably foreseeable flood risks, including associated bedload and debris, and to prevent the diversion of streamflow out of the channel and down the trail if the crossing fails.
   vii. If necessary, the streambank and approach lanes can be stabilized with native vegetation or angular rock to reduce chronic sedimentation. The stream crossing or water gap should be armored with sufficient sized rock (e.g., cobble-size rock) and use angular rock if natural substrate is not of adequate size.
   viii. Livestock crossings will not create barriers to the passage of adult and juvenile fish. Whenever a culvert or bridge—including bridges constructed from flatbed railroad cars, boxcars, or truck flatbeds—is used to create the crossing, the structure width will tier to PDC listed for Stream Simulation Culvert and Bridge Projects under Fish Passage Restoration (PDC 33).

ix. Stream crossings and water gaps will be designed and constructed to a width of 3.1 to 4.8 m (10 to 15 feet) in the upstream-downstream direction to minimize the time livestock will spend in the crossing or riparian area.
x. When using pressure treated lumber for fence posts, complete all cutting/drilling offsite (to the extent possible) so that treated wood chips and debris do not enter water or flood prone areas.
xi. Riparian fencing is not to be used to create livestock handling facilities.

c. Off-channel livestock watering facilities
   i. Livestock watering facilities should be designed to prevent the entrapment of wildlife.
   ii. The development of a spring is not allowed if the spring is occupied by listed species.
   iii. Water withdrawals will not dewater habitats or cause low stream flow conditions that could affect listed fish. Withdrawals may not exceed 10% of the available flow.
   iv. Troughs or tanks fed from a stream or river will have an existing valid water right. Surface water intakes will be screened to meet NMFS fish screen criteria in Anadromous Salmonid Passage Facility Design (NMFS 2011 or the most recent version), be self-cleaning, or regularly maintained by removing debris buildup. A responsible party will be designated to conduct regular inspection and as-needed maintenance to ensure pumps and screens are properly functioning.
   v. Place troughs far enough from a stream or surround with a protective surface to prevent mud and sediment delivery to the stream. Avoid steep slopes and areas where compaction or damage could occur to sensitive soils, slopes, or vegetation due to congregating livestock.
   vi. Ensure that each livestock water development has a float valve or similar device, a return flow system, a fenced overflow area, or similar means to minimize water withdrawal and potential runoff and erosion.
   vii. Minimize removal of vegetation around springs and wet areas.
   viii. When necessary, construct a fence around the spring development to prevent livestock damage.

42. Piling, Marine Debris and Other Structure Removal

Typical projects include the removal of untreated and chemically treated wood pilings, piers, vessels, boat docks, derelict fishing gear, as well as similar structures comprised of plastic, concrete, and other material. Pilings and other structures occur in estuaries, lakes, floodplains, rivers, and nearshore or deeper water habitat, and are typically used in association with boat docks, buildings, and other facilities.

a. When removing an intact pile
   i. Install a floating surface boom to capture floating surface debris.
   ii. To the extent possible, keep all equipment (e.g., bucket, steel cable, vibratory hammer) out of the water, grip piles above the waterline, and complete all work during low water and low current conditions.
   iii. Dislodge the piling with a vibratory hammer, whenever feasible. Never intentionally break a pile by twisting or bending.

iv. Slowly lift piles from the sediment and through the water column.
v. Place chemically-treated piles in a containment basin on a barge deck, pier, or shoreline without attempting to clean or remove any adhering sediment. A containment basin for the removed piles and any adhering sediment may be constructed of durable plastic sheeting with sidewalls supported by hay bales or another support structure to contain all sediment and return flow which may otherwise be directed back to the waterway.
vi. After piling removal, fill the holes with clean, native sediments from the project area when possible, or analogous material from other sources if excavation of native material would increase impacts to listed species.
vii. Dispose of all removed piles, floating surface debris, any sediment spilled on work surfaces, and all containment supplies at a permitted upland disposal site.

b. When removing a broken pile
   i. If a pile breaks above the surface of uncontaminated sediment, or less than 0.61 m (2 feet) below the surface, make every attempt short of excavation to remove it entirely. If the pile cannot be removed without excavation, drive the pile deeper if possible.
   ii. If dredging is likely in the area of piling removal, use a GPS (global positioning device) to note the location of all broken piles for future use in site debris characterization.

c. Removal of derelict vessels and fishing gear.
   i. Removal operations must follow state approved guidelines.

43. Shellfish Bed/Nearshore Habitat Restoration

Typical projects may involve shellfish bed restoration, replacing shore line armoring, and providing beach nourishment. An example of a sustainable restoration action might include restoration of sediment input to the nearshore by removing bulkheads at historical feeder bluff sites, thereby allowing gradual and ongoing erosion/mass wasting of bluffs and LW recruitment, instead of one-time beach nourishment. This Opinion does not cover projects where the sole objective is to protect upland property or to cap contaminants.

a. Shellfish bed restoration
   i. Shell or other substance used for substrate enhancement will be procured from clean sources that do not deplete the existing supply of shell bottom. Shells should be steam cleaned, left on dry land for a minimum of one month, or both, before placement in the aquatic environment. Shells from the local area should be used whenever possible.
   ii. When placing shell substrate, juveniles, adults, or spat-on-shell in areas occupied by submerged aquatic vegetation, there will be an implementation plan submitted, detailing existing condition, density, and spatial extent of native eelgrass; and proposed planting density and anticipated effects on eelgrass density and long-term viability. The implementation plan will provide reasonable assurances that submerged aquatic vegetation (eelgrass, kelp, etc.) will not be significantly affected,

that there will be a net environmental benefit resulting from the action, or both.

iii. Molluscan shellfish (live) and any co-planted submerged aquatic vegetation used for restoration will be species native to the project area.

b. Replacing hard shoreline armoring (riprap and bulkheads) with alternative or soft shore armoring to protect property. Project selection will require accurate assessment of existing conditions, erosion risks, and patterns of future degradation.

   i. Conduct a site assessment describing the conditions that created the need for the restoration project and the mechanisms that underlie it. Site assessments also describe the natural resources and the human infrastructure within the project area and their vulnerability to shoreline erosion. Effective project plans also will consider how the project fits in a broader geomorphologic context of the associated drift cell or other ecosystem component. Alternatives to "hard armor" might include, but are not limited to:

      1. Restoration of original shore geometry (bulkhead removal or setback)
      2. Beach nourishment (gravel beach design) when the goal of importing sediment is to reduce wave energy to the upper beach
      3. Grade control/slope support with LW and/or rock
      4. Wood revetment or wood/rock revetment
      5. Biotechnical slope support (vegetated geogrids, soil pillows, etc.)[17].

   ii. Restrict plantings to native vegetation.

c. Beach nourishment. Projects may use sediment harvested during already permitted dredging activities and/or gravel from upland sources. Imported material will be free of invasive species and non-native seeds. Sediment is either trucked or barged in and placed in the high tide zone of the beach, where it is likely to be reworked and redistributed by wave action. The goal is to use indigenous materials to mimic natural processes, with the expectation that the nourished beach will perform much as a natural one, for a limited period of time following material placement. Consider extant wave exposure, supply and types of natural sources of sediment, net longshore sediment transport, predicted sea level rise and the size of sediment. For example: if the goal is to restore historical surf smelt spawning habitat, sediment placement should include a sand/pea gravel mix, with the bulk in the 1 to 7 mm (< 0.28 inch) diameter range within the uppermost one-third of the tidal range (approximately + 2.1 m (7 feet) upward) (Penttila 2007).

   i. Service review and approval. The Service in consultation with NMFS engineering will review beach nourishment project plans to minimize potential adverse impacts to designated critical habitat/essential fish habitat such as eelgrass or other submerged aquatic vegetation, sea lion

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[17] See *Marine Shoreline Design Guidelines* (Johannessen *et al.*) for examples of a variety of erosion control techniques, including bioengineering, gravel beach nourishment, and the active use of logs and woody debris

haulouts, and other resources that may be present. The Service will also review monitoring reports.

ii. Conduct topographic and bathymetric profile surveys of the beach and offshore within the project and control areas. Pre- and post-construction surveys shall be conducted no more than 90 days before construction commences and no more than 60 days after construction ends.

iii. Develop post-project monitoring plan. The frequency and duration of monitoring should be commensurate with the scale and complexity of the project. Comparisons will be made between conditions at the project site after construction and those that were present before construction, or which exist on an adjacent reference beach similar in form to the constructed beach. (For very large projects performance monitoring of beach restoration projects often continues for 10 (biological performance) to 20 (physical performance) years.)

1. Physical monitoring surveys shall be conducted in years 1, 2, 3, 5, and 10, and during interim years as needed to investigate the functioning of the new beach. Beach/depth profile transect surveys shall be conducted during a spring or summer month and repeated as close as practicable during that same month of the year. Detailed maps of sampling locations shall be presented as needed.
2. Biological monitoring shall be conducted in years 2, 5, and 10 after completion of construction. Biological evaluation of the restored beach may include comparing pre-post project differences in the density of epibenthic zooplankton, numbers and length frequency of juvenile salmonids, and forage fish spawning. Detailed maps of sampling locations shall be presented as needed.

44. In-Channel Nutrient Enhancement

Typical projects include the placement of salmon carcasses, salmon carcass analogs, or inorganic fertilizers in stream channels to help return stream nutrient levels back to historical levels. This action helps restore marine-derived nutrients to aquatic systems, thereby adding an element to the food chain that is important for growth of macroinvertebrates, juvenile salmonids, and riparian vegetation. Application and distribution of nutrients throughout a stream corridor can occur from bridges, stream banks, boats, or helicopter.

a. In Oregon, follow guidelines for the placement of carcasses in the Oregon Watershed Enhancement Board's (1999) Oregon Aquatic Habitat Restoration and Enhancement Guide18. Projects are permitted through Oregon Department of Environmental Quality, which regulates the placement of carcasses instream as a discharge. Use carcasses from the treated watershed or those that are certified disease free by an ODFW pathologist.

b. In Washington, follow WDFW's *Protocols and Guidelines for Distributing Salmonid Carcasses, Salmon Carcass Analogs, and Delayed Release Fertilizers*

[18] http://www.habitat.noaa.gov/pdf/salmon_passage_facility_design.pdf

to Enhance Stream Productivity in Washington State (Cramer 2012) or the most recent edition.

c. Ensure that the relevant streams have the capacity to capture and store placed carcasses.
d. Carcasses should be of species native to the watershed and placed during the normal migration and spawning times that would naturally occur in the watershed.
e. Do not supplement nutrients in eutrophic or naturally oligotrophic systems.

45. Road and Trail Erosion Control and Decommissioning

Typical projects include hydrologically closing or decommissioning roads and trails, including culvert removal in perennial and intermittent streams; removing, installing or upgrading cross-drainage culverts; upgrading culverts on non-fish-bearing steams; constructing water bars and dips; reshaping road prisms; vegetating fill and cut slopes; removing and stabilizing of side-cast materials; grading or resurfacing roads that have been improved for aquatic restoration with gravel, bark chips, or other permeable materials; contour shaping of the road or trail base; removing road fill to native soils; and soil stabilization and tilling compacted surfaces to reestablish native vegetation. Such actions will target priority roads that contribute sediment to streams and wetlands, block fish passage, or disrupt floodplain and riparian functions.

a. Road decommissioning and stormproofing
    i. For road decommissioning projects within riparian areas, recontour the affected area to mimic natural floodplain contours and gradient to the extent possible.
    ii. When obliterating or removing segments immediately adjacent to a stream, use sediment control barriers between the project and stream.
    iii. Dispose of slide and waste material in stable sites out of the flood-prone area. Native material may be used to restore natural or near-natural contours.
    iv. Drainage features used for stormproofing and treatment projects should be spaced as to hydrologically disconnect road surface runoff from stream channels. If grading and resurfacing is required, use gravel, bark, or other permeable materials for resurfacing.
    v. Minimize disturbance of existing vegetation in ditches and at stream crossings.
    vi. Conduct activities during dry-field conditions (generally May 15 to October 15) when the soil is more resistant to compaction and soil moisture is low.
    vii. When removing a culvert from a first or second order, non-fishing bearing stream, project specialists shall determine if culvert removal should include stream isolation and rerouting in project design. Culvert removal on fish bearing streams shall adhere to the measures described in Fish Passage Restoration (PDC 33).
    viii. For culvert removal projects, restore natural drainage patterns and channel morphology. Evaluate channel incision risk and construct in-channel grade control structures when necessary.
b. Road relocation

i. When a road is decommissioned in a floodplain and future vehicle access through the area is still required, relocate the road as far as practical away from the stream or in a location that minimizes impacts to the stream.
ii. Road relocation must be constructed in a manner that will not increase the drainage network. Project must be constructed to hydrologically disconnect road from the stream network to the extent practical. New cross drains shall discharge to stable areas where the outflow will quickly infiltrate the soil and not develop a channel to a stream.
iii. This consultation does not cover new road construction (not associated with road relocation) or routine maintenance within riparian areas.

46. Juniper Removal

This restoration action will be conducted in riparian areas and adjoining uplands to help restore plant species composition and structure that would occur under natural fire regimes. Juniper removal will occur in those areas where juniper have encroached into riparian areas as a result of fire exclusion, thereby replacing more desired riparian plant species such as willow, cottonwood (*Populus* spp.), aspen (*Populus tremuloides*), alder (*Alnus* spp.), sedge, and rush. Guidelines on management of western juniper can be found at:
http://www.oregon.gov/OWEB/MONITOR/docs/westernjunipermanagementfieldguide.pdf.

The following measures will apply:

a. Remove juniper to natural stocking levels where juniper trees are expanding into neighboring plant communities to the detriment of other native riparian vegetation, soils, or streamflow.
b. Do not cut old-growth juniper, which typically has several of the following features: sparse limbs, dead limbed or spiked-tops, deeply furrowed and fibrous bark, branches covered with bright-green arboreal lichens, noticeable decay of cambium layer at base of tree, and limited terminal leader growth in upper branches.
c. Felled trees may be left in place, lower limbs may be cut and scattered, or all or part of the trees may be used for streambank or wetland restoration (e.g., manipulated as necessary to protect riparian or wetland shrubs from grazing by livestock or wildlife or otherwise restore ecological function in floodplain, riparian, and wetland habitats).
d. Where appropriate, cut juniper may be placed into stream channels and floodplains to provide aquatic benefits. Juniper can be felled or placed into the stream to promote channel aggradation as long as such actions do not obstruct fish movement and use of spawning gravels or increase width to depth ratios.
e. On steep or south-facing slopes, where ground vegetation is sparse, leave felled juniper in sufficient quantities to promote reestablishment of vegetation and prevent erosion.
f. If seeding is a part of the action, consider whether seeding will be most appropriate before or after juniper treatment.
g. Juniper tree removal in riparian or upland areas must not result in significant soil disturbances that may cause increased sedimentation and erosion.

h. Slash materials should be gathered by hand or with light machinery to reduce soil disturbance and compaction. Avoid accumulating or spreading slash in upland draws, streams, and springs. Slash control and disposal activities must be conducted in a manner that reduces the occurrence of debris in aquatic habitats.
i. When using feller-buncher and slash-buster equipment, operate equipment in a manner that minimizes soil compaction and disturbance to soils and native vegetation to the extent possible. Equipment exclusion areas (buffer area along stream channels) should be as wide as the feller-buncher or slash-buster arm.

47. Native Fish Protection

Typical projects include the removal of brook trout or other non-native fish species via electrofishing or other manual means to reduce competition or hybridization with bull trout.

a. The measures specified in this PDC are designed to protect listed species under Service's jurisdiction.
b. For brook trout or other non-native fish species removal, staff experienced in the specific removal method shall be involved in project design and implementation.
c. When using electrofishing for removal of brook trout or other non-native fish species, use the following guidelines:
    i. Electrofishing shall be conducted using the methods outlined in the NMFS's guidelines (NMFS 2000).
    ii. Electrofishing equipment shall be operated at the lowest possible effective settings to minimize injury or mortality to bull trout.
    iii. To reduce adverse effects to bull trout, electrofishing shall only occur from May 1 (or after emergence occurs) to July 31 in known bull trout spawning areas. No electrofishing will occur in any bull trout habitat after August 15.
    iv. Electrofishing shall not be conducted when the water conditions are turbid and visibility is poor. This condition may be experienced when the sampler cannot see the stream bottom in 30 cm (1 foot) of water.
    v. Electrofishing will not be conducted within core areas that contain 100 or fewer adult bull trout.
d. Other removal methods, such as dip netting, spearing, and other means can be used.

48. Beaver Habitat Restoration

This restoration action includes installation of in-channel structures to encourage beavers to build dams in incised channels and across potential floodplain surfaces.

a. In-channel structures
    i. Consist of porous channel-spanning structures comprised of biodegradable vertical posts (beaver dam support structures) approximately 0.5 to 1 meter (19.7 to 39.4 inches) apart and at a height intended to act as the crest elevation of an active beaver dam. Variation of this restoration treatment may include post lines only, post lines with wicker weaves, construction of starter dams, reinforcement of existing active beaver dams, and

reinforcement of abandoned beaver dams as described by Lewallen *et al.* (2015 (*In prep*.), 2012).

ii. Place beaver dam support structures in areas conducive to dam construction as determined by stream gradient or historical beaver use.

iii. Place in areas with sufficient deciduous shrub and trees to promote sustained beaver occupancy.

b. Habitat Restoration

i. Beaver restoration activities may include planting riparian hardwoods (species such as willow, red osier dogwood (*Cornus sericea*), and alder) and building exclosures (such as temporary fences) to protect and enhance existing or planted riparian hardwoods until they are established as described by the Malheur National Forest (NF) and the Keystone Project (2007)[19].

ii. Maintain or develop grazing plans that will ensure the success of beaver habitat restoration objectives.

49. Wetland Restoration

Typical projects restore degraded wetlands by a) excavation and removal of fill materials; b) contouring to reestablish more natural topography; c) setting back existing dikes, berms and levees; d) reconnecting or re-creating historical tidal and fluvial channels; e) planting native wetland species; or f) a combination of the above methods. This action does not include installation of water control structures or fish passage structures.

a. Include applicable General Construction Measures (PDC 13-32) and PDC for specific types of actions as applicable (e.g., Off- and Side-Channel Habitat Restoration (PDC 37); Set-Back or Removal of Existing Berms, Dikes, and Levees for Wetland and Estuary Restoration (PDC 39); and Dam and Legacy Structure Removal (PDC 35)) to ensure that all adverse effects to fish and their designated critical habitats are within the range of effects considered in this Opinion.

50. Tide/Flood Gate Removal, Replacement, or Retrofit

Typical projects may include the removal, replacement, or the upgrade of existing tide and flood gates by modifying gate components and mechanisms in tidal stream systems where full tidal exchange is incompatible with current land use or where backwater effects are of concern. Projects will be implemented to reconnect stream/slough corridors, floodplains, estuaries and nearshore habitats, reestablish wetlands, improve aquatic organism passage, and restore more natural channel and flow conditions. Tide/flood gate replacement or retrofit may include, but is not limited to, excavation of existing channels, adjacent floodplains, flood channels, and wetlands, and may include structural elements such as streambank restoration and hydraulic roughness elements. Placement of new gates where they did not previously exist is not covered in this Opinion, except where an existing tidegate is being replaced with one upstream in the same drainage as part of a levee setback project.

[19] http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fsbdev3_033699.pdf

a. Service review and approval. The Service in consultation with NMFS engineering will review tide/flood gate removal, replacement, and retrofit projects for consistency with Anadromous Salmonid Passage Facility Design (NMFS 2011 or the most recent version).
b. For removal projects, if a culvert or bridge will be constructed at the location of a removed tide gate, the structure will be large enough to allow for a full tidal exchange.
c. Follow PDC for Staging, Storage, and Stockpile Areas (PDC 16), Hazardous Material Spill Prevention and Control (PDC18), Equipment, Vehicles, and Power Tools (PDC19), Surface Water Withdrawal and Construction Discharge Water (PDC 23), Work Area Isolation (PDC 27), Timing of In-Water Work (PDC 25), Fish Capture and Release (PDC 28); Site Restoration (PDC 31), and Revegetation (PDC 32). Excavation below the OHW line shall be conducted to the maximum extent possible during low tide cycles or low flow cycles in the downstream watercourse.
d. Overall design goals. Tide/flood gate replacement or retrofit design data will demonstrate:
    i. A clear linkage to limiting factors identified within an appropriate sub-basin plan or recovery plan, or based on recommendations by a technical oversight and steering committee within a localized region.
    ii. The identification and, to the extent possible, the correction of the degraded baseline condition.
    iii. The use of analytical approaches for determination of the tidal prism and exchange.
    iv. Appropriate self-sustaining hydrologic design that includes climate change to reduce maintenance.
e. General project design criteria
    i. Site specific project design criteria will be set based on tidal restoration, fish passage, climate change and flood protection needs as determined and set forth by the RRT. At a minimum, the RRT will assess the following design options after determining necessity of the project.
    ii. Tide/Flood Gate Replacement or Retrofit Options in order of preference
        1. Dike removal
        2. Dike breach
        3. Dike setback (With the existing tide gate, or a replacement with an upgraded tidegate as described below)
        4. Bridge
        5. Non-gated pipe or “bare” culvert
            a. Existing pipe minus the tide gate (removed)
            b. Installation of new pipe minus a tide gate
    iii. Tide Gate
        1. Fiberglass or aluminum gate
        2. Side hinged gate
        3. Self-regulating tide gate
            a. Tension (cable) operated
            b. Float (cam) operated

iv. Hybrid (such as self-regulating tide gate coupled with non-gated pipe)
v. Other design options as recommended by the RRT
vi. Design actions to restore tidal exchange characteristics—elevation, cross-sectional area, timing—in a manner that closely mimics, to the greatest degree possible, those that would naturally occur at that stream type.

f. Design report & associated documentation. Tide/flood gate replacement and retrofit design and adaptive management documentation shall include:
   i. Background and Problem Statement
      1. Site history
      2. Environmental baseline
      3. Problem description
      4. Cause of problem
   ii. Project Description
      1. Goals/objectives
      2. Project elements
      3. Sequencing, implementation
         a. Place cofferdam upstream of the culvert to prevent drainage water from entering the work area. A downstream cofferdam will also be installed to isolate the work area from the watercourse.
         b. The existing culvert requiring replacement is then excavated with equipment staged on the dike or shoreline above OHW.
         c. Excavated material is stockpiled upland for replacement in the dike once the new culvert is in-place.
         d. Waste water removed from within the cofferdam work area shall be discharged to a location landward of OHW line in a manner that allows removal of fine sediments prior to the discharged water returning to the watercourses.
         e. Upon completion of the tide gate/flood gate repairs and/or replacement, all material used to construct the cofferdams shall be removed from the watercourses and the project site returned to pre-project or improved conditions.
         f. Restore LW features to redeveloping tidal channels.
         g. Drainage ditches will be filled to become part of the surrounding contiguous tidal marsh or will be modified to become part of the tidal channel network.
      4. Proposed work window
      5. Recovery trajectory:. Describe how the new stream/tidal channel will develop and evolve.
   iii. Design Analysis, including technical analyses, computations relating design to analysis, and references. Analyses shall be appropriate to the level of project complexity. At a minimum, analyses will include the following:
      1. Hydraulic Analysis

a. Model conditions, duration, boundary conditions, inputs, and outputs will be collaboratively developed by RRT and modeler.
2. Sediment Assessment
3. Risk Analysis

iv. Detailed construction drawings

v. Other regulatory jurisdictions for tide and floodgate repair and replacement will also be addressed: *i.e.*, United States Army Corps of Engineers (USACE), River and Harbors Act §10, Clean Water Act §404, Coastal Zone Management Act, ODFW Fish Passage Oregon Administrative Rule (OAR); ODEQ & WDOE §401, WDFW Hydraulic Project Approval, Washington Environmental Policy Act evaluation, Washington Shoreline Management Act

vi. River Restoration Tool. Review by the RRT will also include an evaluation using the River Restoration Analysis Tool (www.restorationreview.com), and therefore the following questions will be addressed in the project documentation:
1. Problem Identification
    a. Is the problem identified?
    b. Are causes identified at appropriate scales?
2. Project Context
    a. Is the project identified as part of a plan, such as a watershed action plan or recovery plan?
    b. Does the project consider ecological, geomorphic, and socioeconomic context?
3. Goals & Objectives
    a. Do goals and objectives address problem, causes, and context?
    b. Are objectives measurable?
4. Alternatives Evaluation
    a. Were alternative considered?
    b. Are uncertainties and risk associated with selected alternative acceptable?
5. Project Design
    a. Do project elements collectively support project objectives?
    b. Are design criteria defined for all project elements?
    c. Do project elements work with stream processes to create and maintain habitat?
    d. Is the technical basis of design sound for each project element?
6. Implementation
    a. Are plans and specifications sufficient in scope and detail to execute the project?
    b. Does plan address potential implementation impacts and risks?
7. Monitoring and Management

a. Does monitoring plan address project compliance?
b. Does monitoring plan directly measure project effectiveness?
c. Does the maintenance plan include replacement for components that corrode over time?

g. Monitoring and adaptive management. Develop a monitoring and adaptive management plan that has been reviewed and approved by the RRT, that includes the following:
    i. Introduction
    ii. Existing monitoring protocols
    iii. Project effectiveness monitoring plan
    iv. Project review team triggering conditions
    v. Monitoring frequency, timing, and duration
    vi. Monitoring technique protocols
    vii. Data storage and analysis
    viii. Monitoring quality assurance plan
    ix. Literature cited

51. Native Vegetation Restoration and Management

These restoration actions will be conducted in upland areas, including coastal and nearshore habitats, oak savannah and prairie habitats, and forest habitats. Categories of restoration and management activities and PDC included:

1) Manual and mechanical vegetation management techniques,
2) Grazing,
3) Prescribed burning,
4) Herbicide treatments (see also PDC 29),
5) Plant population enhancement,
6) Surveys and Monitoring (see PDC 26).

Restoration and management actions will help restore plant species composition and structure that would occur under natural disturbances regimes, such as flooding, fire, or tidal and wave action. Actions include the conversion of human-altered habitats to historic oak savannahs, short and tall grass prairies, conifer and hardwood forests, and coastal dune restoration. Restoration of these upland communities encompasses the direct manipulation of plants and soils/sand to alter existing or competing plant communities to recover or maintain select native plant communities. This is achieved by the use of mechanical, physical, burn, grazing, or chemical techniques to eradicate or control undesirable vegetation and alter vegetation and soil properties.

Native vegetation restoration will also include plant population enhancement (propagule collection, propagation, population augmentation and reintroduction) of listed plants. Activities can occur in prairie, oak woodland and savanna, and coastal habitats. A summary of treatments used for each activity and the benefits to listed species is presented in the following table. These treatments are an integration of the several restorations actions described in the Programmatic Consultation for Western Oregon Prairie Restoration Activities (2008), Programmatic Consultation for Oregon's Restoration and Recovery Programs (2010), and Programmatic Biological Assessment for Habitat Restoration Activities, Western Washington Version (2006).

In addition to improving conditions for listed plant species, these actions will also benefit other listed species that depend on native plant communities for their continued existence. A complete description of the proposed action, PDC for native vegetation restoration and species-specific conservations measures will be maintained in PROJECTS Handbook, which may be amended through annual updates, provided all additions/amendments do not result in any additional effects beyond those considered in the Biological Opinion issued for PROJECTS.
A summary of the treatments used for each activity and the benefits to the species and habitat for each treatment follows in Table 2.

Table 2. Activities and Treatment Techniques for Native Vegetation Restoration in Idaho, Oregon and Washington.

	Benefits to Species & Habitat				
Restoration Activity & Technique	Control woody vegetation encroachment	Invasive species removal	Reduce thatch buildup	Enhance native plant cover	Data Collection and Reporting
Prairie Restoration and Management					
Mowing		X			
Manual removal		X			
Mechanical removal	X	X			
Cutting/thinning/removing tree stumps	X				
Girdling trees	X				
Raking			X		
Shade cloth		X			
Sod rolling		X			
Solarization		X			
Tilling/Disking		X			
Livestock grazing	X	X			
Prescribed burning	X	X	X	X	
Chemical treatments (see also PDC 29)	X	X			
Plant population enhancement					
Propagule collection				X	
Propagule transport				X	
Propagule storage				X	
Propagule cultivation				X	
Seeding				X	
Outplanting				X	
Surveys and monitoring (see PDC 26)					
Surveys					X
Monitoring					X

i. Manual and mechanical (non-herbicide) treatment methods. The following methods may be used:Limit native vegetation removal and soil disturbance within the riparian zone by limiting the number of workers to the minimum necessary to complete manual, mechanical, or hydro-mechanical plant control (e.g., hand pulling, bending[20], clipping, stabbing, digging, brush-cutting, mulching, radiant heat, portable flame burner, super-heated steam, pressurized hot water, or hot foam (Arsenault *et al.* 2008; Donohoe *et al.* 2010))[21].

ii. Do not allow cut, mowed, or pulled vegetation to enter waterways.

Mowing. Sites may be mowed using tractor mowers, flail mowers, or hand-held mowers (e.g. rotary line trimmers). In sites supporting populations of listed plants and/or butterflies:

i. Mowing will generally be implemented in the fall and winter, after listed plants have senesced for the season and /or butterflies are in diapause (Table 3).

ii. Tractor mowers should be rubber-tracked to minimize soil compaction and/or rutting.

iii. Tractor mowing decks should be set sufficiently high to avoid soil gouging; see Table 3 for species specific information.

iv. Mowing activities will follow the timing restrictions and mower height settings provided in Table 3 for all affected listed species.

v. Spring mowing is allowed at restoration sites with listed plant species, as indicated in Table 3, but only if necessary to control serious infestations of weeds that reproduce mainly by seed (*e.g.*, meadow knapweed) and threaten persistence of the listed species in that area. In these instances, up to one half of area occupied by the listed plant population(s) at a site may be mowed in an effort to reduce seed set by non-native weeds. Spring mowing must be approved by the local Service office and species lead.

vi. Manual removal. Invasive plants may be removed year-round using manual methods and hand tools, including hoeing, grubbing, pulling, clipping or digging. Tools that may be used include shovel, hoe, weed wrench, lopping shears, trowel, etc.

vii. Cutting/thinning/removing tree stumps. Handheld power tools may be used to cut down woody vegetation, control and remove invasive woody plants, and reduce tree density. The extent of these actions could be guided by reviews of site records (including aerial photographs) and percent cover thresholds for the habitat types.

- In highly degraded sites, low impact vehicle-mounted tree shears may be used to thin woody vegetation.
- Tree stumps and their root systems may be removed manually or mechanically using vehicle-supported machinery to avoid re-sprouting. This should be restricted to the dry season if listed species are present.
- Cutting or thinning may be implemented either at times of the year when listed species are dormant, or in the case of selective manual methods where workers enter the site on foot, in such a way as to avoid trampling of any listed species.

[20] Knotweed treatment pre-treatment; See Nickelson (2013).

[21] See http://ahmct.ucdavis.edu/limtask/equipmentdetails.html

- If herbicides will be used to treat freshly-cut stumps, trees must be felled at times that coincide with timing restrictions for chemical use.
- All cut material will be piled or chipped and spread away from populations of listed plants or butterflies or hauled off-site for disposal, unless material is needed to use for a prescribed burn treatment. In cases where work is done during the wet season, cut debris may be temporarily piled on-site, but away from listed plants and butterflies, until the dry season when equipment can access the work area to remove debris.

viii. Girdling trees. Girdling trees involves removal of a ring of bark near the base of a tree with an axe or chainsaw. It eventually kills the tree and is done to control and remove invasive woody plants. Girdling may be applied at any time of year. Workers will enter sites on foot and take care to avoid trampling listed plants and animals, and native species that support listed animals. Depending on management objectives, girdled trees may remain on site or be removed during the dry season when listed plants and butterfly host lupines are dormant.

ix. Raking. Raking is used to reduce thatch build up. Rakes may be tractor-mounted or hand-held.

- Raking will occur when listed plants are dormant (generally August 15 to February 28).
- Efforts will be made to avoid disturbing underlying soil.
- In sites with listed plant species that do not senesce in the winter (*e.g.*, Nelson's checkermallow), efforts will be made to avoid individuals of the listed plant.
- When rakes are tractor-mounted, tractors shall be equipped with rubber tracks to minimize soil compaction.

x. Shade cloth. Used to control monotypic weed infestations. Dark cloth placed over weeds and fastened to ground with stakes for two years. Shade cloth is installed during the growing season, but will not be used directly over any individuals of listed plant or animal species but can be used 20 m (65 feet) from listed species, unless species-specific measures state otherwise.

xi. Sod Rolling. Used to control invasive plants, especially those which spread by rhizomes. A bulldozer is used to roll away the top layer of soil and plant material, leaving a relatively intact soil layer beneath. The removed vegetative mats are deposited into windrows at the edge of the site, where they compost in place. This technique will not be used where listed species are present, but can be used 10 m (33 feet) from listed plant and animal species unless species-specific measures state otherwise.

Table 3. Species-specific timing for mowing and prescribed burn methods for the control or removal of invasive and non-native vegetation at project sites occupied by listed plant species. See species-specific conservation measures for additional restrictions on these activities for listed animals that may be present.

Listed Plant Species	Treatment Method and Timing		
	Prescribed Burns (Calendar Timing)	Mechanical Mowing – Timing [Mower Deck Height]	Spring Mowing Allowed?
Bradshaw's lomatium	Fall burns after August 15	Fall mowing after August 15 [15 cm (6 inches)]	Yes With restrictions.
Cook's desert-parsley	Fall burns after September 1	Summer/Fall mowing after July 15 [5 cm (2 inches)]	No
Gentner's fritillary	Fall burns after September 1	Summer/Fall mowing after July 15 [15 cm (6 inches)]	No
Golden Paintbrush	Fall burns after August 15	Late winter (February to March 15) mowing OK , then mow again after September 15, if site not burned	Yes- with restrictions.. Complete by mid-March
Howell's spectacular thelypody	Not Allowed	Not Allowed	No
Kincaid's lupine	Fall burns after August 15	Fall mowing after August 15 15 cm [6 inches)]	Yes- with restrictions.
Large-flowered woolly meadowfoam	Fall burns after September 1	Summer/Fall mowing after July 15 [5 cm (2 inches)]	No
Nelson's checkermallow	Fall burns after August 15; up to 50% of the occupied area at a site.	Fall mowing after August 15 [15 cm (6 inches)]	Yes With restrictions.
Rough popcorn flower	Fall burns after August 15	Fall mowing after August 15 [10 cm (4 inches)]	No
Spalding's catchfly	Not Allowed	Not Allowed	No
Ute ladies'- tresses	Not Allowed	Not Allowed	No
Water Howellia	Not Allowed	Not Allowed	No
Wenatchee Mountains checkermallow	Fall burns after August 15	Unlikely mowing could be accomplished. Selective weed removal would be helpful.	No
Western lily	Fall burns[7] between November 1 and March 1	Fall mowing[7] between November 1 and March 1 [10 cm (4 inches)]	No
Willamette daisy	Fall burns after August 15	Fall mowing after August 15 [15 cm (6 inches)]	Yes- with restrictions.
LISTED ANIMAL SPECIES			
Fender's blue butterfly	Burning OK on 25 to 33% of an occupied area after August 15 to Nov 15.	August 15 to March 1 [15 cm (6 inches)]	No
Oregon silverspot butterfly	Burning OK on 25 to 33% of an occupied area from October 1 to mid July	October 1 to Mid-May. No more than 75% of an occupied area	Yes Complete by May 15
Taylor's checekerspot butterfly	Burning OK only on 33% of an occupied area during diapause only (Sept 10 to Feb 15)	Mowing OK during diapause September 10 to February 15	No.
Vernal pool fairy shrimp	Any time	Treat invasive plants any time if	Yes

Listed Plant Species	Treatment Method and Timing		
	Prescribed Burns (Calendar Timing)	Mechanical Mowing – Timing [Mower Deck Height]	Spring Mowing Allowed?
		listed plants not present	
Streaked horned lark	Outside of nesting season in suitable habitat. Anytime in unsuitable habitat.	Sept 1 to March 30: 100% April 1 to August 31 no more than 50% of an occupied area. Mower set to highest level to meet objectives.	Yes, up to 50% of an occupied area.
Mazama pocket gopher	Yes but must get approval from local office	Yes, but must get approval from local office	Yes, but must get approval

xii. Solarization. Also used to kill monotypic weed patches. A site is covered with plastic sheeting, which remains for at least three months during the growing season. Follow-up weeding may be necessary once plastic is removed. This technique will not be used where listed plants or animals are present, but can be used in adjacent habitat no closer than 10 m (30 feet) to listed plant and animal species unless species specific measures state otherwise.

xiii. Tilling/disking. A tractor with a tiller/disk attachment will be used to turn up the soil to a depth of no more than 30 cm (12 inches). This technique will be implemented along existing ground contours when possible, and will not occur during the wet season. Tilling/disking must be followed immediately with introduction of native plant species unless further weed eradication is scheduled to take place. Tilling and disking will not be used within 10 m (30 feet) of known populations of listed plant and animal species, unless species specific measures state otherwise.

j. Livestock grazing. Used to control shrubby invasive vegetation, new invasive vegetation sprouts, and leaf litter buildup.
   i. Livestock grazing will not be used to control or remove invasive and non-native vegetation at project sites occupied by Cook’s desert parsley, Gentner’s fritillary, Howell's spectacular thelypody, Nelson’s checkermallow, large-flowered meadowfoam, rough popcornflower, and Spalding's catchfly, unless approved by the local Service office or species lead.
   ii. Grazing at low-moderate levels during the dry season will be allowed in prairies after August 1 and before listed plant species emerge the following year.
   iii. Grazing will not occur during the wet season when soils are soft or saturated, unless approved by the local Service office and species lead.
   iv. Grazing intensity and duration must not result in excessive trampling of vegetation or the creation of bare soil.
   v. Grazing activities will be monitored on a daily or weekly basis, as appropriate to avoid negative impacts.

vi. Grazing activities will be terminated once management objectives are achieved at the project site. Animals will be removed from the site within three days of this termination.
vii. Animals used in grazing activities will be isolated from invasive and non-native vegetation prior to being released into a project site to avoid contaminating the area with seeds and/or other reproductive parts from invasive and non-native vegetation.

k. Prescribed burning.
i. Prescribed burning is the measured application of fire to control invasive woody plants, remove thatch and invigorate native plant populations in upland and wet prairie systems. The technique involves the hand application of fire via drip torches or similar equipment.
ii. A 15 m (50 feet) vegetative buffer will be maintained adjacent to any fish-bearing stream.
iii. A burn plan is required, although it may vary by management objectives and site conditions.
iv. Prescribed fire for sites with listed plants, butterflies, pocket gophers, and remnant prairie vegetation should be of low intensity, and take place on cool, cloudy days later in the dry season. Woody vegetation may be removed from treatment area prior to burning.
v. Timing of burns when listed species are present will be consistent with Table 3.
vi. All burns will comply with State regulations and protocols.
vii. Firebreaks will be used to prevent fire from spreading outside of planned burn area. Fire retardant chemicals will be used sparingly near listed plant and animal populations, and will not be used within 37 m (120 feet) of a watercourse.
viii. An area 3 to 6 m (10 to 20 feet) wide may also be mowed around the outside boundary of the burn area to help assure fire control.
ix. Fire management vehicles will be restricted to adjacent non-native or resilient vegetation except during an emergency, and then for only the duration of the emergency.
x. Human movement in the prescribed burn area will be managed to minimize impacts on listed plants and the native prairie community (except as needed for human safety).
xi. At sites supporting listed plant species that do not completely senesce by late summer (*e.g.*, Nelson's checker-mallow), no more than one half of the occupied habitat may be burned in any year, if burning is allowed (See Table 3).

l. Herbicide Methods for Prairie, Nearshore, and Oak Savannah Sites more than 100 feet from water. Other herbicides identified as "aquatic use" in PDC 29 may also be used in prairies.
i. Allowed Herbicides (a subset of those allowed under PDC 29)
- Aminopyralid
- Triclopyr (*e.g.* Garlon 3A)

- Glyphosate (non-aquatic formulation e.g. Roundup)
- 2,4-D amine (Amine 400)
- Clethodim (*e.g.* Envoy)
- Sethoxydim (*e.g.* Poast)
- Fluazifop-P-butyl (Fusilade)
- Oryzalin
- Diquat dibromide (Reward)
- Triclopyr + 2,4-D ester (Crossbow)

ii. All herbicide treatments will be conducted using a limited number of techniques to reduce potential for chemical drift and runoff. See Table 4 below for specific application techniques and timeframes for each allowed chemical in these habitats.

iii. Use of all herbicides for prairie, nearshore and oak savannah restoration sites will also follow PDC 29, and all species-specific conservation measures for each listed species potentially affected.

Table 4. Upland Herbicide Table. Underlined herbicide indicates aquatic formulation. Non-underlined herbicides are upland only and cannot be used closer than 30.5 m (100 feet) from any waterbody.

2, 4-D amine *(e.g. Weedar 64) will be used for treating broadleaf species. It will be applied primarily via spot foliar application using a hand-held wand or mounted on an all-terrain vehicle.* • *Wipe-on type application will be allowed February 1 to August 15 to allow for control of tall invasive while protecting native plants.* • *Spray and wipe-on application will be permitted August 15 to December 15 when native plants and listed species are dormant.* • *Cannot be used if it may impact threatened or endangered plants that do not completely senesce or in vernal pools.*
Aminopyralid *(e.g. Milestone) will be used for selective control of invasive and noxious broadleaf weeds.* • *Cannot be used closer than 30.5 m (100 feet) from any waterbody* • *Use spot spray or wipe-on.* • *Boom spray may be used with caution as aminopyralid is persistent and can cause damage to native habitats.* • *Check for additional restrictions at sites with listed plants that do not completely senesce and/or listed animals.*
<u>***Chlorsulfuron*** *(e.g. Telar, Glean, Corsair)*</u> *is used for the control of broadleaf weeds and some annual grasses.* • *Use spot spray or wipe-on.* • *Check for additional restrictions at sites with listed plants that do not completely senesce and/or listed animals.*
Clethodim *(e.g Envoy) will be used to treat non-native grass species.* • *Application timing is limited to June 1 to December 15 (upland prairie sites) and August 1 to October 25 (wet prairie sites). Applications during this period will allow for*

residual chemical to break down prior to fall rains. • *It will be applied primarily via spot foliar application using a hand-held wand or mounted on an all-terrain vehicle. If using a weed wiper to apply clethodim near listed plants during the growing season, the herbicide will be applied at a height to target upper grass stems, and avoid lower-stature listed plants.* • *Boom spraying may occur in some areas with large infestations. Boom sprayers may be mounted on all-terrain vehicles or tractors.* • *Check for additional restrictions at sites with listed plants that do not completely senesce and/or listed animals.*
***Clopyralid** (e.g. Transline) Will be used to treat grasses and broadleaf woody and herbaceous species.* • *Will be applied primarily via spot foliar application using a hand-held wand or mounted on an all-terrain vehicle.* • *Wipe-on type application will be allowed February 1 to August 15 to allow for control of tall invasives while protecting native plants.* • *Spray and wipe-on application will be permitted August 15 to December 15 when native plants and listed species are dormant.* • *Check for additional restrictions at sites with listed plants that do not completely senesce and/or listed animals.*
***Diquat dibromide** (e.g., Reward) will be used to top-kill or burn-down annual and perennial vegetation. Non-native plants recovery quicker than native plants allowing a window to use other herbicides on the invasive plants while the native plants are senesced.* • *Wipe-on type application will be allowed February 1 to August 15 to allow for control of tall invasives while protecting native plants.* • *Spray and wipe-on application will be permitted August 15 to December 15 when native plants and listed species are dormant.* • *Check for additional restrictions at sites with listed plants that do not completely senesce and/or listed animals.*
***Fluazifop-P-butyl** (e.g. Fusilade II) will be used for treating competing grass species.* • *It will be applied primarily via spot foliar application using a hand-held wand or mounted on an all-terrain vehicle.* • *Boom spraying may occur in some areas with large infestations. Boom sprayers may be mounted on all-terrain vehicles or tractors.* • *Cannot be used closer than 30.5 m (100 feet) from any waterbody.* • *Early season application should be between February 15 to May 15.* • *Tall oat grass may be treated from February 15-December 15 if listed plants are not present.* • *All other applications should be limited to later in the year June 1 to December 15 at upland prairie sites and August 1 to October 25 at wet prairie sites. Applications during this period will allow residual chemical to break down prior to fall rains.* • *Check for additional restrictions at sites with listed plants that do not completely senesce and/or listed animals.*
***Glyphosate – Aquatic** (e.g. Rodeo, AquaMaster, AquaPro) will be used to treat grasses and broadleaf woody and herbaceous species. It will be applied primarily via spot foliar application using a hand-held wand or mounted on an all-terrain vehicle (tractors may be*

used on dry upland sites).

- *Wipe-on type application will be allowed February 1 to August 15 to allow for control of tall invasives while protecting native plants.*
- *Spray and wipe-on application will be permitted August 15 to December 15 when native plants and listed species are dormant.*
- *Check for additional restrictions at sites with listed plants that do not completely senesce and/or listed animals.*

***Glyphosate – Upland** (e.g. Roundup)*
Same conditions as aquatic glyphosate except cannot be used closer than 30.5 m (100 feet) from any waterbody.

***Imazapic** (e.g. Plateau)is used for pre-and post-emergent control of some annual and perennial grasses and some broadleaf weeds.*

- *Early season application will be allowed (February 15 to May 15).*
- *All other applications will be limited to later in the year (June 1 to December 15 at upland prairie sites and August 1 to October 25 at wet prairie sites). Applications during this period will allow residual chemical to break down prior to fall rains.*
- *Check for additional restrictions at sites with listed plants that do not completely senesce and/or listed animals.*

***Imazapyr – Aquatic** (e.g. Habitat) is a non-selective herbicide used for the control of a broad range of weeds including grasses, herbs, woody species, and riparian and emergent species.*

- *Early season application will be allowed (February 15 to May 15).*
- *All other applications will be limited to later in the year (June 1 to December 15 at upland prairie sites and August 1 to October 25 at wet prairie sites). Applications during this period will allow residual chemical to break down prior to fall rains.*
- *Check for additional restrictions at sites with listed plants that do not completely senesce and/or listed animals.*

***Imazapyr – Upland** (e.g. Arsenal, Chopper)*

- *Same as aquatic Imazapyr except cannot be applied within 30.5 m (100 feet) from any waterbody*

***Metsulfuro- methyl** (e.g. Escort) will be used to treat grasses and broadleaf woody and herbaceous species.*

- *Will be applied primarily via spot foliar application using a backpack sprayer or mounted on an all-terrain vehicle.*
- *Wipe-on type application will be allowed February 1 to August 15 to allow for control of tall invasives while protecting native plants.*
- *Spray and wipe-on application will be permitted August 15 to December 15 when native plants and listed species are dormant.*
- *Check for additional restrictions at sites with listed plants that do not completely senesce and/or listed animals.*

***Oryzalin** (e.g. Surflan) with an adjuvant (Activator 90) will be used for treating woody plants and grass species.*

- *Will be applied via spot foliar application using a hand-held wand.*
- *Will not be allowed at wetland prairie sites.*
- *Early season application will be allowed (February 15 to May 15).*

• *All other applications will be limited to later in the year (August 1 to December 15 at upland prairie sites). Applications during this period will allow for residual chemical to break down prior to fall rains.* • *Cannot be used on listed plants that do not completely senesce, butterflies, on in veral pools.*
***Picloram** (e.g. Tordon) will be used for treating woody plants and grass species.* • *Will be applied via spot foliar application using a hand-held wand.* • *Wipe-on type application will be allowed February 1 to August 15 to allow for control of tall invasives while protecting native plants.* • *Spray and wipe-on application will be permitted August 15 to December 15 when native plants and listed species are dormant.* • *Check for additional restrictions at sites with listed plants that do not completely senesce and/or listed animals.*
***Sethoxydim** (e.g. Poast, Vantage) will be used for treating grass species.* • *Will be applied primarily via spot foliar application using a hand-held wand or mounted on an all-terrain vehicle.* • *Early season application will be allowed (February 15 to May 15).* • *All other applications will be limited to later in the year (June 1 to December 15 at upland prairie sites and August 1 to October 25 at wet prairie sites). Applications during this period will allow for residual chemical to break down prior to fall rains.* • *If using a weed wiper to apply sethoxydim near listed plants during the growing season, the herbicide will be applied at a height to target upper grass stems, and avoid lower-stature listed plants.* • *Check for additional restrictions at sites with listed plants that do not completely senesce and/or listed animals.*
***Sulfometuron- methyl** (e.g. Oust, Oust XP) will be used to control annual and perennial grasses and broad-leaved weeds. Application may be either postemergent or preemergent.* • *Wipe-on type application will be allowed February 1 to August 15 to allow for control of tall invasives while protecting native plants.* • *Spray and wipe-on application will be permitted August 15 to December 15 when native plants and listed species are dormant.* • *Check for additional restrictions at sites with listed plants that do not completely senesce and/or listed animals.*
***Triclopyr-TEA** (e.g. Garlon 3A, Renovate 3) will be used to control woody species and broadleaf weeds.* • *For woody species control, it will be hand painted or directly wicked onto fresh cut stumps within 24 hours of cutting; no spraying is allowed.* • *For broadleaf weed control, it will be applied primarily via spot foliar application using a hand-held wand or mounted on an all-terrain vehicle.* • *Wipe-on type application will be allowed February 1 to August 15 to allow for control of tall invasives while protecting native plants.* • *Spray and wipe-on application will be permitted August 15 to December 15 when native plants and listed species are dormant.* • *Check for additional restrictions at sites with listed plants that do not completely senesce and/or listed animals.*

Triclopyr+2,4-D ester (e.g. Crossbow) *will be used to control woody species and broadleaf weeds.*

- *For broadleaf weed control, it will be applied primarily via spot foliar application using a hand-held wand or mounted on an all-terrain vehicle.*
- *Cannot be used closer than 30.5 m (100 feet) from any waterbody.*
- *Wipe-on type application will be allowed February 1 to August 15 to allow for control of tall invasives while protecting native plants.*
- *Spray and wipe-on application will be permitted August 15 to December 15 when native plants and listed species are dormant.*
- *Check for additional restrictions at sites with listed plants that do not completely senesce and/or listed animals.*

m. Plant Population Enhancement
   i. Plant populations may be augmented or introduced to increase the number and viability of listed plant populations.
   ii. Restoration may also include the restoration of native prairie structure and function; thus, seeds and plant parts of non-listed native species may be collected, and a variety of native forbs, including nectar species for listed butterfly species or forage species for Mazama pocket gophers, and grasses will be augmented or introduced as part of the prairie restoration efforts.
   iii. Enhancement includes propagule collection of seeds and/or rhizomes, propagule storage for later cultivation or outplanting, propagule transport, cultivation and/or outplanting of listed prairie plants in nursery or greenhouse for later cultivation or outplanting, generally described in the subsequent sections, but may be altered if needed to meet species-specific requirements. The most recent, species-specific guidance should be followed for these techniques, as directed by the Service state species lead(s) for the targeted species.

n. Propagule Collection
   i. Seeds and rhizomes of listed plants will be collected from existing populations. Collection on Federal lands will require a 10(a)(1)(a) permit.
   ii. Before propagule collection begins, collectors will determine the number of propagules needed for plant cultivation or reintroduction objectives.
   iii. Restrictive collection methods and limits to propagule removal per local plant population are designed to protect the viability of the source population (Menges *et al.* 2004). Generally, collection limits are defined separately for populations of different sizes and levels of vulnerability: very small populations (<50 individuals) and those that occur on roadsides and other at-risk sites; populations between 50 and 500 individuals; and populations with >500 individuals. Propagule collections should target local populations of >500 individuals, when available. If species-specific information indicates lower limits are needed, those lower limits should be followed.

Annual seed and rhizome collection limits for listed plant populations of various sizes.		
Roadside and populations < 50 individuals	**Populations of 50-500 individuals**	**Populations > 500 individuals (60 m^2 for lupine)**
50% seeds, 2% rhizome biomass	15% seeds, 2% rhizome biomass	25% seeds, 2% rhizome biomass

iv. Collections will occur only after seed is fully mature, or in the fall for rhizomes.
v. Collectors will harvest mature seed from throughout the population and within all habitat types found at the population location, in order to collect a genetically diverse sampling of the population.
vi. Collections will occur in dry weather or when seeds can be dried immediately after collection.
vii. Collectors will gather seed receptacles (pods, capsules or heads), gather loose seed, or excavate and remove a small amount of rhizome material.
viii. Collectors will either remove pods, capsules, or heads by hand or by use of cutting devices. Mesh bags may be tied over stems with developing fruits to capture seeds as they are released from the plant. Loose seed from the plant or from the ground may be gathered by hand or with hand-held harvesting tools such as flails and hoppers (seed containers).
ix. Rhizomes from mature plants will be exposed by carefully hand-digging to avoid harming plants or exposing plant roots. Once a portion of the rhizome is exposed, a portion of it will be removed using a sharp knife or pruner. The exposed rhizome will then be reburied. Small amounts of plant material (less than 2% of individual plant biomass) may be gathered for tissue culture techniques for propagating these species, but tissue samples should be taken from throughout the population to maximize genetic diversity.

o. Propagule Transport
i. Before seeds are transferred to storage bags, they will be cleaned by hand or by sieve and blower. Rhizomes should be stored in cool moist conditions until transferred to potting medium. Collectors will use "breathable" containers to store and transport collected plant propagules; these containers include paper envelopes and bags, tin or glass vessels, or glassine envelopes. Plastic bags will not be used. If collecting small seeds, collectors will avoid seed leakage by taping the seams and corners of paper containers prior to transport. Collectors will label all propagule containers, either before placing seeds in them, or immediately after collection with the following information: 1) Name of plant; 2) Place of collection, and 3) Date of collection.
ii. If possible, collectors will place propagules from each individual plant in a separate container. During transport, propagules will be stored in a cool, dry environment, avoiding placing propagules in heat (*i.e.*, trunk of car) or direct sunlight.

p. Propagule Storage
   i. Plant propagules must be properly stored until cultivation or outplanting. Remove and discard all diseased propagules. Thoroughly dry seeds at room temperature before long-term storage. Only well dried seed should be stored. Moist seeds become damp, moldy and vulnerable to insect attacks. Seeds will be mixed and turned 4 to 5 times per day over 4 to 5 days. After drying the seeds, seeds will be cleaned to remove all malformed, broken, undersized, diseased seeds, weed seeds, other crop seeds, chaff and other vegetative matter.
   ii. Seeds will be stored in containers that are airtight and moisture proof to prolong their viability. Seeds have a tendency to absorb moisture; to maintain dryness and deter insect predation, the storage containers may be filled to a quarter capacity (25%) with such agents as dry wood ash, diatomaceous earth, dry charcoal, lime, silica gel or paper.
   iii. Rhizomes will be stored in cool, moist conditions within a suitable medium to keep the material alive and viable until cultivation. Seed material will be stored for no more than two years before cultivating or outplanting unless placed in a cold-storage facility.

q. Propagule Cultivation
   i. Propagules will be grown in a greenhouse or nursery facility. Plants will be supplied with suitable growing medium, soils, fertilizers or other chemical additives to prevent algal, fungal or insect infestations that inhibit growth or cause mortality.
   ii. Plants will be cultivated in greenhouses so that individual populations are isolated in a manner that cross-pollination contamination does not occur.
   iii. Mixing of genetic lines from source populations that are historically genetically isolated in the field will be conducted with caution and according to a Service-approved genetic management program to avoid deleterious effects due to out-crossing depression and potential loss of entire seed collection efforts.
   iv. Seed and rhizome material from field collections and their carefully maintained F1 progeny from the same population or populations from the same recovery zone may be cultivated for plant introduction activities. Under greenhouse cultivation, propagules and progeny from F1 and F2 generations may used for introduction into prairie habitat. Only the F1 generation should be used for subsequent propagation. The F2 generation propagules and plant plugs may be outplanted in the field, but further greenhouse propagation is not permitted. The F3 propagules or plant plugs will not be propagated or introduced into prairie habitat unless genetic information suggests that negative effects of genetic drift or domestication have not occurred.

r. Propagule Collection from Propagated Plants
   i. Propagules may be collected from plants cultivated at a greenhouse or nursery facility for further cultivation or outplanting. Seed and rhizome material will be collected from greenhouse grown propagules and successive F1 progeny

and outplanted to augmentation and reintroduction sites. To avoid in-breeding depression or genetic drift that could arise from successive population in-crossing of a limited greenhouse-grown population, seed collected from F3 progeny will not be outplanted to augmentation or reintroduction sites.

s. Population augmentation and reintroduction.
    i. Augmentation of existing populations may be accomplished by sowing seeds or planting bulbs or propagules of listed plants to increase the population size.
    ii. Reintroduction (via seeds, bulbs or propagules) into an unoccupied site may be used to create new populations or to recreate a lost one at suitable sites.
    iii. To minimize the potential for outbreeding depression, the source of seeds or propagules used in augmentation and reintroduction projects should be populations that are nearby or which occupy similar habitat as the restoration site. Management tasks to implement augmentation and reintroduction are provided below.

t. Seeding Augmentation or Restoration Sites
    i. If necessary to prepare the seed bed, soil may be prepared for sowing or planting by shallow-depth hand or (where listed plants are not present) equipment tilling the site. Seed will be sown in the ground either by no-till drill if soil is dry enough to support vehicle weight without soil compaction, or by hand-sowing into the soil. Harrowing may be used if all other methods are unfeasible, and harrow equipment is operated at least 2 m (6 feet) from listed plants. Seed or bulb planting will occur in a manner that conforms to the density and spacing of the source populations, taking into consideration that significant pre-establishment mortality may occur and planting in higher densities may compensate for loss.
    ii. Seeding or planting will be planted in a manner to facilitate subsequent monitoring efforts. Mapped grids, metal tags or flags will be used to indicate the planted areas. This will assist with post-planting monitoring of introduction efforts.

u. Outplanting Augmentation or Restoration Sites
    i. When outplanting into prairie sites with existing populations of listed species (plants, butterflies, Mazama pocket gophers), field personnel will take care to avoid trampling listed species.
    ii. Propagules (rhizomes, plugs or bulbs) should be outplanted when soil is saturated by rain (generally November through April). Propagules should be planted when growing cycles of individual plants in the greenhouse or nursery match that of plants growing in the field (*e.g.*, do not outplant an actively growing plug when wild plants are dormant).
    iii. Propagules from native sources or grown from seed, bulbs, or rhizome cuttings will be prepared for outplanting at the project site by first clearing away existing dead and living vegetation to expose soil. Avoid disturbing existing rhizomes. The soil will be excavated to the approximate depth and width of the plug or rhizome. The plug will be inserted directly into the soil

or with amended soils containing mulch or fertilizer so that the rim of the plug is level with the surrounding soil. A small amount of native soil should be added over the plug to reduce desiccation.

iv. Propagules will be planted in a manner that conforms to the density and spacing of the source populations, taking into consideration that some pre-establishment mortality will occur and planting in higher densities may compensate for loss. Propagules will be planted in habitat conditions (soil, topography, etc.) similar to the propagule's source habitat.

v. Propagules will be planted in a manner to facilitate subsequent monitoring efforts. Mapped grids, metal tags or flags will be used to indicate the planted areas. This will assist with post-planting monitoring of introduction efforts.

v. Collection and Out-planting of Non-listed Native Plants

i. Seed and plant parts from many native prairie plants may be collected to create nursery stock for restoration projects, and a variety of native forbs, including nectar species for butterfly species and grasses will be augmented or re-introduced as part of the prairie restoration efforts.

ii. If listed species occur at a site where collection of seeds or plant parts of non-listed plants or outplanting of nonlisted plants is to take place, care will be taken to avoid trampling or otherwise harming listed species.

52. Silvicultural Treatments

This restoration action will be used to alter the structure and plant species composition of forest. Forest road decommissioning and stormproofing or elimination of roads and trails is addressed in PDC 45. Activities can include restorative thinning, understory management, downed wood & snag creation, oak release, prairie and oak savanna restoration, and planting of native species. Work may entail use of power tools and/or hand crews.

a. Silvicultural treatments will not occur if they remove or permanently degrade occupied, suitable, or critical habitats for listed terrestrial species.
b. Forest thinning will occur in overstocked areas or conifer release areas, as prescribed in a management plan for the site.
c. Thinning, or single tree removal will be restricted to areas above the slope break on steep slopes and highly erodible soils to prevent accelerated soil erosion and increased sedimentation rates.
d. Trees will be thinned manually, by cutting or girdling.
e. Felled trees will be left onsite if appropriate for nutrient cycling, cover, and to reduce elk/deer browse on seedlings.
f. Where trees are removed to restore prairie, savanna, or coastal bog habitats, felled trees will be removed from the site and/or limbed, chipped or burned to allow for restoration of desired habitat.
g. Manual pruning of limbs is allowed to attain attributes of growth, structure, or form.
h. Timber yarding techniques used during silvicultural treatments must not cause excessive soil disturbances and compaction.
i. Slash materials should be gathered by hand or with light machinery to reduce soil disturbance and compaction. Avoid accumulating or spreading slash in upland draws

and springs. Slash control and disposal activities must be conducted in a manner that reduces the occurrence of debris in aquatic habitats.

j. Planting of native species can occur on the project site using PDC 32.
k. Control of invasive species may occur on the project site using PDC 29.

53. Installation of Wildlife Structures

The installation or construction of wildlife habitat structures will increase cover, shelter, and nesting habitats for a variety of wildlife species. Habitat structures may include, but are not limited to, bat roosting and breeding boxes, avian nest boxes and platforms, turtle basking logs, conifer and hardwood snags, and brush piles.

a. Wildlife nesting structures should be:
    i. Built for specific native avian and mammalian species.
    ii. Designed for easy cleaning and maintenance.
    iii. Properly suspended or supported.
    iv. Protected from wind driven rain.
    v. Properly ventilated.
    vi. Designed to eliminate predation or placed in protected areas.
    vii. Built without perches to prevent house sparrow and starling occupancy.
    viii. Constructed with pine, plywood, cedar, redwood, or cypress (cedar preferred).
b. Do not use pressure treated or creosote-based wood products for any part of a nesting or feeding structure unless it is in direct contact with the ground, such as a mounting post.

2 ENDANGERED SPECIES ACT BIOLOGICAL OPINION

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat on which they depend. Section 7(a)(2) of the ESA requires Federal agencies to consult with the Service, NMFS, or both, to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species or adversely modify or destroy their designated critical habitat. Section 7(b)(3) requires that at the conclusion of consultation, the Services provide an opinion stating how the agencies' actions will affect listed species or their critical habitat. If incidental take is expected, section 7(b)(4) requires the provision of an incidental take statement to exempt that take from the Section 9 prohibitions and specifying the impact of any incidental taking, and including reasonable and prudent measures to minimize such impacts.

2.1 Approach to the Analysis

Analytical Framework for the Jeopardy and Adverse Modification Determinations

Jeopardy Determination

In accordance with policy and regulation, the jeopardy analysis in this Opinion relies on four components: 1) the *Status of the Species*, which evaluates species'range-wide condition, the factors responsible for that condition, and its survival and recovery needs; 2) the *Environmental Baseline*, which evaluates the condition of listed species in the action area, the factors responsible for that condition, and the relationship of the action area to the survival and recovery of listed species; 3) the *Effects of the Action*, which determines the direct and indirect impacts of the proposed Federal action and the effects of any interrelated or interdependent activities on listed species; and 4) *Cumulative Effects*, which evaluates the effects of future, non-Federal activities in the action area on listed species.

In accordance with policy and regulation, the jeopardy determination is made by evaluating the effects of the proposed Federal action in the context of the listed 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 Opinion places an emphasis on consideration of the range-wide survival and recovery needs of listed species and the role of the action area in the survival and recovery of the listed species as the context for evaluating the significance of the effects of the proposed Federal action, taken together with cumulative effects, for purposes of making the jeopardy determination.

Adverse Modification Determination

This Opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR 402.02. Instead, we have relied upon the statutory provisions of the ESA to complete the following analysis with respect to critical habitat.

In accordance with policy and regulation, the adverse modification analysis in this Opinion relies on four components: 1) the *Status of Critical Habitat*, which evaluates the range-wide condition of designated critical habitat for listed species in terms of primary constituent elements (PCEs), 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 the direct and indirect impacts of the proposed Federal action and the effects of any interrelated or interdependent activities on the PCEs and how that will 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 PCEs and how that will influence the recovery role of affected critical habitat units.

For purposes of the adverse modification determination, the effects of the proposed Federal action on critical habitat are evaluated in the context of the range-wide condition of the critical habitat, taking into account any cumulative effects, to determine if the critical habitat range-wide would remain functional (or would retain the current ability for the PCEs to be functionally established in areas of currently unsuitable but capable habitat) to serve its intended recovery role for the listed species.

The analysis in this Opinion places an emphasis on using the intended range-wide recovery function of critical habitat and the role of the action area relative to that intended function as the context for evaluating the significance of the effects of the proposed Federal action, taken together with cumulative effects, for purposes of making the adverse modification determination. The analysis is generally organized in the following manner.

- *Identify the rangewide status of the species and critical habitat likely to be adversely affected by the proposed action.* This section describes the current status of each listed species and its critical habitat relative to the conditions needed for recovery. We determine the rangewide status of critical habitat by examining the condition of its physical or biological features (PCEs or PBFs) – which were identified when the critical habitat was designated.
- *Describe the environmental baseline in the action area.* The environmental baseline includes the past and present impacts of Federal, state, or private actions and other human activities *in the action area*. It includes the anticipated impacts of proposed Federal projects that have already undergone formal or early section 7 consultation and the impacts of state or private actions that are contemporaneous with the consultation in process.
- *Analyze the effects of the proposed action on both species and their habitat.* In this step, we consider how the proposed action would affect the species' reproduction, numbers, and distribution. Effects of the action" means the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR 402.02). Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur.
- *Describe any cumulative effects in the action area.* Cumulative effects, as defined in our implementing regulations (50 CFR 402.02), are the effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area.

Future Federal actions that are unrelated to the proposed action are not considered because they require separate section 7 consultation.

- *Integrate and synthesize the above factors to assess the risk that the proposed action poses to species and critical habitat.* In this step, we add the effects of the action to the environmental baseline and the cumulative effects to assess whether the action could reasonably be expected to: 1) reduce appreciably the likelihood of both survival and recovery of the species in the wild by reducing its numbers, reproduction, or distribution; or 2) reduce the conservation value of designated or proposed critical habitat. These assessments are made in full consideration of the status of the species and critical habitat.
- *Reach jeopardy and adverse modification conclusions.* In this step, we state our conclusions regarding jeopardy and the destruction or adverse modification of critical habitat. These conclusions flow from the logic and rationale presented in Integration and Synthesis.
- *If necessary, define a reasonable and prudent alternative to the proposed action.* If, in completing the last step in the analysis, we determine that the action under consultation is likely to jeopardize the continued existence of listed species or destroy or adversely modify designated critical habitat, we must identify a reasonable and prudent alternative to the action. The reasonable and prudent alternative must not be likely to jeopardize the continued existence of listed species nor adversely modify their designated critical habitat and it must meet other regulatory requirements.

2.2 Organization of this Opinion

This a large Opinion covering multiple species and actions across three states. However, most actions will only affect one or two species, and the end-user will only be interested in the few species affected by an individual restoration project. For this reason, this Opinion contains individual chapters for each species. Each individual chapter for each species contains the Status of the Species information (legal status, critical habitat description, population numbers, threats/ reasons for listing, ongoing recovery actions), the proposed species-specific conservation measures, environmental baseline/ status of the species within the action area, and effects of the proposed action on that species. After all of the species chapters, there is a chapter for each of the following: Cumulative Effects, Integration and Synthesis, Conclusions, and the Incidental Take Statement.

2.3 Environmental Baseline-Overview

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 (50 CFR 402.02). Because the action area for this programmatic consultation includes combined action areas for specific projects for which exact locations within the region are not yet known, it was not possible to precisely define the current condition of species or critical habitats in these action areas, the factors responsible for that condition, or the conservation role of those specific areas. Therefore, to complete the jeopardy analyses and destruction or adverse modification of critical habitat analyses in this consultation, the Service made the following assumptions regarding the environmental baseline in each area that will eventually be identified to support an action: 1) the purpose of the proposed action is to support, fund or carry out restoration actions for the benefit of listed species and the habitats that support these species; 2) each individual action area will be occupied by one or more listed species; 3) the biological requirements of listed species in those areas are not fully met because habitat functions, including functions related to habitat factors limiting the recovery of the species in each area, are impaired; and 4) active restoration at each site is likely to improve the factors limiting recovery of ESA-listed species in that area.

2.3.1 Forested Environments

The environmental baseline for both listed bird species in forested habitats (Northern spotted owl and marbled murrelet) considered in this Opinion is adequately described within the Status of the Species section of this Opinion (see Sections 3.5 and 3.6).

2.3.2 Aquatic Environments

The condition of aquatic habitats in the Action Area varies from excellent in wilderness, roadless, and undeveloped areas to poor in areas heavily impacted by development and natural resources extraction. West of the Cascade Mountains in Oregon and Washington, stream habitats and riparian areas have been degraded by road construction, timber harvest, splash damming, urbanization, agricultural activities, mining, flood control, filling of estuaries, and construction of dams. East of the Cascade Mountains, aquatic habitats have been degraded by road building, timber harvest, splash damming, livestock grazing, water withdrawal, agricultural activities, mining, urbanization, and construction of reservoirs and dams (FEMAT 1993; Lee *et al.* 1997; McIntosh *et al.* 1994; Wissmar *et al.* 1994). The proposed restoration actions that are the subject of this Opinion are typically carried out in areas degraded by one or more human activity or natural events.

As described in the Status of the Species and Critical Habitats section, factors that limit the recovery of ESA-listed fish species vary with the overall condition of aquatic habitats, which vary from excellent to poor. Many stream, estuarine and marine habitats and riparian areas have been degraded by the effects of land and water use, including road construction, forest management, agriculture, mining, urbanization, and water development. Each of these economic activities has contributed to a myriad of interrelated factors for the decline of ESA-listed fish. Among the most important of these are changes in stream channel morphology, degradation of spawning substrates, reduced instream roughness and cover, loss and degradation of estuarine rearing habitats, loss of wetlands, loss and degradation of riparian areas, water quality (*e.g.*, temperature, sediment, dissolved oxygen, contaminants) degradation, blocked fish passage, and loss of habitat refugia.

Many ESA-listed fish species have been affected by the development and operation of dams. Dams, without adequate fish passage systems, have extirpated many fish from their pre-development spawning and rearing habitats. Dams and reservoirs, within the currently accessible migratory corridor, have greatly altered the river environment and have affected fish passage. The operation of water storage projects has altered the natural hydrograph of many rivers. Water impoundment and dam operations also affect downstream water quality characteristics, vital components to anadromous fish survival. In recent years, high quality fish passage is being restored where it did not previously exist, either through improvements to existing fish passage facilities or through dam removal (*e.g.*, Marmot Dam on the Sandy River, Powerdale Dam on the Hood River, Condit Dam on the White Salmon River, and the Elwha River dams).

Within the habitat currently accessible by species considered in this Opinion, dams have negatively affected spawning and rearing habitat. Floodplains have been reduced, off-channel habitat features have been eliminated or disconnected from the main channel, and the amount of LW in the mainstem has been greatly reduced. Remaining habitats often are affected by flow fluctuations associated with reservoir water management for power peaking, flood control, and other operations.

The development of hydropower and water storage projects within the Columbia River basin have resulted in the inundation of many mainstem spawning and shallow-water rearing areas (loss of spawning gravels and access to spawning and rearing areas); altered water quality (reduced spring turbidity levels), water quantity (seasonal changes in flows and consumptive losses resulting from use of stored water for agricultural, industrial, or municipal purposes), water temperature (including generally warmer minimum winter temperatures and cooler maximum summer temperatures), water velocity (reduced spring flows and increased cross-sectional areas of the river channel), food (alteration of food webs, including the type and availability of prey species), and safe passage (increased mortality rates of migrating juveniles) (Ferguson *et al.* 2005; Williams *et al.* 2005).

The Action Area has a diverse assemblage of native and introduced fish species, some of which prey on or compete with ESA-listed fish. The primary resident fish predators of salmonids in the action are considered in this Opinion are northern pikeminnow (*Ptychocheilus oregonensis*) (native), smallmouth bass (*Micropterus dolomieu*) (introduced), and walleye (*Sander vitreus*) (introduced). Other predatory resident fish include channel catfish (*Ictalurus punctatus*) (introduced), Pacific lamprey (*Entosphenus tridentatus*) (native), yellow perch (*Perca flavescens*) (introduced), largemouth bass (*Micropterus salmoides*) (introduced), and bull trout (*Salvelinus confluentus*)(native). There also exists a natural predation within the salmonids themselves. Steelhead and salmon also prey on salmonids to some degree throughout their life cycles. Increased predation by non-native predators has and continues to decrease population abundance and productivity, and increase competition with native predators that would naturally regulate the system.

Avian predation is another factor limiting ESA-listed fish recovery in the Columbia River Basin, which in turn could limit population abundance and productivity of bull trout, an native apex predator of fishes. Throughout the basin, piscivorous birds congregate near hydroelectric dams and in the estuary near man-made islands and structures. Avian predation has been exacerbated by environmental changes associated with river developments. Water clarity caused by suspended sediments settling in impoundments increases the vulnerability of migrating fish. Delay in project reservoirs, particularly immediately upstream from the dams, increases fish exposure to avian predators, and juvenile bypass systems concentrate juveniles, creating potential "feeding stations" for birds. Dredge spoil islands, associated with maintaining the Columbia River navigation channel, provide habitat for nesting Caspian terns and other piscivorous birds. Caspian terns (*Hydroprogne caspia*), double-crested cormorants (*Phalacrocorax auritus*), glaucous-winged/western gull hybrids (*Larus glaucescens/ L.*

occidentalis), California gulls (*L. californicus*), and ring-billed gulls (*L. delawarensis*) are the principal avian predators in the basin in this portion of the basin. As with piscivorous predators, predation by birds has and continues to decrease population abundance and productivity.

Past Federal actions that affect all action areas addressed by this consultation include the adoption of broad-scale land management plans in 1994 and 1995. For Federal lands in Oregon and Washington, all activities are subject to the provisions of the Northwest Forest Plan or PACFISH/INFISH (USDA and USDI 1995a&b).[22] In response to the ESA listing of the northern spotted owl (USDA and USDI 1994a) and the declining aquatic habitat condition on Federal lands, these plans includes an aquatic conservation strategy. The Northwest Forest Plan and PACFISH/INFISH establish measurable goals for aquatic and riparian habitat, standards and guidelines for land management activities that affect aquatic habitat, and restoration strategies for degraded habitat. These plans provide a consistent approach to aquatic conservation strategy and protection of stream and riparian function and represent a major step forward in protection of ESA-listed fish habitat on Federal lands.

The protections afforded ESA-listed fish and their habitat by the Northwest Forest Plan and PACFISH/INFISH have resulted in improvements in riparian and stream habitat conditions on Federal lands in Oregon and Washington. Many land management activities, such as riparian timber harvest, road construction, and intensive livestock grazing that degraded habitat in the past are now managed to avoid impacts to ESA-listed fish. The establishment of Riparian Reserves or riparian conservation areas has switched the focus of management in these areas to achievement of riparian management objectives rather than extractive resource management.

2.3.3 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

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[22] Environmental Assessment for the Implementation of Interim Strategies for Managing Anadromous Fish-producing Watersheds in Eastern Oregon and Washington, Idaho, and Portions of California (PACFISH).

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.

2.3.4 Summary of the Environmental Baseline

The environmental baseline also includes the anticipated impacts of all Federal projects in the action area that have already undergone consultation. The Service recently completed a programmatic restoration biological opinion with BPA on its Columbia River Habitat Improvement Program (also known as HIPIII)(USFWS 2013). The USFS and BLM have also implemented a restoration program that is focused on aquatic habitat limiting factors and restoring ecosystem function. These actions were most recently covered under the 2013 ARBO II (USFWS 2013). Other aquatic restoration projects were completed under the 2007 ARBO and other programmatic agreements, such as a 2003 programmatic opinion with the USFS for culvert installation. The Service consulted on Federal land management throughout action area, including restoration actions, timber harvest, livestock grazing, and special use permits. Each of these actions was designed to avoid or minimize effects on ESA-listed species, and their habitats. None of these consultations reached a jeopardy or adverse modification of critical habitat conclusion.

Under the current environmental baseline, the biological needs of ESA-listed species are met in some portions of the action area and not met in other portions. Conditions are variable across the action area, and may vary considerably based on site specific conditions. Because a typical project area of a restoration project will be already degraded in one form or another, at least some biological requirements of ESA-listed species are likely to be unmet. The purpose of the actions proposed in this consultation is to restore these degraded habitat conditions. It is very likely that the location of some actions, which were consulted on individually or through other programmatic opinions, will overlap with action areas for restoration projects covered under this Opinion. Impacts to the environmental baseline from previous projects vary from short-term adverse effects to long-term beneficial effects. When considered collectively, these actions have a beneficial effect on the abundance and productivity of affected ESA-listed populations. After going through consultation, many ongoing actions, such as water management, have less impact on ESA-listed species. Restoration actions may have short-term adverse effects, but generally result in long-term improvements to habitat condition and population abundance, productivity, and spatial structure.

3 SPECIES CHAPTERS

3.1 ESA-listed Fish Species

ESA-listed fish covered in this Opinion include bull trout, Lahontan cutthroat trout, and Warner sucker. As aquatic and wetland restoration activities often have similar effects to aquatic systems and their aquatic organisms, including these ESA-listed fish species, we first provide a general description of the effects of restoration to fish. Species-specific effects are described in the subsequent sections for each fish species.

The restoration actions covered by this Opinion have predictable effects. The Service has conducted individual and programmatic consultations on restoration activities similar to those in the proposed action throughout the action area over the past several years, and the information gained from monitoring and feedback has been used by the Action Agencies to refine the PDC and conservation measures for this consultation. Habitat improvement activities that are less predictable will be reviewed by the RRT prior to approval.

The restoration actions addressed by this programmatic Opinion will all have long-term beneficial effects to ESA-listed fishes, and their respective habitats. These beneficial effects will improve three parameters: abundance, productivity of the fish populations, and spatial structure. These improvements will translate into decreased risk of extinction for all of the fish species addressed by this consultation. Restoration projects carried out in critical habitat will improve the condition of that habitat at the site and watershed scale over the long term. In watersheds where multiple restoration projects are carried out, greater improvement of the condition of critical habitat at the watershed scale will be realized.

The actions selected for this Opinion all have predictable effects regardless of where in the action area they are carried out. Most of the adverse effects to ESA-listed fishes from the proposed action are short-term in nature and are caused by construction activities or other management actions carried out in or adjacent to the stream. The actions that are likely to have the most significant effects are those that will disturb the banks and channels of natural water bodies. Those actions include fish passage restoration; LW, boulder and gravel placement; ELJs; manual and mechanical plant control; juniper removal; livestock crossings; channel reconstruction/relocation; channel and off-channel restoration; wetland restoration; piling removal; bank set-backs; and removal of water control structures. The effects analysis for these actions begins by describing a common set of predicted effects related to construction, although an additional analysis based on effects specific to each type of action follows.

The analysis of effects then examines actions that include construction in upland and riparian areas, or that will create little or no disturbance instream. The effects of these actions will be less severe due to the buffering effect of a zone of undisturbed vegetation and soils between the action's footprint and natural water bodies. Those actions will include upland plant control, chemical plant control, upland juniper removal, construction and maintenance of livestock water facilities, beaver habitat restoration, wetland restoration, road treatment, native vegetation restoration and management in upland areas, and surveys. Plant control using herbicides will create an additional effect pathway when they drift or are otherwise transported into natural water bodies.

Under the administrative portion of this proposed action, the Action Agencies will evaluate each individual action to ensure that the following conditions are true: 1) This Opinion will only be applied to proposed actions in areas where ESA-listed fish, or their designated critical habitats, or both, are present; 2) the anticipated range of effects of the action will be within the range considered in this Opinion; 3) the action will be carried out consistent with the proposed PDC and conservation measures; and 4) the action and program level monitoring and reporting requirements will be met. Additionally, many of the projects that would likely have an effect on fish passage will be reviewed and approved by NMFS engineers. Some large projects, such as channel reconstruction, will be reviewed by the RRT. Monitoring and reporting data will be entered into our consultation initiation and reporting system.

3.1.1 Effects of Near and Instream Restoration Construction

The direct physical and chemical effects of the construction associated with the proposed actions typically begin with surveying, minor vegetation clearing, placement of stakes and flagging, and minor movement of personnel and sometimes machines over the action area. The next stage, site preparation, is likely to require development of access roads or temporary access paths, construction staging areas, and materials storage areas that affect more of the action area. If additional earthwork is necessary to clear, excavate, fill, or shape the site, more vegetation and topsoil are to be removed, deeper soil layers exposed, and operations may extend into the channel. The final stage of construction consists of any action necessary to undo the short-term disturbance, and includes replacement of LW, native vegetation, topsoil, and native channel material displaced by construction.

Fish passage will be provided for any adult or juvenile fish likely to be present in the action area during construction, unless passage did not exist before construction, stream isolation and dewatering is required during project implementation, or where the stream reach is dry at the time of construction. When isolation and fish relocation are required, juvenile fish are likely to receive some mechanical injury during capture, holding, or release, and potential horizontal transmission of disease and pathogens and stress-related phenomena. All aspects of fish handling, such as dip netting, time out of water, and data collection (*e.g.*, measuring fish length), are stressful and can lead to immediate or delayed mortality (Murphy and Willis 1996). Electrofishing causes physiological stress and can cause physical injury or death, including cardiac or respiratory failure (Snyder 2003). There is also potential that some fish would be missed or stranded in substrate interstices after a site is dewatered. Although some ESA-listed fish will die during dewatering and relocation, fish will only be exposed to the stress caused by these activities once and the procedure is only expected to last a few hours. If construction took place without work area isolation, more fish would be injured or killed (NMFS 2013a).

Vegetation, soil and channel disturbance caused by construction can disrupt the vegetative and fluvial processes in the action area that create and maintain habitat function, such as delivery of wood, particulate organic matter, and shade to a riparian area and stream; development of root strength for slope and bank stability; and sediment filtering and nutrient absorption from runoff (Darnell 1976; Spence *et al.* 1996). Although the sizes of areas likely to be adversely affected by actions proposed to be funded or carried out under this Opinion are small, and those effects are likely to be short lived (weeks or months), even small denuded areas will lose organic matter and dissolved minerals, such as nitrates and phosphates. The microclimate at each action site where vegetation is removed is likely to become drier and warmer, with a corresponding increase in wind speed, and soil and water temperature. Water tables and spring flows (if present) in the immediate area are likely temporarily reduced. Loose soil will temporarily accumulate in the construction area. In dry weather, this soil is likely to be dispersed as dust and, in wet weather; loose soil will be transported to streams by erosion and runoff, particularly in steep areas.

Erosion and runoff during precipitation and snowmelt will increase the supply of sediment to streams and rivers, where they will increase total suspended solids and sedimentation. Increased runoff also increases the frequency and duration of high stream flows and wetland inundation in construction areas. Higher stream flows increase stream energy that can scour stream bottoms and transport greater sediment loads farther downstream than would otherwise occur. Sediments in the water column reduce light penetration, and can increase water temperature and modify water chemistry. Redeposited sediments can fill pools, reduce the width to depth ratio of streams, and change the distribution of pools, riffles, and glides.

During dry weather, the physical effects of increased runoff will reduce ground water storage, lower stream flows, and lower wetland water levels. The combination of erosion and mineral loss can reduce soil quality and site fertility in upland and riparian areas. Concurrent in-water work can compact or dislodge channel sediments, thus increasing total suspended solids and allowing currents to transport sediment downstream where it will eventually be redeposited. Continued operations when the construction site is inundated can significantly increase the likelihood of severe erosion and contamination (NMFS 2013a).

Using heavy equipment for vegetation removal and earthwork will compact soils, reducing soil permeability and infiltration. The use of heavy equipment also creates a risk that accidental spills of fuel, lubricants, hydraulic fluid, coolants, and other contaminants are likely to occur. Petroleum-based contaminants, such as fuel, oil, and some hydraulic fluids, contain polycyclic aromatic hydrocarbons (PAHs), which can be acutely toxic to fish and other aquatic organisms at high levels of exposure and can cause sublethal adverse effects to aquatic organisms at lower concentrations (Heintz *et al.* 1999; Incardona *et al.* 2005; Incardona *et al.* 2004; Incardona *et al.* 2006). The discharge of construction water used for vehicle washing, concrete washout, pumping for work area isolation, and other purposes can carry sediments and a variety of contaminants to riparian areas and streams. Cement is highly alkaline (commonly exceeding pH of 10) and can be harmful to aquatic life if not properly maintained on-site or treated prior to discharge. High pH effects on fish include death, damage to gills, eyes and skin; and inability to dispose of metabolic wastes (NMFS 2013a).

Some of these adverse effects will abate almost immediately, such as increased total suspended solids caused by boulder or LW placement. Others will create long-term conditions that decline quickly but persist at some level for weeks, months, or years, until riparian and floodplain vegetation are fully reestablished. Failure to complete site restoration, or to prevent disturbance of newly-restored areas by livestock or unauthorized persons, will delay or prevent recovery of processes that form and maintain productive fish habitats (NMFS 2013a).

For actions that include a construction phase, the direct physical and chemical effects of site clean-up after construction is complete are essentially the reverse of the construction activities that go before it. Bare earth will be protected by various methods, including seeding, planting woody shrubs and trees, and mulching. This will dissipate erosive energy associated with precipitation and increase soil infiltration. It also will accelerate vegetative succession necessary to restore root strength necessary for slope and bank stability, delivery of leaf and other particulate organic matter to riparian areas and streams, shade, and sediment filtering and nutrient absorption from runoff. Microclimates will become cooler and moister, and wind speed will decrease. Whether recovery occurs over weeks, months or years, the disturbance frequency (*i.e.*, the number of restoration actions per unit of time, at any given site) is likely to be extremely low, as is the intensity of the disturbance as a function of the quantity and quality of overall habitat conditions present within an action area (NMFS 2013a).

Restoration of aquatic habitats is fundamentally about allowing stream systems to express their capacities, *i.e.*, the relief of human influences that have suppressed the development of desired habitat mosaics (Ebersole *et al.* 1997). The time necessary for recovery of functional habitat attributes sufficient to support species recovery following any disturbance, including construction necessary to complete a restoration action, will vary by the potential capacity of each habitat attribute. Recovery mechanisms such as soil stability, sediment filtering and nutrient absorption, and vegetation succession generally recover quickly (*i.e.*, months to years) after completion of the proposed actions. Recovery of functions related to wood recruitment and microclimate require decades or longer. Functions related to shading of the riparian area and stream, root strength for bank stabilization, and organic matter input generally require intermediate lengths of time.

The indirect effects, or effectiveness, of habitat restoration actions, in general, have not been well documented, in part because they often concentrate on instream habitat without addressing the processes that led to the loss of the habitat (Cederholm *et al.* 1997, Roper *et al.* 1997, Simenstad and Thom 1996, Zedler 1996). Nonetheless, the careful, interagency process proposed by the Action Agencies and use of a regional RRT, to develop proposed actions ensures that they are reasonably certain to lead to some degree of ecological recovery within each action area, including the establishment or restoration of environmental conditions associated with functional habitat and high conservation value.

Additionally, the Action Agencies propose a suite of conservation measures intended to reduce the short-term effects caused by near and instream construction. Limiting instream construction to low flow periods whenever possible and using sediment control measures greatly reduces the amount of suspended sediment created by the restoration actions. Refueling and servicing equipment outside the riparian area reduces the chance of spilling toxic fuels and lubricants. Development and implementation of a pollution and erosion control plan limit any potential adverse effects of a toxic material spill by ensuring that spill response materials are on site during all construction activities. Ensuring that all heavy equipment that will operate instream is cleaned and free of leaks will also reduce the introduction of contaminants into the aquatic environment. The Action Agencies propose several conservation measures to limit stress and mortality during work area isolation and fish relocation. Limiting nearly all in-water work activities to in-water work periods will greatly reduce the chance of affecting adult fish, as these periods are designated to avoid times when most adult fish are present.

3.1.2 Project Category Specific Effects

3.1.2.1 Fish Passage Restoration

The proposed restoration action includes a broad range of activities to restore or improve juvenile and adult fish passage as described in the proposed action. Such projects will take place where fish passage has been partially or completely eliminated through road construction, stream degradation, creation of small dams and step structures, and irrigation diversions. Equipment such as excavators, bull dozers, dump trucks, front-end loaders and similar equipment may be used to implement such projects.

These activities usually require isolation of the work area from flowing water, relocation of fish, and significant instream construction. The construction-related effects described in the above section on restoration construction effects will occur at all culvert and bridge project sites. The Action Agencies propose to replace culverts and bridges using the stream simulation method, in which natural stream substrates will be placed in the bottom of these structures.

Under this activity category, artificial obstructions that block fish passage will be removed or replaced with facilities that restore or improve fish passage. The beneficial effects of this activity category include improved fish passage, restoration of natural bedload movement in streams, and restoration of tidal influence in estuarine areas. Removal of these structures requires instream construction with effects as described earlier. Culverts and bridges, other than stream simulation design crossings that meet the proposed action criteria, will require review and approval by fish NMFS passage engineers.

Culverts and Bridges

Long-term beneficial effects of culvert and bridge replacement or removal projects include restoration of fish passage and restoration of natural stream channel processes through removal of channel constricting structures. Removing fish-passage blockages will restore spatial and temporal connectivity of streams within and between watersheds where fish movement is currently obstructed. This, in turn, will permit fish access to areas critical for fulfilling their life history requirements, especially foraging, spawning, and rearing. At a larger scale this will improve population spatial structure.

However, the removal of fish passage barriers could have short-term (typically lasting less than one week, depending on the duration of instream work), temporary effects to fish and their habitat. Heavy equipment might be used in the stream for unblocking, removing and replacing culverts and bridges. In-water equipment use could temporarily affect ESA-listed fish and critical habitat, including impacts on redds, smothered or crushed eggs and alevins (or larvae), increased suspended sediment and deposition, blocked migration, and disrupted or disturbed overwintering behavior. The PDC will help lessen the amount of sediment, and thus any associated adverse effects to ESA-listed fish. Bull trout are particularly vulnerable during the migration back to spawning areas during late summer and early fall, and when their resident life form is present in the project location. Bull trout would also be vulnerable during the spring, when eggs and fry are still present in the substrate. The activities could move juveniles out of overwintering habitats such as side channels and deep pools, into inferior habitats or high velocity waters. Seasonal restrictions imposed by in-water work windows may lessen the effects to some degree in foraging, migration, and overwintering habitats, however they will not fully protect bull trout, and will provide little protection in spawning and rearing habitats.

Treated wood as a construction material is not allowed for bridge projects under this consultation. Copper and other toxic chemicals, such as zinc, arsenic, chromium, and PAH, that leach from pesticide-treated wood used to construct a road, culvert or bridge are likely to adversely affect ESA-listed fish that spawn, rear, or migrate by those structures, and when they ingest contaminated prey (Poston 2001). These effects are unpredictable, with the intensity of effect depending on numerous factors. Effects from the use of treated wood as a material for structures placed in or over aquatic habitats that support ESA-listed species are best addressed in an individual consultation to consider material selection and site-specific considerations such as background concentrations, density of product installation, location of other treated wood structures, and environmental conditions.

Fish passage impediments are common throughout the action area and restoration planning efforts have highlighted the need to restore fish passage, particularly when the blockage occurs low in a watershed.

Fish Screen Installation/Replacement.

Unscreened or improperly screened irrigation diversion structures can entrain fish into canals where they become trapped and die. If approach velocities are too fast, fish can also be impinged against the screen surface. To avoid any effects from improperly designed screens, all proposed screen installations or replacements must meet NMFS fish passage criteria (NMFS 2011a or the most recent version). No additional water withdrawals points will be established and no greater rate or duty of water withdrawal will be authorized under this consultation.

Replacing, relocating, or constructing fish screens and irrigation diversions activities will require near or instream construction, so related effects as described above will occur. This consultation does not consider the effects of stream flow diminution caused by water withdrawals on listed ESA-listed fish, or their habitat. These effects would be the subject of a site-specific consultation. Installation of screens will occur only on existing diversions, and no additional water withdrawals points will be established and no greater rates of water withdrawal will be authorized under this consultation.

The primary long-term beneficial effect of properly screening diversions is decreased fish mortality. Although it is well accepted that screens prevent fish from dying, the Service cannot predict exactly how many fish would be saved by installing screens in the action area. Despite millions of dollars spent on fish screening of water diversions in the Pacific Northwest and California, there have been few quantitative studies conducted on how screening actually affects fish populations (Moyle and Israel 2005). One recent study, (Walters *et al.* 2012) examined potential losses of Chinook salmon juveniles to unscreened diversions and found that about to 71% of out-migrating smolts could be lost each year within a given river basin. The authors also found that screening was an effective mitigation strategy and reduced estimated mortality to less than 2% when all diversions within the basin were screened. Even though the effects of screening have not been well studied, the Service recognizes the value of screening and supports the Action Agencies' precautionary approach to screen diversions that may affect ESA-listed fish. The removal of unneeded diversion structures improves fish passage and restores natural bedload movement and riverine processes that benefit the aquatic ecosystem.

Head-cut and Grade Stabilization

The stabilization of active or potential head-cuts with LW, rock, or step structures primarily takes place in Rosgen (1994) C- and E-type channels in areas east of the Cascade Mountains in the action area. In these areas, historic land management such as heavy livestock grazing and road construction has destabilized stream channels and increased the chance of head-cut formation. Stabilization requires instream construction, so short-term construction related adverse effects as described earlier will occur.

The Action Agencies propose aggressive treatments to prevent further incision of stream channels including use of rock and log step structures. These aggressive restoration techniques are sometimes necessary to stop the ongoing damage caused by migrating head-cuts. The Action Agencies also propose temporary head-cut stabilization, in which case fish passage may be blocked. In these circumstances, the fish passage must be reestablished during the subsequent in-water work period. This may block fish passage for several months, but without this treatment, head-cut formation might also block fish passage.

The beneficial effects of this proposed activity result primarily from the action's prophylactic nature. Left unchecked, head-cuts lead to channel incision, deposition of fine sediments in downstream substrates, and disconnection of a stream from its floodplain. Stabilizing head-cuts will stop the progression of these adverse effects. No matter where these activities occur in the action area, we expect an increase in habitat functions, improvements to biologic parameters, and a reduction in the risk of extinction to listed species.

Fish Ladders
Installation of a fish ladder and its subsequent operation increases the number of individual fish that are able to move upstream. This, in turn, would increase the number of fish that populate areas upstream from a dam, either because the fish continue to reside in the newly available habitat or because they reproduce in formerly unutilized spawning habitat. In some instances, providing passage will provide connectivity and genetic exchange between fragmented subpopulations that were isolated from one another by a dam's construction. This connectivity of populations and habitats are important to the recovery of bull trout. Short-term construction related adverse effects as described earlier will occur. Restoration of passage through constructing a ladder will improve population spatial structure and possible abundance and productivity if additional spawning habitat is made available.

3.1.2.2 Irrigation Diversion Replacement/Relocation
Under this activity subcategory, the Action Agencies will fund or implement the replacement of instream irrigation diversion structures with screened pump stations or remove unneeded irrigation diversion structures to benefit fish passage. This activity category requires significant in-water construction, so effects as described earlier in this Opinion will occur.

Beneficial effects of removing irrigation diversion structures such as small concrete dams, rock structures, and gravel push-up berms includes improved fish passage and restoration of natural stream bedload movement. Many structures that would be removed provide only marginal fish passage and their removal will improve both adult and juvenile fish passage. The removal of unneeded structures also allows for the restoration of natural stream processes such as bedload movement and alleviates upstream and downstream scour that occurs at some diversion structures. Replacing a gravity diversion with a pump can eliminate the need for yearly construction of gravel push-up berms with heavy equipment and reduce water consumption.

Pump stations created under this subcategory must be screened to NMFS fish passage and screening criteria (NMFS 2011a or the most recent version). This will prevent juvenile fish from being entrained into the irrigation system. Actions involving effects to ESA-listed fish, or their habitat caused by a reduction in stream flow are not covered by this consultation.

3.1.2.3 Large Wood, Boulder, and Gravel Placement; Porous Boulder Step Structures and Vanes; Engineered Logjams (ELJs); Gravel Augmentation; Tree Removal for Large Wood Projects.
Installation of wood and boulder instream structures is likely to require entry of personnel into the riparian area and channel that will result in unavoidable short-term construction related effects as described above, but will increase stream habitat complexity, increase overhead cover, increase terrestrial insect drop, and help reestablish natural hydraulic processes in streams over time. Large wood, in a stream, can accomplish multiple purposes by trapping gravel above the structure, creating pools and increasing the connection with the floodplain vegetation. Wood placement is likely to cause minor damage to riparian soil and vegetation, and minor disturbance of streambank or channel substrate. However, the intensity and duration of disturbance is unlikely to increase total suspended solids, or otherwise impair aquatic habitats or freshwater rearing and migration.

No matter where these activities occur in action area, we expect an increase in habitat functions, improvements to biological parameters, and a reduction in the risk of extinction to listed species. Numerous authors have highlighted the importance of LW to lotic ecosystems (Bilby 1984; Keller *et al.* 1985; Lassettre and Harris 2001; Spence *et al.* 1996), which influences channel morphology, traps and retains spawning gravels, and provides food for aquatic invertebrates that in turn provide food for juvenile salmonids. Large wood, boulders, and other structures provide hydraulic complexity and pool habitats that that serve as resting and feeding stations for salmonids as they rear or migrate upstream to spawn (Spence *et al.* 1996).

Land management actions such as logging, road building, stream clearing, and splash damming carried out over the last 150 years have greatly reduced the amount of LW and boulders in streams in the action area (McIntosh *et al.* 1994; Murphy 1995). These restoration actions will return these important elements to stream ecosystems. Addition of LW is a common and effective restoration technique used throughout the Pacific Northwest (Roni *et al.* 2002). Roni and Quinn (2001a) found that LW placement can lead to higher densities of juvenile coho salmon during summer and winter and higher densities of steelhead and cutthroat trout in the winter. These authors also found that the addition of LW to streams with low levels of wood can lead to greater fish growth and less frequent and shorter fish movements (Roni and Quinn 2001b).

ELJs are an effective tool for restoring physical and biological conditions critical to salmonid recovery in large alluvial rivers. Placement of a single log can provide benefits in certain situations but a logjam typically provides more habitat value. This diverse bio-structure provides the base for different aquatic life to find food, shelter, and space to thrive. A logjam also changes water velocity and direction to sort gravels and create pool and riffle habitat. On the Elwha River, ELJs have proved to be stable with little significant change in position or surface area noted despite frequent inundation from floods including two peak floods that rank within the top 10% of floods recorded for over 100 years of record (McHenry *et al.* 2007). The ELJs have retarded bank erosion along two outside meanders. The ELJs have also helped maximize habitat area by partially balancing flows between two major channels. During flood flows, ELJs have increased exchange of water with floodplain surfaces, primarily through backwatering. This has resulted in the expansion of side-channel habitats, including groundwater fed channels that provide important habitats for multiple salmonid species. The ELJs developed scour pools, stored gravel, and reduced bed substrate grain size in the vicinity of several ELJs, with the mean particle size changing from large cobble to gravel. ELJs also had a measurable and significant positive effect on primary productivity, secondary productivity and juvenile fish populations.

As with LW, the addition of boulders, gravel, and properly designed rock structures can help restore natural stream processes and provide cover for rearing salmonids. Boulders can accomplish the retention of gravel by physically intercepting the bed load or slowing the water, increase the interaction with the floodplain habitat by increasing the bed elevation and providing pool habitat. Boulders are most effective in high velocity or bedrock dominated streams. Roni *et al.* (2006) found that placement of boulder step structures in highly disturbed streams of Western Oregon led to increased pool area and increased abundance of trout and coho salmon. The addition of gravel in areas where it is lacking, such as below impoundments, will provide substrate for food organisms, fill voids in wood and boulder habitat structures to slow water and create pool habitat and provide spawning substrate for fish. Although little research has been conducted on the effectiveness of gravel augmentation in improving salmonid spawning, Merz and Chan (2005) found that gravel augmentation can result in increased macroinvertebrate densities and biomass, thus leading to more food for juvenile salmonids.

The proposed PDC and conservation measures ensure that the Action Agencies will place LW, boulders, and gravel in a natural manner to avoid unintended negative consequences. This activity category will result in numerous long-term beneficial effects including increased cover and resting areas for rearing and migrating fish and restoration of natural stream processes.

3.1.2.4 Dam, Tide Gate, and Legacy Structure Removal

This category of actions includes removal of small dams, channel-spanning step structures, legacy aquatic habitat structures, earthen embankments, subsurface drainage features, spillway systems, tide gates, flood gates, outfalls, pipes, instream flow redirection structures (*e.g.*, drop structure, gabion, groin), or similar devices used to control, discharge, or maintain water levels. Projects will be implemented to reconnect stream corridors, floodplains, and estuaries, reestablish wetlands, improve aquatic organism passage, and restore more natural channel and flow conditions. Any instream water control structures that impound substantial amounts of contaminated sediment are not covered by this Opinion. Equipment such as excavators, bull dozers, dump trucks, front-end loaders and similar equipment may be used to implement such projects. The RRT must review design plans for the removal of a dams greater than 3 m (10 feet) in height. A long-term monitoring and adaptive management plan will be developed for all removal projects.

3.1.2.5 Dam Removal

In addition to the restoration construction effects discussed above, removing a water control structure (*e.g.,* small dam, earthen embankment, subsurface drainage features tide gate, gabion) using the proposed PDC is likely to have significant local and landscape-level effects to processes related to sediment transport, energy flow, stream flow, temperature, and biotic fragmentation (Poff and Hart 2002). The diversity of water control structures distributed on the landscape combined with the relative scarcity of knowledge about the environmental response to their removal makes it difficult to generalize about the ecological harm or benefits of their removal. However, many small water control structures are nearing the end of their useful life, due to sediment accumulation and general deterioration. They can either be removed intentionally by parties concerned about liability, or fail due to lack of maintenance. The planned removal of a structure will minimize adverse effects that follow unplanned failures, such as reducing the size of a contaminated sediment release, preventing an unplanned sediment pulse, controlling undesirable species, or ensuring fish passage around remnants of the structure, or dictating the timing of the sediment release to minimize the effects to listed species.

Whether a water control structure is removed for restoration, safety or economic reasons, neither action is likely to entirely restore pristine conditions. The legacy of flow control includes altered riparian soils and vegetation, channel morphology, and plant and animal species composition that frequently take many years or decades to fully respond to restoration of a more natural flow regime. The indirect effects or long-term consequences of water control structure removal will depend on the long-term progression of climatic factors and the success of follow-up management actions to manage sediments, exclude undesirable species, revegetate/restore vegetation, and ensure that continuing water and land use impacts do not impair ecological recovery.

3.1.2.6 Removal of Legacy Structures

During the 1980s and early 1990s, many habitat-forming structures such as log weirs, boulder weirs, and gabions were placed in streams to create pool habitat. Many of these structures were placed perpendicular to stream flow or placed in a manner that interfered with natural stream function. The Action Agencies propose to remove these structures to restore natural stream function. This activity type requires instream construction causing the short-term effects described earlier. Long-term beneficial effects of removing these structures include decreased streambank erosion, decreased stream width-to-depth ratios, and restoration of natural stream processes. Decreasing erosion will increase the survival of eggs and alevins and reduce interference with feeding, behavioral avoidance and the breakdown of social organization. Decreasing the stream width-to-depth rations will increase adult holding areas and improve rearing sites for yearling and older juveniles.

3.1.2.7 Removal of Tide Gates

Removal of dikes and their tide gates, regardless of how fish friendly their design and operation, will improve fish movement and positively alter the quality of their habitats. Even "fish friendly" automatic-type tide gates on tidal sloughs, which remain open for part of the flood tide, negatively affect the abundance and movement of juvenile Chinook salmon when compared to similar but un-gated sloughs. NOAA Fisheries Science Center and the Skagit River Systems Cooperative (Barnard 2011) suggests that the muted tidal cycle created by the automatic tide gate results in reduced habitat quality, which may be reflected in lower abundance with fewer repeated visits by juvenile Chinook salmon. Further, tide gates alter the salinity, temperature, dissolved oxygen, total suspended solids, *etc.* of the habitat upstream. Such effects may also occur to other fish species, such as bull trout.

Removal of tide gates or tidal levees is likely to result in restoration of estuarine functions related to regulation of temperature, tidal currents, and salinity; increased habitat abundance from distributary channels, that increase in size after tidal flows are allowed to inundate and scour on a twice daily basis; reduction of fine sediment in-channel and downstream; reduced estuary filling due to increased availability of low-energy, overbank storage areas for fine sediment; restoration of fish access into tributaries, off- and side-channel pond and wetlands; restoration of saline-dependent plant species; increased primary productivity; increased estuarine food production; and restoration of an estuarine transition zone for fish and other species migrating through the tidal zone (Cramer 2012; Giannico and Souder 2004; Giannico and Souder 2005).

3.1.2.8 Replacement and Retrofit of Tide/Flood Gates.

Replacement of tidegates is occasionally necessary, and usually involves the replacement of tubes to extend the life of the gate facility or to restore impaired function. Tubes typically collapse due to corrosion.

The replacement of tide gates and flood gates using the proposed PDC are likely to have effects similar to those of the removal of water control structures or fish passage restoration, including impacts of work area isolation, fish capture, and release. The potential for fish to be adversely affected is also related to the size of fish. Larger fish are stronger swimmers and therefore better able to escape and avoid the potential impacts of replacement activities, whereas smaller fish are weaker swimmers and therefore at greater risk of being killed or injured. Additionally, the potential for fish to be adversely affected is greater in those habitats where small fish rear and seek refuge. Habitats typically associated with tidegates and floodgates in river deltas and estuaries provide optimal rearing and refuge habitat for smaller fish, whereas larger fish tend to seek optimal rearing and refuge conditions in deeper water and off shore habitats.

Tide and flood gate replacement or retrofit activities can result in direct and indirect impacts to fish. Replacement of tide gate “tubes” or culvert pipes is typically completed during the late summer to early fall months to coincide with the occurrence of extreme low tides during daylight hours behind cofferdams. Direct impacts include physical and/or chemical trauma to the fish that can result in injury or death. Whenever a watercourse is excavated with motorized equipment, fish can be killed or injured. Fish can be physically removed from the watercourse in the bucket of the excavator and discarded on the shoreline. The excavator bucket can also physically injure fish. Fish can also be chemically injured or killed through the inadvertent discharge of concrete leachate, or hydraulic fluid, gas, or diesel oil into the watercourse from the motorized equipment.

Indirect impacts are temporary and do not directly kill or injure fish. Indirect impacts disturb and/or alter the watercourse and shoreline habitats upon which fish depend for rearing and refuge, thus compromising their rearing ability and their potential to survive. Removing riparian and aquatic vegetation from the watercourse temporarily reduces detritus input into the watercourse and reduces the production of important epibenthic and benthic invertebrates and the availability of terrestrial insects that are important fish prey. The removal of riparian vegetation that provides shade to a watercourse also elevates water temperatures and can stress, displace or kill fish. Excavation of the watercourse (physically removing the aquatic vegetation) results in the temporary loss of refuge and cover habitat. Excavating the watercourse or disturbing the shoreline increases suspended sediments in the watercourse and temporarily reduces the light available for photosynthesis, thus reducing the production of aquatic vegetation. This activity also removes or buries epibenthic and benthic invertebrates that are important fish prey.

3.1.2.9 Channel Reconstruction/Relocation

Channel straightening and dredging were extensively used in the 20th century to enhance agricultural drainage and facilitate crop maintenance and harvest. Channels were also straightened in response to flood events. Forested areas that have a legacy of timber harvest and log drives may also have simplified straightened channels with a scarcity of instream wood. In general, the level of intervention dictates the scale or magnitude necessary for a stream restoration project.

As the streams were channelized or naturally returned to their original bed elevation, stream bank heights increased so that greater water depth and discharge became required before the stream could spread onto the floodplain. The increase in bank heights and bankfull discharge, in turn, increased bank erosion and may be responsible for a significant portion of modern sediment loads in streams. Along many streams, this may cause channel spreading and, over decades, the re-establishment of a new “meander belt” (Knox 2006). The resistance of bed materials to stream incision is one of the major factors that determine how this process manifests itself along each stream course.

Mine tailings produced by placer mining nearly a century ago occupy the majority of the valley floor in some areas. These tailings piles have greatly altered fish and wildlife habitat within the project reach by confining and straightening the stream, creating a nearly continuous riffle with few pools or spawning gravel for fish. These tailings piles essentially function as dikes that cut off flood flows from the original floodplain. Water velocities accelerate as they are compressed through the constricted channel concentrating the stream's energy on the streambed, simplifying substrate and degrading the channel. Sediment and nutrients are transported through the project area, depriving riparian areas of soil and nutrients, which in turn retard disturbance recovery and natural succession. The tailings piles prevent fine sediment and organics carried by floods from being deposited on the floodplain, preventing natural fertilization and soil augmentation needed to reestablish vigorous riparian communities. Tailings piles within the placer-mined reaches disconnect the stream from the historic floodplains and side channel habitat, which historically provided the flood flow refugia and over-wintering habitat, which were critical to salmonids. Mechanical manipulation and grading of thousands of cubic yards of mine tailings may be required to recover floodplain width and elevations.

Projects that involve significant channel reconfiguration over a considerable stream length or require extensive alteration of land management practices are likely to have more constraints, more costs, and a greater level of associated risk. For stream reaches that have evolved to a condition of greater instability, it may be necessary to adjust the channel's geometry. This may involve minor adjustments, such as narrowing the channel cross-section and stabilizing the eroding stream banks. At the opposite end of the intervention scale, extremely unstable conditions with poor potential for natural recovery may require complete reconstruction of the stream channel to provide a stable channel pattern, profile, and cross-section, utilization of bank stabilization techniques, and installation of flow diverting and grade control structures. Therefore, the short-term adverse and long-term beneficial effects of channel reconstruction will vary with the scale of the project. For some stream reaches, restoration may not be a realistic goal without intervention at the watershed level first.

In addition to the restoration construction effects discussed above, channel reconstruction/relocation projects using the proposed PDC are likely to have significant local and landscape-level effects to processes related to sediment transport, energy flow, stream flow, temperature, and biotic fragmentation. Although the Service cannot predict the worse-case effects of this activity, with the proposed PDC and RRT review process we believe that the stream ecological condition will be measurably improved. The RRT will help to fine-tune the process to achieve the best possible outcome.

Although the RRT will play an important role in evaluating large habitat improvement projects, the Service only analyzed the effects of carrying out projects as described by the proposed activity categories with application of the general and activity-specific conservation measures. We did not assume the RRT review process would result in a further reduction of the short-term adverse effects of any particular project. Our evaluation of the beneficial effects of the proposed actions is based on scientific literature and our past experience with similar types of actions.

Typically stream channel reconstruction /relocation projects are conducted in phases that will end with the full return of river flows to the historic channel and the filling of the old shortened channel. Fish passage is typically blocked until the restored channel can be activated. Mechanical manipulation and grading of thousands of cubic yards of mine tailings may be required to recover floodplain width and elevations. Mercury pollution is also a potential concern in creeks that were mined for gold, therefore a site assessment for contamination is a required PDC before a project is implemented.

Fish evacuation and relocation of ESA-listed fish from the old channel to the restored channel can be challenging because of the long transport distances required. Some fish mortality would occur from predation, suffocation, or temperature stress, in the old channel when it is dewatered unless they are relocated upstream or downstream promptly. Fish that are not located would also likely be stranded. Indirect mortality of aquatic species would be possible from high turbidities in lower third of reach and some distance downstream during channel relocation. In-water work windows, work area isolation, fish capture and release PDC are intended to minimize handling and mortality.

With in-water work timing during low water periods and isolation of the work area, the release of suspended sediment is expected to be a short-term event. Sediment is likely to be carried by surface runoff when the newly configured channel(s) are reactivated and erosion control structures are removed. Localized suspended sediment increases are likely to cause some juveniles and adults to seek alternative habitat, which could contain suboptimal cover and forage and cause increases in behavioral stress (*e.g.,* avoidance, displacement), and sub-lethal responses (*e.g.,* increased respiration, reduced feeding success, reduced growth rates). Excessive sediment clogs the gills of juvenile fish, reduces prey availability, and reduces juvenile success in catching prey. However, the proposed implementation procedures and pollution and erosion control plans will be designed to minimize suspended sediment. If turbidity is observed in the outflow, turbidity levels should be measured in the outflow using a hand-held turbidimeter. If these measurements indicate violations of State water quality standards, the Action Agencies will work with the contractor to take appropriate corrective actions.

Disturbances associated with restoration activities have the potential to increase non-native plant abundance in the project area through influx of non-native species on equipment and by providing bare soil conditions. However, PDC for revegetation of native species and active removal/treatment of invasive plants will help to establish native species and reduce the overall presence of non-native plants.

Effectiveness monitoring for channel reconstruction/relocation projects will be designed to measure progress toward achieving the project objectives, inform maintenance needs, and provide input into whether the restoration project is trending towards or away from achieving project goals. Based on the project goals and compliance with this Opinion, physical and biological parameters will be monitored using standard field techniques that will produce data compatible with the various protocols required by the RRT. Monitoring may include evaluation of stream length and channel complexity, riparian and floodplain vegetation, channel-floodplain connectivity, thermal regime, and fish passage. The Action Agencies will complete an existing conditions survey on the existing channel to determine the pre-project conditions and an as-built survey, which follows the same parameters, immediately upon completion of the new channel construction. Generally, post-project monitoring surveys will occur frequently enough to capture change that could result in a significant reduction in the desired habitat conditions. Surveys should occur during a similar timeframe each cycle, and should occur under similar flow conditions. The RRT will approve field methods that will be used to perform the monitoring surveys. Effectiveness of mitigation techniques for the restoration activities would be reviewed at the end of each construction season with NMFS, and any improvements would be incorporated into plans for the next season.

Post-project, hydrologic function of the stream channel would be restored to more natural conditions. Functional floodplains would promote riparian vegetation and stable banks. The restored corridor would provide an adequate riparian buffer zone. Aquatic habitat would be greatly improved in the short-term and long-term. Under this project category streams that are made more self-sustaining and resilient to external perturbation will lead to improved aquatic habitat, which will help improve aquatic population abundance and productivity.

Off- and Side-Channel Habitat Restoration.
The proposed action includes reconnecting existing stream channels to historical off- and side-channels, but not the creation of off- and side-channel habitats. Side channel wetlands and ponds provide important habitats for juvenile fish. Many historical off- and side-channels have been blocked from main stream channels for flood control or by other land management activities, or have ceased functioning due to other in-stream sediment imbalances. When these areas are more regularly and permanently available, as in larger river basins, they can provide additional benefits such as high quality protected spawning habitat (Cramer 2012).

The direct effects of reconnecting stream channels using the proposed PDC with historical river floodplain swales, abandoned side channels, and floodplain channels are likely to include relatively intense restoration construction effects, as discussed above. Side channel reconnections that contain more than 20% of the flow at bankfull will be reviewed as a channel reconstruction/relocation project by the RRT. Indirect effects are likely to include equally intense beneficial effects to habitat diversity and complexity(Cramer 2012), including increased overbank flow and greater potential for groundwater recharge in the floodplain; attenuation of sediment transport downstream due to increased sediment storage; greater channel complexity or increased shoreline length; increased floodplain functionality reduction of chronic bank erosion and channel instability due to sediment deposition; and increased width of riparian corridors. Increased riparian functions are likely to include increased shade and hence moderated water temperatures and microclimate; increased abundance and retention of wood; increased organic material supply; water quality improvement; filtering of sediment and nutrient inputs; more efficient nutrient cycling; and restoration of flood-flow refuge for ESA-listed fish (Cramer 2012).

Streambank Restoration
In addition to restoration construction effects discussed above, the proposed streambank restoration action is likely to allow reestablishment of native riparian forests or other appropriate native riparian plant communities, provide increased cover (LW, boulders, vegetation, and bank

protection structures) and a long-term source of all sizes of instream wood, reduce fine sediment supply, increase shade, moderate microclimate effects, and provide more normative channel migration over time.

The Action Agencies propose to stabilize eroding streambanks using bioengineering methods. This requires instream construction with short-term effects as described above. Heavy equipment might be used in the stream for this activity. In-water equipment use could temporarily affect ESA-listed fish and critical habitat, including impacts on redds, smothered or crushed eggs and alevins, increased suspended sediment and deposition, blocked migration, and disrupted or disturbed overwintering behavior. Seasonal restrictions imposed by in-water work windows may afford some protection in bull trout foraging, migration and overwintering habitats, but cannot fully protect bull trout in spawning and rearing habitats.

The use of rock groins, weirs, rock toes, and riprap to avoid the potential negative effects of using hard structures to stabilize streambanks has been excluded from consideration within this Opinion. Long-term beneficial effects of stabilizing eroding streambanks include reductions in fine sediment inputs. Eliminating a sediment source will help to increase the diversity and densities of aquatic macroinvertebrates, which are used as a food source by ESA-listed fish species. It will also maintain or increase the amount of interstitial cover available to juveniles and juvenile emergence success. Suffocation of fry and entombment caused by excessive siltation of spawning gravels will also be reduced or eliminated. Light penetration, which, in turn, affects the feeding abilities of covered fish species and juvenile growth rates, will improve. By limiting bank restoration to bioengineering methods such as placement of LW and riparian plantings, overhead cover for fish will be increased and streambank stability will improve.

3.1.2.10 Set-back or Removal of Existing Berms, Dikes, and Levees

Channelization of streams through levee construction means that the floodplain no longer benefits from floods, producing many of the changes to living communities and ecosystems as those resulting from dams. Levees, berms, and dikes are commonly found along mid- to large-sized rivers for flood control or infrastructure protection and can severely disrupt ecosystem function (Gergel *et al.* 2002) and fish community structure (Freyer and Healey 2003). Similarly, mine tailings left by dredging for precious metals can have comparable effects on small streams.

Under this project category, the Action Agencies propose to remove dikes, berms, mine tailings or other floodplain overburden to restore river-floodplain interactions and natural channel-forming processes. This project category may often be combined with the stream channel reconstruction/relocation category above. The direct and indirect effects of this type of proposed action are also very similar to off- and side-channel habitat restoration discussed above, although the effects of this type of action may also include short-term or chronic instability of affected streams and rivers as channels adjust to the new hydrologic conditions. Moreover, this type of action is likely to affect larger areas overall because the area isolated by a berm, dike or levee is likely to be larger than that included in an off- or side-channel feature.

In the long-term, removal of floodplain overburden will improve connection between the stream and its floodplain, and allow reestablishment of riparian vegetation. Over time, the removal of overburden will also allow for the restoration of natural channel forming processes. Over the course of many decades, degraded and incised channels will be able to regain meanders, aggrade to the proper elevation, and resume natural formation of habitat features. Ultimately, this will result in more functional fish habitat: streams with overhead cover and undercut banks to provide protection for juvenile fish, low width-to-depth ratios that provide cool and deep refugia for migrating juveniles and healthy riparian plant communities that provide nutrient inputs to the food base that juvenile fish may consume when rearing. More immediate beneficial effects will result from the restoration of "flood pulses" that periodically deliver water, nutrients, and sediment to floodplains.

3.1.2.11 Reduction/Relocation of Recreation Impacts

The Action Agencies propose to close or better control recreational activities occurring along streams or within riparian areas. This activity category includes removal and relocation of campgrounds, toilets, and trails. It also includes placement of rocks or other barriers to limit access to streams and gravel surfacing of existing areas prone to erosion. Some construction activities such as removal of campground fill may occur, but new construction activities within bankfull stream width will not occur under this category.

Adverse effects of this action include minor riparian disturbance from construction. Long-term beneficial effects result primarily from exclusion of people and vehicles from streams and riparian areas. Reduced streambank damage and reduced chronic disturbance of riparian areas will result from implementation of this activity category. Eliminating gravel-clogging sediment sources (*e.g.,* eroding streambanks) will help to increase the diversity and densities of aquatic macroinvertebrates used as a food source by covered fish species. It will also maintain or increase the amount of interstitial cover available to juveniles and juvenile emergence success. Suffocation of fry and entombment caused by excessive siltation of spawning gravels will also be reduced or eliminated. Light penetration, which, in turn, affects the feeding abilities of fish species and juvenile growth rates, will improve. Graveling of areas inside established recreation sites reduces erosion, but also precludes the growth of riparian vegetation in these areas.

3.1.2.12 Livestock Fencing, Stream Crossings and Off-Channel Livestock Watering Facilities

The direct effects of constructing a livestock crossing or off-channel watering facility using the proposed PDC will be similar, though less intense, to the restoration construction effects discussed above. Although the net benefits of fencing streams to reduce livestock or human impacts are clear, some minor adverse effects can occur at watering or crossing sites. Concentration of livestock or human traffic at these areas can result in streambank damage and add fine sediment to stream substrates. Redds could be trampled if they are located in crossings. The Action Agencies propose several conservation measures to reduce the potential for these types of adverse effects. Crossings will be located in areas where streambanks are naturally low, crossing widths are limited to 4.6 m (15 feet), and areas of sensitive soils and vegetation will be avoided. Although these measures will reduce the potential for adverse effects, some minor streambank damage is likely to occur in these small areas and redds or eggs could occasionally be trampled.

Indirect effects are likely to be beneficial, including reducing the likelihood that livestock, particularly cattle, will have unrestricted access to a riparian area or stream channel for shade, forage, drinking water, or to cross the stream. This, in turn, is likely to reduce the likelihood that livestock will disturb streambeds, spawning areas or redds, or erode streambanks, and will improve water quality by increasing riparian vegetation and reducing sediment and nutrient loading to streams.

3.1.2.13 Piling and Other Structure Removal

This category includes the removal of untreated and chemically treated wood pilings, piers, boat docks as well as similar structures comprised of plastic, concrete and other material. The proposed PDC mainly focus on the removal of intact and broken piles which are typically treated with a toxic preservative. Removal of piles using the proposed PDC will re-suspend sediments that are inevitably pulled up with, or attached to, the piles. If sediment in the vicinity of a pile is contaminated, or if the pile is creosote treated, those contaminants will be included with the re-suspended sediments, especially if a creosote-treated pile is damaged during removal, or if debris from a broken pile is allowed to re-enter or remain in the water. Due to the relatively small amount of sediment disturbed during pile removal, any effects to fish from the re-suspended sediments will be minor. The indirect effects of structure removal are likely to be beneficial and include reduction of resting and areas for piscivorous birds, hiding habitat for aquatic predators such as large and smallmouth bass, and, in the case of creosote piles, a chronic source of PAH pollution.

3.1.2.14 Shellfish Bed/Nearshore Habitat Restoration.

Pacific Northwest beaches provide habitat for shellfish (Dethier 2006) and forage fishes such as Pacific herring (*Clupea pallasi*), Pacific sand lance (*Ammodytes hexapterus),* and surf smelt (*Hypomesus pretiosus*), which are important food sources for salmon. Adjacent nearshore habitats are used as nursery grounds by all three species. Each of these species has particular habitat requirements for spawning; *e.g.*, relatively restricted sediment grain size, particular tidal heights, and specific vegetation types. Other forage fish species, *i.e.,* eulachon, Northern anchovy (*Engraulis mordax*), and longfin smelt (*Spirinchus thaleichthys*), do not spawn on Puget Sound beaches, but use nearshore ecosystems in other ways (Penttila 2007).

Five species of Pacific salmon use the nearshore ecosystems of Puget Sound: Chinook, coho, chum, sockeye, and pink (*O. gorbuscha*). Juvenile chum salmon abundance in nearshore areas peaks in May and June. Juvenile Chinook salmon abundance peaks in June and July, although some are present in shoreline habitats through October, but they may occupy nearshore habitat nearly year-round (Fresh 2006). Beaches and shallow waters provide shelter from predators and food for young salmon and trout as their bodies adapt to saltwater. These fish migrate and feed along these nearshore corridors as they move to open water and then as returning adults they use these same areas to re-acclimate to freshwater (Shared Strategy for Puget Sound 2007).

Nearshore habitat forming processes have been interrupted by shoreline armoring, development on top of and below banks, bluffs, and beaches, and changes in flow due to the diversion of rivers or streams. Bluff sediment input, primarily glacially deposited units, is the primary source of beach sediment in Puget Sound. Dams on rivers also hold back sediment important to processes downstream and the nourishment of shoreline beaches. Many beaches, particularly in the Puget Sound region, have been modified with bulkheads, jetties, and armoring to protect industrial or residential development, *i.e.*, roads, railroads, docks, piers, marinas, *etc.*, from erosion. These modifications have disrupted beach forming erosion processes and decreased access to juvenile salmon rearing habitats. Overwater structures and ramps also contribute to this loss of salmon habitat (Shared Strategy for Puget Sound 2007). Sea level is also expected to rise substantially in this century which will affect the amount, structure, and function of nearshore habitat in Puget Sound and elsewhere on the coast. The loss of small parcels of shoreline habitat from hardening may not have a large impact on the ecosystem, but the cumulative impact of the loss of many small parcels will at some point, alter the properties, composition, and values of the ecosystem. Approximately 34% of the Puget Sound and Northern Straits shoreline (more than 805 miles) has been modified (Johannessen and MacLennan 2007) and every year approximately 1.5 miles of new bulkheads are built and about 2.5 miles are replaced (Barnard 2010).

By re-connecting naturally eroding feeder bluffs to the marine environment, beaches will be nourished with a natural source of sediment, and by removing barriers like bulkheads, structures, and piers, wave action will again transport sediment to form beaches. Shoreline restoration measures may include gravel beach nourishment, grade control/slope support with LW and/or rock, wood revetment or wood/rock revetment, and biotechnical slope support (vegetated geogrids, soil pillows, *etc*.) as described by Barnard (2009). However, removing some bank hardening structures may not be sufficient to create sandy beaches; there may also be a need to augment sediment supplies. Furthermore, beach nourishment has significant impacts on local ecosystems. Nourishment may cause direct mortality to sessile organisms in the target area by burying them in the new sand. Seafloor habitat in both source and target areas are disrupted, *e.g.*, when sand is deposited. Nourishment is also typically a repetitive process, since nourishment does not remove the physical forces that cause erosion; it simply mitigates their effects. Thus, this restoration measure will be accompanied by a monitoring plan and reviewed and approved by NMFS.

The placement of cultch, spat-on-shell, or live shellfish as part of shellfish restoration can negatively impact benthic organisms and submerged aquatic vegetation (SAV) due to burial, excessive turbidity, or space competition. Eelgrass (*Zostera marina*) is a particularly important habitat component of Pacific Northwest estuaries, and is susceptible to decline from physical disturbance. This is especially true if the rhizome matrix is disrupted (Boese *et al.* 2009). However, since shellfish restoration generally will not disturb the substrate, it is likely that shellfish restoration conducted under this Opinion will not disrupt rhizomes, but may reduce shoot density or percent cover.

Introduction of non-native species, predators, and pathogens is a potential mechanism for harmful effects of shellfish restoration. Although many safeguards are now in place to protect against such introductions, shellfish have historically been a vector for a variety of non-indigenous species. The proposed action will minimize this danger by ensuring that shell or other substance used for substrate enhancement will be procured from clean sources that are then steam cleaned, left on dry land for a minimum of 1 month, or both, before placement in the water.

In some cases, the planting of SAV is included as part of a shellfish restoration activity. During revegetation activities, workers may disturb the surrounding sediment locally by compacting sediment due to foot traffic, or may disturb existing vegetation. Harvest of SAV from donor beds may harm the donor SAV bed, and may increase turbidity temporarily. For kelp restoration projects, there is potential for damage from divers or equipment, disruption of bottom sediment from diving finds, and impacts resulting from the transplanting of kelp to restoration sites.

3.1.2.15 In-channel Nutrient Enhancement

Many streams throughout the Pacific Northwest that once had large returns of salmon and steelhead are now lacking the nutrients that decomposing fish carcasses provided. This is especially true for trace marine nutrients (Compton *et al.* 2006; Murota 2003; Nagasaka *et al.* 2006; Thomas *et al.* 2003). The Action Agencies propose to add salmon carcasses, carcass analogs, or inorganic fertilizers to replace missing nutrients. The addition of nutrients can increase primary productivity and result in more food for juvenile salmonids (Reeves *et al.* 1991). The organisms in the base of the food chain that rely on those inputs are ultimately the food base that juvenile salmonids consume when rearing and migrating to the ocean. Studies conducted in British Columbia have shown that addition of inorganic fertilizers can increase salmonid production in oligotrophic streams (Slaney *et al.* 2003; Ward *et al.* 2003; Wilson *et al.* 2003).

Because the effects of these nutrient additions, particularly carcass additions, have not been studied in detail (Compton *et al.* 2006), the Action Agencies propose numerous conservation measures in conjunction with this activity type. In Oregon, fish carcasses will be certified as disease free by an ODFW fish pathologist and in Washington, placement of carcasses will follow Washington Department of Fish and Wildlife Habitat Technical Assistance: Nutrient Supplementation (Cramer 2012). Following these steps will minimize the chance of introducing disease causing pathogens through carcass supplementation. The Action Agencies will not place carcasses in naturally oligotrophic systems where nutrient levels would be naturally low, and they will not add nutrients to eutrophic systems where nutrient levels are atypically high. Carcass additions will occur during normal spawning periods, so there is a more than negligible chance that some spawning activities could be temporarily interrupted by the addition activities. These interruptions will last for a maximum of a few hours, will only happen once, and are not likely to cause a measurable decrease in spawning success.

3.1.2.16 Road and Trail Erosion Control and Decommissioning

Road and trail erosion control and decommissioning typically includes one or more of the following actions – culvert removal in perennial and intermittent streams (see fish passage improvements for more information on culvert actions); removing, installing or upgrading cross-drainage culverts; upgrading culverts on non-fish-bearing streams; constructing water bars and dips; reshaping road prisms; vegetating fill and cut slopes; removing and stabilizing of side-cast materials; grading or resurfacing roads that have been improved for aquatic restoration with gravel, bark chips, or other permeable materials; contour shaping of the road or trail base; removing road fill to native soils; soil stabilization and tilling compacted surfaces to reestablish native vegetation. A significant amount of information is available regarding the adverse effects of roads on aquatic habitats (Gucinski *et al.* 2001; Jones *et al.* 2000; Trombulak and Frissell 2000). Increased introduction of invasive species and delivery of fine sediment derived from roads has been linked with decreased fry emergence, decreased juvenile densities, loss of winter carrying capacity, increased predation of fishes, decreased benthic production, and increased algal production. Improper culvert placement can limit or eliminate fish passage. Moreover, roads can greatly increase the frequency of landslides, debris flows, and other mass movements.

Unfortunately, much less information is available on the specific effects of road and trail restoration or removal, and its effectiveness for reversing adverse habitat conditions attributed to the presence of road and trail systems. The short-term effects of these actions using the proposed PDC will include the restoration construction effects and, in the case of culvert removal, fish passage restoration, discussed above. The long-term effects of road and trail restoration or removal appear to include mitigation of many of the negative effects to aquatic habitats that have been associated with roads (Madej 2001; McCaffery *et al.* 2007), but the large variance between stream substrate conditions and other habitat characteristics that are important to fish make it difficult to assign measurable effects to road decommissioning (Madej 2001; McCaffery *et al.* 2007). Thus, road and trail erosion control and decommissioning are likely to result in restoration of riparian and stream functions as a result of reduced sediment yield and improved fish passage.

3.1.2.17 Native Vegetation Restoration and Management.

The proposed action includes manual, mechanical, burning, and herbicidal treatments of invasive and non-native plants. NMFS has recently analyzed the effects these activities using the similar active ingredients and PDC for proposed USFS and BLM invasive plant control programs (NMFS 2010, 2012, 2013a, 2013b). The types of plant control actions analyzed here are a conservative (*i.e.*, less aggressive) subset of the types of actions considered in those analyses, and the effects presented here are summarized from those analyses. Each type of treatment is likely to affect fish and aquatic macrophytes through a combination of pathways, including disturbance, chemical toxicity, dissolve oxygen and nutrients, water temperature, sediment, instream habitat structure, forage, and riparian and emergent vegetation (Table 5).

Table 5. Potential pathways of effects of invasive and non-native plan control.

	Pathways of Effects							
Treatment Methods	**Disturbance***	**Chemical toxicity**	**Dissolved oxygen and nutrients**	**Water temperature**	**Fine sediment and turbidity**	**Instream habitat structure**	**Forage**	**Riparian and emergent vegetation**
Manual	X					X	X	X
Mechanical	X			X	X		X	X
Herbicides		X	X	X	X	X	X	X
Burning	X				X		X	X

*Stepping on redds, displacing fish, interrupting fish feeding, or disturbing banks.

Short-term displacement or disturbance of threatened and endangered fish are likely to occur from activities in the area that disturb or displace fish that are feeding, resting or moving through the area. Due to the proposed PDC, mechanical and herbicidal treatments of invasive plant species in riparian areas are not likely to substantially decrease shading of streams in most cases.

Significant shade loss is likely to be rare, occurring primarily from treating streamside knotweed and blackberry monocultures, and possibly from cutting streamside woody species (tree of heaven, Scot's broom, *etc.*). Most invasive plants are understory species of streamside vegetation that do not provide the majority of streamside shade and, furthermore will be replaced by planted native vegetation or vegetation. The loss of shade would persist until native vegetation reaches and surpasses the height of the invasive plants that were removed. Shade recovery may take one to several years, depending on the success of invasive plant treatment, stream size and location, topography, growing conditions for the replacement plants, and the density and height of the invasive plants when treated. However, short-term shade reduction is likely to occur due to removal of riparian weeds, which could slightly affect stream temperatures or dissolved oxygen levels, and cause short-term stress to fish adults, juveniles and eggs. Effects pathways are described in detail below.

Manual and mechanical treatments are likely to result in mild restoration construction effects (discussed above). Hand pulling of emergent vegetation is likely to result in a localized mobilization of suspended sediments. Treatment of knotweed and other streamside invasive species with herbicides (by stem injection or spot spray) or heavy machinery is likely to result in short-term releases of suspended sediment when treatment of locally extensive streamside monocultures occurs. Thus, these treatments are likely to affect a definite, broad area, and to produce at least minor damage to riparian soil and vegetation. In some cases, this will decrease stream shade, increase suspended sediment and temperature in the water column, reduce organic inputs (*e.g.*, insects, leaves, woody material), and alter streambanks and the composition of stream substrates. However, these circumstances are likely to occur only in rare circumstances, such as treatment of an invasive plant monoculture that encompasses a small stream channel. This effect would vary depending on site aspect, elevation, and amount of topographic shading, but is likely to decrease over time at all sites as shade from native vegetation is reestablished.

Prescribed burns are proposed for prairie and oak savannah restoration actions. Most of these burns will occur in upland areas and are not likely to affect aquatic habitats. However, burns that include the riparian area are likely to cause some short-term adverse effects on ESA-listed fish and their habitats. Generally, fires burn in a mosaic pattern of differing severities across the landscape, depending on topography, aspect, vegetation, weather, and other factors. Riparian areas frequently differ from adjacent uplands in vegetative composition and structure, geomorphology, hydrology, microclimate, and fuel characteristics (Dwire and Kaufmann 2003). Consequently, riparian areas typically react to wildfire and prescribed fire differently than adjacent uplands. Deciduous streamside vegetation immediately adjacent to the stream can recover rapidly (5 year; *e.g.,* willows and alders), whereas forest trees (*e.g.,* Douglas fir) recover over decades.

Wildfire can have a wide range of effects on aquatic ecosystems ranging from minor to severe (Rieman *et al.* 2003). However, prescribed burns will be of low intensity. Under these conditions, burns in riparian areas tend to occur in a mosaic pattern, leaving considerable unburned area and resulting in low tree mortality. Areas with the highest moisture levels, immediately adjacent to streams, tend to receive the least damage from fire. Effects from low to moderate intensity prescribed fire in riparian areas include minor reductions in stream shade, minor reductions in LW recruitment and inputs of fine sediment and nutrients to streams. In some cases, LW levels will increase due to prescribed fire (Chan 1998).

Herbicide applications. The the Service identified three scenarios for the analysis of herbicide application effects to ESA-listed fish: 1) Runoff from riparian application; 2) application within perennial stream channels; and 3) runoff from intermittent stream channels and ditches. Stream margins often provide shallow, low-flow conditions, have a slow mixing rate with mainstem waters, and are the site at which subsurface runoff is introduced. Juvenile fish, particularly recently emerged fry, often use low-flow areas along stream margins. As juveniles grow, they migrate away from stream margins and occupy habitats with progressively higher flow velocities. Nonetheless, stream margins continue to be used by larger fish for a variety of reasons, including nocturnal resting, summer and winter thermal refuge, predator avoidance, and flow refuge (NMFS 2013a, b).

Spray and vapor drift are important pathways for herbicide entry into aquatic habitats. Several factors influence herbicide drift, including spray droplet size, wind and air stability, humidity and temperature, physical properties of herbicides and their formulations, and method of application. For example, the amount of herbicide lost from the target area and the distance the herbicide moves both increase as wind velocity increases. Under inversion conditions, when cool air is near the surface under a layer of warm air, little vertical mixing of air occurs. Spray drift is most severe under these conditions, since small spray droplets will fall slowly and move to adjoining areas even with very little wind. Low relative humidity and high temperature cause more rapid evaporation of spray droplets between sprayer and target. This reduces droplet size, resulting in increased potential for spray drift. Vapor drift can occur when herbicide volatilizes. The formulation and volatility of the compound will determine its vapor drift potential. The potential for vapor drift is greatest under high air temperatures and low humidity and with ester formulations. For example, ester formulations of triclopyr are very susceptible to vapor drift, particularly at temperatures above 27 °C (80 °F). When temperatures go above 24 °C (75 °F), 2,4-D ester chemicals evaporate and drift as vapor. Even a few days after spraying, ester-based phenoxy-type herbicides still release vapor from the leaf surface of the sprayed weed (DiTomaso *et al.* 2006). 2,4-D and triclopyr, which are included in the proposed action, as well as many other herbicides and pesticides are detected frequently in freshwater habitats within the action area (NMFS 2011b).

When herbicides are applied with a sprayer, nozzle height controls the distance a droplet must fall before reaching the weeds or soil. Less distance means less travel time and less drift. Wind velocity is often greater as height above ground increases, so droplets from nozzles close to the ground would be exposed to lower wind speed. The higher that an application is made above the ground, the more likely it is to be above an inversion layer that will not allow herbicides to mix with lower air layers and will increase long distance drift. Several proposed PDC address these concerns by ensuring that herbicide treatments will be made using ground equipment or by hand, under calm conditions, preferably when humidity is high and temperatures are relatively low. Ground equipment reduces the risk of drift, and hand equipment nearly eliminates it.

Surface water contamination with herbicides can occur when herbicides are applied intentionally or accidentally into ditches, irrigation channels or other bodies of water, or when soil-applied herbicides are carried away in runoff to surface waters. Direct application into water sources is generally used for control of aquatic species. Accidental contamination of surface waters can occur when irrigation ditches are sprayed with herbicides or when buffer zones around water sources are not wide enough. In these situations, use of hand application methods will greatly reduce the risk of surface water contamination.

The contribution from runoff will vary depending on site and application variables, although the highest pollutant concentrations generally occur early in the storm runoff period when the greatest amount of herbicide is available for dissolution (Stenstrom and Kayhanian 2005; Wood 2001). Lower exposures are likely when herbicide is applied to smaller areas, when intermittent stream channel or ditches are not completely treated, or when rainfall occurs more than 24 hours after application. Under the proposed action, some formulas of herbicide can be applied within the bankfull elevation of streams, in some cases up to the water's edge. Any juvenile fish in the margins of those streams are more likely to be exposed to herbicides as a result of overspray, inundation of treatment sites, percolation, surface runoff, or a combination of these factors. Overspray and inundation will typically be minimized through the use of dyes or colorants.

In a typical year in the U.S., pesticides are applied at a rate of approximately five billion pounds of active ingredients per year (Kiely *et al.* 2004). Therefore, pesticide contamination in the nation's freshwater habitats is ubiquitous and pesticides usually occur in the environment as mixtures. The USGS National Water-Quality Assessment (NAWQA) Program conducted studies and monitoring to build on the baseline assessment established during the 1990s to assess trends of pesticides in basins across the Nation, including the Willamette River basin. More than 90% of the time, water from streams with agricultural, urban, or mixed-land-use watersheds had detections of 2 or more pesticides or degradates, and about 20% of the time they had detections of 10 or more. Approximately 57% of 83 agricultural streams had concentrations of at least one pesticide that exceeded one or more aquatic-life benchmarks at least one time during the year (68% of sites sampled during 1993–1994, 43% during 1995–1997, and 50% during 1998–2000). 2,4D is one the pesticides detected most frequently in stream water (Gilliom *et al.* 2006). In the Willamette Basin 34 herbicides were detected. Forty-nine pesticides were detected in streams draining predominantly agricultural land (Rinella and Janet 1998). In the lower Clackamas River basin, Oregon (2000 to 2005), USGS detected 63 pesticide compounds, including 33 herbicides. High-use herbicides such as glyphosate, triclopyr, 2,4-D, and metolachlor were frequently detected, particularly in the lower-basin tributaries (Carpenter *et al.* 2008).

Groundwater contamination is another important pathway. Most herbicide groundwater contamination is caused by "point sources," such as spills or leaks at storage and handling facilities, improperly discarded containers, and rinses of equipment in loading and handling areas, often into adjacent drainage ditches. Point sources are discrete, identifiable locations that discharge relatively high local concentrations. In soil and water, herbicides persist or are decomposed by sunlight, microorganisms, hydrolysis, and other factors. 2,4-D and triclopyr are detected frequently in freshwater habitats within the action area (NMFS 2011b). Proposed PDC minimize these concerns by ensuring proper calibration, mixing, and cleaning of equipment. Non-point source groundwater contamination of herbicides is relatively uncommon but can occur when a mobile herbicide is applied in areas with a shallow water table. Proposed PDC minimize this danger by restricting the formulas used, and the time, place and manner of their application to minimize offsite movement.

Herbicide toxicity. Several of the proposed herbicides are termed "Aquatic" herbicides for the purposes of this Opinion (See PDC 29). The aquatic herbicides included in this invasive plant programmatic activity were selected due to their low to moderate aquatic toxicity to listed fish. Available information on effects to organisms was summarized by the Action Agencies and provided the PROJECT BA's Appendix entitled *Detailed Effects and Rish Assessment for Herbicide Use*. The risk of adverse effects from the toxicity of herbicides and other compounds present in formulations to listed aquatic species is mitigated in this programmatic activity by reducing stream delivery potential by restricting application methods. Near wet stream channels, only aquatic labeled herbicides are to be applied. Aquatic glyphosate, aquatic imazapyr, and aquatic triclopyr-TEA can be applied up to the waterline, but only using hand selective techniques. A 3 m (15 feet) buffer is required to use aquatic imazapyr and aquatic triclopyr-TEA by spot spraying. On dry streams, ditches, and wetlands, no buffers are required use the aquatic herbicides for spot spraying or hand selective application. The associated application methods were selected for their low risk of contaminating soils and subsequently introducing herbicides to streams. However, direct and indirect exposure and toxicity risks are inherent in some application scenarios.

Generally, herbicide active ingredients have been tested on only a limited number of species and mostly under laboratory conditions. While laboratory experiments can be used to determine acute toxicity and effects to reproduction, cancer rates, birth defect rates, and other effects to fish and wildlife, laboratory experiments do not typically account for species in their natural environments and little data is available from studies focused specifically on the listed species in this Opinion. This leads to uncertainty in risk assessment analyses. Environmental stressors increase the adverse effects of contaminants, but the degree to which these effects are likely to occur for various herbicides is largely unknown.

The known effects of herbicides to various representative groups of species have been summarized for each proposed herbicide in the PROJECT BA's Appendix entitled *Detailed Effects and Rish Assessment for Herbicide Use*. The effects of the aquatic herbicide applications to various representative groups of species have been previously evaluated for each proposed herbicide (NMFS 2013b). The effects of herbicide applications using spot spray, hand/select, and broadcast spray methods were evaluated under several exposure scenarios: 1) runoff from riparian (above the OHW) application along streams, lakes and ponds, 2) runoff from treated ditches and dry intermittent streams, and 3) application within perennial streams (dry areas within channel and emergent plants). The potential for herbicide movement from broadcast drift was also evaluated. Risks associated with exposure and associated effects were also evaluated for terrestrial species.

Although the PDC would minimize drift and contamination of surface and ground water, herbicides reaching surface waters will likely result in mortality to fish during incubation, or lead to altered development of embryos. Stehr *et al.* (2009) found that the low levels of herbicide delivered to surface waters are unlikely to be toxic to the embryos of ESA-listed fish. However, mortality or sub-lethal effects such as reduced growth and development, decreased predator avoidance, or modified behavior are likely to occur. Herbicides are likely to also adversely affect the food base for listed salmonids and other fish, which includes terrestrial organisms of riparian origin, aquatic macroinvertebrates and forage fish.

Adverse effect threshold values for each species group were defined as either 1/20th of the LC50 value for listed salmonids, 1/10th of the LC50 value for non-listed aquatic species, or the lowest acute or chronic "no observable effect concentration," whichever was lower, found in Syracuse Environmental Research Associates, Inc. (SERA) risk assessments that were completed for the USFS; *i.e.*, sethoxydim (SERA 2001), sulfometuron-methyl (SERA 2004b), imazapic (SERA 2004c), chlorsulfuron (SERA 2004a), imazapyr (SERA 2011a), glyphosate (SERA 2011d), and triclopyr (SERA 2011c). These assessments form the basis of the analysis in this Opinion. Generally, effect threshold values for listed salmonids were lower than values for other fish species groups, so values for salmonids were also used to evaluate potential effects to other listed fish. In the case of sulfometuron-methyl, threshold values for fathead minnow were lower than salmonid values, so threshold values for minnow were used to evaluate effects to listed fish.

Data on toxicity to wild fish under natural conditions are limited and most studies are conducted on lab specimens. Adverse effects could be observed in stressed populations of fish, and it is less likely that effects will be noted in otherwise healthy populations of fish. Chronic studies or even long-term studies on fish egg-and-fry are seldom conducted. Risk characterizations for both terrestrial and aquatic species are limited by the relatively few animal and plant species on which data are available, compared to the large number of species that could potentially be exposed. This limitation and consequent uncertainty is common to most if not all ecological risk assessments. Additionally, in laboratory studies, test animals are exposed to only a single chemical. In the environment, humans and wildlife may be exposed to multiple toxicants simultaneously, which can lead to additive or synergistic effects.

The effects of herbicides on salmonids are fully described by NMFS in other recent opinions with the EPA, USFS, BPA, and USACE (NMFS 2010, 2011c, 2012, 2013a, 2013b) and in SERA reports. For the ARBO II, the USFS, BLM, and BIA evaluated the risk of adverse effects to listed salmonids and their habitat in terms of hazard quotient (HQ) values (NMFS 2008). We anticipate the herbicide-use effects to salmonids, as described by NMFS, are similar to ESA-listed fish covered under this Opinion.

HQ evaluations from the 2008 ARBO (NMFS 2008) are summarized below for the proposed herbicides that are allowed to be used within 30.5 m (100 feet) of any aquatic habitat (chlorsulfuron, clopyralid, glyphosate, imazapyr, metsulfuron methyl, sethoxydim, and sulfometuron methyl). HQs were calculated by dividing the expected environmental concentration by the effects threshold concentration. Adverse effect threshold concentrations are 1/20th (for ESA listed aquatic species) or 1/10th (all other species) of LC50 values, or "no observable adverse effect" concentrations, whichever concentration was lower. The water contamination rate (WCR) values are categorized by herbicide, annual rainfall level, and soil type. Variation of herbicide delivery to streams among soil types (clay, loam, and sand) is displayed as low and high WCR values. All WCR values are from risk assessments conducted by SERA. When there are HQ values greater than 1, adverse effects are likely to occur. Hazard quotient values were calculated for fish, aquatic invertebrates, algae, and aquatic macrophytes.

For imazapic, picloram, and triclopyr (also herbicides allowed within 30.5 (100 feet) of aquatic habitats), we referred to NMFS' opinions, SERA reports, various other literature sources, the 2013 BA for ARBO II (USDA-Forest Service *et al.* 2013) to characterize risk to listed fish species.

Chlorsulfuron. No chlorsulfuron HQ exceedences occur for fish or aquatic invertebrates. HQ exceedences occur for algae at rainfall rates of 127 and 381 cm (50 and 150 inches) per year, and for aquatic macrophytes at rainfall rates of 38.1, 127, and 381 cm (15, 50, and 150 inches) per year.

The HQ values predicted for algae at 127 cm (50 inches) per year ranged from 0.002 to 2.8, and the HQ exceedence occurred at the maximum application rate on clay soils. The HQ values predicted for algae at 381 cm (150 inches) per year ranged from 0.02 to 5.0, and HQ exceedances occurred at both the typical (HQ of 1.1) and maximum (HQ of 5.0) application rates on clay soils. Application of chlorsulfuron adjacent to stream channels at the typical and maximum application rates, in rainfall regimes of 127 and 381 cm (50 to 150 inches) per year, is likely adversely affect algal production when occurring on soils with poor infiltration.

The HQ values predicted for aquatic macrophytes at 38.1 cm (15 inches) per year ranged from 0 to 64, and HQ exceedences occurred at both the typical and maximum application rates on clay soils. The HQ values for aquatic macrophytes at 127 cm (50 inches) per year ranged from 0.5 to 585, and ranged from 4.8 to 1,064 at 381 cm (150 inches) per year. The HQ exceedences at 127 and 381 cm (50 and 150 inches) per year occurred at both typical and maximum application rates, with lower HQ values occurring on loam soils, and the highest values on clay soils. Given the wide range of HQ values observed among soil types at a given rainfall rate, soil type is clearly a major driver of exposure risk for chlorsulfuron, with low permeability soils markedly increasing exposure levels. Application of chlorsulfuron adjacent to stream channels at the typical and maximum application rates, in rainfall regimes of 127 and 381 cm (15 to 150 inches) per year, is likely to adversely affect aquatic macrophytes. Application on soils with low infiltration rates will have a substantially higher risk of resulting in adverse effects.

Clopyralid. Application of clopyralid under the modeled scenario did not result in any HQ exceedences for any of the species groups. Clopyralid applications are not likely to adversely affect listed fish or their habitat because HQ values are less than 1.

Glyphosate. Glyphosate HQ exceedences occurred for fish and algae at a rainfall rate of 381 cm (150 inches) per year, and no HQ exceedences occurred for aquatic invertebrates or aquatic macrophytes. The HQ exceedences occurred at the maximum application rates only. The HQ values for fish at 381 cm (150 inches) per year ranged from 1.5 to 3.6, and occurred within a narrow range on all soil types. The HQ values for algae at 381 cm (150 inches) per year ranged from 0.8 to 2.0 in sand. Application of glyphosate adjacent to stream channels at application rates approaching the maximum, in rainfall regimes approaching 381 cm (150 inches) per year, on all soil types is likely to adversely affect listed fish. When glyphosate is applied adjacent to stream channels at rates approaching the maximum on sandy soils, in rainfall regimes approaching 381 cm (150 inches) per year, adverse effects to algal production will occur.

Imazapic. Aquatic animals appear to be relatively insensitive to imazapic exposures, with LC50 values of greater than 100 mg/L for both acute toxicity and reproductive effects. Aquatic macrophytes may be much more sensitive, with an acute EC50 of 6.1 µg/L in duck weed (*Lemna gibba*). Aquatic algae appear to be much less sensitive, with EC50 values of greater than 45 µg/L. No toxicity studies have been located on the effects of imazapic on amphibians or microorganisms (SERA 2004c).

Imazapyr. No HQ exceedences occurred for imazapyr for fish or aquatic invertebrates. HQ exceedances occurred for algae and aquatic macrophytes at a rainfall rate of 381 cm (150 inches) per year.

The HQ values for algae at 381 cm (150 inches) per year ranged from 0 to 1.3. The HQ exceedence at 381 cm (150 inches) per year occurred only at the maximum application rate on clay soils. The HQ values for aquatic macrophytes at 150 inches per year ranged from 0 to 2.0. The HQ exceedence at 381 cm (150 inches) per year occurred only at the maximum application rate on clay soils. Given the range of HQ values observed for imazapyr at a rainfall rate of 381 cm (150 inches) per year, soil type is an important factor in determining exposure risk, with low permeability soils markedly increasing exposure levels. Application of imazapyr adjacent to stream channels at application rates approaching the maximum on soils with low permeability, in rainfall regimes approaching 381 cm (150 inches) per year, is likely to adversely affect algal production and aquatic macrophytes.

Algae and macrophytes provide food for aquatic macroinvertebrates, particularly those in the scraper feeding guild (Williams and Feltmate 1992). These macroinvertebrates in turn provide food for rearing juvenile salmonids and other fish species. Consequently, adverse effects on algae and aquatic macrophyte production may cause a reduction in availability of forage for juvenile fish. Over time, juvenile fish that receive less food have lower body condition and smaller size. However, the small amount of imazapyr expected to reach the water should not result in effects this severe.

Metsulfuron methyl. No HQ exceedences occurred for metsulfuron for fish, aquatic invertebrates, or algae. The HQ exceedences for aquatic macrophytes occurred at the maximum application rate on clay soils at rainfall rates of 127 and 381 cm (50 and 150 inches) per year. The HQ values ranged from 0.009 to 1.0 at 127 cm (50 inches), and from 0.02 to 1.9 at 381 cm (150 inches) per year.

Given the range of HQ values observed for metsulfuron at each rainfall level, soil type is an important factor in determining exposure risk, with low permeability soils markedly increasing exposure levels. In areas with rainfall rates between 127 and 381 cm (50 and 150 inches) per year, application of metsulfuron adjacent to stream channels on soils with low permeability at application rates approaching the maximum is likely to adversely affect aquatic macrophytes. A slight decrease in forage availability for juvenile fish will result from adverse effects to aquatic macrophytes.

Picloram. Based on expected concentrations of picloram in surface water, all central estimates of the HQs are below the level of concern for fish, aquatic invertebrates, and aquatic plants. No risk characterization for aquatic-phase amphibians can be developed because no directly useful data are available. Upper bound HQs exceed the level of concern for longer-term exposures in sensitive species of fish (HQ=3) and peak exposures in sensitive species of algae (HQ=8). It does not seem likely that either of these HQs would be associated with overt or readily observable effects in either fish or algal populations for typical applications. In the event of an accidental spill, substantial mortality will be likely in both sensitive species of fish and sensitive species of algae (SERA 2011b).

Sethoxydim. No HQ exceedences occurred for sethoxydim for aquatic invertebrates, algae, or aquatic macrophytes. The HQ exceedences for fish occurred at rainfall rates of 127 and 381 cm (50 and 150 inches) per year, and ranged from 0.3 to 1.0, and from 1.1 to 3.0, respectively. The HQ exceedence at 127 cm (50 inches) per year occurred only at the maximum application rate on loam soils. The HQ exceedences at 150 inches per year occurred at the typical application rate on sand, and at the maximum application rate on loam soil.

The HQ values for sethoxydim were calculated using the toxicity data for the Poast formulation, and incorporates the toxicity of naphtha solvent. The toxicity of sethoxydim alone for fish and aquatic invertebrates is much less than that of the formulated product (about 30 times less toxic for invertebrates, and about 100 times less toxic for fish). Since the naphtha solvent tends to volatilize or adsorb to sediments, using Poast formulation data to predict indirect aquatic effects from runoff leaching is likely to overestimate adverse effects (SERA 2001). PDC sharply reduce the risk of naptha solvent presence in percolation runoff reaching streams. When PDC to reduce naptha solvent exposure are employed, application of sethoxydim adjacent to stream channels will not adversely affect listed fish or their habitat.

Sulfometuron-methyl. No HQ exceedences occurred for sulfometuron-methyl for fish, aquatic invertebrates, or algae. The HQ exceedence for aquatic macrophytes occurred at a rainfall rate of 381 cm (150 inches) per year on clay soils, and HQ values ranged from 0.007 to 3.8. Considering the range of HQ values observed for sulfometuron at each rainfall level, soil type is an important factor in determining exposure risk, with low permeability soils markedly increasing exposure levels. In areas with a rainfall rate approaching 127 and 381 cm (50 and 150 inches) per year, application of metsulfuron adjacent to stream channels on soils with low permeability at application rates approaching the maximum is likely to adversely affect aquatic macrophytes. A slight decrease in forage availability for juvenile fish will result from adverse effects to aquatic macrophytes.

Triclopyr. With the exception of aquatic plants, substantial risks to nontarget species (including humans) associated with the contamination of surface water are low, relative to risks associated with contaminated vegetation. Stehr *et al.* (2009) observed no developmental effects at nominal concentrations of 10 mg/L or less for purified triclopyr alone or for the TEA formulations Garlon 3A and Renovate.

Adjuvants. Washington State Departments of Agriculture and Ecology have the following criteria for the registration of spray adjuvants for aquatic use in Washington:

- The adjuvant must fulfill all requirements for registration of a food / feed use spray adjuvant in Washington.
- The adjuvant must be either slightly toxic or practically non-toxic to freshwater fish. Rainbow trout (*Oncorhynchus mykiss*) is the preferred test species.
- The adjuvant must be moderately toxic, slightly toxic or practically non-toxic to aquatic invertebrates. Either *Daphnia magna* or *Daphnia pulex* are acceptable test species.
- The adjuvant formulation must contain less than 10% alkyl phenol ethoxylates (including alkyl phenol ethoxylate phosphate esters).
- The adjuvant formulation must not contain any alkyl amine ethoxylates (including tallow amine ethoxylates).

The proposed action excluded several of these compounds for use within 30.5 m (100 feet) of aquatic habitats because they do contain alkyl phenol ethoxylates (APEOs). Alkylphenols, including nonylphenol (NP) and nonylphenol ethoxylates (NPE), have been detected in the natural environment, including ambient air, sewage treatment plant effluent, sediment, soil, and surface waters, in wildlife, household dust, and human tissues. NP and NPE are toxic to aquatic organisms, and the breakdown products of nonylphenol ethoxylates (NP and shorter-chained ethoxylates) are more toxic and more persistent than their parent chemicals. NP has been shown to have estrogenic effects in a number of aquatic organisms (Environment Canada and Health Canada 2001; Lani 2010; Servos 1999). Environment Canada and Health Canada (2001) concluded that nonylphenol and its ethoxylates are entering the environment in a quantity or concentration or under conditions that have or may have an immediate or long-term harmful effect on the environment or its biological diversity. Zoller (2006) reported that egg production by zebrafish, exposed to 75, 25 and 10 µg/L of a typical industrial APEO was reduced up to 89.6%, 84.7% and 76.9%, respectively, between the 8th and 28th days of exposure.

Summary. Stehr *et al.* (2009) studied developmental toxicity in zebrafish *(Danio rerio)*, which involved conducting rapid and sensitive phenotypic screens for potential developmental defects resulting from exposure to six herbicides (picloram, clopyralid, imazapic, glyphosate, imazapyr, and triclopyr) and several technical formulations. Available evidence indicates that zebrafish embryos are reasonable and appropriate surrogates for embryos of other fish. The absence of detectable toxicity in zebrafish screens is unlikely to represent a false negative in terms of toxicity to early developmental stages of threatened or endangered fish species. Their results indicate that low levels of noxious weed control herbicides are unlikely to be toxic to the embryos of ESA-listed fish. Those findings do not necessarily extend to other life stages or other physiological processes (*e.g.*, disease susceptibility, behavior).

The proposed PDC, including limitations on the herbicides, adjuvants, carriers, handling procedures, application methods, drift minimization measures, and riparian buffers, will greatly reduce the likelihood that significant amounts of herbicide will be transported to aquatic habitats, although some herbicides are still likely to enter streams through aerial drift, in association with eroded sediment in runoff, and dissolved in runoff, including runoff from intermittent streams and ditches. The indirect effects or long-term consequences of invasive, non-native plant control will depend on the long-term progression of climatic factors and the success of follow-up management actions to exclude undesirable species from the action area, provide early detection and rapid response before such species establish a secure position in the plant community, eradicate incipient populations, and control existing populations.

3.1.2.18 Juniper Removal

The direct adverse effects of juniper tree removal will include minor restoration construction effects (*i.e.*, soil compaction, erosion, loss of upland vegetation) caused by the movement of personnel over the action area. Moreover, this action will convert living trees to woody debris and slash that will be left within the action area at densities that are likely to range from less than 1 to more than 8 tons per acre (Azuma *et al.* 2005). This increase in fuel loading will increase the likelihood or intensity of fire, especially during the first 2 to 3 years while needles are still attached, although post-settlement reduction in the extent and return interval of fire is considered to be the most important factor allowing western juniper to expand into neighboring plant communities (Miller *et al.* 2005). Beneficial effects of the juniper removal and retention of slash residue will include increased soil cover that will reduce erosion, increased soil nutrients and organic matter content, and increased distribution and abundance of native vegetation than is otherwise typical for sites that have been degraded by increasing dominance of western juniper. The indirect effects of juniper tree removal using these methods will depend on the long-term progression of climatic factors and the success of follow-up management actions to address fire, livestock management, and other site-specific factors driving woodland succession.

3.1.2.19 Riparian Vegetative Planting

The Action Agencies propose to plant riparian vegetation that would naturally occur in the treatment area. Many authors have discussed the importance of riparian vegetation to stream ecosystems (Dosskey *et al.* 2010; Hicks *et al.* 1991; Murphy and Meehan 1991; Spence *et al.* 1996; Swanston 1991). Streambanks covered with well-rooted woody vegetation have an average critical sheer stress three times that of streambanks weakly vegetated or covered with grass (Millar and Quick 1998). Riparian vegetation also plays an important role in protecting streams from nonpoint source pollutants and in improving the quality of degraded stream water (Dosskey *et al.* 2010).

Planting in riparian areas may result in very minor fine sediment delivery to streams. It could also temporarily flush fish from hiding cover. In the long-term, planting of riparian vegetation will increase shade, hiding cover, LW, and streambank stability. This will improve the survival of juvenile fish by providing appropriate substrate for fry and an increase in cover from predators and high flows. Beneficial effects to fish also include enhanced fitness through improved conditions for forage species and improved reproductive success for adult salmonids as a result of increased deep water cover and holding areas. As plantings mature, width-to-depth ratios of disturbed channels and fine sediment delivery will decrease.

3.1.2.20 Native Fish Protection

This category includes the removal of non-native fish to reduce impacts (predation, competition, and hybridization) of these fish on ESA-listed fishes. This includes the removal of brook trout or other non-native fish species via electrofishing or other manual means to protect bull trout from competition or hybridization. Brook trout, introduced throughout much of the range of bull trout, easily hybridize with them, producing sterile offspring. Brook trout also reproduce earlier and at a higher rate than bull trout, so bull trout populations are often supplanted by these non-natives. Hybridization with brown trout and lake trout is also a problem in some areas. Other non-native fish may prey upon or directly compete with ESA-listed species.

Removal methods, such as dip netting, spearing, and traps would be directed at brook trout or other non-native fish species. Minnow traps could capture nontarget ESA-listed fish species, but this capture method allows the capture and release of juvenile ESA-listed fish with very little harm to individuals. Electrofishing can be an effective measure for controlling non-native brook trout, thus paving the way to native trout recovery (Carmona-Catot *et al.* 2010). Capture mortality to species other than species targeted for removal by electrofishing would be low. Mortality of fish captured by this method would be less than 2% given that NMFS (2000) electrofishing protocol, and specific PDC and timing restrictions for electrofishing within bull trout habitats are included in the proposed action.

Although this category has the potential to harass, kill, or injure some ESA-listed fish, the overall result would be a reduction of non-native fishes that prey on listed species or compete for habitat and food resources. Further, we expect this type of activity would likely occur infrequently. Therefore, the overall threat to ESA-listed fish would be insignificant.

3.1.2.21 Beaver Habitat Restoration

The long-term goal of this category is to restore linear, entrenched, simplified channels to their previously sinuous, structurally complex channels that were connected to their floodplains. This will result in a substantial expansion of riparian vegetation and improved instream habitat. Beavers, which were historically prevalent in many watersheds, build dams that, if they remain intact, will substantially alter the hydrology, geomorphology, and sediment transport within the riparian corridor. Beaver dams will entrain substrate, aggrade the bottom, and reconnect the stream to the floodplain; raise water tables; increase the extent of riparian vegetation; increase pool frequency and depth; increase stream sinuosity and sediment sorting; and lower water temperatures (Pollock *et al.* 2007; Pollock *et al.* 2012b).

The loss of beaver from small stream networks lowers water tables, hampering recovery of willows. Beschta and Ripple (2010) observed that the reintroduction of apex predators, such as wolves in Yellowstone National Park, helped to discourage browsing, allowing recovery of willows along streambanks. However, long-term experiments conducted in the park have shown that restoring physical structure to streams, as well as restoring the historical disturbance and hydrological regimes, requires beaver damming of stream channels (Marshall *et al.* 2013).

The installation of beaver dam support structures, to encourage dam building, may result in very minor fine sediment delivery to streams. Removal of vegetation mechanically will likely adversely affect stream habitat by removing shade trees, which could increase stream temperature in the short term. However, the streams where this action will occur are for the most part incised, lack adequate riparian vegetation, and contribute little to the conservation of the listed fish populations through demonstrated or potential productivity. Long term, the establishment of beavers in these stream reaches will result in the aforementioned benefits to listed fish habitat. To make habitat more suitable to beavers, the Action Agencies will also plant riparian hardwoods, protect hardwoods with enclosures until they are established, and control grazing to the extent possible.

3.1.2.22 Wetland Restoration
Wetland restoration projects using the proposed PDC are likely to have effects similar to those of restoration construction; off-and side channel restoration; set-back of existing berms, dikes, and levees; and removal of water control structures, as described above.

3.1.2.23 Surveys in Support of Restoration Action
Surveys are often conducted as part of a restoration project, including fisheries, hydrology, geomorphology, wildlife, botany, and cultural surveys. For instance, presence/absence fish surveys are often carried out prior to construction activities to determine if fish relocation will be necessary. Proposed fish surveys must only include non-lethal techniques, i.e., snorkel, minnow trapping, not hooking or electrofishing. Engineering surveys are almost always necessary for culvert replacements and other construction activities. When these surveys are carried out within or in close proximity to streams, harassment of listed ESA-listed fish can occur. In some instances, fish are flushed from hiding cover and can become more susceptible to predation. The disturbance typically lasts a few hours and will not have population level effects. No measurable habitat effects are expected from this proposed activity category.

3.1.3 Effects to ESA-listed Salmonids

ESA-listed salmonids under consideration in this Opinion include the bull trout and the Lahontan cutthroat trout. The most intense adverse effects of the proposed action for all fish species result from in- or-near-water construction (i.e., stream crossing replacement projects, channel reconstruction/relocation, *etc.*). The physical and chemical changes in the environment associated with construction, especially decreased water quality (*e.g.*, increased total suspended solids and temperature, and decreased dissolved oxygen), are likely to affect a larger area than direct interactions between fish and construction personnel and equipment. PDC related to in-water work timing, sensitive area protection, fish passage, erosion and pollution control, choice of equipment, in-water use of equipment, herbicide application, and work area isolation are proposed to avoid or reduce these adverse effects. Those measures will ensure that the Action Agencies will 1) not undertake restoration at sites occupied by spawning adult fish or where occupied redds are present; 2) defer construction until the time of year when the fewest fish are present; and 3) otherwise ensure that the adverse environmental consequences of construction are avoided or minimized.

It is still possible that individual adult or embryonic bull trout will be adversely affected by the proposed action even though all in-water construction will occur during the in-water work period before spawning season occurs and after fry have emerged from gravel. In-water work periods are generally designed for salmon and steelhead and may not fully protect bull trout especially in spawning and rearing habitats. Also, in some locations, adult bull trout may be present (either due to migration or residency) during part of the in-water work, and juveniles may still be emerging from the gravel. Additionally, there may be conflicts between inwater work windows for fish and work windows for listed terrestrial species, such as northern spotted owl and marbled murrelet. Therefore, cooperation between the Action Agencies, in cooperation with the State, will be needed to determine the best timing of projects to minimize effects on site-specific basis. The use of heavy equipment in-stream in spawning areas will likely disturb or compact spawning gravel. Upland erosion and sediment delivery will likely increase substrate embeddedness.

These factors make it harder for fish to excavate redds, and decrease redd aeration (Cederholm *et al.*1997). However, the degree of instream substrate compaction and upland soil disturbance likely to occur under most of these actions is so small that significant sedimentation of spawning gravel is unlikely. If, for some reason, an adult fish is migrating in an action area during any phase of construction, it is likely to be able to successfully avoid construction disturbances by moving laterally or stopping briefly during migration, although spawning itself could be delayed until construction was complete (Feist *et al.* 1996; Gregory 1988; Servizi and Martens 1991; Sigler 1988). To the extent that the proposed actions are successful at improving flow conditions, intergravel flow, and fluvial riverine processes, and reducing sedimentation, future spawning success and embryo survival in the action area will be enhanced.

In contrast to migratory adult and embryonic fish that will likely be absent during implementation of most projects, resident adults, sub-adults and juvenile bull trout may be present at some portion of the restoration sites, particularly those located in spawning and rearing habitats, and those located where bull trout exhibit the resident life-history form. At in- or-near-water restoration projects involving construction (i.e., stream crossing replacement projects, channel reconstruction/relocation, *etc.),* some direct effects of the proposed actions are likely to be caused by the isolation of in-water work areas, although other combined lethal and sublethal effects would be greater without the isolation. An effort will be made to capture all Lahontan cutthroat trout and bull trout (all life stages) present within the work isolation area and to release them at a safe location, although some juveniles will likely evade capture and later die when the area is dewatered. Fish that are captured and transferred to holding tanks can experience trauma if care is not taken in the transfer process. Fish can also experience stress and injury from overcrowding in traps, if the traps are not emptied on a regular basis. The primary contributing factors to stress and death from handling are: 1) water temperatures difference between the river and holding buckets; 2) dissolved oxygen conditions; 3) the amount of time that fish are held out of the water; and 4) physical trauma (from capture and handling). Stress from handling increases rapidly if water temperature exceeds 15 ºC (59 ºF), or if dissolved oxygen is below saturation. Debris buildup at traps can also reduce water quality and kill or injure fish if the traps are not monitored and cleared on a regular basis. PDC related to the capture and release of fish during work area isolation will avoid most of these consequences, and ensure that most of the resulting stress is short-lived and non-lethal (Portz 2007).

Rapid changes and extremes in environmental conditions caused by construction are likely to cause a physiological stress response that will change the behavior of juvenile fish (Moberg 2000, Shreck 2000). For example, reduced input of particulate organic matter to streams, addition of fine sediment to channels, and mechanical disturbance of shallow-water habitats are likely to cause displacement from, or avoidance of, preferred rearing areas. Actions that affect stream channel widths are also likely to impair local movements of juvenile fish for hours, days, or longer. Migration will also likely be impaired. These adverse effects vary with the particular life stage and swimming ability, the duration and severity of the stressor, the frequency of stressful situations, the number and temporal separation between exposures, and the number of contemporaneous stressors experienced (Newcombe and Jensen 1996, Shreck 2000).

Juvenile fish compensate for, or adapt to, some of these disturbances so that they continue to perform necessary physiological and behavioral functions, although in a diminished capacity.

However, fish that are subject to prolonged, combined, or repeated stress by the effects of the actions, combined with poor environmental baseline conditions, will likely suffer metabolic costs that are sufficient to impair their rearing, migrating, feeding, and sheltering behaviors and thereby increase the likelihood of injury or death. Because juvenile fish in the project areas are already subject to stress as a result of degraded watershed conditions, it is likely that a small number of those individuals will die due to increased competition, disease, and predation, and reduced ability to obtain food necessary for growth and maintenance (Moberg 2000, Newcombe and Jensen 1996, Sprague and Drury 1969).

In addition to the short-term adverse effects of construction on ESA-listed fishes described above, each type of action will also have the following long-term effects to individual fish. Because each proposed action will increase the amount of habitat available within the underlying stream or river, promote development of more natural riparian and stream channel conditions to improve aquatic functions, or both, the habitat available for fish will be larger, more productive, or both. This will allow more complete expression of essential biological behaviors related to reproduction, feeding, rearing, and migration. In areas where habitat abundance or quality is a limiting factor for ESA-listed fish, the long-term effects of improved access and more productive habitat is likely to increase juvenile survival or adult reproductive success. However, individual response to habitat improvement will also depend on factors, such as the quality and quantity of newly available habitat, and the abundance and nature of the predators, competitors, and available prey (NMFS 2013a, b).

Instantaneous measures of population characteristics, such as population abundance, population spatial structure and population diversity, are the sum of individual characteristics within a particular area, while measures of population change, such as population growth rate, are measured as the productivity of individuals over the entire life cycle (McElhany *et al.* 2000). Thus, although the expected loss of a small number of individuals will have an immediate effect on population abundance at the local scale from those short-tern adverse effects, the effect will not extend to measurable population change unless it reaches a scale that can be observed over an entire life cycle. Because very few project activities are likely to take place within the range of Lahontan cutthroat trout (no projects occurred during the four year period of 2011 through 2014), the likely effects to that species' population are considered insignificant.

Because juvenile-to-adult survival rate for both bull trout and Lahontan cutthroat trout is thought to be quite low, the negative effects of a proposed action would have to impact to large proportions of juvenile fish in a single area or local population before those effects would be equivalent to the death of a single adult, and would have to kill many times more than that to affect the abundance or productivity of the entire local population over a full life cycle. Moreover, because the geographic area that will be affected by the proposed programmatic action is so large for bull trout, the numbers of juvenile fish that are likely to be killed are spread out across dozens of local populations. The adverse effects of each individual restoration action will be too infrequent, short-term, and limited to kill more than a small proportion of juvenile bull trout at any particular site. As such, these effects across the range of a single local population are further reduced, especially when that number is even partly distributed among all local populations within the action area. Thus, the proposed actions will simply kill too few fish, as a function of the size of the affected populations and the habitat carrying capacity, to meaningfully affect the primary attributes of abundance or population growth rate for any single, local population of bull trout. As previously mentioned, although some projects could occur that affect Lahontan cutthroat trout, these actions will be too small and too infrequent to cause population declines.

Another population attribute is within-population spatial structure, a characteristic that depends primarily on spawning group distribution and connectivity, and diversity, which is based on a combination of genetic and environmental factors (McElhany *et al.* 2000). Because the proposed actions are only likely to have short-term adverse effects to spawning sites, if any, and will improve spawning habitat attributes in the long-term, they are unlikely to adversely affect spawning group distributions or within-population spatial structure. Actions that restore fish passage and connectivity between isolated populations will improve population spatial structure. Similarly, because the proposed action does not affect basic demographic processes through human selection, alter environmental processes by reducing environmental complexity, or otherwise limit a population's ability to respond to natural selection, the action will not adversely affect population diversity.

At the species level, biological effects are synonymous with those at the population level or, more likely, are the integrated demographic response of one or more subpopulations (McElhany *et al.* 2000). Because the likely adverse effects of any action funded or carried out under this Opinion will not adversely affect the overall population characteristics of any ESA-listed fish population, the proposed actions also will not have any a measurable effect on species-level abundance, productivity, or the ability to recover bull trout or Lahontan cutthroat trout across their ranges.

The effects of proposed action, as a whole, on both trout and Lahontan cutthroat considered in this Opinion will be the combined effects of all of the individual actions that are funded or carried out under this Opinion. Combining the effects of many actions does not change the nature of the effects caused by individual actions, but does require an analysis of the additive effects of multiple occurrences of the same type of effects at the individual fish, population, and species scales. If the adverse effects of one action are added to the effects of one or more additional actions in the same place and time, individual fish will likely experience a more significant adverse effect than if only one action was present. This would occur when the restoration sites for two or more recovery actions overlap, *i.e.,* are placed within 30.5 to 91.4 m (100 to 300 feet) of each other and are constructed at approximately the same time.

Over time the numbers of projects may decrease as funding becomes less available and the obvious restoration sites are completed and only more comprehensive large scale projects, such as channel reconstruction/relocation projects, are implemented. It is very unlikely that two or more projects would occur within 30.5 to 91.4 m (100 to 300 feet) of each other. Further, the strong emphasis on use of proposed PDC to minimize the short-term adverse effects of these actions, the small size of individual action areas, and the design of actions that are likely to result in a long-term improvement in the function and conservation value of each action area will ensure that individual fish will not suffer greater adverse effects if two or more action areas do overlap. Moreover, the rapid onset of beneficial effects from these types of actions is likely to improve the baseline for subsequent actions so that adverse effects are not likely to be additive at the population or watershed scale.

3.1.4 Scope of Effects to ESA-listed Fishes

The specific anticipated amount and effects of capture are discussed for individual species in the subsequent sections. The scope of effects from other actions to ESA-listed fishes under this Opinion can be described best by looking at the likely number of effects, and by using various metrics to understand those effects by general activity type.

3.1.5 Suspended Sediment and Contaminants

Near and instream construction activities required for many activities will result in an increase in suspended sediment and possibly contaminants that will cause juvenile, sub-adult and adult fish to move away from the action area. ESA-listed fishes exposed to suspended sediment are likely to experience gill abrasion, decreased feeding, stress, or be unable to use the action area, depending on the severity of the suspended sediment release. On occasions some fish may die if sediment is too severe, or if they are unable to move away from the affected area. ESA-listed fishes exposed to petroleum-based contaminants, such as fuel, oil, and some hydraulic fluids, are likely to be killed or suffer acute and chronic sublethal effects. Acute sublethal effects could range from harassment to minor irritation of skin or membranes, chronic sublethal effects could cause gill damage, with resultant respiratory difficulties or illness which would affect growth, and make fish more prone to predation. Construction activities will also cause a minor increase in fine sediment levels in downstream substrates, temporarily reducing the value of that habitat for spawning rearing, and foraging.

The Service estimates that these projects could increase sedimentation up to10% over background levels. The turbidity plume generated by construction activities is visible above background levels and, will result in about a 10% increase in natural stream turbidity downstream from the project area source. A turbidity flux would likely be measureable downstream from a nonpoint discharge a proportionately shorter distance in small streams than large streams. Turbidity would also more likely be measureable for a greater distance for project areas that are subject to tidal or coastal scour (Rosetta 2005). Because of the wide variability of project types, locations and site-specific stream conditions it is impossible to accurately estimate the exact footprint that these projects will have. However, the effects of these projects must comply with EPA direction and State water quality standards, which were designed to insure reasonable protection for aquatic species. Therefore, the extent of measured effects for this category is as follows – a visible increase in suspended sediment (as estimated using turbidity measurements, as described in the Incidental Take Statement) up to 16 m (50 feet) from the project area in streams that are 9.14 m (30 feet) wide or less, up to 30.5 m (100 feet) from the discharge point or nonpoint source of runoff for streams between 9.14 and 30.5 m (30 and 100 feet) wide, up to 61 m (200 feet) from the discharge point or nonpoint source for streams greater than 30.5 m (100 feet) wide, or up to 91.4 m (300 feet) from the discharge point or nonpoint source for areas subject to tidal or coastal scour.

While this increase in turbidity will adversely affect ESA-listed fish, it is likely that most fish will move away from this disturbance rather quickly if they have the ability to do so. This is particularly true of adult bull trout who exhibit extreme sensitivity to sedimentation.

3.1.6 Construction-related Disturbance of Streambank and Channel Areas

The best available indicator for the extent of take due to construction-related disturbance of streambank and channel areas is the total length of stream reach that will be modified by construction each year. This variable is proportional to the amounts of harm that each action is likely to cause through short-term degradation of water quality and physical habitat. The Action Agencies reported for 2010 to 2012 that nearly nine linear-miles of channel and stream banks were restored on 16 restoration projects, which is roughly 0.56 stream miles per project. These 16 projects represented approximately one-fourth (25%) of the 63 total projects reported in that period.

In this Opinion, about 32 stream bank-and channel-altering actions per year (25% of 126 total projects = 32, rounded up) may be funded or carried out under this Opinion. Therefore, the estimated extent of effects to habitat for construction-related disturbance of streambank and channel areas is up to 29 linear km (32 projects x 0.9 km = 28.8 km) or 29,000 stream-meters on average per year across the action area. In English units, this is equivalent to 18 linear miles (32 projects x 0.56 miles = 17.92 miles) (94,618 stream-feet). (NMFS 2013b).

3.1.7 Construction and Vegetation Treatment Related Disturbance of Upland, Wetland and Estuary Areas

Some projects that do not require in-water or near-water construction will nonetheless injure or kill ESA-listed juveniles and adults. These effects will occur primarily due to increased delivery of fine sediments to streams due to activities in upland or wetland areas, or by road restoration projects. For example, prescribed burning will expose soils in upland areas, resulting in increased erosion and production of fine sediments that can be routed to streams, thus reducing productivity and survival or growth of juvenile fish. Other actions such as surveys and nutrient enhancement are likely to result in harassing fish sufficiently to flush them from areas with overhead cover and thus become more susceptible to predation. These types of impacts are expected to occur infrequently, but will nonetheless occur over large areas

To measure those effects to ESA-listed fishes as discussed previously in this Opinion, the extent of adverse effects is best identified by the total number of road miles and vegetation acres treated in each individual recovery unit (IRU) or affected basin (Table 3 from the PROJECTS BA) with a factor of increase (100%) in activity per year. The Action Agencies reported for 2010 to 2012 that nearly 9 linear-miles of channel and stream banks were restored on 16 restoration projects, which is roughly 0.56 stream miles per project. These 16 projects represented approximately one-fourth (25% of the 63 total projects. In this Opinion, about 32 stream bank- and channel-altering actions per year (25% of 126 total projects = 31.5; rounded up to 32) may be funded or carried out under this Opinion. Therefore, the estimated extent of effects to habitat for construction-related disturbance of streambank and channel areas is up to 29 linear km (32 projects x 0.9 km = 28.8 km) or 29,000 stream-meters on average per year across the action area. In English units, this is equivalent to 18 linear miles (32 projects x 0.56 miles = 17.92 miles) (94,618 stream-feet). (NMFS 2013b).

3.1.8 Invasive and Non-native Plant Control

Application of manual, mechanical, or chemical plant controls will result in short-term reduction of vegetative cover or soil disturbance and degradation of water quality which will cause injury to fish in the form of sublethal adverse physiological effects. This is particularly true for herbicide applications in riparian areas or in ditches that may deliver herbicides to streams occupied by ESA-listed fish. These sublethal effects, described in the effects analysis for this Opinion, will include increased respiration, reduced feeding success, and subtle behavioral changes that can result in predation. Direct measurement of herbicide transport using the most commonly accepted method of residue analysis (e.g., liquid chromatography–mass spectrometry, Pico *et al.* 2004) are burdensome and expensive for the type and scale of herbicide applications proposed. Thus, use of those measurements in to determine the extent of adverse effects is likely to outweigh any benefits of using herbicide as a simple and economical restoration tool, and act as an insurmountable disincentive to their use for plant control under this Opinion. Further, the use of simpler, indirect methods, such as olfactometric tests, do not correlate well with measured levels of the airborne pesticides, and may raise ethical questions (Brown *et al.* 2000) that cannot be resolved in consultation. Therefore, the Service has determined that the best available approach to manage the extent of adverse effects due to the proposed invasive plant control is to cap the extent of treated areas to less than, or equal to, 10% of the acres in a Riparian Reserve or riparian habitat conservation areas (RHCA) within a 6^{th} field HUC watershed/year (see PDC 29, Invasive Species and Non-native Plant Control).

3.1.9 Effects at the Population Scale for ESA-listed Fishes

The multiple individual populations potentially affected by the proposed program vary considerably in their biological status. The species addressed in this Opinion have declined due to numerous factors. The one factor for decline that all the aquatic species share is degradation of freshwater habitat (in addition to estuarine habitat for bull trout). Human development of the Pacific Northwest has caused significant negative changes to stream and estuary habitat across the range of these species. The environmental baseline varies across the program area, but habitat will generally be degraded at sites selected for restoration actions, which makes them a candidate for project implementation.

The programmatic nature of the action prevents a precise analysis of each action that eventually will be funded or carried out under this Opinion, although each type of action will be carefully designed and constrained by comprehensive PDC and conservation measures such that the proposed activities will cause only short-term, localized, and relatively minor effects. Also, actions are likely to be widely distributed within and across all IRUs or affected basins, so adverse effects will not be concentrated in time or space within the range of any listed species. In the long-term, these actions will contribute to a lessening of many of the factors limiting the recovery of these species, particularly those factors related to fish passage, degraded floodplain connectivity, reduced aquatic habitat complexity, and riparian conditions, and improve the currently-degraded environmental baseline, particularly at the site scale. A very small number of individual fish, far too few to affect the abundance, productivity, distribution, or genetic diversity of any ESA-listed fish population, will be affected by the adverse effects of any single action permitted under the proposed action. Because characteristics at the population scale will not be affected, the likelihood of survival and recovery of the listed species will not be appreciably reduced by the proposed action.

Individuals of many ESA-listed fish species use the action area for residency, migration, spawning and rearing portions of their life cycle; some bull trout migrate widely and rear in the action area, and some use portions of the action area as residents only occasionally migrating between streams to forage and spawning. The Service identified many factors associated with the life cycle of ESA-listed fishes that are limiting the recovery of these various species. These factors include, but are not limited to, elevated water temperatures, excessive sediment, reduced access to spawning and rearing areas, reductions in habitat complexity, instream wood, and channel stability; degraded floodplain structure and function, and reduced flow. Cumulative effects within the action area described in Section 4 are likely to have a small negative effect on ESA-listed fish population abundance, productivity, and some short-term negative effects on spatial structure (short-term blockages of fish passage). Actions carried out under the proposed program will address and help to alleviate many of these limiting factors in the long run.

3.1.10 Conclusion for ESA-listed Fishes

After reviewing the current status of the listed species, the environmental baseline within the action area, the direct and indirect effects of the proposed action, and cumulative effects, it is the Service's biological opinion that the proposed action is not likely to jeopardize the continued existence of bull trout, Lahotan cutthroat trout, or Warner sucker, or destroy or adversely modify critical habitat designated for these species.

This no jeopardy finding for ESA-listed fishes is supported by the following:

1. While the proposed restoration projects will cause some adverse effects to ESA-listed fishes, these effects will be short-term and localized, and thus relatively minor to the fish populations. Because restoration actions will contribute to a lessening of many of the factors limiting the recovery of these species, particularly those factors related to fish passage, degraded floodplain connectivity, reduced aquatic habitat complexity, and riparian conditions, and improve habitats above the degraded environmental baseline, (particularly at the site scale), we anticipate these projects will support the recovery of ESA-listed fishes in the long-term.
2. While the proposed restoration activities will have site-specific effects, we anticipate individual projects are likely to be widely distributed within and across all bull trout IRUs or affected basins, so adverse effects will not be concentrated in time or space within the range of any listed species.
3. The proposed PDC and conservation measures will greatly reduce the duration and extent of any adverse effects to individual fish or their habitats.
4. While some restoration activities and resulting exposures are likely to result in injury or mortality for individuals, we expect very few individual fish to be adversely affected per project; far too few to affect the abundance, productivity, distribution, or genetic diversity of any ESA-listed fish population. The Service expects that the number and productivity of any ESA-listed fish species will not be appreciably reduced or diminished across the

ranges of each fish species. As the quality and quantity of habitat is improved, the long term viability of local populations will likely be enhanced.

3.1.11 Literature Cited for ESA-listed Fishes (Section 3.1)

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3.2 Bull Trout Status

3.2.1 Legal Status

The coterminous U.S. population of the bull trout was listed as threatened on November 1, 1999 (USFWS 1999a). The threatened bull trout generally 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. 4; Brewin *et al.* 1997, pp. 209-216; Cavender 1978, pp. 165-166; Leary and Allendorf 1997, pp. 715-720).

Throughout its range, the 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, entrainment (a process by which aquatic organisms are pulled through a diversion or other device) into diversion channels, and introduced non-native species (USFWS 1999a). 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; Rieman *et al.* 2007; Porter and Nelitz 2009, pp. 4-8). Poaching and incidental mortality of bull trout during other targeted fisheries are additional threats.

The bull trout was initially listed as three separate Distinct Population Segments (DPSs) (USFWS 1998a, 1998b,1999b). The preamble to the final listing rule for the U.S. coterminous population of the bull trout discusses the consolidation of these DPSs with the Columbia and Klamath population segments into one listed taxon and the application of the jeopardy standard under section 7 of the ESA relative to this species (USFWS 1999a).

3.2.2 Critical Habitat

The Service published a final critical habitat designation for the coterminous U.S. population of the bull trout on October 18, 2010 (USFWS 2010); the rule became effective on November 17, 2010. A justification document was also developed to support the rule and is available on our website (http://www.fws.gov/pacific/bulltrout). The scope of the designation involved the species' coterminous range, which includes the Jarbidge River, Klamath River, Columbia River, Coastal-Puget Sound, and Saint Mary-Belly River population segments (also considered as interim recovery units)[23]. Rangewide, the Service designated reservoirs/lakes and stream/shoreline miles as bull trout critical habitat (Table 6). Designated bull trout critical habitat is of two primary use types: 1) spawning and rearing, and 2) foraging, migration, and overwintering.

[23] The USFWS's 5 year review (USFWS 2008, pg. 9) identifies six draft recovery units. Until the bull trout draft recovery plan is finalized, the current five interim recovery units are in affect for purposes of section 7 jeopardy analysis and recovery. The adverse modification analysis does not rely on recovery units.

Table 6. 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
*Pine Creek Drainage which falls within Oregon				

The 2010 revision increases the amount of designated bull trout critical habitat by approximately 76% for miles of stream/shoreline and by approximately 71% for acres of lakes and reservoirs compared to the 2005 designation.

The final rule also identifies and designates as critical habitat approximately 822.5 miles (1,323.7 km) of streams/shorelines and 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. No unoccupied habitat was included in the 2005 designation. 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 (USFWS 2010). Excluded areas are approximately 10% of the stream/shoreline miles and 4% of the lakes and reservoir acreage of designated critical habitat. Each excluded area is identified in the relevant Critical Habitat Unit (CHU) text, as identified in paragraphs (e)(8) through (e)(41) of the final rule. 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. Because exclusions reflect the often complex pattern of land ownership, designated critical habitat is often fragmented and interspersed with excluded stream segments.

3.2.2.1 The Primary Constituent Elements (PCEs)

The conservation role of bull trout critical habitat is to support viable core area populations (USFWS 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 foraging, migration, and overwintering areas, outside of core areas, that are important to the survival and recovery of bull trout.

Thirty-two CHUs within the geographical area occupied by the species at the time of listing are designated under the revised 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 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).

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 this species and the characteristics of the habitat necessary to sustain its essential life-history functions, we have determined that the PCEs are essential for the conservation of bull trout (USFWS 2010). A summary of those PCEs follows:

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 LW, 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.

The revised PCE's are similar to those previously in effect under the 2005 designation. The most significant modification is the addition of a ninth PCE to address the presence of non-native 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 foraging, migration, and overwintering habitat designated as critical habitat.

Critical habitat 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 OHW 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 m (33 feet), 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 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 can have major effects on physical and biological features of the aquatic environment.

Activities that cause adverse effects to critical habitat are evaluated to determine if they are likely to “destroy or adversely modify” critical habitat by no longer serving the intended conservation role for the species or retaining 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 (USFWS 2010). 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 (USFWS 2010). 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 (USFWS 2010).

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 (USFWS 2002f). 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 non-native species (USFWS 1998a, 1999b).

There is widespread agreement in the scientific literature that many factors related to human activities have impacted bull trout and their habitat, 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 non-native 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 foraging, migration, and overwintering habitat, and the degradation and loss of marine nearshore foraging and migration habitat due to urban and residential development; and 5) degradation of foraging, migration, and overwintering habitat resulting from reduced prey base, roads, agriculture, development, and dams.

3.2.2.2 Effects of Climate Change on Bull Trout Critical Habitat

One objective of the final critical habitat 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).

3.2.3 Species Description

Bull trout have unusually large heads and mouths for salmonids. Their body colors can vary tremendously depending on their environment, but are often brownish green with lighter (often ranging from pale yellow to crimson) colored spots running along their dorsa and flanks, with spots being absent on the dorsal fin, and light colored to white under bellies. They have white leading edges on their fins, as do other species of char. Bull trout have been measured as large as 103 cm (41 inches) in length, with weights as high as 14.5 kg (32 pounds) (Fishbase 2011). Bull trout may be migratory, moving throughout large river systems, lakes, and even the ocean in coastal populations, or they may be resident, remaining in the same stream their entire lives (USFWS 2011). Migratory bull trout are typically larger than resident bull trout (USFWS 1998a).

3.2.3.1 Taxonomy

The bull trout (Salvelinus confluentus) is a native char found in the coastal and intermountain west of North America. Dolly Varden (*Salvelinus malma)* and bull trout were previously considered a single species and were thought to have coastal and interior forms. However, Cavender (1978) described morphometric, meristic and osteological characteristics of the two forms, and provided evidence of specific distinctions between the two. In 1980, the American Fisheries Society formally recognized bull trout and Dolly Varden as separate species (Robins *et al.* 1980). Despite an overlap in the geographic range of bull trout and Dolly Varden in the Puget Sound area and along the British Columbia coast, there is little evidence of introgression (Hass and McPhail 1991). The Columbia River Basin is considered the region of origin for the bull trout. From the Columbia, dispersal to other drainage systems was accomplished by marine migration and headwater stream capture. Behnke and Benson (1980) postulated dispersion to drainages east of the continental divide may have occurred through the North and South Saskatchewan Rivers (Hudson Bay drainage) and the Yukon River system. Marine dispersal may have occurred from Puget Sound north to the Fraser, Skeena and Taku Rivers of British Columbia.

3.2.3.2 Life History

Ecology / Habitat Characteristics

Bull trout have more specific habitat requirements than most other salmonids (Rieman and McIntyre 1993). 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; Goetz 1989; Hoelscher and Bjornn 1989; Howell and Buchanan 1992; Pratt 1992; Rich 1996; Rieman and McIntyre 1993; Rieman and McIntyre 1995; Sedell and Everest 1991; Watson and Hillman 1997). Watson and Hillman (1997) 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), bull trout should not be expected to simultaneously occupy all available habitats (Rieman *et al.* 1997b).

Migratory habitat links seasonally used areas for all bull trout life histories. The ability to migrate is important to the persistence of bull trout (Rieman *et al.* 1997b; Rieman and McIntyre 1993). 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 local populations, which may encourage local adaptation within individual populations, and that reestablishment of extirpated populations may take a long time (Rieman and McIntyre 1993; Spruell *et al.* 1999). 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 below 15° C (59 °F), and spawning habitats are generally characterized by temperatures that drop below 9° C (48 °F) in the fall (Fraley and Shepard 1989; Pratt 1992; Rieman and McIntyre 1993).

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 (Baxter *et al.* 1997; Pratt 1992; Rieman *et al.* 1997b; Rieman and McIntyre 1993). Optimum incubation temperatures for bull trout eggs range from about 2 to 4 °C (35 to 39 °F) whereas optimum water temperatures for rearing range from about , 7 to 10 °C (46 to 50 °F) (Buchanan and Gregory 1997; Goetz 1989; McPhail and Murray 1979). In Granite Creek, Idaho, Bonneau and Scarnecchia (1996) observed that juvenile bull trout selected the coldest water available in a plunge pool, 7 to 9 °C (46 to 48 °F) (within a temperature gradient of 4.5 to 16 °C (40 to 60 °F). In a landscape study relating bull trout distribution to maximum water temperatures, Dunham *et al.* (2003) 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 to 12 °C (52 to 54 °F).

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; Fraley and Shepard 1989; Rieman *et al.* 1997b; Rieman and McIntyre 1993; Rieman and McIntyre 1995). Availability and proximity of cold water patches and food productivity can influence bull trout ability to survive in warmer rivers (Myrick *et al.* 2002). For example, in a study in the Little Lost River of Idaho where bull trout were found at temperatures ranging from 7.8 to 20 °C (46 to 68 °F), most sites that had high densities of bull trout were in areas where primary productivity in streams had increased following a fire (Bart L. Gamett, Salmon-Challis NF, *pers. comm*. June 20, 2002).

All life history stages of bull trout are associated with complex forms of cover, including LW, undercut banks, boulders, and pools (Fraley and Shepard 1989; Goetz 1989; Hoelscher and Bjornn 1989; Pratt 1992; Rich 1996; Sedell and Everest 1991; Sexauer and James 1997; Thomas 1992; Watson and Hillman 1997). Maintaining bull trout habitat requires stability of stream channels and maintenance of natural flow patterns (Rieman and McIntyre 1993). Juvenile and adult bull trout frequently inhabit side channels, stream margins, and pools with suitable cover (Sexauer and James 1997). 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; Pratt 1992; Pratt and Huston 1993). Pratt (1992) indicated that increases in fine sediment reduce egg survival and emergence.

Bull trout are opportunistic feeders, with food habits primarily a function of size and life-history strategy. A single optimal foraging strategy is not necessarily a consistent feature in the life of a fish, because this strategy can change as the fish progresses from one life stage to another (i.e., juvenile to subadult). Fish growth depends on the quantity and quality of food that is eaten (Gerking 1994), and as fish grow, their foraging strategy changes as their food changes, in quantity, size, or other characteristics. Resident and juvenile migratory bull trout prey on terrestrial and aquatic insects, macrozooplankton, and small fish (Boag 1987; Donald and Alger

1993; Goetz 1989). Subadult and adult migratory bull trout feed on various fish species (Brown 1994; Donald and Alger 1993; Fraley and Shepard 1989; Leathe and Graham 1982). Bull trout of all sizes other than fry have been found to eat fish half their length (Beauchamp and VanTassell 2001). 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; WDFW *et al.* 1997).

Bull trout migration and life history strategies are closely related to their feeding and foraging strategies. Migration allows bull trout to access optimal foraging areas and exploit a wider variety of prey resources. Optimal foraging theory can be used to describe strategies fish use to choose between alternative sources of food by weighing the benefits and costs of capturing one source of food over another. For example, prey often occurs in concentrated patches of abundance ("patch model"; Gerking 1994). As the predator feeds in one patch, the prey population is reduced, and it becomes more profitable for the predator to seek a new patch rather than continue feeding on the original one. This can be explained in terms of balancing energy acquired versus energy expended. For example, 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). 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; Goetz *et al.* 2004).

Reproduction

The iteroparous reproductive strategy 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 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 15.2 to 30.5 cm (6 to 12 inches) total length, and migratory adults commonly reach 61 cm (24 inches) or more (Goetz 1989; Pratt 1985). The largest verified bull trout is a 32-pound specimen caught in Lake Pend Oreille, Idaho, in 1949 (Simpson and Wallace 1982).

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). Redds are often constructed in stream reaches fed by springs or near other sources of cold groundwater (Goetz 1989; Pratt 1992; Rieman and McIntyre 1996). Depending on water temperature, incubation is normally 100 to 145 days (Pratt 1992). After hatching, fry remain in the substrate, and time from egg deposition to emergence may surpass 200 days. Fry normally emerge from early April through May, depending on water temperatures and increasing stream flows (Pratt 1992; Ratliff and Howell 1992).

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) indicates that adverse effects of lower oxygen concentrations on embryo survival are magnified as temperatures increase above optimal (for incubation). In a laboratory study conducted in Canada, researchers found that low oxygen levels retarded embryonic development in bull trout (Giles and Van der Zweep 1996 in Stewart *et al.* 2007). 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). 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). 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). 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 (Fraley and Shepard 1989; Goetz 1989). 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; Goetz 1989), or saltwater (anadromous form) to rear as subadults and to live as adults (Cavender 1978; McPhail and Baxter 1996; WDFW *et al.* 1997). 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; Leathe and Graham 1982; Pratt 1992; Rieman and McIntyre 1996).

Migratory forms of bull trout may develop when habitat conditions allow movement between spawning and rearing streams and larger rivers, lakes or nearshore marine habitat where foraging opportunities may be enhanced (Brenkman and Corbett 2005; Frissell 1993; Goetz *et al.* 2004). 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). Parts of this river system have retained habitat conditions that allow free movement between spawning and rearing areas and the mainstem Snake River. Such multiple life history strategies help to maintain the stability and persistence of bull trout populations to environmental changes. Benefits to 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; MBTSG 1998; Rieman and McIntyre 1993). 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).

Whitesel *et al.* (2004) noted that although there are multiple resources that contribute to the subject, Spruell *et al.* (2003) best summarized genetic information on bull trout population structure. Spruell *et al.* (2003) 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). They were characterized as:

1 - “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.

2 - “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.

3 - “Upper Columbia River” which includes the entire basin in Montana and northern Idaho. A tentative assignment was made by Spruell *et al.* (2003) of the Saskatchewan River drainage populations (east of the continental divide), grouping them with the upper Columbia River group.

Spruell *et al.* (2003) noted that within the major assemblages, populations were further subdivided, primarily at the level of major river basins. Taylor *et al.* (1999) surveyed bull trout populations, primarily from Canada, and found a major divergence between inland and coastal populations. Costello *et al.* (2003) suggested the patterns reflected the existence of two glacial refugia, consistent with the conclusions of Spruell and the biogeographic analysis of Haas and McPhail (2001). Both Taylor *et al.* (1999) and Spruell *et al.* (2003) concluded that the Deschutes River represented the most upstream limit of the coastal lineage in the Columbia River Basin.

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). Increased habitat fragmentation reduces the amount of available habitat and increases isolation from other populations of the same species (Saunders *et al.* 1991). Burkey (1989) 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, 1995).

Metapopulation concepts of conservation biology theory have been suggested relative to the distribution and characteristics of bull trout, although empirical evidence is relatively scant (Rieman and McIntyre 1993, Dunham and Rieman 1999, Rieman and Dunham 2000). A metapopulation is an interacting network of local populations with varying frequencies of migration and gene flow among them (Meffe and Carroll 1994). 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). 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 1997a, Dunham and Rieman 1999, Spruell *et al.* 1999, Rieman and Dunham 2000).

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). 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) 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). Recent research (Whiteley *et al.* 2003) does, however, provide genetic evidence for the presence of a metapopulation process for bull trout, at least in the Boise River Basin of Idaho.

3.2.4 Summary of Historical Status and 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, Bond 1992). To the west, the bull trout's range includes Puget Sound, various coastal rivers of British Columbia, Canada, and southeast Alaska (Bond 1992). 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, Brewin *et al.* 1997).

3.2.5 Current Rangewide Status and Distribution

Each of the five interim recovery units is necessary to maintain the bull trout's distribution, as well as its genetic and phenotypic diversity, all of which are important to ensure the species' resilience to changing environmental conditions. No new local populations have been identified and no local populations have been lost since listing.

Jarbidge River Interim Recovery Unit
The Jarbidge River interim recovery unit currently contains a single core area with six local populations. Less than 500 resident and migratory adult bull trout, representing about 50 to 125 spawning adults, are estimated to occur in the core area. The current condition of the bull trout in this interim recovery unit is attributed to the effects of livestock grazing, roads, incidental mortalities of released bull trout from recreational angling, historic angler harvest, timber harvest, and the introduction of non-native fishes (USFWS 2004b). The draft bull trout recovery plan (USFWS 2004b) identifies the following conservation needs for this interim recovery unit: 1) maintain the current distribution of the bull trout within the core area; 2) maintain stable or increasing trends in abundance of both resident and migratory bull trout in the core area; 3) restore and maintain suitable habitat conditions for all life history stages and forms; and 4) conserve genetic diversity and increase natural opportunities for genetic exchange between resident and migratory forms of the bull trout. An estimated 270 to 1,000 spawning bull trout per year are needed to provide for the persistence and viability of the core area and to support both resident and migratory adult bull trout (USFWS 2004b).

Klamath River Interim Recovery Unit
The Klamath River interim recovery unit currently contains three core areas and eight local populations. The current abundance, distribution, and range of the bull trout in the Klamath River Basin are greatly reduced from historical levels due to habitat loss and degradation caused by reduced water quality, timber harvest, livestock grazing, water diversions, roads, and the introduction of non-native fishes (USFWS 2002b). Bull trout populations in this interim recovery unit face a high risk of extirpation (USFWS 2002b). The draft Klamath River bull trout recovery plan (USFWS 2002b) identifies the following conservation needs for this interim recovery unit: 1) maintain the current distribution of bull trout and restore distribution in previously occupied areas; 2) maintain stable or increasing trends in bull trout abundance; 3) restore and maintain suitable habitat conditions for all life history stages and strategies; 4) conserve genetic diversity and provide the opportunity for genetic exchange among appropriate core area populations. Eight to 15 new local populations and an increase in population size from about 2,400 adults currently to 8,250 adults are needed to provide for the persistence and viability of the three core areas (USFWS 2002b).

Columbia River Interim Recovery Unit
The Columbia River interim recovery unit includes bull trout residing in portions of Oregon, Washington, Idaho, and Montana. Bull trout are estimated to have occupied about 60% of the Columbia River Basin, and presently occur in 45% of the estimated historical range (Quigley and Arbelbide 1997, p.1177). This interim recovery unit currently contains approximately 97 core

areas and 527 local populations. About 65% of these core areas and local populations occur in central Idaho and northwestern Montana. The bull trout in the Columbia River interim recovery unit have declined in overall range and numbers of fish (USFWS 1998a). The condition of the bull trout within these core areas varies from poor to good. All core areas have been subject to the combined effects of habitat degradation and fragmentation caused by the following activities: 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 into diversion channels; and introduced non-native species. Although some strongholds still exist with migratory fish present, bull trout generally occur as isolated local populations in headwater lakes or tributaries where the migratory life history form has been lost. Though still widespread, there have been numerous local extirpations reported throughout the Columbia River basin. The Service completed a 5-year status review and determined that, of the 97 core areas in this interim recovery unit, 38 are at high risk of extirpation, 35 are at risk, 20 are at potential risk, 2 are at low risk, and 2 are at unknown risk (USFWS 2005).

The draft Columbia River bull trout recovery plan (USFWS 2002d) identifies the following conservation needs for this interim recovery unit: 1) maintain or expand the current distribution of the bull trout within core areas; 2) maintain stable or increasing trends in bull trout abundance; 3) restore and maintain suitable habitat conditions for all bull trout life history stages and strategies; and 4) conserve genetic diversity and provide opportunities for genetic exchange.

Coastal-Puget Sound Interim Recovery Unit
Bull trout in the Coastal-Puget Sound interim recovery unit exhibit anadromous, adfluvial, fluvial and resident life history patterns. The anadromous life history form is unique to this interim recovery unit. This interim recovery unit currently contains 14 core areas and 67 local populations (USFWS 2004a). Bull trout are distributed throughout most of the large rivers and associated tributary systems within this interim recovery unit. Bull trout continue to be present in nearly all major watersheds where they likely occurred historically, although local extirpations have occurred throughout this interim recovery unit. Many remaining populations are isolated or fragmented and abundance has declined, especially in the southeastern portion of the interim recovery unit. The current condition of the bull trout in this interim recovery unit is attributed to the adverse effects of dams, forest management practices (e.g., timber harvest and associated road building activities), agricultural practices (e.g., diking, water control structures, draining of wetlands, channelization, and the removal of riparian vegetation), livestock grazing, roads, mining, urbanization, poaching, incidental mortality from other targeted fisheries, and the introduction of non-native species. The draft Coastal-Puget Sound bull trout recovery plan (USFWS 2004a) identifies the following conservation needs for this interim recovery unit: 1) maintain or expand the current distribution of bull trout within existing core areas; 2) increase bull trout abundance to about 16,500 adults across all core areas; and 3) maintain or increase connectivity between local populations within each core area.

St. Mary-Belly River Interim Recovery Unit
This interim recovery unit currently contains six core areas and nine local populations (USFWS 2002c). Bull trout are widely distributed in the St. Mary-Belly River drainage and occur in nearly all of the waters that it inhabited historically. Bull trout are found only in a 1.2-mile reach of the North Fork Belly River within the U.S. Redd count surveys of the North Fork Belly River

documented an increase from 27 redds in 1995 to 119 redds in 1999. This increase was attributed primarily to protection from angler harvest (USFWS 2002c). The current condition of the bull trout in this interim recovery unit is primarily attributed to the effects of dams, water diversions, roads, mining, and the introduction of non-native fishes (USFWS 2002c). The draft St. Mary-Belly bull trout recovery plan (USFWS 2002c) identifies the following conservation needs for this interim recovery unit: 1) maintain the current distribution of the bull trout and restore distribution in previously occupied areas; 2) maintain stable or increasing trends in bull trout abundance; 3) restore and maintain suitable habitat conditions for all life history stages and forms; 4) conserve genetic diversity and provide the opportunity for genetic exchange; and 5) establish good working relations with Canadian interests because local bull trout populations in this interim recovery unit are comprised mostly of migratory fish, whose habitat is mostly in Canada.

3.2.6 Threats, Reasons for Listing

Bull trout distribution, abundance, and habitat quality have declined rangewide (Bond 1992, Schill 1992, Thomas 1992, Ziller 1992, Rieman and McIntyre 1993, Newton and Pribyl 1994, McPhail and Baxter 1996). Several local extirpations have been documented, beginning in the 1950s (Rode 1990, Ratliff and Howell 1992, Donald and Alger 1993, Goetz 1994, Newton and Pribyl 1994, Berg and Priest 1995, Light *et al.* 1996, Buchanan *et al.* 1997, WDFW 1998). Bull trout were extirpated from the southernmost portion of their historic range, the McCloud River in California, around 1975 (Moyle 1976, Rode 1990). Bull trout have been functionally extirpated (i.e., few individuals may occur there but do not constitute a viable population) in the Coeur d'Alene River basin in Idaho and in the Lake Chelan and Okanogan River basins in Washington (USFWS 1998a).

These declines result from the combined effects of habitat degradation and fragmentation, the blockage of migratory corridors; poor water quality, angler harvest and poaching, entrainment (process by which aquatic organisms are pulled through a diversion or other device) into diversion channels and dams, and introduced non-native species. Specific land and water management activities that depress bull trout populations and degrade habitat include the effects of dams and other diversion structures, forest management practices, livestock grazing, agriculture, agricultural diversions, road construction and maintenance, mining, and urban and rural development (Beschta *et al.* 1987; Chamberlain *et al.* 1991; Furniss *et al.* 1991; Meehan 1991; Nehlsen *et al.* 1991; Sedell and Everest 1991; Craig and Wissmar 1993; Frissell 1993; Henjum *et al.* 1994; McIntosh *et al.* 1994; Wissmar *et al.* 1994; MBTSG 1995a-e, 1996a-f; Light *et al.* 1996; USDA and USDI 1995b).

Climate Change

Global climate change, and the related warming of global climate, have been well documented (IPCC 2007, ISAB 2007, WWF 2003). Evidence of global climate change/warming includes widespread increases in average air and ocean temperatures and accelerated melting of glaciers, and rising sea level. Given the increasing certainty that climate change is occurring and is accelerating (IPCC 2007, Battin *et al.* 2007), we can no longer assume that climate conditions in the future will resemble those in the past.

Patterns consistent with changes in climate have already been observed in the range of many species and in a wide range of environmental trends (ISAB 2007, Hari *et al.* 2006, Rieman *et al.* 2007). In the northern hemisphere, the duration of ice cover over lakes and rivers has decreased by almost 20 days since the mid-1800's (WWF 2003). The range of many species has shifted poleward and elevationally upward. For cold-water associated salmonids in mountainous regions, where their upper distribution is often limited by impassable barriers, an upward thermal shift in suitable habitat can result in a reduction in range, which in turn can lead to a population decline (Hari *et al.* 2006).

In the Pacific Northwest, most models project warmer air temperatures and increases in winter precipitation and decreases in summer precipitation. Warmer temperatures will lead to more precipitation falling as rain rather than snow. As the seasonal amount of snow pack diminishes, the timing and volume of stream flow are likely to change and peak river flows are likely to increase in affected areas. Higher air temperatures are also likely to increase water temperatures (ISAB 2007). For example, stream gauge data from western Washington over the past 5 to 25 years indicate a marked increasing trend in water temperatures in most major rivers.

Climate change has the potential to profoundly alter the aquatic ecosystems upon which the bull trout depends via alterations in water yield, peak flows, and stream temperature, and an increase in the frequency and magnitude of catastrophic wildfires in adjacent terrestrial habitats (Bisson *et al.* 2003).

All life stages of the bull trout rely on cold water. Increasing air temperatures are likely to impact the availability of suitable cold water habitat. For example, ground water temperature is generally correlated with mean annual air temperature, and has been shown to strongly influence the distribution of other chars. Ground water temperature is linked to bull trout selection of spawning sites, and has been shown to influence the survival of embryos and early juvenile rearing of bull trout (Rieman and McPhail 1993). Increases in air temperature are likely to be reflected in increases in both surface and groundwater temperatures.

Climate change is likely to affect the frequency and magnitude of fires, especially in warmer drier areas such as are found on the eastside of the Cascade Mountains. Bisson *et al.* (2003) note that the forest that naturally occurred in a particular area may or may not be the forest that will be responding to the fire regimes of an altered climate. In several studies related to the effect of large fires on bull trout populations, bull trout appear to have adapted to past fire disturbances through mechanisms such as dispersal and plasticity. However, as stated earlier, the future may well be different than the past and extreme fire events may have a dramatic effect on bull trout and other aquatic species, especially in the context of continued habitat loss, simplification and fragmentation of aquatic systems, and the introduction and expansion of exotic species (Bisson *et al.* 2003).

Migratory bull trout can be found in lakes, large rivers and marine waters. Effects of climate change on lakes are likely to impact migratory adfluvial bull trout that seasonally rely upon lakes for their greater availability of prey and access to tributaries. Climate-warming impacts to lakes will likely lead to longer periods of thermal stratification and coldwater fish such as adfluvial bull trout will be restricted to these bottom layers for greater periods of time. Deeper thermoclines resulting from climate change may further reduce the area of suitable temperatures in the bottom layers and intensify competition for food (WWF 2003).

Bull trout require very cold water for spawning and incubation. Suitable spawning habitat is often found in accessible higher elevation tributaries and headwaters of rivers. However, impacts on hydrology associated with climate change are related to shifts in timing, magnitude and distribution of peak flows that are also likely to be most pronounced in these high elevation stream basins (Battin *et al.* 2007). The increased magnitude of winter peak flows in high elevation areas is likely to impact the location, timing, and success of spawning and incubation for the bull trout and Pacific salmon species. Although lower elevation river reaches are not expected to experience as severe an impact from alterations in stream hydrology, they are unlikely to provide suitably cold temperatures for bull trout spawning, incubation and juvenile rearing.

As climate change progresses and stream temperatures warm, thermal refugia will be critical to the persistence of many bull trout populations. Thermal refugia are important for providing bull trout with patches of suitable habitat during migration through or to make feeding forays into areas with greater than optimal temperatures.

There is still a great deal of uncertainty associated with predictions relative to the timing, location, and magnitude of future climate change. It is also likely that the intensity of effects will vary by region (ISAB 2007) although the scale of that variation may exceed that of States. For example, several studies indicate that climate change has the potential to impact ecosystems in nearly all streams throughout the State of Washington (ISAB 2007, Battin *et al.* 2007, Rieman *et al.* 2007). In streams and rivers with temperatures approaching or at the upper limit of allowable water temperatures, there is little if any likelihood that bull trout will be able to adapt to or avoid the effects of climate change/warming. Climate change will be an important factor affecting bull trout distribution. As its distribution contracts, patch size decreases and connectivity is truncated, bull trout populations that may be currently connected may face increasing isolation, which could accelerate the rate of local extinction beyond that resulting from changes in stream temperature alone (Rieman *et al.* 2007). Due to variations in land form and geographic location across the range of the bull trout, it appears that some populations face higher risks than others. Bull trout in areas with currently degraded water temperatures and/or at the southern edge of its range may already be at risk of adverse impacts from current as well as future climate change.

3.2.7 Conservation Needs

The conservation needs 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 fine sediment and contaminants, complex channel characteristics (including abundant LW 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 at multiple scales ranging from the coterminous to local populations (a local population is a group of bull trout that spawn within a particular stream or portion of a stream system). The recovery planning process for bull trout (USFWS 2002a; 2004a; 2004b) has also identified the following conservation needs: 1) maintenance and restoration of multiple, interconnected populations in diverse habitats across the range of each interim recovery unit, 2) preservation of the diversity of life-history strategies, 3) maintenance of genetic and phenotypic diversity across the range of each interim recovery unit, and 4) establishment of a positive population trend. It has also been recognized that bull trout populations need to be protected from catastrophic fires across the range of each interim recovery unit (Rieman *et al.* 2003).

Central to the survival and recovery of bull trout is the maintenance of viable core areas (USFWS 2002a; 2004a; 2004b). A core area is defined as a geographic area occupied by one or more local bull trout populations that overlap in their use of rearing, foraging, migratory, and overwintering habitat. Each of the interim recovery units listed above consists of one or more core areas. There are approximately 121 core areas recognized across the coterminous range of the bull trout (USFWS 2002a; 2004a; 2004b).

1 - Maintenance and Restoration of Multiple, Interconnected Populations in Diverse Habitats across the Range of Each Interim Recovery Unit

Multiple local populations distributed and interconnected throughout a watershed provide a mechanism for spreading risk from stochastic events (Hard 1995, Healy and Prince 1995, Rieman and Allendorf 2001, Rieman and McIntyre 1993, Spruell *et al.* 1999). Current patterns in bull trout distribution and other empirical evidence, when interpreted in view of emerging conservation theory, indicate that further declines and local extinctions are likely (Dunham and Rieman 1999, Rieman and Allendorf 2001, Rieman *et al.* 1997b, Spruell 2003). Based in part on guidance from Rieman and McIntyre (1993), bull trout core areas with fewer than five local populations are at increased risk of extirpation; core areas with between 5 to 10 local populations are at intermediate risk of extirpation; and core areas which have more than 10 interconnected local populations are at diminished risk of extirpation.

Maintaining and restoring connectivity between existing populations of bull trout is important for the persistence of the species (Rieman and McIntyre 1993). Migration and occasional spawning between populations increases genetic variability and strengthens population variability (Rieman and McIntyre 1993). Migratory corridors allow individuals access to unoccupied but suitable habitats, foraging areas, and refuges from disturbances (Saunders *et al.* 1991).

Because bull trout in the coterminous U.S. are distributed over a wide geographic area consisting of various environmental conditions, and because they exhibit considerable genetic differentiation among populations, the occurrence of local adaptations is expected to be extensive. Some readily observable examples of differentiation between populations include external morphology and behavior (e.g., size and coloration of individuals; timing of spawning and migratory forays). Conserving many populations across the range of the species is crucial to adequately protect genetic and phenotypic diversity of bull trout (Hard 1995, Healy and Prince 1995, Leary *et al.* 1993, Rieman and Allendorf 2001, Rieman and McIntyre 1993, Spruell *et al.* 1999, Taylor *et al.* 1999). Changes in habitats and prevailing environmental conditions are increasingly likely to result in extinction of bull trout if genetic and phenotypic diversity is lost.

2 - Preservation of the Diversity of Life History Strategies

The bull trout has multiple life history strategies, including migratory forms, throughout its range (Rieman and McIntyre 1993). Migratory forms appear to develop when habitat conditions allow movement between spawning and rearing streams and larger rivers or lakes where foraging opportunities may be enhanced (Frissell 1997). 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). Parts of this river system have retained habitat conditions that allow free movement between spawning and rearing areas and the mainstem of the Snake River. Such multiple life history strategies help to maintain the stability and persistence of bull trout populations to environmental changes. Benefits to migratory bull trout include greater growth in the more productive waters of larger streams and lakes, 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 1997, MBTSG 1998, Rieman and McIntyre 1993).

3- Maintenance of Genetic and Phenotypic Diversity across the Range of Each Interim Recovery Unit

Healy and Prince (1995) reported that, because phenotypic diversity is a consequence of the genotype interacting with the habitat, the conservation of phenotypic diversity is achieved through conservation of the sub-population within its habitat. They further note that adaptive variation among salmonids has been observed to occur under relatively short time frames (e.g., changes in genetic composition of salmonids raised in hatcheries; rapid emergence of divergent phenotypes for salmonids introduced to new environments). Healy and Prince (1995) conclude that while the loss of a few sub-populations within an ecosystem might have only a small effect on overall genetic diversity, the effect on phenotypic diversity and, potentially, overall population viability could be substantial (Healy and Prince 1995). This concept of preserving variation in phenotypic traits that is determined by both genetic and environmental (i.e., local habitat) factors has also been identified by Hard (1995) as an important component in maintaining intraspecific adaptability (i.e., phenotypic plasticity) and ecological diversity within a genotype (Hard 1995). He argues that adaptive processes are not entirely encompassed by the interpretation of molecular genetic data; in other words, phenotypic and genetic variation in adaptive traits may exist without detectable variation at the molecular genetic level, particularly for neutral genetic markers. Therefore, the effective conservation of genetic diversity necessarily involves consideration of the conservation of biological units smaller than taxonomic species (or DPSs). Reflecting this theme, the maintenance of local sub-populations has been specifically emphasized as a mechanism for the conservation of bull trout (Rieman and McIntyre 1993, Taylor *et al.* 1999).

4 - Establishment of a Positive Population Trend

A stable or increasing population is a key criterion for recovery under the requirements of the Act. Measures of the trend of a population (the tendency to increase, decrease, or remain stable) include population growth rate or productivity. Estimates of population growth rate (i.e., productivity over the entire life cycle) that indicate a population is consistently failing to replace itself, indicate increased extinction risk. Therefore, the reproductive rate should indicate the population is replacing itself, or growing.

Since data of the total population size are rarely available, the productivity or population growth rate is usually estimated from temporal trends in indices of abundance at a particular life stage. For example, redd counts are often used as an index of a spawning adult population. The direction and magnitude of a trend in the index can be used as a surrogate for the growth rate of the entire population. For instance, a downward trend in an abundance indicator may signal the need for increased protection, regardless of the actual size of the population. A population which is below recovered abundance levels but moving toward recovery would be expected to exhibit an increasing trend in the indicator.

The population growth rate is an indicator of extinction probability. The probability of going extinct cannot be measured directly; it can, however, be estimated as the consequence of the population growth rate and the variability in that rate. For a population to be considered viable, its natural productivity should be sufficient to replace itself from generation to generation. Evaluations of population status will also have to take into account uncertainty in estimates of population growth rate or productivity. For a population to contribute to recovery, its growth rate must indicate that the population is stable or increasing for a period of time (USFWS 2002e, p. 16)

5 - Protect Bull Trout from Catastrophic Fires
Bull trout evolved under historic fire regimes in which disturbance to streams from forest fires resulted in a mosaic of diverse habitats. However, forest management and fire suppression over the past century have increased homogeneity of terrestrial and aquatic habitats, increasing the likelihood of large, intense forest fires in some areas. Because the most severe effects of fire on native fish populations can be expected where populations have become fragmented by human activities or natural events, an effective strategy to ensure persistence of native fishes against the effects of large fires may be to restore aquatic habitat structure and life history complexity of populations in areas susceptible to large fires (Gresswell 1999).

Rieman and Clayton (1997a) discussed relations among the effects of fire and timber harvest, aquatic habitats, and sensitive species. They noted that spatial diversity and complexity of aquatic habitats strongly influence the effects of large disturbances on salmonids (Rieman and Clayton 1997a). For example, Rieman *et al.* (1997b) studied bull trout and redband trout responses to large, intense fires that burned three watersheds in the Boise NF in Idaho. Although the fires were the most intense on record, there was a mix of severely burned to unburned areas left after the fires. Fish were apparently eliminated in some stream reaches, whereas others contained relatively high densities of fish. Within a few years after the fires and after areas within the watersheds experienced debris flows, fish had become reestablished in many reaches, and densities increased. In some instances, fish densities were higher than those present before the fires or in streams that were not burned (Rieman and Clayton 1997a). These responses were attributed to spatial habitat diversity that supplied refuge areas for fish during the fires, and the ability of bull trout and the redband trout to move among stream reaches. For bull trout, the presence of migratory fish within the system was also important (Rieman and Clayton 1997a, Rieman *et al.* 1997b).

In terms of conserving bull trout, the appropriate strategy to reduce the effects of fires on bull trout habitat is to emphasize the restoration of watershed processes that create and maintain habitat diversity, provide bull trout access to habitats, and protect or restore migratory life-history forms of bull trout. Both passive (e.g., encouraging natural riparian vegetation and floodplain processes to function appropriately) and active (e.g., reducing road density, removing barriers to fish movement, and improving habitat complexity) actions offer the best approaches to protect bull trout from the effects of large fires.

3.2.8 Summary of Current Status and Actions

3.2.8.1 Coastal-Puget Sound Interim Recovery Unit

Although the status of bull trout in Coastal-Puget Sound interim recovery unit has been improved by certain actions, it continues to be degraded by other actions, and it is likely that the overall status of the bull trout in this population segment has not improved since its listing on November 1, 1999. Improvement has occurred largely through changes in fishing regulations and habitat-restoration projects. Fishing regulations enacted in 1994 either eliminated harvest of bull trout or restricted the amount of harvest allowed, and this likely has had a positive influence on the abundance of bull trout. Improvement in habitat has occurred following restoration projects intended to benefit either bull trout or salmon, although monitoring the effectiveness of these projects seldom occurs. On the other hand, the status of this population segment has been adversely affected by a number of Federal and non-federal actions, some of which were addressed under section 7 of the ESA. Most of these actions degraded the environmental baseline; all of those addressed through formal consultation under section 7 of the ESA permitted the incidental take of bull trout.

Several Section 10(a)(1)(B) permits have been issued for Habitat Conservation Plans (HCPs) completed in the Coastal-Puget Sound population segment. These include: 1) the City of Seattle's Cedar River Watershed HCP; 2) Simpson Timber HCP; 3) Tacoma Public Utilities Green River HCP; 4) Plum Creek Cascades HCP; 5) Washington State Department of Natural Resources HCP; 6) West Fork Timber HCP (Nisqually River); and 7) Forest Practices HCP. These HCPs provide landscape-scale conservation for fish, including bull trout. Many of the covered activities associated with these HCPs will contribute to conserving bull trout over the long-term; however, some covered activities will result in short-term degradation of the baseline. All HCPs permit the incidental take of bull trout.

3.2.8.2 Columbia River Interim Recovery Unit

The overall status of the Columbia River interim recovery unit has not changed appreciably since its listing on June 10, 1998. Populations of bull trout and their habitat in this area have been affected by a number of actions addressed under section 7 of the ESA. Most of these actions resulted in degradation of the environmental baseline of bull trout habitat, and all permitted or analyzed the potential for incidental take of bull trout. The Plum Creek Cascades HCP, Plum Creek Native Fish HCP, and Forest Practices HCP addressed portions of the Columbia River population segment of bull trout.

3.2.8.3 Klamath River Interim Recovery Unit

Improvements in the Threemile, Sun, and Long creeks local populations have occurred through efforts to remove or reduce competition and hybridization with non-native salmonids, changes in fishing regulations, and habitat-restoration projects. Population status in the remaining local populations (Boulder-Dixon, Deming, Brownsworth, and Leonard creeks) remains relatively unchanged. Grazing within bull trout watersheds throughout the recovery unit has been curtailed. Efforts at removal of non-native species of salmonids appear to have stabilized the Threemile Creek and positively influenced the Sun Creek local populations. The results of similar efforts in Long Creek are inconclusive. Mark and recapture studies of bull trout in Long Creek indicate a larger migratory component than previously expected.

Although the status of specific local populations has been slightly improved by recovery actions, the overall status of Klamath River bull trout continues to be depressed. Factors considered threats to bull trout in the Klamath Basin at the time of listing – habitat loss and degradation caused by reduced water quality, past and present land use management practices, water diversions, roads, and non-native fishes – continue to be threats today.

3.2.8.4 Jarbidge Interim Recovery Unit

While the overall status of the Jarbidge Interim Recovery Unit has not changed significantly since the original time of listing, numerous study efforts have been conducted to obtain more data on populations and distribution. Studies on distribution and genetic variation have been concluded. Bull trout presence has now been documented in Cougar Creek and Deer Creek. Temperature monitoring combined with GIS modeling has identified many thermal barriers that exist throughout the unit.

Both the USFS and BLM have implemented new road management plans that address road maintenance needs and improvements within the Jarbidge Canyon intended to reduce long-term sediment input into the West Fork Jarbidge River. This work is anticipated to improve foraging, migration, and overwintering habitat within the West Fork Jarbidge River and result in positive long-term effects to bull trout abundance, distribution, and trend.

3.2.8.5 Saint Mary-Belly River Interim Recovery Unit

The overall status of bull trout in the Saint Mary-Belly River interim recovery unit has not changed appreciably since its listing on November 1, 1999. Extensive research efforts have been conducted since listing, to better quantify populations of bull trout and their movement patterns. Limited efforts in the way of active recovery actions have occurred. Habitat occurs mostly on Federal and Tribal lands (Glacier National Park and the Blackfeet Nation). Known problems due to instream flow depletion, entrainment, and fish passage barriers resulting from operations of the U.S. Bureau of Reclamation's Milk River Irrigation Project (which transfers Saint Mary-Belly River water to the Missouri River Basin) and similar projects downstream in Canada constitute the primary threats to bull trout and to date they have not been adequately addressed under section 7 of the ESA. Plans to upgrade the aging irrigation delivery system are being pursued, which has potential to mitigate some of these concerns but also the potential to intensify dewatering. A major fire in August 2006 severely burned the forested habitat in Red Eagle and Divide Creeks, potentially affecting three of nine local populations and degrading the baseline.

3.2.8.6 State Conservation Actions

Idaho: Conservation actions by the State of Idaho include: 1) the development of a management plan for bull trout in 1993 (Conley 1993); 2) the approval of the State of Idaho Bull Trout Conservation Plan (Idaho Plan) in July 1996 (Batt 1996); 3) the development of 21 problem assessments involving 59 key watersheds; 4) the implementation of conservation actions identified in the problem assessments; and, 5) the implementation of more restrictive angling regulations.

Montana: Conservation actions by the State of Montana include: 1) development of the Montana Bull Trout Restoration Plan issued in 2000 (MBTRT 2000), which defines strategies for ensuring the long-term persistence of bull trout in Montana; 2) formation of the Montana Bull Trout Restoration Team (MBTRT) and Montana Bull Trout Scientific Group (MBTSG) to produce a plan for maintaining, protecting, and increasing bull trout populations; 3) the development of watershed groups to initiate localized bull trout restoration efforts; 4) funding of habitat restoration projects, recovery actions, and genetic studies throughout the state; 5) the abolition of brook trout stocking programs; and, (6) restrictive angling regulations.

Nevada: Conservation actions by the State of Nevada include: 1) the preparation of a Bull Trout Species Management Plan that recommends management alternatives to ensure that human activities will not jeopardize the future of bull trout in Nevada (Johnson 1990); 2) implementation of more restrictive State angling regulations in an attempt to protect bull trout in the Jarbidge River in Nevada; and 3) the abolition of a rainbow trout stocking in the Jarbidge River.

Oregon: Since 1990, the State of Oregon has taken extensive action to address the conservation of bull trout, including: 1) Establishment of bull trout working groups in the Klamath, Deschutes, Hood, Willamette, Odell Lake, Umatilla and Walla Walla, John Day, Malheur, and Pine Creek river basins for the purpose of developing bull trout conservation strategies; 2) establishment of more restrictive harvest regulations in 1990; 3) reduced stocking of hatchery-reared rainbow trout and brook trout into areas where bull trout occur; 4) angler outreach and education efforts in river basins occupied by bull trout; 5) research to further examine life history, genetics, habitat needs, and limiting factors of bull trout in Oregon; 6) reintroduction of bull trout fry from the McKenzie River watershed to the adjacent Middle Fork of the Willamette River, which is historical but currently unoccupied, isolated habitat; 7) the Oregon Department of Environmental Quality (DEQ) established a water temperature standard such that surface water temperatures may not exceed 10 °C (50 °F) in waters that support or are necessary to maintain the viability of bull trout in the State (Oregon 1996); and; 8) expansion of the Oregon Plan for Salmon and Watersheds (Oregon 1997) to include all at-risk wild salmonids throughout the State.

Washington: Conservation actions by the State of Washington include: 1) establishment of the Salmon Recovery Act (ESHB 2496) and Watershed Management Act (ESHB 2514) by the Washington State legislature to assist in funding and planning salmon recovery efforts; 2) abolition of brook trout stocking in streams or lakes connected to bull trout-occupied waters; 3) changing angling regulations in Washington prohibit the harvest of bull trout, except for a few areas where stocks are considered "healthy"; 4) collecting and mapping updated information on bull trout distribution, spawning and rearing areas, and potential habitat; and; 5) adopting new emergency forest practice rules based on the "Forest and Fish Report" process. These rules address riparian areas, roads, steep slopes, and other elements of forest practices on non-federal lands.

3.2.8.7 Tribal Conservation Activities

Many Tribes throughout the range of the bull trout are participating on bull trout conservation working groups or recovery teams in their geographic areas of interest. Some tribes are also implementing projects which focus on bull trout or that address anadromous fish but also benefit bull trout (e.g., habitat surveys, passage at dams and diversions, habitat improvement, and movement studies).

3.2.9 Status of the Species in the Action Area

Bull trout within action area face all of the challenges described throughout the entire conterminous population. While the threats faced by bull trout may be the same across the action area, individual core areas are threatened by greater or lesser degrees depending on their particular location and site specific conditions.

Water quality (including temperature), habitat fragmentation, sedimentation, invasive species competition and hybridization, and barriers that disrupt migration, genetic interchange, and foraging abound. Bull trout within the action area are still subject to all those threats outlined at the time of listing, and the new threats associated with climate change.

Increased stream temperatures and turbidity both have tremendous potential to pose a threat to bull trout within the action area. Habitat fragmentation combined with poor water quality and physical barriers have left most core areas for bull trout extremely vulnerable to decline.

Increased temperatures (those above 15 °C (59 °F)) pose as barriers to bull trout foraging and migration. Bull trout require high quality, cold water for spawning. Though it is generally accepted that temperatures ranging from 2 to 15 °C (36 to 59 °F) are acceptable for bull trout this can vary to some degree by core area, or local population. The Willamette NF reports that they have never observed bull trout spawning in temperatures greater than 7.5 °C (45.5 °F)(Ray Rivera, USFS, *pers. comm.* 2011).

3.2.10 Conservation Measures for Bull Trout

In addition to the proposed PDC for specific restoration actions, as applicable, the following specific conservation measures are proposed for bull trout:

a. Projects that would expose populations of bull trout to non-native fish such as brook trout or brown trout where such exposure does not currently exist, must be approved by the Service Manager or designee for the affected state.
b. The driving of steel or concrete piles within the wetted width of a stream, lake, or shoreline is not covered under this Opinion. If steel or concrete piles are to be driven adjacent to bull trout spawning and rearing habitat, the action agencies will work with the Service to determine what (if any) site-specific PDC or conservation measures are needed to reduce potential impacts to bull trout.
c. For nearshore projects in Puget Sound, no in-water work is allowed in bull trout marine foraging, migration and overwintering habitat from February 16 – July 15, and near the Duwamish River from February 16 - September 30.
d. For all projects, the project manager will work with internal and external bull trout experts to determine the best timing for each project in occupied habitat to minimize impacts to all listed fish. Any exceptions to in-water work windows recommended by ODFW, WDFW, or IDFG will be approved by the Service and NMFS.

e. To reduce adverse effects to bull trout, electrofishing will only occur from May 1 (or after emergence occurs) to July 31 in known bull trout spawning areas. No electrofishing will occur in any bull trout habitat after August 15.
f. Project specific conservation measures are contained in the applicable PDC above.

3.2.11 Environmental Baseline for Bull Trout

A general description of aquatic habitats in the Action Area was provided in Section 2.3 (Environmental Baseline Overview). Information specific to bull trout was provided in Section 3.2 (Bull Trout Status). As the Action Area encompasses much of the range of bull trout, these sections adequately describe the baseline for bull trout.

3.2.12 Effects to Bull Trout

General effects of the proposed restoration action on bull trout and its habitats are described in Sections 3.1.1 and 3.1.2 (ESA-listed Fish Species), Section 3.1.3 (Effects to ESA-listed salmonids) and Section 3.1.4 (Scope of Effects to ESA-listed Fish). The effects to ESA-listed fishes from restoration actions are generally the same, and thus, a general effects section is appropriate. Capture and handling effects for bull trout are described below. Additional restoration projects implemented by other parties could be covered under this Opinion per year, as described in the Introduction in the section entitled *Action Area and Requirements for Coverage*. We anticipate these additional projects would not increase the amount or extent of effects for capture and handling or habitat effects for bull trout, on a project by project basis.

3.2.12.1 Capture and Handling Effects to Bull Trout

The Service estimates that 126 projects implemented on average per year would occur within the range salmonids, including bull trout (NMFS 2013). Of these, the Service estimates that around 60% will require fish capture and handling (i.e., 76 actions per year). While the majority of ESA-listed fishes captured under these projects would be salmon and steelhead, some portion of these fish is likely to be bull trout. We are unaware of specific capture, handling or mortality data that would be relevant across the action area to use for predictive purposes; thus, we cannot predict the exact proportion of bull trout to other salmonids within future, as of yet undetermined restoration sites.

In the absence of empirical data, and for programmatic assessments where there is uncertainty as to where specific restoration projects will be implemented across the action area, the Service often relies on professional judgment to develop formulas that help predict the likelihood of a listed species occurrence and rate of occurrence within a project area. Given that bull trout are an apex predator and generally persist in much lower abundance than other sympatric salmonids such as salmon, steelhead and other species of trout, we believe bull trout would comprise a relatively low percentage of the overall catch of salmonids within a given project area. Through discussions between numerous fish biologists, the average ratio of bull trout to other salmonids across the action area would be quite low, probably somewhere between 3-4%. There will be wide variation by site-specific location. The majority of work anticipated under the proposed action will most likely occur during the months of July and August. In many systems water quality becomes limited during this period of time, and bull trout start to move upstream into spawning and rearing habitats both to seek the cooler temperatures and in preparation for spawning in the fall. Areas where resident bull trout populations exist may exhibit a ratio somewhere near 10% of the total salmonid population, or possibly higher in some cases. Therefore it is probable that this ratio in spawning and rearing habitats will be increased above 10% during this time of year. In the converse, the ratio of bull trout to other salmonids is likely to drop in much of the foraging, migration and overwintering habitats during this time period to an extremely low ratio (<1%) because of its warmer temperatures and generally poorer water quality. Because the ratio of bull trout to other salmonids varies considerably across their range, and to err on the side of caution the Service estimates that a ratio of bull trout to salmon and steelhead of 5% exists on average across the action area. NMFS conducted an assessment of fish capture in the 2013 NMFS Biological Opinion for PROJECTS and concluded that 8,078 salmon and steelhead might be captured in 76 projects per year where isolation and dewatering would be required within the range of bull trout (NMFS 2013). Therefore, the Service estimates that 404 bull trout might also be captured per year, or 6 bull trout per project on average.

Of the fish that the Action Agencies capture and release, less than 2% are likely to be injured or killed, including delayed mortality, and the remainder is likely to survive with no long-term adverse effects (NMFS 2013). However, this 2% injury/mortality rate is based on primarily handling small fish and may not reflect effects to larger resident fish. Thus, the Service uses a more expansive 5% injury/mortality estimate to account for handling/capture of larger fish and unforeseen circumstances relating to fish health at the time of capture. Of those 404 captured fish, the Service anticipates injury or mortality to no more than 5% of those fish, with the remainder (95%) likely to survive with no long-term adverse effects. Thus, Service anticipates that up to 404 individual bull trout considered in the consultation will be captured, on average per year, and up to 21 individuals will be injured or killed, on average per year, (*i.e*., 5% of 8,078 salmon and steelhead captured = 404 bull trout; and 5% [injured or killed] of 404 bull trout = 21 fish injured or killed as a result of fish capture necessary to isolate in-water construction areas.

As discussed previously the value of an adult bull trout to localized populations is far greater than that of juvenile bull trout. It takes large numbers of juveniles within any population to ultimately recruit one adult. The great majority of juvenile fish in any life stage do not survive to become adults. This is an important concept in gauging effects at the population scale.

An estimation method (adult equivalents) developed by NMFS (2013) was utilized to gauge the maximum effect that capture and release operations for projects authorized or completed under this consultation will have on the abundance of adult bull trout in each IRU was obtained as follows:

A = n(pct), where:

A = number of adult equivalents "killed" each year
n = number of projects likely to occur in an IRU each year on average
p = 5.3 [404 bull trout ÷ 76 projects) i.e., number of juveniles to be captured per project[24]

[24] In 2007, ODOT completed 36 work area isolation operations involving capture and release using nets and electrofishing; 12 of those operations resulted in capture of 0 Chinook salmon, 345 coho salmon, and 22 steelhead; with an average mortality of 5% Cannon (2008). Cannon (2012) reported a mortality rate of 4.4% for 455 listed salmon and steelhead captures during 30 fish salvage operations in 2012.

c = 0.05, i.e., rate of juvenile injury or death caused by electrofishing during capture and release, primarily steelhead and coho salmon, based on data from Cannon (2008, 2012) and McMichael *et al.* (1998).
t = 0.02, i.e., an estimated average smolt to adult survival ratio, see Smoker *et al.* (2004) and Scheuerell and Williams (2005). This is very conservative because many juveniles are likely to be captured as fry or parr, life history stages that have a survival rate to adulthood that is exponentially smaller than for smolts.

The results of the application of this formula on each IRU are displayed below, and assume similar distribution of restoration projects across the IRUs (35% of restoration projects implemented in the Columbia River IRU and 65% in the Coast Puget Sound IRU):

- Columbia River IRU: 142 bull trout x 5% x 2% = 0.15 adult equivalents
- Coast Puget Sound IRU: 262 bull trout x 5% x 2% = 0.27 adult equivalents.

3.2.13 Effects to Bull Trout Designated Critical Habitat

Construction projects have the greatest potential to affect the PCEs of bull trout critical habitat. Most projects that alter stream channel, or provide fish passage will adversely affect PCEs 1, 2, 3, 6, 7 and 8 by contributing sediment to the system and increasing cobble embeddedness during the short term. Depending on the category and specific design of the project these effects could last from a few days or weeks to several months (possibly years or decades where stream channels are reconstructed). While these PCEs will be adversely affected for some period of time by these projects, all of the projects described in this Opinion will eventually contribute to the improvement of fish habitat with long-term benefits resulting from passage enhancement. Thus they will result in benefits over time to these PCEs of critical habitat.

Instream projects, such as additions of LW, or placement of gravel or boulders, will result in some short-term negative effects to PCEs 1, 2, 3, 5, 6, 7 and 8, by contributing minor amounts of sediment to the system, which in turn may increase sedimentation, and increase turbidity thus affecting water quality. These effects are anticipated to be low intensity and short duration (more likely hours than days) and occur at a small, localized scale. Thus, while these effects may result in insignificant negative effects to several PCEs in the short-term, these instream projects be result in wholly beneficial effects to channel complexity (PCE 4).

Vegetation management activities will have some adverse effects on PCEs 1, 2, 3, 4, 5, 6, 7 and 8. The use of herbicides to treat invasive plants could add chemicals to the system that may affect water quality and aquatic flora, and thus aquatic fauna, including refugia. The removal of vegetation can change overland flows and infiltration rates. Increased run off from rainfall or snow melt will result in increased water delivery and sediment to the aquatic system. Increased sediment inputs may result in increased substrate embeddedness, which could negatively affect spawning substrate (if present). These effects are likely to be a combination of short-term (weeks to months) and long-term (one to 20 years depending on the individual project) effects that will contribute increased sediment to the system. Most adverse effects to these PCEs will be short-term and would be expected to lesson and then terminate once native vegetation becomes reestablished on the project sites. Restoration activities that improve conditions for streamside and upland vegetation will ultimately benefit the aquatic system in the long-term (1-20 years) through improved infiltration rates, reduced overland flows, and a more natural hydrograph over time.

Additional effects on individual PCEs of bull trout critical habitat are described below:

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

Channel condition, dynamics and floodplain connectivity will be greatly affected by channel reconstruction projects and other similar actions. Inwater or near-water construction will cause short-term adverse effects to stream channels at the site specific scale. Changes in flow resulting from many construction projects will also cause short-term adverse effects to the dynamics of the stream system. Flow and hydrology (e.g. change in peak/base flows) will be interrupted, and redirected in some cases. In most cases, adverse effects will be short-term (weeks to months). However, larger projects such as stream reconstruction could have adverse effects on flow for many years before beneficial effects to the system are recognized. Ultimately these projects are designed to improve conditions (passage, channel dynamics, adverse anthropogenic conditions), and therefore will benefit the ability of critical habitat to provide high quality water and connectivity. Because short-term impacts will reduce the ability of critical habitat to supply these functions for weeks, months, or even years in some cases, these projects will adversely affect PCE 1.

PCE 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.

Migratory habitats may be disrupted/blocked during implementation of construction projects that require temporary physical barriers for work area isolation, *etc.* Flow will be interrupted, and redirected in some cases. Other barriers to migration may occur from increased turbidity resulting from equipment working instream, or from use of herbicides near waterways. For example, herbicides may drift into stream channels, and the presence of equipment instream adds some degree of risk of contamination from lubricants, antifreeze, and hydraulic fluids. In most cases this disruption may only be ephemeral, but in other cases short-term adverse effects will occur to PCE 2. Depending on the category and specific design of the project these effects could last from a few days or weeks to several months (possibly years where stream channels are reconstructed). These risks are greatly reduced by the proposed PDC contained within the proposed action. While PCE 2 will be adversely affected for some period of time by these projects, all of the projects described in the proposed action will eventually contribute to the improvement of fish habitat and/or passage conditions, with long-term benefits to PCE 2.

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

Water quality, channel condition and dynamics, and habitat access will be adversely affected by construction projects, as described above. These effects will limit the availability of prey species within critical habitat in the short-term, and adversely affect PCE 3. Increased sediment and reduced water quality will increase turbidity and reduce both the availability of prey and the ability of bull trout to pursue such prey, thus reducing the ability of critical habitat to provide foraging opportunities to bull trout through reduced visibility, and reduced presence of prey fish.

Vegetation management projects will adversely affect the ability of critical habitat to provide both aquatic and terrestrial prey species needed by bull trout during the short term, and adversely affect PCE 3. Changes to streamside vegetation will result in some reduction of terrestrial macroinvertebrates available in bull trout critical habitat. This condition should ease over-time as native vegetation becomes reestablished on the affected sites. Because of these factors, vegetation management projects will adversely affect PCE 3.

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

Instream restoration activities are intended to create and maintain habitat, and improve the riverine processes that continue to create and maintain aquatic habitats into the future. In some instances, streamside vegetation or regrading the streambank (or other similar activities) may have short-term (weeks to months) adverse effects on refugia, and thus adversely affect PCE 4. However, we anticipate little refugia will exist in sites selected for restoration, and anticipate long-term benefits to PCE 4 from proposed restoration actions.

PCE 5. Water temperatures ranging from 36 to 59 °F (2 to 15 °C), 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.

Temperatures will largely be unaffected by construction projects. Some projects that remove vegetation will have a slightly negative effect on this PCE: the removal of vegetation could allow increased solar radiation which could affect temperatures to some degree. However, these effects will be extremely localized and of low intensity, and are considered insignificant to PCE 5. Any affects to PCE 5 should dissipate as streamside vegetation re-establishes.

PCE 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.

Instream or near-stream construction projects will increase turbidity and sedimentation in the project area, and result in adverse effects to water quality and substrate embeddedness. For turbidity, we expect short-term effects (hours to days). For embeddedness, we expect that most adverse effects would subside the year following the project when high flows would purge the system of most of the residual sediment on the substrate. Depending on the category and specific design of the project, these adverse effects could last from a few days or weeks to several months (possibly years where stream channels are reconstructed).

<u>PCE 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.</u>

Flow and hydrology (e.g. change in peak/base flows) will be adversely affected by some construction projects, as described in PCE 2. Flow will be interrupted, and redirected in some cases. Most of the adverse effects resulting from these types of projects would be short-term (weeks or months). However, larger projects such as stream reconstruction could have adverse effects on flow for many years before beneficial effects to the system are recognized. In general, construction projects described within the Opinion will adversely affect PCE 7 during the short-term, but will ultimately benefit critical habitat over the long term (1-20 years) by aiding in the restoration of a more natural hydrograph.

<u>PCE 8. Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited.</u>

Water quality (chemical contaminants/nutrients) will be adversely affected by instream and near stream construction projects. These projects will contribute sediment to the system and increase cobble embeddedness during the short term. Depending on the category and specific design of the project these effects could last from a few days or weeks to several months (possibly years where stream channels are reconstructed). The presence of equipment instream or near lakeshore adds some degree of risk of contamination from lubricants, antifreeze, and hydraulic fluids. These risks are greatly reduced by the proposed PDC contained within the proposed action. While PCE 8 will be adversely affected for some period of time by these projects, all of the aquatic restoration projects described in this Opinion will eventually contribute to the improvement of water quality and fish habitats.

<u>PCE 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.</u>

Subpopulation characteristics such as life history diversity and isolation, persistence and genetic integrity*)* will be benefitted by construction projects that improve fish passage. Providing improved passage, or reconnecting isolated local populations where safe to do so, and will not allow an unacceptable expansion of non-native fish, will improve genetic diversity for bull trout.

<u>Summary of effects to bull trout critical habitat at the rangewide scale</u>
While the proposed action will have adverse effects to bull trout critical habitat at the local, site specific scale, these adverse effects will not be significant when evaluated at larger scales. The projects involved are too small and too distant and too infrequent to adversely affect the PCEs across an entire CHU. The proposed PDC will minimize adverse effects to PCEs of bull trout critical habitat. Because of this the effects of these projects cannot rise to a level to adversely modify bull trout critical habitat.

3.2.14 Conclusion for Bull Trout

After reviewing the current status of the listed species, the environmental baseline within the action area, the direct and indirect effects of the proposed action, and cumulative effects, it is Service's biological opinion that the proposed action is not likely to jeopardize the continued existence of bull trout or destroy or adversely modify its critical habitat. See section 3.1.10 for additional information.

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3.3 Lahontan Cutthroat Trout Status

3.3.1 Legal Status

The Lahontan cutthroat trout was first listed, as endangered under the Endangered Species Protection Act of 1969 (USFWS 1970) on October 13, 1970 (USFWS 1970), but was downlisted to "threatened" on July 16, 1975 (USFWS 1975). Within the area covered by this listing, this species is known to occur in: California, Nevada, Oregon, and Utah. In Oregon, the species is present in Harney and Malheur counties (Southeast Oregon). No critical habitat has been designated or proposed for Lahontan cutthroat trout.

Special rules concerning "take" for this subspecies can be found in 50 CFR 17.44 (USFWS 1975, p. 29864). The recovery plan for Lahontan cutthroat trout was finalized in 1995 (USFWS 1995). The Service completed a 90-day finding on a petition to delist Lahontan cutthroat trout (USFWS 2008, pp. 52257-52260). Our conclusion was that the petition did not present substantial information that recovery of Lahontan cutthroat trout throughout the range had been met.

The Service completed the Lahontan cutthroat trout 5-year Review (USFWS 2009). The purpose of a 5-year Review is to evaluate whether or not a species' status has changed since it was listed (or since the most recent 5-year review). Relevant information on the status of Lahontan cutthroat trout, life history traits, population dynamics, habitat requirements, threats, and historical and current distribution can be found in the Recovery Plan (USFWS 1995), and the 5-year Review (USFWS 2009).

3.3.2 Species Description

Cutthroat trout have the most extensive range of any inland trout species in western North America, and occur in anadromous, non-anadromous, fluvial, and lacustrine populations (USFWS 2003b). Many of the basins in which cutthroat trout occur contain remnants of much more extensive bodies of water which were present during the wetter period of the late Pleistocene epoch (USFWS 2003b).

The Lahontan cutthroat trout, a sub species of cutthroat trout, is represented by several populations residing in streams in Harney and Malheur Counties, Oregon (USFWS 1995). The Lahontan cutthroat trout is the largest of all cutthroat races. Although coloration is variable, this species is generally heavily marked with large, rounded black spots, more or less evenly distributed over the sides, head, and abdomen. Spawning fish generally develop bright red coloration on the underside of the mandible and on the opercle. In spawning males, coloration is generally more intense than in females.

3.3.2.1 Taxonomy

Lahontan cutthroat trout (*Oncorhynchus clarki henshawi*) are an inland subspecies (one of 14 recognized subspecies in the western United States) of cutthroat trout endemic to the Lahontan Basin of northern Nevada, eastern California, and southeastern Oregon.

3.3.2.2 Life history

Reproduction

Lahontan cutthroat trout are obligate but opportunistic stream spawners. Typically, they spawn from April through July, depending on water temperature and flow characteristics. Autumn spawning runs have been reported from some populations. The fish may reproduce more than once, though post-spawning mortality is high (60-90%). Lake residents migrate into streams to spawn, typically in riffles on well washed gravels. The behavior of this subspecies is typical of stream spawning trout; adults court, pair, and deposit and fertilize eggs in a redd dug by the female. (Sigler and Sigler 1987, p. 116).

Ecology / Habitat Characteristics

Like other cutthroat races, the Lahontan cutthroat is an opportunistic feeder, with the diet of small individuals dominated by invertebrates, including zooplankton, crustaceans and arthropods and the diet of larger individuals is composed primarily of fish, especially tui chubs and kokanee.

These fish are usually tolerant of both high temperatures (>27 ºC (81 ºF)) and large daily fluctuations up to 20 ºC (68 ºF). They are also quite tolerant of high alkalinity (>3,000 mg/L) and dissolved solids (>1,000 mg/L). They are apparently intolerant of competition or predation by non-native salmonids, and rarely coexist with them (USFWS 2003b).

3.3.3 Status, including Historical Status and Distribution

Lahontan cutthroat trout are an inland subspecies (one of 14 recognized subspecies in the western United States) of cutthroat trout endemic to the Lahontan Basin of northern Nevada, eastern California, and southeastern Oregon. The range of Lahontan cutthroat trout is divided into three Geographic Management Units (GMUs) based on geographical, ecological, behavioral, and genetic factors, and has been managed as such since 1995. The three GMUs include: 1) Western Lahontan Basin comprised of the Truckee, Carson, and Walker River watersheds; 2) Northwestern Lahontan Basin comprised of the Quinn River, Black Rock Desert, and Coyote Lake watersheds; and 3) Eastern Lahontan Basin comprised of the Humboldt River and tributaries including the Marys River.

Lahontan cutthroat trout historically occurred in most cold waters of the Lahontan Basin of Nevada and California, including the Humboldt, Truckee, Carson, Walker, and Summit Lake/Quinn River drainages. Large alkaline lakes, small mountain streams and lakes, small tributary streams, and major rivers were inhabited, resulting in the present highly variable subspecies. Only remnant populations remain in a few streams in the Truckee, Carson, and Walker basins out of an estimated 1,020 miles of historic habitat (Gerstung 1986). Although mechanisms of stream colonization outside of the Lahontan basin by this subspecies are uncertain, transport by humans is suspected. Subsequently, resident stream populations were used to stock Oregon streams during the 1970s and 1980s.

3.3.3.1 Current Rangewide Status and Distribution

The overall status of Lahontan cutthroat trout is unknown, although the population has experienced a severe decline in range and numbers. Riparian and upland habitats have been degraded by intensive grazing by cattle and sheep during the past 130 years. Drought and cold periods during the past decade have further affected the quantity and quality of the aquatic habitat. The ability of local populations to interact is important to the long-term viability of a metapopulation. The population of Lahontan cutthroat in the Whitehorse Creek subbasin has been fragmented by numerous barriers into four discrete local populations. The Willow Creek subbasin is largely free of migration barriers. Seasonally, all streams in the drainages have disjunct populations because of high summer temperatures (>26 °C (78.8 °F)) or dry channels.

The severe decline in range and numbers of Lahontan cutthroat trout is attributed to a number of factors, including hybridization and competition with introduced trout species; loss of spawning habitat due to pollution from logging, mining, and urbanization; blockage of streams due to dams; channelization; de-watering due to irrigation and urban demands; and watershed degradation due to overgrazing of domestic livestock (USFWS 2003a).

3.3.3.2 Threats, Reasons for Listing

Factors that historically influenced the decline in the species include: 1) hybridization, predation, and competition with introduced species; 2) blockage of migrations and genetic isolation due to diversion dams and other impassable structures; 3) degradation of habitat due to logging, grazing management, road construction, irrigation practices, recreational use, channelization, and dewatering due to irrigation and urban demands; and 4) changes in water quality and water temperature. The effects of many of these actions continue today.

Lahontan cutthroat trout populations have been and continue to be impacted by non-native species interactions, habitat fragmentation and isolation, degraded habitat conditions, drought, and fire. Most Lahontan cutthroat trout populations which co-occur with non-native species are decreasing and the majority of population extinctions which have occurred since the mid 1990's have been caused by non-native species. Additionally, non-native fish occupy habitat in nearly all unoccupied Lahontan cutthroat trout historical stream and lake habitat, making repatriation of Lahontan cutthroat trout extremely difficult. The majority of Lahontan cutthroat trout populations are isolated and confined to narrow and short lengths of stream. These factors reduce gene flow between populations, and reduce the ability of populations to recover from catastrophic events, thus threatening their long-term persistence and viability. Pyramid and Walker Lakes are important habitat for the lacustrine form of Lahontan cutthroat trout. Conditions in these lakes have deteriorated over the past 100 years and continue to decline, most dramatically in Walker Lake. The present or threatened destruction, modification, or curtailment of Lahontan cutthroat trout's habitat and range continues to be a significant threat and in some instances is increasing in magnitude and severity.

3.3.3.3 Climate Change

The impacts to Lahontan cutthroat trout from climate change are not known with certainty. Predicted outcomes of climate change imply that negative impacts will occur through increased stream temperatures, decreased stream flow, changes in the hydrograph, and increased frequency of extreme events such as drought and fire. These impacts will likely increase the magnitude and severity of other existing threats to Lahontan cutthroat trout. Adding stressors predicted by climate change may exacerbate the current threats to Lahontan cutthroat trout populations throughout its range, many of which already have multiple stressors affecting their persistence.

3.3.3.4 Recovery Measures

The Lahontan cutthroat trout recovery plan (USFWS 1995) lists strategies for recovery which include: 1) manage and secure habitat to maintain all existing Lahontan cutthroat trout populations; 2) establish 148 self-sustaining fluvial Lahontan cutthroat trout populations within native range and determine appropriate numbers to assure persistence for the next 100 years; 3) implement research and perform population viability analyses to validate recovery objectives; and 4) revise recovery plan. The recovery plan also lists the following general guidance for optimal cutthroat trout habitat parameters related to water quality: 1) clear cold water with an average maximum summer temperature of <22 °C (71.6 °F); 2) specific to fluvial populations, relatively stable summer temperature averaging 13 ± 4 °C (55.4 ± 7.2 °F); and 3) specific to lacustrine habitat, a mid-epilimnion pH of 6.5 to 8.5 and dissolved oxygen content ≥8 mg/L in the epilimnion.

The Lahontan Cutthroat Trout Recovery Plan (USFWS 1995) identified a need for development of ecosystem plans for Lahontan cutthroat trout in the Truckee and Walker River Basins. Subsequently, Short-Term Action Plans (Action Plans) for the Truckee and Walker River Basins were published in 2003 (USFWS 2003c, 2003d) which represent a 3-year planning effort to develop the "ecosystem" based plan identified in the 1995 Recovery Plan. The Action Plans identify short-term activities and research that will further understanding of the conservation needs of Lahontan cutthroat trout specific to the Truckee and Walker River Basins and utilize adaptive management to refine the long-term recovery strategy. The Service completed the Lahontan Cutthroat Trout 5-year Status Review (USFWS 2009).

The Oregon Department of Environmental Quality (ODEQ) has developed a Total Maximum Daily Load (TMDL) and Water Quality Management Plan (WQMP) for the Alvord Lake subbasin that includes the streams subject to this consultation (ODEQ 2003). The water quality constituent relevant to Lahontan cutthroat trout habitat in the planning area is stream temperature. The TMDL and WQMP was initiated in response to streams identified on the Clean Water Act (CWA) 303(d) List for exceeding water quality standards (temperature). These documents incorporate all streams in the Alvord Lake subbasin that provide habitat or may influence habitat condition (tributaries) for salmonid fish species. The streams identified on the CWA 303(d) list that provide habitat for Lahontan cutthroat trout are Mosquito Creek, Willow Creek, Van Horn Creek and Denio Creek. The TMDL and WQMP were approved by the Environmental Protection Agency in February 2004.

3.3.4 Status of the Lahontan Cutthroat Trout in the Action Area

Within the Action Area, Lahontan cutthroat trout are only found in a limited range in southeastern Oregon, primarily in streams of the Lahontan and Coyote Lake Basins. Lahontan cutthroat trout occur in the following streams: Willow Creek, Whitehorse Creek, Little Whitehorse Creek, Doolittle Creek, Fifteen Mile Creek (from the Coyote Lake Basin), and Indian, Sage, and Line Canyon Creeks, tributaries of McDermitt Creek in the Quinn River Basin (Nevada). The Coyote Lake Basin has the only native population of Lahontan cutthroat trout in Oregon that is without threat of hybridization and is broadly distributed throughout one basin. In October 1994, the number of Lahontan cutthroat in the basin was estimated at 39,500 fish, and fish were limited to 56 km (34.8 miles) of stream habitat available (approximately 25,000 in the Whitehorse Creek drainage and about 15,000 cutthroat occupied the Willow Creek drainage).

Surveys conducted by ODFW indicated that Lahontan cutthroat trout populations were reduced from 1985 to 1989 by 62% on Willow Creek, 69% on Whitehorse Creek, 93% on Little Whitehorse Creek, and 42% on Doolittle Creek. No Lahontan cutthroat trout were found in either the 1985 or 1989 ODFW surveys on Fifteen Mile Creek (USFWS 2003a). These declining numbers prompted ODFW to close area streams to fishing by special order in 1989. The closure remains in effect. Fish surveys of area streams were conducted again in October of 1994. Although methods vary among the conducted surveys (1985, 1989, and 1994), fish numbers have increased in general from approximately 8,000 fish in the mid-1980s to approximately 40,000 fish in 1994; however, in many areas, stream conditions remain less than favorable for the cutthroat.

3.3.5 Conservation Measures

In addition to the proposed PDC for specific restoration actions, as applicable, the following specific conservation measures are proposed forLahontan cutthroat trout:

a. For all projects, the project manager will work with internal and external Lahontan cutthroat trout experts to determine the best timing for each project in occupied habitat to minimize impacts to all listed fish. Any exceptions to in-water work windows recommended by ODFW, WDFW, or IDFG will be approved by the Service and NMFS.
b. Project specific conservation measures are contained in the applicable PDC above.

3.3.6 Environmental Baseline for Lahontan Cutthroat Trout

A general description of aquatic habitats in the Action Area was provided in Section 2.3 (Environmental Baseline Overview). This summary and the preceding section (Status of the Lahontan Cutthroat Trout in the Action Area) adequately describe the baseline for Lahontan cutthroat trout.

3.3.7 Effects to Lahontan Cutthroat Trout

General effects of the proposed restoration action on Lahontan cutthroat trout and its habitats are described in Section 3.1.1 and 3.1.2 (ESA-listed Fish Species), Section 3.1.3 (Effects to ESA-listed salmonids) and Section 3.1.4 (Scope of Effects to ESA-listed Fish). The effects to ESA-listed fishes from restoration actions are generally the same, and thus, a general effects section is appropriate. Capture and handling effects for Lahontan cutthroat trout are described below.

3.3.7.1 Capture and Handling Effects

While there were no projects completed by any Service funding program in Lahontan cutthroat trout habitat from 2011-2014, the Service estimates that one project will be completed each year, on average, that would negatively affect Lahontan cutthroat trout and require capture and handling of these fish. Because low flows exist within Lahontan cutthroat trout habitat during the part of the year when such projects would likely be implemented, it is unlikely that very many fish would need to be salvaged because of low flows during the time period when projects would be implemented. Therefore we assume that no more than five Lahontan cutthroat trout will be captured in any one project. This would equate to a total of 15 fish captured over any three-year period. Mortality or injury is also expected to be low (5% or less). Thus, the Service estimates that no more than one (rounded up to the whole fish) Lahontan cutthroat trout would suffer injury or mortality per year, or no more than 3 fish over a three year period. This analysis indicates the effects to the abundance from capture, on any population will be quite small, and would not significantly reduce population abundance, or the ability of either species to persist or recover. Additional restoration projects implemented by other parties could be covered under this Opinion per year, as described in the Introduction in the section entitled *Action Area and Requirements for Coverage.* We anticipate these additional projects would be included in this amount of capture and handling described for Lahontan cutthroat trout, as there are typically less than one project for this species in any one year.

Given the limited number of potential restoration projects that may occur in any one year and anticipated low number of fish that will negatively be affected, the numerous PDC and proposed conservation measures to minimize the number of individuals adversely affected by the proposed action, and the anticipated long-term benefits from each project to native habitats and listed species in the long-term, we conclude the proposed restoration actions will not jeopardize the continued existence of Lahontan cutthroat trout.

3.3.8 Conclusion for Lahontan Cutthroat Trout

After reviewing the current status of the listed species, the environmental baseline within the action area, the direct and indirect effects of the proposed action, and cumulative effects, it is Service's biological opinion that the proposed action is not likely to jeopardize the continued existence of Lahontan cutthroat trout. See section 3.1.10 for additional information.

3.3.9 Literature Cited for Lahontan Cutthroat Trout

Gerstung, E.R. 1986. Fisheries management plan for Lahontan cutthroat trout (*Salmo clarki henshawi*) in California and western Nevada waters. Inland Fisheries Administrative Report No. 86. Federal Aid Project F33-R-11. California Department of Fish and Game, Sacramento, California. 54 pp.

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Sigler, W.F. and J.W. Sigler. 1987. Fishes of the great basin. University of Nevada press. Reno, Nevada. 425 pp.

USFWS (U.S. Fish and Wildlife Service). 1970. United States list of endangered native fish and wildlife. Federal Register 35:16047-16048. October 13, 1970.

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USFWS. 1995. Lahontan cutthroat trout, *Oncorhynchus clarki henshawi*, Recovery Plan. Portland, Oregon. 147 pp.

USFWS. 2003a. Short-term action plan for Lahontan cutthroat trout (*Oncorhynchus clarki henshawi*) in the Truckee River basin. U.S. Fish and Wildlife Service, Reno, Nevada. August, 2003. i-iv + 71 pp.

USFWS. 2003b. Short-term action plan for Lahontan cutthroat trout (*Oncorhynchus clarki henshawi*) in the Walker River basin. U.S. Fish and Wildlife Service, Reno, Nevada. August, 2003. i-iii + 44 pp. + appendices.

USFWS. 2003c. Short-term action plan for Lahontan cutthroat trout (*Oncorhynchus clarki henshawi*) in the Truckee River basin. U.S. Fish and Wildlife Service, Reno, Nevada. August, 2003. i-iv + 71 pp.

USFWS. 2003d. Short-term action plan for Lahontan cutthroat trout (*Oncorhynchus clarki henshawi*) in the Walker River basin. U.S. Fish and Wildlife Service, Reno, Nevada. August, 2003. i-iii + 44 pp. + appendices.

USFWS. 2008. Endangered and threatened wildlife and plants: 90-day finding on a petition to delist the Lahontan cutthroat trout. Federal Register 73:52257-52260. September 9, 2008.

USFWS. 2009. 5-Year Review: Summary and Evaluation. Lahontan cutthroat trout (*Oncorhynchus clarkii henshawi*). Region 8, Sacramento, California. 199 pp.

3.4 Warner Sucker Status

3.4.1 Legal Status

The Service listed the Warner sucker as a threatened species and designated critical habitat on September 27, 1985 (USFWS 1985).

3.4.2 Critical Habitat Description

Critical habitat has been designated on September 27, 1985 (USFWS 1985). Warner sucker critical habitat includes the following areas: Twelvemile Creek from the confluence of Twelvemile and Twentymile Creeks upstream for about 6 stream km (4 stream miles); Twentymile Creek starting about 14 km (9 miles) upstream of the junction of Twelvemile and Twentymile Creeks and extending downstream for about 14 km (9 miles); Spillway Canal north of Hart Lake and continuing about 3 km (2 miles) downstream; Snyder Creek, from the confluence of Snyder and Honey Creeks upstream for about 5 km (3 miles); Honey Creek from the confluence of Hart Lake upstream for about 25 km (16 miles). Warner sucker critical habitat includes 16 m (50 feet) on either side of these waterways.

The Primary Constituent Elements (PCEs)
No PCEs have been described for Warner sucker critical habitat. However the designation describes the importance of maintaining the riparian zone for 16 m (50 feet) on either side of the stream. Therefore, the Service considers the following as an interim primary biological feature (PBF) for Warner sucker critical habitat:

Interim PBF: The bankfull width stream channel and a naturally diverse riparian zone extending at a minimum for 16 m (50 feet) from either edge of the stream channel, which includes abundant native vegetation that functions to reduce inputs of sediment and other pollutants. This vegetation should include small trees or shrubs to help maintain suitable water temperature and dissolved oxygen levels in the streams, and provide nutrient inputs from litter fall.

3.4.3 Species Description

The Warner sucker is a slender-bodied species that attains a maximum recorded fork length (the measurement on a fish from the tip of the nose to the middle of the tail where a V is formed) of 45.6 cm (17.9 inches). Pigmentation of sexually mature adults can be striking. The dorsal two-thirds of the head and body are blanketed with dark pigment, which borders creamy white lower sides and belly. During the spawning season, males have a brilliant red (or, rarely, bronze) lateral band along the midline of the body, female coloration is lighter. Breeding tubercles (small bumps usually found on the anal, caudal and pelvic fins during spawning season) are present along the anal and caudal fins of mature males and smaller tubercles occasionally occur on females (Coombs *et al.* 1979).

Sexes can be distinguished by fin shape, particularly the anal fin, among sexually mature adults (Coombs *et al*. 1979). The anal fin of males is broad and rounded distally, whereas the female anal fin is narrower in appearance and nearly pointed or angular. Bond and Coombs (1985) listed the following characteristics of the Warner sucker that differentiate it from other western species of Catostomus: dorsal fin base short, its length typically less than, or equal to, the depth of the head; dorsal fin and pelvic fins with 9 to 11 rays; lateral line (microscopic canal along the body, located roughly at midside) with 73-83 scales, and greater than 25 scales around the caudal peduncle (rear, usually slender part of the body between the base of the last anal fin ray and the caudal fin base); eye small, 0.035 mm (0.0013 inch) Standard Length (straight-line distance from the tip of the snout to the rear end of the vertebral column) or less in adults; dark pigmentation absent from lower 1/3 of body; in adults, pigmented area extends around snout above upper lip; the membrane-covered opening between bones of the skull (fontanelle) is unusually large, its width more than one half the eye diameter in adults.

3.4.3.1 Taxonomy

The Warner sucker (*Catostomas warnerensis*) was first described as a distinct species in 1908. Cope (1883) collected suckers he referred to as *Catostomus tahoensis* from the "third Warner lake" (presumably Hart Lake) although he noted differences in the size of scales between the Warner Lake suckers and *C. tahoensis* from Pyramid Lake, Nevada. The Warner sucker was recognized as distinct and described as a new species by J.O. Snyder (1908) based on specimens collected from the Warner Valley in 1897 and 1904. He reported the species from Warner Creek (now Deep Creek), sloughs south of Warner Creek, and Honey Creek. Relationships of the new sucker to existing species were not precisely defined, but Snyder (1908) noted affinities to *C. tahoensis* of the Lahontan Basin, and *C. catostomus* of wide distribution in northern North America. The distinctiveness of the Warner sucker as a species was confirmed by additional collections (Andreasen 1975, Bond and Coombs 1985). Relationships of the Warner sucker are clearly within the subgenus *Catostomus* (Smith 1966), although identification of the closest relative has remained elusive. Morphologically, all these species are similar and probably the result of speciation due to geographic isolation (USFWS 1998 pp. 4-5).

3.4.4 Life History

3.4.4.1 Reproduction

The distribution of Warner sucker is well known, but limited information is available on stream habitat requirements and spawning habits. Relatively little is known about feeding, fecundity, recruitment, age at sexual maturity, natural mortality, and interactions with introduced game fishes. In this account, "larvae" refers to the young from the time of hatching to transformation into juvenile (several weeks or months), and "juvenile" refers to young that are similar in appearance to adults. Young of year refers to members of age-group 0, including transformation into juvenile until January 1 of the following year. Spawning usually occurs in April and May in streams, although variations in water temperature and stream flows may result in either earlier or later spawning. Temperature and flow cues appear to trigger spawning, with most spawning taking place at 14 to 20 °C (57 to 68 °F) when stream flows are relatively high. Warner sucker spawn in sand or gravel beds in slow pools (White *et al.* 1990, 1991, Kennedy and North 1993). Allen *et al.* (1996) surmise that spawning aggregations in Hart Lake are triggered more by rising stream temperatures than by peak discharge events in Honey Creek.

Tait and Mulkey (1993b) found young of year were abundant in the upper Honey Creek drainage, suggesting this area may be important spawning habitat and a source of recruitment for lake recolonization. The warm, constant temperatures of Source Springs at the headwaters of Snyder Creek (a tributary of Honey Creek) may provide an especially important rearing or spawning site for Warner sucker (Coombs and Bond 1980).

During years when access to stream spawning areas is limited by low flow or by physical in-stream blockages (such as beaver dams or irrigation diversion structures),Warner sucker may attempt to spawn on gravel beds along the lake shorelines. In 1990, Warner sucker were observed digging nests in 40+ cm (16+ inches) of water on the east shore of Hart Lake at a time when access to Honey Creek was blocked by extremely low flows (White *et al.* 1990).

Warner sucker larvae are found in shallow backwater pools or on stream margins where there is no current, often among or near macrophytes. Young of year Warner sucker are often found over deep, still water (from midwater to the surface) but also move into faster flowing areas near the heads of pools (Coombs *et al.* 1979).

Warner sucker larvae venture near higher velocities during the daytime to feed on planktonic organisms but avoid the mid-channel water current at night. This aversion to downstream drift may indicate that spawning habitats are also used as rearing grounds during the first few months of life (Kennedy and North 1993). None of the studies conducted thus far have succeeded in capturing Warner sucker younger than two years old in the Warner lakes, and it has been suggested that Warner sucker do not migrate down from the streams for two to three years (Coombs *et al.* 1979). The absence of young Warner sucker in the Warner lakes, even in years following spawning in the lakes, could be due to predation by introduced game fishes (White *et al.* 1991).

Juvenile suckers (one to two years old) are usually found at the bottom of deep pools or in other habitats that are relatively cool and permanent, such as near springs. As with adults, juvenile Warner sucker prefer areas of the streams that are protected from the higher velocities of the main stream flow (Coombs *et al.* 1979). Larval and juvenile mortality over a two month period during the summer has been estimated at 98% and 89%, respectively, although accurate larval Warner sucker counts were hampered by dense macrophyte cover (Tait and Mulkey 1993b).

3.4.4.2 Population structure

A population estimate of Warner sucker in streams was conducted in 1993 on the Honey Creek and Twentymile Creek drainages (Tait and Mulkey 1993b). Approximately 20% of available stream habitat in the Honey Creek drainage was sampled. The population within the area sampled was estimated at 77 adults, 172 juveniles, and 4,616 young of year. Approximately 60% of the available stream habitat in the Twentymile Creek drainage was also sampled. The population estimates within this area sampled was 2,563 adults, 2,794 juveniles, and 4,435 young of year.

As of 1996, the Hart Lake Warner sucker population was estimated at 493 spawning individuals (95% confidence intervals of 439 to 563) (Allen *et al.* 1996). Although this is the only quantified population estimate of Warner sucker ever made for Hart Lake, it is likely well below the abundances found in Hart Lake prior to the drought.

In 1997, Bosse *et al.* (1997) documented the continued existence, but reduced numbers, of Warner sucker in the Warner Lakes. The number of Warner sucker, as measured by catch per unit effort, had declined 75% over the 1996 results. The reduction in sucker numbers was offset by a sharp increase in the percentage composition of introduced game fish, especially white crappie and brown bullhead.

Hartzell and Popper (2002) indicated a continued reduction of Warner sucker numbers and an increase of introduced fish in Warner Lakes. The greatest number of Warner sucker captured was in Hart Lake (96% of total Warner sucker catch) with only a few Warner sucker captured in the other Warner Lakes, including Crump Lake. Suckers represented a greater percentage of the catch in relation to introduced and other native fish compared to the efforts of 1997, although a smaller total number of sucker were captured than in 1997. This was the first year since 1991 that native fish made up a smaller percentage of the catch than introduced fish.

3.4.4.3 Ecology / Habitat Characteristics

A common phenomenon among fishes is phenotypic plasticity (the ability of different individuals of the same species to have different appearances despite identical genotypes) induced by changes in environmental factors (Wooton 1990, Barlow 1995). This is most easily seen by a difference in the size of the same species living in different but contiguous, and at times sympatric (occurring in the same area) habitats for a portion of their lives (Healey and Prince 1995, Wood 1995). The Warner Basin provides two generally continuous aquatic habitat types; a temporally more stable stream environment and a temporally less stable lake environment (e.g., lakes dried in 1992 and in the early 1930's).

Observations indicate that Warner sucker grow larger in the lakes than they do in streams (White *et al.* 1990). The smaller stream morph (development form) and the larger lake morph are examples of phenotypic plasticity within metapopulations of the Warner sucker. Expressions of these two morphs in Warner sucker might be as simple as the species being opportunistic. When lake habitat is available, the stream morph migrates downstream and grows to become a lake morph. These lake morphs can migrate upstream to spawn or become resident populations while the lake habitat is available. Presumably, when the lake habitat dries up the lake morph is lost but the stream morph persists. When the lakes refill, the stream morph can reinvade the lakes to again become lake morphs. The lake habitat represents a less stable but more productive environment than the metapopulations of Warner sucker use on an opportunistic basis. The exact nature of the relationship between lake and stream morphs remains poorly understood and not well studied.

The lake and stream morphs of the Warner sucker probably evolved with frequent migration and gene exchange between them. The larger, presumably longer-lived, lake morphs are capable of surviving through several continuous years of isolation (e.g., drought or other factors) from stream spawning habitats. Similarly, stream morphs probably serve as sources for recolonization of lake habitats in wet years following droughts, such as the refilling of the Warner Lakes in 1993 following their desiccation in 1992. The loss of either lake or stream morphs to drought, winter kill, excessive flows and a flushing of the fish in a stream, in conjunction with the lack of safe migration routes and the presence of predaceous exotic fishes, may strain the ability of the species to rebound (White *et al.* 1990, Berg 1991).

Lake morph Warner sucker occupy the lakes and, possibly, deep areas in the low elevation creeks, reservoirs, sloughs and canals. Recently, only stream morph suckers have exhibited frequent recruitment, indicated by a high percentage of young of year and juveniles in Twelvemile and Honey Creeks (Tait and Mulkey 1993a,b). Lake morph suckers, on the other hand, were skewed towards larger, older adults (8 to 12 years old) with no juveniles and few younger adult fish (White *et al.* 1991) before the lakes dried up in 1992. Since the lakes refilled, the larger lake morph suckers have reappeared. Captured lake suckers averaged 267 mm (10.5 inches) standard length (SL) in 1996 (Chris Allen, The Nature Conservancy (TNC), Portland, Oregon, *pers. comm*., 1996), 244 mm (9.6 inches) SL in 1995 (Allen *et al.* 1995a) and 198 mm (7.8 inches) SL in 1994 (Allen *et al.* 1995b). Stream caught fish averaged 138 mm (5.4 inches) SL in 1993 (Tait and Mulkey 1993b).

Warner sucker recovered from an ice induced kill in Crump Lake were aged to 17 years old and had a maximum fork length of 456 mm (17.9 inches) (White *et al.* 1991). Lake resident suckers are generally much larger than stream residents, but growth rates for adults are not known for either form. Sexual maturity occurs at an age of three to four years (Coombs *et al.* 1979), although in 1993, captive fish at Summer Lake Wildlife Management Area, Oregon, successfully spawned at the age of two years (White *et al.* 1991).

Coombs *et al.* (1979) measured Warner sucker larval growth and found a growth rate of approximately 10 mm (0.39 inch) per month during the summer (i.e., when the larvae were 1-4 months old). Sucker larvae at Summer Lake Wildlife Management Area grew as large as 85 mm (3.3 inches) in three months during the summer of 1991, but this was in an artificial environment (earth ponds) and may not reflect natural growth patterns.

The feeding habits of the Warner sucker depend to a large degree on habitat and life history stage, with adult suckers becoming more generalized than juveniles and young of year. Larvae have terminal mouths and short digestive tracts, enabling them to feed selectively in midwater or on the surface. Invertebrates, particularly planktonic (having weak powers of locomotion) crustaceans, make up most of their diet. As the suckers grow, they develop subterminal mouths, longer digestive tracts, and gradually become generalized benthic (living on the bottom) feeders on diatoms (small, usually microscopic, plants), filamentous (having a fine string-like appearance) algae, and detritus (decomposed plant and animal remains). Adult stream morph suckers forage nocturnally over a wide variety of substrates such as boulders, gravel, and silt. Adult lake morph suckers are thought to have a similar diet, though caught over predominantly muddy substrates (Tait and Mulkey 1993a, b).

White *et al.* (1991) found in qualitative surveys that, in general, adult suckers used stretches of stream where the gradient was sufficiently low to allow the formation of long (50 m [166.6 feet] or longer pools. These pools tended to have undercut banks, large beds of aquatic macrophytes (usually greater than 70% of substrate covered), root wads or boulders, a surface to bottom temperature differential of at least 2 °C (3.6 °F) at low flows, a maximum depth greater than 1.5 m (5 feet), and overhanging vegetation (often *Salix* spp.). About 45% of these pools were beaver ponds, although there were many beaver ponds in which Warner sucker were not observed. Warner sucker were also found in smaller or shallower pools or pools without some of the above mentioned features. However, they were only found in such places when a larger pool was within approximately 0.4 km (0.25 mile) upstream or downstream of the site.

Submersed and floating vascular macrophytes are often a major component of Warner sucker-inhabited pools, providing cover and harboring planktonic crustaceans which make up most of the young of year Warner sucker diet. Rock substrates such as large gravel and boulders are important in providing surfaces for epilithic (living on the surface of stones, rocks, or pebbles) organisms upon which adult stream resident Warner sucker feed, and finer gravels or sand are used for spawning. Siltation of Warner sucker stream habitat increases the area of soft stream bed necessary for macrophyte growth, but embeds the rock substrates utilized by adult Warner sucker for foraging and spawning. Embeddedness, or the degree to which hard substrates are covered with silt, has been negatively correlated with total Warner sucker density (Tait and Mulkey 1993a).

Habitat use by lake resident Warner sucker appears to be similar to that of stream resident Warner sucker in that adult Warner sucker are generally found in the deepest available water where food is plentiful. Not surprisingly, this describes much of the habitat available in Hart, Crump, and Pelican Lakes, as well as the ephemeral lakes north of Hart Lake. Most of these lakes are shallow and of uniform depth (the deepest is Hart Lake at 3.4 m (11.3 feet) maximum depth), and all have mud bottoms that provide the Warner sucker with abundant food in the form of invertebrates, algae, and organic matter.

3.4.5 Historical Status and Distribution

The Warner sucker (*Catostomus warnerensis*) is endemic to the Warner Valley in southeast Oregon, an endoreic (closed) sub-basin of the Great Basin area. The valley contains a dozen lakes and many potholes during wet years, but only the three southernmost lakes are semi-permanent. In addition, three permanent creeks drain into the valley (Honey Creek, Deep Creek, and Twentymile Creek).

Cope (1883) collected suckers he referred to as *Catostomus tahoensis* from the "third Warner lake" (presumably Hart Lake) although he noted differences in the size of scales between the Warner Lake suckers and *C. tahoensis* from Pyramid Lake, Nevada. The Warner sucker was recognized as distinct and described as a new species by Snyder (1908) based on specimens collected from the Warner Valley in 1897 and 1904. He reported the species from Warner Creek (now Deep Creek), sloughs south of Warner Creek, and Honey Creek. Relationships of the new sucker to existing species were not precisely defined, but Snyder (1908) noted affinities to *C. tahoensis* of the Lahontan Basin, and *C. catostomus* of wide distribution in northern North America. The distinctiveness of the Warner sucker as a species was confirmed by additional collections (Andreasen 1975, Bond and Coombs 1985). The Warner sucker is clearly within the subgenus *Catostomus* (Smith 1966), although identification of the closest relative has remained elusive.

The probable historic range of the Warner sucker includes the main Warner Lakes (Pelican, Crump, and Hart), and other accessible standing or flowing water in the Warner Valley, as well as the low to moderate gradient reaches of the tributaries which drain into the Warner Valley. Warner sucker historic distribution in tributaries includes Deep Creek (up to the falls west of Adel), the Honey Creek drainage, and the Twentymile Creek drainage. In Twelvemile Creek, a tributary to Twentymile Creek, the historic range of Warner sucker extended through Nevada and back into Oregon.

Early collection records document the occurrence of Warner sucker from Deep Creek up to the falls about 5 km (3.1 miles) west of Adel, the sloughs south of Deep Creek, and Honey Creek (Snyder 1908). Andreasen (1975) reported that long-time residents of the Warner Valley described large runs of suckers in the Honey Creek drainage, even far up into the canyon area.

3.4.5.1 Current Status and Distribution

Most of the habitat occupied by Warner sucker is located on BLM administered lands. Additional Warner sucker habitat is located on private lands, State lands, and bordered by Hart Mountain National Antelope Refuge.

Within the Lakeview Resource Area Resource Management Plan area, Warner sucker inhabit lakes, sloughs, and potholes in the Warner Valley, including the canal north of Hart Lake, Hart Lake, Crump Lake, Anderson Lake, Swamp Lake, Mugwump Lake, Greaser Reservoir, Honey Creek, Snyder Creek, Twentymile Creek and Twelvemile Creek. A majority of Warner sucker habitat is located in waterways managed by the Lakeview BLM.

Between 1987 and 1991, five consecutive drought years prompted resource agencies to plan a Warner sucker salvage operation and establish a refuge population of Warner sucker at Service's Dexter National Fish Hatchery and Technology Center (Dexter), New Mexico. Salvage operations consisted of intensive trap netting in Hart Lake to collect Warner sucker, then transportation of the captured fish to a temporary holding facility at ODFW's Summer Lake Wildlife Management Area (Summer Lake). The suckers were held at Summer Lake until September 1991, when 75 adults were recaptured and transported to Dexter.

While being held at Summer Lake, Warner sucker spawned successfully, leaving an estimated 250+ young in the Summer Lake holding ponds. The young suckers survived, growing approximately 85 mm (3.3 inches) during their first summer and reaching sexual maturity at the age of only two years. Warner sucker larvae were observed in the ponds during the summer of 1993, just over two years after the original wild suckers from Hart Lake were held there. Approximately 30 of the two year-old suckers were captured and released in Hart Lake in September 1993. In June 1994, over 100 100 to 175 mm (4 to 7 inches) Warner sucker were observed in the Summer Lake ponds. In 1996, nine adult fish were observed in these ponds along with about 20 larvae.

The suckers taken to Dexter were reduced from 75 to 46 individuals between September 1991 and March 1993, largely due to *Lorna* (anchor worm) infestation. In March 1993, the 46 survivors (12 males and 34 females) appeared ready to spawn, but the females did not produce any eggs. Between March 1993 and March 1994, *Lorna* further reduced the population to 20 individuals (5 males and 15 females) (USFWS 1998). In May 1994, the five males and seven of the females spawned, producing a total of approximately 175,000 eggs. However, for reasons that are not clear, none of the eggs were successfully fertilized. The remaining 20 fish at Dexter died in 1995 (USFWS 1998). In November of 1995, approximately 65 more suckers from Summer Lake were transferred to Dexter for spawning purposes but as yet no attempts to spawn these fish have occurred.

Between 1977 and 1991, eight studies examined the range and distribution of the Warner sucker throughout the Warner Valley (Kobetich 1977, Swenson 1978, Coombs *et al.* 1979, Coombs and Bond 1980, Hayes 1980, White *et al.* 1990, Williams *et al.* 1990, White *et al.* 1991). These surveys have shown that when adequate water is present, Warner sucker may inhabit all the lakes, sloughs, and potholes in the Warner Valley. The documented range of the sucker extended as far north into the ephemeral lakes as Flagstaff Lake during high water in the early 1980's, and again in the 1990's (Allen *et al.* 1996). The Warner sucker population of Hart Lake was intensively sampled to salvage individuals before the lake went dry in 1992.

Stream resident populations of Warner sucker are found in Honey Creek, Snyder Creek, Twentymile Creek and Twelvemile Creek. Intermittent streams in the drainages may support small numbers of migratory suckers in high water years. No stream resident Warner sucker have been found in Deep Creek since 1983 (Smith *et al.* 1984, Allen *et al.* 1994), although a lake resident female apparently trying to migrate to stream spawning habitat was captured and released in 1990 (White *et al.* 1990). The known upstream limit of the Warner sucker in Twelvemile Creek is through the Nevada reach and back into Oregon (Allen *et al.* 1994). However, the distribution appears to be discontinuous and centered around low gradient areas that form deep pools with protective cover. In the lower Twentymile Slough area on the east side of the Warner Valley, White *et al.* (1990) collected adult and young suckers throughout the slough and Greaser Reservoir. This area dried up in 1991, but because of its marshy character, may be important sucker habitat during high flows. Larval, young-of-year, juvenile and adult Warner sucker captured immediately below Greaser Dam suggest either a slough resident population, or lake resident suckers migrating up the Twentymile Slough channel from Crump Lake to spawn (White *et al.* 1990, Allen *et al.* 1996).

While investigating the distribution of Cowhead Lake tui chub, Scoppettone and Rissler (2001) discovered a single juvenile Warner sucker in West Barrel Creek. West Barrel Creek is a tributary to Cow Head Slough that eventually enters Twelvemile Creek at the known upper extension of suckers in the Twelvemile drainage. This discovery of a Warner sucker in the Cowhead Lake drainage is a significant range extension for Warner sucker.

3.4.5.2 Threats, Reasons for Listing

Warner sucker were listed due to reductions in the range and numbers, reduced survival due to predation by introduced game fishes in lake habitats, and habitat fragmentation and migration corridor blockage due to stream diversion structures and agricultural practices. Since the time of listing, it has been recognized that habitat modification, due to both stream channel degradation and overall reduced watershed function has worsened and the status and viability of the Warner sucker has declined. Signs of stream channel and watershed degradation are common in the Warner Valley, and include fences hanging in mid-air because stream banks have collapsed beneath them, high cut banks on streams, damaged riparian zones, bare banks, and large sagebrush flats where there were once wet meadows (White *et al.* 1991).

The first large scale human impact to migration of the Warner sucker within the Warner Basin was the construction of irrigation diversion structures in the late 1930s (Hunt 1964). These structures hamper or block both upstream and downstream migrations of various life stages of Warner sucker. Few irrigation diversions have upstream fish passage. Adult suckers that have spawned and are moving downstream can be diverted from the main channel to become lethally trapped in unscreened irrigation canals. Larval, post larval, young of year, and juvenile suckers are probably also lethally diverted into unscreened irrigation canals.

In high water years, the amount of water diverted from Warner Valley streams may be only a small portion of the total flow, but in drought years, total stream flows often do not meet existing water rights, and so entire streams may be diverted. Over a series of drought years, reduced flows can cause drops in lake levels and sometimes, especially in conjunction with lake pumping for irrigation, cause complete dry-ups, as was the case with Hart Lake in 1992.

Although the native species composition in the Warner basin included some piscivorus fishes, like the Warner Valley redband trout (*Oncorhynchus mykiss sp.*), the introduction of exotic game fish disrupted this prey predator balance. In the early 1970s, ODFW stocked white crappie (*Pomoxis annularis*), black crappie (*P. nigromaculatus)*, and largemouth bass (*Micropterus salmoides*), in Crump and Hart Lakes. Prior to this, brown bullhead (*Ameiurus nebulosus*) and non-native rainbow trout were introduced into the Warner Valley. The adults of all five piscivorus fish species feed on Warner sucker to varying degrees.

The presence of the introduced game fishes threaten Warner sucker through competitive interactions. Brown bullhead are bottom oriented omnivores (Moyle 1976) that may compete directly with Warner sucker for the same food sources. Bullhead may also prey on sucker eggs in the lower creek or lake spawning areas, as well as on sucker larvae and juveniles. Young crappie probably eat many of the same zooplankton and other small invertebrates that young suckers depend on. Habitat use by young Warner sucker remains poorly understood, but there may be competition between suckers and other fishes for what scarce cover resources are available.

3.4.6 Recovery Measures

Warner sucker naturally inhabit Twentymile Creek. Irrigation water is diverted out of Twentymile Creek and into a series of canals which are then diverted out onto agricultural fields for forage and livestock. Warner sucker are known to occupy Twentymile Creek and likely disperse downstream into the irrigation canals. Larvae stage fish are most vulnerable to be affected by the diversion structures and pumps. The diversion structures which transfer water from Twentymile Creek into the canal does not have a fish screen on it. Although surveys have not been conducted indicating Warner sucker presence in the canal, NRCS assumes Warner sucker fry would be present in the vicinity of the proposed irrigation diversion structures.

Fish passage improvements. In 1991, BLM installed a modified steep-pass Denial fish passage facility on the Dyke diversion on lower Twentymile Creek. The fishway is intended to re-establish a migration corridor, and allow access to high quality spawning and rearing habitats. The Dyke diversion structure is a 1.2 m (4 feet) high irrigation diversion that was impassable to Warner sucker and redband trout before the fishway was installed. It blocked all migration of fishes from the lower Twentymile Creek, Twentymile Slough and Greaser Reservoir populations from moving upstream to spawning or other habitats above the structure. To date, no suckers have been observed or captured passing the structure, but redband trout have been observed and captured in upstream migrant traps.

An evaluation of fish passage alternatives has been done for diversions on Honey Creek which identifies the eight dams and diversions on the lower part of the creek that are barriers to fish migration (Campbell-Craven Environmental Consultants 1994). In May 1994, a fish passage structure was tested on Honey Creek. It consisted of a removable fishway and screen. The ladder immediately provided passage for a small redband trout. These structures were removed by ODFW shortly after their installation due to design flaws that did not pass allocated water.

Warner sucker research. Research through 1989 summarized in Williams *et al.* (1990) consisted of small scale surveys of known populations. Williams *et al.* (1990) primarily tried to document spawning and recruitment of the Hart Lake population, define the distributional limits of the Warner sucker in the streams, and lay the groundwork for further studies. White *et al.* (1990) conducted trap net surveys of the Anderson Lake, Hart Lake, Crump Lake, Pelican Lake, Greaser Reservoir, and Twentymile Slough populations. A population estimate was attempted for the Hart Lake population, but was not successful. Lake spawning activity was observed in Hart Lake, though no evidence of successful recruitment was found.

White *et al.* (1991) documented the presence of suckers in the Nevada reach of Twelvemile Creek. This area had been described as apparently suitable habitat by Williams *et al.* (1990), but suckers had not previously been recorded there.

Kennedy and North (1993) and Kennedy and Olsen (1994) studied sucker larvae drift behavior and distribution in streams in an attempt to understand why recruitment had been low or nonexistent for the lake morphs in previous years. They found that larvae did not show a tendency to drift downstream and theorized that rearing habitat in the creeks may be vital to later recruitment.

Tait and Mulkey (1993a, b) investigated factors limiting the distribution and abundance of Warner sucker in streams above the man-made stream barriers. The detrimental effects of these barriers are well-known, but there may be other less obvious factors that are also affecting the suckers in streams. These studies found that general summertime stream conditions, particularly water temperature and flows, were poor for most fish species. Recent studies have concentrated on population estimates, marking fish from Hart Lake and monitoring the recolonization of the lakes by native and non-native fishes (Allen *et al.* 1995a, b; Allen *et al.* 1996).

3.4.7 Conservation Measures for Warner Sucker

In addition to the proposed PDC for specific restoration actions, as applicable, the following specific conservation measures are proposed for for Warner sucker:

a. Consider all options for alternatives to fish ladder construction including 1) dam removal; 2) relocation of the point of diversion to allow for water withdrawal without the use of a dam; 3) consult with NMFS and the Service while designing project and before implementation.
b. Fishways for Warner sucker should be reviewed for use of the most current state of knowledge for design. Criteria for sucker passage are in development and likely to be refined. For example, a 15.2 x 15.2 cm (6 x 6 inch) orifice and no more than 1.16 m/s (3.8 feet per second) velocity are the best current design standards. Baffled chutes and roughened channels are preferred and should be considered where feasible to install.

c. Whenever practical projects in sucker habitat should be carried out during October or November to this reduce stress on the fish and avoid impacts to larval suckers. For all projects that occur outside of the October-November timeframe, the project manager will work closely with internal and external Warner sucker experts to determine the best timing for each project on a site-specific basis. Any exceptions to in-water work windows recommended by ODFW will be approved by the Service.

3.4.8 Environmental Baseline for Warner Sucker

A general description of aquatic habitats in the Action Area was provided in Section 2.3 (Environmental Baseline Overview). As the Action Area encompasses the entire range of the Warner sucker, Section 2.3 and the preceding sections on Warner sucker status adequately describe the baseline for this species.

3.4.9 Effects to Warner Sucker

General effects of the proposed restoration action on Warner sucker and its habitats are described in Sections 3.1.1 and 3.1.2 (ESA-listed Fish Species), and Section 3.1.4 (Scope of Effects to ESA-listed Fish). The effects to ESA-listed fishes from restoration actions are generally the same, and thus, a general effects section is appropriate. Effects specific to Warner sucker are described below, including capture and handling effects.

Warner suckers (suckers) are limited to a relatively few lake and stream systems in southeast Oregon. Generally suckers will spawn in areas along shallow stream banks with large amounts of riparian vegetation, but may also spawn near lakeshore areas. Generally, Warner suckers better tolerate warmer water temperature than salmonids. They also prefer lower to moderate graded streams, with quieter water than salmonids. Therefore, when suckers are found in streams inhabited by salmonids, suckers are usually found in greater numbers in the mid-system as juveniles and in greater abundance in the lower portion of the system, where deeper pools exist, as adults.

Effects to Warner suckers would primarily result from instream (or in-lake) and streambank (or lakeshore) projects on the few areas where they occur. Large quantities of riparian vegetation are needed by suckers as cover and refugia for larval suckers, who often have great distances to travel to reach lakes or deep quiet pools in streams as they mature. Activities that remove riparian vegetation, or alter over-hanging banks could have adverse effects on sucker spawning and rearing success.

Fish passage projects could temporarily block sucker migration within the stream system and disrupt normal feeding behavior. Construction projects that increase fine sediments could disrupt the ability of suckers to linger and feed on cobble or boulder substrates, while these same sediments could cover spawning gravel and sand used by Warner sucker. Suckers could also be exposed to temporary increases in sedimentation from juniper treatments or prescribed burning proposed under PROJECTS. The removal of encroaching juniper and use of prescribed fire could change infiltration rates and overland flow. These changes in base and peak flow could cause increased sedimentation. However, these effects would be short-term as the removal of juniper would encourage the reestablishment of native bunch grasses which have a much greater propensity to hold soil and resist erosion.

The proposed PDC and conservation measures should greatly reduce these risks to Warner suckers. Local in-water work periods are established to minimize effects, and reduce conflicts between spawning seasons and project implementation. Also following local in-water work period restrictions should further reduce effects to suckers by insuring that any fine sediments that are deposited on substrates have adequate opportunity to be dispelled by high flows before spawning occurs the following year. Whenever practical, projects in sucker habitat should be carried out during October or November, which reduces stress on the fish and avoids impacts to larval suckers. The Action Agencies will work closely with ODFW to determine the best timing for individual projects on a site-specific basis. While undoubtedly some individual suckers will be exposed to some degree of adverse effects from temporary migration blockage, increased suspended sediments, capture and handling, and local habitat degradation through the removal of riparian vegetation, the number will be small.

Over 4 years (2011 to 2014), the Oregon PFW Program funded 4 restoration projects that affected Warner sucker. The Service's Recovery Program in Oregon funded 2 projects that may have affected Warner sucker. Given this information, we anticipate up to 2 projects per year funded by either Action Agency will negatively affect Warner suckers. In addition to the Action Agencies' restoration projects, coverage for other restoration projects may also be extended to other parties, including traditional Section 6 Grants to States, provided that party is able to meet all requirements (project review, PDC, conservation measures, reporting requirements, etc.) and review by the local Service office determines the proposed action will not exceed the level of effects described in this Opinion. For Warner sucker, this Opinion authorizes 2 projects per year, as calculated on a rolling three-year average. Additional restoration projects implemented by other parties could be covered under this Opinion per year, as described in the Introduction in the section entitled *Action Area and Requirements for Coverage.* We anticipate these additional projects would be included in this amount of capture and handling described for Warner suckers, as there are typically less than two projects for this species in any one year.

Given the limited number of potential restoration projects that may occur in any one year relative to population numbers and acres of available suitable habitat, the numerous PDC and proposed conservation measures to minimize the number of individual Warner suckers adversely affected by the proposed action, and the anticipated long-term benefits from each project to native habitats and listed species in the long-term, we conclude the proposed restoration actions will not jeopardize the continued existence of Warner sucker. Because the likely adverse effects of any action funded or carried out under this Opinion will not adversely affect the population characteristics of any Warner sucker population, the proposed actions also will not have any measurable effect on species-level abundance, productivity, or ability to recover.

Capture and handling effects for Warner Sucker

Projects that require dewatering and capture are expected. The Service estimates that about 20 suckers would be captured per project. Based on past projects done under the previous programmatic opinions, it could be expected that somewhere around one project per year would be carried out that could capture suckers. Because of the increased interest in habitat restoration and the expanded number of categories available under PROJECTS, the Service anticipates that one project per year will be conducted that could require capture and handling of Warner suckers

The Service estimates that a maximum of 5% of those fish (or 1 fish) that are captured and handled will suffer injury or mortality per year. The vast majority of the fish captured will be juveniles and the overall effect to population abundance will be very small.

3.4.10 Effects to Warner Sucker Designated Critical Habitat

No PCEs have been described for Warner sucker critical habitat. However the designation describes the importance of maintaining the riparian zone for 16 m (50 feet) on either side of the stream. Therefore, the Service considers the following as an interim primary biological feature (PBF) for Warner sucker critical habitat:

Interim PBF: The bankfull width stream channel and a naturally diverse riparian zone extending at a minimum for 16 m (50 feet) from either edge of the stream channel, which includes abundant native vegetation that functions to reduce inputs of sediment and other pollutants. This vegetation should include small trees or shrubs to help maintain suitable water temperature and dissolved oxygen levels in the streams, and provide nutrient inputs from litter fall.

Instream and near-shore construction projects have the greatest potential to affect the PBF for Warner sucker. Construction projects may adversely affect streambank conditions and riparian vegetation at project sites. The removal of vegetation combined with the disturbance of soils (i.e. re-grading activities) will change streambank dynamics to some extent wherever these projects occur within Warner sucker critical habitat. These effects will result from the removal of vegetation that holds soil in place, preventing erosion, and that helps to regulate sediment delivery to the system.

PACFISH/INFISH suggests that a potential natural community comprised of greater than 50% native riparian vegetation is needed to achieve properly functioning condition for RHCA. Projects that remove non-native streamside vegetation may ultimately benefit the RHCA, but will cause a short-term adverse effect by decreasing of the ability of the RHCA to filter sediment and other pollutants. These treatments may remove small trees and shrubs needed to provide streambank stability and stream shade. In the case of Warner sucker critical habitat, it is likely that most of these adverse effects will be short-term (weeks to months), although the time needed to replace any lost shade could be longer. Most of these effects would occur short-term (weeks to months), but some could last longer (more than one year). Ultimately, projects that improve the density of native plants will benefit streambank and overall riparian conditions over-time.

Instream projects would be entirely beneficial to the RHCA within Warner sucker critical habitat. Increases in LW, boulder and gravel placement, would all contribute to the value of the interim PBF.

Removal of some riparian vegetation via instream construction projects may also alter water quality at project sites, and potentially adversely affect the interim PBF. This vegetation removal will cause a decrease in the amount of nutrients available from litter fall. Further, the removal of small trees of shrubs that provide stream shade will allow increased solar radiation which will increase stream temperatures. The removal of streamside vegetation would reduce the ability of critical habitat to provide a riparian buffer to filter sediment and other pollutants. These effects should be short-term (lasting weeks to months), but some effects could last for more than a year. Over time any vegetation removed will return and negative effects will diminish.

Summary Effects to Warner sucker critical habitat at the rangewide scale

While the proposed action will have adverse effects to Warner sucker critical habitat at the local, site specific scale, these adverse effects will not be significant when evaluated at larger scales. The projects involved are too small and of too short duration to adversely affect critical habitat across the range of the Warner sucker. Based on previous years' projects (2011 to 2014) described in the Opinion, we anticipate no more than two projects per year within the range of the Warner sucker. This indicates that the frequency of projects was quite low. So when forecasting it must be considered that the number of projects that will be conducted will be widely spaced both by location and temporally. Thus, implementation of restoration projects under this Opinion will not adversely modify critical habitat for the Warner sucker.

3.4.11 Conclusion for Warner Sucker

After reviewing the current status of the listed species, the environmental baseline within the action area, the direct and indirect effects of the proposed action, and cumulative effects, it is Service's biological opinion that the proposed action is not likely to jeopardize the continued existence of Warner suckers, or result in the destruction or adverse modification of critical habitat that has been designated for Warner sucker. See section 3.1.10 for additional information.

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3.5 Northern Spotted Owl

3.5.1 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 (USFWS 1990a, p. 26114). The Service recovery priority number for the spotted owl is 12C (USFWS 2011, p. 55), on a scale of 1C (highest) to 18 (lowest). This number reflects a moderate degree of threat, a low potential for recovery, the spotted owl's taxonomic status as a subspecies and inherent conflicts with development, construction, or other economic activity given the economic value of older forest spotted owl habitat. A moderate degree of threat equates to a continual population decline and threat to its habitat, although extinction is not imminent. While the Service is optimistic regarding the potential for recovery, there is uncertainty regarding our ability to alleviate the barred owl impacts to spotted owls and the techniques are still experimental, which matches our guidelines' "low recovery potential" definition (USFWS 1983a 43101-43104, 1983b 51985). 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 (USFWS 2004, p. 55) and to 12C in the 2011 Revised Recovery Plan for the spotted owl (USFWS 2011, p.22).

3.5.2 Spotted Owl Critical Habitat

On December 4, 2012, the final rule for critical habitat for spotted owls was published (USFWS 2012a), and became effective on January 3rd, 2013. The revised critical habitat currently includes approximately 9,577,969 acres in 11 units and 60 subunits in California, Oregon, and Washington.

3.5.2.1 Conservation Role of Critical Habitat

The expectation of critical habitat is to support population viability and demographically stable populations of spotted owls, but this will likely require habitat conservation in concert with the implementation of recovery actions that address other, non-habitat-based threats to the species, including the barred owl (USFWS 2012a, p. 71879). This is expected to be done by:

1. Conserve the older growth, high quality and occupied forest habitat as necessary to meet recovery goals. This includes conserving old growth trees and forests on Federal lands *wherever they are found* (emphasis added), and undertake appropriate restoration treatment in the threatened forest types.

2. Implement science-based, active vegetation management to restore forest health, especially in drier forests in the eastern and southern portions of the spotted owl's range. This includes managing NWFP forests as dynamic ecosystems that conserve all stages of forest development (e.g., old growth and early seral), and where tradeoffs between short-term and long-term risks are better balanced. The NWFP should be recognized as an integrated conservation strategy that contributes to all components of sustainability across Federal lands.

3. Encourage landscape-level planning and vegetation management that allow historical ecological processes, such as characteristic fire regimes and natural forest succession, to occur on these landscapes throughout the range of the spotted owl. This approach has the best chance

of resulting in forests that are resilient to future changes that may arise due to climate change (USFWS 2012a, p. 71881).

3.5.2.2 Primary Constituent Elements

The PCEs are described in the critical habitat rule as the specific elements that comprise the Physical or Biological Features (PBFs) needed for the conservation of the spotted owl. The PBFs are the forested areas that are used or likely to be used by the spotted owl for nesting, roosting, foraging (NRF), or dispersing (USFWS 2012a, p. 71904). The PCEs are the specific characteristics that make habitat areas suitable for NRF and dispersal (USFWS 2012a, pp. 71906-71908). The PCEs include: 1) Forest types in early-, mid-, or late-seral stages; and specific habitat that provides for 2) nesting/roosting, 3) foraging, and 4) transience and colonization phases of dispersal. Any activity occurring within critical habitat that impacts any of these PCEs may adversely affect spotted owl critical habitat.

3.5.2.3 Special Considerations for PCEs in the Action Area (USFWS 2012a, p. 71909-71910)

West Cascades/Coast Ranges of Oregon and Washington

Special management considerations or protection may be required in areas of moist forests to conserve or protect older stands that contain spotted owl sites or contain high-value spotted owl habitat. Silvicultural treatments are generally not needed to maintain existing old-growth forests on moist sites. In contrast to dry and mesic forests, short-term fire risk is generally lower in the moist forests that dominate on the west side of the Cascade Range, and occur east of the Cascades as a higher elevation band or as peninsulas or inclusions in mesic forests. Disturbance based management for forests and spotted owls in moist forest areas should be different from that applied in dry or mesic forests. Efforts to alter either fuel loading or potential fire behavior in these sites could have undesirable ecological consequences as well. Furthermore, commercial thinning has been shown to have negative consequences for spotted owls and their prey. Active management may be more appropriate in younger plantations that are not currently on a trajectory to develop old-growth structure. These stands typically do not provide high-quality spotted owl habitat, although they may occasionally be used for foraging and dispersal.

3.5.2.4 Analysis

The consultation process evaluates how a proposed action is likely to affect the capability of the critical habitat to support the spotted owl by considering the scales at which life-history requirements are based (USFWS 2012a, p.71940):

i. *Action area*

- The impact of the proposed action on the ability of the affected critical habitat to continue to support the life history functions supplied by the PCEs.

ii. *Subunit*

- The extent of the proposed action, both its temporal and spatial scale, relative to the critical habitat subunit within which it occurs.
- The specific purpose for which the affected subunit was identified and designated as critical habitat.

- The impact of the proposed action on the subunit's likelihood of serving its intended conservation function or purpose.
- The overall consistency of the proposed action with the intent of the recovery plan or other landscape-level conservation plans.
- The special importance of project scale and context in evaluating the potential effects of timber harvest to spotted owl critical habitat.

iii. Unit

- The extent of the proposed action, both its temporal and spatial scale, relative to the critical habitat unit within which it occurs.
- The cumulative effects of all completed activities in the critical habitat unit.
- The impact of the proposed action on the unit's likelihood of continuing to contribute to the conservation of the species.

iv. Range wide

- The extent of the proposed action, both its temporal and spatial scale, relative to the entire critical habitat network.

3.5.2.5 Summary of Past Adverse Effects to Revised Critical Habitat

Adverse effects from conferences and consultations, as of January 2, 2013, are summarized in Table 10.

Table 10. Summary of Spotted owl Critical Habitat NRF[1] Acres Removed or Downgraded as documented through Section 7 Consultations on Northwest Forest Plan (NWFP) Lands; Environmental Baseline and Summary of Effects By State, Physiographic Province and Land Use Function on February 4, 2013.

Physiographic Province[2]		Evaluation Baseline		Habitat Removed/Downgraded					% Provincial Baseline Affected	% Range-wide Effects
				Land Use Allocations[5]			Habitat Loss to Natural Events			
		Total Designated Critical Habitat Acres[3]	Nesting/Roosting/ Foraging Acres[4]	Reserves	Non-Reserves	Total		Total		
WA	Eastern Cascades	1,022,960	416,069	0	0	0	0	0	0.00	0.00
	Olympic Peninsula	507,165	238,390	6	0	6	0	6	0.00	0.15
	Western Cascades	1,387,567	667,173	18	0	18	0	18	0.00	0.46
OR	Cascades East	529,652	181,065	0	0	0	0	0	0.00	0.00

Physiographic Province[2]		Evaluation Baseline		Habitat Removed/Downgraded					% Provincial Baseline Affected	% Range-wide Effects
				Land Use Allocations[5]			Habitat Loss to Natural Events	Total		
		Total Designated Critical Habitat Acres[3]	Nesting/Roosting/ Foraging Acres[4]	Reserves	Non-Reserves	Total				
	Cascades West	1,965,407	1,161,780	58	779	837	0	837	0.07	21.18
	Coast Range	1,151,874	535,602	361	1,347	1,708	0	1,708	0.32	43.22
	Klamath Mountains	911,681	481,577	1,292	91	1,383	0	1,383	0.29	34.99
CA	**Cascades**	243,205	98,243	0	0	0	0	0	0.00	0.00
	Coast	149,044	58,278	0	0	0	0	0	0.00	0.00
	Klamath	1,708,787	752,131	0	0	0	0	0	0.00	0.00
Total		**9,577,342**	**4,590,308**	**1,735**	**2,217**	**3,952**	**0**	**3,952**	**0.09%**	**100%**

Notes:

1. Nesting, roosting, foraging (NRF) habitat. In California, suitable habitat is divided into two components; nesting - roosting (NR) habitat, and foraging (F) habitat. The NR component in CA most closely resembles NRF habitat in Oregon and Washington.
2. Defined in the Revised Recovery Plan for the spotted owl (USFWS 2011) as Recovery Units as depicted on page A-3.
3. 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. Calculated from GIS data for spotted owl Nesting/Roosting habitat generated by Davis *et al.* 2011 for the Northwest Forest Plan 15-year Monitoring Report (PNW-GTR-850). NR habitat acres are approximate values based on 2006 (OR/WA) and 2007 (CA) satellite imagery.
5. Reserve land use allocations under the NWFP intended to provide demographic support for spotted owls include LSR, MLSA, and CRA. Non-reserve allocations under the NWFP intended to provide dispersal connectivity between reserves include AWA, AMA, and MX.

3.5.3 Life History

3.5.3.1 Taxonomy

The spotted owl (*Strix occidentalis caurina*) 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, pp.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 Nevadas, appears to be stable (Barrowclough *et al.* 2005, p. 1116).

3.5.3.2 Physical Description

The spotted owl is a medium-sized owl and is the largest of the three subspecies of spotted owls (Gutiérrez 1996, p. 2). It is approximately 46 to 48 cm (18 to 19 inches) long and the sexes are dimorphic, with males averaging about 13% 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) (P. Loschl and E. Forsman, *pers. comm.* cited in USFWS 2008a, p. 43). 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 (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).

3.5.3.3 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 (USFWS 1990a, p. 26115). The range of the spotted owl is partitioned into 12 physiographic provinces based on recognized landscape subdivisions exhibiting different physical and environmental features (USFWS 1992b, p. 31). 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 (USFWS 1992a, p. 1799).

3.5.3.4 Behavior

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. 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).

3.5.3.5 Habitat Relationships

Home Range. Home-range sizes vary geographically, generally increasing from south to north, which is likely a response to differences in habitat quality (USFWS 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, p. 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 (USFWS 1994a, 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. Within the home range there is a smaller area of concentrated use during the breeding season (~20% of the homerange), often referred to as the core area (Bingham and Noon 1997, pp. 133-135). 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). 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).

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 nesting success (Bart 1995, p. 944) and abundance (Bart and Forsman 1992, pp. 98-99).

Habitat Use. 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).

Roost sites selected by spotted owls have more complex vegetation structure than forests generally available to them (Barrows and Barrows 1978, p.3; Forsman *et al.* 1984, pp.29-30; Solis and Gutiérrez 1990, pp.742-743). These habitats are usually multi-layered forests having high canopy closure and large diameter trees in the overstory.

Spotted owls nest almost exclusively in trees. Like roosts, nest sites are found in forests having complex structure dominated by large diameter trees (Forsman *et al.* 1984, p.30; Hershey *et al.* 1998, p.1402). 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.1402; Hershey *et al.* 1998 p. 1404).

Foraging habitat is the most variable of all habitats used by territorial spotted owls (USFWS 1992b, p. 20). Descriptions of foraging habitat have ranged from complex structure (Solis and Gutiérrez 1990, pp. 742-744) to forests with lower canopy closure and smaller trees than forests containing nests or roosts (Gutiérrez 1996, p.5).

Habitat Selection. Spotted owls generally rely on older forested habitats because such forests contain the structures and characteristics required for nesting, roosting, and foraging (NRF). Features that support nesting and roosting typically include a moderate to high canopy closure (60 to 90%); a multi-layered, multi-species canopy with large overstory trees (with diameter at breast height [dbh] of greater than 76 cm (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). Nesting spotted owls consistently occupy stands with a high degree of canopy closure that may provide thermoregulatory benefits (Weathers *et al.* 2001, p. 686) and protection from predators.

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 (Irwin *et al.* 2000, p. 180; Courtney *et al.* 2004, p. 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, p. 5-15), density of trees greater than or equal to 80 cm (31 inches) 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.* 2005, 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, p. 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. 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 (USFWS 1992a, p. 1798). 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% of nest sites were in old-growth forests, 57% were in the understory reinitiation phase of stand development, and 17% were in the stem exclusion phase (Buchanan *et al.* 1995, p. 304). In the western Cascades of Oregon, 50% 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 cm (19.7 inches) dbh with greater than 60% canopy closure more often than expected for roosting during the non-breeding season. Spotted owls also used young forest (trees of 20 to 50 cm (7.9 inches to 19.7 inches) dbh with greater than 60% canopy closure) less often than expected based on this habitat's availability (Herter *et al.* 2002, p. 437).

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; 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.

Recent 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 m (2,395 feet). Survival decreased dramatically when the amount of non-habitat (non-forest areas, sapling stands, etc.) exceeded approximately 50% 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%—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.

3.5.3.6 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 (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 (Forsman *et al.* 1984, pp. 32-34, Anthony *et al.* 2006, p. 28), and renesting 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 (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).

3.5.3.7 Dispersal Biology

Natal dispersal of spotted owls typically occurs in September and October with a few individuals dispersing in November and December (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% in some studies (Miller 1989, pp. 32-41). Known or suspected causes of mortality during dispersal include starvation, predation, and accidents (Miller 1989, pp. 41-44; 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).

3.5.3.8 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 (Hamer *et al.* 2001, p. 224) 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). 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, p. 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*) (r^2 = 0.68), despite the fact they only made up 1.6 ±0.5 % 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).

3.5.3.9 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 (Gutiérrez 1996, 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 and Zabel *et al.* 1996, p.81 *In*: Forsman *et al.* 1996) and fluctuation in prey abundance (Zabel *et al.* 1996, p.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).

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.

3.5.4 Threats, Reasons for Listing

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" (USFWS 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 (USFWS 1992a, pp. 33-41). These threats were characterized for each province as severe, moderate, low or unknown (USFWS 1992a, p. 33-41) (The range of the spotted owl is divided into 12 provinces from Canada to northern California and from the Pacific Coast to the eastern Cascades; see Figure 1). 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 range-wide 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.

3.5.4.1 New Threats

The Service conducted a 5-year review of the spotted owl in 2004 (USFWS 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 are:

- "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, p. 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% of the range-wide habitat base over a 10-year period)." (Courtney and Gutiérrez 2004, p. 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, p. 11-8).

Barred Owls (Strix varia)

With its recent expansion to as far south as Marin County, California (Gutiérrez *et al.* 2004, pp. 7-12-7-13), the barred owl's range now completely overlaps that of the spotted owl. Barred owls may be competing with spotted owls for prey (Hamer *et al.* 2001, p.226) or habitat (Hamer *et al.* 1989, p.55; Dunbar *et al.* 1991, p. 467; Herter and Hicks 2000, p. 285; Pearson and Livezey 2003, p. 274). In addition, barred owls 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). Evidence that barred owls are causing negative effects on spotted owls is largely indirect, based primarily on retrospective examination of long-term data collected on spotted owls (Kelly *et al.* 2003, p. 46; Pearson and Livezey 2003, p. 267; Olson *et al.* 2005, p. 921). It is widely believed, but not conclusively confirmed, that the two species of owls are competing for resources. However, given that the presence of barred owls has been identified as a negative effect while using methods designed to detect a different species (spotted owls), it seems safe to presume that the effects are stronger than estimated. Because there has been no research to quantitatively evaluate the strength of different types of competitive interactions, such as resource partitioning and competitive interference, the particular mechanism by which the two owl species may be competing is unknown.

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, recent studies conducted in the Pacific Northwest show that barred owls frequently use mature and old-growth forests (Pearson and Livezey 2003, p. 270; Schmidt 2006, p. 13). In the fire prone forests of eastern Washington, a telemetry study conducted on barred 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.* 2010, p. 1).

The only study comparing spotted owl and barred owl food habits in the Pacific Northwest indicated that barred owl diets overlap strongly (76%) with spotted owl diets (Hamer *et al.* 2001, p. 226). However, barred owl diets are more diverse than spotted owl diets and include species associated with riparian and other moist habitats, along with more terrestrial and diurnal species (Hamer *et al.* 2001, pp. 225-226).

The presence of barred owls has been reported to reduce spotted owl detectability, site occupancy, reproduction, and survival. Olson *et al.* (2005, p. 924) found that the presence of barred owls had a significant negative effect on the detectability of spotted owls, and that the magnitude of this effect did not vary among years. The occupancy of historical territories by spotted owls in Washington and Oregon was significantly lower ($p < 0.001$) after barred owls were detected within 0.8 km (0.5 miles) of the territory center but was "only marginally lower" ($p = 0.06$) if barred owls were located more than 0.8 km (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 km (0.5 miles) ($p = 0.001$), 1.6 km (1 mile) ($p = 0.049$), and 2.9 km (1.8 miles) ($p = 0.005$) in Gifford Pinchot NF. 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% in the H.J. Andrews study area, 12% in the Coast Range study area, and 15% in the Tyee study area.

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 (E. Forsman, *pers. comm.*, cited in USFWS 2008a p. 65). 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.

In a recent 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).

The preponderance of evidence suggests that barred owls are exacerbating the spotted owl population decline, particularly in Washington, portions of Oregon, and the northern coast of California (Gutiérrez *et al.* 2004, pp. 7-39 -40; Olson *et al.* 2005, pp. 930-931; Foreman *et al.* 2011, p 3). 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).

Wildfire

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. Bond *et al.* (2002, p. 1025) 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. 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.

In 1994, the Hatchery Complex fire burned 17,603 hectares in the Wenatchee NF in Washington's eastern Cascades, affecting six spotted owl activity centers (Gaines *et al.* 1997, p. 125). Spotted owl habitat within a 2.9-km (1.8-mile) radius of the activity centers was reduced by 8 to 45% (mean = 31%) as a result of the direct effects of the fire and by 10 to 85% (mean = 55%) as a result of delayed mortality of fire-damaged trees and insects. Direct mortality of spotted owls was assumed to have occurred at one site, and spotted owls were present at only one of the six sites 1 year after the 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). Although the amount of home ranges burned was not quantified, spotted owls were observed using areas that burned at low and medium intensities. No direct mortality of spotted owls was observed, even though thick smoke covered several spotted owl site-centers for a week. It appears that, at least in the short-term, spotted owls may be resilient to the effects of wildfire—a process with which they have evolved. More research is needed to further understand the relationship between fire and spotted owl habitat use.

At the time of listing there was recognition that large-scale wildfire posed a threat to the spotted owl and its habitat (USFWS 1990a, p. 26183). New information suggests fire may be more of a threat than previously thought. In particular, the rate of habitat loss due to fire has been expected with over 102,000 acres of late-successional forest lost on Federal lands from 1993-2004 (Moeur *et al.* 2005, p. 110). Currently, the overall total amount of habitat loss from wildfires has been relatively small, estimated at approximately 1.2% on Federal lands (Lint 2005, p. v). It may be possible to influence through silvicultural management how fire prone forests will burn and the extent of the fire when it occurs. 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, our 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).

West Nile Virus

West Nile virus (WNV) has killed millions of wild birds in North America since it arrived in 1999 (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). One captive spotted owl in Ontario, Canada, is known to have contracted WNV and died (Gancz *et al.* 2004, p. 2137), but there are no documented cases of the virus in wild spotted owls.

Health officials expect that WNV eventually will spread throughout the range of the spotted owl (Blakesley *et al.* 2004, p. 8-31), but it is unknown how the virus will ultimately affect spotted owl populations. Susceptibility to infection and the mortality rates of infected individuals vary among bird species (Blakesley *et al.* 2004, p. 8-33), but most owls appear to be quite susceptible. For example, eastern screech-owls breeding in Ohio that were exposed to WNV experienced 100% mortality (T. Grubb, *pers. comm.* in Blakesley *et al.* 2004, p. 8-33). Barred owls, in contrast, showed lower susceptibility (B. Hunter, *pers. comm. in* Blakesley *et al.* 2004, p. 8-34).

Blakesley *et al.* (2004, p. 8-35) offer two possible scenarios for the likely outcome of spotted owl populations being infected by WNV. One scenario is that a range-wide reduction in spotted owl population viability is unlikely because the risk of contracting WNV varies between regions. 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. WNV remains a potential threat of uncertain magnitude and effect (Blakesley *et al.* 2004, p. 8-34).

Sudden Oak Death

Sudden oak death was recently identified as a potential threat to the spotted owl (Courtney and Gutiérrez 2004, p. 11-8). This disease is caused by the fungus-like pathogen, *Phytopthora ramorum* that was recently introduced from Europe and is rapidly spreading. At the present time, sudden oak death is found in natural stands from Monterey to Humboldt Counties, California, and has reached epidemic proportions in oak (*Quercus* spp.) and tanoak (*Lithocarpus densiflorus*) forests along approximately 300 km (186 miles) of the central and northern California coast (Rizzo *et al.* 2002, p. 733). It has also been found near Brookings, Oregon, killing tanoak and causing dieback of closely associated wild rhododendron (*Rhododendron* spp.) and evergreen huckleberry (*Vaccinium ovatum*) (Goheen *et al.* 2002, p. 441). It has been found in several different forest types and at elevations from sea level to over 800 m. 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 - canopy closure and nest tree mortality); especially in the southern portion of the spotted owl's range (Courtney and Gutiérrez 2004, p. 11-8).

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. Recent studies show no indication of significantly reduced genetic variation in Washington, Oregon, or California (Barrowclough *et al.* 1999, p. 922; Haig *et al.* 2001, p. 36). However, in Canada, the breeding population is estimated to be less than 33 pairs and annual population decline may be as high as 35% (Harestad *et al.* 2004, p. 13). 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, p. 11-9). 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.

Climate Change

Climate change, a potential additional threat to spotted owl populations, is not explicitly addressed in the NWFP. Climate change could have direct and indirect impacts on spotted owls and their prey. However, the emphasis on maintenance of seral stage complexity and related organismal diversity in the Matrix under the NWFP should contribute to the resiliency of the Federal forest landscape to the impacts of climate change (Courtney *et al.* 2004, p. 9-15). There is no indication in the literature regarding the direction (positive or negative) of the threat.

Based upon a global meta-analysis, Parmesan and Yohe (2003, pp. 37-42) discussed several potential implications of global climate change to biological systems, including terrestrial flora and fauna. Results indicated that 62% of species exhibited trends indicative of advancement of spring conditions. In bird species, trends were manifested in earlier nesting activities. Because the spotted owl exhibits a limited tolerance to heat relative to other bird species (Weathers *et al.* 2001, p. 685), subtle changes in climate have the potential to affect this. However, the specific impacts to the species are unknown.

Disturbance-Related Effects

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.

Although information specific to behavioral responses of spotted owls to disturbance is limited, research indicates that close proximity to recreational hikers can cause Mexican spotted owls (*S. o. lucida*) to flush from their roosts (Swarthout and Steidl 2001, p. 314) and helicopter overflights can reduce prey delivery rates to nests (Delaney *et al.* 1999a, 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).

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 & Gutiérrez 2003, p. 698; Tempel & 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 & Gutiérrez 2004, p. 544).

Post-harvest fuels treatments may also create above-ambient smoke or heat. Although it has not been conclusively demonstrated, it is anticipated that nesting spotted owls may be disturbed by heat and smoke intrusion into the nest grove.

3.5.5 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:

3.5.5.1 Habitat-specific Needs

1. Large blocks of suitable habitat to support 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 to 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.

3.5.5.2 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 better understand 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.

3.5.5.3 Conservation Strategy

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 (USFWS 1992a), the Draft Recovery Plan (USFWS 1992b), 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 Northwest Forest Plan (NWFP)(USDA and USDI 1994a). Each conservation strategy was 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.

3.5.5.4 Federal Contribution to Recovery

NWFP (Conservation Strategy for the Spotted Owl)

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 and USDI 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% late-successional provision, etc. (USDA and USDI 1994a, USFWS 1994b) 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, pp. 279-280): 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). In addition, the 1992 Draft Recovery Plan for the spotted owl (USFWS 1992b) was based on the ISC report.

The Forest Ecosystem Management Assessment Team 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 and USDI 1994b, pp. 3&4-229). Based on the results of the first decade of monitoring, Lint (2005, p. 18) could not determine 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 do 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). Bigley and Franklin (2004, pp. 6-34) suggested that more fuels treatments are needed in east-side forests to preclude large-scale losses of habitat to stand-replacing wildfires. 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. The arrangement, distribution, and resilience of the NWFP land use allocation system may prove to be the most appropriate strategy in responding to these unexpected challenges (Bigley and Franklin 2004, pp. 6-34).

Under the NWFP, the agencies anticipated a decline of spotted owl populations during the first decade of implementation. Recent reports (Anthony *et al.* 2006, pp. 33-34) identified greater than expected spotted owl declines in Washington and northern portions of Oregon, and more stationary populations in southern Oregon and northern California. The reports did not find a direct correlation between habitat conditions and changes in vital rates of spotted owls at the meta-population scale. However, at the territory scale, there is evidence of negative effects to spotted owl fitness due to reduced habitat quantity and quality. Also, there is no evidence to suggest that dispersal habitat is currently limiting (Courtney *et al.* 2004, p. 9-12, Lint 2005, p. 87). Even with the population decline, Courtney *et al.* (2004, p. 9-15) noted that there is little reason to doubt the effectiveness of the core principles underpinning the NWFP conservation strategy.

The current scientific information, including information showing spotted owl population declines, indicates that the spotted owl continues to meet the definition of a threatened species (USFWS 2004, p. 54). That is, populations are still relatively numerous over most of its historic range, which suggests that the threat of extinction is not imminent, and that the subspecies is not endangered; even though, in the northern part of its range population trend estimates are showing a decline.

Spotted Owl Recovery Plan

In May, 2008, the Service published the 2008 Final Recovery Plan for the spotted owl (USFWS 2008a). The recovery plan identifies that competition with barred owls, ongoing loss of suitable habitat as a result of timber harvest and catastrophic fire, and loss of amount and distribution of suitable habitat as a result of past activities and disturbances are the most important range-wide threats to the spotted owl (USFWS 2008a, pp. 57-67). To address these threats, the present recovery strategy has the following three essential elements: barred owl control, dry-forest landscape management strategy, and managed owl conservation areas (MOCAs) (USFWS

2008a, pp. 12-15). The recovery plan lists recovery actions that address research of the competition between spotted and barred owls, experimental control of barred owls to better understand the impact the species is having on spotted owls, and, if recommended by research, management of barred owls (USFWS 2008a, p. 15). The foundation of the plan for managing forest habitat in the non-fire-prone western Provinces of Washington and Oregon is the MOCA network on Federal lands, which are intended to support stable and well-distributed populations of spotted owls over time and allow for movement of spotted owls across the network (USFWS 2008a, p. 13). On the fire-dominated east side of the Cascade Mountains in Washington and Oregon, and the California Cascades, the dry-forest habitat management strategy is intended to maintain spotted owl habitat in an environment of frequent natural disturbances (USFWS 2008a, p. 14). Additionally, the recovery plan identifies Conservation Support Areas (CSAs) in Washington, the west side of the Cascades in Oregon, and in California. These CSAs are located on private, State, and Federal lands and are expected to support the MOCA network and the dry-forest landscape management approach (USFWS 2008a, p. 14). In addition, the recovery plan recommends a research and monitoring program be implemented to track progress toward recovery, inform changes in recovery strategy by a process of adaptive management, and ultimately determine when delisting is appropriate (USFWS 2008a, p. 15). The three primary elements of this program include 1) the monitoring of spotted owl population trends, 2) an inventory of spotted owl distribution, and 3) a comprehensive program of barred owl research and monitoring (USFWS 2008a, p. 15). The recovery plan estimates that recovery of the spotted owl could be achieved in approximately 30 years (USFWS 2008a).

3.5.5.5 Conservation Efforts on Non-federal Lands

In the report from the Interagency Scientific Committee (Thomas *et al.* 1990, p. 3), the draft recovery plan (USFWS 1992b, p. 272), and the report from the Forest Ecosystem Management Assessment Team (Thomas and Raphael 1993, pp. IV-189), it was noted that limited Federal ownership in some areas constrained the ability to form a network of old-forest reserves to meet the conservation needs of the spotted owl. In these areas in particular, non-federal lands would be important to the range-wide goal of achieving conservation and recovery of the spotted owl. 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. In addition, timber harvest within each state is governed by rules that provide protection of spotted owls or their habitat to varying degrees.

There are 17 current or completed Habitat Conservation Plans (HCPs) that have incidental take permits issued for spotted owls—eight in Washington, three in Oregon, and four in California (USFWS 2008a, p. 55). The HCPs range in size from 40 acres to more than 1.6 million acres, although not all acres are included in the mitigation for spotted owls. In total, the HCPs cover approximately 2.9 million acres (9.1%) of the 32 million acres of non-federal forest lands in the range of the spotted owl. The period of time that the HCPs will be in place ranges from 5 to 100 years; however, most of the HCPs are of fairly long duration. While each HCP is unique, there are several general approaches to mitigation of incidental take:

- Reserves of various sizes, some associated with adjacent Federal reserves
- Forest harvest that maintains or develops suitable habitat
- Forest management that maintains or develops dispersal habitat
- Deferral of harvest near specific sites

Washington: In 1996, the State Forest Practices Board adopted rules (Washington Forest Practices Board 1996) that would contribute to conserving the spotted owl and its habitat 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). Spotted owl-related HCPs in Washington generally were intended to provide demographic or connectivity support (USFWS 1992b, p. 272).

Oregon: The Oregon Forest Practices Act provides for protection of 70-acre core areas around sites occupied by an adult pair of spotted owls capable of breeding (as determined by recent protocol surveys), but it does not provide for protection of spotted owl habitat beyond these areas (Oregon Department of Forestry 2007, p. 64). In general, no large-scale spotted owl habitat protection strategy or mechanism currently exists for non-federal lands in Oregon. The three spotted owl-related HCPs currently in effect cover more than 300,000 acres of non-federal lands. These HCPs are intended to provide some nesting habitat and connectivity over the next few decades (USFWS 2008a, p. 56).

California: The California State Forest Practice Rules, which govern timber harvest on private lands, require surveys for spotted owls in suitable habitat and to provide protection around activity centers (California Department of Forestry and Fire Protection 2007, pp. 85-87). Under the Forest Practice Rules, no timber harvest plan 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 (California Department of Forestry and Fire Protection 2007, pp. 85-87). The California Department of Fish and Game initially reviewed all timber harvest plans to ensure that take was not likely to occur; the Service took over that review function in 2000. Several large industrial owners operate under spotted owl management plans that have been reviewed by the Service and that specify basic measures for spotted owl protection. Four HCPs authorizing take of spotted owls have been approved; these HCPs cover more than 669,000 acres of non-federal lands. Implementation of these plans is intended to provide for spotted owl demographic and connectivity support to NWFP lands (USFWS 2008a, p. 56)

3.5.6 Current Condition of the Spotted Owl

The current condition 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 (USFWS and NMFS 1998, pp. 4-19).

3.5.6.1 Range-wide Habitat and Population Trends

Habitat Baseline

The 1992 Draft Spotted Owl Recovery Plan estimated approximately 8.3 million acres of spotted owl habitat remained range-wide (USFWS 1992b, p. 37). However, reliable habitat baseline information for non-federal lands is not available (Courtney *et al.* 2004, p. 6-5). The Service has used information provided by the USFS, Bureau of Land Management, and National Park

Service to update the habitat baseline conditions on Federal lands for spotted owls on several occasions since the spotted owl was listed in 1990. The estimate of 7.4 million acres used for the NWFP in 1994 (USDA and USDI 1994b, p. G-34) was believed to be representative of the general amount of spotted owl habitat on these lands. This baseline has been used to track relative changes over time in subsequent analyses, including those presented here.

In 2005 a new map depicting suitable spotted owl habitat throughout the range of the spotted owl was produced as a result of the NWFP's effectiveness monitoring program (Lint 2005, pp. 21-82). However, the spatial resolution of this new habitat map currently makes it unsuitable for tracking habitat effects at the scale of individual projects. The Service is evaluating the map for future use in tracking habitat trends. Additionally, there continues to be no reliable estimates of spotted owl habitat on non-federal lands; consequently, consulted-on acres can be tracked, but not evaluated in the context of change with respect to a reference condition on non-federal lands. The production of the monitoring program habitat map does, however, provide an opportunity for future evaluations of trends in non-federal habitat.

NWFP Lands Analysis 1994 to 2001.
In 2001, the Service conducted an assessment of habitat baseline conditions, the first since implementation of the NWFP (USFWS 2001, p. 1). This range-wide evaluation of habitat, compared to the FSEIS, was necessary to determine if the rate of potential change to spotted owl habitat was consistent with the change anticipated in the NWFP. In particular, the Service considered habitat effects that were documented through the section 7 consultation process since 1994. In general, the analytical framework of these consultations focused on the reserve and connectivity goals established by the NWFP land-use allocations (USDA and USDI 1994a, p. 6), with effects expressed in terms of changes in suitable spotted owl habitat within those land-use allocations. The Service determined that actions and effects were consistent with the expectations for implementation of the NWFP from 1994 to June, 2001 (USFWS 2001, p. 32).

Range-wide Analysis from 1994 to February 10, 2015.
This section updates the information considered in USFWS (2001), relying particularly on information in documents the Service produced pursuant to section 7 of the ESA and information provided by NWFP agencies on habitat loss resulting from natural events (e.g., fires, windthrow, insect and disease). To track impacts to spotted owl habitat, the Service designed the Consultation Effects Tracking System database which records impacts to spotted owls and their habitat at a variety of spatial and temporal scales. Data are entered into the database under various categories including, land management agency, land-use allocation, physiographic province, and type of habitat affected.

In 1994, about 7.4 million acres of suitable spotted owl habitat were estimated to exist on Federal lands managed under the NWFP. As of February 10, 2015, the Service had consulted on the proposed removal and had natural events resulting in the loss of approximately 947,477 acres or 12.8% of 7.4 million acres of spotted owl suitable habitat on Federal lands (USFWS 2013). Of the total NWFP Federal acres consulted on for removal, approximately 204,360 acres (Table 7) or 2.8% of 7.4 million acres of spotted owl habitat were removed as a result of timber harvest. These changes in suitable spotted owl habitat are consistent with the expectations for implementation of the NWFP (USDA and USDI 1994a). Table 8 tracks habitat loss from

Federal lands due to management activities and natural events against the 2006 baseline (USFWS 2013).

Other Habitat Trend Assessments.
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, p. 88) estimated there was 816,000 acres of suitable spotted owl habitat in 2004, or about 25% of their study area. Based on their results, Pierce and others (2005, p. 98) 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% of the owl habitat in the study area distributed across all ownerships (Pierce *et al.* 2005, p. 91). Approximately 77% of the harvested habitat occurred on private lands and about 15% occurred on State lands. Pierce and others (2005, p. 80) 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% suitable habitat in the circle across all landscapes. Values in the study ranged from an average of 7% in southwest Washington to an average of 31% in the east Cascades, suggesting that many owl territories in Washington are significantly below the 40% suitable habitat threshold used by the State as a viability indicator for spotted owl territories (Pierce *et al.* 2005, p. 90).

Moeur *et al.* 2005 (p. 110) estimated an increase of approximately 1.25 to 1.5 million acres of medium and large older forest (greater than 51 cm (20 inches) dbh, single and multi-storied canopies) on Federal lands in the Northwest Forest Plan area between 1994 and 2003. The increase occurred primarily in the lower end of the diameter range for older forest. The net area in the greater than 76 cm (30 inch) dbh size class increased by only an estimated 102,000 to 127,000 acres (Moeur *et al.* 2005, p. 100). The estimates were based on change-detection layers for losses due to harvest and fire and remeasured 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 USFS 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 spotted owl habitat, the significance of these acres to spotted owl conservation remains unknown.

Spotted Owl Numbers, Distribution, and Reproduction Trends.
There are no estimates of the size of the spotted owl population prior to settlement by Europeans. Spotted owls are believed to have inhabited most old-growth forests or stands throughout the Pacific Northwest, including northwestern California, prior to beginning of modern settlement in the mid-1800s (USFWS 1989, pp. 2-17). According to the final rule listing the spotted owl as

threatened (USFWS 1990a, p. 26118), approximately 90% of the roughly 2,000 known spotted owl breeding pairs were located on Federally managed lands, 1.4% on State lands, and 6.2% on private lands; the percent of spotted owls on private lands in northern California was slightly higher (USFWS 1989, pp. 4-11; Thomas *et al.* 1990, p. 64).

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 (USFWS 1990a, p. 26115). The range of the spotted owl is partitioned into 12 physiographic provinces (Figure 1) based on recognized landscape subdivisions exhibiting different physical and environmental features (USFWS 1992b, p. 31). The spotted owl has become rare in certain areas, such as British Columbia, southwestern Washington, and the northern coastal ranges of Oregon.

As of July 1, 1994, there were 5,431 known site-centers of spotted owl pairs or resident singles: 851 sites (16%) in Washington, 2,893 sites (53%) in Oregon, and 1,687 sites (31%) in California (USFWS 1995, p. 9495). By June 2004, the number of territorial spotted owl sites in Washington recognized by the Washington Department of Fish and Wildlife was 1,044 (Buchanan and Swedeen 2005, p. 37). The actual number of currently occupied spotted owl locations across the range is unknown because many areas remain unsurveyed (USFWS 2008a, p. 44). 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 in USFWS (1995, p. 9495) represent the cumulative number of locations recorded in the three states, not population estimates.

Because the existing survey coverage and effort are insufficient to produce reliable range-wide 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) (lambda), 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 (Anderson and Burnham 1992; Burnham *et al.* 1994: Forsman *et al.* 1996; Anthony *et al.* 2006 and Forsman *et al.* 2011) to estimate trends in the populations of the spotted owl.

In January 2009, two meta-analyses modeled rates of population change for up to 24 years using the re-parameterized Jolly-Seber method (λ_{RJS}). One meta-analysis modeled the 11 long-term study areas (Table 9), while the other modeled the eight study areas that are part of the effectiveness monitoring program of the NWFP (Forsman *et al.* 2011).

Point estimates of λ_{RJS} were all below 1.0 and ranged from 0.929 to 0.996 for the 11 long-term study areas. There was strong evidence that populations declined on 7 of the 11 areas (Forsman *et al.* 2011), these areas included Rainier, Olympic, Cle Elum, Coast Range, HJ Andrews, Northwest California and Green Diamond. On other four areas (Tyee, Klamath, Southern

Cascades, and Hoopa), populations were either stable, or the precision of the estimates was not sufficient to detect declines.

The weighted mean λ_{RJS} for all of the 11 study areas was 0.971 (standard error [SE] = 0.007, 95% confidence interval [CI] = 0.960 to 0.983), which indicated an average population decline of 2.9% per year from 1985 to 2006. This is a lower rate of decline than the 3.7% reported by Anthony *et al.* (2006), but the rates are not directly comparable because Anthony *et al.* (2006) examined a different series of years and because two of the study areas in their analysis were discontinued and not included in Forsman *et al.* (2011). Forsman *et al.* (2011) explains that the indication populations were declining was based on the fact that the 95% confidence intervals around the estimate of mean lambda did not overlap 1.0 (stable) or barely included 1.0.

The mean λ_{RJS} for the eight demographic monitoring areas (Cle Elum, Olympic, Coast Range, HJ Andrews, Tyee, Klamath, Southern Cascades and Northwest California) that are part of the effectiveness monitoring program of the NWFP was 0.972 (SE = 0.006, 95% CI = 0.958 to 0.985), which indicated an estimated decline of 2.8% per year on Federal lands with the range of the spotted owl. The weighted mean estimate λ_{RJS} for the other three study areas (Rainier, Hoopa and Green Diamond) was 0.969 (SE = 0.016, 95% CI = 0.938 to 1.000), yielding an estimated average decline of 3.1% per year. These data suggest that demographic rates for spotted owl populations on Federal lands were somewhat better than elsewhere; however, this comparison is confounded by the interspersion of non-federal land in study areas and the likelihood that spotted owls use habitat on multiple ownerships in some demography study areas.

The number of populations that declined and the rate at which they have declined are noteworthy, particularly the precipitous declines in the Olympic, Cle Elum, and Rainier study areas in Washington and the Coast Range study area in Oregon. Estimates of population declines in these areas ranged from 40 to 60% during the study period through 2006 (Forsman *et al.* 2011). Spotted owl populations on the HJ Andrews, Northwest California, and Green Diamond study areas declined by 20-30% whereas the Tyee, Klamath, Southern Cascades, and Hoopa study areas showed declines of 5 to 15%.

Decreases in adult apparent survival rates were an important factor contributing to decreasing population trends. Forsman *et al.* (2011) found apparent survival rates were declining on 10 of the study area with the Klamath study area in Oregon being the exception. Estimated declines in adult survival were most precipitous in Washington where apparent survival rates were less than 80% in recent years, a rate that may not allow for sustainable populations (Forsman *et al.* 2011). In addition, declines in adult survival for study areas in Oregon have occurred predominately within the last five years and were not observed in the previous analysis by Anthony *et al.* 2006. Forsman *et al.* (2011) express concerns by the collective declines in adult survival across the subspecies range because spotted owl populations are most sensitive to changes in adult survival.

There are few spotted owls remaining in British Columbia. Chutter *et al.* (2004, p. *v*) suggested immediate action was required to improve the likelihood of recovering the spotted owl population in British Columbia. So, in 2007, personnel in British Columbia captured and brought into captivity the remaining 16 known wild spotted owls (USFWS 2008a, p. 48). Prior to initiating the captive-breeding program, the population of spotted owls in Canada was declining by as much as 10.4% per year (Chutter *et al.* 2004, p. *v*). The amount of previous interaction between spotted owls in Canada and the United States is unknown.

Table 7. Range-wide Aggregate of Changes to NRF[1] Habitat Acres From Activities Subject to Section 7 Consultations and Other Causes from 1994 to February 10, 2015.

Land Ownership	Consulted On Habitat Changes[2]		Other Habitat Changes[3]	
	Removed/ Downgraded	Maintained/ Improved	Removed/ Downgraded	Maintained/ Improved
NWFP (USFS, BLM, NPS)	204,360	548,500	254,911	39,720
Bureau of Indian Affairs / Tribes	111,666	28,372	2,398	0
Habitat Conservation Plans/Safe Harbor Agreements	303,007	14,539	N/A	N/A
Other Federal, State, County, Private Lands	68,713	28,447	2,392	0
Total Changes	**687,746**	**619,858**	**259,701**	**39,720**

Notes:

1. Nesting, roosting, foraging (NRF) habitat. In California, suitable habitat is divided into two components; nesting - roosting (NR) habitat, and foraging (F) habitat. The NR component most closely resembles NRF habitat in Oregon and Washington. Due to differences in reporting methods, effects to suitable habitat compiled in this, and all subsequent tables include effects for nesting, roosting, and foraging (NRF) for 1994-6/26/2001. After 6/26/2001 suitable habitat includes NRF for Washington and Oregon but only nesting and roosting (NR) for California.
2. Includes both effects reported in USFWS (2001) and subsequent effects reported in the spotted owl Consultation Effects Tracking System (web application and database.)
3. Includes effects to suitable NRF habitat (as generally documented through technical assistance, etc.) resulting from wildfires (not from suppression efforts), insect and disease outbreaks, and other natural causes, private timber harvest, and land exchanges not associated with consultation.

Table 8. Summary of spotted owl suitable habitat (NRF[1]) acres removed or downgraded as documented through Section 7 consultations on all Federal Lands within the Northwest Forest Plan area. Environmental baseline and summary of effects by State, Physiographic Province, and Land Use Function from 2006 to February 10, 2015.

		Evaluation Baseline (2006/2007)[3]			Habitat Removed/Downgraded[4]								
					Land Management Effects			Habitat Loss from Natural Events					
State	Physiographic Province[2]	NRF[1] Acres in Reserves	NRF[1] Acres in Non-Reserves	Total Nesting Roosting Acres	Reserves[5]	Non-Reserves	Total	Reserves	Non-Reserves	Total	Total NRF removed/ downgraded	% Provincial Baseline Affected	% Range-wide Effects
WA	Eastern Cascades	462,400	181,100	643,500	2,700	2,238	4,938	1,559	132	1,691	6,629	1.03	5.98
	Olympic Peninsula	729,000	33,400	762,400	6	0	6	0	1	1	7	0	0.01
	Western Cascades	1,031,600	246,600	1,278,200	529	831	1,360	3	0	3	1,363	0.11	1.23
	Western Lowlands	24,300	0	24,300	0	0	0	0	0	0	0	0	0
OR	Cascades East	248,500	128,400	376,900	2,994	7,499	10,493	7,639	1,981	9,620	20,113	5.34	18.14
	Cascades West	1,275,200	939,600	2,214,800	1,183	23,087	24,270	95	1,531	1,626	25,896	1.17	23.35
	Coast Range	494,400	113,400	607,800	750	1,623	2,373	0	0	0	2,373	0.39	2.14
	Klamath Mountains	549,400	334,900	884,300	2,985	5,367	8,352	1,468	3,696	5,164	13,516	1.53	12.19
	Willamette Valley	700	2,600	3,300	0	0	0	0	0	0	0	0	0
CA	Cascades	101,700	102,900	204,600	10	1	11	325	0	325	336	0.16	0.3
	Coast	132,900	10,100	143,000	274	1	275	0	175	175	450	0.31	0.41
	Klamath	910,900	501,200	1,412,100	75	649	724	19,072	20,409	39,481	40,205	2.85	36.26
Total		**5,961,000**	**2,594,200**	**8,555,200**	**11,506**	**41,296**	**52,802**	**30,161**	**27,925**	**58,086**	**110,888**	**1.3**	**100**

Notes:

1. Nesting, roosting, foraging (NRF) habitat. In WA/OR, the values for Nesting/Roosting habitat generally represent the distribution of suitable owl habitat, including foraging habitat. In CA, foraging habitat occurs in a much broader range of forest types than what is represented by nesting/roosting habitat. Baseline information for foraging habitat as a separate category in CA is currently not available at a provincial scale.

State	Physiographic Province[2]	Evaluation Baseline (2006/2007)[3]			Habitat Removed/Downgraded[4]							% Provincial Baseline Affected	% Range-wide Effects
					Land Management Effects			Habitat Loss from Natural Events					
		NRF[1] Acres in Reserves	NRF[1] Acres in Non-Reserves	Total Nesting Roosting Acres	Reserves[5]	Non-Reserves	Total	Reserves	Non-Reserves	Total	Total NRF removed/ downgraded		

2. Defined in the Revised Recovery Plan for the spotted owl (USFWS 2011) as Recovery Units as depicted on page A-3.
3. Spotted owl nesting and roosting habitat on all Federal lands (includes USFS, BLM, NPS, DoD, USFWS, etc.) as reported by Davis *et al.* 2011 for the Northwest Forest Plan 15-Year Monitoring Report (PNW-GTR-80, Appendix D). NR habitat acres are approximate values based on 2006 (OR/WA) and 2007 (CA) satellite imagery.
4. Estimated NRF habitat removed or downgraded from land management (timber sales) or natural events (wildfires) as documented through section 7 consultation or technical assistance. Effects reported here include all acres removed or downgraded from 2006 to present. Effects in California reported here only include effects to Nesting/Roosting habitat. Foraging habitat removed or downgraded in California is not summarized in this table.
5. Reserve land use allocations under the NWFP intended to provide demographic support for spotted owls include LSR, MLSA, and CRA. Non-reserve allocations under the NWFP intended to provide dispersal connectivity between reserves include AWA, AMA, and MX.

	Demographic Study Area	Land Ownership	# Owls Banded	Fecundity	Apparent Survival	λ_{RJS}	Population Trend Based on $\Delta\lambda$
	Washington						
	Wenatchee (WEN)	Mixed	1,200	Declining	Declining	0.917	Declining
	Rainer (RAI)	Mixed	217	Stable	Declining	0.896	Declining
	Olympic (OLY)	Federal	985	Stable	Declining	0.956	Declining
	Cle Elum (CLE)	Mixed	724	Declining[1]	Declining?[2]	0.938	Declining
	Oregon						
	Oregon Coast Range (COA)	Mixed	1,025	Declining?[1]	Stable	0.968	Declining
	Tyee (TYE)	Mixed	1,032	Increasing	Stable	1.005	Stationary
	South Oregon Cascades (CAS)	Federal	881	Declining	Stable	0.974	Stationary
	H.J. Andrews (HJA)	Federal	1,095	Stable?[3]	Stable	0.978	Declining
	Klamath (KLA)	Mixed	1,147	Stable	Stable	0.997	Stationary
	Warm Springs (WSR)	Tribal	381	Stable	Stable	0.908	Declining
	California						
	Marin (MAR)	Federal	96	Stable	Stable	NA	NA
	Simpson (SIM)	Private	1,344	Declining[1]	Stable	0.970	Declining
	Hoopa (HUP)	Tribal	279	Increasing	Stable	0.980	Stationary
	NW California (NWC)	Federal	1,026	Declining	Declining	0.985	Declining?[4]

[1] Best model included age and even-odd year effects, but a competing model had a negative time effect on productivity.
[2] Variable among years, but with a declining trend.
[3] Decreasing in early years, increase in last 5 years, stable overall.
[4] Gradual declines in fecundity and apparent survival, plus estimates of realized population change suggest a decline in last 8 years.

Figure 1. Physiographic provinces, spotted owl demographic study areas, and demographic trends (Anthony *et al.* 2006).

Table 9. Spotted owl demographic parameters from demographic study areas (adapted from Forsman *et al.* 2011).

Study Area	Fecundity	Apparent Survival[1]	λ_{RJS}	Population change[2]
Cle Elum	Declining	Declining	0.937	Declining
Rainier	Increasing	Declining	0.929	Declining
Olympic	Stable	Declining	0.957	Declining
Coast Ranges	Increasing	Declining since 1998	0.966	Declining
HJ Andrews	Increasing	Declining since 1997	0.977	Declining
Tyee	Stable	Declining since 2000	0.996	Stationary
Klamath	Declining	Stable	0.990	Stationary
Southern Cascades	Declining	Declining since 2000	0.982	Stationary
NW California	Declining	Declining	0.983	Declining
Hoopa	Stable	Declining since 2004	0.989	Stationary
Green Diamond	Declining	Declining	0.972	Declining

[1]Apparent survival calculations are based on model average.
[2]Population trends are based on estimates of realized population change.

3.5.7 Conservation Measures

The proposed conservation measures for spotted owl are:

a. To reduce adverse effects to spotted owl, projects will not generally occur during the critical breeding period between March 1 to July 15. Exact timing for a given location may vary and deviations from the above breeding period can be modified with approval of the local Service office. Projects should (a) be delayed until after the critical breeding season (unless the action involves Type I helicopters, which extends the critical nesting window to September 30); (b) delayed until it is determined that young are not present.
b. The Service wildlife biologist may extend the restricted season based on site-specific information (such as a late nesting attempt).
c. Table 12 shows disruption distances applicable to the equipment types proposed in the BA. These distances can be locally altered based on current information.
d. No activity within this proposed action will cause adverse effects to spotted owl critical habitat when analyzed at the appropriate local scale as determined by the Service wildlife biologist.
e. For (LW) projects, follow conservation measures as outlined in the Tree Removal for LW Projects under PDC 34f.
f. No hovering or lifting within 152 m (500 feet) of the ground within occupied northern spotted owl habitat during the critical breeding season by Incident Command System

(ICS) Type I or II helicopters would occur as part of any proposed action addressed by this assessment.

3.5.8 Environmental Baseline for Marbled Murrelet

The action area includes Oregon and Washington, which represents the majority of the range of the northern spotted owl. Thus, the environmental baseline for this species is adequately described in the preceding sections.

3.5.9 Effects to Northern Spotted Owl

The Service analyzed whether effects related to habitat changes (i.e., habitat effects) and effects related to increased noise and smoke (i.e., harassment effects via disturbance/ disruption) are likely to cause spotted owl injury or mortality. The primary focus or concern is disturbance effects, since this consultation does not cover projects that may adversely affect spotted owls via habitat changes, or that adversely affect their critical habitat. Disruption from disturbance is limited in the proposed action to two spotted owl nests annually, as calculated on a three year rolling average during term of this Opinion.

3.5.9.1 Habitat Effects

The Service describes how habitat modifications may negatively impact spotted owls and why actions covered under this consultation are not likely to adversely affect spotted owl through habitat changes.

The spotted owl's decline is linked to removal and fragmentation of available suitable habitat. Spotted owl habitat includes both NRF and dispersal categories. Removal of any of these habitat components during the implementation of a proposed action can potentially adversely affect spotted owls by the following: 1) immediate displacement of birds from traditional nesting areas; 2) concentrating displaced birds into smaller, fragmented areas of suitable nesting habitat that may already be occupied; 3) increasing competition for suitable nest sites; 4) decreasing potential for survival of remaining spotted owls and offspring due to increased predation and/or limited resource (forage) availability; 5) diminishing reproductive success for nesting pairs; 6) diminishing population due to declines in productivity and recruitment; and 7) reducing future nesting opportunities. Habitat modification effects for spotted owls also depend on the type of silvicultural prescriptions used and the location of the activities relative to suitable habitat. For example, light thinning may have less impact than heavy thinning. Since no commercial thinning will occur under this consultation, it is not considered in the effects analysis.

The Service assumes that suitable habitat is likely to be occupied by spotted owls based on life history traits already described in the spotted owl baseline. One of the key threats to spotted owls has historically been habitat loss from timber harvest across its range. While this Opinion does not cover timber harvest activities, there are a limited number of aquatic and upland restoration actions that involve non-commercial vegetation treatments (conifer and/or hardwood thinning in riparian areas and uplands impacting forest conditions), removal of non-nest trees for stream enhancement, riparian area invasive plant treatment, thinning, snag creation, removal or storm proofing of forest roads, invasive plant control, and riparian area vegetation planting. This consultation involves very little tree removal; however, the proposed action includes non-commercial thinning, select removal for large wood, and small trees associated with road removal. Any light thinning done as part of the proposed actions will retain habitat functionality at the stand scale and thus will not cause adverse impacts to spotted owls. Removal of understory may alter foraging habitat (i.e., affect prey availability by altering prey's habitat), but projects will be designed such that they do not remove dispersal habitat's function. Road removal will remove small trees associated with the road, but will be followed by revegetation that will provide a diverse native stand. These actions are intended to benefit species and will also contribute to overall watershed health by improving stand structure, reduce sedimentation and erosion, and fewer invasive plants helping maintain the survival and/or promote growth of late-seral trees.

Project activities that remove, downgrade, or do not maintain suitable, dispersal, or spotted owl critical habitat will not be covered under this consultation. Trees removed as part of a commercial thinning or harvest will be covered by a Federal or state harvest permit, and any adverse modification of critical habitat associated with that harvest would be consulted on separately. Therefore, activities in this programmatic consultation are not anticipated to have adverse effects to spotted owls or spotted owl critical habitat (i.e., significantly modify spotted owl habitat such that it results in death or injury) through habitat loss or modification.

In addition to the commitment to design projects without adverse effects on spotted owls through habitat modification, there are additional factors enabling us to concur with the BA's "no likely to adversely affect" determination for critical habitat. First, the amount of (non-commercial) thinning relative to the project's action area will be negligible. Many riparian areas are dominated by dense, even-aged stands of small diameter conifers and hardwoods. Although, some vegetation treatments will remove woody vegetation, most shrubs, trees, and limbs will remain in the stands as the actions are designed to restore habitat values in these areas. For example, PDC for LW placement state that silvicultural treatments will not occur if they remove or permanently degrade occupied, suitable, or critical habitats for listed terrestrial species; and forest thinning will occur in overstocked areas or conifer release areas, as prescribed in a management plan for the site. Secondly, some projects may benefit spotted owls as a primary or secondary goal. For example, PDC 52 (Silvicultural Treatments) specifically targets improving habitat for northern spotted owl by demolishing roads, thinning, and understory management to improve the habitat for owls and their prey. Vegetation plantings designed for aquatic restoration purposes (e.g., provide shade and reduce run-off to water bodies), may also benefit owl habitat by adding habitat complexity (e.g., restore native species and increase species diversity) within or near suitable spotted owl habitat. Also, vegetation treatments will promote/maintain late-seral trees, which spotted owls may use in the long-term. Third, we anticipate vegetation treatments will be dispersed throughout the portion of the action area within the range of the spotted owl, which includes Oregon and Washington. This means that any potential effects to spotted owls are very unlikely to be concentrated in any one province or administrative unit. Finally, adverse effects are not expected because most construction activities will occur in the road prism or river channel, which is generally edge habitat (or edge non-habitat). Most spotted owls nest in interior stands, however, they may forage nocturnally closer to edges.

Over 4 years (2011 to 2014), the PFW and Coastal programs funded 15 projects over approximately 2,500 acres in or near northern spotted owls but all of these projects were determined to not likely to adversely affect spotted owls, or have no effect on spotted owl habitats. The Service Recovery Programs in Oregon and Washington funded 6 projects over a 3 year period; most of the recovery projects were survey and data management funds and did not affect spotted owl habitat. No information was available from NOAA RC how many projects they may have implemented in spotted owl habitat. The Service considers the potential for NOAA RC to impact spotted owl habitat less than the Service's restoration programs since most NOAA RC projects are lower in the watershed, away from spotted owl habitat, and NOAA RC does not fund upland restoration or recovery actions for spotted owls. NOAA RC will also follow the same proposed PDC and conservation measures.

Past consultation history shows that all of the above projects from the Service's restoration programs did not adversely affect spotted owl critical habitat. Similarly, we do not expect any aquatic projects funded by the NOAA RC (which targets anadromous salmonids) to adversely affect spotted owl critical habitat. Summaries of potential effects to spotted owl habitat from the 21 actions are included in Table 11. Activities that do not involve intentional vegetation modification are grouped together.

Table 11. Summary of habitat effects from the 21 proposed actions to spotted owl habitats.

Activity	Effects	Rationale for Effects Determination
Fish passage Restoration; Channel Reconstruction /Relocation; Off-and Side-channel Habitat Restoration; Streambank Restoration; Set-back or Removal of Existing Berms, Dikes and Levees; Livestock Fencing, Stream Crossings, and Off-Channel Livestock Watering; Piling and other Structure Removal; In-channel Nutrient Enhancement; Juniper Removal; Native Fish Protection; Beaver Habitat Restoration; Wetland Restoration; Install Wildlife Structures; and Fisheries, Hydrology, Geomorphology Wildlife, Botany, and Cultural Surveys in Support of Restoration	NLAA	These actions do not involve removal of NRF or dispersal habitat for spotted owls, and do not specifically involve vegetation treatment (except to return sites to pre-work conditions). They will minimize clearing and grubbing activities when preparing staging, project, and or stockpile areas. They will stockpile large wood, trees, vegetation, sand, topsoil and other excavated material, that is removed when establishing area(s) for site restoration. Sites will undergo rehabilitation of all disturbed areas to maintain similar or better than pre-work conditions through spreading of stockpiled materials, seeding, and/or planting with locally native seed mixes or plants. Since sites will be returned to pre-work conditions, the action is unlikely to measurably affect spotted owl's ability to nest, roost, forage, or disperse.

Activity	Effects	Rationale for Effects Determination
Road and Trail Erosion Control and Decomissioning	NLAA	Erosion control is expected to have very little to no impact on native vegetation. Road decommissioning may remove small, immature stands of trees that have established in and along the sides of the road to be removed. However modification will not impede development of constituent elements or reduce any buffer qualities of the stand for adjacent suitable habitat. Post removal, the former roadbed will be stable and revegetated with a mix of conifers, deciduous trees, and shrubs, improving the long term habitat and forage production.
Stream Channel Enhancement; large wood boulder and gravel placement, tree removal for wood	NLAA	This activity is not likely to affect spotted owl's ability to nest, roost, forage, or disperse because few trees will be removed relative to the project site and nest trees will not be removed. Also, LW placement is unlikely to alter shrub structure (i.e., spotted owl prey habitat).
Upland Silvicultural Treatments	NLAA	The intent of this activity is to improve critical habitat for spotted owls. It is stipulated that silvicultural treatments will not permanently degrade occupied, suitable, or critical habitat for listed terrestrial species. This activity will not remove or reduce the function of suitable or critical habitat.
Reduction/Relocation of recreation impacts	NLAA	This activity may involve planting shrubs/trees to restore streamside, floodplain, and meadow vegetation, and may remove/reduce noxious weeds from areas disturbed by recreational activities. Activities will not remove spotted owl habitat, and could conceivably add vegetation (increased diversity and structure) which may mature into NRF or dispersal habitat that could be used by spotted owls. This does not involve removal of large trees (e.g., potential nests or perches).
Non-native Invasive Plant Control	NLAA	Actions will help restore plant species composition and structure present during natural disturbance regimes. This action will help control and minimize spread of invasive plants that can out-compete plant seeds, seedlings, etc., that may mature and be used by spotted owls in the future for NRF or dispersal. Treatments are very specific to targeted plants, and do not involve broadcast applications. Therefore, we do not anticipate any impacts (e.g., death) of plants used by spotted owls or their prey species.

Activity	Effects	Rationale for Effects Determination
Juniper Removal	NLAA	These actions are generally not expected to occur in spotted owl suitable habitat. In the unlikely event they occur in areas near/within suitable habitat, the project will be designed so suitable habitat is not removed/downgraded/failed to be fully maintained.
Riparian Vegetation planting	NLAA	Actions involve planting conifers, deciduous trees and shrubs, sedges/rushes, and willows. This may incidentally add vegetative complexity that may be used by spotted owls for NRF or dispersal habitat, and will not remove or reduce the function of suitable or critical habitat.
Shellfish bed/nearshore Habitat Restoration; Tide/Flood Gate Removal, Replacement, or Retrofit; Restore Native Vegetation	NE	Shellfish bed/nearshore restoration and treatment of tide/flood gates will occur in nearshore marine environments that are distant from any northern spotted owl habitat and will therefore have no effect. Restoration of native vegetation is targeted at restoration and maintenance of native prairie, oak, and dune habitat. None of these habitats are used by spotted owls or their prey. Therefore, there will be no effect on spotted owl habitat from these activities.

3.5.9.2 Harassment Effects

The proposed restorations actions have the potential to negatively affect spotted owls primarily through increased noise associated with human activities and operation of tools and heavy equipment. These negative effects are referred to as disturbance and disruption. Briefly, *disturbance* occurs when an action causes a spotted owl to be distracted from its normal activity. *Disruption* occurs when an action is likely to cause a spotted owl to be distracted to such an extent as to significantly disrupt normal behavior and create the likelihood of harm or loss of reproduction. Both disturbance and disruption have temporal and spatial components (Table 12).

There is a potential of injury to spotted owl young from harassment via disturbance or disruption from the proposed action because some projects will occur within disruption distances of occupied or suitable, unsurveyed spotted owl areas during the spotted owl breeding season. This may cause premature fledging, missed feeding attempts, or adults to flush from nests, which can increase the likelihood of predation of the young. The Action Agencies proposed to implement a limited amount of projects within disruption distances during the spotted owl breeding season. While most projects will avoid disrupting spotted owls, the Action Agencies anticipate some projects near nesting spotted owls that can only be implemented during the spotted owl breeding period because of in-water work periods designed to limit effects to listed salmonids, and site access from increased perception in the later summer that would make projects more damaging and difficult to implement.

The likelihood of injury from disturbance/disruption is greatly reduced because few restoration projects will occur 1) during the critical breeding period and 2) within implementation of timing and distance restrictions (Table 12). Additionally, restoration projects may not disturb or disrupt spotted owls unless all of the following steps have been taken to attempt to fully avoid or minimize adverse effects to spotted owls: 1) a wildlife biologist has determined spotted owls may occur in the project area; 2) either a site survey by a wildlife biologist indicates an active nest is within the species-specific disruption distance of the project or, if protocol survey is not completed, then the Action Agencies will assume suitable habitat is occupied; and 3) the action cannot be scheduled outside of the spotted owl critical nesting period, or moved to a location outside of the spotted owl disturbance/disruption distances described on Table 12.

Given the limited number of projects implemented by the Action Agencies in any given year, the large area covered by the programmatic, relative small scale of individual restoration projects, and the efforts to avoid and minimize adverse effects to spotted owls, it is unnecessary to allocate take by any administrative or habitat unit; however, all take that does occur will be documented by administrative and habitat unit for reporting purposes. Therefore, take will assessed for all actions covered by the programmatic in Oregon and Washington. For the same reasons, we do not anticipate an individual project would impact more than one nest per year.

After making all attempts to avoid or minimize adverse effects by changing project timing, equipment, or location, we anticipate that no more than two restoration projects will disrupt spotted owl nests each year in Washington and Oregon combined. Since we only anticipate disruption/disturbance that rises to the level of injury or death to spotted owl young (eggs or chicks), we anticipate the injury or death of four young. This limitation of disruption is based on past reporting by the Action Agencies over the past four years (an average of 6 projects per year that were determined to not adversely affect owls) and estimating that NOAA RC may implement 75% fewer projects than the Service’s restoration programs in spotted owl habitat (less than 2 projects per year). The Service therefore anticipates, over the entire action area, harm of up to four birds (2 nests/4 young) per year. Compliance with this number will be based on a three-year rolling average to allow for annual variance in funding.

3.5.9.3 Description of Anticipated Harassment Effects

The remainder of our effects analysis relates to harassment via disturbance or disruption that may occur to the four spotted owl young (2 nests) every year.

The Service anticipates disturbance from noise, and human presence is less problematic to the spotted owl population than habitat loss, but can still negatively affect spotted owls. The effects of disturbance to spotted owl individuals and populations are not well documented. A review of spotted owl research (Courtney *et al.* 2004) did not even consider noise or human presence as threats. However, based on anecdotal information and documented effects to other bird species (Wesemann and Rowe 1987, Awbrey and Bowles 1990, Grubb and King 1991, Delaney *et al.* 1999a, Delaney and Grubb 2001, Swarthout and Steidl 2001, USFWS 2005, USFWS 2003), disturbance to individuals is negatively related to stimulus distance and positively related to noise levels.

Noise above ambient levels may adversely affect spotted owls by creating a likelihood of injury during the nesting season. These activities may cause flushing of individuals: flushing adults off a nest would leave eggs or young exposed to predation; causing a juvenile to prematurely fledge would increase the young's risk of predation. The likelihood that a bird's response will cause injury depends on numerous factors including the type, timing and duration of activity, proximity to nests, site-specific conditions, and individual spotted owl behavior. The Service considers injury to an individual as reduced productivity or survival (e.g., lower fledging weight, physical injury or death of adult, hatchling, or egg) due to a sufficient number of missed feedings or flushes (USFWS 2003), or premature fledging, or predation.

Other anticipated disruption effects include interrupting foraging activities, which would result in the reduced fitness or even mortality of an individual, and disrupting roosting activities that would cause a spotted owl to relocate. A spotted owl disturbed at a roost site is presumably capable of moving away from disturbance without increasing its risk factors such as predation. Spotted owls forage primarily at night. Therefore, projects that occur during the day are not likely to disrupt its foraging behavior. The potential for adverse effects is mainly associated with breeding behavior at an active nest site.

Disturbance is most easily verified by physical responses to stimuli (e.g., no response, turning attention toward stimuli, flushing of an individual, or disrupted feeding attempts of the young). The Service believes injury is likely to occur when adults or juveniles are flushed from nests, young fledge prematurely, or when feeding attempts are disrupted (USFWS 2003) all of which could cause injury to the young. Disturbance may also manifest itself through increased corticosterone (steroid hormone) levels (Wasser *et al.* 1997), but we currently do not have the scientific information to determine whether auditory or visual disturbances may cause this sort of physiological stress.

Utilizing the best available scientific information, the Service previously developed a list of distances at which various activities may affect spotted owl behavior (USFWS 2003, USFWS 2005). Distances at which disruption of normal behavioral patterns is likely to occur depend on the time of year (i.e., breeding, critical breeding, or non-breeding season) and the type of activity. Activities and associated disturbance and disruption distances are shown in Table 12.

Table 12. Disturbance, disruption (harass) and/or physical injury (harm) distance thresholds for spotted owls. Distances are to a known occupied spotted owl nest tree or suitable nest trees in unsurveyed nesting habitat.

Project Activity	**No Effect** **(Mar 1 – Sept. 30)**	**NLAA** "may affect" disturbance distance **(Mar 1 – Sept. 30)**	**LAA – Harass** early nesting season disruption distance (**Mar 1–Jul 15**[11])	**LAA – Harass** late nesting season disruption distance (**Jul 16**[11]**– Sep 30**)	**LAA – Harm** direct injury and/or mortality (**Mar 1 – Sept. 30)**
Light maintenance (e.g., road brushing and grading) at	>0.25 mile	≤ 0.25 mile	NA[1]	NA	NA

Project Activity	No Effect (Mar 1 – Sept. 30)	NLAA "may affect" disturbance distance (Mar 1 – Sept. 30)	LAA – Harass early nesting season disruption distance (Mar 1–Jul 15[11])	LAA – Harass late nesting season disruption distance (Jul 16[11]– Sep 30)	LAA – Harm direct injury and/or mortality (Mar 1 – Sept. 30)
campgrounds, administrative facilities, and heavily-used roads					
Log hauling on heavily-used roads (USFS maintenance levels 3, 4, and 5)	>0.25 mile	≤ 0.25 mile	NA[1]	NA	NA
Chainsaws (includes felling hazard/danger trees)	>0.25 mile	66 yards to 0.25 mile	≤ 65 yards[2]	NA	NA
Heavy equipment for road construction, road repairs, bridge construction, culvert replacements, etc.	>0.25 mile	66 yards to 0.25 mile	≤ 65 yards[2]	NA	NA
Pile-driving (steel H piles, pipe piles) Rock Crushing and Screening Equipment	>0.25 mile	120 yards to 0.25 mile	≤ 120 yards[3]	NA	≤ 5 yards(injury)[3]
Helicopter: Chinook 47d	>0.5 mile	266 yards to 0.5 mile	≤ 265 yards[5]	≤ 100 yards[6] (hovering only)	NA
Helicopter: Boeing Vertol 107, Sikorsky S-64 (SkyCrane)	>0.25 mile	151 yards to 0.25 mile	≤ 150 yards[7]	≤ 50 yards[6] (hovering only)	NA
Helicopters: K-MAX, Bell 206 L4, Hughes 500	>0.25 mile	111 yards to 0.25 mile	≤ 110 yards[8]	≤ 50 yards[6] (hovering only)	NA
Small fixed-wing aircraft (Cessna 185, etc.)	>0.25 mile	111 yards to 0.25 mile	≤ 110 yards	NA	NA
Tree Climbing	>66 yards	26 yards to 65 yards	≤ 25 yards[9]	NA	NA
NLAA = "not likely to adversely affect." **LAA** = "likely to adversely affect" ≥ **is greater than**					

Project Activity	**No Effect** (Mar 1 – Sept. 30)	**NLAA** "may affect" disturbance distance **(Mar 1 – Sept. 30)**	**LAA – Harass** early nesting season disruption distance **(Mar 1–Jul 15[11])**	**LAA – Harass** late nesting season disruption distance **(Jul 16[11]– Sep 30)**	**LAA – Harm** direct injury and/or mortality **(Mar 1 – Sept. 30)**
or equal to, ≤ is less than or equal to.					

Table 12 (Spotted Owl) Footnotes:

1. NA = not applicable. Based on information presented in Tempel and Gutiérrez (2003, p. 700), Delaney *et al.* (1999, p. 69), and Kerns and Allwardt (1992, p. 9), we anticipate that 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.
2. Based on Delaney *et al.* (1999a, 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.
3. Impulsive sound associated with pile-driving is highly variable and potentially injurious at close distances. A review compiled by Dooling and Popper (2007, p. 25) indicates that birds exposed to multiple impulses (e.g., pile driving) of sound at 125 dBA or greater are likely to suffer hearing damage. We have conservatively chosen a distance threshold of 120 yards for impact pile-driving to avoid potential effects to hearing and to account for significant behavioral responses (e.g. flushing) from exposure to loud, impulsive sounds. Based on an average maximum sound level of 110 dBA at 15.2 m (50 feet) for pile-driving, exposure to injurious sound levels would only occur at extremely close distances (e.g., ≤ 5 yards).
4. Impulsive sound associated with blasts 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 to 0.6 miles from blast sites (Holthuijzen *et al.* 1990, p. 273). 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 to 146 dBA at a distance of 100 m (110 yards).
5. Based on an estimated 92 dBA sound-contour (approximately 265 yards) 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. The hovering rotor-wash distance for the Chinook 47d 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 (USDA-Forest Service 2008b, chapters 5, 6).
8. The estimated 92 dBA sound contours for these helicopters is less than 110 yards (e.g., K-MAX (100 feet) (USDA-Forest Service 2008b, chapters 5, 6), and Bell 206 (85-89 dBA at 100 m)(Grubb *et al.* 2010, p. 1277).
9. Based on Swarthout and Steidl (2001, p. 312) who found that 95% of flush responses by spotted owls due to the presence of hikers on trails occurred within a distance of 24 m.
10. Based on recommendations presented in *Smoke Effects to Northern Spotted Owls* (USFWS 2008b, p. 4).
11. The exact dates are variable by physiographic province, and differences by locality. Work with the Service to select the proper dates when planning or implementing projects.

Disturbance and disruption distances (Table 12) are likely conservative because they consider the worst-case disturbance distance scenario for spotted owls. It is likely that the most severe impacts of noise disturbance occur within a narrower zone. As noise attenuates, the likelihood that it remains at a level sufficient to create the likelihood of injury is reduced. The exact distances where different activities and noises disrupt breeding are difficult to predict and can be influenced by many factors. Site-specific information (e.g., topographic features, climate conditions, project length/duration or frequency of disturbance to an area) and the individual's unique behavior will influence how disturbances affect individuals. Whether there is a likelihood of injury also depends on the background or baseline noise levels in the environment. In areas continually exposed to higher ambient noise levels (e.g., areas near well-traveled roads, campgrounds), spotted owls are probably less susceptible to small increases in disturbances because they may become accustomed to such activities and may habituate to increased noise levels.

Mere human presence will rarely flush a spotted owl. Northern spotted owls are generally naive, and frequently continue normal behaviors including mutual-preening, feeding, catching prey, and sleeping within a few yards of observers (USFWS 2003). According to experts cited in the 2003 Olympic National Forest Biological Opinion (USFWS 2003), humans need to be within two to six yards of a perching bird, climbing the nest tree of a nesting bird, or looking into the nest hole of a cavity nest to flush a spotted owl. Swarthout and Steidl's (2001) Mexican spotted owl (*S. o. lucida*) study found that 95% of adult and juvenile flushes occurred within 24 and 12 m of hikers, and that a 55-m buffer "would eliminate virtually all behavioral responses of owls to hikers." Since similar data are not available for spotted owls, this study on the closely related Mexican spotted owl is the best available information on this topic.

All proposed actions, excluding surveys, may use potentially disruptive equipment. For surveys, disturbance amount will depend on how spotted owl surveys are conducted. Protocol surveys (USFWS 1992b) limit the amount of potential disturbance to the point where disruption is unlikely. Protocol for evaluating spotted owl nest success also minimizes disturbance to young. After fledging occurs, surveyors use visual searches and/or mousing to detect the presence of young. If young are present, the adults should take at least some of the prey to their young. The sight of an adult with prey will usually stimulate the young to beg, revealing their number and location. Therefore, it should not be necessary harass owls by climbing nests trees or looking into nest cavity holes to determine the status of young.

While proposed actions may temporarily alter adult behavior, actions are not likely to cause adult injury or mortality or significantly disrupt normal behavioral patterns. First, missed or delayed feeding attempts are not reasonably certain to occur from projects covered under this programmatic. Spotted owls typically forage at night on arboreal or semi-arboreal species (Courtney *et al.* 2004). Peak activity occurs during the two hours after sunset and the two hours prior to sunrise (Courtney *et al.* 2004). Although diurnal species occur in their diet in limited quantities, this does not necessarily indicate extensive diurnal movements since most capture attempts were made from the roost tree suggesting opportunistic foraging (Courtney *et al.* 2004). Since restoration actions are implemented during the day and diurnal foraging is limited, there is a small probability that the action area will intersect foraging owls. Second, we assume that nesting or roosting adults can move temporarily to avoid the source of disturbance, making it unlikely that adults will be injured by activities. Also, many actions will not be implemented during nocturnal or crepuscular hours, which is when many early-breeding season spotted owl activities occur (Forsman *et al.* 1984).

The Service anticipates the greatest possibility of injury or death from the proposed action is to spotted owl young (eggs and chicks). Based on adult foraging information mentioned above (i.e., nocturnal foraging, diurnal project effects), the Service believes injury to or death of young is not likely to occur from missed or delayed feeding attempts. Instead, injury is possible when young prematurely fledge as a flush response to the noise or when disturbance causes adults to temporarily abandon nests, thereby reducing incubation times or making young more vulnerable to predation.

There is little published information on whether activities similar to those covered under this consultation cause flushing or premature fledging, and the ultimate impact on individual and/or population-level fitness or survival. This can be indirectly estimated by comparing when disturbance events cause temporary nest abandonment, the proportion of nests abandoned, timing and length of abandonment, and reproductive success of disturbed nests compared to undisturbed nests where those data are available.

Previous studies indicate that sounds around 85 dBA are at the acoustic irritation threshold where many birds begin to show a response to noise (i.e., body movements [e.g., head and tail shaking] and movement away from the noise source (Thiessen and Shaw 1957)). Roughly 95 dBA (e.g., aircraft noise) is the threshold for the flush response in raptors (Awbrey and Bowles 1990). Likelihood of flushing appears to decrease when individuals are nesting (Delaney *et al.* 1999a). This may be due to a high cost of flushing (i.e., potentially adverse effects to young) and the possibility that there will not be another nesting attempt that year (since there is little documentation showing multiple nesting attempts in spotted owls for a given year (Courtney *et al.* 2004)).

Helicopter use and smoke have the largest disturbance buffers, followed by chainsaws, and then heavy equipment for actions covered under this programmatic. Helicopters may be used in LW placement, culvert/bridge, and instream nutrient enhancement projects. Smoke resulting from chainsaws and heavy equipment may be used in all proposed restoration actions (excluding surveys). Delaney *et al.* (1999a) studied disturbance effects from chainsaws and Type I helicopters on the closely-related Mexican spotted owl. Mexican spotted owls exhibit similar nest attendance patterns as spotted owls (Delaney *et al.* 1999a, 1999b, Courtney *et al.* 2004), making it reasonable to assume that spotted owls may have similar reactions to disturbance events. Although limited by sample size, Delaney *et al.* (1999a) found: 1) all flushes during the nesting season occurred during fledging stage, after juveniles left the nest (i.e., none during incubation and nestling stages), 2) disturbances did not affect reproductive success or the number of young fledged, 3) nests were abandoned 16.6 ± 16.8 minutes from stimuli within 60 m of a nest, and 7 ± 7.9 minutes from stimuli over 60 m from their nest, and 4) only two flushing events occurred when stimuli were over 60 m from the nest, one from a Type I helicopter at 89 m, and one from chainsaw activity 105 m away (out of 161 trials on 28 territories over nesting and non-nesting seasons). During the nesting season (post-fledging) flushing only occurred twice (of 30 trials) within 60-105 m of chainsaw activity and four (of 30 trials) between 1 and 105 m of helicopter activity.

Johnson and Reynolds (2002) investigated the effects of low-altitude, military fixed-wing aircraft training on Mexican spotted owl behavior. Flyovers occurred about 460 m above canyon rims. Maximum noise levels, measured at one owl site were 78, 92, and 95 dB (sound volume) for the first, second, and third fly-by periods, respectively. Behaviors of owls during 25-second flyover periods ranged from "no response" (no body movement) to "intermediate response" (sudden turning of head). Although these were day roosting and not nesting owls (we would expect nesting spotted owls to be less likely to flush given their young nearby), they still did not flush from activities with noise-levels similar to those expected from a Type I helicopter flyover.

Based on limited flushing behavior studies it appears that non-hovering helicopters may not cause adult flushing within a much narrower distance than 0.25 miles, and that flushing is rare for nesting females (Delaney *et al.* 1999a). Therefore, while non-hovering helicopters may create a likelihood of injury by flushing adults (thereby increasing likelihood of predation), we do not anticipate that this action will cause mortality: spotted owl nests are at such low densities across the landscape that flight paths are unlikely to cross over a nest, and flyovers near nests will be brief. However, we anticipate greater disturbance from hovering helicopters due to prolonged noise and debris movement from rotor-wash (downwash and side-wash) near nests. Rotor wash is strongly correlated to "flight and helicopter characteristics of ground speed, height (from the rotor), rotor span, and helicopter mass" (Slijepcevic and Fogarty 1998). Rotor side-wash increases when ground speed decreases, the height of the helicopter decreases, helicopter mass increases, and rotor span decreases. Appendix 4 in Slijepcevic and Fogarty (1998) illustrates how helicopter ground speed and rotor heights influence rotor side-wash. Based on the appendix, a hovering Type I (i.e., CH-47 Chinook) helicopter can produce strong gale to storm force winds when hovering closely to the ground. The Service expects rotor-wash effects to decrease from the source, but the rate of decrease is uncertain.

Near-ground helicopter hovering is necessary for some actions (LW placement, culvert/bridge, and possibly instream nutrient enhancement). Hovering may indirectly injure spotted owl young by causing adults to flush from nests, or may directly injure birds from flying debris. The likelihood that adult spotted owls will leave active nests with hovering helicopters nearby has not been studied. As with other disturbances, responses may range from no reaction and slight changes in body position, to more severe reactions, such as panic and escape behavior. Poole (1989) anecdotally noted that osprey surveys are problematic because adults do not flush with young in the nests, even with a helicopter hovering nearby. The Service does not know the proximity and duration of these surveys, and it is possible that ospreys may be less likely to flush than spotted owls. However, based on the high nest attendance demonstrated by nesting owls in Delaney *et al.* (1999a), it is reasonable to assume that some spotted owls would behave similarly, by not abandoning nests during similar hovering activities. However, reactions would depend on the proximity and length of time that helicopters hovered near nests, and this threshold is unknown.

The likelihood of injury or mortality from helicopter hovering and lifting actions covered by this Opinion is low. While the PROJECTS BA does not specifically limit the number of actions using helicopters, the number of actions that may adversely affect spotted owls is limited in this Opinion to two nests per year in Washington and Oregon combined, as calculated on a three-year rolling average. It is unlikely that all spotted owl injury will be caused by helicopters for several reasons. First, actions will be implemented based on resources and priorities, meaning that future helicopter use will be rare. Helicopters are often expensive and/or unavailable, and restoration funding is limited.

Potentially negative effects from helicopters are also greatly minimized because there will be no hovering or lifting of ICS Type I helicopters within 152 m (500 feet or 0.1 miles) of occupied habitat during their breeding season, as proposed in the conservation measures for owls. Activities may still use Type II, III, and IV helicopters for hovering and lifting within 152 m (0.1 miles), and Type I for hovering and lifting between 152 and 402 m (0.1 and 0.25 miles) of nests during the breeding season (these are still LAA for spotted owls). Wind speeds from Type III and IV helicopter rotor-wash is about two-thirds of Type I and II helicopter rotor-wash, and wind speed from Type I helicopter rotor-wash is greater than Type II rotor-wash (Slijepcevic and Fogarty 1998). Therefore, limitation of Type I helicopter hovering near occupied habitat during the breeding season will substantially decrease the likelihood of injury or mortality. This conservation measure, combined with rationale from the preceding paragraph, makes it unlikely that mortality will occur (from predation on abandoned young) from activities involving helicopter hovering and lifting.

The Service presumes that any disturbances/disruptions causing exposure of adult or juvenile spotted owls will increase predation risk. A flushing owl may create the likelihood of injury by increasing the likelihood of predation through the advertisement of the nest's location, advertisement of the adult spotted owl, or premature departure of a nestling from a platform nest. Platform nests are elevated, relatively simple accumulations of sticks and debris that provide a suitable nesting surface. The likelihood of predation depends on the type and proximity of potential predators and also how they react to disturbances. Potential spotted owl predators include several bird species and fishers (Courtney *et al.* 2004). It is unlikely that fishers would have increased predation success on disrupted nests because they are rare (i.e., have a low probability of occurring in the vicinity of a disrupted nest when/if an adult is flushed). It is also reasonable to assume that some potential avian predators (i.e., red-tailed hawks, northern goshawks, cooper's hawks, barred owls and great horned owls) may also respond to disturbances by flushing from nests (i.e., not necessarily taking advantage of disturbances in the short-term for increased predation). For example, one study showed that red-tailed hawks flushed from helicopter flyovers 40% of the time (Larkin 1994). Also, Cooper's hawks exhibit and alert response to low-level jet aircraft and sonic booms (NPS 1994).

However, some predators may take advantage of disturbances for predation purposes. For example, corvids may eat unprotected eggs or nestlings when adults flush. Ravens in particular were noted as a potential predator (p. 8-27 but not p. 2-8 of Courtney *et al.* 2004), probably of spotted owl eggs and nestlings. Since corvids are highly intelligent we expect ravens would adapt quickly to disturbance activities. Also, since ravens rely on visual cues to detect prey (Liebezeit and George 1992), we presume they would key in on a flushing adult. However, predation risk from corvids is partly reduced because: 1) spotted owls are less likely to flush during the incubation and nestling phase (Delaney *et al.* 1999a); 2) spotted owls will defend nests from corvids (Forsman *et al.* 1984); 3) During their breeding season (which is similar to spotted owl's breeding period) 75% of raven's prey come from 400 m from their nest and, therefore, we must consider the probability a raven nest will be located within 400 m from a disrupted spotted owl nest (Liebezeit and George 1992); and 4) garbage will be removed from the site reducing a known corvid attractant (PDC 31). Overall, predation effects at the population-level are uncertain. Predation remains an important risk factor for individuals, but a strong effect of predation is untested, lacks empirical support, and is thought to be low (USFWS 2004).

Since adult flushing from covered actions is less likely to occur during incubation and nestling phases, increased predation is more of a concern when young are nearly ready to fledge because 1) the adult may be more likely to flush at this point leaving abandoned young vulnerable, and 2) disturbances may cause premature fledging which can also make young more vulnerable to predators. Predation risk to fledglings decreases as they become more capable of movement later in the breeding season. Spotted owls generally fledge when five weeks old (Forsman *et al.* 1984). Within two weeks of fledging, spotted owl professionals believe that juveniles are capable of some sustained flight. Once capable of sustained flight, young owls are presumably able to distance themselves from disturbance and minimize their risk of predation. The critical breeding window accommodates the majority of all spotted owl young, but some young are capable of moving away from disturbance (thereby decreasing predation risk because they can stay with protective parents) during the critical breeding window. After July 15, most fledging spotted owls are capable of sustained flight and can move away from disruptive activities.

Causes of premature fledging, and whether this increases the likelihood of injury or mortality, have not been extensively documented or studied. Late-stage fledglings should demonstrate stress responses, including flushing, similar to adults, and mortality from premature fledging has been documented. Forsman *et al.* (1984) reported premature fledging of nine spotted owl young that were raised in platform nests (i.e., fell or jumped from the nest). Seven of these died, or disappeared (Forsman *et al.* 1984). Premature fledging is most likely to occur as the nestlings mature and prepare for nest departure, usually when chicks are between 20 and 36 days old. The cause of premature fledging documented by Forsman *et al.* (1984) was the presumed death of the adult female, disrupted incubation when rotten wood fell into the nest cavity, and a case where a female ceased incubation for unknown reasons. Forsman *et al.* (1984) documented that premature fledglings spent up to 10 days on the ground, which increased their vulnerability to predators. The Service expects premature fledging to occur more frequently for chicks in platform nests than ones in cavity nests since platform nests are more exposed to disturbances. The ratio of platform to cavity nests varies by province, therefore premature fledging may be more likely in provinces with greater occurrences of platform nests. If owls are rarely flushed until fledging occurs (Delaney *et al.* 1999a) then premature fledging may not be as significant of an issue as previously anticipated for most activities (i.e., except actions involving lifting and hovering helicopters).

Injury (from premature fledging) or mortality (by blowing chicks from nest) may occur when large helicopters hover near active nests. The likelihood of injury or mortality is greater for Chinook helicopters. Hovering/lifting from Type I helicopters can mimic the strength of gale force or storm winds when close to a nest (i.e., 15-20 m above ground per Slijepcevic and Fogarty 1998). Published literature has described the potentially adverse impacts of stormy weather on reproduction for birds (North *et al.* 2000), and catastrophic weather has been considered a threat to spotted owls since listing (USFWS 1990a).

While most spotted owl discussion has centered on habitat loss or alteration (i.e., broken trees), and weather effects on diet (USFWS 2004), failed nest attempts and chick displacement for other bird species due to high winds has been documented (Lafferty *et al.* 2006, Bowman and Woolfenden 2002). Therefore it is possible that chicks directly exposed to rotor-wash could be blown from nests. Chicks further from hovering/lifting activities may not be blown off nests, but may be more likely to prematurely fledge (i.e., injury) if the superficial wind created by helicopters accelerates this process. The Service assumes that chicks in platforms nests are more likely to suffer injury or mortality because they are more exposed to activities than cavity nests. Both types of nests are common (i.e., ratio varies by province). The Service assumes helicopter use will be later in the breeding season when older chicks are present, due to in-water work periods and helicopters generally not being available for use until later in the breeding season due to their use to fight forest fires. Therefore, the Service also assumes that helicopter work will only cause the likelihood of injury to spotted owls. We do not expect that noise, rotor wash, smoke and visual disturbance will result in actual nest failure, but the anticipated disturbance is reasonably certain to create a likelihood of injury that can indirectly result in nest failure due to a reduced fitness of individuals.

Table 13. Summary of disturbance effects from the 21 proposed actions to spotted owls when nests are within the disturbance/disruption distances of activities during the breeding season.

Disturbance Type	Time Period*	Effect	Rationale for Effects Determination
Mechanical noise (other than Large helicopters)	Mar 1 to Jul 15	LAA	Noise effects vary and may cause little to no significant disruption depending on site- and activity-specific factors and an individual's tolerance to noise. In the worst-case scenario, adults can move from noise, likely causing increased predation to young, missed feedings, or premature fledging, which could result in a reduce fitness or death of young. However, we anticipate noise from actions will only increase the likelihood of injury to young through potentially increased predation of abandoned young.
	Jul 15 to Sept 30	NLAA	Spotted owls are still developing flight and hunting skills and are heavily cared for by parents. However, most have fledged by this date and are believed to be able to move short distances to stay with the parents if displaced.
Helicopters	Mar 1 to Jul 15	LAA	Noise/rotor wash can significantly disrupt birds. The worst-case scenario is that adults can move from noise, causing increased predation to young, missed feedings, or premature fledging, which could result in a reduce fitness or death of young. However, we anticipate likely injury only when large helicopter noise is within close proximity of nests which may result in the flushing of adults and which may cause increased predation or premature fledging. Since hovering near known nests and historic nests/centers is limited, we do not anticipate mortality from rotor wash.

Disturbance Type	Time Period*	Effect	Rationale for Effects Determination
	Jul 16 to Sept 30	LAA	spotted owls are still developing flight and hunting skills and are heavily cared for by parents. While most young have fledged, the greater noise may cause the parents to travel greater distances to avoid the noise, and therefore the young who are not yet skilled flyers are potentially more susceptible to predation.
On-ground Human presence	Mar 1 to Sept 30	NLAA	Spotted owls have not shown any flushing from a nest due to human presence on the ground.
In-canopy human presence	Mar 1 to Jul 15	LAA	Spotted owls may flush from a nest due to human presence in the tree canopy (based on expert judgment of spotted owl biologists in USFWS 2003).
	Jul 15 to Sept 30	NLAA	Most young are fledged and likely able to move from tree climbers.
*Exact dates may vary by physiographic province or site-specific location.			

3.5.9.4 Summary of Harassment Effects

Summaries of potential disruption effects to spotted owls (three/unit/year) from the 21 action categories are included in Table 13. Since each activity may be designed a multitude of ways, and we do not know the specific type of equipment that will be used on-site, we describe actions in terms of the equipment types that may be used.

There is a potential of injury to spotted owl young from harassment from the proposed action because some projects will occur within disruption distances of occupied or suitable, unsurveyed spotted owl areas during the spotted owl breeding season. The likelihood of injury and adverse effects are greatly reduced because few restoration actions (of all actions implemented under this programmatic consultation) will occur 1) during the critical breeding period and, 2) within implementation of timing and distance restrictions (Table 12).

Disturbance from proposed actions conducted: 1) outside of the breeding period (between October 1 and February 28), 2) greater than 0.25 mile from a known activity center, predicted nest patches, or unsurveyed suitable habitat during any time of the year, or 3) within 0.25 mile of surveyed unoccupied habitat during any time of the year, *may affect, but are not likely to adversely affect* spotted owls because these activities are not likely to cause missed feeding attempts of young (since they are not reliant on adults for food during this time or else the disturbance distance is too far away to cause disruption), or flushes that affect young (since the stimulus is too far from the spotted owl nest).

Proposed actions generating noise above local ambient levels within activity-specific disturbance (but not within disruption) distances of unsurveyed suitable or occupied habitat, between March 1 and Sept 30 (breeding period), *may affect, but are not likely to adversely affect* spotted owls. This is because actions will occur far enough away from nests so that flushing, premature fledging, and missed feeding attempts are unlikely. Proposed actions generating noise above local ambient levels within activity-specific disruption distances of unsurveyed suitable or occupied habitat between March 1 and July 15 (critical nesting period), *may affect, and are likely to adversely affect* spotted owls. This is because it is probable that at least one young will be affected by the flushing of an adult from the nest, premature fledging, or missed feeding attempts due to the closer proximity of actions to the nest which may result in injury from predation, reduced feeding and stress. Helicopter activities conducted within 100 yards of unsurveyed suitable or occupied habitat during the spotted owl late nesting season also *may affect, and are likely to adversely affect* spotted owls due to rotor-wash producing flying debris and tree shaking which may cause spotted owl young harm from an injury.

Few restoration projects are likely to occur annually in spotted owl habitat, and effects will be largely limited to the restoration site. Negative effects to spotted owls are significantly reduced by the proposed PDC and spotted owl conservation measures. Thus, there is low potential for large-scale disturbance from the proposed action. The disturbance and disruption guidelines listed in Tables 12 and 13 will be used to determine whether projects are likely to adversely affect spotted owls. Most activities will result in "not likely to adversely affect" or "no effect" determinations for spotted owl disturbance since most actions will occur outside of critical nesting period and/or outside of disturbance or disruption distance from spotted owl nests and unsurveyed suitable habitat, or outside of suitable habitats.

3.5.9.5 Provincial and Range-wide Effects

The anticipated disruption of normal nesting behaviors will result in an increased likelihood of injury to spotted owls nesting within those affected acres but is not reasonably certain to result in direct nest failures. The anticipated increased likelihood of injury is not anticipated to appreciably reduce spotted owl numbers or reproduction at the scale of the action area or any larger scale because 1) most nests exposed to disturbance are not expected to fail given the variability of responses to noise and visual disturbance; and 2) no direct mortality of adult spotted owls is anticipated, so there would be no reduction in the current population of breeding adults. Therefore, the Service believes the proposed project will not result in jeopardy for the spotted owl. As the proposed projects are not likely to adversely affect spotted owl habitat or their critical habitat, the proposed projects will not affect spotted owl critical habitat at the Provincial or range-wide scales.

However, it is possible a restoration project may be in the vicinity of an owl nest and cause disturbance to individual spotted owls, especially if there is a conflict with an established in-water work period for a listed fish species or if extended time is needed to complete a large or complicated restoration project. Therefore, with a lack of information on the number of projects by NOAA RC in spotted owl habitat, the Service estimates that NOAA RC could implement half the number of projects per year as the Service's restoration programs. This is because NOAA RC generally conducts restoration on lower elevation fish habitats that are generally away from NSO habitat, and NOAA RC does not fund recovery projects focused on spotted owl.

Over 4 years (2011 to 2014), the PFW and Coastal programs funded 15 projects over approximately 2,500 acres in or near northern spotted owls but all of these projects were determined to not likely to adversely affect spotted owls, or have no effect on spotted owl habitats. The Service's Recovery Programs in Oregon and Washington funded 6 projects over a 3 year period; most of the recovery projects were survey and data management funds and did not affect spotted owl habitat. No information was available from NOAA RC how many projects they may have implemented in spotted owl habitat, but we assume NOAA RC will implement only a quarter of the projects implemented by the Service's restoration programs. The Service considers the potential for NOAA RC to impact spotted owl habitat less than the Service's restoration programs since most NOAA RC projects are lower in the watershed, away from spotted owl habitat, and NOAA RC does not fund upland restoration or recovery actions for spotted owls. We also estimate 1 additional restoration project implemented by other parties could be covered under this Opinion per year, as described in the Introduction in the section entitled *Action Area and Requirements for Coverage.*

Given this information, we anticipate up to 9 restoration projects per year that may occur in northern spotted owl habitat in Oregon and Washington. Of these 9 projects in spotted owl habitat each year, we assume a worst case scenario where impacts cannot be avoided in 20% of the projects, which equals 2 projects per year (rounded up) that may adversely affect northern spotted owl nests. Thus, we anticipate that no more than two nests,or four owls (two per nest) will be injured or killed annually. Additionally, projects by the Action Agencies can vary annually by location and magnitude. Therefore to allow for the annual variability of projects, take will be calculated on a three-year rolling average for the duration of this Opinion.

3.5.10 Conclusion for Northern Spotted Owl

After reviewing the status of the northern spotted owl, the environmental baseline for the action area, and the effects of the proposed action, including all measures proposed to avoid and minimize adverse effects, and the cumulative effects, it is the Service's Biological Opinion that the activities implemented under the PROJECTS restoration program are not likely to jeopardize the continued existence of the northern spotted owl.

This no jeopardy finding for the northern spotted owl is supported by the following:

1. Most projects within owl habitat will occur outside of the critical breeding period and outside of established distance restrictions for noise. Only 2 projects are anticipated to occur annually within northern spotted owl habitat during the critical breeding period and within established distance restrictions for noise.
2. Effects to the northern spotted owl from the proposed project will be mainly harassment through disturbance associated with restoration activities.
3. No direct mortality of adult spotted owls is anticipated, so there is no reduction in the current population of breeding adults.
4. Individual projects will be widely distributed in time and space across the range of northern spotted owls.
5. No proposed activities are anticipated to have adverse effects to spotted owls or spotted owl critical habitat through habitat loss or modification.

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3.6 Marbled Murrelet

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.

3.6.1 Legal Status

The murrelet was listed as a threatened species on September 28, 1992, in Washington, Oregon, and northern California (USFWS 1992). Since the species' listing, the Service has completed two 5-yr status reviews of the species: September 1, 2004 (USFWS 2004) and June 12, 2009 (USFWS 2009). 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 (USFWS and USDC NMFS 1996, USFWS 2004). 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 (USFWS 2009, pages 3-12). The legal status of the murrelet remains unchanged from the original designation.

3.6.2 Critical Habitat

Critical habitat consists of geographic areas essential to the conservation of a listed species. Under the ESA, conservation means to use and the use of all methods and procedures which are necessary to bring an endangered species or threatened species to the point at which the measures provided pursuant to the ESA are no longer necessary.

Critical habitat is provided protection under section 7 of the ESA by ensuring that activities funded, authorized, or carried out by Federal agencies do not adversely modify such habitat to the point that it no longer remains functional (or retains its current ability for PCEs to be functionally established) to serve the intended conservation role for the species.

On May 24, 1996, the Service designated critical habitat for the murrelet within 104 critical habitat Units (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 intended the scope of the section 7(a)(2) analysis to evaluate impacts of an action on critical habitat at the conservation zone(s) or even a major part of a conservation zone (USFWS 1996, page 26271).

On October 5, 2011, the final rule revising critical habitat for the murrelet was published (USFWS 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 (USFWS 2011, page 61599).

3.6.2.1 Primary Constituent Elements

The PCEs are physical and biological features the Service determines are essential to a species' conservation (i.e., recovery) and require special management considerations. The PCEs 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 km (0.5 miles) of individual trees with potential nesting platforms, and that are used or potentially used by murrelets for nesting or roosting (USFWS 1996, page 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 PCE are intended to support terrestrial habitat for successful reproduction, roosting and other normal behaviors.

3.6.3 Life History

3.6.3.1 Reproduction

Murrelets produce one egg per nest and usually only nest once a year, however re-nesting has been documented. 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 semiprecocial, 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.

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),[25] 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[26] are available from telemetry studies conducted in California (Hebert and Golightly 2006; Peery *et al.* 2004) and Washington (Bloxton and Raphael 2006). 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 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, 302), and in Oregon (0.0254 - 0.0598 - CCR 2008, p. 13). Estimates for Ŕ (adjusted) in the

[25] The juvenile ratio (Ŕ) for murrelets is derived from the relative abundance of hatch-year (HY; 0-1 yr-old) to after-hatch-year (AHY; 1+ yr-old) birds (Beissinger and Peery 2007, p. 297) and is calculated from marine survey data.

[26] Nest success here is defined by the annual number of known hatchlings departing from the nest (fledging) divided by the number of nest starts.

San Juan Islands in Washington have been below 0.15 every year since surveys began in 1995, with three of those years below 0.05 (Raphael *et al.* 2007, p. 16).

These current estimates of Ŕ are assumed to be below the level necessary to maintain or increase the murrelet population. Demographic modeling suggests murrelet population stability requires a minimum reproductive rate of 0.18 to 0.28 (95 % CI) chicks per pair per year (Beissinger and Peery 2007, p. 302; USFWS 1997). The estimates for Ŕ discussed above from individual studies, as well as estimates for the listed range (0.02 to 0.13) are all below the lowest estimated value (0.18) identified as required for population stability (USFWS 1997, 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% CI: 0.15 to 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.

3.6.3.2 Population Structure

Murrelets are long-lived seabirds that spend most of their life in the marine environment, with breeding adult birds 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. Murrelets lay just one egg and are thought to usually first breed at age 3.

3.6.3.3 Recovery Zones

The Recovery Plan identified six Conservation Zones (Figure 2) throughout the listed range of the species: Puget Sound (Conservation Zone 1), Western Washington Coast Range (Conservation 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 (USFWS 1997, p. 115).

3.6.3.4 Recovery Zones in Washington

Conservation Zone 1 (Puget Coast Range Zone)

The majority of suitable murrelet habitat in Conservation Zone (Zone) 1 occurs in northwest Washington and is found on Forest Service and National Park Service lands, and to a lesser extent on State lands. The majority of the historic habitat along the eastern and southern shores of the Puget Sound has been replaced by urban development resulting in the remaining suitable habitat further inland from the marine environment (USFWS 1997).

Conservation Zone 2 (Western Washington Coast Range Zone

Murrelet nesting habitat north of Gray's Harbor in Zone 2 occurs largely on State, Forest Service, National Park Service, and Tribal lands, and to a lesser extent, on private lands.

Alternatively, the majority of habitat in the southern portion of Zone 2 occurs primarily on State lands, with a small amount on private lands.

3.6.3.5 Recovery Zones in Oregon

Conservation Zone 3 (Oregon Coast Range Zone*)*
This zone extends from the Columbia River, south to North Bend, Coos County, Oregon. Conservation zone 3 includes waters within 2 km (1.2 miles) of the Pacific Ocean shoreline and extends inland a distance of up to 56 km (35 miles) from the Pacific Ocean shoreline and coincides with the zone 1 boundary line. This zone contains the majority of murrelet sites in Oregon. 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 (USFWS 1997). Beissinger and Peery (2003, page 22) estimated a 2.8 to 13.4% annual population decline for this zone. Miller *et al.* (2012, page 775) estimated a 1.5% population decline for this zone, with a 95% confidence limit of 5.4% decline to 2.6% increase in the population.

Conservation Zone 4 (Siskiyou Coast Range Zone)
The Siskiyou Coast Range zone extends from North Bend, Coos County, Oregon south to the southern end of Humboldt County, California. It includes waters within 1.2 miles of the Pacific Ocean shoreline (including Humboldt and Arcata bays) and, generally extends inland a distance of 56 km (35 miles) from the Pacific shoreline. This zone contains populations in Redwood National Park and several state parks. It contains nesting habitat on private lands in southern Humboldt County and at lower elevations in the western portions of Smith River National Recreation Area (USFWS 1997). Beissinger and Peery (2003, page 22) estimated a 2.5 to 13.2% annual population decline for this zone. Miller *et al.* (2012, page 775) estimated a 0.9% population decline for this zone, with a 95% confidence limit of 3.8% decline to 2.0% increase in the population.

3.6.3.6 Ecology / Habitat Characteristics

Murrelets are long-lived seabirds that 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.

Murrelets spend most of their lives in the marine environment where they forage in near-shore areas and consume a diversity of prey species, including small fish and invertebrates. 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), McShane *et al.* (2004), and Piatt *et al.* (2007).

3.6.3.7 Aquatic Habitat Use

Murrelets are usually found within 8 km (5 miles) from shore, and in water less than 60 m (197 feet) deep (Ainley *et al.* 1995; Burger 1995; Strachan *et al.* 1995; Nelson 1997; Day and Nigro 2000; Raphael *et al.* 2007). In general, birds occur closer to shore in exposed coastal areas and farther offshore in protected coastal areas (Nelson 1997). 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; Henkel *et al.* 2003; Kuletz 2005). 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, Whitworth *et al.* 2000; Becker 2001; Hull *et al.* 2001; Mason *et al.* 2002; Piatt *et al.* 2007). Murrelets are also known to forage in freshwater lakes (Nelson 1997). 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; Burger 1995; Strong *et al.* 1995; Speckman 1996; Nelson 1997).

Juveniles are generally found closer to shore than adults (Beissinger 1995) and forage without the assistance of adults (Strachan *et al.* 1995). Kuletz and Piatt (1999) 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). McAllister (in Strachan *et al.* 1995) found that juveniles were more common within 100 m (328 feet) of shorelines, particularly where bull kelp was present.

Within the area of use, murrelets usually concentrate feedings in shallow, near-shore water less than 30 m (98 feet) deep (Huff *et al.* 2006), but are thought to be able to dive up to depths of 47 m (157 feet) (Mathews and Burger 1998). During the non-breeding season, murrelets disperse and can be found farther from shore (Strachan *et al.* 1995). Although little information is available outside of the nesting season, limited information on winter distribution also suggests they do move farther offshore (Craig Strong, Biologist, Crescent Coast Research, Crescent City, California, *pers. comm.*, 2007). 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); 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). In many areas, murrelets also undertake occasional trips to inland nesting habitat during the winter months (Carter and Erickson 1992). Throughout the listed range, murrelets do not appear to disperse long distances, indicating they are year-round residents (McShane *et al.* 2004). 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; USFWS 1992). 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

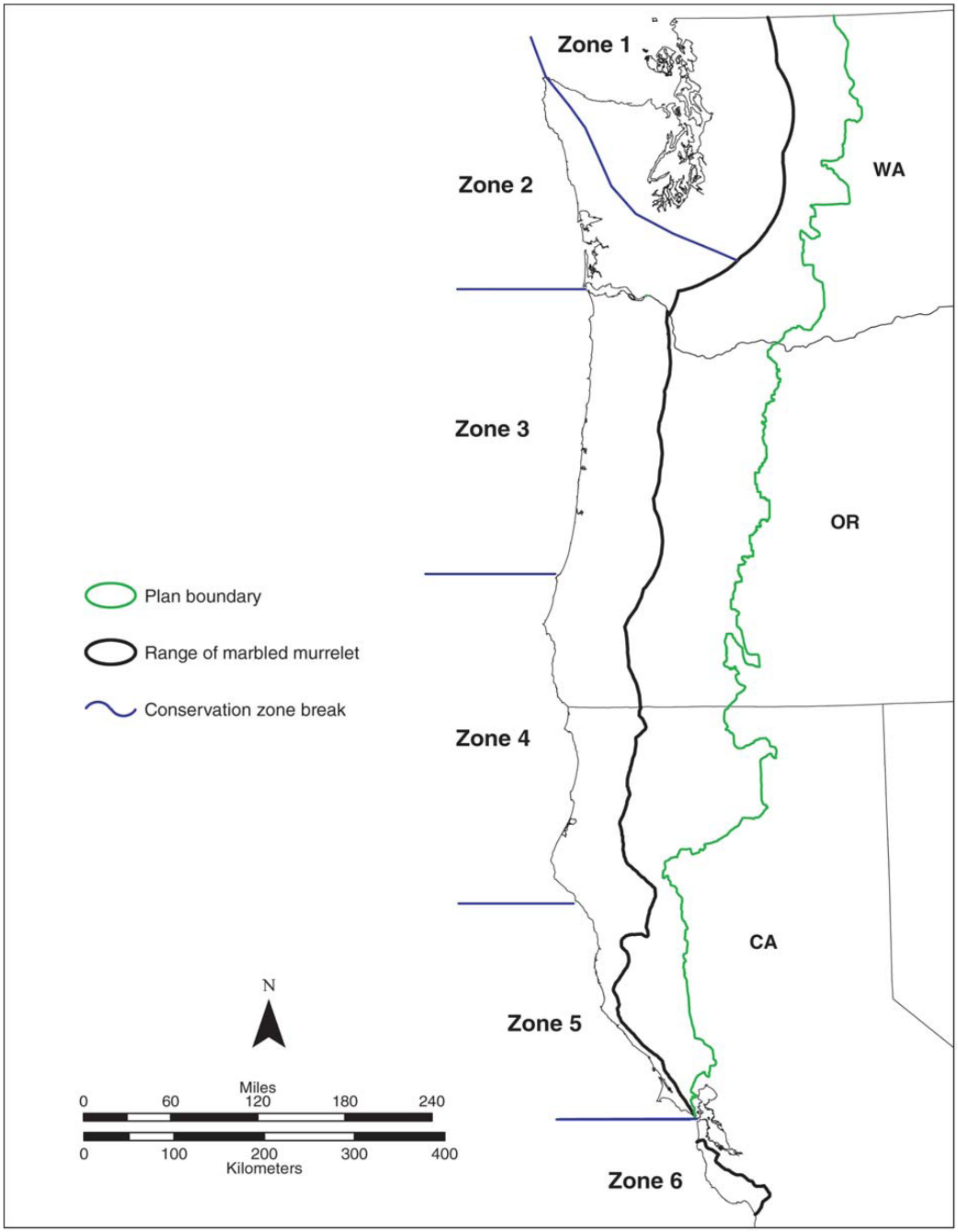

Figure 2. The six geographical areas identified as Conservation Zones in the recovery plan for the murrelet (USFWS 1997). Note: "Plan Boundary" refers to the Northwest Forest Plan. Figure adapted from Huff *et al.* (2006, p. 6).

(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). 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).

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; Nelson 1997), primarily around dawn and dusk (Nelson 1997, Kuletz 2005). 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). Becker *et al.* (2007) 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). 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, and/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). As a result, 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), 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).

3.6.3.8 Nesting Biology

Incubation is shared by both sexes, and incubation shifts are generally one day, with nest exchanges occurring at dawn (Nelson 1997, Bradley 2002). 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). 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 (Hamer and Nelson 1995a). Chicks fledge 27-40 days after hatching, at 58 to 71% of adult mass (Nelson 1997). Fledging has seldom been documented, but it typically appears to occur at dusk (Nelson 1997).

3.6.3.9 Nest Tree Characteristics

Lank *et al.* (2003) 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). 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 46 cm (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 (Manley 1999, Burger 2002, Nelson and Wilson 2002). Over 95% of measured nest limbs were ≥15 cm (38 inches) diameter, with limb diameter ranges from 7 to 74 cm (2.8 to 29.1 inches) diameter (Burger 2002). Nelson and Wilson (2002) found that all 37 nest cups identified were in trees containing at least seven 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) 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.

3.6.3.10 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 (Burger 2002), but nest in stands as small as one acre (Nelson and Wilson 2002). 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 (USFWS 1992, Singer *et al.* 1995).

At the stand level, vertical complexity is correlated with nest sites (Meekins and Hamer 1998, Manley 1999, Waterhouse *et al.* 2002, Nelson and Wilson 2002), and flight accessibility is probably a necessary component of suitable habitat (Burger 2002). Some studies have shown higher murrelet activity near stands of old-forest blocks over fragmented or unsuitable forest areas (Paton *et al.* 1992, Rodway *et al.* 1993, Burger 1995, Deschesne and Smith 1997, Rodway and Regehr 2002), but this correlation may be confounded by ocean conditions, distance inland, elevation, survey bias and disproportionately available habitat. Nelson and Wilson (2002) 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 (USFWS 1996, Burger 2001, Meyer *et al.* 2002, and Raphael *et al.* 2002). 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).

Consulted on effects from October 1, 2003 to January 22, 2015 that impact nest stands are summarized in Table 14.

Table 14. Aggregate Results of All Suitable Habitat (acres) Affected by Section 7 Consultation for the Murrelet; Summary of Effects by Conservation Zone and Habitat Type from October 1st, 2003 to February 4, 2015.

Conservation Zone[1]	Authorized Habitat Effects In Acres[2]		Reported Habitat Effects in Acres[2]	
	Stands[3]	Remnants[4]	Stands[3]	Remnants[4]
Puget Sound	-69	0	-1	0
Western Washington	-75	0	-12	0
Outside CZ Area in WA	0	0	0	0
Oregon Coast Range	-2,887	-1050	-2,217	0
Siskiyou Coast Range	-2,581	0	-137	0
Outside CZ Area in OR	-2	0	0	0
Mendocino	0	0	0	0
Santa Cruz Mountains	0	0	0	0
Outside CZ Area in CA	0	0	0	0
Total	-5614	-1050	-2368	

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 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 Murrelet Effectiveness Monitoring Module is in the process. Some useable working definitions include the PCEs as defined in the Critical Habitat Final Rule, or the criteria used for Washington State by Raphael *et al.* (2002).
3. Stand: A patch of older forest in an area with potential platform trees.
4. Remnants: A residual/remnant stand is an area with scattered potential platform trees within a younger forest that lacks, overall, the structures for murrelet nesting.

3.6.3.11 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, and radar. McShane *et al.* (2004, pg. 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 60 km (37 miles)) did not seem important." Elevation had a negative association in some studies with murrelet habitat occupancy (Burger 2002). Hamer and Nelson (1995b) sampled 45 nest trees in British Columbia, Washington, Oregon, and California and found the mean elevation to be 332 m (1,089 feet).

Multiple radar studies (e.g., Burger 2001, Cullen 2002, Raphael *et al.* 2002, Steventon and Holmes 2002) 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). Several studies have concluded that murrelets do not pack into higher densities within remaining habitat when nesting habitat is removed (Burger 2001, Manley *et al.* 2001, Cullen 2002).

There is a relationship between proximity of human-modified habitat and increased avian predator abundance. However, increased numbers of avian predators does not always result in increased predation on murrelet nests. For example, Luginbuhl *et al.* (2001, pg. 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, pg. 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 km^2 in our study). Rather this approach should be considered useful only at a broader, landscape scale on the order of 5-50 km^2 (based on the scale of our fragmentation and human-use measures)."

Artificial murrelet nest depredation rates were highest in western conifer forests where stand edges were close to human development (Luginbuhl *et al.* 2001), and Bradley (2002) found increased corvid densities within three miles of an urban interface, probably due to supplemental feeding opportunities from anthropogenic activities. Golightly *et al.* (2002) found extremely low reproductive success for murrelets nesting in large old-growth blocks of redwoods in the California Redwoods National and State Parks. Artificially high corvid densities from adjacent urbanization and park campgrounds are suspected to be a direct cause of the high nesting failure rates for murrelets in the redwoods parks.

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).

3.6.4 Population Status

3.6.4.1 Historical Status and Distribution

Murrelet abundance during the early 1990s in Washington, Oregon, and California was estimated at 18,550 to 32,000 birds (Ralph *et al.* 1995).

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 (USFWS 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 (Table 15).

3.6.4.2 Current Rangewide Status and Distribution

Based primarily on the results from the NWFP Effectiveness Monitoring (EM) Program, the 2010 murrelet population for the listed range (Table 15) is estimated at 16,691 birds (95% confidence interval [CI]: 13,075 to 20,307;(Table 15). Based on the 2010 estimates, Conservation Zones 3 and 4 support approximately 65% of the murrelet population within the U.S., and consistently have the highest – at-sea densities during the nesting season (Falxa *et al.* 2011). As with the historic status, murrelets continue to occur in the lowest abundance in Conservation Zones 5 and 6.

Table 15. Estimates of murrelet density and population size (95% CI) in Conservation Zones 1 through 5 during the 2010 breeding season (Falxa *et al.* 2011), and in Conservation Zone 6 during the 2009 breeding season (Perry and Henry 2010).

Conservation Zone	Density (birds/km^2)	Coefficient of Variation (% Density)	Population Size Estimates with 95% CI			Survey Area (km^2)
			Number of Birds	Lower	Upper	
1	1.26	20.4	4393	2,689	6,367	3,497
2	0.18	25.7	1,286	650	1946	1,650
3	4.53	16.9	7,223	4,605	9,520	1,595
4	3.16	27.3	3,668	2,196	6,140	1,159
5	0.14	-	121	-	242	883
6	-	-	631	449	885	-
Zones 1-6	-	-	17,322	13,524	21,192	-

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).

The current breeding range of the murrelet is the same as the historic breeding range. Birds winter throughout the breeding range and also occur in small numbers off southern California.

3.6.4.3 Trend

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.

3.6.4.4 Marine Surveys

Researchers from the EM Program detected a statistically significant decline ($p < 0.001$) in the abundance of the population in Conservation Zones 1 through 5 combined, for the 2001-2010 sample period (Falxa *et al.* 2011). The estimated average annual rate of decline for this period was 3.7% (95% CI: -4.8 to -2.7%). This rate of annual decline suggests a total population decline of about 29% between 2001 and 2010 (Miller *et al.* 2012).

At the scale of individual conservation zones, the murrelet population declined at an estimated average rate of 7.4% per year (95% CI: -11.2 to -3.5) in Conservation Zone 1 (Falxa *et al.* 2011, Miller *et al.* 2012). In that same analysis, statistically significant trends were not detected elsewhere at the single-zone scale, but evidence of a declining trend was strong in Zone 2 (6.5% rate of decline, $P = 0.06$). For Washington State (Conservation Zones 1 and 2 combined) there was a 7.31% (standard error = 1.31%) annual rate of decline in murrelet density for the 2001-2010 period (Pearson *et al.* 2011, p. 10), which equates to a loss of approximately 47% of the murrelet population since 2001.

In Conservation Zone 6, the 2008 population estimate for Conservation Zone 6 suggested a decline of about 55% from the 2007 estimate and a 75% decline from the 2003 estimate (Peery *et al.* 2008). However, in the most recent population estimate available, the 2009 estimate was similar to estimates from 1999-2003 (Peery and Henry 2010). Peery and Henry (2010) speculated that their 2009 results may have indicated murrelets in central California moved out of the survey area in 2007 and 2008, and then returned in 2009, or the higher estimate in 2009 may have been due to immigration from larger populations to the north. Results from 2010 and 2011 surveys from Zone 6 are currently not available.

3.6.4.5 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; Cam *et al.* 2003; McShane *et al.* 2004; USFWS 1997). 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/emigration rates.

In a report developed for the 5-year Status Review of the Murrelet in Washington, Oregon, and California (McShane *et al.* 2004, p. 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 16) for each conservation zone to describe population trends and evaluate extinction probabilities (McShane *et al.* 2004, p. 3-49).

McShane *et al.* (2004) used mark-recapture studies conducted in British Columbia by Cam *et al.* (2003) and Bradley *et al.* (2004) to estimate annual adult survival and telemetry studies or at-sea survey data to estimate fecundity. Model outputs predicted 3.1 to 4.6% 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% decline per decade (McShane *et al.* 2004, p. 3-52). These reported rates of decline are similar to the estimates of 4 to 7% per year decline reported in the Recovery Plan (USFWS 1997, p. 5).

Table 16. Rangewide 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 USFWS (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[27] of 16% and mean population size of 45 individuals in 100 years in the listed range of the species (McShane *et al.* 2004, pp. 3-58).

3.6.5 Threats, Reasons for Listing, Current Rangewide Threats

When the murrelet was listed under the ESA (USFWS 1992) and threats summarized in the Recovery Plan (USFWS 1997, pp. 43-76), several anthropogenic threats were identified as having caused the dramatic decline in the species.

- habitat destruction and modification in the terrestrial environment from timber harvest and human development caused a severe reduction in the amount of nesting habitat
- unnaturally high levels of predation resulting from forest “edge effects” ;
- 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
- manmade factors such as mortality from oil spills and entanglement in fishing nets used in gill-net fisheries.

[27] Extinction was defined by McShane *et al.* (2004, p. 3-58) as any murrelet conservation zone containing less than 30 birds.

There have been changes in the levels of these threats since the 1992 listing (USFWS 2004, pp. 11-12; USFWS 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 (USFWS 2004, pp. 11-12). The levels for the other threats identified in 1992 listing (USFWS 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 (USFWS 2004, pp. 11-12).

However, new threats were identified in the Service's 2009, 5-year review for the murrelet (USFWS 2009, pp. 27-67). These new stressors are due to several environmental factors affecting murrelets in the marine environment. These new stressors include:

- Habitat destruction, modification, or curtailment of the marine environmental conditions necessary to support murrelets due to:
    - elevated levels of polychlorinated biphenyls in murrelet prey species;
    - changes in prey abundance and availability;
    - changes in prey quality;
    - harmful algal blooms that produce biotoxins leading to domoic acid and paralytic shellfish poisoning that have caused murrelet mortality; and
    - climate change in the Pacific Northwest.

- Manmade factors that affect the continued existence of the species include:
    - derelict fishing gear leading to mortality from entanglement;
    - energy development projects (wave, tidal, and on-shore wind energy projects) leading to mortality; and
    - 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).

The Service also 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, and increases in extreme flooding, landslides and windthrow events in the short-term (10 to 30 years). However, while it appears likely that the murrelet will be adversely affected, we lack adequate information to quantify the magnitude of effects to the species from the climate change projections described above (USFWS 2009, page 34).

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 (USFWS 1992); the Recovery Plan, Ecology and Conservation of the Murrelet (Ralph *et al.* 1995); the final rule designating murrelet critical habitat (USFWS 1996); the Evaluation Report in the 5-Year Status Review of the Murrelet in Washington, Oregon, and California (McShane *et al.* 2004); the 2004 and 2009, 5-year Reviews for the Murrelet (USFWS 2004, 2009), and the final rule revising critical habitat for the murrelet (USFWS 2011]).

3.6.6 Conservation

3.6.6.1 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[28] 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 (USFWS 1997, p. 114-115). The general criteria include:

- 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
- implementing management and monitoring strategies in the marine and terrestrial environments to ensure protection of murrelets for at least 50 years.

Thus, increasing murrelet reproductive success and reducing the frequency, magnitude, or duration of any anthropogenic stressor that directly or indirectly 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 (USFWS 1997).

3.6.6.2 Current Actions

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

[28] Fitness is measure of the relative capability of individuals within a species to reproduce and pass its' genotype to the next generation.

murrelets, then the habitat and recruitment habitat (trees at least 0.5 site potential tree height) 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.

3.6.7 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 3 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 (USFWS 1996, page 26265).

3.6.8 Current Condition

The majority (77%) of designated critical habitat occurs on Federal lands in LSRs as identified in the Northwest Forest Plan. 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 to January 22, 2015 (Table 17), indicates 465 acres of PCE 1 and 463 acres of PCE 2 were planned for removal in critical habitat, of which 444 acres of PCE 1 and 234 acres of PCE 2 removal was associated with Tribal activities in the Siskiyou Coast Range Zone. All other impacts are associated with Federal activities.

Table 17. Aggregate Results of All Critical Habitat (acres) Affected by Section 7 Consultation for the Murrelet; Baseline and Summary Effects by Conservation Zone and Habitat Type from October 1, 2003 to February 4, 2015.

Conservation Zone[1]	Designated Acres[2]	Authorized Habitat Effects in Acres[3]			Reported Habitat Effects in Acres[3]		
	Total CHU Acres	Stands[4]	Remnants[5]	PCE 2[6]	Stands[4]	Remnants[5]	PCE 2[6]
Puget Sound	1,271,782	-16	0	-21	0	-1	0
Western Washington	414,050	0	0	0	0	0	0
Outside CZ Area in WA	0	0	0	0	0	0	0

Conservation Zone[1]	Designated Acres[2]	Authorized Habitat Effects in Acres[3]			Reported Habitat Effects in Acres[3]		
	Total CHU Acres	Stands[4]	Remnants[5]	PCE 2[6]	Stands[4]	Remnants[5]	PCE 2[6]
Oregon Coast Range	1,024,122	-5	0	-208	0	0	0
Siskiyou Coast Range	1,055,788	-444	0	-234	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	-465	0	-463	0	-98	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 Murrelet (USFWS 1997).
2. Critical Habitat Unit acres within each 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 Murrelet Effectiveness Monitoring Module is in the process. Some useable working definitions include the PCEs as defined in the Critical Habitat Final Rule, or the criteria used for Washington State by Raphael *et al.* (2002).
4. Stand: A patch of older forest in an area with potential platform trees.
5. Remnants: A residual/remnant stand is an area with scattered potential platform trees within a younger forest that lacks, overall, the structures for murrelet nesting.
6. PCE 2: trees with a ½ site-potential tree height within 0.5 mile of a potential nest tree.

3.6.9 Conservation Measures for the Murrelet

The proposed conservation measures for the murrelet are:

a. To avoid or minimize adverse effects to marbled murrelets, a wildlife biologist must 1) determine if murrelets may occur in the vicinity of the project, and 2) if it is determined that murrelets may occur in the vicinity of the project, conduct a site survey to determine if an active nest may be within the disruption distance of the project. If a survey approved by the Service is not completed, it will be assumed that suitable habitat is occupied, and appropriate conservation measures will be implemented.
b. Projects will seek to avoid disturbance by every reasonable means, including; adjusting project timing, location, and equipment used.

c. If impacts cannot be avoided, projects within the applicable disruption distance of occupied or suitable but unsurveyed habitat will be LAA, until it can be determined that young are not present.
d. Projects within occupied or suitable but unsurveyed murrelet habitat will only occur 2 hours after official sunrise, and will cease 2 hours prior to official sunset during the murrelet nesting season, which in Oregon is April 1 to September 15, and in Washington from April 1 to September 23.
e. No suitable, potential, or critical marbled murrelet habitat is to be removed as part of this action.
f. Within suitable, potential, or critical habitat, garbage containing food and food trash generated by workers in project areas will be secured or removed to minimize attraction of corvids, which have been identified as predators of murrelet eggs and young.
g. Table 18 shows marbled murrelets disruption distances that are applicable to the proposed actions under this Opinion. Distances and times can be locally revised based on current information available from the appropriate Service field office.
h. For large wood (LW) projects, follow conservation measures as outlined in PDC 34. When the proposed action agency is involved in the selection of trees for removal, a wildlife biologist will determine if individual trees are suitable for nesting or have other important listed bird habitat value. No trees determined as suitable for nesting or having other critical habitat value for listed birds will be removed under this Opinion.

3.6.10 Environmental Baseline for Marbled Murrelet

The action area includes Oregon and Washington, which represents the majority of the range of the Marbled Murrelet. Thus, the environmental baseline for this species is adequately described in the preceding sections.

3.6.11 Effects to Marbled Murrelet

Marbled murrelets may be affected by the proposed restoration actions that occur in or adjacent to forested habitats. The Service analyzed whether effects related to habitat changes (i.e., habitat effects) and effects related to increased noise (i.e., harassment effects via disturbance/disruption) are likely to cause murrelet injury or mortality. The primary focus is disturbance effects, since this Opinion does not cover restoration projects that may adversely affect murrelets via habitat changes, or that adversely affect their critical habitat. Disruption from disturbance is limited in the proposed action to three marbled murrelet nests per year, as calculated by a three-year rolling average during the term of this Opinion.

3.6.11.1 Habitat Effects

We describe below how habitat modifications may negatively impact murrelets and why actions covered under this consultation are not likely to adversely affect murrelets through habitat changes. Considerable evidence links the declining numbers of murrelets to the removal and degradation of available suitable nesting habitat (Ralph *et al.* 1995). The removal of habitat can potentially adversely affect the murrelet population in several ways including the following: 1) immediate displacement of birds from traditional nesting areas; 2) concentration of displaced birds into smaller, fragmented areas of suitable nesting habitat that may already be occupied; 3) increased competition for suitable nest sites; 4) decreased potential for survival of remaining murrelets and offspring due to increased predation; 5) diminished reproductive success for nesting pairs; 6) diminished population due to declines in productivity and recruitment; and 7) reduction of future nesting opportunities.

For the purposes of this Opinion, we assume suitable habitat is likely to be occupied by murrelets. As part of the proposed action, activities that remove or reduce the capability of suitable, potential, or critical murrelet habitat will not be covered under this Opinion. This includes suitable habitat and potential nest structures, which are defined below. Also, for actions to avoid adverse effects to murrelet critical habitat, the Action Agencies must ensure that site-specific actions would not remove or eliminate the availability of PCEs in designated critical habitats. In other words, adverse effects to PCEs [i.e., "individual trees with potential nesting platforms and forested areas within 0.8 km (0.5 miles) of individual trees with nesting platforms, and with a canopy height of at least one-half the site-potential tree height (USFWS 1996)."] are not covered by this Opinion. Any proposed restoration action that includes silviculture treatments will be designed to increase habitat diversity within forested areas and benefit the overall ecosystem. Other restoration actions in forested systems are likely to target aquatic or wetland restoration, and must still protect PCEs for murrelets. Thus, restoration activities will not significantly change habitat such that it results in death or injury to murrelets by habitat loss.

Definitions.

Suitable habitat: Conifer-dominated stands that generally are 80 years old or older and/or have trees greater than or equal to 46 cm (18 inches) mean diameter at breast height (dbh). Murrelet suitable habitat must include potential nesting structure.

Potential Nesting Structure: Consists of individual tree(s) with the following characteristics:

- It occurs within 81 km (50 miles) of the coast (USFWS 1997);
- It is a conifer tree (USFWS 1997)
- It is ≥ 49 cm (19.1 inches) (dbh) in diameter, > 33 m (107 feet) in height, has at least one platform ≥ 10 cm (4 inches) in diameter, nesting substrate (e.g., moss, epiphytes, duff) on that platform, and an access route through the canopy that a murrelet could use to approach and land on the platform (Burger 2002, Nelson & Wilson 2002);
- It has a platform ≥ 9.9 m (32.5 feet) above the ground (Nelson & Wilson 2002);
- And it has a tree branch or foliage, either on the tree with nesting structure or on an adjacent tree, that provides protective cover over the platform (Nelson & Wilson 2002)

Unsurveyed Habitat: Consists of suitable habitat or potential structure within younger stands that has not been surveyed by the established survey protocol (Evans *et al.* 2003). In cases of uncertainty such as stand occupancy, it is Service policy to give the benefit of the doubt to the listed species. On that basis, the Service considers unsurveyed habitat as occupied when analyzing effects to murrelets.

3.6.11.2 Harassment Effects

The proposed restorations actions have the potential to negatively affect murrelets primarily through increased noise associated with human activities and operation of tools and heavy equipment. These negative effects are referred to as disturbance and disruption. Briefly, *disturbance* occurs when an action causes a murrelet to be distracted from its normal activity. *Disruption* occurs when an action is likely to cause a murrelet to be distracted to such an extent as to significantly disrupt normal behavior and create the likelihood of harm or loss of reproduction. Both disturbance and disruption have temporal and spatial components (Table 18).

There is an increased likelihood of injury to murrelets from harassment effects related to the proposed action, because some projects will need to occur within disruption distances of occupied or suitable-unsurveyed murrelet areas during the murrelet breeding season (Table 18). While most projects will avoid disturbing murrelets, we assume for the purposes of this effects analysis that some projects will occur near nesting murrelets that can only be implemented during the murrelet breeding period. The greatest risk of injury from disturbance/disruption is to murrelet young (eggs and chicks) during the breeding season.

The likelihood of injury to murrelet young is greatly reduced because few restoration actions will occur during the breeding season. Restoration projects may disturb or disrupt murrelets only after the following steps have been taken to attempt to fully avoid or minimize adverse effects to murrelets: 1) a wildlife biologist has determined murrelets may occur in the project area; 2) a site survey by wildlife biologist indicates an active nest is within the species-specific disturbance distance of the project (or if protocol survey (Evans *et al.* 2003) is not completed then the Action Agencies will assume suitable habitat is occupied); and 3) the action cannot be scheduled outside of the murrelet nesting period, or moved to a location outside of the murrelet disturbance/disruption distance.

Table 18. Disturbance and disruption distance thresholds for Marbled Murrelet during the nesting season (April 1 to September 15 for Oregon; April 1 to September 23 for Washington). Distances are to a known occupied marbled murrelet nest tree or suitable nest trees in unsurveyed nesting habitat.

Action	Action Not Likely Detected Above Ambient Levels	Disturbance Distances	Disruption Distances	Increased Risk of Physical Injury and/or Mortality
Light maintenance (e.g., road brushing and grading), at campgrounds, administrative facilities, and heavily-used roads	> 0.25 mile	≤ 0.25 mile	NA[1]	NA
Log hauling on heavily-used roads (USFS maintenance levels 3, 4, 5)	>0.25 mile	≤ 0.25 mile	NA[1]	NA
Chainsaws (includes felling hazard/danger trees)	>0.25 mile	111 yards to 0.25 mile	≤ 110 yards[2]	Potential for mortality if trees felled contain platforms

Heavy equipment for road construction, road repairs, bridge construction, culvert replacements, piling removal, road decommissioning, beach nourishment, infrastructure removal, etc.	>0.25 mile	111 yards to 0.25 mile	≤ 110 yards[2]	NA
Pile-driving (steel H piles, pipe piles)	>0.25 mile	121 yards to 0.25 mile	≤ 120 yards[3]	≤ 5 yards(injury)[3]
Helicopter: Chinook 47d	>0.5 mile	266 yards to 0.5 mile	≤ 265 yards[4]	100 yards[5] (injury/mortality)
Helicopter: Boeing Vertol 107, Sikorsky S-64 (SkyCrane)	>0.25 mile	151 yards to 0.25 mile	≤ 150 yards[6]	50 yards[5] (injury/mortality)
Helicopters: K-MAX, Bell 206 L4, Hughes 500	>0.25 mile	111 yards to 0.25 mile	≤ 110 yards[7]	50 yards[5] (injury/mortality)
Tree Climbing	>0.25 mile	111 yards to 0.25 mile	≤ 110 yards[8]	NA

1. NA = not applicable. We anticipate that marbled murrelets that select nest sites in close proximity to heavily used roads are either undisturbed by or habituate to the 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 m (328 feet) to reduce potential noise and visual disturbance to murrelets (Hamer and Nelson 1998, p. 13, USFWS 2012, pp. 6-9).
3. Impulsive sound associated with pile-driving is highly variable and potentially injurious at close distances. A review compiled by Dooling and Popper (2007, p. 25) indicates that birds exposed to multiple impulses (e.g., pile driving) of sound at 125 dBA or greater are likely to suffer hearing damage. We have conservatively chosen a distance threshold of 120 yards for impact pile-driving to avoid potential effects to hearing and to account for significant behavioral responses (e.g. flushing) from exposure to loud, impulsive sounds. Based on an average maximum sound level of 110 dBA at 15.2 m (50 feet) for pile-driving, exposure to injurious sound levels would only occur at extremely close distances (e.g., ≤ 5 yards).
4. Based on an estimated 92 dBA sound-contour (approximately 265 yards) for the Chinook 47d (Newman *et al.* 1984, Table D.1).
5. 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. Hovering 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.
6. 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).
7. 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).

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

3.6.11.3 Description of Anticipated Effects

Noise and human intrusion are one of many threats to this species (McShane *et al.* 2004). Effects to murrelets from noise and human intrusion are not well known, but effects (e.g., energetic expenditure, stress levels, and susceptibility to predation) have been documented in other species (Knight and Gutzwiller 1995). While studies have not directly linked murrelet nest failure, abandonment, or chick mortality to disturbance, they have documented flushes from the nest, and missed or delayed feedings at the nest (Singer *et al.* 1995, Hamer and Nelson 1998, Golightly *et al.* 2002). Murrelet breeding biology may preclude easy detection of sub-lethal disturbance effects (i.e., flushes from the nest and missed feedings) at the population level. Therefore, potential effects of disturbance on murrelet fitness and reproductive success should not be completely discounted (McShane *et al.* 2004).

Based on available information for the murrelets (Nelson and Hamer 1995, Long and Ralph 1998, Hamer and Nelson 1998, Nelson and Wilson 2002) and other bird species (Kitaysky *et al.* 2001, Delaney *et al.* 1999), the Service has concluded that significant noise, helicopter rotor wash and human presence in the canopy may significantly disrupt murrelet breeding, feeding, or sheltering behavior such that it creates the potential of injury to the species (i.e., adverse effects in the form of harassment; USFWS 2003). Additionally, groups of people are known to attract corvids, which temporarily increase the likelihood of predation on young or eggs by corvids.

An effect to murrelet behavior may occur when restoration activities covered under this Opinion occur within the disturbance/disruption distance of active murrelet nests. The disturbance and disruption distances were developed utilizing the best available scientific information (Table 18). Loud noises at distances greater than those identified in Table 18 are expected to either have no or negligible effects on murrelet behavior. In Washington the Service considers the murrelet nesting season to span from April 1 to September 23, while in Oregon the Service considers the murrelet nesting season to span from April 1 to September 15. The differences in applied nesting seasons are due to internal evaluations of murrelet biology and nesting season data, which are on-going. Within the murrelet nesting period, the Service considers two distinct periods: the critical and late nesting periods, which also vary by state:

State	Murrelet Nesting Season	Critical Nesting Period	Late Nesting Period..
Oregon	April 1 – Sept 15	April 1 – August 5	August 6 – Sept 15
Washington	April 1 – Sept 23	April 1 – September 4	Sept 5 – Sept 23

During the late nesting season, restoration activities other than helicopters are not likely to adversely affect murrelets provided that they don't begin until two hours after sunrise and cease prior to two hours before sunset.

The likelihood of injury or mortality from helicopter hovering and lifting actions covered by this Opinion is low. While the PROJECTS BA does not specifically limit the number of actions using helicopters, the number of actions that may adversely affect murrelets is limited in this Opinion to three nests per year in Washington and Oregon combined, as calculated on a three-year rolling average. It is unlikely that all murrelet injury will be caused by helicopters for several reasons. First, we assume relatively low levels of future helicopter use based on relatively low levels of past helicopter use. Also, actions will be implemented based on resources and priorities, meaning that future helicopter use will be rare, because helicopters are often expensive and/or unavailable, and restoration funding is limited.

We anticipate marbled murrelet nesting habitat in the action area (recovery zones 1, 2, 3 and 4) will be subjected to the mechanical disruption from rotor wash (excessive wind) during implementation of the very few restoration actions, and that all murrelets associated with occupied or unsurveyed nesting habitat subjected to rotor wash would have a significant behavioral response to these disturbances that results in an increased likelihood of injury. Potential murrelet responses to this disturbance includes being blown or shaken from the nest, which would result in death, or being injured from debris (i.e., a branch) being blown onto the chick at nest sites with implications for reduced individual fitness and reduced nesting success. Rotor wash has a small footprint and tree canopy cover may reduce actual impacts at a nest site. These behavioral disruptions create a likelihood of injury by increasing the risk of reduced fitness of nestlings as a result of physical injury from flying debris or being blown from the nest. We do expect that rotor wash disturbance will result in a likelihood of injury that can result in a reduced fitness of individuals.

Although the Service has assumed disruption distances based on interpretation of the best available information, distances are likely conservative because they consider the reasonable worst-case scenario for murrelets. While the most severe impacts of noise likely occur within a narrower zone, the exact distance where activities disrupt murrelets is 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 influence effects. Activities that are short duration (i.e., 1-3 days) that do not cause physical injury to murrelets, and include both daily timing restrictions and garbage pick-up may have limited exposure to nesting murrelets to an extent that renders the effects insignificant or discountable. The potential for noise or human intrusion-producing activities to create the likelihood of injury to murrelets also depends on background (baseline) environmental levels. In areas that are continually exposed to higher ambient noise or human presence levels (e.g., areas near well- traveled roads, camp grounds), murrelets are probably less susceptible to small increases in disturbances because they are accustomed to such activities. Murrelets do occur in areas near human activities and may habituate to certain levels of noise.

Human presence (including an associated increase in corvids) or excessive noise levels (e.g. machinery used for restoration work) within close proximity to individual murrelets may cause nesting adults to flush and leave their eggs exposed to predation or increase the risk of predation to a chick. These disruptions may also cause delayed feeding attempts by adults, which may reduce the fitness of the young. Such disruptions may also cause premature juvenile fledging, potentially reducing their fitness due to sub-optimal energy reserves before leaving the nest. Disruptions caused by restoration actions could cause a chick to fall off a nest branch, prematurely fledge, or have an injury due to excessive noise. These activities may potentially cause the likelihood of injury to fledglings throughout the entire breeding period. In contrast, a murrelet flying into the forested stand for other reasons than nest exchange or feeding young is presumably capable of moving away from disturbance without a significant disruption of its own behavior, because murrelets feed at sea and only rely on forest habitat for nesting.

In the late breeding period, the likelihood that disturbance will cause disruption or injury declines because most murrelets have finished incubating. About half of the murrelets have completed nesting and the chicks have fledged (Hamer *et al.* 2003), or adult murrelets are still tending the nest. Adults still tending their young in the late breeding period are heavily invested in chick-rearing, making it unlikely adults will abandon their young due to noise from the proposed activities. In addition, one of the proposed conservation measure limits restoration activities during the entire breeding period for the two hours after sunrise and two hours before sunset when most food deliveries to young are made. This conservation measure reduces the likelihood of nest abandonment or significant alteration of breeding success (injury), because it minimizes the likelihood of annoyance to a murrelet to such an extent as to significantly disrupt normal behavior patterns (i.e. breeding feeding or sheltering). However, some data indicate that murrelets make more food deliveries during the day than previously assumed and that predation pressures on eggs and chicks occur throughout the entire breeding period.

As the breeding season progresses there are fewer nesting murrelets as nests either fledge or fail. Therefore, projects that start during the late nesting season reach a point where the likelihood of a nearby nest site is low and negative effects are discountable. For example, in Washington after September 4th, 97.72% of all nests are estimated to have fledged (Tuerler, 2015). Therefore, projects conducted during the late nesting season are not likely to adversely affect murrelets, as the likelihood that a nest site is still active is very low and thus, any negative effects are considered discountable.

The potential for large-scale disturbance and disruption are greatly reduced by the proposed PDC and species specific conservation measures associated with the proposed action. The Action Agencies will use disturbance and disruption guidelines listed in (Tables 19 and 20) to determine whether projects are likely to adversely affect murrelets. Many restoration projects will result in “no effect” determinations for disturbance since most actions will be completed outside of nesting period windows and/or outside of disturbance distances from murrelet nests and unsurveyed suitable habitat. Additional activities will result in “not likely to adversely affect” determinations for disturbance since the Action Agencies will implement some actions in the late nesting period with daily timing restrictions and outside of the disruption distance from murrelet nests and unsurveyed suitable habitat. The conservation measures for marbled murrelets proposed by the Action Agencies will ensure that most projects will not rise to the level of an “likely to adversely affect” determination.

Table 19. Summary of disturbance effects from the proposed action when active marbled murrelet nests are within the disruption distances of actions within Washington State.

Disturbance Type	Time Period[1]	Effects	Rationale for Effect Determination
Noise other than helicopters (i.e., all actions except surveys)	Apr 1 to Sept 4	LAA[1]	Effects vary and may cause from little to significant disruption depending on site- and activity-specific factors and the individual murrelet's noise tolerance. Worst-case scenario, adults move from noise, causing increased predation to young, missed feedings, or premature fledging. Based on anecdotal observations and limited studies, murrelets appear generally undisturbed by sharp or prolonged loud noise, and nesting attempts are not easily disrupted by human disturbance except when confronted very near the nest itself (Long and Ralph 1998, USFWS 2003). Most actions will not occur within 100 yards of active nests or likely occupied, unsurveyed habitat from Apr 1-Aug 5. For those that do, likelihood of injury to young will mostly occur through the potential increase of predation of abandoned young. However, predation likelihood is reduced by PDC that are part of the proposed action (e.g., removal of project generated garbage to prevent attraction of corvids). Since this likelihood cannot be eliminated this type of disturbance is considered likely to adversely affect murrelets. Actions will seldom occur during crepuscular time periods, thereby significantly reducing the probability of missed feeding attempts.
	Sept 5 to Sept 23	NLAA[1]	This is the tail end of the nesting season when approximately 98% of all nests are estimated to have fledged. Therefore in WA, projects conducted September 5 – September 23 are not likely to adversely affect murrelets as the likelihood of exposure to a nest site that is still active is considered discountable.
	Sept 24 to March 31	NE	This time period is outside of the murrelet breeding season.

Disturbance Type	Time Period[1]	Effects	Rationale for Effect Determination
Noise and rotor wash associated with helicopters (i.e., some culvert/bridge, nutrient enhancement, LW placement actions).	Apr 1 to Sept 4	LAA[1]	Noise effects vary and may cause little to significant disruption depending on site- and activity-specific factors and an individual's noise tolerance. Worst-case scenario, adults move from noise, causing increased predation to young, missed feedings, or premature fledging. Young, which are not capable of moving away from noise, may have injury form excessive noise levels. Most activities do not use helicopters, and most helicopter use will not occur within 0.25 miles of active nests or likely occupied, unsurveyed habitat from Apr 1-Sept 15. Helicopters will generally hover no closer than 91 m (300 feet) from the ground and ferry logs at 152 m (500 feet) altitude for safety purposes. Activities will seldom occur during crepuscular time periods, thereby significantly reducing the probability of delayed feeding attempts. Helicopter passes over nests are less likely to cause injury than hovering in close proximity to nests. There is some indication that murrelets do not respond to airplanes and helicopters flying overhead unless they pass over at low altitude (Long and Ralph 1998). Prior murrelet studies involved circling/hovering over 125 nests for 3-min intervals within 100-300 m (328 to 984 feet), which did not flush any of the incubating adults (USFWS 2003).
	Sept 5 to Sept 23	NLAA[1]	This is the tail end of the nesting season when approximately 98% of all nests are estimated to have fledged. Therefore in WA, projects conducted September 5 to September 23 are not likely to adversely affect murrelets as the likelihood of exposure to a nest site that is still active is considered discountable.
	Sept 24 to March 31	NE	This time period is outside of the murrelets breeding season.
On-the-ground human presence (i.e., all	Apr 1 to Sept 4	LAA[1]	Murrelets are susceptible to an increase in predation levels within an action area when groups of humans attract corvids.

Disturbance Type	Time Period[1]	Effects	Rationale for Effect Determination
actions)	Sept 5 to Sept 23	NLAA[1]	This is the tail end of the nesting season when approximately 98% of all nests are estimated to have fledged. Therefore in WA, projects conducted September 5 – September 23 are not likely to adversely affect murrelets as the likelihood of exposure to a nest site that is still active is considered discountable.
	Sept 24 to March 31	NLAA	This time period is outside of the murrelet breeding season.
In canopy human presence (i.e., if needed to monitor adverse effects surveys)	Apr 1 to Sept 4	LAA[1]	Murrelets have been known to flush from a nest due to human presence in the tree canopy.
	Sept 5 to Sept 23	NLAA[1]	This is the tail end of the nesting season when approximately 98% of all nests are estimated to have fledged. Therefore in WA, projects conducted September 5 – September 23 are not likely to adversely affect murrelets as the likelihood of exposure to a nest site that is still active is considered discountable.
	Sept 24 to March 31	NE	This time period is outside of the murrelet breeding season.
At sea human presence	April 1 to Sept 23	NLAA	Murrelets may be disturbed by boats when humans are retrieving derelict fishing gear. Disturbance is considered minor and temporary and not expected to impact prey resources.

[1] - All activities in the breeding season affecting murrelet habitat will have 2-hour timing restrictions applied.

Table 20. Summary of disturbance effects from the proposed action when active marbled murrelet nests are within the disruption distances of actions with the state of Oregon.

Disturbance Type	Time Period	Effects	Rationale for Effect Determination
Noise other than helicopters (i.e., all actions except surveys)	Apr 1 to Aug 5	LAA[1]	Effects vary and may cause little to significant disruption depending on site- and activity-specific factors and the individual's noise tolerance. Worst-case scenario, adults move from noise, causing increased predation to young, missed feedings, or premature fledging. Most actions will not occur within 100 yards of active nests or likely occupied, unsurveyed habitat from Apr 1-Aug 5. For those that do, likelihood of injury to young will mostly occur through the potential increase of predation of abandoned young. However, predation likelihood is reduced by PDC that are part of the proposed action (e.g., removal of project generated garbage to prevent attraction of corvids). Actions will seldom occur during crepuscular time periods, thereby significantly reducing the probability of missed feeding attempts. Based on anecdotal observations and limited studies, murrelets appear generally undisturbed by sharp or prolonged loud noise, and nesting attempts are not easily disrupted by human disturbance except when confronted very near the nest itself (Long and Ralph 1998, USFWS 2003).
	Aug 6 to Sept 15	NLAA[1]	In this period nests have been established, most of incubation is complete and many young have fledged. PDC in the proposed action require 2-hour timing restrictions, which will allow feedings of murrelet young to occur during crepuscular periods.
	Sept 16 to March 31	NE	Based on nest fledging data this time period is past when most murrelets fledge.

Disturbance Type	Time Period	Effects	Rationale for Effect Determination
Noise and rotor wash associated with helicopters (i.e., some culvert/bridge, nutrient enhancement, LW placement actions).	Apr 1 to Aug 5	LAA[1]	Noise effects vary and may cause little to significant disruption depending on site- and activity-specific factors and an individual's noise tolerance. Worst-case scenario, adults move from noise, causing increased predation to young, missed feedings, or premature fledging. Young, which are not capable of moving away from noise, may have injury form excessive noise levels. Most activities do not use helicopters, and most helicopter use will not occur within 0.25 miles of active nests or likely occupied, unsurveyed habitat from Apr 1 to Sept 15. Helicopters will generally hover no closer than 91 m (300 feet) from the ground and ferries logs at 152 m (500 feet) for safety purposes. Also, helicopters will not hover within 152 m (500 feet) of active nests. Activities will seldom occur during crepuscular time periods, thereby significantly reducing the probability of delayed feeding attempts. Helicopters passes over nests are less likely to cause injury than hovering in close proximity to nests. There is some indication that murrelets do not respond to airplanes and helicopters flying overhead unless they pass over at low altitude (Long and Ralph 1998). Prior murrelet studies involved circling/hovering over 125 nests for 3-min intervals within 100 to 300 m (328 to 984 feet), which did not flush any of the incubating adults (USFWS 2003).
	Aug 6 to Sept 15	LAA[1]	For young that have not fledged, the action could cause a chick to fall off a nest branch, prematurely fledge or may cause the chick injury form excessive noise levels or from being hit by flying debris.
	Sept 16 to March 31	NE	Based on nest fledging data this time period is past when most murrelets fledge.
	Sept 16 to March 31	NE	Based on nest fledging data this time period is past when most murrelets fledge.
On-ground human presence	Apr 1 to Aug5	LAA[1]	Murrelets are susceptible to an increase in predation levels within an action area when groups of humans attract corvids.

Disturbance Type	Time Period	Effects	Rationale for Effect Determination
(i.e., all actions)	Aug 6 to Sept 15	NLAA[1]	In this period nests have been established, most incubation is complete and many young have fledged. PDC in the proposed action require 2-hour timing restrictions, which will allow feedings of murrelet young to occur during crepuscular periods.
	Sept 16 to Sept 30	NLAA[1]	Based on two hour daily timing restrictions, and that more marbled murrelets have finished nesting and have fledged as the season goes on, the risk of corvid predation is decreasing in this time period.
In canopy human presence (i.e., if needed to monitor adverse effects surveys)	Apr 1 to Aug 5	LAA[1]	Murrelets have been known to flush from a nest due to human presence in the tree canopy.
	Aug 6 to Sept 15	NLAA[1]	In this period nests have been established, most of incubation is completed and many young have fledged. PDC in the proposed action require 2-hour timing restrictions, which will allow feedings of murrelet young to occur during crepuscular periods.
	Sept 16 to March 31	NE	Based on nest fledging data this time period is past when most murrelets fledge.
[1] - All activities in the breeding season affecting murrelet habitat will have 2-hour timing restrictions applied.			

3.6.11.4 Summary of Harassment Effects

Summaries of potential disruption effects to murrelets from restoration actions are provided in Tables 19 and 20. There is a potential of injury to murrelets from harassment from the proposed action because some projects will occur within disruption distances of occupied or suitable, unsurveyed murrelet habitat during the breeding season. The likelihood of injury via disturbance and disruption is greatly reduced because few restoration actions (of all actions implemented under this programmatic consultation) will occur 1) during the critical breeding period and, 2) within implementation of timing and distance restrictions (Tables 19 and 20).

Disturbance from proposed actions conducted: 1) outside of the breeding period, and 2) greater than 0.4 km (0.25 miles) from occupied or unsurveyed suitable habitat during the breeding season; or 3) within 0.4 km (0.25 miles) of surveyed, unoccupied habitat during any time of the year, *is not expected to adversely affect* murrelets because these activities are not likely to result in any exposure to nesting murrelets. Murrelets that are not nesting are expected to be able to move away from disturbance with no increased risk of death or injury. Additionally, in these situations corvid attraction will not cause an increased risk of predation because we believe corvid predation is only likely to affect murrelet chicks and eggs, not adults.

Proposed actions generating noise above local ambient levels within activity-specific disturbance (but not within disruption) distances of unsurveyed suitable or occupied habitat, during the critical breeding period, *may affect, but are not likely to adversely affect* murrelets. This is because actions will occur far enough away from nests so that flushing, premature fledging, and missed feeding attempts are unlikely. Proposed actions generating noise above local ambient levels within activity-specific disruption distances of unsurveyed suitable or occupied habitat during the critical nesting period, *may affect, and are likely to adversely affect* murrelets. This is because it is probable that young will be affected by the flushing of an adult from the nest (exposure to predation), premature fledging, or missed feeding attempts due to the close proximity of actions to the nest. These effects may result in injury from predation, reduced feeding/energy levels, and stress. Helicopter activities conducted within 91.4 m (100 yards) of unsurveyed suitable or occupied habitat during the murrelet late nesting season also *may affect, and are likely to adversely affect* murrelets due to rotor-wash producing flying debris and tree shaking that may cause harm or injury to murrelets.

3.6.11.5 Effects at the Conservation Zone and Rangewide

Few restoration projects with negative effects are likely to occur annually, and those effects will be largely limited to the restoration site. Negative effects to murrelets are significantly reduced by the proposed PDC and murrelet conservation measures. Thus, there is low potential for large-scale disturbance from the proposed action. The Action Agencies will use disturbance and disruption guidelines listed in Tables 19 and 20 to determine whether projects are likely to adversely affect murrelets. Most activities will result in "no effect" determinations for disturbance since agencies will implement most actions outside of nesting period windows and/or outside of disturbance distances from murrelet nests and unsurveyed suitable habitat. Additional activities will result in "not likely to adversely affect" determinations for disturbance since the Action Agencies will implement most actions in the late nesting period with daily timing restrictions and outside of the disruption distance from murrelet nests and unsurveyed suitable habitat. The conservation measures for murrelets proposed by the Action Agencies will ensure that most projects will not rise to the level of a "likely to adversely affect" determination for murrelet.

It is likely that some nesting murrelets exposed to these disturbances will still nest successfully. We anticipate murrelet nesting habitat in the action area will be subjected to noise and visual disturbance during implementation of the proposed action, and that all murrelets associated with occupied or unsurveyed nesting habitat would have a significant behavioral response to noise and visual disturbance that results in an increased likelihood of injury. Potential murrelet responses to disturbance include delay in or avoidance of nest establishment, flushing from a nest or branch within nesting habitat, aborted or delayed feeding of juveniles, or increased vigilance/alert behaviors at nest sites with implications for reduced individual fitness and reduced nesting success. These behavioral disruptions create a likelihood of injury by increasing the risk of predation, reduced fitness of nestlings as a result of missed feedings, and/or increased energetic costs to adults that must make additional foraging trips. We do not expect that noise and visual disturbance will result in actual nest failure, but acknowledge that disturbance creates a likelihood of injury that can indirectly result in nest failure due to predation or reduced fitness of some individuals. The proposed action incorporates a daily operating restriction that will avoid project activities during the murrelets' daily peak activity periods during dawn and dusk hours. This daily restriction reduces but does not eliminate the potential for adverse disturbance effects or disrupted feeding attempts during mid-day hours.

The anticipated disruption of normal nesting behaviors will result in an increased likelihood of injury to murrelets nesting within those affected acres but is not reasonably certain to result in direct nest failures. The anticipated increased likelihood of injury is not anticipated to appreciably reduce murrelet numbers or reproduction at the scale of the action area or any larger scale because 1) most nests exposed to disturbance are not expected to fail given the variability of responses to noise, rotor wash and visual disturbance; and 2) no direct mortality of adult murrelets is anticipated, so there would be no reduction in the current population of breeding adults. Therefore, the Service believes the proposed project will not result in jeopardy for the marbled murrelet at the Conservation Zone or Range Wide scales.

Over 4 years (2011 to 2014), the PFW funded 19 projects over 2,556 acres that affected murrelets and the Coastal Program funded 11 projects over 415 acres. The Service's Recovery Programs in Oregon and Washington funded 6 projects over a 3 year period. Most of the recovery projects were survey and data management funds and did not affect murrelet habitat. Based on past consultation history, the majority of the above projects were determined to not likely to adversely affect murrelets because the projects were implemented outside the critical nesting period. Similarly, we would expect a portion of aquatic projects funded by the NOAA RC (which target anadromous salmonids) will also adversely affect murrelets, when an aquatic restoration project site occurs in the vicinity of a murrelet nest and project activities may cause disturbance/disruption to individual murrelets, especially if there is a conflict with an established in-water work period for a listed fish species or if extended time is needed to complete a large or complicated restoration project. We also estimate up to 1 additional restoration project implemented by other parties could be covered under this Opinion per year, as described in the Introduction in the section entitled *Action Area and Requirements for Coverage.*

Given this information and through discussions with NOAA RC, we anticipate up to 10 restoration projects per year will be funded by the Service's restoration programs and estimate half of those projects (5 project per year) for NOAA RC will be implemented in or near occupied or unsurveyed suitable habitat for murrelets. Thus, the total number of projects that may occur in murrelet habitat in Oregon and Washington is estimated to be 15 projects per year. Of these 15 proposed actions in murrelet habitat, we assume a worst case scenario where impacts cannot be avoided for 20% of the projects. Therefore 20% of the 15 projects (including surveys) per year (three projects per year, rounded up) may adversely affect murrelets. Projects by the Action Agencies can vary annually where in one year there may be no projects affecting marbled murrelets, and next year there may be four. Therefore, to allow for the annual variability of projects, take will be calculated on a three-year rolling average. There will be no more than three nests, or three chicks or eggs (one per nest) taken per year, as averaged over a consecutive three year period.

3.6.12 Conclusion for Marbled Murrelet

After reviewing the status of the marbled murrelet, the environmental baseline for the action area, and the effects of the proposed action, including all measures proposed to avoid and minimize adverse effects, and the cumulative effects, it is the Service's Biological Opinion that the activities implemented under the proposed PROJECTS restoration program are not likely to jeopardize the continued existence of the marbled murrelet.

This no jeopardy finding for the marbled murrelet is supported by the following:

1. Most projects within marbled murrelet habitat will occur outside of the critical breeding period and outside of established distance restrictions for noise. Only three projects are anticipated to occur annually within murrelet habitat during the critical breeding period and within established distance restrictions for noise.
2. Effects to the marbled murrelet from the proposed project will be mainly harassment through disturbance associated with restoration activities.
3. No direct mortality of adult murrelets is anticipated, so there is no reduction in the current population of breeding adults.
4. Individual projects will be widely distributed in time and space across the range of marbled murrelets.
5. No proposed activities are anticipated to have adverse effects to marbled murrelets or marbled murrelet critical habitat through habitat loss or modification.

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3.7 Streaked Horned Lark

3.7.1 Legal Status

3.7.1.1 The streaked horned lark was listed as a threatened species on October 3, 2013 (USFWS 2013a). A special rule under section 4(d) of the ESA was promulgated at the time of listing. As a result of the special rule, certain activities that create habitat for the streaked horned lark will not be considered prohibited take under section 9 of the ESA. The activities covered in the 4(d) rule are: 1) routine management activities associated with airport operations to minimize hazardous wildlife at airports on non-federal lands, 2) accepted agricultural and farming practices implemented on farms in the Willamette Valley, consistent with State laws on non-federal lands, and 3) routine removal or other management of noxious weeds on non-federal lands (USFWS 2013a).

3.7.2 Critical Habitat

In October 2013, the Service designated critical habitat for the threatened streaked horned lark (USFWS 2013b). Approximately 4,629 acres in Grays Harbor, Pacific, and Wahkiakum Counties in Washington, and in Clatsop, Columbia, Marion, Polk, and Benton Counties in Oregon, fall within the boundaries of the critical habitat designation for the streaked horned lark.

Critical habitat is defined in section 3 of the ESA as: 1) The specific areas within the geographical area occupied by the species, at the time it is listed in accordance with the ESA, on which are found those physical or biological features: a) essential to the conservation of the species, and b) which may require special management considerations or protection; and 2) Specific areas outside the geographical area occupied by the species at the time it is listed, upon a determination that such areas are essential for the conservation of the species. Conservation, as defined under section 3 of the ESA, means to use and the use of all methods and procedures that are necessary to bring an endangered or threatened species to the point at which the measures provided pursuant to the ESA are no longer necessary.

Primary Constituent Elements (PCEs)
Under the ESA and its implementing regulations, the physical or biological features essential to the conservation of the streaked horned lark must be identified in areas occupied at the time of listing, focusing on the features' PCEs. PCEs are the features that provide for the species' life-history processes and are essential to the conservation of the species. The PCEs specific to the streaked horned lark are areas having a minimum of 16% bare ground that have sparse, low-stature vegetation composed primarily of grasses and forbs less than 33 cm (13 inches) in height found in: 1) Large (300-acre), flat (0 to 5% slope) areas within a landscape context that provides visual access to open areas such as open water or fields, or 2) areas smaller than described in 1), but that provide visual access to open areas such as open water or fields. All of the units designated as critical habitat are currently occupied by the streaked horned lark and contain the PCEs to support the life-history needs of the subspecies.

Critical Habitat Units and Subunits
The Service designated two units of critical habitat for the streaked horned lark based on the presence of sufficient elements of physical or biological features to support life history processes

during the breeding or winter seasons. (The two units are identified as Unit 3 and Unit 4; there are no Units 1 or 2. The reason for this is that critical habitat for the streaked horned lark was designated at the same time as critical habitat for Taylor's checkerspot butterfly [*Euphydryas editha taylori*]; Units 1 and 2 contain critical habitat only for the butterfly). The two units designated for the streaked horned lark are further divided into 16 subunits. The two units designated as critical habitat are: Unit 3 (Washington Coast and Columbia River, with 13 subunits), and Unit 4 (Willamette Valley, with 3 subunits) (Table 21).

Table 21. Critical Habitat Units for the Streaked Horned Lark. All units were occupied by larks at the time of designation.

Unit 3: Washington Coast and Columbia River Islands		Federal	State	Private	Tribal	Other*
	Subunit name	Ac (Ha)	Ac (Ha)	Ac (Ha)	Ac (Ha)	Ac (Ha)
3–A	Damon Point	0	456 (185)	24 (10)	0	0
3–B	Midway Beach	0	611 (247)	0	0	0
3–C	Shoalwater Spit	0	377 (152)	102 (41)	0	0
3–D	Leadbetter Point	564 (228)	101 (41)	0	0	0
3–E	Rice Island	0	224 (91)	0	0	0
3–F	Miller Sands	0	123 (50)	0	0	0
3–G	Pillar Rock/Jim Crow	0	44 (18)	0	0	0
3–H	Welch Island	0	43 (18)	0	0	0
3–I	Tenasillahe Island	0	23 (9)	0	0	0
3–J	Whites/Brown	0	98 (39)	0	0	0
3–K	Wallace Island	0	13 (5)	0	0	0
3–L	Crims Island	0	60 (24)	0	0	0
3–M	Sandy Island	0	37 (15)	0	0	0
	Unit 3 Totals	564 (228)	2,209 (894)	126 (51)	0	0
Unit 4: Willamette Valley:						
4–A	Baskett Slough NWR	1,006 (407)	0	0	0	0
4–B	Ankeny NWR	264 (107)	0	0	0	0
4–C	William L Finley NWR	459 (186)	0	0	0	0
	Unit 4 Totals	1,729 (700)	0	0	0	0
	Grand Total—all Units	2,293 (928)	2,209 (894)	126 (51)	0	0
	GRAND TOTAL OF ALL UNITS, ALL OWNERSHIP.	....	....	4,629 (1,873)	....	....

* Other = Ports, local municipalities, and nonprofit conservation organizations.

<u>Unit 3: Washington Coast and Columbia River</u>

The Washington Coast and Columbia River Unit totals 2,900 acres and includes 564 acres of Federal ownership, 2,209 acres of State-owned lands, and 126 acres of private lands. On the Washington coastal sites, the streaked horned lark occurs on sandy beaches and breeds in the sparsely vegetated, low dune habitats of the upper beach. There are four subunits (Subunits 3–A, 3–B, 3–C and 3–D) and a total of 2,235 acres of critical habitat on the Washington coast. The coastal sites are owned and managed by Federal, State, and private entities. The physical or biological features essential to the conservation of the streaked horned lark may require special management considerations or protection to reduce human disturbance during the nesting season, and the continued encroachment of invasive, nonnative plants requires special management to restore or retain the open habitat preferred by the streaked horned lark. Subunits 3–A, 3–B, 3–C and 3–D overlap areas that are designated as critical habitat for the western snowy plover. The snowy plover nesting areas are posted and monitored during the spring and summer to keep recreational beach users away from the nesting areas (Pearson *et al.* 2009); these management actions also benefit the streaked horned lark. In the lower Columbia River, there are nine island subunits (Subunits 3–E through 3–M) for a total of 665 acres. The island subunits are owned by the States of Oregon and Washington. On the Columbia River island sites, only a small portion of each island is designated as critical habitat for the streaked horned lark; most of the areas mapped are used by the U.S. Army Corps of Engineers for dredge material deposition in its channel maintenance program. Within any deposition site, only a portion is likely to be used by the streaked horned lark in any year, as the area of habitat shifts within the deposition site over time as new materials are deposited and as older deposition sites become too heavily vegetated for use by streaked horned larks. All of the island subunits are small, but are adjacent to open water, which provides the open landscape context needed by streaked horned larks. The main threats to the essential features in the critical habitat subunits designated on the Columbia River islands are invasive vegetation and direct impacts associated with deposition of dredge material onto streaked horned lark nests during the nesting season. In all subunits, the physical or biological features essential to the conservation of the streaked horned lark may require special management considerations or protection to manage, protect, and maintain the PCEs supported by the subunits.

Unit 4: Willamette Valley

The Willamette Valley Unit totals 1,729 acres and is entirely composed of Federal lands. There are three subunits (4–A, 4–B and 4–C) for the streaked horned lark in the Willamette Valley, all on the Willamette Valley National Wildlife Refuge Complex. These subunits at the Basket Slough, Ankeny and William L. Finley refuge units are managed for restored native prairie habitat and as agricultural land to provide forage for wintering dusky Canada geese (*Branta canadensis occidentalis*). This management is compatible with maintaining the essential habitat features for the streaked horned lark. The refuge complex has incorporated management for streaked horned lark into its recently completed comprehensive conservation plan (USFWS 2011), and streaked horned lark habitat conservation is being implemented in the refuge units. In all subunits, the physical or biological features essential to the conservation of the streaked horned lark may require special management considerations or protection to manage, protect, and maintain the PCEs supported by the subunits.

3.7.3 Species Description

The streaked horned lark (*Eremophila alpestris strigata*) is endemic to the Pacific Northwest (British Columbia, Washington, and Oregon) (Altman 2011, p. 196) and is a subspecies of the wide-ranging horned lark (*Eremophila alpestris* sp.). Horned larks are small, ground-dwelling birds, approximately 16 to 20 cm (6 to 8 inches) in length (Beason 1995, p. 2). Adults are pale brown, but shades of brown vary geographically among the subspecies. The male's face has a yellow wash in most subspecies. Adults have a black bib, black whisker marks, black "horns" (feather tufts that can be raised or lowered), and black tail feathers with white margins (Beason 1995, p. 2). Juveniles lack the black face pattern and are varying shades of gray, from almost white to almost black with a silver-speckled back (Beason 1995, p. 2).

The streaked horned lark have unique characteristics that differentiate them from horned larks including a dark brown back, yellowish underparts, a walnut brown nape and yellow eyebrow stripe and throat (Beason 1995, p. 4). The streaked horned lark subspecies is conspicuously more yellow beneath and darker on the back than almost all other subspecies of horned lark. The combination of small size, dark brown back, and yellow underparts distinguishes this subspecies from other horned larks.

3.7.3.1 Taxonomy

The horned lark is found throughout the northern hemisphere (Beason 1995, p. 1); it is the only true lark native to North America (Beason 1995, p. 1). Subspecies of horned larks are based primarily on differences in color, body size, and wing length. Molecular analysis has further borne out these morphological distinctions (Drovetski *et al.* 2005, p. 875). Western populations of horned larks are generally paler and smaller than eastern and northern populations (Beason 1995, p. 3). The streaked horned lark was first described as *Otocorys alpestris strigata* by Henshaw (1884, pp. 261–264, 267–268). There are four other subspecies of horned larks that occur in Washington and Oregon: pallid horned lark (*E. a. alpina*), dusky horned lark (*E. a. merrilli*), Warner horned lark (*E. a. lamprochroma*), and arctic horned lark (*E. a. articola*) (Marshall *et al.* 2003, p. 426; Wahl *et al.* 2005, p. 268). None of these other subspecies breed within the range of the streaked horned lark, but all four subspecies frequently overwinter in mixed species flocks in the Willamette Valley (Marshall *et al.* 2003, pp. 425–427).

Drovetski *et al.* (2005, p. 877) evaluated the genetic distinctiveness, conservation status, and level of genetic diversity of the streaked horned lark using the complete mitochondrial ND2 gene. Samples from 32 streaked horned larks in western Washington and 66 horned larks from Alaska, alpine Washington, eastern Washington, eastern Oregon, and California were analyzed. The 30 haplotypes identified from the 98 horned larks formed three clades (taxonomic group of organisms classed together based on homologous features traced to a common ancestor): Pacific Northwest (alpine and eastern Washington, Alaska), Pacific Coast (Puget Sound and Washington coast) and coastal California, and Great Basin (Oregon) (Drovetski *et al.* 2005, p. 880).

Analyses indicate that the streaked horned lark population is well-differentiated and isolated from all other sampled localities, including coastal California, and has "remarkably low genetic diversity" (Drovetski *et al.* 2005, p. 875). All 32 streaked horned lark individuals shared the same haplotype with no variation between sequences compared. All other localities had multiple haplotypes despite smaller sample sizes (Drovetski *et al.* 2005, pp. 879–880).

The lack of mitochondrial DNA (mtDNA) diversity exhibited by streaked horned larks is consistent with a population bottleneck (Drovetski *et al.* 2005, p. 881). The streaked horned lark is differentiated and isolated from all other sampled localities, and although it was "…historically a part of a larger Pacific Coast lineage of horned larks, it has been evolving independently for some time and can be considered a distinct evolutionary unit" (Drovetski *et al.* 2005, p. 880). The streaked horned lark is recognized as a valid subspecies by the Integrated Taxonomic Information System (2012c).

3.7.3.2 Life History and Habitat

Current and Historical Range

The current range and distribution of the streaked horned lark can be divided into three regions: 1) the south Puget Sound in Washington; 2) the Washington coast and lower Columbia River islands (including dredge spoil deposition and industrial sites near the Columbia River in Portland, Oregon); and 3) the Willamette Valley in Oregon.

The streaked horned lark's breeding range historically extended from southern British Columbia, Canada, south through the Puget lowlands and outer coast of Washington, along the lower Columbia River, through the Willamette Valley, the Oregon coast and into the Umpqua and Rogue River Valleys of southwestern Oregon (Altman 2011). The subspecies has been extirpated as a breeding species throughout much of its range, including all of its former range in British Columbia, the San Juan Islands, the northern Puget Trough, the Washington coast north of Grays Harbor County, the Oregon coast, and the Rogue and Umpqua Valleys in southwestern Oregon (Pearson and Altman 2005).

Breeding Range

Streaked horned larks currently breed on seven sites in the south Puget Sound. Four of these sites are on Joint Base Lewis McChord: 13th Division Prairie, Gray Army Airfield, McChord Field, and 91st Division Prairie. The largest population of streaked horned larks currently breeds at the Olympia Regional Airport and a small population nests at the Port of Shelton's Sanderson Field (airport) (Pearson and Altman 2005; Pearson *et al.* 2008). One additional breeding population has recently been documented at the Tacoma Narrows Airport (Michele Tirhi, WDFW, *pers. comm*., 2014); however, there is very limited population abundance information available.

On the Washington coast, there are four known breeding sites in Grays Harbor and Pacific Counties: Damon Point; Midway Beach; Graveyard Spit; and Leadbetter Point (Pearson and Altman 2005). On the lower Columbia River, streaked horned larks breed on several of the sandy islands downstream of Portland, Oregon. Recent surveys have documented breeding streaked horned larks on Rice, Miller Sands Spit, Pillar Rock, Welch, Tenasillahe, Coffeepot, Whites/Browns, Wallace, Crims, and Sandy Islands in Wahkiakum and Cowlitz Counties in Washington, and Columbia and Clatsop Counties in Oregon (Pearson and Altman 2005; Anderson 2013). Larks also breed at the Rivergate Industrial Complex and the Southwest Quad at Portland International Airport; both sites are owned by the Port of Portland, and are former dredge spoil deposition fields (Moore 2011a).

In the Willamette Valley, streaked horned larks breed in Benton, Clackamas, Lane, Linn, Marion, Polk, Washington, and Yamhill Counties. Larks are most abundant in the southern part of the Willamette Valley. The largest known population of larks is resident at Corvallis Municipal Airport in Benton County (Moore 2008); other resident populations occur at the Baskett Slough, William L. Finley, and Ankeny units of the Service's Willamette Valley National Wildlife Refuge Complex (Moore 2008) and on Oregon Department of Fish and Wildlife's (ODFW's) E.E. Wilson Wildlife Area (ODFW 2008). Breeding populations also occur at municipal airports in the valley (including McMinnville, Salem, and Eugene) (Moore 2008). Much of the Willamette Valley is private agricultural land, and has not been surveyed for streaked horned larks, except along public road margins. There are numerous other locations on private and municipal lands on which streaked horned larks have been observed in the Willamette Valley, particularly in the southern valley (Linn, Polk, and Benton Counties) (eBird 2013, ebird.org). In 2008, a large population of streaked horned larks colonized a wetland and prairie restoration site on M–DAC Farms, a privately owned parcel in Linn County; as the vegetation at the site matured in the following two years, the site became less suitable for larks, and the population declined (Moore and Kotaich 2010). This is likely a common pattern, as breeding streaked horned larks opportunistically shift sites as habitat becomes available among private agricultural lands in the Willamette Valley (Moore 2008).

Winter Range

Pearson *et al.* (2005b) found that most streaked horned larks winter in the Willamette Valley (72%) and on the islands in the lower Columbia River (20%); the rest spend the winter on the Washington coast (8%) or in the south Puget Sound (1%). In the winter, most of the streaked horned larks that breed in the south Puget Sound migrate south to the Willamette Valley or west to the Washington coast; streaked horned larks that breed on the Washington coast either remain on the coast or migrate south to the Willamette Valley; birds that breed on the lower Columbia River islands remain on the islands or migrate to the Washington coast; and birds that breed in the Willamette Valley remain there over the winter (Pearson *et al.* 2005). Streaked horned larks spend the winter in large groups of mixed subspecies of horned larks in the Willamette Valley, and in smaller flocks along the lower Columbia River and Washington Coast (Pearson *et al.* 2005; Pearson and Altman 2005).

Habitat and Biology

<u>Habitat Selection</u>

Habitat used by larks is generally flat with substantial areas of bare ground and sparse low-stature vegetation primarily composed of grasses and forbs (Pearson and Hopey 2005). Suitable habitat is generally 16 to 17% bare ground and may be even more open at sites selected for nesting (Altman 1999; Pearson and Hopey 2005). Vegetation height is generally less than 33cm (13 inches) (Altman 1999; Pearson and Hopey 2005). A key attribute of habitat used by larks is open landscape context. Sites used by larks are generally found in open (*i.e.*, flat, treeless) landscapes of 300 acres or more (Converse *et al.* 2010).

Some patches with the appropriate characteristics (*i.e*., bare ground, low stature vegetation) may be smaller in size if the adjacent areas provide the required open landscape context; this situation is common in agricultural habitats and on sites next to water. For example, many of the sites used by larks on the islands in the Columbia River are small (less than 100 acres), but are adjacent to open water, which provides the open landscape context needed. Streaked horned lark populations are found at many airports within the range of the subspecies, because airport maintenance requirements provide the desired open landscape context and short vegetation structure.

Although streaked horned larks use a wide variety of habitats, populations are vulnerable because the habitats used are often ephemeral or subject to frequent human disturbance. Ephemeral habitats include bare ground in agricultural fields and wetland mudflats; habitats subject to frequent human disturbance include mowed fields at airports, managed road margins, agricultural crop fields, and disposal sites for dredge material (Altman 1999).

<u>Foraging</u>

Horned larks forage on the ground in low vegetation or on bare ground (Beason 1995); adults feed on a wide variety of grass and weed seeds, but feed insects to their young (Beason 1995). Larks eat a wide variety of seeds and insects (Beason 1995) and appear to select habitats based on the structure of the vegetation rather than the presence of any specific food plants (Moore 2008).

Breeding and Nesting

Horned larks form pairs in the spring (Beason 1995) and establish territories approximately 1.9 acres in size (range 1.5 to 2.5 acres) (Altman 1999). Horned larks create nests in shallow depressions in the ground and line them with soft vegetation (Beason 1995). Female horned larks select the nest site and construct the nest without help from the male (Beason 1995). Streaked horned larks establish their nests in areas of extensive bare ground, and nests are placed adjacent to clumps of bunchgrass (Pearson and Hopey 2004). Studies from Washington sites (the open coast, Puget lowlands and the Columbia River islands) have found strong natal fidelity to nesting sites – that is, streaked horned larks return each year to the place they were born (Pearson *et al.* 2008).

Historically, nesting habitat was found on grasslands, estuaries, and sandy beaches in British Columbia, in dune habitats along the coast of Washington, in western Washington and western Oregon prairies, and on the sandy beaches and spits along the Columbia and Willamette Rivers. Today, the streaked horned lark nests in a broad range of habitats, including native prairies, coastal dunes, fallow and active agricultural fields, wetland mudflats, sparsely-vegetated edges of grass fields, recently planted Christmas tree farms with extensive bare ground, moderately- to heavily-grazed pastures, gravel roads or gravel shoulders of lightly-traveled roads, airports, and dredge deposition sites in the lower Columbia River (Altman 1999; Pearson and Altman 2005; Pearson and Hopey 2005; Moore 2008). Wintering streaked horned larks use habitats that are very similar to breeding habitats (Pearson *et al.* 2005).

The nesting season for streaked horned larks begins in early April and ends mid- to late August (Pearson and Hopey 2004; Moore 2011a). Clutches range from 1 to 5 eggs, with a mean of 3 eggs (Pearson and Hopey 2004). After the first nesting attempt in April, streaked horned larks will often re-nest in late June or early July (Pearson and Hopey 2004). Young streaked horned larks leave the nest by the end of the first week after hatching, and are cared for by the parents until they are about four weeks old when they become independent (Beason 1995).

Nest success studies (*i.e.*, the proportion of nests that result in at least one fledged chick) in streaked horned larks report highly variable results. Nest success on the Puget lowlands of Washington is low, with only 28% of nests successfully fledging young (Pearson and Hopey 2004, Pearson and Hopey 2005). According to reports from sites in the Willamette Valley, Oregon, nest success has varied from 23 to 60% depending on the site (Altman 1999; Moore and Kotaich 2010). At one site in Portland, Oregon, Moore (2011) found 100% nest success.

3.7.4 Current Status of the Streaked Horned Lark

Data from the North American Breeding Bird Survey (BBS) indicate that most grassland-associated birds, including the horned lark, have declined across their ranges in the past three decades (Sauer *et al.* 2012). The BBS can provide population trend data only for those species with sufficient sample sizes for analyses. There is insufficient data in the BBS for a rangewide analysis of the streaked horned lark population trend (Altman 2011); however, see below for additional analysis of the BBS data for the Willamette Valley.

An analysis of recent data from a variety of sources concludes that the streaked horned lark has been extirpated from the Georgia Depression (British Columbia, Canada), the Oregon coast, and the Rogue and Umpqua Valleys (Altman 2011); this analysis estimates the current rangewide population of streaked horned larks to be about 1,170 to 1,610 individuals (Altman 2011). In the south Puget Sound, approximately 150 to170 streaked horned larks breed at six sites (Altman 2011). Recent studies have found that larks have very low nest success in Washington (Pearson *et al.* 2008); comparisons with other ground-nesting birds in the same prairie habitats in the south Puget Sound showed that streaked horned larks had significantly lower values in all measures of reproductive success (Anderson 2010). Estimates of population growth rate (λ, lambda) that include vital rates from nesting areas in the south Puget Sound, Washington coast, and Whites Island in the lower Columbia River indicate streaked horned larks have abnormally low vital rates, which are significantly lower than the vital rates of the arctic horned lark (*Eremophila alpestris leucolaema*) (Camfield *et al.* 2010). One study estimated that the population of streaked horned larks in Washington was declining by 40% per year ($\lambda = 0.61 \pm 0.10$ SD), apparently due to a combination of low survival and fecundity rates (Pearson *et al.* 2008). More recent analyses of territory mapping at four sites in the south Puget Sound found that the total number of breeding streaked horned lark territories decreased from 77 territories in 2004, to 42 territories in 2007, a decline of over 45% in three years (Camfield *et al.* 2011). Pearson *et al.* (2008) concluded that there is a high probability that the south Puget Sound population will disappear in the future given the low estimates of fecundity and adult survival along with high emigration out of the Puget Sound.

On the Washington coast and Columbia River islands, there are about 120 to 140 breeding larks (Altman 2011). Data from the Washington coast and Whites Islands were included in the population growth rate study discussed above; populations at these sites appear to be declining by 40% per year (Pearson *et al.* 2008). Conversely, nest success appears to be very high at the Portland industrial sites (Rivergate and the Southwest Quad). In 2010, nearly all nests successfully fledged young (Moore 2011a); only 1 of 10 monitored nests lost young to predation (Moore 2011a).

There are about 900 to 1,300 breeding streaked horned larks in the Willamette Valley (Altman 2011). The largest known population of streaked horned larks breeds at the Corvallis Municipal Airport (CVO); depending on the management conducted at the airport and the surrounding grass fields each year, the population has been as high as 100 breeding pairs (Moore and Kotaich 2010). Heavy snows in the southern Willamette Valley during the winter of 2013-2014 resulted in an apparent reduction of the population at CVO. Surveys during spring and early summer at CVO detected about half the number of streaked horned larks as were found in the previous year (Randy Moore, Oregon State University, Corvallis, Oregon, *pers. comm*., 2014). In 2007, a large (580-acre) wetland and native prairie restoration project was initiated at M–DAC Farms on a former rye grass field in Linn County (Cascade Pacific RC&D 2012). Large, semi-permanent wetlands were created at the site, and the prairie portions were burned and treated with herbicides (Moore and Kotaich 2010). These conditions created excellent quality ephemeral habitat for streaked horned larks, and the site was used by about 75 breeding pairs in 2008 (Moore and Kotaich 2010), making M–DAC the second-largest known breeding population of streaked horned larks that year. M–DAC had high use again in 2009, but as vegetation at the site matured, the number of breeding larks has declined, likely shifting to other agricultural habitats (Moore and Kotaich 2010).

We do not have population trend data in Oregon that is comparable to the study in Washington by Pearson *et al.* (2008). However, research on breeding streaked horned larks indicates that nest success in the southern Willamette Valley is higher than in Washington (Randy Moore, Oregon State University, Corvallis, Oregon, *pers. comm.*, 2011). The best information on trends in the Willamette Valley comes from surveys by the ODFW; the agency conducted surveys for grassland-associated birds, including the streaked horned lark, in 1996 and again in 2008 (Altman 1999; Myers and Kreager 2010). Point count surveys were conducted at 544 stations in the Willamette Valley (Myers and Kreager 2010). Over the 12-year period between the surveys, measures of relative abundance of streaked horned larks increased slightly from 1996 to 2008, according to this report. Detections at both point count stations and within regions showed moderate increases (3% and 6%, respectively) (Myers and Kreager 2010). Population numbers decreased slightly in the northern Willamette Valley and increased slightly in the middle and southern portions of the valley (Myers and Kreager 2010).

Data from the BBS may provide additional insight into the trend of the streaked horned lark population in the Willamette Valley. Although the BBS does not track bird counts by subspecies, the streaked horned lark is the only subspecies of horned lark that breeds in the Oregon portion of the Northern Pacific Rainforest Bird Conservation Region (BCR). Therefore it is reasonable to assume that counts of horned larks from the breeding season in the Willamette Valley are actually counts of the streaked horned lark. The BBS data regularly detect horned larks on several routes in the Willamette Valley, and counts from these routes show that horned larks in this BCR have been declining since 1960s, with an estimated annual trend of – 4.6% (95% confidence intervals –6.9, –2.4) (Sauer *et al.* 2012). The U.S. Geological Survey (USGS), which manages the BBS data, recommends caution when analyzing these data due to the small sample size, high variance, and potential for observer bias in the raw BBS data.

The BBS data from the Willamette Valley indicate that horned larks (as mentioned above, the BBS tracks only the full species) have been declining for decades, which is coincident with the restrictions on grass seed field burning imposed by the Oregon Department of Agriculture (Oregon Department of Environmental Quality and Oregon Department of Agriculture 2011). Prior to 1990, about 250,000 acres of grass seed fields in the Willamette Valley were burned each year. Public health and safety issues led the Oregon legislature to order gradual reductions in field burning beginning in 1991. By 2009, field burning was essentially banned in the Willamette Valley (Oregon Department of Environmental Quality and Oregon Department of Agriculture 2011). We believe that some of the observed declines in lark detections in the BBS data are attributable to the reduction of highly suitable burned habitats due to the field burning ban. Since the ban is now fully in effect, the decline in BBS observations of streaked horned larks is not expected to continue at the previously noted rate. We do not have conclusive data on population trends throughout the streaked horned lark's range, but the rapidly declining population on the south Puget Sound suggests that the range of the streaked horned lark may still be contracting.

3.7.5 Threats/Reasons for Listing

The streaked horned lark was listed as a threatened species because of the following:

- The streaked horned lark has disappeared from all formerly documented locations in the northern portion of its range, the Oregon coast, and the southern edge of its range.
- There are currently estimated to be fewer than 1,600 streaked horned larks rangewide,

and population numbers are declining.

- Their range is small may be continuing to contract;
    - The south Puget Sound breeding population is estimated to be less than 170 individuals.
    - The Washington coast and Columbia River islands breeding population is less than 140 individuals.
    - Recent research estimates the number of streaked horned larks in Washington and on the Columbia River islands is declining.
        - This decline considered with evidence of inbreeding depression on the south Puget Sound indicates that the lark's range may contract further in the future.
- Their habitat is threatened throughout their entire range from loss of natural disturbance regimes, invasion of unsuitable vegetation that alter habitat structure, and incompatible land management practices.
- Large winter congregations are limited to one region, Oregon's Willamette Valley, which may put larks at risk from stochastic weather events.
- Most sites currently used by larks require some level of disturbance or management to maintain the habitat structure they need. The natural processes that previously provided this disturbance no longer operate.

3.7.6 Environmental Baseline for Streaked Horned Lark

The action area for this consultation is the states of Oregon, Washington and Idaho, which encompasses the entire range of the streaked horned lark. Since the action area exceeds the entire range of the species, the Status of the Species and the Status of Critical Habitat discussed in the previous section essentially constitutes the environmental baseline.

3.7.6.1 Factors Affecting the Species' Environment in the Action Area

The baseline for consultation includes state, tribal, local and private actions already affecting the species or that will occur contemporaneously with the consultation in progress. Unrelated Federal actions affecting the species or critical habitat that have completed formal or informal consultation are also part of the environmental baseline, as are Federal and other actions within the action area that may benefit listed species or critical habitat. Other Federal actions affecting the streaked horned lark or its designated critical habitat that required previous formal section 7 consultation include: the USACE's maintenance dredging program in the lower Columbia River, the Endangered Species Management Plan for larks at the Army's Joint Base Lewis-McChord, the Service's PFW program in the Willamette Valley, the Service's issuance of section 10(a)(1)(A) recovery permits for the lark, and various construction and maintenance projects at airports and river port sites in Oregon and Washington. None of the completed section 7 consultations reached a jeopardy finding for the streaked horned lark or a finding of adverse modification of its designated critical habitat.

Climate Change
It is likely that climate change will play an increasingly important role in future years in determining the distribution of species and the conservation value of currently important habitats. Increasing air temperature will affect precipitation, stream flow, habitat quality, the abundance of predators and competitors, and marine productivity (CIG 2004, ISAB 2007). According to the U.S. Global Change Research Program (USGCRP), the average regional air temperatures have increased by an average of 1 °C (1.5°F) over the last century (up to 2.3 °C (4 °F) in some areas), with warming trends expected to continue into the next century (2009).

Precipitation trends during the next century are less certain than those for temperature, but increased precipitation is likely to occur during October through March and less during summer, with more winter precipitation falling as rain rather than snow (ISAB 2007, USGCRP 2009). Where snow occurs, a warmer climate will cause earlier runoff resulting in lower stream flows and warmer water temperatures in late spring, summer, and fall (ISAB 2007, USGCRP 2009). These changes will not be uniform across the Columbia River basin. Areas with elevations high enough to maintain temperatures well below freezing for most of the winter and early spring would be less affected. Low-lying areas that historically have received scant precipitation during the winter and contribute little to total stream flow and are likely to be more affected. The ISAB recommends planning now for future climate conditions by implementing protective tributary, mainstem, and estuarine habitat measures; as well as protective hydropower mitigation measures (2007).

The effects of climate change in the Action Area could lead to a change in the timing of precipitation, the extent of snowpack, and rain-on-snow events. These changes in weather patterns could influence seasonal river flows, subsequently influencing the presence of size of shoaling in the lower Columbia River, thereby influencing the timing of dredging and placement of materials, which could affect the amount and distribution of suitable habitat on the Columbia River islands. The effects of climate change on other habitats for the lark, including managed prairies and agricultural fields, have not been projected, and therefore we have not identified nor are we aware of any data at this scale to make predictions about future trends that may affect the streaked horned lark.

3.7.7 Conservation Measures for Streaked Horn Larks

The proposed action includes several specific conservation measures for projects that may affect streaked horned larks. These measures will be incorporated into the project design as appropriate, prior to review and approval by the appropriate Service Manager, as specified in item 6.c. of the proposed action:

a. For projects that will occur during the nesting season (April 1 to August 31) within the range of the streaked horned lark, pre-project surveys will be conducted using survey methods approved by the Service to determine presence/absence of larks in suitable habitat. Information acquired through these surveys will be used to direct restoration activities away from likely nesting areas and/or stagger treatments to allow for nests to be incubated, hatched, and fledged on known occupied sites.
b. Implement surveys and monitoring activities using the most efficient and least disruptive methods to ensure that streaked horned larks at the restoration sites are identified and appropriately protected during project implementation.

  - Surveys for streaked horned larks must be conducted according to the current survey protocols recommended by the Service.
  - Surveys and monitoring must be conducted by highly qualified staff with a background in avian transect and point count survey techniques. The ability to hear and identify lark songs is necessary.
  - Conduct surveys and monitoring in a way that minimizes disturbance of larks on the site; this is particularly important during the breeding season.

c. Mowing: When possible mowing will be accomplished outside of the April 1- August 31 nesting season. When that is not possible, individual mowing treatments during the nesting season may occur on up to 50% of a project site at any given treatment period. Cumulative mowing during the April 1 to August 31 nesting season may equal 100% of a project site.

d. Mower decks will be raised to highest level possible to achieve the desired biological outcomes and to minimize ground level impacts. Mowing will target tall/dense vegetation to prevent seed set of undesirable species and/or foster native prairie seedlings (i.e. targeted mosaic/patch mowing).

e. Grazing will occur outside of the nesting season April 1 to August 31.

f. Prescribed fire may be used on 100% of an area to reduce thatch and improve the characteristics of the site for nesting.

g. Herbicide application: Limit herbicide use to those listed under PDC 51. Use the largest spray booms practical to minimize wheel track passes in treatment unit. Where possible use narrow tires and/or 4 wheeled machines rather than floatation tires/3 three wheeled machines. Individual herbicide applications may cover up to 100% of suitable lark habitat on a given site.

h. All of the above tools may be used singly or in combination as treatments specifically to enhance breeding conditions for streaked horned larks in the short term at a project site.

3.7.8 Effects of the Action to Streaked Horned Lark

The aspects of the action that may affect streaked horned larks are those that focus on restoration of native vegetation in upland habitats. These activities are described in the following Project Design Criteria (PDC):

- PDC 6.c. Species-specific review for Oregon spotted frog, streaked horned lark, Taylor's checkerspot butterfly and Mazama pocket gopher
- PDC 26. Fisheries, Hydrology, Geomorphology, Wildlife, Botany, and Cultural Surveys in Support of Habitat Restoration
- PDC 29. Invasive species and non-native plant control
- PDC 51. Native Vegetation Restoration and Management

PDC 6.c. specifies that additional review is required for any project that may affect one of four recently listed species, including the streaked horned lark. If a project is proposed that may affect the streaked horned lark or its designated critical habitat, PDC 6.c. requires the project to be reviewed and approved by the Service Manager or designee for the affected state. Project approval may require additional conservation measures beyond those contained in this Opinion to ensure that the effects of the project are consistent with those that were considered in this Opinion. If a project may have effects to a streaked horned lark population that are greater than those anticipated in this Opinion, the Service Manager reviewing the project will inform the project proponent that the project will not be covered by this consultation, and will require an individual consultation.

To estimate the likely number of prairie restoration projects and the number of acres of potential streaked horned lark habitat that may be treated under the PROJECTS program, we reviewed the history of the Service's Recovery, Coastal and PFW programs over the last several years. Over 3 years (2010 to 2012), the Recovery program funded 43 prairie restoration projects in Washington; from 2012 to 2014, the Recovery program funded 33 prairie restoration projects in Oregon. From these totals, we estimate that there will be an average of 26 prairie restoration projects per year within the range of the streaked horned lark in Washington and Oregon.

To estimate acreages, we looked at the PFW and Coastal program accomplishments. From 2011 to 2014, the PFW program reported 16 projects that had the potential to affect streaked horned larks; these projects totaled 2,874 acres. In the same time period, the Coastal program in Washington reported two projects with a total acreage of 18 acres in Washington at sites that had streaked horned larks. From these totals, we calculate an average size of 161 acres per project with and average of 26 projects per year. Restoration work for prairies conducted by the Willamette Valley Refuge Complex could also occur on up to 1,224 prairie acres of occupied or suitable habitat for larks (WVNWR 2011, p. 4-2). Given this information, we foresee an average of 5,410 acres of potential lark habitat treated each year under the PROJECTS habitat restoration programs. Additional restoration projects implemented by other parties could be covered under this Opinion per year, as described in the Introduction in the section entitled *Action Area and Requirements for Coverage.* We anticipate these additional projects would be included in this amount of treated acres that affect larks, as we do not expect all prairie restoration projects within the range of the lark to result in the take of streaked horned larks. The effects of the action are described by activity below; the effects are summarized in Table 22.

3.7.8.1 Mowing

Mowing is one of the most commonly used techniques to restore prairie habitat. The project description in the PROJECTS BA states that sites may be mowed using tractor mowers or hand-held mowers (e.g., rotary line trimmers). Conservation measures specified in this Opinion will minimize the adverse effects of mowing to streaked horned larks. These measures include mowing outside of the April 1- August 31 nesting season, or if mowing must occur during the nesting season, individual mowing treatments during the nesting season will be limited to 50% of a project site in any given treatment period. Cumulative mowing during the nesting season may equal 100% of a project site. Another key conservation measure is setting mower deck height to the highest level possible to achieve the desired biological outcomes.

The beneficial effects of mowing are substantial; without periodic mowing, prairie restoration sites would be invaded by non-native vegetation, likely changing the structure and function of the habitat. Several studies have documented the positive and negative effects of mowing in occupied streaked horned lark habitat (Pearson and Hopey 2004, Moore 2011b). Moore (2011b) notes that mowing during the breeding season is a valuable tool to maintain habitat quality, and the equipment appears to have negative effects only when tires pass directly over the nests.

The negative effects of mowing have been demonstrated to be crushing of eggs, nestlings and fledglings, and disturbance of adults and juveniles. The tires of the mowing vehicles appear to be the largest threat to streaked horned lark nests and fledglings (Moore 2011b). Mowing has resulted in direct mortality of nestlings and eggs and nest failures of streaked horned larks at sites monitored in Washington (Pearson and Hopey 2004, Pearson and Hopey 2005). Recent monitoring at Joint Base Lewis-McChord in Washington found that some streaked horned larks successfully fledged young from nests in mowed fields, although the risk of crushing and the subsequent exposure of nests to predators were documented hazards associated with mowing within the breeding season (Wolf and Anderson 2014).

Under the PROJECTS program, up to 5,410 acres of potential lark habitat could be mowed each year; most of the habitat treated is unlikely to have any larks present due to the degraded condition of the restoration sites. Due to lack of information regarding the actual number of streaked horned larks that may be present on the restoration sites in any year, we use a habitat surrogate (acres) for quantifying the effects of the action to this species. We expect that a small number of nests containing eggs or nestlings could be crushed (less than 20%) and all individuals (adults, juveniles, fledglings, nestlings) will be disturbed by mowing at up to 5,410 acres of restoration sites each year.

3.7.8.2 Manual and Mechanical Removal

Manual and mechanical removal of invasive plants may implemented year-round using hand tools and power tools. These methods are focused on the invasive plants. Targeted removal of invasive plants will have minimal adverse effects to streaked horned larks. The adverse effects will be mainly temporary disturbance of adults and juveniles associated with crews entering the site and noise; there is a negligible chance of death of eggs or nestlings due to inadvertent crushing, and a very small chance of prolonged abandonment of nests by the parent birds. Ultimately, the effects will be beneficial, as it will result in the removal of invasive plants and improved habitat quality at the site.

Under the PROJECTS program, up to 5,410 acres of potential lark habitat could be treated with manual and mechanical removal of invasive plants each year; most of the habitat treated is unlikely to have any larks present due to the degraded condition of the restoration sites. Given the lack of information regarding the actual number of streaked horned larks that may be present on the restoration sites in any year, we use a habitat surrogate (acres) for quantifying the effects of removal of invasive plants to this species. We expect temporary disturbance of all individual streaked horned larks at restoration sites, and a small number (likely fewer than 1% of all nests) abandoned at up to 5,410 acres of restoration sites each year.

3.7.8.3 Cutting/Thinning/Removing Tree Stumps

Handheld power tools may be used to cut down woody vegetation, control and remove invasive woody plants, and reduce tree density. Removal of woody vegetation will have minimal adverse effects to streaked horned larks, primarily through disturbance of juveniles and adults by crews in the site. The long-term effects will be beneficial, as it will result in the removal of encroaching woody plants that displace native prairie plants and improved habitat quality at the site.

Under the PROJECTS program, up to 5,410 acres of potential lark habitat could be treated with cutting, thinning and removal of tree stumps each year; most of the habitat treated is unlikely to have any larks present due to the degraded condition of the restoration sites. Given the lack of information regarding the actual number of streaked horned larks that may be present on the restoration sites in any year, we use a habitat surrogate (acres) for quantifying the effects of cutting, thinning and removal of tree stumps to this species. We expect temporary disturbance of all individual streaked horned larks at restoration sites at up to 5,410 acres of restoration sites each year.

3.7.8.4 Girdling Trees

Girdling trees will have minimal adverse effects to streaked horned larks, primarily through disturbance of juveniles and adults by crews in the site. The long-term effects will be beneficial, as it will result in the removal of encroaching woody plants that displace native prairie plants and improved habitat quality at the site.

Under the PROJECTS program, up to 5,410 acres of potential lark habitat could be treated with tree girdling each year; most of the habitat treated is unlikely to have any larks present due to the degraded condition of the restoration sites. Given the lack of information regarding the actual number of streaked horned larks that may be present on the restoration sites in any year, we use a habitat surrogate (acres) for quantifying the effects of tree girdling. We expect temporary disturbance of all individual streaked horned larks at restoration sites at up to 5,410 acres of restoration sites each year.

3.7.8.5 Raking /Shade Cloth/Sod Rolling/ Solarization

The restoration techniques of raking, application of shade cloth, sod rolling and solarization will have few, if any, adverse effects to streaked horned larks, because at sites where these practices are needed, the habitat would be too dense to be suitable for larks. There is the possibility of disturbance of adults and juvenile larks in adjacent suitable habitats, but the level of effects is likely to be low. In general, these restoration practices will have long-term beneficial effects, as they will result in the removal of thatch and the creation of bare ground and low-stature vegetation, ultimately creating improved habitat quality at the site.

Under the PROJECTS program, up to 5,410 acres of potential lark habitat could be treated with raking, application of shade cloth, sod rolling and solarization each year; most of the habitat treated is unlikely to have any larks present due to the degraded condition of the restoration sites. Given the lack of information regarding the actual number of streaked horned larks that may be present on the restoration sites in any year, we use a habitat surrogate (acres) for quantifying the effects of raking, application of shade cloth, sod rolling and solarization. We expect temporary disturbance of all individual streaked horned larks on habitats adjacent to up to 5,410 acres of restoration sites each year.

3.7.8.6 Tilling/Disking

A tractor with a tiller/disk attachment will be used to turn up the soil to a depth of no more than 30 cm (12 inches). Tilling and disking will not be used within 10 m (30 feet) of known populations of listed plant and animal species, unless species specific measures state otherwise.

Given the restriction on distance from individuals of listed species, tilling and disking are unlikely to have more than negligible adverse effects to streaked horned larks. Tilling and disking will have clear beneficial effects, as these practices will result in the creation of bare ground, which will provide suitable habitat for larks, at least in the short-term.

3.7.8.7 Livestock Grazing

The PROJECTS BA states that livestock grazing will not be used at sites with known populations of listed plant species that do not senesce (such as Nelson's checker-mallow) or listed animal species. Since this practice will not be implemented at sites with streaked horned larks, there will be no effects of grazing to the species.

3.7.8.8 Prescribed Burning

At restoration sites with larks, burning will be restricted to outside of the nesting season on suitable habitat (i.e., burning will be allowed from September 1 to March 31). This conservation measure will ensure that the adverse effects of burning will be limited to disturbance of adults and juveniles, with a negligible likelihood of causing death or injury to individuals. The beneficial effects of burning are well documented. Prescribed burns in grasslands reduce thatch buildup, and expose bare ground. Evidence shows that late summer burning creates habitat conditions selected by post-breeding adult and hatch-year larks (Pearson and Hopey 2005). Burning at Joint Base Lewis-McChord has increased the amount of high quality habitat for larks and the number of lark nests in a treated area (Wolf and Anderson 2014).

Under the PROJECTS program, up to 5,410 acres of potential lark habitat could be burned each year; most of the habitat treated is unlikely to have any larks present due to the degraded condition of the restoration sites. A restriction on burning to the period outside of the lark's breeding season will ensure that the effects of burning are mainly beneficial. Due to lack of information regarding the actual number of streaked horned larks that may be present on the restoration sites in any year, we use a habitat surrogate (acres) for quantifying the effects of the action to this species. We expect that all individuals will be disturbed by burning at up to 5,410 acres of restoration sites each year.

3.7.8.9 Chemical Treatments (see PDC 29 and PDC 51)

Herbicides will be used to control woody plants and invasive vegetation and are an important tool for controlling non-native vegetation; application will be via spot application and spray booms. The lark-specific conservation measures specified in this Opinion include use of the largest spray booms practical to minimize wheel track passes in treatment unit, and the use of narrow tires or four-wheeled machines rather than floatation tires or three-wheeled machines. Individual herbicide applications may cover up to 100% of suitable lark habitat on a given site.

We have limited information on the effects herbicides on streaked horned larks. Available information on herbicide effects to organisms was summarized by the Action Agencies and provided the PROJECT BA's Appendix entitled *Detailed Effects and Rish Assessment for Herbicide Use*. From that information, the proposed herbicides range from "slightly toxic" to "practically non-toxic" to avian species. While this information is not specific to streaked horned larks, this information suggests that herbicides will not have significant effects to larks. Further, anecdotal observations of lark nests sprayed with herbicides have reported no apparent adverse effects from the herbicides (Moore 2011b). The effects of the application methods during the breeding season would be the disturbance of adult or juvenile larks and the destruction of nest, eggs or nestlings. Application of herbicides outside of the breeding season would likely be limited to disturbance of larks due to the application techniques and flushing due to human disturbance. The use of narrow tire equipment and large booms will minimize the number of times a piece of equipment will need to cross a field, thereby reducing the chance that eggs or nestlings could be crushed or die due to abandonment, however, a small number of eggs or nestlings could be killed by herbicide application.

Under the PROJECTS program, up to 5,410 acres of potential lark habitat could be treated with herbicides each year; most of the habitat treated is unlikely to have any larks present due to the degraded condition of the restoration sites. Implementation of conservation measures specified in this Opinion will help ensure that herbicide applications will target the woody and invasive plants, and will have limited effects to non-target wildlife. Due to lack of information regarding the actual number of streaked horned larks that may be present on the restoration sites in any year, we use a habitat surrogate (acres) for quantifying the effects of the action to this species. We expect that all individuals will be disturbed by herbicide application at up to 5,410 acres of restoration sites each year.

3.7.8.10 Plant Population Enhancement

The activities associated with plant population enhancement (propagule collection, propagule transport, propagule storage, propagule cultivation, and seeding outplanting) will generally have no effects to streaked horned larks. If a site has suitable habitat and larks are present, there could be temporary disturbance of adults and juveniles from the crews collecting plant propagules. These effects are likely to be minor and temporary.

3.7.8.11 Surveys and Monitoring

Surveys and monitoring associated with restoration activities will require trained observers stationed in or adjacent to restoration areas. Transect counts may require surveyors to walk through suitable, occupied habitat of the streaked horned lark; observers traversing a site may cause temporary disturbance of individual adult and juvenile streaked horned larks at the site. Point counts generally are less likely to disturb larks due to the stationary nature of the observers, although some disturbance is possible. Despite the low levels of temporary disturbance, surveys and monitoring are essential to implementing restoration activities. Assessing the level of lark use of a site will ensure that site-specific information guides restoration actions and the appropriate implementation of conservation measures to protect streaked horned larks. Due to lack of information regarding the actual number of streaked horned larks that may be present on the restoration sites in any year, we use a habitat surrogate (acres) for quantifying the effects of the action to this species. We expect that all individuals may be subject to minor and temporary disturbance effects from surveys and monitoring at up to 5,410 acres of restoration sites each year.

3.7.8.12 Summary of Effects

Table 22. Summary of effects to streaked horned larks from proposed activities included in the PROJECTS in Idaho, Oregon and Washington.

Activity	Anticipated adverse effects	Anticipated beneficial effects
Prairie Restoration and Management		
Mowing	During the breeding season: death of eggs or juveniles due to crushing (<20% of nests at site), disturbance of all juveniles and adults at site. Outside of the breeding season: disturbance of all individuals at the site.	Creation of suitable habitat structure for nesting and foraging
Manual and mechanical removal	Small likelihood of death to eggs or juveniles by crushing or abandonment (<1%) if conducted before August 31, disturbance of all juveniles and adults	Creation of suitable habitat structure for nesting and foraging
Cutting/thinning/removing tree stumps	Small likelihood of disturbance of juveniles and adults	Control woody vegetation encroachment into areas of suitable habitat
Girdling trees	Small likelihood of harassment of juveniles and adults	Control woody vegetation encroachment into areas of suitable habitat
Raking	Small likelihood of disturbance of juveniles and adults on sites adjacent to treatments	Reduce thatch buildup, create areas of bare ground
Shade cloth	Small likelihood of disturbance of juveniles and adults on sites adjacent to treatments	Creation of suitable habitat structure for nesting and foraging
Sod rolling	Small likelihood of disturbance of juveniles and adults on sites adjacent to treatments	Creation of suitable habitat structure for nesting and foraging
Solarization	Small likelihood of disturbance of juveniles and adults on sites adjacent to treatments	Creation of suitable habitat structure for nesting and foraging
Tilling/Disking	None	Creation of suitable habitat structure for nesting and foraging
Livestock grazing	None	Creation of suitable habitat structure for nesting and foraging
Prescribed burning	During the breeding season: none. Outside of breeding season, disturbance of all individuals (juveniles and adults)	Thatch removal and creation of bare ground, creation of suitable habitat structure for nesting and foraging
Chemical treatments (see also PDC 29)	Small likelihood of death of eggs or juveniles due to crushing by equipment if conducted during the breeding season. After the breeding season, disturbance of all individuals (juveniles and adults)	Creation of suitable habitat structure for nesting and foraging
Plant Population Enhancement		
Propagule collection	Small likelihood of disturbance of juveniles and adults	None
Propagule transport	None	None

Propagule storage	None	None
Propagule cultivation	None	None
Seeding	None	None
Outplanting	None	None
Surveys and Monitoring		
Surveys and monitoring	Small likelihood of disturbance of juveniles and adults	Improved management of the species

In summary, some of the habitat restoration activities that will be implemented under this Biological Opinion have the potential to adversely affect streaked horned larks, but most of the projects will have mainly or entirely beneficial effects to the species. For those projects that have adverse effects to larks on the treatment site, the conservation measures that will be implemented will limit the adverse effects to larks, and will ensure that populations are maintained. Most of the prairie restoration projects will likely be implemented in habitat that is not suitable for streaked horned larks, or is highly degraded (i.e., dense vegetation, deep thatch, etc.). Therefore, most projects that affect larks will be at sites that have few, if any, larks, and the effects will be largely beneficial through creation or restoration of suitable habitat for the species. All projects to be implemented will be reviewed by a local Service office, which ensures that projects with untenable effects to vulnerable streaked horned lark populations will be carefully reviewed, and if necessary, will be reviewed under a separate formal consultation.

3.7.9 Conclusion for Streaked Horned Lark

After reviewing the status of the streaked horned lark, the environmental baseline for the action area, and the effects of the proposed action, including all measures proposed to avoid and minimize adverse effects, and the cumulative effects, it is the Service's Biological Opinion that the activities implemented under the PROJECTS restoration program are not likely to jeopardize the continued existence of the streaked horned lark.

This no jeopardy finding for the streaked horned lark is supported by the following:

1. The proposed action may temporarily disturb an average of 5,410 acres of potentially suitable habitat for the streaked horned lark each year. The restoration activities may have short-term adverse effects, but will provide restored high-quality habitat for the species.
2. Effects to the streaked horned lark from the proposed project will be mainly through disturbance associated with restoration activities.
3. While all streaked horned larks on a project site may be affected due to disturbance, the actual killing of eggs, juveniles or adults is expected to be low due to the conservation measures that will be in place.
4. The requirement for review of each project by local Service office staff will ensure that sites with highly vulnerable populations will not be covered by this Biological Opinion.

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3.8 Fender's Blue Butterfly

3.8.1 Legal Status

Fender's blue butterfly was listed as endangered, without critical habitat, on January 25, 2000 (USFWS 2000). Critical habitat for the butterfly was designated on October 6, 2006 (USFWS 2006). 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 for the butterfly was designated on October 6, 2006 (USFWS 2006). Critical habitat units for the Fender's blue butterfly have been designated in Benton, Lane, Polk and Yamhill Counties, Oregon.

3.8.2 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).

3.8.2.1 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).

3.8.3 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 Table 23 (Fitzpatrick 2014).

Table 23. 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	3391	1713	3843	4490	5996	2017	3525	5355	2309	6064	4531	3761	13011	15029	16644

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.

3.8.4 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.

3.8.4.1 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.

3.8.5 Conservation Measures for Fender's Blue Butterfly

The proposed action included following conservation measures for Fender's blue butterfly:

a. Pre-project surveys will be conducted using direct observation methods by a qualified biologist for adult Fender's blue butterfly during the midApril to June 30 flight period on any project site that supports or may support Kincaid's lupine (*Lupinus sulphureus ssp. kincaidii*), longspur lupine (*L. arbustus*), or sickle-keeled lupine (*L. albicaulis*). Information acquired through population and vegetation surveys will be used to direct restoration/recovery activities away from key breeding areas. Unsurveyed areas within 2 km of a known Fender's blue butterfly population will be assumed occupied if no surveys are conducted.
b. Restoration activities will minimize impacts to Kincaid's lupine, spur lupine (*Lupinus laxiflorus = L. arbustus*) or sickle-keeled lupine (*L. albicaulis*) or remove habitat including the following nectar sources: tapertip onion (*Allium acuminatum*), narrowleaf onion (*Allium amplectens*), Tolmie's mariposa lilly (*Calochortus tolmiei*), small camas (Camassia quamash), clearwater cryptantha (*Cryptantha intermedia*), Oregon sunshine (*Eriophyllum lanatum*), Oregon geranium (*Geranium oreganum*), toughleaf iris (*Iris tenax*), pale flax (*Linum angustifolium*), blue flax (*Linum perenne*), Meadow checkermallow (*Sidalcea campestris*), rose checker-mallow (*Sidalcea virgata*), American

vetch (*Vicia Americana*), bird vetch (*V. cracca*), common vetch (*V. sativa*), and tiny vetch (*V. hirsute*)) within occupied habitats.

c. Care shall be taken to avoid trampling or damaging Fender's blue butterflies (adult, eggs and larvae) and their host and nectar plants during all activities. Foot traffic shall be minimized in occupied habitat. High occupancy areas will be identified and flagged. On-site personnel will meet and discuss a 'walking plan' each day before work begins.
d. All vehicles, equipment, and supplies (e.g., boots, clothing, hand tools, heavy equipment, utility all-terrain vehicles, etc.), before being used in and around Fender's blue butterfly habitat, will be disinfected and/or cleaned of mud, dirt, debris, and vegetative matter, as appropriate, to prevent the potential introduction of nonnative/invasive plant, plant/animal pathogens, and wildlife species into the habitat.

Manual, Mowing and Ground Disturbing Activities

e. Manual and mechanical treatments for invasive and non-native plant control may occur adjacent to occupied habitat or critical habitat for Fender's blue butterfly but will not occur the butterfly flight period from April 15 to June 30 to avoid impacts to adults. Occupied areas include all nectar habitat within 0.5 km (0.3 miles) of occupied lupine habitat.
f. Untreated strips of occupied habitat, approximately 12 m (39.4 feet) wide, will be evenly distributed throughout the mowed portions of a site.
g. The center of a mowed area will be within 100 m (328 feet) of untreated occupied habitat, which can serve as a recolonization source.
h. Tractor mower decks will be a set a minimum of 15 cm (6 inches) above ground to reduce impacts to butterfly larvae.
i. Spring mowing will not be allowed at sites with Fender's blue butterflies.
j. Mowing may be conducted throughout sites with Fender's blue butterflies after lupine senescence and before lupine re-emergence (generally August 15 to March 1).
k. After the butterfly flight season but before Kincaid's lupine senescence (generally June 30 through August 15), tractor mowing may occur no closer than 2 m (6 feet) from the nearest Kincaid's lupine plants.
l. Mowing with hand-held mowers may be implemented during Fender's blue butterfly flight season (generally April 15 to June 30) as long as a buffer of at least 8 m (25 feet) is maintained between the mower and any individual of a Kincaid's lupine plant.
m. Tilling, disking, plowing, excavation, or other extensive ground disturbing activities will not occur within 20 m (65 feet) of critical habitat or known Fender's blue butterfly or Kincaid's, spur, or sickle-keeled lupine occupied habitats.
n. Removed vegetation shall not be piled in areas where Fender's blue butterfly larval food plants and adult nectar plants are present. In cases where work is done during the wet season, cut debris may be temporarily piled on-site, but away from listed plants and butterflies, until the dry season when equipment can access the work area to remove debris.
o. Raking:_At sites supporting Fender's blue butterfly populations of 100 or more adult butterflies, a maximum of one third of the occupied habitat may be raked annually. At sites supporting Fender's blue butterfly populations of fewer than 100 adult butterflies, a maximum of one quarter of the occupied habitat may be raked annually.
p. Tree Removal:_If large vegetation is removed in close proximity to known occupied butterfly habitat, trees shall be felled away from the occupied habitat. Any fallen trees

shall be carefully removed from the habitat to minimize disturbance to vegetation, particularly to the larval food plants. Trees and shrubs near roads or trails that may serve as effective visual and/or access barriers near occupied or suitable butterfly habitat would not be removed.

Livestock Grazing

q. Livestock grazing will not occur in critical habitat or any habitat occupied by the Fender's blue butterfly.

Prescribed fires

r. Prescribed fires will occur after August 15 to allow for the most native plants to have set and released their seeds, and begun to senesce, and, if Fender's blue butterfly is present, to avoid the flight season of adults (April 15- June 30).
s. Fender's blue butterfly refugia within project sites will be protected with a firebreak and/or watered down prior to a burn.
t. The year following a burn, management of project sites will be limited to manual methods and herbicide applications, as appropriate. Additionally, during a burn year, management activities will also be limited for areas adjacent to these project sites.
u. At sites supporting 100 or more adult Fender's blue butterflies, the size of the burn unit will be no more than one third of the occupied habitat actively used by butterflies. At sites supporting fewer than 100 adult Fender's blue butterflies, the size of the burn unit will be no more than one quarter of the occupied habitat.
v. The center of the burn unit must be within 100 m (328 feet) of unburned occupied habitat, which can serve as a recolonization source.
w. In any one year, no more than 1,000 acres of occupied butterfly habitat will be burned; this number represents about one third of designated critical habitat across the range of the species, and imposes a conservative limit on the potential losses to fire.

Herbicides

a. Application of herbicides for control of nonnative grasses, shrubs, and forbs, as well as removal of conifers may include broadcast or spot-spray application. Broadcast application will only occur outside of occupied habitat with a 5 m (16 feet) buffer. Wiping using an ATV mounted boom and spot-spray applications of herbicide may occur in butterfly occupied habitat.
b. At sites supporting 100 or more adult Fender's blue butterflies, the size of the area treated with herbicides will be no more than one half of the occupied habitat actively used by butterflies. At sites supporting fewer than 100 adult Fender's blue butterflies, the size of the area treated with herbicides will be no more than one third of the occupied habitat.
c. In Fender's blue butterfly-occupied habitats, the only herbicide treatment allowed in the spring is: Fluazifop-p-butyl (Fusilade) with Nufilm surfactant.
d. For upland prairie habitats within occupied habitats: application of grass specific herbicides may only occur in the spring (February 15 to April 15) and June 1 to October 31. For wet prairie habitat that is occupied, application of grass specific herbicides may only occur from August 1 to approximately October 31 to allow herbicides to decay prior to the rainy season.

e. If using a weed wiper for grass specific herbicide in listed plants during the growing season, the herbicide will be applied to the upper grass stems of targeted non-native plants, thus avoiding the shorter listed plant species.
f. All other herbicides (not grass-specific) will only be applied from August 15 to October 31 when listed plant species are dormant and Fender's blue butterflies are in diapause.
g. For herbicide applications following fire, but before April 15 (the start of the flight season), burned areas may be treated with no restrictions for butterflies, because fire will have killed any larvae and the area will be unoccupied.

3.8.6 Environmental Baseline for Fender's Blue Butterfly

The action area under this consultation coincides with the entire range of the Fender's blue butterfly. Therefore, the Status of the Species in the previous section for the Fender's blue butterfly constitutes the environmental baseline for the species.

3.8.7 Effects to Fender's Blue Butterflies

The actions will occur within the current and historic range of the Fender's blue butterflies and may affect any of the known Fender's blue butterfly populations. Direct and indirect effects to Fender's blue butterfly may occur when implementing any of the restoration/recovery activities under the various project categories described in the proposed action. However, effects to the butterfly will most likely result from activities under PDC 51 (Native Vegetation Restoration and Management). Activities implemented near or within butterfly occupied habitats will have the greatest impact to the species.

Short term impacts of the action will include the intentional taking of Fender's blue butterflies, with intentional and possible incidental harassment, injury and/or death of a limited number of individuals. Control or removal of invasive and non-native vegetation will have the most potential adverse effects to the Fender's blue butterflies. Adverse effects, especially in butterfly occupied habitats, include, but are not limited to, the following restoration/recovery activities:

- Surveys,
- Manual and mechanical methods,
- Herbicide applications,
- Prescribed burns,
- Planting native vegetation.

For all of the above restoration activities, the presence of vehicles, equipment, and foot traffic to complete these activities all have the potential of causing soil disturbance and compaction that may negatively affect native plant host and nectar species, including the reduction of adult and larvae host plants and nectar plants; and lethal or sub-lethal loss of eggs, larvae, pupae, and/or adults butterflies via trampling or crushing. PDC and conservation measures will minimize these impacts, but cannot completely avoid some mortality.

3.8.7.1 Surveys in Support of Habitat Restoration

Surveys in support of habitat restoration may include surveys for Fender's blue butterflies or for other physical and biological attributes of the area. Where these surveys occur in Fender's blue butterfly occupied habitat, Fender's blue butterflies may be affected by the foot traffic associated with the surveys.

3.8.7.2 Manual and mechanical methods

Early spring mowing will not occur in areas where Fender's blue butterfly is present due to the possibility of reducing host and nectar plants and/or causing injury or death to butterfly life stages that may be present. Fall mowing has been shown to be one of the most effective techniques for increasing native prairie species cover and reducing the dominance of competitive invasive species (Kaye and Benfield 2005, Messinger 2006).

Mowing may result in short-term adverse effects to the Fender's blue butterfly, but long-term benefits are expected due to reduced competition between lupine host plants and invasive or non-native plants. Extensive research has been conducted in the last decade on the effects of various mowing regimes on rare prairie species. Studies have shown that mowing is an important tool for restoring native prairies and increasing populations of sensitive prairie species.

Studies in the Willamette Valley have found that adult and larval Fender's blue butterflies increased in number following mowing when used to reduce the stature of herbaceous non-native vegetation (Fitzpatrick 2005, Kaye and Benfield 2005). A study on the effects of fire and mowing on Fender's blue butterfly and native upland prairie at Baskett Slough National Wildlife Refuge 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 (Wilson and Clark 1997). At the USACE's Fern Ridge Reservoir, the Fender's blue butterfly population has increased dramatically since implementation of fall mowing within lupine patches (Messinger 2006). Larger butterfly population trends appear to have been correlated with high lupine vigor and leaf growth. The abundance of Fender's blue butterfly eggs has been found to be correlated with the abundance of Kincaid's lupine leaves at a number of study sites (Kaye and Cramer 2003). Egg abundance has also been shown to increase substantially at sites which had been treated to control invasive and non-native vegetation (Schultz *et al.* 2003).

Manual activities (use of hand tools such as hoeing, digging, clipping, *etc.*) will potentially have minimal adverse effects to Fender's blue butterfly relative to mechanical mowing activities. Activities will occur outside of the flight season and have no impacts on adults. Potential impacts include mortality to eggs and larvae via foot traffic when implementing various vegetation management activities. However, all of the manual activities are expected to have long-term beneficial effects to host plants and butterfly populations by restoring native prairie habitats.

3.8.7.3 Herbicide applications

Herbicide applications have the potential to negatively affect insects, including butterflies. However, limited information is available on effects of these chemicals to non-target species. Available information on herbicide effects to organisms was summarized by the Action Agencies and provided the PROJECT BA's Appendix entitled *Detailed Effects and Rish Assessment for Herbicide Use*. From that information, the proposed herbicides are "practically non-toxic" to bees. Not much is known about specific adverse effects of herbicides on Fender's blue butterfly, but several adverse effects to the butterfly are possible. All butterfly life stages and its host and nectar plants may be affected due to herbicides reaching these non-target species from herbicide drift, over-spray, run-off, and/or soil transport. However, the potential for herbicides to come into contact with Fender's blue butterflies and their host and nectar plants will be eliminated or minimized based on the following information:

- Habitat application limitations.
- Types of herbicides to be used in butterfly occupied habitats, including limiting the spring herbicide treatments to Fluazifop-p-butyl (Fusilade) with Nufilm surfactant only.
- Implementation of herbicide-related PDC, and conservation measures for both the butterfly and its host plant (Kincaid's lupine).

Herbicides may only be used on sites occupied by the Fender's blue butterfly when they are in diapause, except for the application of Fluazifop-p-butyl (Fusilade) with Nufilm surfactant from February 1 to April 15 to treat non-native grasses. During diapause, larvae are typically located at or near the base of host plants (which have senencsed at this time), minimizing exposure to herbicide contact which is applied higher on the target non-native plants. Fluazifop-p-butyl (Fusilade) with Nufilm surfactant for spring treatments was selected based upon best available scientific information regarding efficacy and EPA abbreviated risk assessments that considered potential effects to federally listed species. In fact, field studies suggest that the herbicide Fusilade used in conjunction with the surfactant NuFilm offers the most efficient control of the primary problem grass, tall oatgrass, in Fender's blue butterfly habitat on and near Baskett Slough NWR (Hicks *et al.* 2011). In addition, results from captive studies suggest that this combination of herbicide and surfactant poses the smallest risk to butterflies of the grass-specific herbicide/surfactant combinations tested to date (Hicks *et al.* 2011). Further, work by the Nature Conservancy found that Fusilade used with the non-ionic surfactant NuFilm was more effective at controlling tall oatgrass than sethoxydim (Dennehy 2010). We cannot determine the number of butterfly larvae that may be killed or injured by incidental exposures to herbicides, but we expect that the actual number should be very low since larvae will be shielded at the time of application.

3.8.7.4 Prescribed burns

Larval Fender's blue butterflies will be dormant at the base of host plants during prescribed burns. In burn plots at project sites, larval mortality is expected to be 100%. Since up to one-third of the occupied habitat might be burned annually at butterfly sites supporting more than 100 individuals, burning could result in the loss of 33% of the butterfly population at these sites in a given year. Similarly, since up to one-quarter of the occupied habitat might be burned annually at sites supporting less than 100 individuals, burning could result in the loss of 25% of the butterfly population at these sites in a given year. As discussed below, post-burn lupine plants are very robust and readily attract female Fender's blue butterflies for egg deposition. Maintaining unburned occupied habitat within 100 m (328 feet) of the burned areas will provide a recolonization source for the site and therefore, offset the associated short-term losses by providing the long-term beneficial effect of maintaining suitable Fender's blue butterfly habitat.

Completed studies on prescribed burns have documented increases in Fender's blue butterfly populations after conducting burns in butterfly occupied habitats. To our knowledge, there has not been a Fender's blue butterfly burn study conducted that resulted in a decrease in the butterfly population the following year. The effects of prescribed burning on Kincaid's lupine, longspur lupine, and Fender's blue butterfly were also studied as part of a larger research project conducted from 1994-1997 at Baskett Slough National Wildlife Refuge (Wilson and Clark 1997). Their findings indicated that Kincaid's lupine plants were more vigorous after prescribed burns than the control group. Fender's blue butterfly egg abundance was also 10 to 14 times higher in burned or mowed plots than the control group. Lupine burn sites resulted in 100%

mortality to larval Fender's blue butterfly, but the adult females from the unburned area were able to colonize all burned areas, including lupine plants in burn patches up to 107 m (351 feet) from the unburned area (Wilson and Clark 2000).

Schultz and Crone (1998) present a modeling approach in order to assess the management tradeoffs associated with burning prairies to restore Fender's blue butterfly habitat. To rank potential burn strategies, an empirically based mathematical model was developed with parameter estimates based on experiments conducted by Wilson and Clark (1997) from 1994-1997. Based on the study results, they recommend burning, on average, one-third of a butterfly site every year (if funds were available) or every two years (if funds were not available). This strategy would yield the highest long-term population growth rate for the Fender's blue butterfly in both the step function and the exponential decay function models (Schultz and Crone 1998).

3.8.7.5 Planting Native Vegetation

Restoration projects include planting native prairie plant species as plugs or seed to improve habitat conditions for Fender's blue butterflies. The conversion of degraded prairie to high-quality habitat for Fender's blue butterflies is a critically important ecological factor for continued Fender's blue butterfly survival. Native species plantings to benefit butterflies are a key final stage in prairie restoration. We anticipate that the increased abundance and diversity of native plants on the landscape would improve the resiliency of Fender's blue butterfly populations. Planting native species would have a significant beneficial effect on Fender's blue butterflies in the action area. When establishing native vegetation, a small number of Fender's blue butterfly eggs and larvae may be accidentally trampled on during planting efforts. This small potential adverse effect is offset by the large beneficial effect inherent in reestablishing native vegetation to prairie sites for Kincaid's lupine and Fender's blue butterfly.

3.8.8 Summary of Effects to Fender's Blue Butterfly

It is expected that the control or removal of invasive and non-native vegetation is likely to result in adverse effects to the Fender's blue butterfly in the short-term. However, these techniques are necessary to keep aggressive invasive and non-native vegetation from out-competing native lupine host plant species that the butterfly depends on. Adverse effects can be minimized or eliminated, to the extent possible, by implementing PDC and butterfly specific conservation measures. The Service anticipates that there will significant long-term beneficial effects to the butterfly by implementing these restoration/recovery activities.

Although most of the restoration/recovery activities will be implemented when the Fender's blue butterfly is in diapause, lethal and sub-lethal losses of butterfly eggs and larvae will still likely occur. Losses will most likely result from mechanical mowing and prescribed burning since these activities can affect large portions of occupied habitat. Herbicide applications and manual control or removal activities should have a lesser likelihood of adverse effects to the butterfly relative to mowing and burning activities.

The Service anticipates Fender's blue butterflies may be incidentally taken during activities associated with the control or remove of invasive and non-native vegetation (i.e., by manual, mechanical, and chemical methods, and prescribed burns) in occupied suitable and designated critical habitats. The amount of take will be dependent the population size of the affected habitat. All life stages (i.e., eggs, larvae, pupae, and adults) may be taken. Take will be in the form of sub-lethal and lethal losses to any or all of the life stages depending on the timing, intensity, and frequency of activities. Determining the number of individuals within the life stages that result in a take would be very difficult under normal habitat conditions. Therefore, incidental take will be defined in the percentage of occupied habitat that is affected by restoration/recovery activities. Timing and habitat limitations, as addressed under the proposed action and butterfly PDC, based on specific activities, will reduce the likelihood of take for the species. These activities will likely result in increasing the Fender's blue butterfly populations and their associated host and nectar plant species in the affected areas.

Over 4 years (2011 to 2014), the PFW funded 24 projects over 1,660 acres that affected Fender's blue butterflies; the Coastal Program did not fund any projects that affected Fender's blue butterflies. The Service Recovery Programs in Oregon funded 23 projects over a three year period (2012 to 2014) that potentially affected Fender's blue butterflies. We anticipate most projects that affect Fender's blue butterflies will be upland prairie projects. Restoration work for prairies conducted by the Willamette Valley Refuge Complex could occur on up to 1,224 acres of occupied or suitable habitat for Fender's blue butterflies (WVNWR 2011, p. 4-2).We would expect few, if any aquatic projects funded by the NOAA RC (which target anadromous salmonids) will adversely affect Fender's blue butterflies. We also estimate up to 5 additional restoration projects implemented by other parties could be covered under this Opinion per year, as described in the Introduction in the section entitled *Action Area and Requirements for Coverage.*

Given this information, we anticipate up to 19 restoration projects per year averaging 70 acres each (or 1,330 acres annually), plus restoration work on up to 1,224 acres annually on refuge lands will have short-term, negative effects to Fender's blue butterflies. Given the importance of restoration activities to maintain prairie habitats, the numerous PDC and proposed conservation measures to minimize the number of individuals adversely affected by the proposed actions, and the anticipated long-term benefits from each project to native habitats and Fender's blue butterflies in the long-term, we conclude the proposed restoration actions will not jeopardize the continued existence of Fender's blue butterflies.

3.8.9 Conclusion for Fender's Blue Butterfly

After reviewing the current status of the Fender's blue butterfly, the environmental baseline for the action area, the effects of the proposed actions, and cumulative effects, it is our biological opinion that the activities implemented under the PROJECTS restoration program are not likely to jeopardize the continued existence of the Fender's blue butterfly.

This no jeopardy finding for the Fender's blue butterfly is supported by the following:

1. The proposed action may temporarily disturb an average of 1,330 acres of occupied or potentially suitable habitat for the Fender's blue butterfly each year. The restoration activities may have short-term adverse effects, but are necessary to restore and maintain high-quality habitat for this species in the absence of natural disturbance regimes. Significant long-term beneficial effects to the butterfly are anticipated from these activities.
2. Most of the restoration activities will be implemented when Fender's blue butterfly is in diapause, thereby minimizing effects to adult butterflies.

3. Proposed PDC and conservation measures will minimize lethal and sublethal effects to butterfly eggs and larvae, including areal limitations for the several activities (prescribed burning, mowing, raking and herbicide use) that cannot avoid adverse effects. These areal limitations allow a proportion of the population in untreated areas at the site to recolonize the restored area the following year.

3.8.10 Literature Cited for Fender's Blue Butterfly

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3.9 Oregon Silverspot Butterfly

3.9.1 Legal Status

The Oregon silverspot butterfly was listed as threatened with critical habitat in 1980 (USFWS 1980). A recovery plan was completed for the butterfly in 1982 and a revised recovery plan was completed in 2001 (USFWS 1982, USFWS 2001). The Oregon silverspot butterfly recovery priority number is three, indicating a high degree of threat and recovery potential for the species (USFWS 2001).

3.9.2 Critical Habitat

The Oregon silverspot butterfly was listed as a threatened species, effective on October, 15, 1980 (USFWS 1980). Critical habitat was designated at the same time. Lands included in the critical habitat are those that were known to be occupied by the butterfly at the time and believed to be the last viable population: portions of Section 15 and the south half of Section 10 that are west of a line parallel to and about 450 m (1,500 feet) west of the eastern section boundaries of Sections 10 and 15, T16S, R12W, Willamette meridian, Lane County, Oregon.

The Primary Constituent Elements (PCEs)

The PCEs mentioned at the time of listing include the caterpillar host plant, *Viola adunca*, the grasses and forbs which provide shelter for the caterpillars, native nectar plants on which the adult butterflies feed and the Sitka spruce forests which provide shelter for the adult butterflies (USFWS 1980).

3.9.3 Species Description

The Oregon silverspot butterfly is an orange and brown butterfly named for the metallic silver spots located on the ventral hindwing. The butterfly formerly occurred along the coasts of Washington, Oregon, and California but most of the colonies have been extirpated due to a lack of suitable habitat (USFWS 2001).

3.9.3.1 Taxonomy

The Oregon silverspot butterfly, a true fritillary of the family Nymphalidae, is one of eight species and 36 subspecies of the genus *Speyeria* found in the Pacific Northwest. The butterfly is one of five subspecies in the *bremnerii* group which differs from other subspecies in its coloration (*i.e.,* dark reddish brown disc color and clear yellow sub-marginal band) and small size, with a mean forewing length of 27 mm (1.1 inches). Caterpillar development rate is very slow in comparison to the other subspecies (USFWS 2001).

3.9.3.2 Life history

The Oregon silverspot butterfly occupies four types of grassland habitats: marine terrace, coastal headland “salt spray” meadows, stabilized dunes, and montane grasslands. To support the butterfly, each habitat area must provide the caterpillar host plant, early blue violets, and adult butterfly nectar sources. Violet density influences the number and location of Oregon silverspot butterfly eggs laid, with areas of higher violet densities used most frequently for ovipositing. Native nectar plants most frequently used by the adult butterflies are *Solidago canadensis* (Canada goldenrod), *Solidago spathulata* (dune goldenrod) *Symphyotrichum chilense* (Pacific aster), *Anaphalis margaritacea* (western pearly everlasting), *Cirsium edule* (edible thistle), and *Achillea millefolium* (common yarrow).

The life cycle of the Oregon silverspot butterfly begins when the adult female deposits eggs during late August-September. Eggs are laid within or adjacent to areas which contain early blue violets. The larvae hatch in approximately sixteen days, and the newly hatched larvae wander a short distance to find a suitable place for diapause (*i.e.,* suspension of growth for overwintering). In late spring and early summer, the larvae emerge to feed on the violet leaves. The larvae feed and grow for two months going through six instars (*i.e.,* developmental stages). Larvae then seek shelter to pupate. At least two weeks later (July-September) the butterfly emerges from its chrysalis as an adult, with males emerging a few weeks prior to females. The adult silverspot butterflies leave the windy meadows for shelter in an adjacent forest. There, the butterflies will feed on nectar-producing flowers (composites) and find a mate. Mating usually takes place in relatively sheltered areas. The gravid (*i.e.,* mated, egg-bearing) female returns to the meadow to lay eggs in August-September. An individual female may lay 200-300 eggs.

Central to the life cycle of the Oregon silverspot butterfly is the abundance of the caterpillar host plant, the early blue violet (*Viola adunca*). Field studies have demonstrated that female butterflies select areas with high violet densities for egg-laying (USFWS 2001, Damiani 2011). Based on laboratory studies 200-300 violets leaves are needed to allow an Oregon silverspot butterfly to develop from caterpillar to pupae. In the wild a caterpillar would require a clump of approximately 16 violet plants for development, assuming each violet could provide about 12 to 20 leaves. Based on studies of other butterflies, nectar abundance and quality are also important to adult survival and particularly fecundity (Schultz and Dlugosch 1999, Boggs and Ross 1993, Mevi-Schutz and Erhard 2005).

Both violet abundance and butterfly native nectar sources have declined at all Oregon silverspot butterfly habitat areas due primarily to competition from non-native vegetation. Habitat disturbance regimes, that maintain an early seral habitat stage, have been altered dramatically over the past 150 years, increasing the rate of grassland succession to shrub or forest. Non-native plants have played a role in stabilizing the previously dynamic coastal ecosystem. Detailed accounts of the taxonomy, ecology, reproductive characteristics, range, distribution, habitat requirements, and habitat management of the Oregon silverspot butterfly are found in the revised recovery plan (USFWS 2001).

3.9.4 Population Status

There are only five remaining populations of Oregon silverspot butterfly in existence - four in Oregon and one in northern California (Table 24). Each small population is at great risk of extirpation. The Oregon silverspot butterfly 5-Year Review (USFWS 2012) concluded that the butterfly "*is in danger of extinction throughout its range*" and recommended an up-listing to endangered status.

Standardized butterfly survey methods using a modified Pollard method (Pollard 1977) have been conducted at four Oregon occupied sites annually, 1990 to 2014 (Pickering 2014, Patterson 2014). The Del Norte County, California, site has been monitored using the same method annually 2005 to 2014 (USFWS 2014). The survey results produce an index of abundance value which provides a relative population measure from year to year. (Table 24). These index counts are not designed to estimate population size in smaller populations, but do provide a measure to compare year to year variation.

Butterfly population size is the most significant factor contributing to population size the following year (USFWS 2012). Small populations are much more likely to become extirpated than larger populations. The combined threats to small isolated populations, habitat degradation, and climate change continue to endanger the species throughout its range. Without augmentations the three coastal Oregon populations would likely be extirpated leaving only the Mt. Hebo and Del Norte populations.

In 2014, the Mt. Hebo population crashed, falling to less than 600 butterflies, the lowest count in 25 years. The 25-year average index count on Mt. Hebo is 1,871 butterflies with a high count of 4,983 in 1999 and a low count of 582 in 2014. In addition, the captive butterflies laid only one-third the expected numbers of eggs in August 2014, resulting in another drastic reduction to the number of butterflies available for site augmentation in 2015. With the only viable population (Mt. Hebo) currently in drastic decline, and the other four tenuous populations located in deteriorating habitat, the risk of extinction is real and immediate.

3.9.4.1 Summary of historical status and current distribution range wide

Historically, the Oregon silverspot butterfly was distributed along the Washington and Oregon coasts from Westport in Grays Harbor County, Washington, south to Heceta Head in Lane County, Oregon, with a disjunct population located north of Crescent City in Del Norte County, California. At least 20 separate locations were known to support Oregon silverspot butterfly in the past, discovered 1895-1975 (McCorkle *et al.* 1980). At the time of listing in 1980, only the Rock Creek-Big Creek population and what was then called the Tenmile Creek population, now called the Bray Pt. population, were considered healthy. One population in Washington and 7 populations in Oregon were mentioned in the 1980 listing document. Currently just 5 populations are known to be extant, located at Rock Creek-Big Creek, Bray Pt, Cascade Head and Mt. Hebo, Oregon and the Del Norte County, California.

The 2001 Revised Recovery Plan for the Oregon Silverspot Butterfly identified 6 Habitat Conservation Areas. Table 25 summaries the habitat and population trends within each area.

3.9.5 Threats, Reasons for Listing

Habitat disturbance regimes, which maintain an early seral habitat stage, have been altered dramatically over the years. Without disturbance meadow habitat is lost to succession. Aerial photo interpretation of the Oregon silverspot butterfly critical habitat area at Rock Creek-Big Creek done by TNC determined there was 100 acres of prairie in 1943, 45 acres in 1975 and just 28 acres in 2005 due to succession (Pickering 2011). Inspection of aerial photos from the Del Norte site also indicates substantial loss of grassland habitats to succession since the early 1970's. In addition to allowing succession, fire suppression activities such as fire-line construction, fire roads and use of fire retardant can destroy habitat. If for example, a high nutrient fire retardant were used within occupied habitat such as the meadows of Mt. Hebo, the extra nutrients would likely increase the ability of non-native plant species to out-complete the native low nutrient adapted plant community. While fire was used historically to maintain prairies, in the presence of non-native invasive plants and a depleted native seed bank, fire can degrade habitat by releasing the faster growing non-native grass species. Prairie restoration methods have been developed for use on northwest prairies in the Puget Trough in Washington. The use of fire has been beneficial when used in conjunction with grass specific herbicide followed by seeding with native species to augment the existing seed bank.

Within remaining early seral habitats, wild violet abundance and native nectar sources have declined at all Oregon silverspot butterfly habitat areas due primarily to competition from non-native vegetation. Non-native plants have also played a role in stabilizing the previously dynamic coastal ecosystem. This stabilization has reduced suitable habitat for Oregon silverspot butterfly by eliminating former grassland and preventing formation of native-dominated early seral habitat.

Table 24. Oregon silverspot butterfly Index of Abundance Counts 2004 to 2014 with captive reared butterfly release numbers in parenthesis. Numbers in parenthesis are the number of captive-reared larvae, pupae, or adults released to augment populations. These butterflies are included in the index counts if observed on transects (Pickering 2014, Patterson 2014, and USFWS 2014).

	Mt. Hebo	Cascade Head	Bray Point	Rock Creek	Del Norte
2004	588	36	2 (5)	131 (47)	--
2005	657	147 (132)	0	55	121
2006	2,624	130 (26)	0	25	198
2007	1,473	686 (560)	21 (123)	202 (153)	477
2008	1,452	521 (537)	82 (300)	219 (199)	883
2009	1,411	1,420 (1,219)	124 (1,220)	437 (834)	729
2010	1,334	610 (1,023)	140 (1,367)	426 (665)	352
2011	1,377	643 (1,089)	204 (560)	352	625
2012	3,091	103	341 (1,110)	251 (993)	491
2013	1,489	88	133 (672)	302 (582)	332
2014	582	87 (89)	105 (724)	199 (723)	440

Table 25. Summary of Oregon silverspot butterfly populations by Habitat Conservation Area. (*) indicates the populations have been augmented with captive-reared individuals that are included in the population index counts if observed (Patterson 2014, Pickering 2014, USFWS 2014).

Conservation Area	Known #pops	Recovery Criteria # pops.	Location	Habitat Acres	Habitat condition	Pop. Index Count (2014)	Primary Ownership	Current 5-year trend
Long Beach Peninsula, Washington	0	1	SW WA	110	Degraded, restoration in progress	Last observed 1990	WDFW, Willapa NWR, NRCS Easement	Likely extirpated
Clatsop Plains, Oregon	0	1	NW OR	130	Degraded, restoration in progress	Last observed 1998	Private property	Likely extirpated
Coastal Mountain, Oregon	1	2	Mt. Hebo	65	Suitable	582	Siuslaw NF	Decreasing
Cascade Head, Oregon	1	2	OR Central Coast	50	Degraded, restoration in progress	*89	TNC, Siuslaw NF	Stable but augmented
Central Coast, Oregon	2	2	Bray Point, OR Central Coast	6	Degraded, 31.1 % suitable,small	*105	Siuslaw NF, Private	Stable but augmented
			Rock Ck-Big Ck., OR Central Coast	30	Degraded, 15% suitable	*199	TNC, Siuslaw NF, Private	Stable but augmented
Del Norte, California	1	2	NW CA	42	Suitable	440	CDFG, CA State Parks	Stable

The most significant threat to the species is a lack of suitable habitat. At all sites, invasive plant species have degraded habitat quality. Habitat maintenance methods are currently inadequate to control non-native plant species within habitat areas. Each habitat site has different invasive species issues depending upon prior land use, soils and ecosystem type. Most experimental research plots within the butterfly habitat areas have been small in scale. While native seed availability has increased dramatically in recent years, with the involvement of the NRCS Plant Material Center, lacking is an effective site preparation method to address invasive species. The use of herbicides is likely needed to successfully restore enough suitable habitat for the butterfly to preserve existing populations and provide habitat for reintroduced populations.

3.9.5.1 Climate Change

The 2014 National Climate Assessment contains the most recent regional overview of Pacific Northwest climate change predictions. Regional changes expected in the Pacific Northwest by the year 2100 include warmer, wetter winters; hotter, drier summers; and an increased frequency of extreme precipitation events (Mote *et al.* 2014). Climate change has the potential to result in phenological shifts that will change the relationship between the timing of Oregon silverspot butterfly flight and the blooming of nectar species, especially in montane ecosystems, such as Mt. Hebo. Climate change has the potential to degrade critical habitat if changes in local weather patterns favor invasive plant species over the native coastal prairie species that support the butterfly (USFWS 2012). Meadows may actually shrink in size under a warmer climate (Stolte 2014).

The onset of increased average temperatures and decreased average precipitation, especially for summer months, will likely begin to result in changes to the habitat on Mt. Hebo, which supports possibly the only viable Oregon silverspot butterfly population and has been the last stronghold of the species. The meadows on Mt. Hebo, which are 6.2 km (10 miles) inland, may dry out earlier in the season, while the meadows on the coast will get moisture from fog and morning dew during the summer months. The predicted decrease in snowpack and more winter precipitation falling as rain vs. snow may result in the invasion of currently suitable butterfly habitat on Mt Hebo by non-native plants similar to the current situation at the coastal sites, which do not have snow to inhibit the winter growth of some invasive, non-native plant species. Expected changes also include range shifts of native and invasive species. For example, the invasive non-native plant, reed canary grass (*Phalaris arundinacea*) has recently been spreading into meadow areas at Mt. Hebo. If habitat at Mt. Hebo becomes unsuitable, butterflies will not be able to migrate up in elevation because they are already located at the highest elevation. The loss of the northern range of the species, from the Oregon central coast to the Washington central coast, is a considerable concern as well, since all of the butterfly populations north of Mt. Hebo are extirpated.

3.9.5.2 Captive Rearing Program

The release of captive-reared Oregon silverspot butterflies began in 2000 to address the decline of the Cascade Head population. The captive-rearing program involves the collection of a small number of wild, mated female butterflies, primarily from Mt. Hebo, which are taken to the Oregon Zoo, in Portland, Oregon, and the Woodland Park Zoo, in Seattle, Washington. The females lay eggs in the zoo laboratories, where the eggs soon hatch, and the small caterpillars are cared for at the zoos until the following summer, when they are released into habitat areas. Each year, captive-reared offspring are released into the wild, and a new set of females are captured to lay eggs for the next year's releases. The augmentation efforts from 2000 to 2014 involved the release of thousands captive-reared larvae, pupae, or adults at Cascade Head and/or Bray Point and Rock Creek. The purpose of the releases is to stabilize these small vulnerable populations, and reduce the likelihood of extirpation in populations at risk. Survivorship of caterpillars in the zoo facilities has increased dramatically with the average number of surviving offspring per female increasing from 7 in 2000 to 41 in 2009 (Van Buskirk 2010). In 2010 both zoos collaborated to complete the Oregon Silverspot Butterfly Husbandry Manual (Andersen *et al.*

2010), to ensure the methods developed through multiple years of captive-rearing could be implemented consistently each year and potentially provide methods to others involved in captive-rearing efforts of other butterfly species.

In 2010, a Propagation and Reintroduction Plan was completed for the species to determine appropriate release numbers at each augmentation or future reintroduction site, and maximize genetic diversity. A population viability analysis was used to estimate extinction probabilities from the Rock Creek, Cascade Head and Mt. Hebo count data. Successive years of large-scale augmentations have increased the predicted persistence of the Rock Creek and Cascade Head populations (Van Buskirk 2010). It is not known if this increase will persist without ongoing augmentation, and monitoring will be needed to determine the long-term success of the program. This analysis also found the Mt. Hebo population to have a negative growth rate, (1999-2009) and a chance of extinction within less than 50 years, (Van Buskirk 2010).

3.9.6 Conservation Measures for Oregon Silverspot Butterfly

The proposed action included following conservation measures for Oregon silverspot butterfly:

a. Population surveys for Oregon silverspot butterfly will be required prior to restoration activities proposed in areas with suitable habitat for the butterfly. Surveys using direct observation will be conducted for Oregon silverspot butterfly from mid-July-September 30 during the flight period using a modified Pollard walk method in occupied habitat (Pickering *et al.* 1992). Occupancy of listed species will be assumed in all suitable habitat located within 2 km (1.2 miles) of known occupied habitats.
b. Habitat surveys for early blue violets (*Viola adunca*) will be done during the peak violet blooming period from April-May to determine habitat suitability for Oregon silverspot butterfly. Information acquired through population and vegetation surveys will be used to direct restoration/recovery activities away from key breeding areas with violet concentrations of 10 to 15 violets per square meter, depending on leaf density.
c. Care shall be taken to avoid trampling or damaging Oregon silverspot butterfly (adult, eggs and larvae) and early blue violets during all activities. Foot traffic shall be minimized in occupied habitat. High occupancy areas will be identified and flagged. On-site personnel will meet and discuss a ‘walking plan’ each day before work begins.
d. All vehicles, equipment, and supplies (e.g., boots, clothing, hand tools, heavy equipment, utility all-terrain vehicles, etc.), before being used in and around Oregon silverspot butterfly habitat, will be disinfected and/or cleaned of mud, dirt, debris, and vegetative matter, as appropriate, to prevent the potential introduction of nonnative/invasive plant, plant/animal pathogens, and wildlife species into the habitat.

Grazing

e. Livestock grazing will not occur in critical habitat or any habitat occupied by the Oregon silverspot butterfly or early blue violet.

Manual, Mechanical and Ground-Disturbing Treatments

f. Manual and mechanical treatments will only be used to maintain or increase meadow size in unsuitable habitat areas which do not contain high concentrations of early blue violets (high concentration is 10 to 15 violets plants per square meter, depending on leaf density) or Oregon silverspot butterfly larvae or pupae. These activities may occur adjacent to occupied habitat but will not occur during the butterfly flight period from mid-July to September 30 to avoid impacts to adults and nectar plants.

g. Mowing, tilling, disking, plowing, excavation, or other extensive ground disturbing activities will not occur during the butterfly flight period or within known Oregon silverspot butterfly or early blue violet occupied habitats. Mowing may occur in occupied habitat in the fall after September 30 to avoid impacts to adults and nectar plants.
h. Mowing and handwork with line-trimmers will not occur May 15-September 30 within habitat areas containing early blue violets to minimize the potential to harm the larger butterfly larvae or pupae.
i. No more than 75% of the occupied habitat at any given site will be mowed each year.
j. Untreated strips of occupied habitat, approximately 3 m (10 feet) wide, will be distributed on the meadow edges throughout the mowed portions of a site, or 25% of each meadow.
k. Mowers will be set at a 100 mm (4 inches) height or higher to minimize impacts to larvae located on or near the violets.
l. Removed vegetation shall not be piled in areas where Oregon silverspot butterfly larval food plants and adult nectar plants are present. In cases where work is done during the wet season, cut debris may be temporarily piled on-site, but away from larval food plants and butterflies, until the dry season when equipment can access the work area to remove debris.
m. Raking: At sites supporting Oregon silverspot butterfly populations of 200 or more adult butterflies, a maximum of one third of the occupied habitat may be raked annually. At sites supporting Oregon silverspot butterfly populations of fewer than 200 adult butterflies, a maximum of one quarter of the occupied habitat may be raked annually.
n. Shade Cloth: Prior to planting native seed or vegetation, black plastic or tarps may be used to smother and solarize the existing vegetation. When the tarps are removed six months to two years later, the bare soil must be replanted with native vegetation to minimize the establishment of unwanted vegetation. Tarps will not be placed over areas containing early blue violet plants.
o. Tilling/Disking /Sod Rolling: Tilling, disking, plowing, excavation, sod rolling, or other extensive ground disturbing activities will not occur within 10 m (33 feet) of known Oregon silverspot butterfly or early blue violet occupied habitats.
p. Tree Removal: If large vegetation is removed in close proximity to known occupied butterfly habitat, trees shall be felled away from the occupied habitat. Any fallen trees shall be carefully removed from the habitat to minimize disturbance to vegetation, particularly to the larval food plants. Trees and shrubs near roads or trails that may serve as effective visual and/or access barriers near occupied or suitable butterfly habitat would not be removed.

Prescribed Fires

q. Burns will not occur during the butterfly flight season from mid-July to September 30.
r. Burns will not occur in occupied habitat where early blue violets have been identified in high densities ($\geq$ 10 to 15 violets per square meter, depending on leaf density).
s. For project sites supporting less than 200 butterflies, no more than one quarter of the meadow habitat will be burned.

t. For project sites supporting greater than 200 butterflies no more than one-third of meadow habitat will be burned.
u. Once burned, a project site will not be re-burned for at least three years, to allow butterfly and native plant populations to rebuild. The year following a burn, management of project sites will be limited to seeding, manual techniques and herbicide applications.
v. In any one year, no more than 33% of all Oregon silverspot butterfly occupied habitat may be burned.

Herbicide Application

w. Use of herbicides is limited to those listed in PDC 29 for use with listed butterflies.
x. Within Oregon silverspot butterfly occupied habitat, herbicide applications will be limited to unsuitable Oregon silverspot butterfly breeding habitat (*i.e.,* only in habitats that support less than 5 violets/m^2).
y. All herbicide applications will occur during Oregon silverspot butterfly diapause, October 1-April 1, prior to peak early blue violets leaf production and outside of the butterfly flight period.
z. All herbicide applications require a 5 m (16.4 feet) buffer around Oregon silverspot butterfly occupied habitats and areas with high densities of violets or nectar plants.
aa. Herbicide treatments must be followed with native seed or plant introductions to minimize or eliminate the establishment of invasive and non-native vegetation.

3.9.7 Environmental Baseline for Oregon Silverspot Butterfly

The action area under this consultation coincides with the majority of the current Oregon silverspot butterfly populations. Based on survey data for the past five years (Table 24), the four butterfly occupied sites in Oregon (*i.e.,* Mt Hebo, Cascade Head, Bray Point, and Rock Creek) comprised 81 to 84% of the overall species population. The California butterfly population at Del Norte during this same time period comprised between 16 to 19% of the overall species population. In addition, the populations at three of the four Oregon sites are currently being augmented through captive breeding efforts (Engelmeyer 2014). Therefore, the baseline for the Oregon silverspot butterfly includes all known populations within Oregon, and is adequately described in the preceding sections.

3.9.8 Effects to Oregon Silverspot Butterfly

The actions will occur within the current and historic range of the Oregon silverspot butterfly in Oregon and Washington. These actions may affect any of four known Oregon silverspot butterfly populations in Oregon. Direct and indirect effects to Oregon silverspot butterfly may occur when implementing any of the restoration/recovery activities under the various project categories described in the proposed action. However, effects to the butterfly will most likely result from activities under PDC 51 (Native Vegetation Restoration and Management). Activities implemented near or within butterfly occupied habitats will have the greatest impact to the species.

Short-term impacts of the action will include the intentional taking of Oregon silverspot butterfly, with intentional and possible incidental harassment, injury and/or death of a limited number of individuals. Control or removal of invasive and non-native vegetation will have the most potential adverse effects to the Oregon silverspot butterfly. Adverse effects, especially in butterfly occupied habitats, include, but are not limited to, the following restoration/recovery activities:

- Surveys,
- Manual and mechanical methods,
- Herbicide applications,
- Prescribed burns,
- Planting native vegetation.

For all of the above restoration activities, the presence of vehicles, equipment, and foot traffic to complete these activities all have the potential of causing soil disturbance and compaction that may negatively affect native plant host and nectar species, including the reduction of adult and larvae host plants (*i.e.,* early blue violet) and nectar plants; and lethal or sub-lethal loss of eggs, larvae, pupae, and/or adults butterflies via trampling or crushing. PDC and conservation measures will minimize these impacts, but cannot completely avoid some mortality.

3.9.8.1 Surveys in Support of Habitat Restoration

Surveys in support of habitat restoration may include surveys for Oregon silverspot butterflies or for other physical and biological attributes of the area. Where these surveys occur in occupied habitat, Oregon silverspot butterfly may be affected by the foot traffic associated with the surveys.

3.9.8.2 Manual and Mechanical Methods

Mowing will not occur May 15 to September 30 in areas where Oregon silverspot butterfly is present due to the possibility of limiting blooming nectar plants and/or causing injury or death to butterfly life stages that may be present. Fall mowing has been shown to be one of the most effective techniques for increasing native prairie species cover and reducing the dominance of competitive invasive species (Kaye and Benfield 2005, Messinger 2006).

Mowing may result in short-term adverse effects to the Oregon silverspot butterfly, but long-term benefits are expected due to reduced competition between early blue violet host plants and invasive or non-native plants. Mowing benefits the coastal prairie system by providing a disturbance that maintains a grassland structure and limits habitat succession to brush and trees.

Manual activities (use of hand tools or weed trimmers, *etc.*) will potentially have minimal adverse effects to Oregon silverspot butterfly relative to mechanical mowing activities. Potential impacts include trampling on or crushing larvae when implementing various vegetation management activities. The implementation of spring treatments has a greater potential to adversely impact Oregon silverspot butterfly larvae, since they will be actively feeding on host plants. However, all of the manual activities are expected to have long-term beneficial effects to host plants and butterfly populations by restoring native prairie habitats.

3.9.8.3 Herbicide Applications

Herbicide applications have the potential to negatively affect insects, including butterflies. However, limited information is available on effects of these chemicals to non-target species. Available information on herbicide effects to organisms was summarized by the Action Agencies and provided the PROJECT BA's Appendix entitled *Detailed Effects and Rish Assessment for Herbicide Use*. From that information, the proposed herbicides are "practically non-toxic" to bees. Not much is known about specific adverse effects of herbicides on Oregon silverspot butterfly, but several adverse effects to the butterfly are possible. All butterfly life stages and its host and nectar plants may be affected due to herbicides reaching these non-target species from herbicide drift, over-spray, run-off, and/or soil transport. However, the potential for herbicides to come into contact with Oregon silverspot butterfly and their host and nectar plants will be eliminated or minimized based on the following:

- Habitat application limitations.
- Types of herbicides to be used in butterfly occupied habitats.
- Implementation of herbicide-related PDC and butterfly conservation measures.
- Avoidance of occupied areas supporting high densities of violets ($\geq$10 to 15 violets/m^2).

Herbicides may only be used on sites occupied by the Oregon silverspot butterfly when they are in diapause, and will only be used in areas with low violet densities. We cannot determine the number of butterfly larvae that may be killed or injured by incidental exposures to herbicides, but we expect that the actual number should be very low since most violets will be avoided and larvae will likely be shielded by vegetation at the time of application.

3.9.8.4 Prescribed Burns

Larval Oregon silverspot butterfly will be dormant at the base of host plants during prescribed burns. In burn plots at project sites, larval mortality is expected to be 100%. Since up to one-third of the occupied habitat might be burned annually at butterfly sites supporting more than 200 individuals, burning could result in the loss of 33% of the butterfly population at these sites in a given year. Similarly, since up to one-quarter of the occupied habitat might be burned annually at sites supporting less than 200 individuals, burning could result in the loss of 25% of the butterfly population at these sites in a given year. Maintaining unburned occupied habitat within 100 m (328 feet) of the burned areas will provide a recolonization source for the site and therefore, offset the associated short-term losses by providing the long-term beneficial effect of maintaining suitable Oregon silverspot butterfly habitat.

Prescribed and accidental burns in Oregon silverspot butterfly habitat have resulted in increases in early blue violet abundance. To our knowledge, there has not been an Oregon silverspot butterfly burn study conducted that resulted in a significant decrease in the butterfly population the following year. However, unless the burn is followed by herbicide treatments and/or native seed or plant introductions, invasive and non-native vegetation may over-take the slower growing coastal native species. Additional information is needed to document the effectiveness of burns to restore coastal prairie habitat in the long term.

3.9.8.5 Planting native vegetation

Restoration projects include planting native prairie plant species as plugs or seed to improve habitat conditions for Oregon silverspot butterfly. The conversion of degraded prairie to high-quality habitat for Oregon silverspot butterfly is a critically important ecological factor for their continued survival. Native species plantings to benefit butterflies are a key final stage in prairie restoration. We anticipate that the increased abundance and diversity of native plants on the landscape would improve the resiliency of Oregon silverspot butterfly populations. Planting native species would have a significant beneficial effect on Oregon silverspot butterflies in the action area. When establishing native vegetation, a small number of Oregon silverspot butterfly eggs and larvae may be accidentally trampled on during planting efforts. This small potential adverse effect is offset by the large beneficial effect inherent in reestablishing native vegetation to prairie sites for Oregon silverspot butterfly.

3.9.8.6 Summary of Effects

The Oregon silverspot butterfly populations in Oregon have been intensively monitored for more than 20 years. The best information indicates that the species is at great risk of extirpation. The reduction of suitable breeding habitat appears to be a major threat and factor limiting the range and distribution of the silverspot butterfly. Maintaining and restoring the remaining breeding grassland habitat in productive condition is of paramount concern. Therefore, the manipulation of vegetation to maintain, restore or enhance habitat is necessary to benefit the species in the long-term. However, habitat manipulation activities, though designed to benefit the Oregon silverspot butterfly, may take the species in the form of harm, harassment or killing. Harm, harassment and killing may result from trampling, fire, mowing, watering, weeding, removal or dragging of brush, trees, and other vegetation through habitat. These activities may result in the trampling, crushing, and injuring of Oregon silverspot butterfly and disruption of resting, feeding, reproductive and/or other essential behaviors. Oregon silverspot butterfly may be indirectly and adversely affected by the immediate, short-term changes in habitat condition until new vegetation grows. The burning of occupied habitat is likely to result in the death of any Oregon silverspot butterfly eggs and larvae in the habitat during the time of the burn. Experimental techniques may have unforeseen adverse effects on the habitat (e.g. enhancement of undesirable flora or fauna) that may indirectly result in adverse effects to the Oregon silverspot butterfly.

Some individual Oregon silverspot butterflies may be harmed, harassed or killed during implementation of habitat manipulation, restoration, and enhancement activities. We cannot calculate the number of larvae that might be killed or injured by incidental exposure to herbicides or other restoration actions, but expect the actual effect to be very low given the site specific conservations measures developed for each project. Harassment is generally temporary and should not have significant negative effects on the Oregon silverspot butterfly. Harm to the species should not have a long-term negative effect on Oregon silverspot butterfly populations, provided that a majority of the population or high quality habitat is unaffected by activities to provide for the continuing viability of an extant population, which is assured by areal limitation per projects in the proposed conservation measures. In this way, unaffected areas serve as refugia for the population and source of emigrating individuals to recolonize newly restored or unoccupied habitats.

The proposed restoration actions all ameliorate the factors responsible for the imperiled condition of Oregon silverspot butterfly. Implementation of these programs is critical for the recovery of the species because the action area represents the entire remaining habitat for the species throughout its range, and thus the conservation role of the action area is to sustain and recover the species. The anticipated beneficial effects of the proposed programs are likely to have a significantly greater effect on Oregon silverspot butterfly abundance, distribution, and population stability than the anticipated adverse effects. Habitat conditions are a more significant controller of Oregon silverspot butterfly abundance and persistence than direct sources of mortality that occur on a limited spatial scale (e.g., footprints, mower tracks, or spot spraying of herbicide). The conservation measures included in the proposed action are expected to effectively reduce those sources of mortality.

Over 4 years (2011 to 2014), the Coastal Program funded 2 projects over 5.0 acres that affected Oregon silverspot butterflies; PFW did not fund any projects that affected Oregon silverspot butterflies. The Service Recovery Programs in Oregon funded 9 projects over a three year period (2012 to 2014). We anticipate most projects that affect Oregon silverspot butterflies will be upland prairie projects, and some of these projects will occur in unoccupied areas for future reintroduction of Oregon silverspot butterflies. We would expect few, if any aquatic projects funded by the NOAA RC (which target anadromous salmonids) will adversely affect Oregon silverspot butterflies. We also estimate up to 2 additional restoration projects implemented by other parties could be covered under this Opinion per year, as described in the Introduction in the section entitled *Action Area and Requirements for Coverage.*

Given this information, we anticipate up to 5 restoration projects per year averaging 2.5 acres each (or 12.5 acres annually) will negatively affect Oregon silverspot butterflies in the short-term. Given the importance of restoration activities to create and sustain Oregon silverspot butterfly habitats, the numerous PDC and proposed conservation measures to minimize the number of individuals adversely affected by the proposed actions, and the anticipated long-term benefits from each project to native habitats and Oregon silverspot butterflies in the long-term, we conclude the proposed restoration actions will not jeopardize the continued existence of Oregon silverspot butterflies.

3.9.9 Summary of Effects for Oregon Silverspot Butterfly

The Service anticipates that there will significant long-term beneficial effects to the butterfly by implementing these restoration/recovery activities. The proposed actions, when implemented, will likely result in improved habitat conditions and the creation of new suitable habitats. Once restoration techniques can be proven to be successful, large scale habitat improvements will likely provide needed habitat and result in population increases, decreasing the risk of extinction.

The control or removal of invasive and non-native vegetation is likely to result in adverse effects to the Oregon silverspot butterfly and its critical habitat in the short-term. However, these techniques are necessary to keep aggressive invasive and non-native vegetation from out-competing native violet host plant species that the butterfly depends on. Adverse effects will be minimized or eliminated, to the extent possible, by implementing the PDC and butterfly specific conservation measures.

3.9.10 Effects to Critical Habitat for Oregon Silverspot Butterfly

The primary constituent elements for Oregon silverspot butterfly include the caterpillar host plant, *Viola adunca* (PCE 1), the grasses and forbs which provide shelter for the caterpillars (PCE 2), native nectar plants on which the adult butterflies feed (PCE 3) and the Sitka spruce forests which provide shelter for the adult butterflies (PCE 4)(USFWS 1980).

The proposed restoration actions are also necessary to create and maintain suitable habitats to support Oregon silverspot butterfly. However, some short-term negative effects to PCEs may occur during these activities. All restoration techniques may involve the traversing of critical habitat. Walking in critical habitat may crush and trample native vegetation, including larval host plants and nectar sources (PCEs 1, 2, and 3). The effects to critical habitat from surveys and development of techniques for habitat manipulation, restoration, and enhancement are anticipated to be limited in scale and temporary. In many cases, measures implemented to reduce take of the Oregon silverspot butterfly will also reduce the magnitude, frequency, or duration of any potential short-term adverse effects on the PCEs of critical habitat. In the long-term, habitat manipulation, restoration, and enhancement activities will have beneficial effects on habitat quality for Oregon silverspot butterfly, resulting in an increase in abundance of the PCEs, both within and outside critical habitat. The long-term effects of the proposed activities are not likely to diminish the value of critical habitat for the purpose for which it was designated. Thus, the proposed activities will not destroy or adversely modify critical habitat.

3.9.11 Conclusion for Oregon Silverspot Butterfly

After reviewing the current status of the Oregon silverspot butterfly and its critical habitat, the environmental baseline for the action area, the effects of the proposed actions, and cumulative effects, it is our biological opinion that the activities implemented under the PROJECTS restoration program are not likely to jeopardize the continued existence of the Oregon silverspot butterfly, or adversely modify its critical habitat.

This no jeopardy finding for the Oregon silverspot butterfly and no adverse modification of designated critical habitat is supported by the following:

1. The proposed action may temporarily disturb an average of 12.5 acres of potentially suitable or occupied habitat for the Oregon silverspot butterfly each year. The restoration activities may have short-term adverse effects, but are necessary to restore and maintain high-quality habitat for this species. Significant long-term beneficial effects to the butterfly are anticipated from these activities.
2. Most of the restoration activities will be implemented when Oregon silverspot butterfly is in diapause, thereby minimizing effects to adult butterflies.
3. Proposed PDC and conservation measures will minimize lethal and sublethal effects to butterfly eggs and larvae, including areal limitations for the several activities (prescribed burning, mowing, raking and herbicide use) that cannot avoid adverse effects. These areal limitations allow a proportion of the population in untreated areas at the site to recolonize the restored area the following year.
4. Adverse effects to butterflies and PCEs of critical habiat will be short-term in nature, with long-term benefits to the Oregon silverspot butterfly and its critical habitat.

3.9.12 Literature Cited for Oregon Silverspot Butterfly

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3.10 Taylor's Checkerspot Butterfly

3.10.1 Legal Status

The Taylor's checkerspot butterfly (*Euphydyas editha taylori*) (TCB) was listed as an endangered species on October 3, 2013, throughout the subspecies range in Washington, Oregon, and British Columbia (USFWS 2013). The primary reasons for listing included extensive habitat loss through conversion and degradation of habitat, particularly from agricultural and urban development, successional changes to grassland habitat, military training, and the spread of invasive plants; inadequate existing regulatory mechanisms that allow significant threats such as habitat loss; and, other factors, including low genetic diversity, small or isolated populations, low reproductive success, and declining population sizes. Classified as an endangered species, the TCB is considered to be presently in danger of extinction throughout its entire range. For a detailed account of TCB biology, life history, threats, demography, and conservation needs, refer to USFWS (2013).

3.10.2 Critical Habitat

On October 3, 2013, the Service designated critical habitat for TCB under the ESA. The critical habitat designation includes three critical habitat units (CHUs) which encompass approximately 1,941 acres in Island, Clallam, and Thurston Counties in Washington; and in Benton County, Oregon (USFWS 2013, p. 61506-61589). The critical habitat designation within the three CHUs is further subdivided into 11 subunits. Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of TCB critical habitat consist of four components (USFWS 2013, p. 61576-61577): 1) patches of early seral, short-statured, perennial bunchgrass plant communities, 2) primary larval host plants, 3) adult nectar sources, and 4) aquatic features.

3.10.3 Species Description and Taxonomy

The Taylor's checkerspot is a butterfly in the Order Lepidoptera (butterflies and moths), and family Nymphalidae (brushfoots), subfamily Melitaeinae (checkerspots). TCB is a medium-sized (≤ 2.25"), colorfully marked butterfly with a checkerboard pattern on the upper (dorsal) side of the wings (Pyle 2002, p. 310). The upperside of the wings are black with orange and yellowish (or white) spot bands, giving them a checkered appearance (Pyle 2002, p. 310). Taylor's checkerspot is one of several subspecies of the Edith's checkerspot butterfly (*Euphydryas editha*), that includes the bay checkerspot (*E. e. bayensis*) and the Quino checkerspot (*E. e. quino*), both of which are federally listed as endangered species.

3.10.3.1 Life History and Habitat Requirements

TCB requires open grassland habitat dominated by short-statured grasses, with abundant forbs to serve as larval host plants and nectar sources. These habitats are found on prairies, shallow-soil balds (Chappell 2006, p. 1), grassland bluffs, and grassy openings within a forested matrix on south Vancouver Island, British Columbia; the north Olympic Peninsula; south Puget Sound, Washington; and the Willamette Valley, Oregon. Occupied habitats range in elevation from near sea-level to over 975 m (3,200 feet) in elevation, and occupied grassland patches range in size from less than 1 acre up to 100-plus acres.

In Washington, TCB inhabit glacial outwash prairies in the south Puget Sound region. Northwest prairies were formerly more common, larger, and interconnected, and supported a greater distribution and abundance of TCB than prairie habitat does today. On the northeast Olympic Peninsula they use shallow-soil balds and grasses within a forested landscape, as well as roadsides, former clear-cut areas within a forested matrix, and a coastal stabilized dune site near the Strait of Juan de Fuca (Stinson 2005, pp. 93–96). The two Oregon sites are on grassland hills in the Willamette Valley within a forested matrix (Ross 2008, p. 1; Benton County 2010, Appendix N, p. 5). The total area and quality of habitat for the Taylor's checkerspot has rapidly declined over the past century due to development, conversion, successional changes to grassland habitat, and the spread of nonnative invasive plants.

The TCB is univoltine (producing a single generation per year) and is nonmigratory. All butterflies have four stages of development (egg, larvae, pupae, and adult). TCB emerge as adults in the spring, typically flying in May, although depending on local site and climatic conditions, the flight period may begin in mid-April (Stinson 2005, p. 79) and extends into June, as in Oregon, where the flight season has been documented as lasting up to 43 days (Ross 2008, p. 3). The life-span of the adult butterflies is brief, lasting only 4 to 14 days (Cushman et al 1994, p. 196). During the flight period adult butterflies patrol their habitat for mates, nectar sources and host plants. Adult checkerspot butterflies are non-migratory, rarely dispersing from their natal habitats (Singer and Hanski 2004, pp. 184-185). Males seek females for mating, and once mated, the females seek larval host plants on which to lay eggs (oviposit). Female *E. editha* generally only mate once and may lay up to 1,200 eggs in clusters of 20-350 directly onto larval host plants (James and Nunnallee 2011, p. 286). Captive Taylors checkerspot typically produce 100 to 400 eggs depending on body condition of the female (Linders and Lewis 2013, pp. 12-14). Eggs hatch after 13 to 15 days (Murphy et al 2004, p. 25). In *E. editha*, newly hatched caterpillars live colonially in a loose silk web during early development. The web is thought to deter generalist predators and parasitoids (Kuusaari *et al.* 2004, p. 139).

Checkerspot larvae (caterpillars) feed on the green leaves and flowers of host plants and undergo a series of molts as they develop. The larval stages between molts, called instars, express changes in color or markings. Taylor's checkerspot larvae generally grow through four or five instars during the spring and early summer months, and then enter diapause during mid- to late summer and will overwinter in this state until the following late winter or early spring (Guppy and Shephard 2001, p. 311). Diapause is a dormant state similar to hibernation when no feeding, growth or development occurs (Scott 1986, p. 26). Larvae of *E. editha* diapause in a sheltered spot under rocks, dry wood and vegetation, or in the soil and leaf litter at the base of a host or nonhost plant (Moore 1989, p. 1727). Prediapause larvae race to mature before host plants dry out and become unpalatable. First and second instar larvae cannot enter diapause, so if host plants senesce too early, the larvae suffer high rates of mortality (Murphy et al 2004, p. 26). Prediapause larvae move to new host plants when a host becomes completely eaten, and may shift to an alternate host plant species with changes in palatability as the season advances (Hellmann *et al.* 2004).

When temperatures begin to rise in late February or March, the caterpillars break diapause and resume feeding as post-diapause larvae for several weeks (Stinson 2005, p. 80). When the caterpillar is fully grown (5^{th} instar) it forms a pupa, and undergoes metamorphosis into the adult form. Pupation lasts about two weeks, after which the adult butterfly ecloses (emerges) and lives for a few days to two weeks (Stinson 2005, p. 80). All nontropical checkerspot butterflies, including the TCB, have the capability to reenter diapause prior to metamorphosis during years that weather is extremely inhospitable or when the larval food resources are restricted (Ehrlich and Hanski 2004, p. 22). The portion of the larval population that overwinters for a 2nd year is unknown, but may be as high as 30 to 50% in some years (Oregon Zoo 2009, cited in COSEWIC 2011, p. 36). Larvae that overwinter for a second year may aid in local population persistence during years when conditions are unfavorable.

Areas of habitat with open bare soil are an important habitat component for the butterfly as these areas warm more quickly than the surrounding vegetation, and butterflies thermoregulate by basking (Scott 1986, p. 296; Kuussaari *et al.* 2004, p. 140; Stinson 2005, p. 81). Post-diapause larvae forage singularly and are capable of moving much greater distances than pre-diapause larvae (Kuussaari *et al.* 2004, p. 140). Edith's checkerspot larvae have been documented to move up to 10 m (33 feet) from a release site, often moving within a habitat patch to different exposures to raise their body temperature, and presumably to find suitable foraging conditions (Kuussaari *et al.* 2004, p. 140). Dispersal within a habitat patch benefits the larvae because they are able to elevate their body temperature to an optimal range for foraging and development (Kuussaari *et al.* 2004, p. 156).

3.10.4 Population Status

The TCB was historically known to occur in British Columbia, Washington, and Oregon, and its current distribution represents a reduction from over 80 locations rangewide to 14 sites in 2013. Historically, the TCB was likely distributed throughout grassland habitat found on prairies, shallow-soil balds (a bald is a small opening on slopes in a treeless area, dominated by herbaceous vegetation), grassland bluffs, and grassland openings within a forested matrix on south Vancouver Island, the northern Olympic Peninsula, the south Puget Sound prairies, and the Willamette Valley.

Nearly all localities for the TCB in British Columbia have been lost; the only location currently known from British Columbia was discovered in 2005 (COSEWIC 2011, p. iv). In Oregon, the number of locations occupied by TCB has declined from 13 to 2 (Ross 2011, *in litt.,* p. 1). In Washington State, 43 historical locales were documented for the TCB. In 2013, there were 11 documented locations for the TCB with only one of the localities consistently harboring more than 1,000 individuals, and the majority of known sites have daily counts of fewer than 100 individual butterflies.

Total population sizes for TCB are unknown, as this type of information requires intensive monitoring using mark-recapture techniques. Because butterfly populations vary so much year-to-year, and are very difficult to estimate accurately without intrusive techniques, no population estimate has been attempted. Current information on relative population sizes are derived from day counts which reflect only a portion of the total population during any given flight season.

Based on historical and current data, the distribution and abundance of TCB have declined significantly rangewide, with the majority of recent extirpations occurring from approximately the mid-1990s in Canada (COSEWIC 2011, p. 15), 1999–2004 in south Puget Sound prairies, and around 2007 at the Bald Hills location in Washington. Currently 14 individual locations are considered occupied by the TCB rangewide, distributed in four disjunct geographic areas:

Denman Island (BC) (1 occupied site), North Olympic Peninsula (WA) (6 occupied sites), South Puget Prairies (WA) (5 occupied sites), and the Willamette Valley (OR) (2 occupied sites) (Table 26). The TCB is a declining taxon found only on a few declining habitat patches throughout the subspecies' range.

The distances between each of these disjunct geographic areas is great enough that there is no potential for connectivity or genetic exchange between these distant populations. Populations at each of the occupied sites face ongoing threats of habitat loss and degradation associated with succession and invasive nonnative plants, and other factors (see *Threats* discussion, below). A number of sites in Oregon and Washington where TCB have been recently extirpated are considered high priority sites for habitat restoration and reintroduction of the species. These sites, which were unoccupied at the time the species was listed, are identified in the October 11, 2012 proposed rule to designate critical habitat for the TCB (USFWS 2012).

Checkerspot butterfly populations can fluctuate widely from year to year primarily due to the complex interactions of host plant phenology, annual weather conditions, and local topography (McLaughlin *et al.*, 2002, p. 538, Hellmann *et al.*, 2004, p. 41). Some Taylor's checkerspot populations in Washington have exhibited boom years with several thousand individuals and then declined dramatically with only 100 or so butterflies remaining the following year (Stinson 2005, p. 85). Long-term monitoring of checkerspot populations has revealed that population dynamics in *E. editha* are driven by both density-dependent factors (e.g., host plant availability) and density-independent factors (e.g., weather and topography) and that the response of local butterfly populations to the same weather conditions is highly variable depending on site topography and habitat conditions (McLaughlin *et al.*, 2002, p. 538). Local topography is important, as minor variations in aspect and moisture directly influence development of larvae and pupae, as well as host plant development (Hellmann *et al.* 2004, p. 47).

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Population survival for checkerspots depends on the production of large numbers of larvae, so that some larvae survive to maturity. Drought affects populations by reducing the period of host plant availability, while extended periods of rain reduces reproduction, egg survival, and larval growth (Hellmann *et al.* 2004, p. 44). Pre-diapause mortality strongly affects adult abundance in the subsequent year (McLaughlin *et al.*, 2002, p. 538). Climate and topography also affect growth of post-diapause larvae in the winter, when aspect-determined contrasts in solar exposure

Table 26. Summary of extant TCB populations at the time of Federal listing in October 2013.

Region	Site	Approximate habitat area[1] (acres)	Potential estimated population size[2]	Distance to nearest occupied site (miles)[3]	Sources
BC	Denman Island	2,000+	1,000 - 10,000+	200+	COSEWIC 2011
WA – Olympic Peninsula	Sequim - (Graymarsh)	151 (5 acres occupied)	50-500+	10.5	Severns & Grosboll 2011, Hays 2011
	Dan Kelly Ridge	209	50-100+	1.6	
	Eden Valley	26	50-100+	1.6	
	Upper Dungeness	93	50-100+	1.2	Holtrop 2010
	Three O'clock Ridge	103	50-100+	1.2	
	Bear Mountain	3	50-100+	3.9	
WA – South Puget Prairies	91st Division Prairie (East) (Range 72-76)	980	1,000 – 10,000+	2	Linders & Lewis 2013
	91st Division Prairie (West) (Range 50-51)	397	Reintroduced (2009-2011) 1,000-2,000+	2	
	13th Division Prairie (Training Area 15 and Pacemaker)	674	Reintroduced (2009, 2012) 0-50	8	
	Scatter Creek (South unit)	399	Reintroduced (2009-2013) 100-200+	2.1	
	Glacial Heritage	545	Reintroduced (2012-2013) 100 – 200+	2.1	
OR – Willamette Valley	Beazell Memorial Forest (5 sites)	61	200 – 800+	4.3	Ross 2012
	Fitton Green (4 sites)	83	500 – 1,000+	4.3	

Footnotes:

1. Approximate habitat area is a gross estimate based on areas mapped as proposed critical habitat for the TCB (USFWS 2012) and includes areas that are not currently suitable habitat (i.e, areas occupied by trees and shrubs, etc.). Denman Island habitat area is from COSEWIC 2011, p. 15.
2. Actual population sizes for the TCB are unknown, and can fluctuate considerably from year to year. Estimates listed here are considered to be general in nature and represent the cumulative total of adult butterflies on a site over the entire flight season. These estimates provide only a relative index of adult butterfly abundance based on multiple day counts or other monitoring surveys completed from 2008-2013.
3. Typical dispersal distances for checkerspot butterflies are generally considered to be ≤0.5 km (≤ 0.3 miles) (USFWS 2012). Maximum known dispersal distance for Taylor's checkerspot are estimated at ≥ 3.1 miles (≥ 5 km or 3.1 miles) (Page *et al.* 2009, p. 18).

are greatest and weather patterns strongly influence post-diapause larval development (McLaughlin *et al.*, 2002, p. 539).

3.10.5 Threats, Reasons for Listing

The primary reasons for listing included the following: extensive habitat loss through conversion and degradation of habitat, particularly from agricultural and urban development; successional changes to grassland habitat; military training; the spread of invasive plants; and other factors including low genetic diversity, small or isolated populations, low reproductive success, and declining population sizes. The primary long-term threat to the TCB is the loss, conversion, and degradation of habitat, particularly as a consequence of agricultural and urban development, successional changes to grassland habitat, and the spread of invasive plants.

Prairies, which historically covered over 145,000 acres of the south Puget Sound region, have largely been lost over the past 150 years (Crawford and Hall 1997, p.11). 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, p. 11). 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, p. 261).

Native prairies and grasslands have been severely reduced throughout the range of the TCB as a result of human activity due to conversion of habitat to residential and commercial development and agriculture. Prairie habitat continues to be lost, particularly to residential development (Stinson 2005, p. 70) by removal of native vegetation and the excavation and grading of surfaces and conversion to non-habitat (buildings, pavement, other infrastructure). Residential development is associated with increased infrastructure such as new road construction, which is one of the primary causes of landscape fragmentation (Watts *et al.* 2007, p. 736).

The suppression and loss of natural and anthropogenic disturbance regimes, such as fire, across vast portions of the landscape has resulted in altered vegetation structure in the prairies and meadows and has facilitated invasion by nonnative grasses and woody vegetation, rendering habitat unusable for TCB. Historically, the prairies and meadows of the south Puget Sound region of Washington and western Oregon are thought to have been actively maintained by the native peoples of the region, who lived there for at least 10,000 years before the arrival of Euro-American settlers (Boyd 1986, entire; Christy and Alverson 2011, p. 93). Frequent burning reduced the encroachment and spread of shrubs and trees (Boyd 1986, entire; Chappell and Kagan 2001, p. 42; Storm and Shebitz 2006, p. 264), favoring open grasslands with a rich variety of native plants and animals. The basic ecological processes that maintain prairies or meadows have disappeared from, or have been altered on, all but a few protected and managed sites. At JBLM, approximately 39% (over 16,200 acres) of the original prairie habitat has transitioned to Douglas-fir forest, and only a fraction of the original prairie habitat remains as small, isolated prairies (Tveten 1997, p. 124).

Fires on the prairie create a mosaic of vegetation conditions, which serve to maintain native prairie forbs like *Camassia quamash* (common camas), *Achillea millefolium* (yarrow), and *Lomatium* spp. (desert parsley or biscuit root), which are adult nectar foods for the TCB. Stands of native perennial grasses (*Festuca idahoensis* ssp. *roemeri* (Roemer's fescue)) are also well adapted to regular fires and produce habitat favorable to the TCB. In some prairie patches, fires will reset succession back to bare ground, creating early successional vegetation conditions suitable for TCB (Pearson and Altman 2005, p. 13). The historical fire return frequency on prairies has been estimated to be 3 to 5 years (Foster 2005, p. 8).

The result of fire suppression has been the invasion of the prairies and oak woodlands by native and nonnative plant species (Dunn and Ewing 1997, p. v; Tveten and Fonda 1999, p. 146), notably woody plants such as the native Douglas-fir (*Pseudotsuga menziesii*) and the nonnative Scot's broom, and nonnative grasses such as *Arrhenatherum elatius* (tall oatgrass) in Washington and *Brachypodium sylvaticum* (false brome) in the Willamette Valley of Oregon. This increase in woody vegetation and nonnative plant species has resulted in less available prairie habitat overall, and habitat that is avoided by TCB (Tveten and Fonda 1999, p. 155; Pearson and Hopey 2005, pp. 2, 27; Olson 2011a, pp. 12, 16). Where controlled burns or direct tree removal are not used as a management tool, this encroachment will continue to cause the loss of open grassland habitats for the TCB.

The distribution of the TCB has been reduced from more than 80 populations to the 14 occupied locations with small populations that are known rangewide today. Some of the populations that have been extirpated have disappeared in the past decade, and some declined from robust population sizes of 1,000s of individual butterflies to zero within a 3-year interval and have not returned (Stinson 2005, p. 94). In the south Puget prairies, only one native local population remains, others are the result of recent reintroduction efforts. Most remaining populations of TCB are very small; 5 of the 14 known populations are estimated to have fewer than 100 individuals.

The threats of land development and loss of habitat from conversion to other uses (agriculture); the impacts of military training and recreation; existing and likely future habitat fragmentation, habitat disturbance; long-term fire suppression; and ongoing loss and degradation of habitat associated with native and nonnative invasive species continues. These factors have resulted in the present isolation and limited distribution of the subspecies, and are currently ongoing and will continue into the foreseeable future. The combination of ongoing threats coupled with small population sizes and highly variable population dynamics leads us to conclude that the TCB is currently in danger of extinction throughout its range.

3.10.5.1 Climate Change

Over the next century, climate change at global and regional scales is predicted to result in changes in butterfly species distributions and altered life histories (McLaughlin *et al.* 2002, p. 6074, Hill *et al.* 2002, p. 2163, Singer and Parmesan 2010, p. 3161). Rare butterflies, including the Taylor's checkerspot, may be vulnerable to climate change, as their populations are often fragmented due to habitat losses that restrict the species' ability to adapt to changing environmental conditions (Schultz *et al.* 2011, p. 375).

In the Pacific Northwest, mean annual temperatures rose 0.8 °C (1.5 °F) in the 20th century and are expected to continue to warm from 0.1 to 0.6 °C (0.2 to 1 °F) per decade (Mote and Salathe 2010, p.29). Global climate models project an increase of 1 to 2% in annual average precipitation, with some models predicting wetter autumns and winters with drier summers (Mote and Salathe 2010, p.29). Regional models of potential climate changes are much more variable, but the models generally indicate a warming trend in mean annual temperature, reduced snowpack, and increased frequency of extreme weather events (Salathe *et al.* 2010, pp. 72-73). Downscaled regional climate models, such as those presented by www.climatewizard.org have tremendous variation in projections for annual changes in temperature or precipitation depending upon the climate model or scenario. Averaged values across large areas generally indicate a general warming trend in mean annual temperature consistent with the climate projections reported by Salathe and others (2010, pp. 72-73).

Because the TCB occupies a relatively small area of specialized habitat, it may be vulnerable to climatic changes that could decrease suitable habitat or alter food plant seasonal growth patterns (phenology). The relationship between climate change and survival for the *Euphydryas editha* complex is driven more by the indirect effects of the interaction between seasonal growth patterns of host plants and the life cycle of the checkerspot butterfly than by the direct effects of temperature and precipitation (Guppy and Fischer 2001, p. 11; Parmesan 2007, p. 1868; Singer and Parmesan 2010, p. 3170). Predicting seasonal growth patterns of butterfly host plants is complicated, because these patterns are likely more sensitive to moisture than temperature (Cushman et al 1992, pp. 197–198; Bale *et al.* 2002, p. 11), which is predicted to be highly variable and uncertain in the Pacific Northwest (Mote and Salathé 2010, p. 31). Climate models for the Georgia Basin—Puget Sound Trough—Willamette Valley Ecoregion consistently predict a deviation from the historical monthly average precipitation, with the months of January through April projected to show an increase in precipitation across the region, while June through September are predicted to be much drier than the historical average (Climatewizard 2012).

It is likely that the overlap of seasonal growth patterns between primary larval host plants and the TCB will display some level of stochasticity due to climatic shifts in precipitation and increased frequency of extreme weather events. For the Edith's checkerspot (*E. editha*), Parmesan (2007, p. 1869) reported that a lifecycle mismatch can cause a shortening of the time window available for larval feeding, causing the death of those individuals unable to complete their larval development within the shortened period, citing a study by Singer (1972, p. 75). In that study, Singer documented routine mortality of greater than 98% in the field due to phenological mismatches between larval development and senescence of their annual host plant *Plantago erecta* (California plantain). When mismatches such as these form the 'starting point,' insects may be highly vulnerable to small changes in synchrony with their hosts (Parmesan 2007, p. 1869).

The interplay between host plant distribution, larval and adult butterfly dispersal, and female choice of where to lay eggs will ultimately determine the population response to climate change (Singer and Parmesan 2010, p. 3164). However, determining the long-term responses to climate change from even well-studied butterflies in the genus *Euphydryas* is difficult, given their ability to switch to alternative larval food plants in some instances (Singer and Thomas 1996, pp. S33–34; Hellmann 2002, p. 933; Singer *et al.* 1992, pp. 17–18). Attempts to analyze the interplay between climate and host plant growth patterns using predictive models or general State-wide assessments and to relate these to the TCB are equally complicated (Murphy and Weiss 1992, p. 8). Despite the potential for future climate change in Western Washington, we have not identified, nor are we aware of any data on an appropriate scale to evaluate the effects of climate change to habitat or population trends for the TCB. However, we recognize that weather events and climatic factors strongly influence the reproduction and larval survival rates for the Taylor's checkerspot, and these effects are most profound in species with small, isolated populations such as the Taylor's checkerspot.

3.10.6 Recovery Measures

Habitat for the TCB requires active management to prevent the establishment of invasive, nonnative and native woody species, and restoration by actively managing sites to establish native plant species and the structure of the plant community that is suitable for the TCB, while also being protective of extant TCB populations. The recovery needs of the TCB include sufficient suitable habitat for population expansion and growth, and these sites must receive routine and sustained management to maintain the early seral conditions essential to the TCB. Reintroduction efforts using captive-rearing and translocation techniques to reestablish local populations are also necessary, because the distances and isolation of extant populations preclude the potential for natural dispersal and colonization in most areas.

The imperiled status of the TCB has led to a number of habitat restoration actions and reintroduction efforts. The Washington Department of Fish and Wildlife in cooperation with the Oregon Zoo and others have an ongoing captive rearing program to support reintroduction of TCB at south Puget prairie sites that have been managed for butterfly habitat (Linders 2011, p. 383). Sites targeted for reintroduction include areas that historically supported TCB. Reintroductions of captive-reared postdiapause larvae and adult butterflies have resulted in the tentative establishment of three Taylor's checkerspot populations since 2007 (Table 26), while efforts at fourth site (JBLM-Pacemaker) have been discontinued, and very few butterflies were seen at this site in 2013 (Linders & Lewis 2013, p. 45).

Habitat restoration efforts to manage invasive species and restore native forb and grass communities is ongoing at most sites currently occupied by the TCB (e.g., Linders & Lewis 2013, Hayes 2011, Ross 2008). In 2007, JBLM, started an Army Compatible Use Buffer (ACUB) initiative that includes support for interagency butterfly habitat management on several Puget prairie sites (Fimbel et al 2011, p. 379). Habitat restoration using prescribed fire, herbicide applications, followed by seeding and planting of native grasses and forbs have proven to be successful methods for restoring degraded prairie habitats (Fimbel et al 2011, p. 379). Removal of small trees and shrubs within natural balds and occupied clearcut areas on the Olympic Peninsula has been undertaken to slow the rate of natural succession occurring there, as these sites are undergoing rapid transition from grass to forested habitat (Hayes 2011, p. 10). Habitat restoration and maintenance is an ongoing conservation need at all sites currently occupied by TCB, as native plant communities have largely been replaced by non-native grasses and invasive shrubs.

3.10.7 Conservation Measures for Taylor's Checkerspot Butterfly

Restoration activities in TCB habitat (both occupied and unoccupied) will be completed in an effort to conserve, create, and sustain high quality prairie habitat. These activities will be designed to increase the abundance and diversity of host and nectar plant species and the extent of early seral habitat conditions. All activities will be coordinated with the Service and land owners/managers, as appropriate. Proposed conservation measures for TCB include:

- Surveys for TCB within 0.81 km (0.5 miles) of known populations will be required prior to restoration activities proposed in areas with suitable habitat for the butterfly. Suitable habitat would include prairie/grassland areas containing the larval host plants *Plantago lanceolata* (narrow-leaf plantain) or *Castilleja levisecta* (golden paintbrush) in Oregon, and narrow-leaf plantain and *Castilleja hispida* (harsh paintbrush) in Washington. Surveys using direct observation will be conducted for TCB during the mid-April to June 15 flight period, except in the North Olympic Penisula where surveys may occur until July 15. Information acquired through surveys will be used to direct restoration/recovery activities away from key breeding areas.
- Unless further restricted below, restoration activities in occupied habitat would not be performed during the TCB flight season (April 15 to June 15) to reduce the potential for adverse effects to TCB individuals.
- Use of prescribed fire shall be limited to no more than one-third of each occupied site each year depending on site specific conditions.
- Mowing (large mow deck motorized or pulled by tractor, all-terrain vehicle, etc.) in occupied habitat will only be permitted for restoration purposes and when prescribed fire is not a feasible substitute or would not achieve the desired treatment without first being mowed. Mowing in occupied habitat shall occur while larvae are in extended diapause (September 10 to February 15).
- Cutting and removal of vegetation in occupied habitat shall be implemented while TCB larvae are in extended diapause *(*September 10 to February 15).
- If large trees are removed in close proximity to known occupied butterfly habitat, they shall be felled away from the occupied habitat. Any fallen trees shall be carefully removed from the habitat to minimize disturbance to vegetation, particularly to the larval food plants. Trees and shrubs near roads or trails that may serve as effective visual and/or access barriers near occupied or suitable butterfly habitat will not be removed.
- Removed vegetation shall not be piled in areas where TCB larval food plants and adult nectar plants are present. Removed vegetation, including trees and shrubs, may be piled on-site to serve as fuel for on-site prescribed burns, but well away (>10 m or ~33 feet) from larval and adult food sources.
- The application of herbicides for control of nonnative grasses, shrubs, and forbs, as well as removal of conifers may include broadcast or spot-spray application. Broadcast application shall only occur outside of occupied habitat with a ~3 m (15 feet) buffer. Spot-spray application of herbicide may occur in occupied habitat.
- Herbicide selection, storage, use, and disposal shall be implemented according to the product label instructions and any special provisions written into the restoration proposal included with the permit application. Any modifications associated with the restoration proposal must be approved by the Service before being implemented.
- If appropriate to improve habitat conditions for TCB, herbicide treatments will be followed with native seed or plant introductions to minimize or eliminate the establishment of invasive and non-native vegetation where there is significant bare

ground exposed.

- Livestock grazing may occur in critical habitat or any habitat occupied by the TCB. Livestock grazing may only occur while TCB are in diapause (September 10 to February 15). A grazing plan must be approved by the local office before implementation.
- Livestock exclusion fences and fencing/gating to exclude off-road vehicles and restrict recreational use would be designed not to impede the movement of TCB between areas of suitable habitat.
- All vehicles, equipment, and supplies (*e.g.,* boots, clothing, hand tools, heavy equipment, utility all-terrain vehicles, *etc.*), before being used in and around TCB habitat, will be disinfected and/or cleaned of mud, dirt, debris, and vegetative matter, as appropriate, to prevent the potential introduction of nonnative/invasive plant, plant/animal pathogens, and wildlife species into the habitat.
- Foot traffic shall be minimized in occupied TCB habitat. High occupancy areas will be identified and flagged. On-site personnel will meet and discuss a 'walking plan' each day before work begins.
- Care shall be taken to avoid trampling or damaging the following: TCB larval food plants which include narrow-leaved plantain (*Plantago lanceolata*), harsh and the threatened golden paintbrush (*Castilleja hispida and, Castilleja levisecta*), annual Blue-eyed Mary (*Collinsia parviflora*), and annual Sea blush (*Plectritus congesta*); and TCB adult nectar plants which include Puget balsamroot (*Balsamorhiza deltoidea)*, Sea thrift (*Armeria maritima)*, biscuit root (*Lomatium triternatum, L. utriculatum),* wild strawberry (*Fragaria virginiana),* common camas (*Camassia quamash*)*,* and grassland Saxifrage *(Saxifrage integrifolia).* Special care should also be taken to avoid disturbance to the threatened golden paintbrush.
- If more than 5% of the TCB larval host plants (*P. lanceolata, C. hispida and C. levisecta*) and/or adult nectar plants are trampled or damaged in any individual location during permitted activities (*i.e.,* during the growing season on a calendar year basis), the project manager shall cease all activity at the location and contact the appropriate Service office as soon as possible to re-evaluate these activities.

3.10.8 Environmental Baseline for Taylor's Checkerspot Butterfly

The action area includes the entire range of the species. Given the species' recent listing, the current condition of the species in the action area and the factors responsible for the condition of the species in the action area are well described in the Status of the Species section of this Opinion and in the final rule listing the species (USFWS 2013, p. 61452).

The action area is essential for re-establishing viable and persistent populations of TCB. Since the action area is the range of the species, the action area clearly is critical for conserving the species. The threats in the action area include low genetic diversity, small or isolated populations, low reproductive success, and declining population sizes, as well as habitat loss from invasive species and successional changes to grassland habitat.

3.10.9 Effects of the Action for Taylor's Checkerspot Butterfly

The effects of the action refers to the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR 402.02). Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur.

Restoration projects that could occur in habitat for TCB may include the following activities: prescribed fires, mowing and other methods for control of non-native vegetation, herbicide application, tree/vegetation removal, seeding and planting, maintenance and/or installation of fencing, livestock grazing, surveys in support of habitat restoration, and the foot traffic associated with these activities. These activities may affect TCB when implemented at occupied sites. To reduce the potential for adverse effects to TCB individuals, restoration activities in occupied habitat would not be performed during the TCB flight season (April 15 to June 15). Additionally, restoration activities would generally occur in marginal habitat at the periphery of densely occupied habitat.

Although restoration activities would be performed outside of the flight season and at the periphery of densely occupied habitat, TCB individuals in juvenile life stages may be present year-round in low densities at locations permitted for restoration, and foot traffic from all activities in the proposed action present a low-impact but unavoidable risk in all occupied areas. Anticipated adverse effects to TCB individuals in occupied sites are described below in the categories of restoration activities. Approximately 14 sites in Oregon and Washington were occupied at the time of this analysis, but any site in the action area may become occupied during the indefinite term of the proposed action. Using the quantity of acres that were proposed for critical habitat (USFWS 2012, p. 61983) as a surrogate for the amount of prairie habitat potentially available to TCB, and subtracting the quantity of acres on Federal lands (because restoration activities for TCB at those locations will be consulted on separately under Section 7 of the ESA), we estimate that up to 4,391 acres could receive restoration treatments annually under this proposed action. However, much of the restoration that occurs in those 4,391 acres would have been issued a Section 10(a)(1)(A) permit and therefore was consulted on under a different biological opinon (USFWS Tracking No. 01EWFW00-2014-F-0396). The actual number of acres that would receive restoration treatments in any given year through the proposed programs (which may include other locations not identified in the acres of proposed critical habitat) is unknown and may vary from year to year but we do not anticipate it will exceed 4,391 acres. The proposed restoration may occur on other lands within the action area that were not identified as proposed critical habitat, we are simply using 4,391 acres as an estimated cap of total occupied acres that could receive treatment in a given year. Additional restoration projects implemented by other parties could be covered under this Opinion per year, as described in the Introduction in the section entitled *Action Area and Requirements for Coverage.* We anticipate these additional projects would be included in this amount of treated acres that affect TCB, as we do not expect all prairie restoration projects within the species range to result in the take of TCB.

Restoration actions would continue to have a net positive benefit for TCB populations and the recovery of the species, discussed below. In the following sections, we summarize the proposed conservation measures and then discuss the anticipated beneficial, insignificant, and incidental adverse effects from each of the following categories: prescribed fires, mowing, herbicide application, tree/vegetation removal, seeding and planting, maintenance and/or installation of fencing, livestock grazing, surveys in support of habitat restoration, and the foot traffic associated with these activities.

3.10.9.1 Prescribed Fires

Prescribed fires improve TCB habitat by removing vegetative competition for the early-seral host and nectar plants that TCB depend on and by creating habitat structure conducive to TCB life history requirements. This is especially true when the return frequency of the fires is short and swales and overall topographic heterogeneity prevent the entire grassland from being consumed by fire. Fires on grassland (prairie) habitat generally have low fuel content and produce regular, short duration fires (Agee 1993, p. 354; Chappell and Kagan 2001, p. 43), which restricts the establishment of invasive plants and encroaching trees and helps to maintain short-statured vegetation dominated by native grasses and forbs. Short duration fires with low fuel loads create the open, short-statured, and patchy prairie structure and vegetation communities (Severns and Warren 2008, p. 476) that TCB prefer. Bare ground for basking is a key feature of these recently burned landscapes. Fire also improves the health and composition of grassland habitat by providing a short-term nitrogen addition, which results in a fertilizer effect to vegetation, thus aiding grasses and forbs as they re-sprout. Fires on the prairie create a mosaic of vegetation conditions which serve to maintain native prairie forbs and adult nectar foods for TCB like Puget balsamroot, common camas, yarrow (*Achillea millefolium*) and desert parsley or biscuit root (*Lomatium* spp.). Stands of native perennial grasses like Roemer's fescue (*Festuca idahoensis* ssp. *Roemeri*) are also well adapted to regular fires and produce habitat favorable for TCB.

The historical fire frequency on prairies has been estimated to be once every 3 to 5 years (Foster 2005, p. 8). The result of fire suppression has been the invasion of the prairies and oak woodlands by native and nonnative plant species (Dunn and Ewing 1997, p. v; Tveten and Fonda 1999, p. 146), notably woody plants such as the native Douglas-fir and the nonnative Scot's broom, and nonnative grasses such as tall oatgrass (*Arrhenatherum elatius*) in Washington and false brome (*Brachypodium sylvaticum*) in the Willamette Valley of Oregon. This increase in woody vegetation and nonnative plant species has resulted in less available prairie habitat overall and habitat that is avoided by TCB and streaked horned larks (Tveten and Fonda 1999, p. 155; Pearson and Hopey 2005, pp. 2, 27). Most butterflies avoid densely forested areas, as they are unable to generate enough heat from their own metabolism to provide the heat and energy needed to fly in shaded conditions (USFWS 2013, p. 61475). On JBLM alone, over 16,000 acres of prairie have been invaded by Douglas-fir forest since the mid-19th century (Foster and Shaff 2003, p. 284).

Prescribed fires are therefore essential to creating and maintaining TCB habitat in the action area. Conservation groups and their partners have been using prescribed fire for more than a decade in the south Puget Sound to improve habitat conditions for TCB and other prairie species. "Between times of planned disturbance, sites should receive protection from disturbance in a temporal context, as too much disturbance too often will reduce numbers of TCB and the spatial extent of their habitat. Disturbance will be beneficial and essential to resetting the habitat back to early seral conditions approximately every 2 to 5 years, based on recovery from disturbance history, and the resiliency of larval food plants as documented from experience at JBLM and other south Puget Sound locations that have received proactive management. The larval host plants and adult nectar plants are resilient and can recover if the habitat is provided sufficient time to rest (at least two growing seasons) between episodes of use and disturbance (USFWS 2013, p. 61979)."

The majority of prescribed fire operations to improve habitat conditions for TCB are performed outside of currently occupied habitat, but the proposed restoration includes burns on up to one-third of any occupied habitat patch in a given year to maintain suitable habitat conditions. Prescribed fires have been (and would be) performed in the late summer and fall after the larvae have entered diapause. Accordingly, prescribed fires that occur in occupied habitat may adversely affect larvae while in diapause. Burning in the fall also minimizes adverse effects to host and nectar plants because those plants will have partially or completely senesced and will regrow by the following spring. Therefore, adverse effects of the proposed prescribed fires would be limited to the potential for destroying larvae in diapause. Several other factors also reduce, but not eliminate, the likelihood to destroying TCB larvae during prescribed fires: Larvae of *E. editha* diapause in a sheltered spot under rocks, dry wood and vegetation, or in the soil and leaf litter at the base of a host or non-host plant (Kuussaari et al 2004, p. 140; Moore 1989, p. 1727), a behavior that may lead to surviving low-intensity fires (Thomas, USFWS, *pers. comm*. 2013). Furthermore, prescribed fires are expected to target habitat areas that are losing suitability for TCB and are unlikely to support the presence of a large number of individuals. For these reasons, prescribed fire in one-third of an occupied habitat patch is not expected to result in a significant decline in population size or extirpation from the site. Based on one-third of occupied habitat patches being burned each year, and the estimated acreage that could potentially be occupied and affected by the permitted restoration activities in Oregon and Washington (4,391 acres), we anticipate that as much as 1,463 acres of occupied habitat may receive prescribed fire each year. This number is likely to be much smaller than 1,463 acres due a current lack of occupancy and the availability of resources for implementing prescribed fires. An unknown number of TCB larvae associated with those acres are reasonably certain to die in those fires.

3.10.9.2 Mechanical and Manual Treatments

The proposed restoration action include the maintenance of short-statured grasslands with motorized mowing equipment (including hand-held weed trimmers, *etc*.), but only while TCB are in diapause and only for the purposes of habitat restoration when prescribed fire is not a feasible substitute. Mowing for habitat restoration is usually performed in low-quality habitat or in unsuitable habitat outside of occupied habitat. However, mowing may occasionally occur at occupied sites, and mowers could potentially crush and kill TCB in juvenile life stages. We anticipate that a small fraction of the estimated 4,391 acres that may be occupied and affected by the permitted restoration activities in Oregon and Washington could be mowed each year. An unknown number of TCB larvae associated with those acres are reasonably certain to be crushed and killed by the wheels of the mower.

3.10.9.3 Herbicide Application

Both broadcast herbicide application and spot-spraying herbicide application may be funded or carried out by the proposed programs to restore and maintain prairies in the action area. Broadcast herbicide application would only occur outside of occupied habitat with a ~3 m (15 feet) buffer from occupied areas. Broadcast treatments are applied by boom spray from a truck or all-terrain vehicle to areas with a high density of invasive species and inappropriate structure for TCB (e.g., Scot's broom or pasture grass dominated areas). It is possible that these areas contain a low-density of host plants (particularly, narrow-leaved plantain), but because the Action Agencies and/or funded entities would only apply broadcast treatments away from identified occupied areas, it is extremely unlikely that TCB living at the edge of a population center would be present in an area treated with a broadcast herbicide. Therefore, the potential effects of broadcast herbicide application on TCB are discountable.

Herbicides are commonly used to manage rare butterfly habitat and control invasive nonnative plants in south Puget Sound prairies (Schultz *et al.* 2011, p. 373). Available information on effects to organisms was summarized by the Action Agencies and provided the PROJECT BA's Appendix entitled *Detailed Effects and Rish Assessment for Herbicide Use*. From that information, the proposed herbicides are "practically non-toxic" to bees. Not much is known about specific adverse effects of herbicides to TCB, but several adverse effects to the butterfly are possible. Herbicide use can affect butterflies by damaging or destroying larval or adult food sources, or through the direct ingestion of a toxic substance. Permitted and/or funding entities would be required to use low-toxicity formulas, particularly when applying herbicide in occupied habitat. One method of reducing risk to host and larval plants is to use a grass-specific herbicide when grass is the plant targeted for eradication. Loss of nontarget plants can be minimized by using grass-specific herbicides, such as sethoxydim, which has been used effectively to control invasive grasses such as tall oatgrass (*Arrhenatherum elatius*), while having minimal impacts on native bunchgrasses and forbs (Schultz *et al.* 2011, p. 373).

There are currently dozens of herbicide formulations that are available for general use. The toxicity of an herbicide to butterflies varies from nontoxic to lethal depending upon the compounds used. All herbicides are required to be tested on honeybees (*Apis* spp.) as part of registration requirements (USFS 2005, p. 252), but there are relatively few studies that evaluate the effects of herbicides on butterflies. Herbicides that are reported to have a low risk to bees may not generalize to non-target species such as butterflies due to differences in foraging, life history, habitat selection or other details of species' ecology (Russell and Schultz 2010, p. 54).

Use of the grass-specific herbicide compounds sethoxydim or fluazifop-p-butyl with the nonionic surfactant Preference® can affect butterflies, resulting in reduced larval survival and increased rates of development from larvae to adult, as well as decreased wing area in some species of butterflies (Russell and Schultz 2010, p. 53). Survival of cabbage white butterfly larvae (*Pieris rapae)* was reduced by 32% with exposure to sethoxydim and 21% with fluazifo-p-butyl, while survival rates of Puget blue butterfly larvae (*Icaricia icarioides blackmorei*) were not reduced by exposure to these herbicides (Russell and Schultz 2010, p. 57). Wing size and pupal weights of cabbage white butterflies were reduced by herbicide exposure, while Puget blue butterflies experienced a 21% reduction in larval development time from the date of treatment to eclosure (Russell and Schultz 2010, p. 53).

Stark *et al.* (2012, pp. 26-27) found that early instar Behr's metalmark butterfly (*Apodemia virgulti*) larvae exposed to field rates of triclopyr, sethoxydim, and imazapyr reduced the number of adults that emerged from pupation by 24-36%, perhaps due to effects from inert ingredients or indirect effects on food plant quality. Another study with the Karner blue butterfly (*Lycaeides melissa samuelis*) found that direct application of glyphosate to butterfly eggs had no apparent effect on egg survival and larval development; however, treatments with a glyphosate-triclopyr mix resulted in 22% reduction in egg hatching rates (Sucoff *et al.* 2001, p. 18). These studies indicate that the direct application of herbicide onto eggs, larvae, and larval host plants can result in reduced rates of larva-to-adult survival in some butterfly species, emphasizing the need for careful management using selective applications in habitats occupied by threatened or endangered butterfly species.

Herbicides may affect TCB by causing host or nectar plant mortality during the season of use by butterfly individuals as juveniles or adults. Herbicides may also affect the larvae if the larvae consume treated vegetation or are directly exposed. Spot-spraying of herbicides may occur in occupied habitat under the proposed action. Spot-spray applications target invasive plants, but there is a potential for adjacent host plants (and any TCB on those plants) to be exposed to herbicide. Based on the information presented above, this exposure is reasonably certain to result in sub-lethal or lethal effects to butterfly larva, and reduce overall survival rates from early instar development to adult emergence. However, we expect that the proposed conservation measures (targeted application, less toxic formulations, and conservative application timing) are adequate to minimize the risks of herbicide exposure to the local butterfly populations, and that the resulting mortality would be significantly less than the 21 to 36% mortality rate suggested by the authors referenced above (Sucoff *et al.* 2001, Russell and Schultz 2010, Stark *et al.* 2012). Those higher mortality rates were associated with broadcast application (consistent application across all plants and larva in the study). Instead, we expect that relatively few larvae (less than 1% of the larval population) would be exposed to herbicides applied through spot spraying, and that the incidental loss of larval host plants and nectar sources will be minimal.

Spot-spraying at occupied areas is reasonably certain to result in lethal and sublethal effects to less than 1% of the larval population present at the site. We anticipate that as much as all of the estimated acreage that could potentially be occupied and affected by the permitted restoration activities in Oregon and Washington (4,391 acres) may receive spot-spray herbicide applications each year. An unknown number of TCB larvae associated with those acres are reasonably certain to be killed from exposure to herbicides. The potential for crushing TCB while implementing this work is addressed under *Foot Traffic*, below.

Herbicides are recognized as an important tool for managing invasive plants and maintaining habitat for butterflies. Invasive plants are a leading threat to at-risk butterfly populations and are directly linked to the decline and extirpation of TCB populations throughout the subspecies range (Stinson 2005, pp. 101-102). Conversion of a diverse prairie plant community to one dominated by invasive weeds is clearly more deleterious to prairie butterflies than documented herbicide-induced impacts (Schultz *et al.* 2011, p. 373). Land managers in the south Puget Sound that are currently using herbicides to manage invasive plants at rare butterfly sites are successfully using BMPs to minimize effects to non-target plant species with no observable impact to the local butterfly populations (e.g., Fimbel and Dunn, 2012, Hays 2010). We anticipate similar population-scale impacts as a result of herbicide application associated with the proposed action.

3.10.9.4 Tree/Vegetation Removal

Proposed restoration projects may include removing trees and other vegetation from occupied sites while TCB larval are in extended diapause *(*September 10 to February 15). Tree/vegetation removal may affect TCB by altering habitat conditions in occupied habitat. Tree/vegetation removal would improve habitat conditions for TCB by reducing competition for host and nectar plants and by maintaining the vegetative structure that TCB prefer. A description of the importance of maintaining early seral structure and preventing conifer encroachment was previously discussed under *Prescribed Fires*, above. The permitted tree and vegetation removal would have a significant beneficial effect on TCB in the action area. The potential for crushing

TCB while implementing this work will be addressed under *Foot Traffic*, below.

3.10.9.5 Seeding and Planting

Proposed restoration projects would include planting native prairie plant species as plugs or seed to improve habitat conditions for TCB in the action area. This section describes the wholly beneficial effects of seeding and planting native species. The conversion of degraded prairie to high-quality habitat for TCB is the single most important ecological factor for continued TCB survival. Native species plantings to benefit butterflies are a key final stage in prairie restoration. We anticipate that the increased abundance and diversity of native plants on the landscape would improve the resiliency of TCB populations from both atmospheric and anthropogenic sources of mortality. The proposed action to continue planting native species would have a significant beneficial effect on TCB in the action area. The potential for crushing TCB while implementing this work will be addressed under *Foot Traffic*, below.

3.10.9.6 Maintenance and/or Installation of Fencing

Restoration projects may include maintenance and/or installation of livestock exclusion fencing and maintenance and/or installation of fencing/gating to exclude off-road vehicles and restrict recreational use. Fencing would generally reduce adverse effects to TCB in all life-history stages, but incidental mortality may occur during fence installation or maintenance. The potential for crushing TCB while implementing this work will be addressed under *Foot Traffic*, below. Other than the associated foot traffic, the installation and maintenance of fencing is extremely unlikely to directly affect TCB and will provide long-term benefits by excluding potential sources of mortality (people, animals, vehicles, etc.).

3.10.9.7 Livestock Grazing

Proposed projects may use grazing livestock as a restoration technique in habitat occupied by TCB, if the Action Agencies have coordinated with the landowner to create a grazing plan. A grazing plan is an agreement between the landowner and the Action Agencies about how many livestock shall graze for how long; depending on the location, total area, number of paddocks, livestock species, livestock quantity, availability of water resources, vegetative composition, etc. As described in the conservation measures section above, grazing would only occur while TCB are in diapause (September 10 to February 15).

Managed intensive grazing can be a cost-effective restoration technique, particularly when the lands targeted for restoration already have co-use and shared objectives with livestock operations. Livestock grazing removes above-ground biomass and can change the structure and composition of grassland/prairie habitats. Restoration objectives are met when the intensity and timing of livestock grazing corresponds with and reduces the growth of nonnative invasive plants and therefore opens up growing space and reduces competition for native plants. The duration of grazing cannot be static, instead the soil conditions and vegetation height must be monitored and livestock moved accordingly. Although the usefulness of managed intensive grazing varies by location and butterfly species of interest, several studies have shown that grazing as a tool for restoration can improve the abundance and/or diversity of butterfly species compared to ungrazed areas in similar conditions (e.g., WallisDeVries and Raemakers 2001, Vogel *et al.* 2007).

TCB rely on forbs to complete their life cycle. Livestock, particularly cattle, tend to selectively graze introduced grasses in preference to forbs (Weiss 1999, p. 1484). Additionally, TCB host plants and nectar plants are almost entirely spring perennials that senesce by late summer. Livestock grazing for TCB habitat restoration, accordingly, allows a limited number of animals to graze for a limited amount of time after host and nectar plants have senesced and TCB have entered diapause. Grazing is stopped when vegetative targets are met. Specific limitations and vegetative targets are set by the grazing plan.

Livestock grazing may affect TCB when this restoration activity occurs in occupied habitats. Larvae of *E. editha* diapause in a sheltered spot under rocks, dry wood and vegetation, or in the soil and plant litter at the base of a host or nonhost plant (Kuussaari et al 2004, p. 140; Moore 1989, p. 1727), a behavior that may lead to surviving potential trampling by livestock. However, when livestock grazing is allowed in TCB-occupied habitat, some incidental mortality from livestock trampling is inevitable. Regardless, the anticipated beneficial effects on habitat conditions (vegetation structure and composition) would lead to a net positive effect on the local population. We anticipate that a small fraction of the estimated 4,391 acres that may be occupied and affected by the permitted restoration activities in Oregon and Washington could be grazed by livestock each year. An unknown number of TCB larvae associated with those acres are reasonably certain to be crushed and killed by the hooves of livestock.

3.10.9.8 Surveys in Support of Habitat Restoration
Surveys in support of habitat restoration may include surveys for TCB or for other physical and biological attributes of the area. Where these surveys occur in TCB occupied habitat, TCB may be affected by the foot traffic associated with the surveys. The potential for crushing TCB while implementing this work will be addressed under *Foot Traffic*, below.

3.10.9.9 Foot Traffic
Foot traffic is associated with all of the surveying and restoration actions that could be funded or carried out by the proposed programs. Foot traffic in occupied habitats is likely to adversely affect TCB because of the potential for crushing TCB in all life stages. Adults are vulnerable during cold and wet weather when they are perched in a state of torpor and unable to flush away from foot traffic. Juvenile life stages are constantly vulnerable to being crushed by foot traffic unless they have entered diapause in a well-sheltered or protected location. The Action Agencies and funded entities will reduce, but not avoid, the probability of crushing TCB under foot by abstaining from restoration work during the flight season (and in some cases during all times outside of extended diapause), minimizing foot traffic in occupied and suitable TCB habitat, and by attempting to avoid stepping on larval food and host plants.

The probability of foot traffic crushing TCB individuals is dependent on the frequency of foot traffic and the abundance/density of TCB in the area. WDFW, while surveying a TCB site (Bald Hill in the South Puget Sound) in 2004, made a rough calculation of the percentage of individuals that were likely to be killed by foot traffic during transect surveys (Linders 2013). This reproducible calculation made a series of conservative assumptions and concluded that 0.36% of the population could be killed each year by crushing during three days of protocol transect surveys through densely occupied habitat. We believe this is a reasonable worst-case representation of likely effects.

Surveying and restoration actions that may be funded or carried out by the proposed programs would cause a level of foot traffic that is reasonably certain to result in crushing some TCB individuals in all life stages at occupied sites each year during the indefinite term of the proposed action. Using WDFW's conservative calculation for the impact of foot traffic during surveys, and adding a margin of error to account for other activities funded and carried out by the proposed programs that would involve foot traffic, foot traffic is reasonably certain to result in the death of no more than 1% of the TCB individuals at each occupied site each year. However, given the uncertainties associated with this estimate, and the difficulty in applying this calculation to other anticipated types of foot traffic, the potential for foot traffic to crush TCB is better described in terms of the total area that is likely to receive foot traffic under the proposed programs. An unknown number of TCB individuals associated with the 4,391 acres that could potentially be occupied and affected by the permitted restoration activities in Oregon and Washington are reasonably certain to be killed by foot traffic.

3.10.9.10 Summary of the Effects of the Proposed Action

Some activities will have insignificant and discountable effects each year during the indefinite duration of the proposed action. Specifically, 1) all authorized activities that occur outside of occupied habitat, and 2) surveys, tree/vegetation removal, seeding, planting, and fencing [excluding the effects of foot traffic] are not likely to adversely affect TCB.

Some activities are reasonably certain to adversely affect TCB individuals each year at occupied sites during the indefinite duration of the proposed action. In implementing surveys and restoration actions, incidental mortality of TCB is unavoidable due to their small size, year-round occupancy, and the short and fragile nature of their lives. Specifically, an unknown number of TCB (mostly larvae) associated with up to 4,391 acres of occupied habitat receiving restoration treatments (prescribed fires, mowing, herbicide application, livestock grazing, and the foot traffic associated all activities) would be killed. All of the activities to be funded or carried out by the proposed programs will also have beneficial effects for TCB individuals and populations each year during the indefinite duration of the proposed action.

The activities allowed under the proposed permit are all actions that ameliorate the factors responsible for the imperiled condition of TCB. Specifically, the factor that would be addressed by the activities above is "habitat loss through conversion and degradation of habitat from successional changes to grassland habitat … and the spread of invasive plants" (USFWS 2013, p. 61452). Implementation of these programs is critical for the recovery of the species because the action area represents almost the entire remaining habitat for the species throughout its range, and thus the conservation role of the action area is to sustain and recover the species.

Habitat loss, habitat fragmentation, and invasive species have reduced TCB populations range-wide to such a degree that the species is now heavily dependent on land managers to restore habitat and provide for dispersal and colonization opportunities. Colonization opportunities are critical because the dispersal abilities of TCB are not great enough to connect the patches of habitat that still exist within the range of the species. For the conservation of checkerspots "…there will need to be an ability to recolonize new habitat and provide for genetic exchange, which is essential to the long-term viability (survival) of the species" (USFWS 2012, p. 61976). Similarly, active habitat management is now necessary to replace lost ecosystem processes and the cessation of burning by Native Americans. A focus on the quality, quantity, and distribution of TCB habitat is paramount. "Butterfly conservation is usually best accomplished through habitat preservation, in part, because their numbers cannot be readily managed" (New *et al.* 1995; cited in Stinson 2005, p. 85). Despite the potential for future changes in conditions due to climate change in the action area, we have not identified, nor are we aware of, any data on an appropriate scale to predict the effects of climate change on habitat for, or the population trends of, TCB.

The anticipated beneficial effects of the proposed programs are likely to have a significantly greater effect on TCB abundance, distribution, and population stability than the anticipated adverse effects. As asserted in the previous paragraphs, habitat conditions are a more significant controller of TCB abundance and persistence than direct sources of mortality that occur on a limited spatial scale (e.g., footprints, mower tracks, or spot spraying of herbicide). The conservation measures included in the proposed action are expected to effectively reduce those sources of mortality.

The three most important factors for the continued survival of TCB range-wide are 1) TCB distribution across multiple habitat patches that have heterogeneous habitat characteristics within sites and between sites, 2) continued habitat restoration at currently occupied sites and sites targeted for future translocation; and 3) continued use and expansion of programs to provide for demographic support and colonization opportunities. The proposed restoration activities related to the second factor and hopefully improve the first factor in the process. Incidental mortality, as reduced by the conservation measures in this proposed action, is not expected to measurably reduce TCB distribution or increase the likelihood of extirpation even in the short-term or at small spatial scales. Therefore, we do not expect that the proposed programs would contribute to an appreciable reduction in the likelihood of survival and recovery of TCB in the wild at the scale of an occupied site, or within the listed range of the species (which is synonymous with the action area). In fact, the proposed programs are expected to greatly contribute to the survival and recovery of TCB in the wild throughout the action area.

3.10.10 Conclusion for Taylor's Checkerspot Butterfly

After reviewing the current status of TCB, the environmental baseline for the action area, the effects of the Action Agencies' proposed restoration programs, and the cumulative effects, it is the Service's Opinion that the activities implemented under the PROJECTS restoration program are not likely to jeopardize the continued existence of TCB.

This no jeopardy finding for the TCB is supported by the following:

1. The proposed action may temporarily disturb up to 4,391 acres of potentially suitable or occupied habitat for the TCB each year. The restoration activities may have short-term adverse effects to TCB, but are necessary to restore and maintain high-quality habitat for this species. Significant long-term beneficial effects to the butterfly are anticipated from these activities.
2. Most of the restoration activities will be implemented when TCB is in diapause, thereby minimizing effects to adult butterflies.
3. Proposed PDC and conservation measures will minimize lethal and sublethal effects to butterfly eggs and larvae, including areal limitations for the several activities (prescribed burning and herbicide use) that cannot avoid adverse effects. These areal limitations

allow a proportion of the population in untreated areas at the site to recolonize the restored area the following year.

3.10.11 Literature Cited for Taylor's Checkerspot Butterfly

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3.11 Vernal Pool Fairy Shrimp

3.11.1 Legal Status

The Service listed the vernal pool fairy shrimp (fairy shrimp) as a threatened species on September 19, 1994, along with three other fairy shrimp species, primarily due to the present or threatened destruction, modification, or curtailment of their habitat or range (USFWS 1994). The vernal pool fairy shrimp has a recovery priority number of 2C (based on a 1-18 ranking system where 1 indicates the highest recovery priority and 18 the lowest priority), which signifies that the species is subject to a high degree of threat, but also has a high potential for recovery (USFWS 2007).

3.11.2 Critical Habitat Description

Critical habitat for fairy shrimp, along with 14 other vernal pool species, was originally designated in a final rule published on August 6, 2003 (USFWS 2003). A revised final rule for critical habitat, with a re-evaluation of non-economic exclusions, was published in 2005 (USFWS 2005a). Administrative revisions with species-by-unit designations were published on February 20, 2006, providing 35 critical habitat units for fairy shrimp totaling 597,821 acres in Oregon and California (USFWS 2006). The Oregon units occur approximately 201.2 km (125 miles) north of the nearest unit designated for this species in California. The Service identified critical habitat areas essential to the conservation of fairy shrimp to reflect the species geographic distribution and varying habitat types and species associations across its range.

In Oregon, 7,574 acres of vernal pool habitat were designated as critical habitat for fairy shrimp, all in Jackson County. These habitats were selected due to the high probability of long term sustainability of the function and habitat value, based on current biological and physical conditions present at the site. Approximately 80% of currently existing vernal pool habitat is contained within designated critical habitat for fairy shrimp.

The Service cannot quantify in any meaningful way to determine what proportion of each critical habitat unit may actually be occupied by the fairy shrimp (USFWS 2011). Therefore, areas of unoccupied habitat are probably interspersed with areas of occupied habitat in each unit. The inclusion of unoccupied habitat in critical habitat units reflects the dynamic nature of the habitat and the life history characteristics of the fairy shrimp. Unoccupied areas provide areas into which populations might expand, provide connectivity or linkage between groups of organisms within a unit, and support populations of pollinators and seed dispersal organisms. Both occupied and unoccupied areas that are designated as critical habitat are essential to the conservation of the species.

3.11.2.1 The Primary Constituent Elements (PCEs)

The following two PCEs of designated critical for fairy shrimp are:

1) Vernal pools, swales, and other ephemeral wetland features of appropriate sizes and depths that typically become inundated during winter rains and hold water for sufficient lengths of time necessary for the fifteen species to complete their life cycle.
2) The geographic, topographic, and edaphic features that support aggregations or systems of hydrologically interconnected pools, swales, and other ephemeral wetlands and depressions within a matrix of surrounding uplands when taken together form

hydrologically and ecologically functional units called vernal pool complexes. These features contribute to the filling and drying of the vernal pool, maintain suitable periods of pool inundation, and maintain water quality and soil moisture to enable the fifteen vernal pool species to carry out their lifecycles (USFWS 2006).

3.11.3 Species Description

The vernal pool fairy shrimp are aquatic members of the Crustacean order Anostraca in the Branchinectidae family (USFWS 1992). They are endemic to ephemeral freshwater habitats, such as vernal pools and swales. The fairy shrimp is a thin "shrimp like" invertebrate that ranges in size from 10.2 to 25.4 mm (0.4 to 1.0 inch) (Eng *et al.* 1990).

Fairy shrimp have delicate elongate bodies which are encased in a translucent shell, which can be whitish or dusky colored. They have large stalked compound eyes, no carapace, and 11 pairs of orange-colored swimming legs. Fairy shrimp swim or glide gracefully upside down by means of complex beating movements of their legs that pass in a wave-like anterior to posterior direction. Fairy shrimp have two pairs of antennae. The second pair of antennae in the adult females is cylindrical and elongate, but the males' antennae are greatly enlarged and specialized for clasping the females during copulation. The females carry the fertilized eggs in a discernible oval or elongate ventral brood sac.

The fairy shrimp is endemic to California and the Agate Desert of southern Oregon in Jackson County. Of the federally-listed vernal pool crustaceans, this fairy shrimp has the widest geographic range, but it is seldom abundant where found, especially where it co-occurs with other species (Eng *et al.* 1990; Eriksen and Belk 1999).

3.11.3.1 Life History and Habitat Requirements

Vernal pool fairy shrimp have an ephemeral life cycle and exist only in vernal pools or vernal pool-like habitats; the species does not occur in riverine, marine, or other permanent bodies of water. They are ecologically dependent on seasonal fluctuations in their habitat, such as absence or presence of water during specific times of the year, duration of water, and other environmental factors including specific pH levels, salinity, temperature, and quantities of dissolved oxygen. Water chemistry is one of the most important factors in determining the distribution of fairy shrimp (Belk 1977). Roughly 80% of observations of the shrimp are from vernal pools (Helm 1998; Helm and Vollmar 2002). Vernal pools are a prominent feature of the Agate Desert landform in the Agate Desert.

Fairy shrimp inhabit vernal pools with clear to tea-colored water, most commonly in grass-or mud-bottomed swales, or basalt flow depression pools in unplowed grasslands (USFWS 2011). This species has a sporadic distribution within vernal pool complexes wherein the majority of pools in a given complex typically are not inhabited by the species. Fairy shrimp typically are found at low population densities. Eggs (or cysts) are speculated to be dispersed by "hitching a ride" on the legs or feet of wading birds or other animals passing through the pool, or by animals that ingest the eggs. They can mature quickly, with populations persisting in short-lived shallow pools, but they also can persist later into the spring where pools are longer lasting.

Fairy shrimp first hatch at the bottom of the vernal pool when water temperatures reach 10 °C (50 °F)(USFWS 2011). Under optimal conditions they undergo a series of molts before reaching maturity in about 2 1/2 weeks, when they are approximately 5 to 20 mm (0.2 inches to 0.8 inches) in length. They have been reported to live anywhere from 2 to 4 1/2 months, depending on many environmental factors (Eriksen and Belk 1999). These fairy shrimp often disappear early in the season long before the vernal pools dry up. Many species of insects, amphibians, waterfowl and crustaceans prey on fairy shrimp, making this species an important link in the food web, particularly as a supply of energy for migratory birds. Variation in environmental conditions such as precipitation amount, precipitation timing, and temperature, influence vernal pool species including hatching and reproduction of fairy shrimp from year to year (Eriksen and Belk 1999, Helm 1998).

When the pools refill in the same or subsequent seasons some, but not all, of the cysts/eggs may hatch. Fairy shrimp respond to inherent variability in climatic conditions by producing eggs with different diapause characteristics in each clutch. Some hatch after a single wet and dry cycle; while others may go through several wet/dry cycles before they hatch. The egg bank in the soil may also be comprised of individuals from several years of breeding. Fairy shrimp typically produce only one clutch of eggs each year and then dies (Belk 1977).

3.11.4 Rangewide Status and Distribution

At the time they were listed, there were 32 known populations of the fairy shrimp including a total of 178 occurrence records, all within California (USFWS 2007). In 1998, fairy shrimp were subsequently discovered in two distinct vernal pool habitats in Jackson County Oregon. After in depth mapping and assessment surveys were conducted across the Rogue Valley in 1997 and 1998, 17 population centers are known in the Klamath Mountains Vernal Pool Region, corresponding to 17 critical habitat subunits, all located approximately 209.2 km (130 miles) north of the species' previously known range (ONHP 1999, Service 2006). In Oregon, the vernal pool fairy shrimp is known only from the Middle Rogue River Subbasin.

The range-wide status of the fairy shrimp was assessed in the 2005 Recovery Plan (USFWS 2005b) and the 2007 Five-Year Review (USFWS 2007). In Oregon, status of the Klamath Mountains Vernal Pool Region was assessed in the Recovery Plan for Rogue and Illinois Valley Vernal Pool and Wet Meadow Ecosystems (USFWS 2012). The Service is in the process of finalizeing its most current Five-Year review for fairy shrimp (USFWS 2015). Within the range of the vernal pool fairy shrimp, required surveys for federally-listed crustaceans have increased the recorded observations of the shrimp (USFWS 2007), but no new observations have been documented in Oregon outside of the 17 critical habitat units. As of 2007, there were currently 400 "occurrences" posted on the California Natural Diversity Database. However, the number of occurrence records overstates the number of separate localities that have been recorded for the shrimp. Most additional occurrences recorded since listing are in areas where the shrimp were already known to exist.

The Recovery Plan delineates a total of 85 core recovery areas that are based on mapped areas of extant vernal pool habitat and that are deemed necessary to recover one or more listed vernal pool species (USFWS 2007). As of 2007, the vernal pool fairy shrimp is presumed to occur in at least one pool in 45 of the core recovery areas. The occurrences are few, small, and/or fragmented. Ten core recovery areas in California have relatively large areas of extant vernal pool habitat where known records of the shrimp are located within or near to the core area (USFWS 2007).

No change in the fairy shrimp listing status was recommened in the Five-Year review (USFWS 2007). Threats such as the loss of vernal pool habita primiarly due to wide spread urbanization were evaluated and have continued to act on the fairy shrimp since 2007 (USFWS 2015). The construction of infrastructure associated with urbanization has also contributed greatly to the loss and fragmentation of vernal pool species. Habitat loss exacerbates the highly fragmented distribution of this species. Direct losses of habitat generally represent an irreversible damage to vernal pools. The alternative and destruction of habitat disrupts the physical processes conducive to functinos veral pool ecosystems. Vernal pool hydrologogy maybe altered by further changes to the patterns of surface and subsurface flow due to the increase in the runoff associated with infrastructure. While there have been continued losses of vernal pool habitat throught the various vernal pool regions identified in the 2005 Recovery Plan (USFWS 2005b), to date, no project has prosed a level of effect for which the Service issued a biological opinion of jeopardy to fairy shrimp (USFWS 2015).

3.11.5 Threats, Reasons for Listing

In the 1994 listing rule, fairy shrimp were listed as threatened due to habitat loss in the form of human-caused activities, primarily urban development, water supply/flood control activities, and conversion of land to agricultural use. Habitat loss can occur from direct destruction and modification of pools due to filling, grading, disking, leveling, and other activities, as well as modification of surrounding uplands that alters vernal pool watersheds. Although progress has been made in protecting remaining large expanses of land from development in some regions, threats such as habitat loss and fragmentation have continued in every vernal pool region (USFWS 2007).

Vernal pool fairy shrimp occurrences continue to be threatened by conversion of natural habitat for urban and agricultural uses (USFWS 2007). Fragmentation of habitat due to these causes results in isolated occurrences of this species in some core areas. Highly fragmented populations are thought to be highly susceptible to extirpation due to environmental disturbance. If an extirpation event occurs in a population that has been fragmented, the opportunities for natural re-colonization will be greatly reduced due to physical isolation from source populations.

In addition to direct habitat loss, fairy shrimp populations have declined from of a variety of activities that degrade existing vernal pools by altering pool hydrology (water regime). Vernal pool hydrology can be altered by a variety of activities, including the construction of roads, trails, ditches, or canals that can block the flow of water into, or drain water away from, the vernal pool complex.

Vernal pool hydrology can also be altered by the nonnative grasses that occur commonly in vernal pool complexes. Nonnative grasses maintain dominance at pool edges, sequestering light and soil moisture, promoting thatch build-up, and shortening inundation periods. Although the mechanism responsible for the change in inundation is not documented, reduction in inundation period is thought to be due to increased evapo-transpiration at the vernal pools (Marty 2005).

Cessation of cattle grazing has been found to exacerbate the negative effects of invasive nonnative plants on vernal pool inundation period, presumably due to the positive effects of grazing on evapo-transpiration rates. The change in vernal pool inundation due to loss of grazing is an emerging threat for vernal pool species (C. Martz, CDFG, *pers. comm*. 2006). Vernal pool inundation has been reduced by 50-80% in the southeastern Sacramento Valley when grazing is discontinued (Marty 2005). Vernal pool habitat in southwest Oregon has similar climate and dominance of annual invasive plants as the Sacramento Valley vernal pool habitat; accordingly this could apply to Oregon vernal pools as well (S. Friedman, USFWS, *pers. comm.* 2014). The smaller and shallower vernal pools that were not mowed or grazed were observed to lose their wetland characteristics over relatively short periods of time (Marty 2005). Borgias (2004) considered that mowing or burning, if performed at the appropriate time, like grazing, can reduce annual accumulated thatch growth which stifles native plant seedling emergence and plant recruitment.

3.11.5.1 Effects of Climate Change

Climate change has the potential to adversely affect the vernal pool fairy shrimp through changes in vernal pool inundation patterns and temperature regimes (USFWS 2007). Drought is likely to decrease or terminate reproductive output as pools fail to flood, or dry up before reproduction is complete. Weather conditions which cause vernal pool inundation followed by quick drying patterns would promote hatching, but then drying would occur before fairy shrimp are fully developed. This might lead to a long term decline in the resistance and resilience of vernal pool fairy shrimp populations and depletion of the egg banks.

Vernal pool crustaceans have developed life history strategies to survive drought periods (USFWS 2007). They are, however, adapted to complete their life cycles within limited temperature ranges and require a minimum length of inundation to reach maturity and reproduce. Although vernal pool fairy shrimp mature relatively fast, they are able to produce more eggs when water conditions are suitable for a longer period of time (see Eriksen and Belk 1999; Helm 1998). Climate change is expected to lead to increased variability in precipitation (McLaughlin *et al.* 2002), and to increased loss of soil moisture due to evaporation and transpiration of water from plants (Field *et al.* 1999), which may exacerbate effects due to drought.

3.11.5.2 Vernal Pool Conservation Strategy

The Service recently prepared a recovery plan for the listed species of the Rogue Valley Vernal Pool and Illinois Valley Wet Meadow Ecosystems (USFWS 2012). This recovery plan sets out specific goals, objectives and tasks to direct recovery efforts for Cook's desert parsley and large-flowered woolly meadowfoam and included specific goals, objectives and tasks to direct recovery efforts for the fairy shrimp in Oregon.

Strategies to protect and recover the fairy shrimp rely primarily on preservation and restoration/creation of vernal pool habitat (USFWS 2005b, USFWS 2012). In Oregon, approximately 2,550 acres of vernal pool habitats, including mitigation banks, have been set aside for the fairy shrimp. The fairy shrimp is protected on U.S. Bureau of Land Management, U.S. Bureau of Reclamation, Oregon State lands (such as ODOT managed properties) and receives protection on TNC's Agate Desert, Rogue River Plains, and Whetstone Savannah Preserves (USFWS 2012) in Oregon.

The overall recovery goal for fairy shrimp in this area is to protect 85% of the 5,000 acres of remaining suitable vernal pool habitat (4,250 acres) (USFWS 2011). To date, approximately

2,547 acres are currently protected (Table 27) (S. Friedman, USFWS, *pers. comm*. 2015). Management plans for several of these protected areas need to be finalized and implemented. The Klamath Mountain vernal pool region is expected to be a significant contributor to the recovery of fairy shrimp (USFWS 2011). As such, the Service has developed the following guidance for vernal pool conservation in this area:

- A minimum of 4,300 acres of vernal pool habitat should be protected through ownership, management; or conservation easement or agreement.
    - A minimum of 1,500 acres should be protected in the form of conservation banks.
        - Conservation banks should be a minimum of 150 acres. Banks can be composed of discontinuous parcels, with a core parcel of a minimum of 100 acres. Banks smaller than 100 acres can be approved on a case-by-case basis.
        - Conservations banks or bank parcels shall be located within the historical range of the agate-winlo soil type. Existing vernal pool habitat can be conserved, restored and enhanced. Re-creation of vernal pool habitat (re-creation of surface topography where the underlaying duripan layer is intact), may be considered on a case-by-case basis.
        - Creation of vernal pools (making vernal pool habitat in upland area) is considered a possible option at this time. Consideration of creating vernal pools will be on a case-by-case basis.
- A minimum of 1,100 acres should be protected in the form of conservation easements or agreements.
- This conservation effort should be distributed throughout the Agate Desert and Table Rocks area. The arrangement of the protected parcels will allow for a network of protected parcels with a maximum distance of 3.2 km (2 miles) from the nearest parcel.

This includes approximately:

- 180 acres of conservation banks in various stages of establishment,
- 130 acres in conservation easements,
- 550 acres administered by Federal agencies,
- 800 acres in state ownership,
- 660 acres owned by TNC.

Approximately 1,700 acres still need to be protected to meet the recovery objective for the Klamath Mountain Vernal Pool region.

3.11.6 Conservation Measures for Vernal Pool Fairy Shrimp

The following conservation measures are proposed for fairy shrimp:

a. For all activities, care shall be taken to avoid trampling or damaging fairy shrimp during its active life stages (outside of the egg stage), which occurs when pools are inundated for 2 to 3 weeks typically sometime between October 15 to March 15. Care shall also be taken to avoid damaging vernal pool habitats during all activities year-round.

Table 27. Acres of Critical Habitat, by CHU, by ownership, providing Habitat Protection for vernal pool fairy shrimp, as of December 2014.

Land Parcel	CHU#	Ownership	Acres Of Critical Habitat
Wildlands Bank	CHU1	Wildlands, Inc.	120
Parson's Easement	CHU1	Private	40
Rogue Plains Reserve	CHU1	The Nature Conservancy (TNC))	100
Agate Reservoir	CHU2	U.S. Bureau of Reclamation	154
Jackson County School District #9	CHU2	Jackson County School District #9	34
Hornecker	CHU2	Private	5
ODOT Dutton road mitigation area	CHU2	Oregon Department of Transportation	4
Jackson Sports Park	CHU2	Jackson County	73
Agate Desert Preserve	CHU3	TNC	53
Denman Wildlife Area[29]	CHU3	Oregon Department of Fish & Wildlife	720
Whetstone Preserve	CHU3	TNC	144
ODOT Conservation Bank	CHU3	Oregon Department of Transportation	200
City of Medford	CHU3	City of Medford	3
Bear Creek Valley Sanitary Authority	CHU3	City of Medford	5
Upper and Lower Table Rock	CHU4	BLM	892
Total			**2,547**

b. Population surveys to determine presence/absence will be conducted as needed. All surveyors must have current Service permits and follow terms and conditions of the permit and Service survey guidelines (USFWS 2011).
c. Mowing/Mechanical: Manual and mechanical treatments for invasive and non-native plant control may occur anytime of the year adjacent to occupied habitat or fairy shrimp critical habitat if listed plants are not present. If listed plants are present, manual and mechanical treatments are allowed during the listed plant dormancy periods (typically from mid-June to January).
d. Raking: Raking may be permitted any time of year if location does not have listed plant presence or during summer/fall dormancy from mid-June to January.
e. Shade Cloth: Use of shade cloth in uplands around the vernal pool flanks (when pools are wet) to control non-native invasive plants is allowed if location has been determined to have no listed plant species present. Shade cloth may be also be used in the flanks or basins when pools are no longer inundated.
f. Sod Rolling: Sod rolling is not permitted in vernal pool complexes unless area has been cleared for presence of listed plants and vernal pool fairy shrimp.
g. Tilling/Disking: Tilling and disking is not permitted in vernal pool habitat.

[29] This Area is composed of the Military Slough Tract (1,178 acres) and the Hall Tract (620 acres). A 12-acre wetland mitigation site is also located within the Military Slough Tract for impacts associated with the filling of 3 acres of wetlands at the Medford Airport.

h. Tree Removal: If large vegetation is removed in close proximity to vernal pool habitat, trees shall be felled away from the pools. Any fallen trees shall be carefully removed from the habitat to minimize disturbance to vegetation.
i. Livestock Grazing: Livestock grazing may be used in critical habitat or any habitat occupied by fairy shrimp, but will be managed with seasonal restrictions or with rotational grazing to allow the vernal pool habitats to rest every 2 to 3 years.
j. Burning: Burning is permissible any time of year. No buffers are required around pools.
k. Herbicides: Herbicides may be used in habitat surrounding vernal pools to control of noxious and invasive weed infestations when other approved methods are not expected to effective. Only herbicides listed as appropriate for riparian/aquatic use in PDC 29 will be used, and application of herbicides will occur when vernal pools are dry. Herbicide applications will maintain a 3 m (10 feet) buffer from the high water mark of each pool.

3.11.7 Environmental Baseline for Vernal Pool Fairy Shrimp

The Action Area includes approximately 9,470 acres of vernal pool complexes in Jackson County, Oregon. The action area comprises the entire Klamath Mountain Vernal Pool Recovery Region, which includes both relatively intact and disturbed vernal pool habitat, as well as areas with designated critical habitat and no critical habitat.

Oregon is the extreme northern extent of the species' range (USFWS 2007). Within the Klamath Mountains region, there are three core recovery areas, the Agate Desert, White City, and Table Rocks, all clustered within 20 km (12.4 miles) of each other near Medford, Jackson County, Oregon (USFWS 2005b). Originally, vernal pool habitat covered approximately 21,000 acres in the Agate Desert-Rogue River Plains region. Estimates by the Oregon Natural Heritage Program suggest that the range of the vernal pool fairy shrimp in Oregon has most likely declined by 75% (USFWS 2006). Residential, commercial, and industrial development, along with land leveling (primarily for agriculture), has altered nearly 60% of the historic range of the Agate Desert landform. The remainder of the habitat is either severely altered by historic and continuing land uses, or occurs along the fringes of the landform where vernal pools are weakly expressed.

Human population growth in Jackson County is occurring at a very rapid rate. Much of this growth is taking place near Medford and White City in the heart of the Agate Desert with an increase in residential, commercial, and industrial development and subsequent loss of vernal pool habitat. Several development projects have resulted in the destruction of vernal pool habitat in Jackson County, especially near White City and Medford (USFWS 2011). An economic impact study forecasts the loss of 1,843 acres of vernal pool habitat in the next 20 years due to development (Itter and Flight 2010).

Thus, most of the fairy shrimp occupied sites in Oregon are moderately to highly disturbed due to expanding commercial and residential development and agricultural activities in the area (USFWS 2012). Urban development, incompatible agriculture practices, mining, habitat alteration due to invasion of nonnative species, habitat fragmentation and degradation, and other human-caused disturbances have resulted in substantial losses of seasonal wet meadow habitat throughout the historical range of fairy shrimp. Conservation needs include establishing a network of protected populations in natural habitat distributed throughout their native range.

To date, vernal pool fairy shrimp populations and habitats are protected on 15 different parcels totaling 2,547 acres in Oregon (Table 27) (S. Friedman, USFWS, *pers. comm*. 2015). Although over 2,500 acres (both Federal and non-federal lands) receive protection, approximately1,700 acres still need to be protected to meet the recovery objective for the Klamath Mountain Vernal Pool region. On non-Federal lands, protected areas include three Nature Conservancy Preserves totaling 297 acres, a conservation bank totaling 120 acres, and the 720-acre Oregon Department of Fish and Wildlife's Denman Wildlife Management Area. Within federally-managed lands in Oregon, the U.S. Bureau of Land Management provides protection on 892 acres and the Bureau of Reclamation on 154 acres. However, other areas in Oregon with extant vernal pools appear to have degraded conditions for the vernal pool fairy shrimp. Surveys conducted by TNC have shown a variable range in occurrence, with fairy shrimp occurring in 50% of the pools sampled at the Agate Desert Preserve and 8% of the pools sampled at the Denman Wildlife Management Area (USFWS 2012).

3.11.8 Effects to Vernal Pool Fairy Shrimp

Proposed restoration activities may occur in vernal pool habitats occupied by fairy shrimp and may affect fairy shrimp. Direct and indirect effects to fairy shrimp may occur when implementing any of the restoration/recovery activities under the various project categories described in the proposed action. However, fairy shrimp are most likely to be affected by techniques for prairie restoration (mowing, herbicide use, burning, grazing, and plant propagation) and wetland restoration (re-grading, etc). Activities implemented near or within fairy shrimp occupied habitats will have the greatest impact to the species.

Short term impacts of the action will include the direct and indirect effects to fairy shrimp, with intentional and possible incidental harassment, injury and/or death of a limited number of individuals. Earth-moving work in and around occupied vernal pool and wetland habitats will have the most potential adverse effects to the fairy shrimp. Adverse effects, especially in occupied habitats, include, but are not limited to, the following restoration/recovery activities:

- Surveys,
- Manual and mechanical removal of vegetation,
- Herbicide applications,
- Prescribed burns,
- All wetland restoration activities,
- Planting native vegetation.

For all of the above restoration activities, the presence of vehicles, equipment, and foot traffic (including grazing animals) to complete these activities all have the potential of causing soil disturbance and compaction that may negatively affect vernal pool complexes, including alteration of soil hydrology; and lethal or sub-lethal loss of eggs, cysts, and/or adults fairy shrimp via trampling or crushing. In some instances, cysts may be transported via mud on equipment or foot traffic (including grazing animals) to unsuitable habitats. PDC and conservation measures will minimize these impacts, but cannot completely avoid some mortality.

3.11.8.1 Surveys in Support of Habitat Restoration

Surveys in support of habitat restoration may include surveys for fairy shrimp or for other physical and biological attributes of the area. Where these surveys occur in occupied habitat, fairy shrimp may be affected by the foot traffic associated with the surveys.

3.11.8.2 Vegetation Removal- All Methods

Vegetation removal will occur by a variety of methods and may occur adjacent to vernal pools and ephemeral wetland used by fairy shrimp; however, it is unlikely that persons or vehicles would enter the pools to accomplish these activities. Thus, no negative effects to adults are anticipated. Manual activities (use of hand tools such as hoeing, digging, clipping, *etc.*) will have minimal adverse effects. Anticipated negative effects to fairy shrimp from other methods are described below in the section entitled Use of Vehicles and Heavy Equipment. However, all vegetation removal for restoration activities are expected to have long-term beneficial effects to vernal pool complexes and adjacent native prairie habitats.

3.11.8.3 Herbicide applications

Herbicide applications have the potential to negatively affect invertebrates, including fairy shrimp. Available information on effects to organisms was summarized by the Action Agencies and provided the PROJECT BA's Appendix entitled *Detailed Effects and Rish Assessment for Herbicide Use*. From that information, the proposed herbicides are "practically non-toxic" to bees, and range from "practically non-toxic" to "highly toxic" for aquatic organisms. However, PDC limit the use of the more toxic herbicides for use with fairy shrimp; this and other PDC will reduce toxicity effects to fairy shrimp.

Herbicide use in vernal pool habitat can kill fairy shrimp by poisoning. Also herbicides could cause sub-lethal effect to fairy shrimp food or prey via non-lethal toxicity, which could impact potential sensory, mobility, or reproductive processes for a limited period of time. Not much is known about specific adverse effects of herbicides on fairy shrimp, but several adverse effects are possible. All fairy shrimp life stages may be affected due to herbicides reaching these non-target species from herbicide drift, over-spray, run-off, and/or soil transport. However, the potential for herbicides to come into contact with fairy shrimp will be eliminated or minimized based on the following information:

- Habitat application limitations.
- Types of herbicides to be used near aquatic habitats.
- Implementation of herbicide-related PDC, and conservation measures for fairy shrimp.

3.11.8.4 Prescribed Burns

Burning is a necessary tool to maintain and create habitat in open areas with native vegetation, like those that support vernal pools and fairy shrimp. In burn plots at project sites, mortality of eggs/cysts in burnable areas is expected to be 100%. If pools are still present when the fire occurs, we anticipate that some cysts would survive, but cannot assume that at this time.

3.11.8.5 Foot Traffic

Foot traffic is associated with all of the proposed surveying and restoration actions. Foot traffic, (both humans and grazing animals) in occupied habitats may affect fairy shrimp because of the potential for crushing all life stages. Entry into vernal pool habitat from other habitats could also introduce non-native invasive plants capable of displacing native plant communities in favor of a non-native plant community. This in turn, could negatively affect vernal pool hydrology and limit the inundation period and thus decrease the breeding cycle and reproduction at the affected site. However, the proposed PDC should minimize these potential effects.

3.11.8.6 Use of Vehicles and Heavy Equipment

Equipment and vehicle entry into vernal pool habitat could introduce non-native invasive plants capable of displacing native plant communities in favor of a non-native plant community. This in turn, could negatively affect vernal pool hydrology and limit the inundation period and thus decrease the breeding cycle and reproduction at the affected site. Similarly, use of heavy equipment has the potential of causing soil disturbance and compaction that may negatively affect vernal pool hydrology, which could also negative affect vernal pools and the fairy shrimp that depend on them, especially if earth-moving / regrading is necessary.

Changes to the perched water table can lead to alterations in the rate, extent, and duration of inundation (water regime) of remaining habitat. The biota of vernal pools and swales can change when the hydrologic regime is altered (Bauder 1986, 1987). Survival of aquatic organisms like fairy shrimp is directly linked to the water regime of their habitat (Zedler 1987). Therefore, some restoration activities near vernal pool areas may, at times, result in the failure of local sub-populations of vernal pool organisms, including fairy shrimp. However, we do not expect earth-moving or regrading to occur in occupied sites, unless necessary to maintain the long-term suitability of the site to support vernal pools and fairy shrimp. We expect such instances to be uncommon; and most large projects would restore degraded sites that are likely unoccupied. Use of vehicles and heavy equipment in occupied habitats may result in crushing eggs or adult fairy shrimp. The propsed PDC should minimize these potential effects. Tilling and disking is not permitted in vernal pool habitat, so these activites will have no effect.

3.11.9 Summary of Effects for Vernal Pool Fairy Shrimp

Proposed restoration activities in and around vernal pool complexes have the potential to negatively affect fairy shrimp and their habitats. The Service estimates that restoration activities under this consultation would be carried out on no more than 266 acres of fairy shrimp habitat per year. Restoration actions will be designed to maintain or improve habitat for fairy shrimp, and in some instances may be necessary to maintain habitat suitability for fairy shrimp. Multiple PDC and species-specific conservation measures are proposed to avoid and minimize impacts to fairy shrimp and include species monitoring. Implementation of some of these restoration activities may result in some adverse effects to individual fairy shrimp; however, we anticipate these effects will be short term in nature, localized to the project site, and not detectable at the population level. We cannot calculate the number of shrimp or eggs that might be killed or injured by incidental exposure to herbicides or other restoration actions, but expect the actual effect to be low given the numerous proposed PDC and species-specific conservation measures. These short-term adverse effects will be small and of limited duration, and are necessary to achieve long-term, beneficial effects to fairy shrimp and vernal pool habitats that support this species. Most impacts to fairy shrimp resulting from these activities are expected to be insignificant, but there some will be harmed or killed. Thus, these activities may affect, and are likely to adversely affect fairy shrimp.

Over 4 years (2011 to 2014), PFW worked in 17 projects that restored 642 acres of upland habitat in Jackson County, Oregon that may have affected fairy shrimp. The Service's Recovery Program funded an additional 2 restoration projects benefitting fairy shrimp between 2012 and 2014. We anticipate few if any aquatic projects funded by the NOAA RC (which target anadromous salmonids) will occur in habitats occupied by fairy shrimp. We also estimate up to 5 additional restoration projects implemented by other parties could be covered under this

Opinion per year, as described in the Introduction in the section entitled *Action Area and Requirements for Coverage.*

Given this information, we anticipate that an annual average of 7 projects averaging 38 acres each (or 266 acres annually) will negatively affect fairy shrimp in the short-term. Given the importance of restoration activities to maintaining vernal pool habitats, the limited number and average size of the potential restoration projects relative to number of population occurrences and acres of occupied habitat, the numerous PDC and proposed conservation measures to minimize the number of fairy shrimp adversely affected by the proposed action, and the anticipated long-term benefits from each project to native habitats and listed species in the long-term, we conclude the proposed restoration actions will not jeopardize the continued existence of fairy shrimp.

We estimate the proposed action may directly or indirectly affect up to 266 acres of fairy shrimp associated vernal pool complex per year in Jackson County, Oregon. The impacts associated with these restoration actions are anticipated to be positive and beneficial for the conservation and recovery of the species. Short-term adverse effects resulting from these otherwise beneficial actions are inherently very near-term and temporary in nature, and will be significantly minimized by the proposed PDC and species-specific conservation measures. Collectively, the proposed restoration activities will not appreciably reduce the size, distribution, or viability/productivity of fairy shrimp at the local, regional, or range-wide scales, and will not appreciably reducing the function and value of designated critical habitat or its PCEs. The proposed restoration activities will result in maintaining or improving habitat conditions above baseline.

3.11.10 Effects to Critical Habitat for Vernal Pool Fairy Shrimp

The PCEs for fairy shrimp are described earlier in this Opinion, Briefly, PCEs are vernal pool and similar wetland features, and the geographic, topographic, and edaphic features that support aggregations or systems of hydrologically interconnected pools, swales, and other ephemeral wetlands and depressions within a matrix of surrounding uplands.

Restoration activities most likely to affect the PCEs of fairy shrimp critical habitat include wetland restoration techniques (regrading, etc) and some prairie restoration techniques. Restoration in vernal pool complexes may alter soil and hydrologic conditions, resulting in short-term, adverse effects to these PCEs. Use of heavy equipment has the potential of causing soil disturbance and compaction that may negatively affect vernal pool hydrology, which could also negative affect vernal pools, especially if earth-moving/ regrading is necessary. However, extensive restoration projects involving regrading and other ground disturbing actions are likely to occur in areas that do not already contain highly functioning vernal pool or wetland complexes. Thus, the anticipated adverse effects are likely to be short-term in nature with likely long-term benefits to listed species, native habitats and vernal pool complexes.

In the long-term, habitat manipulation, restoration, and enhancement activities will have beneficial effects on vernal pool complexes, resulting in an increase in abundance of the PCEs of critical habitat for this species. While there may be short-term adverse effects to PCEs of critical habitat for the fairy shrimp, the numerous proposed PDCs and proposed conservation measures have been designed to substantially minimize or eliminate these effects. Each project is intended to benefit native habitats, and the size and extent of a typical restoration project is very small relative to the overall size and extent of designated critical habitat. Thus, the long-term effects of the proposed activities are not likely to diminish the values of these critical habitats for the purpose for which it was designated. Thus, the proposed activities will not destroy or adversely modify the PCEs of critical habitats for fairy shrimp.

3.11.11 Conclusion for Vernal Pool Fairy Shrimp

After reviewing the current status of fairy shrimp, the environmental baseline for the action area, the effects of the Service's proposed restoration programs, and the cumulative effects, it is the Service's Opinion that the activities implemented under the proposed restoration program are not likely to jeopardize the continued existence of fairy shrimp.

This no jeopardy finding for the fairy shrimp is supported by the following:

1. The proposed action may temporarily disturb up to 266 acres of occupied habitat for the fairy shrimp each year. The restoration activities may have short-term adverse effects, but will have a net positive impact on the species via - a) protection and maintenance of existing properly functioning habitats; b) restoration and enhancement of currently impaired habitats; c) increased occurrence of these beneficial activities in habitat areas (including critical habitat) identified as high-value/high-priority for conservation action; d) reduction of ongoing adverse impacts that are currently not subject to appropriate mitigation; and e) constraining remaining adverse impacts to scale, scope, and location determined by the recovery plan and associated local conservation strategy to be consistent with long-term survival and recovery of the species.
2. The proposed restoration and project design criteria are consistent with the vernal pool conservation strategy for Jackson County, Oregon (USFWS 2011) and the goals and objectives of the Final Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon (USFWS 2005b) and associated strategies developed for Jackson County, Oregon (USFWS 2011, 2012). All of these documents provide guidance to improve conditions for vernal pools and fairy shrimp.
3. The proposed PDC and specific conservation measures for fairy shrimp are expected to significantly constrain the overall amount and extent of adverse effects to the species and to ensure that the majority of such adverse effects are short-term and temporary in nature, while the restoration projects will benefit the conservation and recovery of the species.

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3.12 Mazama Pocket Gophers (Roy Prairie, Olympia, Tenino and Yelm Pocket Gophers)

3.12.1 Legal Status

On April 9, 2014, the Service published a final rule in the Federal Register listing four subspecies of the Mazama pocket gopher as threatened throughout their ranges in the State of Washington (USFWS 2014a) (*Thomomys mazama glacialis, T. m. pugetensis, T. m. tumuli, and T. m. yelmensis*, a.k.a. the Roy Prairie pocket gopher, Olympia pocket gopher, Tenino pocket gopher, and Yelm pocket gopher, respectively).

3.12.2 Critical Habitat

In total, approximately 1,607 acres in Thurston County, Washington, fall within the boundaries of the final critical habitat designation for the Olympia, Tenino, and Yelm pocket gophers (USFWS 2014b). All critical habitat proposed for the Roy Prairie pocket gopher (*T. m. glacialis*), in Pierce County, Washington, was exempted under section 4(a)(3)(B)(i) of the ESA; therefore there is no final critical habitat for this subspecies. We proposed critical habitat only in areas within the geographical area we consider likely occupied at the time of listing, and all provide one or more of the physical or biological features that may require special management considerations or protection. The Service has designated three units totaling 1,607 acres as critical habitat for the Olympia, Tenino, and Yelm subspecies of the Mazama pocket gopher. Each unit is presently occupied, or likely to be occupied, by the subspecies for which it is designated, and contains one or more of the PCEs to support essential life-history processes for that subspecies.

The PCEs of Critical Habitat

The PCEs mentioned at the time of listing include:

(1) Soils that support the burrowing habits of the Mazama pocket gopher. These are usually friable, loamy and deep, generally on slopes less than 15%, usually well-drained. Soils series in which each subspecies (O = Olympia pocket gopher; T = Tenino pocket gopher, and Y = Yelm pocket gopher) had been found at the time of listing include: Alderwood (O, Y), Cagey (O), Everett (O, T, Y), Godfrey (Y), Indianola (O), Kapowsin (Y), McKenna (O, Y), Nisqually (O, T, Y), Norma (O, T, Y), Spana (O, Y), Spanaway (T, Y), Spanaway-Nisqually complex (O, T, Y), Yelm (O, Y).

(2) Areas equal to or larger than 50 acres in size that provide for breeding, foraging, and dispersal activities, found in the soil series or soil series complexes listed in (1), above, that have:

a. Less than 10% woody vegetation cover;
b. Vegetative cover suitable for foraging by pocket gophers. The pocket gophers' diet includes a wide variety of plant material, including leafy vegetation, succulent roots, shoots, tubers, and grasses.
c. Few, if any, barriers to dispersal within the unit or subunit. Barriers to dispersal may include, but are not limited to, forest edges, roads (paved and unpaved), abrupt elevation changes, Scot's broom thickets, highly cultivated lawns, inhospitable soil or substrates, development and buildings, slopes greater than 35% , and open water.

The critical habitat areas we describe constitute our current best assessment of areas that meet the definition of critical habitat for the Olympia, Tenino, and Yelm pocket gophers. The three units we designate as critical habitat are: 1) Olympia Pocket Gopher Critical Habitat - Olympia Airport Unit; 2) Tenino Pocket Gopher Critical Habitat - Rocky Prairie Unit; and 3) Yelm Pocket Gopher Critical Habitat - Tenalquot Prairie Subunit and Rock Prairie Subunit. The approximate area and landownership for each critical habitat unit and subunit is described in Table 28.

Table 28. Designated Critical Habitat Units and Subunits for the Olympia, Tenino, and Yelm Subspecies of the Mazama Pocket Gopher (USFWS 2014b).

Critical habitat unit	Location name	Subunit as identified in proposed rule	Federal	State	Private	Other*
			Ac (Ha)	Ac (Ha)	Ac (Ha)	Ac (Ha)
Olympia Pocket Gopher Critical Habitat.	Olympia Airport Unit	1–C	0	0	0	676 (274)
Tenino Pocket Gopher Critical Habitat.	Rocky Prairie Unit	1–D	0	0	399 (162)	0
Yelm Pocket Gopher Critical Habitat.	Tenalquot Prairie Subunit	1–E	0	0	154 (62)	135 (55)
	Rock Prairie Subunit	1–H	0	0	243 (98)	0
Totals			0	0	796 (322)	811 (329)

* Other = Local municipalities and nonprofit conservation organization.
Note: Area sizes may not sum due to rounding.

All units are subject to some or all of the following threats: Loss of habitat through conversion to incompatible uses, such as development, or pit mining; loss of natural disturbance processes and invasion by woody plants; predation; small or isolated populations as a result of habitat fragmentation; control as a pest species; and habitat degradation or destruction due to the inadequacy of existing regulatory mechanisms. The threats of loss of ecological disturbance processes, invasive species and succession, and control as a pest species are threats to the Tenino pocket gopher in the Rocky Prairie Unit and the Yelm pocket gopher in the Tenalquot Prairie and Rock Prairie Subunits.

In all units, the physical or biological features essential to the conservation of each subspecies may require special management considerations or protection to restore, protect, and maintain the essential features found there. Special management considerations or protection may be required to address: Direct or indirect habitat loss due to conversion to other uses; invasion of woody plant species; use of equipment that may compact soils; development; construction and maintenance of roads and utility corridors; habitat modifications; predation by feral or domestic animals; or use of trapping or poisoning techniques by landowners or land managers of the units themselves or adjacent landowners or land managers.

Olympia Pocket Gopher Critical Habitat - Olympia Airport Unit: This unit consists of 676 acres and includes land owned by the Port of Olympia, a municipal corporation. The Olympia Airport Unit is located south of the cities of Olympia and Tumwater, in Thurston County, Washington. This unit is occupied by the Olympia pocket gopher and contains the physical or biological features essential to the conservation of the subspecies due to the underlying soil series (Cagey, Everett, Indianola, and Nisqually), suitable forb and grass vegetation present onsite, and its large size. The physical or biological features in this subunit are threatened by: Loss of habitat through conversion to incompatible uses, such as development; predation; and the habitat degradation or destruction due to the inadequacy of existing regulatory mechanisms.

Tenino Pocket Gopher Critical Habitat - Rocky Prairie Unit: This unit consists of 399 acres and is owned by one commercial land owner and Burlington Northern Santa Fe Railroad. The Rocky Prairie Unit is located north of the city of Tenino, Thurston County, Washington; is likely occupied by the Tenino pocket gopher; and contains the physical or biological features essential to the conservation of the species due to the underlying soil series or soil series complex (Everett, Nisqually, Spanaway, and Spanaway-Nisqually complex), suitable forb and grass vegetation present onsite, and its large size. The physical or biological features in this subunit are threatened by: Loss of habitat through conversion to incompatible uses, such as pit mining; development on adjacent or surrounding areas; the loss of natural disturbance processes and invasion by woody plants; predation; small or isolated populations as a result of habitat fragmentation; habitat degradation or destruction as the result of the inadequacy of existing regulatory mechanisms; and control as a pest species.

Yelm Pocket Gopher Critical Habitat - Tenalquot Prairie Subunit: This subunit consists of 289 acres and includes lands owned by one commercial landowner and TNC. This subunit is located northwest of the city of Rainier, Thurston County, Washington. As proposed, subunit 1–E (Tenalquot Prairie Subunit) included 1,505 acres of JBLM land, which has been exempted based on a completed Endangered Species Management Plan. This 4(a)(3)(B)(i) exemption, based on this species specific management plan, has been determined to provide a conservation benefit to the Yelm pocket gopher. The Tenalquot Prairie Subunit is occupied by the Yelm pocket gopher and contains the physical or biological features essential to the conservation of the species due to the underlying soil series (Spanaway), suitable forb and grass vegetation present onsite, and its large size. The physical or biological features in this subunit are threatened by: Loss of habitat through conversion to incompatible uses, such as development; the loss of natural disturbance processes and invasion by woody plants; inadequacy of existing regulatory mechanisms; and control as a pest species.

Yelm Pocket Gopher Critical Habitat - Rock Prairie Subunit: This subunit consists of 243 acres and includes lands owned by one private residential and commercial landowner. As proposed (subunit 1–H), this subunit included 378 acres of private ranch land, which has been excluded under section 4(b)(2) of the ESA. The Rock Prairie Subunit is likely occupied by the Yelm pocket gopher and contains the physical or biological features essential to the conservation of the species due to the underlying soil series or soil series complex (Spanaway and Spanaway-Nisqually complex), suitable forb and grass vegetation present onsite, and its size. The physical or biological features in this subunit are threatened by: Loss of habitat through conversion to incompatible uses, such as development; the loss of natural disturbance processes and invasion by woody plants; predation; inadequacy of existing regulatory mechanisms; and control as a pest species.

Effects of Climate Change on Olympia, Tenino, and Yelm Pocket Gopher Critical Habitat

Shifts in temperature, precipitation, and soil moisture may result in changes in the vegetation structure through woody plant invasion and encroachment and thus affect the habitat for all pocket gopher species and subspecies in the region. Despite this potential for future environmental changes, we have not identified nor are we aware of any data on an appropriate scale to evaluate impacts to designated Olympia, Tenino, and Yelm pocket gopher critical habitat, or to make predictions about whether critical habitat will be significantly impacted by climate change.

3.12.3 Species Description

Adult Mazama pocket gophers are reddish brown to black above, and the underparts are lead-colored with buff-colored tips. The lips, nose, and patches behind the ears are black; the wrists are white. Adults range from 7 to 189 to 220 mm (9 inches) in total length, with tails that range from 45 to 85 mm (2 to 3 inches) (Verts and Carraway 2000, p. 2). Mazama pocket gophers are morphologically similar to other species of pocket gophers that exploit a subterranean existence. They are stocky and tubular in shape, with short necks, powerful limbs, long claws, and tiny ears and eyes. Their short, nearly hairless tails are highly sensitive and probably assist when navigating tunnels. The "pockets" are external, fur-lined cheek pouches on either side of the mouth that are used to transport nesting material and plant cuttings. Mazama pocket gophers reach reproductive age in the spring of the year after their birth and produce litters between spring and early summer. Litter size ranges from one to nine (Wight 1918, p. 14), with an average of five (Scheffer 1938, p. 222). They do not hibernate in winter; they remain active throughout the year (Case and Jasch 1994, p. B-20).

The four Thurston/Pierce subspecies of the Mazama pocket gopher are found only in Pierce and Thurston Counties, Washington. Their populations are concentrated in well-drained, friable soils often associated with glacial outwash.

3.12.3.1 Taxonomy

Although the species *Thomomys mazama*, or Mazama pocket gopher, includes numerous subspecies that are found in the States of Washington, Oregon, and California, only the four Thurston/Pierce subspecies are federally listed. An additional 11 unlisted subspecies occur in Washington (4, including one that's presumed extinct), Oregon (5), and California (1), with another one occurring in both Oregon and California.

The first pocket gophers collected in western Washington were considered subspecies of the northern pocket gopher (*Thomomys talpoides*) (Goldman 1939), until 1960 when the complex of pocket gophers found in western Washington was determined to be more similar to the western pocket gopher (*T. mazama*) (Johnson and Benson 1960, p. 20). Eight western Washington subspecies of Mazama pocket gopher (*T. mazama*, *ssp. couchi*, *glacialis*, *louiei*, *melanops*, *pugetensis*, *tacomensis*, *tumuli*, and *yelmensis*) have been identified (Hall 1981, p. 467). *Thomomys mazama* is recognized as a valid species by the Integrated Taxonomic Information System (ITIS 2012). Although there have been suggestions that potential changes to the classification of some of these subspecies should be considered, we have no information to suggest that any of the presently recognized subspecies are the subject of serious dispute.

We follow the subspecies designations of Verts and Carraway (2000), as this text represents the currently accepted taxonomy for the species *T. mazama*. Verts and Carraway (2000, p.1) recognize *T. m. glacialis*, *pugetensis*, *tumuli*, and *yelmensis* as separate subspecies (the Roy Prairie, Olympia, Tenino, and Yelm pocket gophers, respectively) based on morphological characteristics, distribution, and differences in number of chromosomes. These four subspecies occur in relatively close proximity to each other geographically, and at least three of them occur in the same clade.

3.12.3.2 Habitat and Life History

The four Thurston/Pierce subspecies of the Mazama pocket gopher (pocket gopher) are associated with glacial outwash prairies in Pierce and Thurston Counties, Washington, an ecosystem of conservation concern (Hartway and Steinberg 1997, p. 1). Steinberg and Heller (1997, p. 46) found that pocket gophers are even more patchily distributed than are prairies, as there are some seemingly high quality prairies within the species' range that lack pocket gophers; *e.g.,* Mima Mounds Natural Area Preserve (NAP), and 13th Division Prairie on Joint Base Lewis-McChord (JBLM).

Pocket gopher distribution is affected by the rock content of soils, drainage, forage availability, and climate (Case and Jasch 1994, p. B-21; Hafner *et al.* 1998, p. 279; Reichman 2007, pp. 273-274; Steinberg and Heller 1997, p. 45; Stinson 2005, p. 31; WDFW 2009). Prairie and meadow habitats used by pocket gophers have a naturally patchy distribution. In their prairie habitats, there is an even patchier distribution of soil rockiness which may further restrict the total area that pocket gophers can utilize (Steinberg and Heller 1997, p. 45; WDFW 2009). We assume that meadow soils have a similarly patchy distribution of rockiness, though the soil surveys to support this are, at this time, incomplete.

The four Thurston/Pierce subspecies of the Mazama pocket gopher are currently known to occupy the following soils series: Alderwood, Cagey, Carstairs, Everett, Everett-Spanaway complex, Everett-Spanaway-Spana complex, Godfrey, Grove, Indianola, Kapowsin, McKenna, Murnen, Nisqually, Norma, Shelton, Spana, Spana-Spanaway-Nisqually complex, Spanaway, Spanaway-Nisqually complex, and Yelm.

In the above list, we purposely avoid using specific map unit names, because we know that there are imperfections in soil mapping. Maps are based on the technology, standards, and tools available at the time soil surveys were conducted, sometimes up to 50 years ago. We recognize that soil survey boundaries may be adjusted in the future, and that soil series names may be added or removed to soil survey maps and databases. As a result, the overlap of pocket gopher locations with soil series names may be different in the future. The soils information presented here is based on best scientific data available at the time of listing.

We also recognize that some of these soil series or soil series complexes are not typically either deep or well-drained. For a variety of reasons, mapped soil types may or may not have all of the characteristics described by the U.S. Department of Agriculture, Natural Resources Conservation Service, and the actual soils that occur on sites may have characteristics that make them more or less habitable by pocket gophers. These reasons may include: map boundary or transcription errors, map projection errors or differences, map identification or typing errors, soil or hydrological manipulations that have occurred since mapping took place, and small-scale inclusions that are different from the mapped soil. Because soils are mapped at large scales, mapped soils may not identify smaller inclusions.

Any of the soil series or soil series complexes listed above could potentially be suitable for the four Thurston/Pierce subspecies of the Mazama pocket gopher. And, the four Thurston/Pierce subspecies of the Mazama pocket gopher may also inhabit soil series not included in the above list. Although some soils are sandier, more gravelly, or may have more or less silt than described, most all soils used by pocket gophers are friable (easily pulverized or crumbled), loamy, and deep, and generally have slopes less than 15% .

A study of the relationship between soil rockiness and pocket gopher distribution revealed a strong negative correlation between the proportion of medium-sized rocks in the soil, and the presence of pocket gophers (eight of nine prairies sampled); medium sized rocks were considered greater than 12.7 mm (0.5 inch), but less than 50.8 mm (2 inches) in diameter (Steinberg 1996, p. 32). In observations of pocket gopher distribution on JBLM, pocket gophers did not occur in areas with a high percentage of Scot's broom cover (*Cytisus scoparius*), or where mole populations were particularly dense (Steinberg 1995, p. 26). A more recent study on JBLM also found that pocket gopher presence was negatively associated with Scot's broom; however, the researcher found no relationship between pocket gopher presence and mole density (Olson 2011a, pp. 12, 13).

Pocket gopher burrows consist of a series of main runways, off which lateral tunnels lead to the surface of the ground (Wight 1918, p. 7). Pocket gophers dig their burrows using their sharp teeth and claws and then push the soil out through the lateral tunnels (Case and Jasch 1994, p. B-20; Wight 1918, p. 8). Nests containing dried vegetation are generally located near the center of each pocket gopher's home tunnel system (Wight 1918, p. 10), though this may not always be the case. Food caches and store piles are usually placed near the nest, and excrement is piled into blind tunnels or loop tunnels, and then covered with dirt, leaving the nest and main runways clean (Wight 1918, p. 11).

A variety of natural predators prey on pocket gophers, including weasels (*Mustela* spp.), snakes, badgers (*Taxidea taxus*), foxes (*Vulpes* spp.), skunks (*Mephitis mephitis*), bobcats (*Lynx rufus*), coyotes (*Canis latrans*), great horned owls (*Bubo virginianus*), barn owls (*Tyto alba*), and several hawks (Case and Jasch 1994, p. B-21; Fichter *et al.* 1955, p. 13; Hisaw and Gloyd 1926; Huntly and Inouye 1988, p. 792; Stinson 2005, pp. 29, 30). In addition to natural predators, predation by feral and domestic dogs (*Canis lupus familiaris*) and cats (*Felis catus*) is an increasing problem for the four Thurston/Pierce subspecies of the Mazama pocket gopher. Pocket gophers are exposed to increased levels of this type of predation in developed semi-urban and rural environments.

Pocket gophers are generalist herbivores and their diet includes a wide variety of plant material, including leafy vegetation, succulent roots, shoots, and tubers. In natural settings pocket gophers play a key ecological role by aerating soils, activating the seed bank, and stimulating plant growth, though they can be considered pests in agricultural systems. In prairie and meadow ecosystems, pocket gopher activity plays an important role in maintaining species richness and diversity.

Foraging primarily takes place below the surface of the soil, where pocket gophers snip off roots of plants before occasionally pulling the whole plant below ground to eat or store in caches. If above-ground foraging occurs, it's usually within a few feet of an opening and forage plants are quickly cut into small pieces and carried back to the nest or cache (Wight 1918, p. 12). Any water they need is obtained from their food (Gettinger 1984, pp. 749-750; Wight 1918, p. 13). The probability of pocket gopher occupancy is much higher in areas with less than 10% woody vegetation cover (Olson 2011a, p. 16), presumably because such vegetation will shade out the forbs, bulbs, and grasses that pocket gophers prefer to eat, and high densities of woody plants make travel both below and above the ground difficult.

The pocket gopher's home range is composed of suitable breeding and foraging habitat. Home range size varies based on factors such as soil type, climate, and density and type of vegetative cover (Case and Jasch 1994, p. B-21; Cox and Hunt 1992, p. 133; Hafner *et al.* 1998, p. 279). Little research has been conducted regarding home range size for individual pocket gophers in western Washington. Witmer *et al.* (1996b, p. 96) reported an average home range size of approximately 100 m^2 (1,076 square feet) for one location in Thurston County, Washington. Pocket gopher density varies greatly due to local climate, soil suitability, and vegetation types (Case and Jasch 1994, p. B-21; Howard and Childs Jr. 1959, pp. 329-336), and densities are likely to be higher when habitat quality is better. Therefore, this one report (Witmer *et al.* 1996b) is unlikely to represent the average density across all soil types, vegetation types, and other unique site characteristics across the ranges of the four Thurston/Pierce subspecies of the Mazama pocket gopher.

Research on other species of *Thomomys* pocket gophers show a wide range of home range sizes, from approximately 7.4 to 1,335 m^2 (80 to 14,370 square feet). Studies that have included live-capture and enumeration continue to find that densities of the four Thurston/Pierce subspecies of the Mazama pocket gopher vary significantly, between sites with dissimilar characteristics, between sites with similar characteristics, and within the same sites over time.

In the absence of studies demonstrating the minimum possible patch size for persistence of pocket gophers, we used 50 acres as the smallest area necessary for contributing to the recovery of populations, which was the agreed upon estimate of an expert panel assembled to assist with the construction of a prairie habitat modeling exercise (Converse *et al.* 2010, pp. 14, 15). We acknowledge uncertainty with this estimate, but there are currently no studies regarding minimum patch size, nor are there any obvious means by which a better answer can be obtained. Thus, the best available scientific data in this case is the opinion of an informed expert panel. This does not mean that gophers cannot persist on smaller patches over time, or that those smaller patches do not play an interim role in gopher population dynamics.

Pocket gophers reach sexual maturity during the spring of the year following their birth, and generally produce one litter per year (Case and Jasch 1994, p. B-20), though timing of sexual maturity has been shown to vary with habitat quality (Patton and Brylski 1987, p. 502; Patton and Smith 1990, p. 76). Gestation lasts approximately 18 days (Andersen 1978, p. 421; Schramm 1961, p. 169). Young are born in the spring to early summer (Wight 1918, p. 13), and are reared by the female. Aside from the breeding season, males and females remain segregated in their own tunnel systems. There are 1 to 9 pups per litter (averaging 5), born without hair, pockets, or teeth, and they must be kept warm by the mother or "packed" in dried vegetation (Case and Jasch 1994, p. B-20; Wight 1918, p. 14). Juvenile pelage starts growing in at just over a week (Andersen 1978, p. 420). The young eat vegetation in the nest within three weeks of birth, with eyes and ears opening and pockets developing at about a month (Andersen 1978, p. 420; Wight 1918, p. 14). At six weeks they are weaned, fighting with siblings, and nearly ready to disperse (Andersen 1978, p. 420; Wight 1918, p. 15), which usually occurs at about two months of age (Stinson 2005, p. 26). They attain their adult weight between four and five months of age (Andersen 1978, pp. 419, 421). Most pocket gophers live only a year or two, with few living to three or four years of age (Hansen 1962, pp. 152, 153; Livezey and Verts 1979, p. 39).

Pocket gophers rarely surface completely from their burrow except as juveniles, when they disperse above- or below-ground from spring through early fall (Howard and Childs Jr. 1959, p. 312; Ingles 1952, p. 89). They may also surface above ground briefly when foraging. They are highly asocial and generally intolerant of other pocket gophers, except during mating and pup-rearing. Each pocket gopher maintains its own burrow system, and occupancy of a burrow system by multiple individuals occurs only for brief periods during mating seasons and prior to weaning young (Ingles 1952, pp. 88, 89; Marsh and Steele 1992, p. 209; Witmer and Engeman 2007, p. 288).

The mating system is probably polygynous (a single male mates with multiple females) and most likely based on female choice. The adult sex ratio has been reported as biased toward females in most species of pocket gophers that have been studied, often as much as 4:1 (Howard and Childs Jr. 1959, p. 296; Patton and Feder 1981, p. 917), though Witmer *et al.* (1996a, p. 95) reported a sex ratio of close to 1:1. Sex ratio may vary with population density, which is often influenced by forage density and soil suitability for burrowing (Patton and Smith 1990, p. 6). One site having a deep soil layer with considerably less rock was estimated to have a pocket gopher population density five times that of another site having rocky soil (Steinberg 1996, p. 26).

Pocket gophers have limited dispersal capabilities (Williams and Baker 1976, p. 303). Mazama pocket gophers are smaller in size than other sympatric or peripatric *Thomomys* species (Verts and Carraway 2000, p. 1). Both dispersal distance and home range size are therefore likely to be smaller than for other *Thomomys* species. Dispersal distances may vary based on surface or soil conditions and size of the animal. For other, larger, *Thomomys* species, dispersal distances average about 40 m (131 feet) (Barnes Jr. 1973, pp. 168, 169; Daly and Patton 1990, pp. 1286, 1288; Williams and Baker 1976, p. 306). Initial results from research being conducted on JBLM, indicates that juvenile pocket gophers usually make movements from 4 to 10 m (13.1 to 32.8 feet), though these may not be dispersal movements. One juvenile made a distinct dispersal movement of 160 m (525 feet) in a single day (Olson 2012, p. 5).

Suitable dispersal habitat is free of barriers to movement, and may need to contain foraging habitat if an animal is required to make a long-distance dispersal movement. Potential barriers include, but are not limited to, forest edges, roads (paved and unpaved), abrupt elevation changes, Scot's broom thickets (Olson 2012, p. 3), highly cultivated lawns, inhospitable soil types or substrates (Olson 2008, p. 4), development and buildings, slopes greater than 35% , and open water. Barriers may be permeable, meaning that they impede movement from place to place without completely blocking it, or they may be impermeable, meaning they cannot be crossed. Permeable barriers, as well as lower quality dispersal habitats, may present a risk of mortality for animals that use them (*e.g.,* open areas where predation risk is increased, or a paved area where vehicular mortality is high).

3.12.4 Population Estimates Rangewide

There are few data on historical or current population sizes of the four Thurston/Pierce subspecies of the Mazama pocket gopher, although several local populations are believed to be extinct. Knowledge of the past status of the four Thurston/Pierce subspecies of the Mazama pocket gopher is limited to distributional information.

Recent surveys have focused on determining current distribution, primarily in response to development applications. In addition, in 2012, the WDFW initiated a five county-wide distribution survey. Because the object of all of these surveys has mainly been presence/absence only, total population numbers for each subspecies are unknown. And, the precise boundaries of each subspecies' range are not currently known. Local population estimates have been reported but are based on using apparent gopher mounds to delineate the number of territories, a method that has not been validated (Stinson 2005, pp. 40, 41). Olson (2011a, p. 2) evaluated this methodology on pocket gopher populations at the Olympia Airport and Wolf Haven International. Although there was a positive relationship between the number of mounds and number of pocket gophers, the relationship varies spatially, temporally, and demographically (Olson 2011a, pp. 2, 39). Based on the results of Olson's 2011 study, we believe past population estimates (Stinson 2005) may have been too high. As there is no generally-accepted standard survey protocol to determine population size for pocket gophers, it is not currently possible to obtain an estimate of subspecies population sizes or trends. Overall habitat availability has declined, however, and habitat has a finite ability to support pocket gophers. For these reasons, the Service concludes that the overall population trend of each of the four Thurston/Pierce subspecies of the Mazama pocket gopher is negative.

Increased survey effort since 2007 has resulted in the identification of numerous additional occupied sites located on private lands, especially in Thurston County (e.g., WDFW 2013a). Some of these new detections are adjacent to other known occupied sites, such as the population at the Olympia Airport. The full extent of these smaller discontinuous sites is currently unknown, and no research has been done to determine whether or not these aggregations are "stepping stone" sites that may facilitate dispersal into nearby unoccupied suitable habitat, or if they are population sinks (sites that do not add to the overall population through recruitment). Others of these additional occupied sites are separate locations, seemingly unassociated (physically) with known populations (Tirhi 2008, *in litt.*). The largest known expanse of areas occupied by any of the four Thurston/Pierce subspecies of the Mazama pocket gopher in Washington occur on JBLM (Roy Prairie and Yelm pocket gophers), and at the Olympia airports (Olympia pocket gopher).

A translocated population occurs on Wolf Haven International's land near Tenino, Washington. Between 2005 and 2008, over 200 gophers from a variety of areas in Thurston County (some from around Olympia Airport (Olympia pocket gopher, *T. m. pugetensis*)) and some from near the intersection of Rich Road and Yelm Highway (assumed to be Olympia pocket gophers) were released into the 38-acre mounded prairie site. Based on the best available information, we do not believe the property previously supported pocket gophers. Today, pocket gophers continue to occupy the site (Tirhi 2011, *in litt.*); however, current population estimates are not available.

Another site, West Rocky Prairie Wildlife Area, received a total of 560 translocated pocket gophers (*T. m. pugetensis*) from the Olympia Airport between 2009 and 2011. Initial translocation efforts were unsuccessful: a majority of the pocket gophers died within three days due to predation (Olson 2009, p. 3). Modified release techniques used in 2010 and 2011 resulted in improved survival rates (Olson 2011b, p. 4). It is too soon to know if the population will become self-sustaining, or if additional translocations of gophers will be necessary. This research is ongoing.

3.12.5 Threats/Reasons for Listing

The four Thurston/Pierce subspecies of Mazama pocket gopher face significant threats that contribute to a risk of extinction. Best available scientific and commercial information identifies the following significant threats to the subspecies; each of these threats is discussed in greater detail below:

1. Destruction, modification, or curtailment of habitat and range, including the on-going, cumulative effects of development, military training, and loss or curtailment of natural disturbance processes;
2. Poor connectivity between small and isolated populations; and,
3. Predation and pest control, including that which is attributable to feral and domesticated pets.

<u>Destruction, Modification, or Curtailment of Habitat and Range</u>
The primary long term threats to the pocket gopher are the loss, conversion, and degradation of habitat, particularly to urban development, successional changes to grassland habitat, and the spread of invasive plants. The threats also include increased predation pressure, which is closely linked to habitat degradation.
The prairies of south Puget Sound are one of the rarest ecosystems in the United States (Dunn and Ewing 1997b, p. v; Noss *et al.* 1995, p. I-2). Dramatic changes have occurred on the landscape over the last 150 years, including a 90 to 95% reduction in the extent of the prairie ecosystem. In the south Puget Sound region, where most of western Washington's prairies historically occurred, less than 10% of the original prairie persists, and only 3% remains dominated by native vegetation (Crawford and Hall 1997, pp. 13, 14).

Development: Native prairies and grasslands have been severely reduced throughout the range of the four Thurston/Pierce subspecies of Mazama pocket gopher, especially as a result of conversion to residential and commercial development and agriculture. Prairie habitat continues to be lost, particularly to residential development (Stinson 2005, p. 70), by removal and fragmentation of native vegetation, and the excavation, and/or heavy equipment-caused compaction of surfaces and conversion to non-habitat (*e.g.,* buildings, pavement, other infrastructure), rendering soils unsuitable for burrowing.

Residential development is associated with increased infrastructure, such as new road construction, which is one of the primary causes of landscape fragmentation (Watts *et al.* 2007, p. 736). Activities that accompany low-density development are correlated with decreased levels of biodiversity, mortality to wildlife, and facilitated introduction of nonnative invasive species (Trombulak and Frissell 2001; Watts *et al.* 2007, p. 736). In the south Puget Sound lowlands, the glacial outwash soils and gravels underlying the prairies are deep and valued for use in construction and road building, which leads to their degradation and destruction.

In the south Puget Sound, Nisqually loamy soils appear to support high densities of pocket gophers (Stinson2010a, *in litt* ; Olson 2008, p. 6), the vast majority of which occur in developed areas of Thurston County, or within the Urban Growth Areas for the cities of Olympia, Tumwater, and Lacey (WDFW 2009), where future development is most likely to occur. Where pocket gopher populations presumably extended across an undeveloped expanse of open prairie (Dalquest and Scheffer 1942, pp. 95, 96), areas currently occupied by the four Thurston/Pierce subspecies of the Mazama pocket gopher are now isolated to small fragmented patches due to development and conversion of suitable habitat to incompatible uses.

The presumed extinction of the Tacoma pocket gopher is likely linked directly to residential and commercial development, which has replaced nearly all pocket gopher habitats in the historical range of the subspecies (Stinson 2005, pp. 18, 34, 46). One of the historical Tacoma pocket gopher sites was converted to a large gravel pit and golf course (Steinberg 1996, pp. 24, 27; Stinson 2005, pp. 47, 120). In addition, two gravel pits are now operating on part of the site recognized as the type locality for the Roy Prairie pocket gopher (Stinson 2005, p. 42), and another is in operation near Tenino (Stinson 2010b, *in litt.*), in the vicinity of the type locality for the Tenino pocket gopher.

Multiple pocket gopher sites in Pierce and Thurston Counties may be, or have been, lost to gravel pit development, golf course development, or residential and commercial development (Stinson 2005, *in litt.*; Stinson 2005, pp. 26, 42; Stinson 2010b, *in litt.*). Multiple prairies that used to contain uninterrupted expanses of prairie habitat suitable for pocket gophers within the range of the four Thurston/Pierce subspecies have been developed to cities, neighborhoods, agricultural lands, or military bases, and/or negatively impacted by such development, including Baker Prairie, Bush Prairie, Chambers Prairie, Frost Prairie, Grand Mound Prairie, Little Chambers Prairie, Marion Prairie, Roy Prairie, Ruth Prairie, Woods Prairie, Violet Prairie, and Yelm Prairie. Some of these prairie areas still contain smaller areas that support pocket gophers, and some appear to no longer support pocket gophers at all (WDFW 2012).

Where their properties coincide with pocket gopher occupancy, many private lands developers and landowners in Thurston County have agreed to create set-asides or agree to other mitigation activities in order to obtain development permits from the County (Tirhi 2008, *in litt.*). However, it is unknown if any pocket gophers will remain on these sites due to the small size of the set-asides, extensive grading in some areas adjacent to set-asides, lack of dedicated funding for enforcement or monitoring of set-aside maintenance (Thurston County Long Range Planning and Resource Stewardship 2011, *in litt.*, p. 2), and lack of control of predation by domestic or feral cats and dogs. In addition, some landowners have received variances from Thurston County that allowed development to occur without a requirement to set aside areas for pocket gophers.

A population of Olympia pocket gophers is located at and around the Port of Olympia's Olympia Airport, which is sited on the historical Bush Prairie. Gophers on Bush Prairie are currently vulnerable to negative impacts from proposed future development by the Port of Olympia and ongoing development by adjacent landowners. The Port of Olympia has plans to develop large portions of the existing grassland that likely supports the largest population of the Olympia pocket gopher in Washington (Stinson 2007, *in litt.*; Port of Olympia and WDFW 2008, p.1; Port of Olympia 2012). The Olympia Airport is realigning the airport runway, which is in known occupied habitat. They continue to work with the Service and WDFW on mitigating airport expansion activities that may negatively impact gophers (Tirhi 2010, *in litt.*).

The Olympia pocket gopher has a population at the Olympia Airport that spans several hundred acres, and there are two translocated populations: one at West Rocky Prairie Wildlife Area (some individuals from the Olympia Airport) and one at Wolf Haven (individuals from the Olympia

Airport and some from near the intersection of Rich Road and Yelm Highway). The population centered on the Olympia Airport could be negatively impacted by plans for development both on and off the airport, while the two translocated populations are currently secure from intense commercial and residential development pressures as they occur on conserved lands.

The Roy Prairie pocket gopher is known to occur across a large expanse of prairie on JBLM, which is currently secure from the threat of development. The Tenino pocket gopher has a single known population, which has been detected during surveys on the Rocky Prairie NAP, although the intermittent nature of these detections suggests it must be part of a larger metapopulation that occurs across nearby areas that have not been accessible for surveys. No known development poses a threat to the NAP, but any future conversion of the surrounding area to incompatible land use would likely hinder the recovery of this subspecies. The Yelm pocket gophers on Tenalquot prairie (which is owned in large part by JBLM) and Scatter Creek Wildlife Area are also secure from such residential and commercial development, but the Yelm pocket gopher habitat on Rock Prairie north of Old Highway 99 is in an area that is likely to be developed soon, which may negatively affect any local populations in the vicinity.

Loss or Curtailment of Natural Disturbance Processes: The suppression and loss of ecological disturbance regimes across vast portions of the landscape, such as fire, has resulted in altered vegetation structure in the prairies and meadows and has facilitated invasion by native and nonnative woody vegetation, rendering habitat unusable for the four Thurston/Pierce subspecies of Mazama pocket gopher. The basic ecological processes that maintain prairies and meadows have disappeared from, or have been altered on, all but a few protected and managed sites.

Historically, the prairies and meadows of the south Puget Sound region are thought to have been actively maintained by native peoples, who lived here for at least 10,000 years before the arrival of Euro-American settlers (Boyd 1986; Christy and Alverson 2011, p. 93). Frequent burning reduced the encroachment and spread of shrubs and trees (Boyd 1986; Chappell and Kagan 2001, p. 42), favoring open grasslands with a variety of native plants and animals. Following Euro-American settlement of the region in the mid-19th century, fire was actively suppressed on grasslands, allowing encroachment by woody vegetation into the remaining prairie habitat and oak woodlands (Agee 1993, p. 360; Altman *et al.* 2001, p. 262; Boyd 1986; Franklin and Dyrness 1973, p. 122; Kruckeberg 1991, p. 287).

Fires on the prairie create a mosaic of vegetation conditions, which serve to maintain native prairie plant communities. In some prairie patches fires will kill encroaching woody vegetation and reset succession back to bare ground, creating early successional vegetation conditions suitable for many native prairie species. Early succession forbs and grasses are favored by pocket gophers. The historical fire frequency on prairies has been estimated to be 3 to 5 years (Foster 2005, p. 8). On sites where regular fires occur, there is a high complement of native plants and fewer invasive species. These types of fires maintain the native short-statured plant communities favored by pocket gophers.

The result of fire suppression has been the invasion of the prairies and oak woodlands by native and nonnative plant species (Dunn and Ewing 1997a, p. v; Tveten and Fonda 1999, p. 146), notably woody plants such as the native Douglas-fir (*Pseudotsuga menziesii*) and the nonnative Scot's broom. On tallgrass prairies in midwestern North America, fire suppression has led to degradation and the loss of native grasslands (Curtis 1959, pp. 296, 298; Panzer 2002, p. 1297). On northwestern prairies, fire suppression has allowed Douglas-fir to encroach on and out-compete native prairie vegetation for light, water, and nutrients (Stinson 2005, p. 7). This increase in woody vegetation and nonnative plant species has resulted in less available prairie habitat overall and habitat that is unsuitable for and avoided by many native prairie species, including pocket gophers (Olson 2011a, pp. 12, 16; Pearson and *et al.* 2005, pp. 2, 27; Tveten and Fonda 1999, p. 155).

Pocket gophers prefer early successional vegetation as forage. Woody plants shade out the forbs and grasses that pocket gophers prefer to eat, and high densities of woody plants make travel both below and above the ground difficult. In locations with poor forage, pocket gophers tend to have larger territories, which may be difficult or impossible to establish in densely forested areas. The probability of pocket gopher occupancy is much higher in areas with less than 10% woody vegetation cover (Olson 2011a, p. 16).

On JBLM alone, over 16,000 acres of prairie has converted to Douglas-fir forest since the mid-19th century (Foster and Shaff 2003, p. 284). Where controlled burns or direct tree removal are not used as a management tool, this encroachment will continue to cause the loss of open grassland habitats for pocket gophers and is an ongoing threat to the species.

Restoration in some of the south Puget Sound grasslands has resulted in temporary control of Scot's broom and other invasive plants through the careful and judicious use of herbicides, mowing, grazing, and fire. Fire has been used as a management tool to maintain native prairie composition and structure and is generally acknowledged to improve the health and composition of grassland habitat by providing a short-term nitrogen addition, which results in a fertilizer effect to vegetation, thus aiding grasses and forbs to sprout.

Unintentional fires ignited by military training burn patches of prairie grasses and forbs on JBLM on an annual basis. These light ground fires create a mosaic of conditions within the grassland, maintaining a low vegetative structure of native and nonnative plant composition, and patches of bare soil. Because of the topography of the landscape, fires create a patchy mosaic of areas that burn completely, some areas that do not burn, and areas where consumption of the vegetation is mixed in its effects to the habitat. One of the benefits of fire in grasslands is that it tends to kill regenerating conifers, and reduces the cover of nonnative shrubs such as Scot's broom, although Scot's broom seed stored in the soil can be stimulated by fire (Agee 1993, p. 367). Fire also improves conditions for many native bulb-forming plants, such as *Camassia spp.* (Agee and Dunwiddie 1984). On sites where regular fires occur, such as on JBLM, there is a high complement of native plants and fewer invasive species. These types of fires maintain the native, short-statured plant communities favored by pocket gophers.

Management practices such as intentional burning and mowing require expertise in timing and technique to achieve desired results. If applied at the wrong season, frequency, or scale, fire and mowing can be detrimental to the restoration of native prairie species. Excessive and high-intensity burning can result in a lack of vegetation or encourage regrowth of nonnative grasses. Where such burning has occurred over a period of more than 50 years on the artillery ranges of JBLM, prairies are covered by nonnative forbs and grasses instead of native perennial bunchgrasses (Tveten and Fonda 1999, pp. 154, 155).

Pocket gophers are not commonly found in areas colonized by Douglas-fir trees because pocket gophers require forbs and grasses of an early successional stage for food (Witmer *et al.* 1996a, p. 96). Pocket gophers observed on JBLM did not occur in areas with high cover of Scot's broom (Steinberg 1995, p. 26). A more recent study on JBLM also found that pocket gopher presence was negatively associated with Scot's broom (Olson 2011a, pp. 12, 13, 16). Some subspecies may disperse through forested areas or may temporarily establish territories on forest edges, but there is currently not enough data available to determine how common this behavior may be or which subspecies employ it. The four Thurston/Pierce subspecies of the Mazama pocket gopher occur on prairie-type habitats, many of which, if not actively managed to maintain vegetation in an early-successional state, have been invaded by shrubs and trees that either preclude pocket gophers or limit their ability to fully occupy the landscape. Typical management at civilian airports prevents woody vegetation from encroaching onto surrounding areas for flight safety reasons. Woody vegetation encroachment is therefore not a threat at civilian airports.

Military Training: Pocket gopher populations occurring on JBLM are exposed to differing levels of training activities on the base. The Department of Defense's (DOD) proposed actions under their "Grow the Army" initiative include stationing 5,700 new soldiers, new combat service support units, a combat aviation brigade, facility demolition and construction to support the increased troop levels, and additional aviation, maneuver, and live fire training (75 FR 55313, September 10, 2010). The increased training activities will affect nearly all training areas at JBLM, resulting in an increased risk of accidental fires, and habitat destruction and degradation attributable to vehicle use in occupied areas, mounted and dismounted training, bivouac activities, and digging. Even though the training areas on the base are degraded, with implementation of agreed-upon conservation measures, these areas still provide habitat for the Roy Prairie and Yelm pocket gopher.

JBLM's recently signed Endangered Species Management Plan for the Mazama pocket gopher will serve to minimize threats across the base by redirecting some training activities to areas outside of occupied habitat, designating areas where no vehicles are permitted, designating areas where vehicles will remain on roads only, and designating areas where no digging is allowed, among other conservation measures. JBLM has further committed to enhancing and expanding suitable habitat for the Roy Prairie and Yelm pocket gophers in "priority habitat" areas on base (areas that were proposed as critical habitat); enforcing restrictions on recreational use of occupied habitat by dog owners and horseback riders; and continuing to support the off-base recovery of the four Thurston/Pierce subspecies of the Mazama pocket gopher.

Several moderate- to large-sized areas supporting pocket gophers have been identified on JBLM. These areas are within the historical ranges of the Roy Prairie (Pierce County) and Yelm (Thurston County) pocket gophers. Their absence from some sites of what is presumed to have been formerly suitable habitat may be related to compaction of the soil due to years of mechanized vehicle training (Steinberg 1995, p. 36).

Training infrastructure (*e.g.,* roads, firing ranges, bunkers) also degrades pocket gopher habitat and may lead to reduced use of these areas by pocket gophers. For example, JBLM has plans to add a third rifle range on the south impact area where it overlaps with a densely occupied pocket gopher site. The area may be usable by pocket gophers when the project is completed; however, construction of the rifle range may result in removal of forage and direct mortality of pocket gophers through crushing of burrows (Stinson 2011, *in litt.*).

Recent survey access to the center of the artillery impact area on 91st Division Prairie, where bombardment is presumably of the highest intensity, did detect some unspecified level of occupancy by the Roy Prairie pocket gopher (WDFW 2013b, enclosure 1, p. 6). This apparently suitable central portion of the 91st Division Prairie is subject to repeated and ongoing bombardment, which may create an ecological trap for dispersing juveniles.
JBLM training areas have varying levels of use; some allow excavation and off-road vehicle use, while other areas have restrictions that limit off-road vehicle use. The Endangered Species Management Plan specifically requires coordination between the JBLM Fish and Wildlife personnel and the JBLM entities responsible for training activities (*e.g.,* Range Support, battalion commanders, and/or first field grade officers) to ensure all parties are aware of where occupied areas occur in relation to training activities, the effects of training, and the potential ramifications of habitat destruction or animal mortality. Since military training has the potential to directly or indirectly harm or harass pocket gophers, we conclude that these activities will negatively impact the Roy Prairie and Yelm pocket gophers.

JBLM has committed to operational restrictions on portions of the base in order to avoid and minimize potential impacts to Roy Prairie and Yelm pocket gophers. Currently-occupied areas will be buffered from training activities, with an emphasis on occupied habitat in "priority habitat" areas. Regular surveys will be conducted with the goals of determining distribution, protecting pocket gophers and their habitat from disturbance or destruction, and determining population status. Where possible, JBLM will alleviate training pressure by transferring activities to unoccupied areas where encroaching forest has been removed. This strategy has the effect of both releasing large areas of land that were historically prairie and providing unoccupied areas where training is free of the risk of negatively impacting Roy Prairie or Yelm pocket gophers. While the Service fully supports the implementation of these impact minimization efforts and will continue to collaborate with DOD to address all aspects of training impacts on the species, not all adverse impacts on pocket gophers can be fully avoided. Military training continues to pose a threat to the Roy Prairie and Yelm subspecies at this time. No military training occurs in the ranges of the Olympia or Tenino subspecies of the Mazama pocket gopher.

<u>Poor Connectivity Between Small and Isolated Populations</u>
Most species' populations fluctuate naturally, responding to various factors such as weather events, disease, and predation. Populations that are small, fragmented, or isolated by habitat loss or modification of naturally patchy habitat, and other human-related factors, are more vulnerable to extirpation by natural randomly occurring events, cumulative effects, and to genetic effect (collectively known as small population effects). These effects can include genetic drift (loss of recessive alleles), founder effects (over time, an increasing percentage of the population inheriting a narrow range of traits), and genetic bottlenecks leading to increasingly lower genetic diversity, with consequent negative effects on evolutionary potential.

To date, of the eight subspecies of Mazama pocket gopher in Washington, only the Olympic pocket gopher (unlisted; not one of the four Thurston/Pierce subspecies of the Mazama pocket gopher) has been documented as having low genetic diversity (Welch and Kenagy 2008, p. 7), although the six other extant subspecies have local populations that are small, fragmented, and physically isolated from one another.

The four Thurston/Pierce subspecies of the Mazama pocket gopher face threats from loss or fragmentation of habitat. Historically, pocket gophers probably persisted by continually recolonizing habitat patches after local extinctions. However, widespread development and conversion of habitat has resulted in widely separated populations, and intervening habitat corridors are now gone, with the effect of impeding or stopping much of the natural recolonization that historically occurred (Stinson 2005, p. 46).

Although pocket gophers are not known to have low genetic diversity, small population sizes at most sites, coupled with disjunct and fragmented habitat, may contribute to further population declines. Little is known about the local or rangewide reproductive success of the four subspecies.

Predation and Pest Control

Predation: Predation influences the distribution, abundance, and diversity of species in ecological communities. Generally, predation leads to changes in both the population size of the predator and that of the prey. In unfavorable environments, prey species are stressed or living at low population densities such that predation is likely to have negative effects on all prey species, thus lowering species richness. In addition, when a nonnative predator is introduced to the ecosystem, negative effects on the prey population may be higher than those from co-evolved native predators. The effect of predation may be magnified when populations are small, and the disproportionate effect of predation on declining populations has been shown to drive rare species even further towards extinction (Woodworth 1999, pp. 74, 75).

Predation has an impact on populations of the four Thurston/Pierce subspecies of Mazama pocket gopher. Urbanization, particularly in the south Puget Sound region, has resulted in not only habitat loss, but also increased exposure to feral and domestic cats and dogs. Cats are known to have serious impacts on small mammals and birds and have been implicated in the decline of several endangered and threatened mammals, including marsh rabbits (*Sylvilagus palustris*) in Florida and the salt-marsh harvest mouse (*Reithrodontomys raviventris*) in California (Ogan and Jurek 1997, p. 89).

Domestic cats and dogs have been specifically identified as common predators of pocket gophers (Case and Jasch 1994, p. B-21; Henderson 1981, p. 233; Wight 1918, p. 21) and at least two pocket gopher locations were found as a result of house cats bringing home pocket gopher carcasses (WDFW 2001). Informal interviews with area biologists document multiple incidents of domestic pet predation on pocket gophers (Chan 2013, *in litt.*; Clouse 2012, *in litt.*; Skriletz 2013, *in litt.*; Wood 2013, *in litt.*). There is also one recorded instance of a WDFW biologist being presented with a dead Mazama pocket gopher by a dog during an east Olympia, Washington, site visit in 2006 (Burke Museum 2012; McAllister 2013, *in litt.*). Some local populations of the pocket gopher occur in areas where people recreate with their dogs, bringing these potential predators into environments that may otherwise be relatively free of them, consequently increasing the risks to individual pocket gophers and populations that may be small and isolated.

The four Thurston/Pierce subspecies of Mazama pocket gopher occur in rapidly developing areas. Local populations that survive commercial and residential development (adjacent to and within habitat) are potentially vulnerable to extirpation by domestic and feral cats and dogs (Case and Jasch 1994, p. B-21; Henderson 1981, p. 233). As stated previously, predation is a natural part of the pocket gopher's life history; however, the effect of predation may be magnified when populations are small and habitat is fragmented. The disproportionate effect of additional predation on declining populations has been shown to drive rare species even further towards extinction (Woodworth 1999, pp. 74, 75). Predation, particularly from nonnative species, will likely continue to be a threat to the four Thurston/Pierce subspecies of the Mazama pocket gopher now and in the future. This is particularly likely where development abuts gopher habitat, resulting in increased numbers of cats and dogs in the vicinity, and in areas where people recreate with their dogs – particularly if dogs are off-leash and not prevented from harassing wildlife. In such areas, where local populations of pocket gophers are already small, this additional predation pressure (above natural levels of predation) is expected to further negatively impact population numbers.

Pest Control: Pocket gophers are often considered a pest because they sometimes damage crops and seedling trees, and their mounds can create a nuisance. Several site locations were found as a result of trapping conducted on Christmas tree farms, a nursery, and in a livestock pasture (WDFW 2001). Pocket gophers from Thurston County were used in a rodenticide experiment as recently as 1995 (Witmer *et al.* 1996a, p. 97).
In Washington State it is currently illegal to trap or poison Mazama pocket gophers, or to trap or poison moles where they overlap with Mazama pocket gopher populations, but not all property owners are cognizant of these laws, nor are most citizens capable of differentiating between moles, pocket gophers, or the signs of their habitation (*e.g.,* soil disturbance). In light of this, it is reasonable to believe that mole trapping or poisoning still has the potential to adversely affect pocket gopher populations. Local populations that survive commercial and residential development (adjacent to and within habitat) may be subsequently extirpated by trapping or poisoning. Lethal control by trapping or poisoning is most likely to be a threat to the four Thurston/Pierce subspecies where their ranges overlap residential properties.

3.12.5.1 Climate Change

The effects of climate change may be buffered by pocket gophers' fossorial lifestyle and are likely to be restricted to indirect effects in the form of changes in vegetation structure and subsequent habitat shifts through plant invasion and encroachment (Blois 2009, p. 217). Further, the impacts of climate change on western Washington are projected to be less severe than in other parts of the country. While overall annual average precipitation in western Washington is predicted to increase, seasonal precipitation is projected to become increasingly variable, with wetter and warmer winters and springs and drier, hotter summers (Mote and Salathe´ 2010, p. 34; Climatewizard 2012). These shifts in temperature, precipitation, and soil moisture may result in changes in the vegetation structure through woody plant invasion and encroachment and thus affect the habitat for all pocket gopher species and subspecies in the region. Despite this potential for future environmental changes, we have not identified nor are we aware of any data on an appropriate scale to evaluate habitat or populations trends for the four Thurston/Pierce subspecies of the Mazama pocket gopher or to make predictions about future trends and whether the subspecies will be significantly impacted by climate change.

Stochastic Weather Events: The impact of stochastic weather and extreme weather events on pocket gophers is difficult to predict. Pocket gophers may largely be buffered from these impacts due to their fossorial lifestyle, but Case and Jasch (1994, p. B-21) connect sharp population declines of pocket gophers of several genera with stochastic weather events such as heavy snow cover and rapid snowmelt with a corresponding rise in the water table. Based on our review, we found no information to indicate that the effects of stochastic weather events are a threat to any of the four Thurston/Pierce subspecies of the Mazama pocket gopher.

3.12.6 Environmental Baseline for the Mazama Pocket Gopher Subspecies and their Designated Critical Habitat

Because the range of the four subspecies and their designated critical habitat are completely subsumed by the scope of the action, the Status of the Species and Status of the Species in the Action Area (Environmental Baseline) are one and the same for the purposes of this Opinion.

3.12.7 Conservation Measures for the Mazama Pocket Gophers

The average number of acres per year (averaged over 5 years) of Mazama pocket gopher subspecies habitat expected to be treated is: Roy Prairie pocket gopher: 40 ac; Olympia pocket gopher: 135 ac; Tenino pocket gopher: 79 ac; and Yelm pocket gopher: 107 acres (Carlson 2015a, *in litt.*; Carlson 2015b, *in litt.*). Many sites will be treated in succession using multiple types of restoration, e.g., first mow, then burn, then apply herbicides, within 1 or 2 seasons or between years.

The following conservation measures should be incorporated into the project design prior to review and approval by the appropriate Service manager as required in PDC 6.c of the proposed action:

a. Determine habitat suitability and the potential for gopher occupancy. A person qualified in identifying gopher habitat suitability will assess habitat suitability throughout all areas that would be affected by the action, either directly or indirectly. If the action will require on-site staging of equipment, sourcing, stockpiling, or wasting/disposal of materials, and/or new or improved haul roads or points of access, the probable locations for these activities will be included in the survey.
b. Conduct mound surveys within suitable and potentially occupied habitat. A person qualified in identifying gopher habitat suitability will perform and gopher mound survey (Service-approved occupancy/absence survey when developed and approved, or best professional judgment of species expert) well in advance of the restoration. If such a survey protocol is not yet in place, suitable habitat will be the surrogate used for analysis of species impacts. Occupancy/absence surveys will only be conducted by or under the supervision of a qualified, trained and experienced (Service-approved) biologist. Occupancy/absence surveys should only be conducted during the months of June through October, when the likelihood of detecting and positively identifying signs of occupancy is highest, or at the time an approved protocol deems necessary.
c. Projects in pocket gopher Habitat/Potential Habitat. Projects in documented pocket gopher habitat will require approval from the local Service office prior to implementation (see PDC 6.c in Section 1.3.2.1). If there is no Service-approved occupancy/absence protocol in place, and potential habitat is being used as the surrogate, then projects in potential habitat will require approval from the local Service office prior to

implementation. The following design criteria should be incorporated into project design before seeking Service approval:

i. Identify all Mazama pocket gopher mounds in the project area. Although mounds are an imprecise measure or indicator of pocket gopher activity and occupancy, they are useful at determining occupancy when combined with other information, such as soils and historic range. Occupied gopher habitat should be assumed to extend well beyond all positively identified gopher mounds and other signs of occupancy. This enlarged area, which will generally extend to surround a grouping or cluster of observed mounds and corresponding tunnel systems, represents a Habitat Protection Area or Zone (HPA or HPZ) intended to help minimize project impacts to gophers.
ii. Projects should make significant efforts to avoid impacting HPAs or HPZs.
iii. Heavy Equipment. Heavy equipment operations pose a risk of collapsing Mazama pocket gopher tunnel systems and burrows. To minimize impacts to gophers, the following activities should be conducted on areas that will not be occupied by gophers, such as existing roads, areas lacking appropriate soil, and other developed areas.
    i. on-site staging of equipment
    ii. sourcing
    iii. stockpiling, and/or wasting/disposal of materials
    iv. new or improved haul roads or points of access.
iv. Soil Disturbance. For projects and actions that involve grading, excavation within the HPA or HPZ, placement of fill, and/or other soil disturbance extending more than 20 cm (8 inches) below the ground surface (e.g., deep tillage to remove or break clayey subsoils and hardpan): a) these activities will fully avoid occupied gopher habitat (HPA or HPZ) during the months of April, May, and June, the period of gopher birthing and early natal development, so as to avoid collapsing, excavating, or otherwise physically disturbing burrows or nests that may contain immobile pups; and, b) an Adaptive Management Plan, subject to approval by the appropriate Service office, will be prepared in advance and implemented to avoid and reduce impacts to occupied gopher habitat (or potential habitat, if that is being used as a surrogate) and avoid impacts to gopher individuals.

<u>Mowing/Mechanical treatments to reduce non-native vegetation:</u>
Use lightest machine possible, broadest sweep (to reduce number of passes required), and not less than 20.3 cm (8 inches) above ground. Mowing will generally be implemented in the fall and winter; tractor mowers should be rubber-tracked to minimize soil compaction and/or rutting; tractor decks should be set sufficiently high to avoid soil gouging.

<u>Tilling/Disking/Sod Rolling treatments to reduce non-native vegetation:</u>
These project types will not be used in occupied gopher habitat, and will not be used in the wet season. Tilling/disking must be followed immediately with introduction of native plant species unless further weed eradication is scheduled to take place.

Seeding with a Harrow:
A harrow may be used in conjunction with seeding, but it is usually the wire mesh type of harrow, not tines. There will be very little ground disturbance from the harrow itself (Carlson 2015a, *in litt.*).

Raking:
Raking will only disturb the shallow duff on top of the soil, not standing or live plants (Carlson 2015a, *in litt.*).

Tree Removal
Minimize soil disturbance if this occurs in occupied Mazama pocket gopher habitat (or in potential habitat, if used as a surrogate). Fell tree in sections if possible to minimize soil impacts. Fell away from suitable habitat if possible, and minimize soil disturbance when removing downed trees.

Livestock Grazing
Used sparingly and carefully to avoid soil impacts, tunnel compaction, and foraging vegetation loss.

Prescribed Burns:
Objectives for prescribed ecological burns will focus on creating a mosaic of burned habitat patches that will incorporate exclusions plots within each burn unit with the long-term management goal of a 1 to 3 year rotational burn of each managed area, if at all possible. The goal is to conduct increased ecological burns, with appropriate oversight, to support Mazama pocket gopher habitat. Prescribed ecological fire goals will be measured based on a three-year average of acres burned. Potential and currently suitable Mazama pocket gopher habitat will be managed with prescribed ecological burning as necessary and appropriate. Ecological fire is required to create quality gopher foraging vegetation in prairie habitat and keep woody vegetation out of Mazama pocket gopher habitat. Fire is one tool to support development of gopher foraging habitat and it may be necessary to use selective or broadcast herbicide application, or manual removal of encroaching plant species when the use of fire is either not possible or inadequate to ensure the maintenance of suitable Mazama pocket gopher habitat. Restrictions on size and placement of prescribed fire units must be established in coordination with other species' needs, particularly Taylor's checkerspot butterfly and streaked horned lark, which may not tolerate large-scale or poorly timed burns. Fire extent may vary from 5 to 20% of any individual site (Carlson 2015a, *in litt.*; Freed 2015, *in litt.*). From the description of PDC 51: Prescribed fire for sites with pocket gophers should be of low intensity, and take place on cool, cloudy days later in the dry season. Timing of burns will require Service approval.

Herbicide Application:
Lower toxicity herbicides shall be used whenever possible. Herbicide may be applied throughout the year; not every area is treated, but some areas may be treated twice in one year. Selective herbicide application is encouraged, i.e., spot/targeted treatment vs broadcast application treatments (see PDC 29). In occupied (or presumed occupied) gopher habitat, spot spraying will be the preferred method, but broadcast spraying may occur at some occupied sites for three different purposes (Hamman, CNLM, 2015, *pers. comm.*). Broadcast spraying involves the use of wheeled or tracked vehicles such as ATVs or tractors.

(1) Broadcast spraying in occupied habitat is used immediately following a fall burn, within the footprint of a burned area, to kill the non-native vegetation that emerges before the native plants. This usually occurs within 2 weeks to 1 month of the burn, dependent on weather; newly-emerging plants need some amount of moisture to grow so, often this will not happen until after the first rain, post-burn. The herbicide used is glyphosate, and it targets non-native grasses, herbs, and forbs. Glyphosate disrupts photosynthesis, so only actively growing (photosynthesizing) plants are killed, and they are killed down through the root. Seeds are not affected, and neither are plants without growing parts above ground. Prior to glyphosate application, the burned area is surveyed to determine the density of the non-native plants vs native plants that have emerged. If too many native plants would be affected, spot spray would be utilized. If native plants would not be substantially harmed, then herbicides may be applied using a broadcast spray. If there are just a few places with native plants, these areas would be covered for protection from broadcast spraying.

No herbicide kills everything it targets. There are multiple "flushes" of growth after a burn. Some non-natives will come in with the natives, in that second flush of growth, or even later. Some are covered by duff or other cover during herbicide application and are thus protected from the herbicide's effects. Therefore it is anticipated that some non-natives will remain on-site requiring a future treatment.

In very degraded prairie sites, such as areas with abundant tall oat grass or Scot's broom, there are not many native plants left on the site or within the seed bank. Therefore, the area would be seeded after herbicide treatment. Areas may need repeated seeding in successive years to fully establish a native plant community at a site. It is unknown how many acres of degraded prairie will be treated for the duration of this project. As per the description of the proposed action, burned areas will not exceed 20% of a given site, and thus neither will post-burn herbicide treatments.

In very degraded prairie sites that are occupied by gophers, the only food available to the gophers is non-native plants. Broadcast application of glyphosate will kill the photosynthesizing non-native plants that the gophers would otherwise be eating. Food remaining for gophers afterwards will be the individual non-native plants that did not have green parts above ground, and any available food caches. The newly seeded natives will not have a developed root system (i.e., food for gophers) for perhaps a year, a period longer than their cache will feed them, estimated at about 2 weeks (based on Andersen and MacMahon 1981, p. 195). Gophers will be reliant on those remaining non-native plants -- and whatever native plants still occur on these sites -- for food.

(2) In spring, in low-quality prairie habitats, the herbicide Fusilade will be used to target grasses such as tall oat grass (*Agrostis* spp). Fusilade is a grass-specific herbicide, and does not kill forbs and herbs. Fusilade is applied when the target grasses reach about 20.3 to 30.5 cm (8 to 12 inches), usually in late March to early May. If too many native grasses would be negatively affected by the use of broadcast spraying, spot spraying will be used. Sometimes a second application is warranted, but the second time is usually a spot-spray to catch the few patches of grass that were missed the first time.

(3) Garlon is usually used for controlling infestations of Scot's broom. Garlon is a broad-spectrum herbicide that will also kill forbs and grasses. Garlon is used when burning is either not possible or feasible (e.g., in an area that cannot be burned due to its location adjacent to housing, or because there are only so many burns that can be performed in a single year due to limited burn windows and/or limited staffing). It is usually applied in the late summer or fall, after native plants have senesced. The area is often mowed first to limit seed-set.

Shade Cloth and Solarization:
Use of shade cloth will not occur within 19.8 m (65 feet) of occupied habitat, and solarization will not occur within 10 m (33 feet) of occupied habitat. A maximum of 3 acres of Mazama pocket gopher habitat will be treated using shade cloth or solarization (each) per year within each subspecies' range (Carlson 2015b and c, *in litt.*). Likely it would be far less than this amount (per subspecies) in any given year.

3.12.8 Effects to the Mazama Pocket Gopher

The effects of the action refers to the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR 402.02). Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur.

The proposed programs would fund or carry out aquatic and upland restoration projects in Washington, Idaho, and Oregon. Only upland restoration actions under PDC 29 and 51 are likely to affect Mazama pocket gophers or their habitat; other PROJECTS actions occur outside of areas known to support the four Thurston/Pierce subspecies of the Mazama pocket gopher.

Upland restoration actions under PDC 29 and 51 that could occur in, and have the potential to affect, Roy Prairie, Olympia, Tenino, or Yelm pocket gophers or their habitat, include the following activities: prescribed burning, herbicide treatments, mowing, raking, sod rolling, tilling/disking, seeding with a harrow, use of shade cloth, and solarization. These activities may affect Mazama pocket gophers when implemented at occupied sites. Impacts to occupied habitat is the surrogate the Service uses for impacts to individuals, as there is not currently a statistical survey method to determine the number of Mazama pocket gophers that may inhabit any given site.

To avoid the potential for adverse effects to individual pocket gophers, some restoration activities would not occur in occupied habitat, including tilling/disking, sod rolling, use of shade cloth, and solarization. To minimize adverse effects to Mazama pocket gophers and their habitat, some activities would not occur during the wet season (tilling/disking), would require use of rubber tracked tractors (mowing, broadcast spraying, seeding with a harrow, raking), or would be designed to be low intensity (prescribed burning). In occupied habitats, herbicides will either be spot applied, or broadcast sprayed when native vegetation is senesced. All projects occurring in occupied gopher habitat would require review and approval by the appropriate Service manager or designee as per PDC 6.c. Refer to the *Conservation Measures for Mazama Pocket Gophers* section, above, for details. Although restoration activities would include the above conservation measures, Mazama pocket gopher individuals may be present year-round at varying densities at locations permitted for restoration. There are an unknown total number of sites occupied by the four subspecies in Thurston and Pierce Counties, Washington. The actual number of acres that would receive restoration treatments in any given year through the proposed programs is estimated for each activity; as mentioned above, multiple treatments may be used on a single site within a year or between years.

Upland restoration activities under PDC 51 that may occur in suitable Mazama pocket gopher habitat, but which are expected to have no adverse effects to Mazama pocket gophers, or be wholly beneficial or have no effect on gophers or gopher habitat. These include: manual removal of invasive plants, cutting/thinning/removing tree stumps, girdling trees, shade cloth application, sod rolling, solarization, livestock grazing, plant population enhancement, propagule collection, outplanting augmentation, and collection and out-planting of non-listed native plants. These projects are not expected to affect gophers or their habitat due to the design criteria themselves, or conservation measures in place, including: the action will use only people on foot using hand tools, neither of which are known to have measureable impacts to gophers or their habitats (manual removal of invasive plants; cutting/thinning/removal of tree stumps; girdling trees; plant population enhancement; propagule collection; outplanting augmentation; collection and out-planting of non-listed native plants); will not occur in occupied habitats, and will improve the forage quality of unoccupied habitat (shade cloth application, sod rolling, solarization); or, will be designed and implemented so as to have no negative impacts to the soil or any foraging vegetation (livestock grazing).

3.12.8.1 Prescribed Burning

Prescribed fires improve Mazama pocket gopher habitat by removing vegetative competition for the early-seral plants that Mazama pocket gophers prefer as foraging habitat. This is especially true when the return frequency of the fires is short, fire intensity is low (this is the intended goal for the use of prescribed fire in gopher potential or known gopher habitat), and swales and overall topographic heterogeneity prevent the entire grassland from being consumed by fire. Fires on grassland (prairie) habitat generally have low fuel content and produce regular, short duration fires (Agee 1993, p. 354; Chappell and Kagan 2001, p. 43), which restricts the establishment of invasive plants and encroaching trees and helps to maintain short-statured vegetation dominated by native grasses and forbs. Short duration fires with low fuel loads create the open and short-statured prairie structure and vegetation communities (Severns and Warren 2008, p. 476) that Mazama pocket gophers prefer. Fire also improves the health and composition of grassland habitat by providing a short-term nitrogen addition, which results in a fertilizer effect to vegetation, thus aiding grasses and forbs as they re-sprout. Fires on the prairie create a mosaic of vegetation conditions which serve to maintain native prairie forbs for Mazama pocket gophers like camas (*Camassia* spp.) and yarrow (*Achillea millefolium*).

The historical fire frequency on prairies has been estimated to be 3 to 5 years (Foster 2005, p. 8). The result of fire suppression has been the invasion of the prairies and oak woodlands by native and nonnative plant species (Dunn and Ewing 1997, p. v; Tveten and Fonda 1999, p. 146), notably woody plants such as the native Douglas-fir and the nonnative Scot’s broom, and nonnative grasses such as tall oatgrass (*Arrhenatherum elatius*), which when dense, are areas Mazama pocket gophers are not known to occupy (Marsh and Steel 1992, p. 210). The probability of Mazama pocket gopher occupancy is much higher in areas with less than 10% woody vegetation cover (Olson 2011a, p. 16). It is reasonable to conclude that increasing amounts of woody vegetation will shade out the forbs, bulbs, and grasses that gophers prefer, and high densities of woody plants make travel both below and above the ground difficult for gophers. The Service considers encroachment by woody vegetation to potentially have substantial negative impacts on occupied Mazama pocket gopher habitat and thus their populations.

Prescribed fires are therefore essential to creating and maintaining Mazama pocket gopher habitat in the action area. Conservation groups and their partners have been using prescribed fire for more than a decade in the south Puget Sound to improve habitat conditions for Mazama pocket gophers and other prairie species, with positive response seen by gophers in areas that have been treated. Such management will need to be repeated to counteract the invasion of woody plants into prairies. CNLM (Center for Natural Lands Management), who solely or jointly performs the majority of prescribed burns in Mazama pocket gopher habitat, limits the acreage burned at any site, never exceeding 20% of the site. For example, Wolf Haven is on a five-year regime (20% per year), while Tenalquot is on a 6-year regime (about 17% per year) (Freed 2015, *in litt.*).

The Service has no information to demonstrate that the types of prescribed fire intended to be used under PROJECTS will directly cause injury or mortality of Mazama pocket gopher individuals. Neary *et al*. (1999) reviewed literature addressing the effects of fire on ecosystem processes, including the physical, chemical, and biological functions and processes of soils and soil communities. The authors conclude that "…the direct effects of fire on most soil vertebrates are minimal as they are mobile enough to escape fires by burrowing deep … to escape lethal temperatures or by fleeing on the surface … indirect effects, such as loss of habitat, exposure of soil burrow openings, and increased predation" may be more significant (Neary *et al*. 1999, p. 66). Based on the best available information, the Service concludes that direct Mazama pocket gopher injury or mortality resulting directly from fire is extremely unlikely, and therefore considered discountable.

Prescribed fire operations to improve habitat conditions for Mazama pocket gophers may be performed within currently occupied habitat. Prescribed fires have been (and would be) performed in the late summer and fall, when conditions are drier. The intent will be to achieve a cool, low intensity burn that does not remove all plant material above ground, and which leaves below-ground foraging plant material intact. Prescribed fires are expected to target habitat areas that are losing suitability for Mazama pocket gophers, and never cover a large percentage of any given site (estimated at 5 to 20% of any given site; Carlson 2015a, *in litt.*). In the past, Mazama pocket gopher use within burned areas appeared to be more-or-less unaffected, based on continued fresh mounding within the perimeter of the burns, immediately following the burns. However, in 2014 two small-scale fires (fewer than 10 acres each) unaccountably resulted in a lack of fresh mounding within the interior of the fire perimeter; this was an anomalous response, as typically fresh mounding is seen soon after a prescribed burn (Olson and Hayes, WDFW, 2015, *pers. comm.*). Future research is aimed at determining the cause of this atypical response. However until additional information leads to a conclusion that such a response represented significant impacts to individuals or populations, we have determined that prescribed fires that occur in occupied habitat are not likely to adversely affect either Mazama pocket gophers or their habitat.

3.12.8.2 Herbicide Application

The PROJECTS program will use a variety of herbicides, including: aquatic imazapyr (e.g., Habitat), aquatic glyphosate (can be used in uplands; e.g., AquaMaster, AquaPro, Rodeo), aquatic triclopyr-TEA (e.g., Renovate 3), chlorsulfuron (e.g., Telar, Glean, Corsair), clopyralid (e.g., Transline), imazapic (e.g., Plateau), imazapyr (e.g., Arsenal, Chopper), metsulfuron-methyl (e.g., Escort), picloram (e.g., Tordon), sethoxydim (e.g., Poast, Vantage), sulfometuron-methyl (e.g., Oust, Oust XP), glyphosate (nonaquatic formulation), triclopyr (e.g., Garlon4Ultra), fluazifop-p-butyl (e.g., Fusilade), clethodim (e.g., Envoy), triclopyr +2,4-D ester (e.g., Crossbow), diquat dibromide (e.g., Reward), 2,4-D amine, oryzalin, and aminopyralid. Of these, 2,4-D amine, aminopyralid, chlorsulfuron, clopyralid, diquat dibromide, glyphosate, imazapic, imazapyr, metsulfuron-methyl, sulfometuron-methyl, triclopyr-TEA, and triclopyr + 2,4-D ester are used to treat broadleaf weeds, many of which are foraging vegetation for Mazama pocket gophers. The other herbicides in the list are used solely to treat woody species or invasive grasses. According to CNLM, however, the most commonly used herbicides in occupied or unoccupied Mazama pocket gopher habitat are glyphosate, triclopyr (Garlon), and fluazifop-p-butyl (Fusilade). For the purposes of this consultation, the use of other, similar-acting herbicides would be analyzed the same. Thus in the future, if similar-acting herbicides replaced the use of these three herbicides in occupied gopher habitat, impacts to gophers would be considered to be similar.

The use of herbicides that target grasses only are not likely to directly affect Mazama pocket gophers, because grasses constitute such a small proportion of the total sum of plants that make up their diet (extremely high percentages of their diet are made up of forbs). The use of such herbicides will provide long-term benefits by reducing competition between native plants and non-native grasses.

Fluazifop-p-butyl and glyphosate exhibit low acute oral toxicity (Castrale 1987, p. 216). Most of the newer products have a similar, low acute toxicity in vertebrates, owing to the fact that their mechanisms of action are related to plant-specific metabolic pathways, and most are water soluble and poorly lipophilic (Berny 2007, p. 93). Castrale (1987, pp. 215-219) investigated the use of 14 herbicides (16 commercial formulations) as part of a no-till row crop operation, and found that herbicide treatments had little direct impact on deer mouse (*Peromyscus maniculatus*) densities. For this reason, the Service concludes that ingestion of any of the herbicides used on occupied sites is extremely unlikely to directly affect Mazama pocket gophers.

Research has shown that broad-scale removal of forage (forbs) due to broadcast herbicide application within occupied pocket gopher habitats leads to decreases in pocket gopher density (Keith *et al.* 1959, p. 143; Sullivan and Hogue 1987, p. 975; Tietjen *et al.* 1967, p. 642). Mazama pocket gophers store plant material in below-ground food caches, and caches may contain approximately 2 weeks worth of food at any given time (Andersen and MacMahon 1981, p. 195). The majority of herbicide application will be through spot spraying, however, some sites will require the use of broadcast spraying. The timing of spraying will be limited to when the native plants are senesced and are least vulnerable to the herbicide.

In Mazama pocket gopher-occupied habitats that are spot sprayed, any individual area treated is not expected to exceed the size of an individual gopher's home range. Herbicide treatments are directed and applied to the invasive and non-native vegetative components. When present, residual native prairie and grassland vegetation generally responds positively and quickly when released from the competition and dominance of non-native grasses, invasive shrubs, and broadleaf weeds. Gophers will still have the un-treated portion of their home range available to forage in, and will still have access to their food caches. Therefore, we expect that any individuals that may be temporarily affected (i.e., as a result of the temporary reduction in forage availability), will continue to have adequate available food reserves. For that reason, the Service concludes that spot-spray application of herbicides may affect Mazama pocket gophers by removing some portion of their foraging plants. However, spot-spray application of herbicides is not reasonably certain to kill or injure Mazama pocket gophers, nor is it reasonably certain to modify their habitat to such an extent that their essential behavior patterns are significantly impaired or disrupted.

Glyphosate will be broadcast applied in the spring, after fall prescribed burns, and only in the footprint of the burns. This means application will not exceed 20% of any given site per year. As discussed earlier, glyphosate is applied to target emerging non-native plants, including non-native forbs that are eaten by gophers. Garlon will be broadcast applied in late summer/early fall to control Scot's broom, but only when native plants have senesced. Garlon is a broad-spectrum herbicide that will also kill forbs and grasses. Garlon is usually applied after Scot's broom is mowed. It is unlikely that Garlon would be applied to more than 20% of any given site per year. When there is a residual native forb component still present, those native plants will not be affected by the application of glyphosate or Garlon, and will remain available for foraging by gophers. Most of the current restoration sites fall into this category. These native plants generally respond positively and quickly when released from the competition and dominance of non-native grasses, invasive shrubs, and broadleaf weeds. Gophers in these areas will also still have access to their food caches. Therefore, we expect that any individuals that may be temporarily affected (i.e., as a result of the temporary reduction in forage availability), will continue to have adequate available food reserves. For these reasons, the Service concludes that broadcast application of herbicides in locations where there is a residual native forb component may affect Mazama pocket gophers by removing some portion of their foraging plants. However, broadcast spray application of herbicides in these types of areas is not reasonably certain to kill or injure Mazama pocket gophers, nor is it reasonably certain to modify their habitat to such an extent that their essential behavior patterns are significantly impaired or disrupted.

When glyphosate or Garlon are broadcast applied in gopher-occupied areas with <u>few or no</u> residual native forbs remaining, a large proportion of the available forage base will be lost after application. This situation is not currently common (Hamman, CNLM, 2015, *pers. comm.*), but in the future it may become more common as new restoration properties are acquired or managed. Not all plants within the treated area will succumb to the effects of the herbicide, and food caches will still be available. It is likely that the mass of forbs that remain within the treated area will not be sufficient to support on-site gophers. Gophers' low vagility means that they are unlikely to move far from their home range in search of forage. Seeding or planting with native forbs and grasses will occur shortly after broadcast herbicide application in these areas.

Springtime is the time of year with the largest energetic demands on female gophers; females are gestating, lactating, and rearing pups. In poor forage habitats, "[t]he energy demands of late lactation could never be met through burrowing" to find food (Andersen and MacMahon 1981, p. 190). This is also true for males in poor forage habitats (Andersen and MacMahon 1981, p. 189). The broadcast application of herbicides in areas with only non-native forbs and grasses will create poor forage habitats for a period of time after application, until native plants take over and develop a mature root system sufficient to support foraging by gophers. But that takes a year or two – much longer than food caches will last. In the long-term, foraging conditions will improve overall. For these reasons, the Service concludes that broadcast application of glyphosate or Garlon in locations where there is not a residual native forb component may affect Mazama pocket gophers by removing a large percentage of available foraging plants. Broadcast spray application of glyphosate or Garlon in these types of areas is reasonably certain to injure Mazama pocket gophers, and is reasonably certain to modify their habitat to such an extent that their essential behavior patterns are significantly impaired or disrupted.

Because glyphosate application follows prescribed burning, a maximum of 20% of any site will be treated. The average total number of acres per year (averaged over 5 years) of Mazama pocket gopher subspecies habitat expected to be treated is: Roy Prairie pocket gopher: 40 ac; Olympia pocket gopher: 135 ac; Tenino pocket gopher: 79 ac; and Yelm pocket gopher: 107 ac. Therefore, a maximum of approximately 8 acres of Roy Prairie pocket gopher habitat, 27 acres of Olympia pocket gopher habitat, 16 acres of Tenino pocket gopher habitat, and 21 acres of Yelm pocket gopher habitat will receive broadcast applications of glyphosate or Garlon. No single site within a subspecies' range will have this much of its habitat affected since these are percentages of subspecies' range totals, not percentages of any individual site. In addition, because most of the current restoration sites do not meet description, these maximum numbers are unlikely to ever be reached, even in the future (in other words, it is unlikely that all treated acres in a given year will meet this degraded description). The essential behavior patterns of an unknown number of Mazama pocket gophers associated with those acres are reasonably certain to be impaired or disrupted, and may lead to death of gophers.

3.12.8.3 Broadcast Spraying, Mowing, Seeding with a Harrow, and Raking

The proposed programs may fund or carry out the maintenance of short-statured grasslands with motorized, wheeled or tracked equipment in occupied gopher habitat, but only for the purposes of habitat restoration when prescribed fire is not a feasible substitute or is inadequate to control the invasive species. Broadcast spraying, mowing, seeding with a harrow, and raking may occur in both occupied and unoccupied gopher habitat. Mowers, and the tractors used with broadcast spraying, harrowing, and raking, could potentially crush and kill Mazama pocket gophers when the wheels of these machines crush near-surface foraging tunnels when soil conditions allow for such compaction. Juvenile gophers are known to stay in these foraging tunnels during dispersal and even later into their first months in their new territories. And while adults or juveniles may at times be able to escape to a below-ground nest or chamber when they sense a mower or tractor advancing, the speed or trajectory of the mower or tractor may be such that escape to a deep-enough chamber is not possible, and the adults or juveniles may be crushed or killed.

We anticipate that a fraction of the total number of adults and juveniles in tunnels beneath mower or tractor wheels would be crushed or killed: not all gophers would stay in foraging tunnels (near the surface) at the approach of a mower or tractor; not all gophers would be at the surface at the moment a mower or tractor went by (only a portion of a gopher's day is spent foraging – not 100% of the day); mower or tractor weight and pounds per square inch of wheel weight would not always be sufficient to crush or kill a gopher under the soil; soil conditions would not always be such that crushing would occur (e.g., during extreme dry weather, this risk is minimized).

For purposes of calculation of impacts, we assume that no more than 5% of gophers in tunnels intersected by wheels or tracks of mowers or tractors would be crushed or killed. This is an estimate only; based on best professional judgment, and for the reasons mentioned above, we anticipate that the number (%) is *very low*. In addition, we know that past restoration actions (such as mowing) have shown apparent expansion of gopher populations in restored areas, a feat that would not be possible if large percentages of the population were killed each time a mower or tractor traversed a site. Based on work at Olympia Airport by Olson (2008, p. 2), and in other Nisqually soils (Olson unpubl.), density of gophers in Nisqually soils is approximately 2.5 to 9/acre (Olympia Airport is almost entirely Nisqually soils). Therefore, for any acre mowed, 26.2% of each acre is impacted by the mower's or tractor's wheels = 0.262 acres impacted x 2.5 to 9 gophers occupying that acre x 5% of gophers exposed = 0.03 to 0.12 gophers/acre may be crushed or killed. On a 10 acre site, that would mean 0.3 to 1 gopher may be crushed or killed.

When foraging tunnels are crushed, the juvenile or adult occupying those tunnels must subsequently rebuild the tunnels, which exerts an energetic cost on the juvenile or adult. Burrowing is an energetically costly behavior – the costliest that gophers undergo, aside from when females are gestating or rearing pups (Andersen and MacMahon 1981, pp. 189-190). However, in forage-rich environments (such as Nisqually soils provide), the daily cost of foraging is much smaller than in forage-poor environments (Andersen and MacMahon 1981, p. 190), and adding an additional amount of burrowing per day (in this case, just one or two days per year, outside of the pupping season) is not likely to require so much additional energy that a gopher's energetics are measurably compromised. So while gophers in Nisqually soils may be affected by the need to rebuild their foraging tunnels, they are not likely to suffer any measurable adverse effects to energetics, growth, fitness, or long-term survival as a result.

Only Nisqually soils are determined likely to be susceptible to significant impacts from this type of compaction (Thomas 2015, *in litt.*), and as such, work conducted in Nisqually soils will be undertaken only when soil moisture is low, thus reducing the risk of compaction. Other soil types are not as susceptible to compaction – they are generally shallower, or less compressible or friable due to sand, rock, or clay content. In some cases, they are wetter soils, and waiting for drier months to use wheeled or tracked equipment is necessary to avoid serious damage to plants and soils. For these reasons, we only anticipate this risk of compaction when using wheeled or tracked equipment (while mowing, harrowing, or raking) in Nisqually soils.

Of the total 361 acres per year, not all of them will be Nisqually soils; Nisqually soils are concentrated in large swaths around the cities of Olympia, Lacey, and Tumwater (presumed range of Olympia pocket gopher), and on JBLM lands and the City of Roy. Relatively smaller areas of Nisqually are scattered north of Tenino (range of Tenino pocket gopher), south of Tenino, around the City of Rainier, around the City of Yelm, and in the Grand Mound/Rochester area (range of Yelm pocket gopher). In total, off of JBLM lands but within the ranges of the four Thurston/Pierce subspecies of Mazama pocket gopher, there are approximately 6,924 acres of Nisqually soils in Pierce and Thurston Counties that are not built on or otherwise covered by some sort of impervious surface (USFWS 2014b). Of these, there are approximately 270 acres within the range of Roy Prairie pocket gopher, 4,681 acres within the range of Olympia pocket gopher, approximately 281 acres within the range of Tenino pocket gopher, and approximately 1,958 acres within the range of Yelm pocket gopher[30]. Activities occurring on JBLM lands will be consulted on separately. Not all of these non-JBLM Nisqually soils would be subject to restoration, since not all are owned by people who want their lands restored, or they occur in areas that are not restorable at the scale this program of work is aimed at (e.g., areas within neighborhoods or commercial areas are not likely to be subject to this body of work).

Many fewer acres will ultimately be impacted by the wheels or tracks of mowers. Use of lighter mowers with rubber tracks will minimize the risk of compaction, mowers will use the broadest sweep possible (i.e., widest mower decks, to reduce the number of passes required), mower decks will be set high enough to avoid soil gouging, and care will be taken to avoid saturated (compactible) soils. The average tractor used for mowing during restoration (approximately 30 hp (Carlson and Thomas, USFWS, 2015, *pers. comm.*), has an 28.5 cm (11.2 inches) wheel width, and 160 cm (63 inches) between wheels. If we assume there will be no overlapping wheel tracks between passes, with each pass of the mower the wheels will cover a maximum of approximately 26.2% of the area mowed between the outer edges of the wheels. For purposes of calculation of impacts, we will assume mowers cover an entire site each time, and make one pass of the mower – i.e., mow only in one direction, not criss-crossing paths (most of the time the mower will not need to criss-cross, though sometimes it will). We will also assume that the impacts from subsequent work performed with other wheeled or tracked equipment (e.g., for harrowing or raking) on the same piece of property within the same year would be subsumed by this initial impact from mowing, i.e., that no significant amount of additional impact needs to be accounted for. This is reasonable since not all areas are likely to be mowed, and this calculation is likely an over-estimate of what would actually be impacted by mowing, and would account for/compensate for the small additional impacts due to seeding with a harrow or raking, which occur on smaller portions of sites.

We have no reliable way to estimate what total number of acres on restoration sites per year will occur on Nisqually soils. The maximum number of acres restored in any given year will not all be on Nisqually soils, however, that "maximum number of acres restored in any year" will be our default maximum per year. We therefore anticipate that no more than 26.2% of the total number of acres anticipated to be restored per year will be subject to compaction sufficient to adversely affect gophers in Thurston and Pierce Counties, Washington. This equates to the following acreages by subspecies: Roy Prairie pocket gopher: 40 acres x 26.2% = 10.4 ac; Olympia pocket gopher: 135 acres x 26.2% = 35.4 ac; Tenino pocket gopher: 79 acres x 26.2% = 20.7 ac; and Yelm pocket gopher: 107 acres x 26.2% = 28 ac. Grand total of affected acres across all subspecies = 94.5 ac. We estimate that a maximum of 5% of gophers associated with these acres are reasonably certain to be crushed or killed by the wheels of the mower.

3.12.8.4 Summary of Effects to the Four Thurston/Pierce Subspecies of the Mazama Pocket Gopher

Of the activities that may affect the four Thurston/Pierce subspecies of Mazama pocket gopher, some will have insignificant and discountable effects each year for the duration of the proposed action. Specifically: 1) all authorized activities that occur outside of occupied habitat; 2)

[30] These ranges are based on USFWS (2014c).

prescribed burning; 3) spot spraying herbicides; 4) broadcast spraying of Fusilade (or similar-acting herbicide); and, 5) broadcast spraying of glyphosate or Garlon (or similar-acting herbicides) in areas with a residual component of native forbs.

Some authorized activities are reasonably certain to adversely affect individual Roy Prairie, Olympia, Tenino, or Yelm pocket gophers each year at occupied sites for the duration of the proposed action. The Service does not have sufficient information with which to inform estimates of Mazama pocket gopher subspecies population sizes in Thurston and Pierce Counties. Habitat quality varies considerably across the range of the four subspecies, occupancy appears to be discontinuous within and between occupied sites, and some portion of the suitable habitat on a site (or from site to site) may be unoccupied in any given year. Ongoing research may eventually lead to development of a site-specific or general index method relating mound density to estimated population size. However, serious challenges remain and it is unlikely that estimates will be available in the near term. Thus, effects are quantified by areal extent of a treatment.

Specific adverse effects are: 1) an unknown number of Mazama pocket gophers associated with a maximum of approximately 8 acres of Roy Prairie pocket gopher habitat, 27 acres of Olympia pocket gopher habitat, 16 acres of Tenino pocket gopher habitat, and 21 acres of Yelm pocket gopher habitat that will receive broadcast applications of glyphosate or Garlon (or similar-acting herbicides); and, 2) 5% of Mazama pocket gophers associated with up to 94.5 acres of Nisqually soils, when mower or tractor wheels/tracks are used on those soils while mowing, broadcast spraying herbicides, seeding with a harrow, or raking (10.4 acres within the range of Roy Prairie pocket gopher; 35.4 acres within the range of Olympia pocket gopher; 20.7 acres within the range of Tenino pocket gopher; and, 28 acres within the range of Yelm pocket gopher).

3.12.9 Cumulative Effects to the Mazama Pocket Gopher and Designated Critical Habitat

Cumulative effects include the effects of future state, tribal, local, or private actions that are reasonably certain to occur in the action area. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA. The following cumulative effects analysis only includes actions that are reasonably certain to occur. For the purposes of the jeopardy analysis in this Opinion, the nature and extent of these cumulative effects are expected to continue, but not be exceeded, for the duration of the actions covered by this Opinion.

The Service is working closely with state and local governments (e.g., WDFW; WDNR; Thurston and Pierce Counties; the Cities of Lacey, Olympia, and Tumwater), and with non-governmental organizations, to plan and implement programs for more effective protection and conservation of south Puget Sound prairies and prairie-dependent species. The Service, WDFW, and Thurston County are currently working together to develop a reserve design specifically intended to direct and prioritize acquisitions, grant funding, mitigation, zoning, restoration, research, and monitoring for the long term conservation of the Olympia, Tenino, and Yelm pocket gophers.

Research institutions, non-governmental organizations, and state and local governments are all serving important planning, monitoring, and research functions. These parties are both independently and cooperatively advancing the basic science and practical know-how necessary to achieve prairie enhancement and landscape-scale conservation. These parties are also assisting with public outreach and education.

The Service expects that future state, local, and private actions will help to make significant progress in accomplishing objectives that are important to the rangewide conservation of all four subspecies. These efforts are critical components of the shared local, State, and Federal strategy to address existing and future threats, and thereby achieve long term persistence and recovery of the four subspecies.

Development is a known and significant threat to Mazama pocket gophers in areas where it overlaps Mazama pocket gopher habitat. Future development and population growth in Pierce and Thurston Counties, as described below, is reasonably certain to occur.

According to Thurston County's 2008 Comprehensive Plan (updated through 2014), "Thurston County has been among the fastest growing counties in the state since the 1960s. During the 1990s, the County grew at an annual rate of 2.5% , adding over 46,000 new residents between 1990 and 2000. The cities and urban growth areas experience the fastest growth rates. Most of the County's population growth is due to in-migration" (Thurston County 2008, p. 1-10). The County's population was approximately 231,000 in 2006. Projections show over 360,000 people living in the county in the year 2028 (Thurston County 2008, p. 2-7), an increase of over 57%. While most of this will occur in the Urban Growth Areas (approximately 34,000 new households anticipated), the rural and small-town areas of the County will be accommodating some of this growth, spurring a need for approximately 14,400 new households in the small-town and unincorporated portions of the County by the year 2025. "This demand for housing will, in turn, result in increased demands for public services (e.g., social, housing assistance, and health services; police and fire protection; schools; roads; utilities; and, parks) and increased pressure on aquifers, wetlands, and other natural systems" (Thurston County 2008, p. 4-2). Such human population growth would inevitably impact the ability of the Mazama pocket gopher to recover, potentially barring efforts to mitigation and conserve the subspecies and their habitats. Much emphasis therefore will be placed on the efficacy of the Thurston County Habitat Conservation Plan (HCP), which is not yet final, in terms of species conservation and recovery. Population growth projections beyond year 2028 are not available for Thurston County, and therefore cannot be analyzed.

According to Pierce County's DRAFT 2015 Comprehensive Plan, the County's "2010 Census reports that 795,225 people, 299,918 households, and 202,174 families resided in the County with a population density of 476.3 people per square mile. Approximately 46% of the population resides within unincorporated Pierce County." Between 2000 and 2010, the County's population grew by approximately 13.5% (Pierce County 2015, p. 2-9). The City of Roy, the only non-Federal municipality or population center in the County known to overlap the range of the Roy Prairie pocket gopher (i.e., not including areas on JBLM), is expected to grow from 793 people in 2010 to 1,070 people in 2030, an increase of approximately 35% . Total County population is expected to increase by approximately 28% (Pierce County 2010, p. 2-11). Such human population growth may impact the ability of the Mazama pocket gopher to recover off of JBLM lands, potentially barring efforts to mitigation and conserve the subspecies and their habitats there. Neither Pierce County nor the City of Roy is currently working towards adoption of an

HCP. Population growth projections beyond year 2030 are not available for Pierce County, and therefore cannot be analyzed.

As a result of future population growth that overlaps the ranges of the Roy Prairie, Olympia, Tenino, and Yelm pocket gophers, we anticipate adverse effects to the species due to: the increased destruction, modification, or curtailment of their habitat and range; increased loss or curtailment of natural disturbance processes; an increase in poor connectivity between small and isolated populations; and increased predation and control as a pest. We anticipate some number of Mazama pocket gopher will be adversely affected by such population growth and development. Although most growth will occur within cities' UGAs, much growth will occur in the unincorporated portions of each County. Within each UGA, if we were to assume total build-out and loss of all Mazama pocket gopher habitat in the UGAs, certainly there would be extensive adverse effects to the Roy Prairie, Olympia, and Yelm pocket gophers (the range of the Tenino pocket gopher does not currently overlap a UGA). In the unincorporated portions of each County, it's unknown where or how much development may affect Mazama pocket gophers and their habitat.

However, the Service is currently working with Thurston County to minimize the potential for unmitigated impacts to the Olympia, Tenino, and Yelm pocket gophers; all County permits that occur on Mazama pocket gopher soils are screened to determine if permitted actions may affect Mazama pocket gopher. Thurston County is committed to conservation of the species, and is implementing interim measures to avoid adverse effects to Mazama pocket gopher prior to completion of their HCP. Any future HCP would not be subject to this Cumulative Effects analysis.

Approximately 83% of the Roy Prairie pocket gopher's range lies on JBLM lands, and management of those lands is not part of this Cumulative Effects analysis. The remainder lies within the City of Roy, and a few acres of Mazama pocket gopher habitat are protected in habitat set-asides. We anticipate that Pierce County and the City of Roy will work with the Service to minimize and mitigate adverse effects to the Roy Prairie pocket gopher in a way that does not preclude recovery of the species off of JBLM lands. Any future HCP would not be subject to this Cumulative Effects analysis.

Available information indicates that individual Mazama pocket gophers and their habitat (including forage resources) are likely to be affected by development as a result of population growth in Pierce and Thurston Counties between now and 2030 and 2028, respectively. Exposure to these effects is not discountable ("extremely unlikely") and available information is not sufficient to demonstrate that these exposures will result in insignificant or immeasurable effects. Despite minimization and avoidance measures that may be implemented, the Service anticipates that development is certain to result in direct injury or mortality, a significant disruption of normal behaviors (i.e., the ability to successfully feed, move, and/or shelter), or measurable adverse effects to energetics, growth, fitness, or long term survival. However, all of these impacts are likely to be covered under a future HCP with the Service, and in the interim, it is anticipated that such effects will be avoided.

3.12.10 Conclusion for the Mazama Pocket Gopher

After reviewing the current rangewide status of the Roy Prairie pocket gopher, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects that are reasonably certain to occur in the action area, it is the Service's Biological Opinion that the action, as proposed, is not likely to jeopardize the continued existence of the Roy Prairie pocket gopher, the Olympia pocket gopher, the Tenino pocket gopher, and the Yelm pocket gopher. This no jeopardy finding for these 4 species of Mazama pocket gopher is supported by the following:

1. Restoration projects, implemented with the proposed PDC and conservation measures, will improve or maintain gopher habitat and habitat connectivity, and thereby support recovery of the four subspecies of the Mazama pocket gopher.
2. The proposed restoration activities will restore disturbance processes that are important to maintain prairie communities that support early succession habitats, which in turn support all four subspecies of Mazama pocket gopher.
3. While some restoration activities and resulting exposures are likely to result in injury or mortality for individuals, we expect that no single local population (at a site) of any of the subspecies would be lost as a result of this work with the implementation of PDC and conservation measures. The Service expects that Mazama pocket gopher numbers (abundance) and reproduction (productivity) will not be appreciably reduced or diminished across the ranges of the subspecies. As the quality and quantity of habitat is maintained and/or improved, the long term viability of local populations will be enhanced.

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3.13 ESA-listed Plant Species Introduction

This Opinion covers restoration project effects to several listed plant species (Table 29) in Idaho, Oregon and Washington. This section first presents the General Plant Conservation Measures and then describes the different potential impacts to plants from the various proposed measures. In the subsequent sections, each species and its status is described, as well as any additional effects or species-specific conservation measures.

Table 29. Listed plant species addressed in this Opinion.

Listed Plant Species						
Species	**Federal Status**	**Federal Listing Date and Reference**	**Recovery Priority Number[31]**	**State Status**		
				ID	**OR**	**WA**
Bradshaw's lomatium, *Lomatium bradshawii*	Endangered	September 30, 1988; 53 FR 38448	5	--	Endan gered	Endan gered
Cook's Desert-Parsley (*Lomatium cookii)*	Endangered	December 7, 2002; 67 FR 68004	2C	--	Endan gered	--
Gentner's fritillary (*Fritillaria gentneri*)	Endangered	December 10, 1999; 64 FR 69195	2	--	Endan gered	--
Golden paintbrush, *Castilleja levisecta*	Threatened	June 11, 1997; 62 FR 31740	2	--	Endan gered	Endan gered
Howell's spectacular thelypody (*Thelypodium howellii ssp. spectabilis*)	Threatened	May 26, 1999; 64 FR 28393	8	--	Endan gered	--
Kincaid's lupine, *Lupinus sulphureus* ssp. *Kincaidii*	Threatened	January 25, 2000; 65 FR 3875	6C	--	Threat ened	Endan gered
Large-flowered Woolly Meadowfoam (*Limnanthes floccosa ssp. grandiflora*)	Endangered	December 7, 2002; 67 FR 68004	3C	--	Endan gered	--
Nelson's checker-mallow, *Sidalcea nelsoniana*	Threatened	February 12, 1993; 58 FR 8235	2	--	Threat ened	Endan gered
Rough Popcornflower (*Plagiobothrys hirtus*)	Endangered	January 25, 2000; 65 FR 3866	2C	--	Endan gered	--
Spalding's Catchfly *(Silene spaldingii)*	Threatened	October 10, 2001; 66 FR 51597	8C	Threa tened	Endan gered	Threat ened
Ute Ladies'- Tresses (*Spiranthes diluvialis*)	Threatened	January 17, 1992; 57 FR 2048		Threa	--	Endan gered

[31] Listed species are given a recovery priority number, which may range from a high of 1C to a low of 18, whereby priorities to recovery tasks are assigned. The criteria on which the recovery priority number is based are degree of threat, recovery potential, taxonomic distinctiveness, and presence of an actual or imminent conflict between the species and development activities. The "C" indicates the potential for conflict between the species and construction, development, or other economic activities.

				tened		
Water Howellia (*Howellia aquatilis*)	Threatened	July 14, 1994; 59 FR 35860	13	Threa tened	Threat ened	Threat ened
Wenatchee Mountains Checker-Mallow (*Sidalcea oregana* var. *calva*)	Endangered	December 22, 1999; 64 FR 71680	3	--	--	Endan gered
Western lily (*Lilium occidentale*)	Endangered	August 17, 1994; 59 FR 42171	2	--	Endan gered	--
Willamette daisy, *Erigeron decumbens* var. *decumbens*	Endangered	January 25, 2000; 65 FR 3875	3C	--	Endan gered	--

3.13.1 General Plant Conservation Measures

The required conservation measures to minimize impacts to listed plants are listed below. In addition to these measures, species specific measures are found in the following species sections.

For all of the above mentioned listed plant species that may occur in a project area within the scope of this proposed action, the following conservation measures will be applied:

For all projects:

1) A qualified biologist with experience in pertinent species will determine whether there are listed plants, critical habitat, or suitable habitat for listed plants in the project area. If the site conditions warrant, surveys and site visits will be conducted at the appropriate time of year to identify all listed plant species and determine whether individual listed plants or potential habitat are present and may be adversely affected by project activities. (See Table 30 for survey timing).
2) If one or more listed plants are present and likely to be adversely affected by the project, the project will establish clearly marked buffers to avoid or minimize effects to listed plants. Buffers from listed plants are as follows:
    i) Vehicle and equipment staging areas will be located at least 15 m (50 feet) from listed plants.
    ii) Manual and mechanical methods to remove invasive/non-native plants at project sites occupied by a listed plant species will maintain a buffer of 2 m (6 feet.) around green growing plants. If listed plants have senesced, this buffer is no longer required.
    iii) Tilling, disking, plowing, excavation, raking or sod rolling (*i.e.,* larger scale sub-surface ground disturbances) or other use of heavy equipment will not occur within 10 m (33 feet) of listed plants.
    iv) Spot and hand applications of herbicide will maintain a minimum distance of 1 m (3.3 feet) from listed plants, unless they are dormant, in which case no buffer is required.
    v) Broadcast applications will maintain a minimum distance of 3 m (16 feet) from listed plants.
    vi) For all herbicide applications, listed plants will be physically shielded (e.g., covered with buckets or some other barrier that will not harm the plants) as needed to protect them from spray or drift, unless they are dormant, in which case

shielding is not necessary. Plants will be uncovered immediately after spraying has been completed.

vii) Dust-abatement additives and stabilization chemicals will not be applied within 10 m (33 feet) of listed plants or critical habitat for listed plants.

3) Prior to restoration activities at areas with listed plants, all project staff will be familiarized with identification of any listed plants in the area and will be aware of listed plant locations within the project area.
4) Access points and tracks within occupied, suitable or critical habitats for listed plant species must be limited and clearly marked to avoid soil compaction and damage to listed plant species from vehicles and/or foot traffic.
5) Herbicide applications may be used to control or remove invasive native and non-native vegetation in accordance PDC 29 of the proposed action of the biological assessment. Appropriate protective measures must be used to protect listed plants to herbicide exposure, as listed in PDC 29 and as determined necessary during project design by the appropriate species' leads.
6) Herbicides will not be applied at locations where nearby listed plants may be in the path of surface runoff from the project.
7) Ground-disturbance activities (*e.g.,* tilling, disking, and plowing) and herbicide use should be followed with native seed or plant introductions to minimize or eliminate the establishment of invasive and non-native vegetation, unless it is determined the local seed source/bank is sufficient.

For aquatic restoration projects (Restoration Actions 33-53)

8) Where listed plant(s) are present at the site and habitat conditions may or may not be improved for listed plants:
   a) Establish clearly marked buffers (as listed above) to avoid effects to listed plants and identify treatment areas with flagging or fencing prior to restoration activities to minimize effects to listed plants.
   b) If the site and location of listed plants is such that goals of the aquatic restoration project cannot be achieved without harming or killing a portion or all listed plant(s) at the site, the project manager will work with the appropriate local Service office to develop a site plan that minimizes the number of plants that are harmed or killed while still achieving project goals and objectives. The plan will include which plants will be affected, including salvage and relocation of these plants if deemed appropriate.

For upland restoration projects (Restoration Actions included under PDC 51)

9) Where listed plants and their critical and/or occupied habitats are affected by habitat improvements that promote better habitat conditions for those species in the long term (such as prairie restoration actions):
   a) Project will follow all appropriate restrictions under PDC 51.
   b) Project design will address both the critical elements of the life cycle of the listed plant species as well as the biotic and abiotic environmental factors that sustain rare plant taxa (e.g., pollinators).
   c) Recovery Plans and Action Plans should be used to prioritize, guide and plan restoration activities.

Table 30. Generalized Optimal Survey Times for Flowering Periods of Listed Plants in Oregon and Washington. (*) timing may need to be adjusted in some localities, based on site specific conditions.

Species	Optimal Survey Time Period*
Bradshaw's Lomatium (*Lomatium bradshawii*)	April to mid-May
Cook's Desert Parsley (*Lomatium cookii*)	Mid-March through May (varies with spring moisture)
Gentner's Fritillary (*Fritillaria gentneri*)	April to June
Golden Paintbrush (*Castilleja levisecta*)	April to September
Howell's Spectacular Thelypody (*Thelypodium howellii* ssp. *spectabilis*)	June through July
Kincaid's Lupine (*Lupinus sulphureus* ssp. *kincaidii*)	May through July
Large-flowered Wooly Meadowfoam (*Limnanthes floccose*)	Mid-March to May (varies with spring moisture)
Nelson's Checkermallow (*Sidalcea nelsoniana*)	Late May to Mid-July
Rough Popcornflower (*Plagiobothrys hirtus*)	Mid-June to early July
Spalding's Catchfly (*Silene spaldingii*)	June to September
Ute Ladies'-Tresses (*Spiranthes diluvialis*)	July to late August
Water Howellia (*Howellia aquatilis*)	May through August
Wenatchee Mountains Checker-Mallow (*Sidalcea oregano* var. *calva*)	June to Mid-August
Western Lily (*Lilium occidentale*)	May to July
Willamette Daisy (*Erigeron decumbens* var. *decumbens*)	Mid-June to early July

d) Treatment areas will be clearly marked with flagging or fencing prior to restoration activities to avoid inadvertently affecting listed plants.
e) Livestock grazing will not be used to control or remove invasive and non-native vegetation at project sites occupied by Cook's desert parsley, Gentner's fritillary, Howell's spectacular thelypody, large-flowered meadowfoam, Nelson's checkermallow, rough popcornflower, and Spalding's catchfly, unless approved by the local Service office.
f) Mowing activities will follow the timing restrictions and mower height settings provided in Table 31 for all affected listed species.

g) Spring mowing is allowed at restoration sites with listed plant species, as indicated in Table 31, but only if necessary to control serious infestations of weeds that reproduce mainly by seed (e.g., meadow knapweed) and threaten persistence of the listed species in that area. In these instances, up to one half of area occupied by the listed plant population(s) at a site may be mowed in an effort to reduce seed set by non-native weeds. Spring mowing must be approved by the local Service office.
h) Herbicides applications may be used to control or remove invasive native and non-native vegetation in accordance PDC 29 of the proposed action of the biological assessment. If listed animals are present (*e.g.*, streaked horned larks, butterflies, Mazama pocket gophers, or vernal pool fairy shrimp), additional restrictions may be required.
i) All broadcast applications will only occur after listed when plants are senesced and/or no longer growing (which varies by species and site conditions from year to year) , unless otherwise approved by the local Service office or species lead. Shield listed plants that do not fully senensce. Use appropriate buffers, as described in the General Plant Conservation Measure #2.
j) Spot and hand applications may occur any time of the year. Use appropriate buffers, and shield plants, as described in the General Plant Conservation Measure #2.
k) Herbicides will not be applied at locations where nearby listed plants may be in the path of surface runoff from the project.
l) Herbicide treatments must be followed with native seed or plant introductions if necessary to minimize or eliminate the establishment of invasive and non-native vegetation.

Table 31. Species-specific timing for mowing and prescribed burn methods for the control or removal of invasive and non-native vegetation at project sites occupied by listed plant species. See species-specific conservation measures for additional restrictions on these activities for listed animals that may be present.

Listed Plant Species	Treatment Method and Timing		
	Prescribed Burns (Calendar Timing)	Mechanical Mowing – Timing [Mower Deck Height]	Spring Mowing Allowed?
Bradshaw's lomatium	Fall burns after August 15	Fall mowing after August 15 [15 cm (6 inches)]	Yes With restrictions.
Cook's desert parsley	Fall burns after September 1	Summer/Fall mowing after July 15 [5 cm (2 inches)]	No
Gentner's fritillary	Fall burns after September 1	Summer/Fall mowing after July 15 [15 cm (6 inches)]	No
Golden Paintbrush	Fall burns after August 15	Late winter (February to March 15) mowing OK , then mow again after September 15, if site not burned	Yes- with restrictions. Complete by mid-March
Howell's spectacular thelypody	Not Allowed	Not Allowed	No
Kincaid's lupine	Fall burns after August 15	Fall mowing after August 15 15 cm [6 inches)]	Yes- with restrictions.
Large-flowered woolly meadowfoam	Fall burns after September 1	Summer/Fall mowing after July 15 [5 cm (2 inches)]	No
Nelson's checkermallow	Fall burns after August 15;	Fall mowing after August 15	Yes

Listed Plant Species	Treatment Method and Timing		
	Prescribed Burns (Calendar Timing)	Mechanical Mowing – Timing [Mower Deck Height]	Spring Mowing Allowed?
	up to 50% of the occupied area at a site.	[15 cm (6 inches)]	With restrictions.
Rough popcorn flower	Fall burns after August 15	Fall mowing after August 15 [10 cm (4 inches)]	No
Spalding's catchfly	Not Allowed	Not Allowed	No
Ute ladies'- tresses	Not Allowed	Not Allowed	No
Water Howellia	Not Allowed	Not Allowed	No
Wenatchee Mountains checkermallow	Fall burns after August 15	Unlikely mowing could be accomplished. Selective weed removal would be helpful.	No
Western lily	Fall burns[7] between November 1 and March 1	Fall mowing[7] between November 1 and March 1 [10 cm (4 inches)]	No
Willamette daisy	Fall burns after August 15	Fall mowing after August 15 [15 cm (6 inches)]	Yes- with restrictions.
LISTED ANIMAL SPECIES			
Fender's blue butterfly	Burning OK on 25 to 33% of an occupied area after August 15 to Nov 15.	August 15 to March 1 [15 cm (6 inches)]	No
Oregon silverspot butterfly	Burning OK on 25 to 33% of an occupied area from October 1 to mid July	October 1 to Mid-May. No more than 75% of an occupied area	Yes Complete by May 15
Taylor's checekerspot butterfly	Burning OK only on 33% of an occupied area during diapause only (Sept 10 to Feb 15)	Mowing OK during diapause only; September 10 to February 15	No.
Vernal pool fairy shrimp	Any time	Treat invasive plants any time if listed plants not present	Yes
Streaked horned lark	Outside of nesting season in suitable habitat. Anytime in unsuitable habitat.	Sept 1 to March 30: 100% April 1 to August 31 no more than 50% of an occupied area. Mower set to highest level to meet objectives.	Yes, up to 50% of an occupied area.
Mazama pocket gopher	Yes but must get approval from local office	Yes, but must get approval from local office	Yes, but must get approval

3.14 Bradshaw's Lomatium (*Lomatium bradshawii*)

Bradshaw's lomatium (also known as Bradshaw's desert-parsley) was listed as endangered, without critical habitat designation, on September 30, 1988 (USFWS 1988). A recovery plan for the species was published on May 20, 2010 (USFWS 2010). This species is on the state of Oregon's State Endangered Plant list; in Washington it is classified by the WNHP as endangered (USFWS 2010). Bradshaw's lomatium is currently known to occur in Oregon (Benton, Lane, Linn, and Marion and Polk counties), and in Washington (Clark county).

3.14.1 Population Trends and Distribution for Bradshaw's Lomatium

Bradshaw's lomatium was historically overlooked and poorly documented, and there were no known collections between 1941 and 1969, leading to the assumption that the taxon might be extinct. By 1980, following a study of the species, six populations of the species had been located, including one large population (Kagan 1980). Since 1980, over 40 new sites have been discovered, including 3 large populations.

In Oregon, there are currently more than 60 sites with Bradshaw's lomatium, concentrated in three population centers located in Benton, Lane, Linn, and Marion Counties (Gisler 2004, Oregon Natural Heritage Information Center 2007. Most of these populations are small, ranging from about 10 to 1,000 individuals, although the two largest sites each have over 100,000 plants (Oregon Natural Heritage Information Center 2007). In 2010, the total area of occupied habitat is about 742 acres (USFWS 2010). Data collection for a range-wide inventory of Bradshaw's lomatium was completed in 2014 (Currin, Institute for Applied Ecology, *pers. comm.* 2015). Results indicated that 45 populations composed of 313,422 individual plants in Oregon that have potential to contribute towards achieving recovery goals. Other small, isolated populations exist, but are unlikely to contribute to recovery. Of these 45 populations, 5 populations were less than 100 plants; 19 populations had 100 to 2,499 plants; and 18 populations had more than 2500 plants. Of those 18 populations, seven contained over 10,000 plants.

For many years Bradshaw's lomatium was considered an Oregon endemic, its range limited to the area between Salem and Creswell, Oregon (Kagan 1980). However, in 1994, two populations of the species were discovered in Lacamas Prairie, Clark County, Washington. The Washington populations are large, with one (Camas Meadows) estimated to have over ten million individuals in 2010 (Arnett 2014; Currin, Institute for Applied Ecology, pers. comm. 2015). Because of their proximity, these two populations are considered to be a single occurrence under NatureServe guidelines. The second population (Green Mountain) has fluctuated dramatically in size, ranging from over 1,000 plants in 2004 to a low of 20 plants in 2013 (Arnett 2014).

3.14.2 Life History and Ecology for Bradshaw's Lomatium

Bradshaw's lomatium is a member of the Apiaceae (*Umbelliferae*) or the umbel or parsley family (USFWS 2010). The plant is a low, upright perennial arising from a long slender taproot that displays pale-yellow flowers. The plant's leaves are smooth, minutely inter-divided, glossy bluish-green, and strictly basal.

Bradshaw's lomatium blooms in the spring, usually in April and early May (USFWS 2010). The flowers have a spatial and temporal separation of sexual phases, presumably to promote outcrossing, resulting in protandry on a whole plant basis, and protogyny within the flowers. A typical population is composed of many more vegetative plants than reproductive plants. The plant is pollinated by insects. Over 30 species of solitary bees, flies, wasps and beetles have been observed visiting the flowers (Kaye and Kirkland 1994, Jackson 1996). The very general nature of the insect pollinators probably buffers Bradshaw's lomatium from the population swings of any one pollinator (Kaye 1992).

Bradshaw's lomatium does not spread vegetatively and depends exclusively on seeds for reproduction (Kaye 1992). The large fruits have corky thickened wings, and usually fall to the ground fairly close to the parent. Fruits appear to float somewhat, and may be distributed by water. The fine-scale population patterns at a given site appear to follow seasonal microchannels in the tufted hairgrass prairies, but whether this is due to dispersal, habitat preference, or both, is not clear (Kaye 1992, Kaye and Kirkland 1994).

In a genetic study that included six populations of Bradshaw's lomatium, the species displayed little population differentiation but the level of diversity was high across the species (Gitzendanner 2000). Isolated populations in Washington appear to have lower levels of diversity, but they do not appear to be genetically differentiated from the other populations of the species, consistent with historical gene flow among all populations, and a recent bottleneck in the Washington populations.

The species generally responds positively to disturbance. Low intensity fire appears to stimulate population growth of Bradshaw's lomatium. The density and abundance of reproductive plants increased following fires (Pendergrass *et al.*1999), although monitoring showed the effects to be temporary, dissipating after one to three years. Frequent burns may be required to sustain population growth, as determined from population models (Caswell and Kaye 2001, Kaye *et al.*2001). Annual fall mowing has significantly increased the number of individual Bradshaw's lomatium plants persisting in the City of Eugene's Amazon Park, from 10,134 individuals in 1995 to 31,252 individuals in 2005 (Trevor Taylor, City of Eugene, *in litt*. 2008).

3.14.3 Habitat Characteristics for Bradshaw's Lomatium

Bradshaw's lomatium is restricted to wet prairie habitats (USFWS 2010). These sites have heavy, sticky clay soils or a dense clay layer below the surface that results in seasonal hydric soils. Most of the known Bradshaw's lomatium populations occur on seasonally saturated or flooded prairies, which are found near creeks and small rivers in the southern Willamette Valley (Kagan 1980). The soils at these sites are dense, heavy clays with a slowly permeable clay layer located between 15 and 30 cm (6 and 12 inches) below the surface. This slowly permeable clay layer, which results in a perched water table in winter and spring, allows soils to be saturated to the surface or slightly inundated during the wet season. The soils include Dayton silt loams, Natroy silty clay loams or Bashaw clays; other soils on which the species has been found include Amity, Awbrig , Coburg, Conser, Courtney, Cove, Hazelair, Linslaw, Oxley, Panther, Pengra, Salem, Willamette, and Witzel.

Bradshaw's lomatium is often associated with *Deschampsia cespitosa*, and frequently occurs on and around the small mounds created by senescent *Deschampsia cespitosa* plants. In wetter areas, Bradshaw's lomatium occurs on the edges of *Deschampsia cespitosa* or sedge bunches in patches of bare or open soil. In drier areas, it is found in low areas, such as small depressions, trails or seasonal channels, with open, exposed soils. The grassland habitat of Bradshaw's lomatium frequently includes these species: *Carex* spp., *Danthonia californica*, *Eryngium petiolatum*, *Galium cymosum* (bedstraw), *Grindelia integrifolia* (Willamette Valley gumweed), *Hordeum brachyantherum*, *Juncus* spp., *Luzula comosa* (Pacific woodrush), *Microseris laciniata* (cut-leaved microseris), and *Perideridia* sp. (yampah) (Kagan 1980). In most sites, introduced pasture grasses (*Anthoxanthum odoratum*, *Holcus lanatus*, *Poa pratensis* [Kentucky bluegrass], *Agrostis capillaris* [colonial bentgrass], *Dactylis glomerata* and *Festuca arundinacea*) are present. Invasive bentgrasses, including *Agrostis stolonifera*, have been found at many protected sites with Bradshaw's lomatium populations, including TNC's Willow Creek Preserve and William L. Finley National Wildlife Refuge.

3.14.4 Threats/Reasons for Listing for Bradshaw's Lomatium

Expanding urban development, pesticides, encroachment of woody and invasive species, herbivory and grazing are threats to remaining Bradshaw's lomatium populations (USFWS 1988, 2010). The majority of Oregon's Bradshaw's lomatium populations are located within a 16 km (10 miles) radius of Eugene. The continued expansion of this city is a potential threat to the future of these sites. Even when the sites themselves are protected, the resultant changes in hydrology caused by surrounding development can alter the species' habitat (Meinke 1982, Gisler 2004). The majority of sites from which herbarium specimens have been collected are within areas of Salem or Eugene which have been developed for housing and agriculture. The populations in Washington occur on private lands and are not protected (Gisler 2004).

Populations occurring on roadsides are at risk from maintenance activities, and from adverse effects of management on adjacent lands (USFWS 2010). Pesticide use on agricultural fields and herbicide application adjacent to roads may harm Bradshaw's lomatium populations across its range. There is concern that pesticides kill the pollinators necessary for plant reproduction; Bradshaw's lomatium does not form a seed bank, therefore, any loss of pollinators (and subsequent lack of successful reproduction) could have an immediate effect on population numbers (Kaye and Kirkland 1994). Herbicides may drift, and even when Bradshaw's lomatium is not the target, applications near a population may damage or kill the plants outright.

3.14.5 Recovery Measures for Bradshaw's Lomatium

Extensive research has been conducted on the ecology and population biology of Bradshaw's lomatium, effective methods for habitat enhancement, and propagation and reintroduction techniques (Kagan 1980, Kaye 1992, Kaye and Kirkland 1994, Kaye and Meinke 1996, Caswell and Kaye 2001, Kaye and Kuykendall 2001, Kaye *et al.*2003). The results of these studies have been used to direct the management of the species at sites managed for wet prairies.

Propagation studies have found that long-term (8 weeks) cold stratification was necessary to fully break dormancy in this species (Kaye *et al.*2003). Bradshaw's lomatium plants can be grown from seed in a greenhouse environment (Kaye *et al.*2003). Plants may be successfully established at existing populations or new locations through out-planting of greenhouse-grown plants. Fertilizing transplants may have a negative effect on survival in some cases. Direct seeding has a relatively high success rate (17 to 38%), and is improved by removal of competing vegetation (Kaye and Kuykendall 2001, Kaye *et al.*2003). Seeds of this species have been banked at the Rae Selling Berry Seed Bank (Portland State Environmental Science and Management 2015) in Portland, Oregon and the University of Washington Botanic Garden (USFWS 2010).

Studies of the effects of cattle grazing on Bradshaw's lomatium populations show mixed results (USFWS 2010). Grazing in the springtime, when the plants are growing and reproducing, can harm the plants by biomass removal, trampling and soil disturbance; however, late-season livestock grazing, after fruit maturation, has been observed to lead to an increase in emergence of new plants, and the density of plants with multiple umbels, although it did not alter survival rates or population structure (Drew 2000). Observed increases in seedlings may be due to small disturbances in the soil, a reduction of shading by nearby plants, and reduced herbivory by small mammals.

Populations of Bradshaw's lomatium occur on public lands or lands that are managed by a conservation organization at the Service's William L. Finley and Oak Creek units of the Willamette Valley National Wildlife Refuge Complex, the USACE at Fern Ridge Reservoir, the Bureau of Land Management at the West Eugene Wetlands, TNC at Willow Creek Natural Area and Kingston Prairie Preserve, and Lane County at Howard Buford Recreation Area (USFWS 2010). All of these parcels have some level of management for native prairie habitat values. A habitat conservation plan that addresses conservation of Bradshaw's lomatium within Benton County was completed in 2010 (Benton County 2010).

Washington populations are with the Lacamas Prairie area, which has been approved by the WDNR as a combination Natural Area Preserve and Natural Resources Conservation Areas (Arnett 2014). Of a total area of 1,652 acres that is eligible for inclusion in this designated natural area, 201 acres are acquired to date; only the Green Mountain sub-population is in public ownership.

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.

3.14.6 Conservation Measures for Bradshaw's Lomatium

All of the General Plant Conservation Measures (Section 3.13.1) apply for Bradshaw's lomatium. Additional species-specific measures include:

- Broadcast application of grass-specific herbicides may be used in on up to half of an area occupied by Bradshaw's lomatium between February 15 and April 15. If using a weed wiper to apply a grass-specific herbicide for a particular listed plant during the growing season, the herbicide will be applied to the upper grass stems of targeted non-native plants, thus avoiding the shorter listed plant species.
- All other broadcast applications will only occur after August 15 when Bradshaw's lomatium is dormant.

3.14.7 Environmental Baseline for Bradshaw's Lomatium

The action area encompasses the entire range of Bradshaw's lomatium, and therefore the environmental baseline for this species is adequately described in the preceding sections.

3.14.8 Effects Analysis and Summary for Bradshaw's Lomatium

Bradshaw's lomatium is a wet prairie species that may be affected by some aquatic restoration projects, but is most likely to be affected by techniques for prairie restoration (mowing, herbicide use, burning, grazing, and plant propagation) and wetland restoration (re-grading, etc). The general effects of aquatic and prairie restoration projects are described in General Effects to Listed Plants (Section 3.29), and these adequately describe the potential effects to Bradshaw's lomatium. No additional effects are anticipated for any of the proposed activities.

Over 4 years (2011 to 2014), PFW worked in 10 projects that restored 780 acres of wetland habitat in Oregon that affected Bradshaw's lomatium; the Coastal Program did not work on any projects that directly affected Bradshaw's lomatium during that time. The Service's Recovery Program funded an additional 33 restoration projects in Oregon (where the majority of Bradshaw's lomatium populations exist) that affected prairie habitats between 2012 and 2014; 4 of those projects affected Bradshaw's lomatium. One additional project in Washington for Bradshaw's lomation was funded between 2010 and 2012. Restoration work conducted by the Willamette Valley Refuge Complex could occur on up to 652 acres of wet prairie (WVNWR CCP 2011, p. 4-2). We anticipate few projects, if any aquatic projects funded by the NOAA RC (which target anadromous salmonids) will occur in habitats occupied by Bradshaw's lomatium. We also estimate an additional 2 restoration projects implemented by other parties could be covered under this Opinion per year, as described in the Introduction in the section entitled *Action Area and Requirements for Coverage.*

Given this information, we anticipate that an average of 8 projects averaging 78 acres (or 468 acres annually) will affect Bradshaw's lomatium, plus restoration work on up to 652 acres annually on refuge lands. Given the limited number and average size of the potential restoration projects relative to number of population occurrences and acres of occupied habitat, the numerous PDC and proposed conservation measures to minimize the number of plants adversely affected by the proposed action, and the anticipated long-term benefits from each project to native habitats and listed species in the long-term, we conclude the proposed restoration actions will not jeopardize the continued existence of Bradshaw's lomatium.

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3.15 Cook's Desert-Parsley (*Lomatium cookii)*

Cook's desert-parsley (also known as Cook's lomatium) (desert parsley) was listed as federally endangered on December 7, 2002 (USFWS 2002a). Critical habitat was designated for desert parsley in July 2010 (USFWS 2010). A draft recovery plan for this species was developed on September 22, 2006 (USFWS 2006) and updated in November 2012 (USFWS 2012). This species is on the state of Oregon's State Endangered Plant list. Desert parsley is currently known to occur in Oregon (Jackson and Josephine counties).

3.15.1 Critical Habitat for Cook's Desert-Parsley

The PCEs for desert parsley critical habitat include vernal pool habitats, the dominant native plant association of this habitat, intact hydrology and soils that provides for adequate soil moisture (USFWS 2010). Critical habitat is designated for desert parsley on 6,289 acres in Jackson and Josephine Counties, Oregon. In Josephine County, 2,153 acres are designated on private lands, 1,781 on Federal lands, and 72 on State lands for a total of 4,006 acres. In Jackson County, there is a total of 2,282 acres designated as critical habitat: 1,413 acres are designated on private lands, 277 acres are designated on municipal lands, 200 acres are designated on county lands, and 392 acres are designated on State lands.

3.15.2 Population Trends and Distribution for Cook's Desert-Parsley

Desert parsley was first collected in 1981 and subsequently described from vernal pools in the Agate Desert, Jackson County, Oregon (Kagan 1986). Additional populations were found at French Flat in the Illinois Valley, Josephine County, Oregon in 1988 (Oregon Natural Heritage Information Center 2008). Currently, the distribution of desert parsley ranges from the Agate Desert area of the Rogue Valley in Jackson County to the Illinois Valley in Josephine County.

In the Rogue Valley's Agate Desert, desert parsley in the Rogue Valley is known from 13 occurrences, of which 6 are extant, 6 are unknown in current status, and 1 is extirpated. The populations occur within or adjacent to vernal pool-mounded prairie habitat on Agate-Winlo mapped soils (USFWS 2012). Approximately 40% of the population occurs on publicly owned land and 60% occurs on privately owned land.

In the Illinois Valley, the 24 occurrences of desert parsley cover 29.5 acres, with an estimated 7,766 acres of potential desert parsley habitat present. Occurrences range from areas north of Selma, Oregon, south to the French Flat area.

3.15.2.1 Rogue Valley Population Trends

Population census results at the Agate Desert Preserve between 1997 and 2012 indicate a fluctuating but gradual decline in desert parsley numbers, ranging from a high of 5,000 in 1997 to a low of 1,800 in 2002 (M. Morison, pers. comm. 2012). The most recent *L. cookii* census, in 2011, estimated 1,710 plants, a continuing decline.

Surveys at an Oregon Department of Transportation Special Management Area along Highway 140 have found fluctuating populations that are relatively stable: 200 plants observed in 1992, decreasing to 26 plants in 2000 and 60 plants in 2004, and most recently increasing to 160 plants in 2009 (D. Sharp, pers. comm. 2009).

On private land in central White City, a population numbering 2,000 individuals was documented in 1992 but was extirpated due to competition with non-native invasive grasses (Oregon Natural Heritage Information Center 2008; USFWS 2010).

Several desert parsley populations at the Hall Tract of the Denman Wildlife Area decreased in size from an original estimate between 700 and 1,000 plants in 1992 to an estimate of 500 plants in 2000, but were estimated to contain 3,000 plants in 2008 (K. Perchemliedes, *pers. comm.* 2011).

The estimated population size at the Rogue Valley International-Medford Airport is approximately 5,000 plants (USFWS 2009) due to consistent airport mowing and thought to give the species a competitive edge. This population is stable (USFWS 2012).

During 2001, roughly 500,000 individuals were estimated in a single population of desert parsley on private property in White City (Oregon Natural Heritage Information Center 2008). This is the largest population ever recorded; however, the status of this population is currently unknown.

3.15.2.2 Illinois Valley Population Trends

Annual monitoring of three populations (Indian Hill, Rough and Ready Botanical Wayside, and French Flat ACEC) on BLM lands since 1994 has revealed an overall stable population with increases at some sites and decreases at others (Pfingsten *et al.*2012). For example, the Indian Hill population increased from 2007 to 2011, and then decreased in 2012. Similarly, the French Flat South population increased each year from 2007 to 2010, and then declined in 2011 and 2012. French Flat Middle, in contrast, has steadily declined since 2009, reaching in 2012 an all-time low since monitoring began in 1993. There have been large variations in population densities and reproduction over time and among the three sites.

A survey along an Oregon Department of Transportation Special Management Area along Highway 46 in 2012 reported approximately 1,095 plants, which was up from the 1,035 plants observed in 2003 (D. Sharp, *pers. comm.* 2012).

A population viability analyses conducted at French Flat South and French Flat Middle populations predict a high probability (98% and 78%, respectively) of a 50% population decline in the next 20 years (Pfingsten *et al.*2012).

In summary, desert parsley is fairly stable across its range but still at risk; populations are increasing in some areas, but slowly declining in other areas due to competition with native and non-native vegetation recruitment.

3.15.3 Habitat Characteristics for Cook's Desert-Parsley

Desert parsley in the Illinois Valley grows on seasonally wet soils. For much of its range in the Rogue River Valley, the plant occurs on upland mounds, at the bottom of rocky vernal pools, and on vernal pools flanks. It occurs in either strongly expressed or weakly expressed vernal pool formations and appears to tolerate various types of disturbance.

In the Rogue River Valley, populations of desert parsley are found in shallow Agate-Winlo complex in sparse prairie vegetation. Common plant associates include *Lupinus bicolor* (bicolor lupine), *Colinsia sparsiflora* (sparse-flowered collinsia), *Clarkia purpurea* (purple clarkia), *Erodium cicutarium* (filaree), foothills desert-parsely, *Achnatherum lemmonii* (Lemmon's needlegrass), *Poa bulbosa* (bulbous bluegrass), *Brodiaea elegans* (elegant brodiaea), *Madia spp* (tarweed), *Lasthenia californica* (goldfields), *Hemizonia fitchii* (Fitch's tarweed), and *Plagiobothrys spp* (popcornflower).

In the Illinois Valley, desert parsley occurs in open wet meadows and along roadsides adjacent to meadows on Brockman clay loam, Josephine gravelly loam, Pollard loam, Eightlar extremely stony clay, Takilma cobbly loam, Abegg clay loam, and Newberg loam soils. Brockman clay loam soils in the French Flat area average 61 to 89 cm (24 to 35 inches) in depth. These seasonally wet soils have the ability to block water permeability through the soil, similar to the Agate Desert vernal pools, but lack that region's distinctive mound and swale topography.

Soils in the Illinois Valley are partially derived from serpentine formations that occur on surrounding slopes and hilltops. Common species in the Illinois Valley associated with desert parsley include *Danthonia californica* (California oatgrass), *Chlorogalum pomeridianum* (soap plant), *Plagiobothrys bracteatus* (bracted popcornflower), *Hesperichiron californica* (hesperichiron), *Horkelia californica* (California horkelia), *Calochortus uniflorus* (short-stemmed mariposa lily), and wedge-leaved buckbrush. Two rare plants that may occasionally occur with desert parsley in the Illinois Valley are *Senecio hesparius* (western senecio) and *Microseris howellii* (Howell's microseris).

3.15.4 Threats/Reasons for Listing for Cook's Desert-Parsley

Specific threats to desert parsley are habitat loss, off-road vehicle use, mining, road construction, logging in surrounding forests and meadows, livestock grazing, woody plant encroachment, invasion of non-native annual grasses and herbs, herbicide spraying, and dredging for gold in surrounding hills (USFWS 2012). Off-road vehicle tires create large ruts and can fracture the clay hardpan layer when soils are moist, which allows water to drain and compromises plant survival. Off-road vehicle use caused the drainage of an estimated 15 acres from French Flat in 2000 (USFWS 2002b) and by 2004 has drained an additional 10 acres (USFWS 2012).

3.15.5 Recovery Measures for Cook's Desert-Parsley

The Service published the Recovery Plan for Listed Species of the Rogue Valley Vernal Pool and Illinois Valley Wet Meadow Ecosystems (recovery plan) in 2012 (USFWS 2012). The recovery plan sets out specific goals, objectives and tasks to direct recovery efforts for meadowfoam, Cook's desert parsley and vernal pool fairy shrimp. These species are all listed and associated with vernal pool complexes. Nine core areas were identified as focal areas for conservation.

The Service's Conservation Strategy in the Rogue Valley relies on conservation of vernal pool habitat to assist in the recovery of meadowfoam, Cook's desert parsley, and fairy shrimp (USFWS 2011). The strategy has a goal to conserve up to 2,000 acres of contiguous blocks of vernal pool complexes (USFWS 2011) to meet recovery criteria for the three species. This Conservation Strategy and its biological opinion (USFWS 2011), coupled with the recovery plan are anticipated to provide long-term conservation benefits to meadowfoam, Cook's desert parsley, and vernal pool fairy shrimp, and streamline projects with the principal purposes of protecting, preserving, restoring, enhancing, or maintaining the habitat and listed species attributes of the vernal pool complex.

Where desert parsley occurs on public lands, it receives some form of protection. The Bureau of Land Management protects 16 populations of desert parsley in the Illinois Valley by restricting off-road vehicle access, maintaining a long-term population inventory program, and monitoring existing populations. Additionally, the Service signed a Conservation Agreement with the Bureau of Land Management in January 2003 to enable additional protection of the species on Federal lands through cooperative actions (e.g. fencing, monitoring) (BLM and USFWS 2003). Although some trespass and damage problems still exist, the agencies are working cooperatively to address these issues.

Of the four desert parsley populations on Oregon Department of Transportation (ODOT) administered land, one has become extirpated. The ODOT maintains the remaining desert parsley populations in both Jackson and Josephine Counties within three roadside Special Management Areas by limiting destructive maintenance activities during the growing season, restricting herbicide use, and performing restorative practices that benefit the plants (D. Sharp, *pers. comm.* 2012; ODOT 2013).

The desert parsley population on Jackson County land at the Rogue Valley International-Medford Airport appears to be in good condition. Seasonal mowing of the airport fields during dry weather and protection from vehicular disturbance has benefitted desert parsley. At the property, the plants appear prolific, relatively densely spaced, and exhibit a high degree of germination (Friedman 2003). Although more detailed studies need to be conducted at the airport property to determine population trends and the long-term health of the population, the current management of the population appears to be successful.

TNC has managed two populations of desert parsley at two preserves for over 20 years. Although the two populations are protected from development and grazing was eliminated from the preserves, the populations are not very large or robust. Noxious weeds have been greatly reduced from both preserves and prescribed burning has been conducted, but the desert parsley population has not responded well. Mowing, grazing, and reintroduction are now used to maintain or restore vernal pool-mounded prairie habitat at the Agate Desert and the Whetstone Savanna preserves in an attempt to bring the populations back to their former robust size (M. Morison, *pers. comm*. 2011).

Seeds from three desert parsley populations in the Rogue Valley and two locations in Josephine County (French Flat) are stored at the Rae Selling Berry Seed Bank in Portland, Oregon (Portland State Environmental Science and Management 2015). In 2006, the Service funded the ODA to develop detailed propagation and reintroduction protocols for the species.

Since 2008 ODOT has been working to establish a desert parsley population at the ODOT vernal pool mitigation and conservation bank (bank) in Central Point, Oregon in anticipation of future vernal pool and desert parsley impacts. This bank will be owned and co-managed by TNC. In 2011, ODOT collected seed from a 0.4 acre highway expansion project build site to grow out desert parsley within the bank (USFWS 2013). They collected over 10,000 seed from an estimated 3,397 plants and planted these at the Stone Nursery, near Jacksonville, Oregon. The resulting plants had nearly 100% successful germination and grew to produce over 20 pounds of seed, which have been sown into the ODOT bank area. Efforts to establish the population have been met by set-backs, but ODOT and TNC are persistently working to improve siting and growing conditions so that the successful re-introduction will be achieved (USFWS 2013; Benton, *pers. comm*. 2015).

3.15.6 Conservation Measures for Cook's Desert-Parsley

All of the General Plant Conservation Measures (Section 3.13.1) apply for Cook's desert parsley. In addition, livestock grazing will not be used to control or remove invasive and non-native vegetation at project sites occupied by Cook's desert-parsley, unless approved by the local Service office. This plant can be associated with vernal pool habitats, which can support vernal pool fairy shrimp (another listed species), and additional PDC, restrictions, and conservation measures may apply for vernal pool fairy shrimp.

3.15.7 Environmental Baseline for Cook's Desert-Parsley

The action area encompasses the entire range of Cook's desert parsley, and therefore the environmental baseline for this species and its critical habitat is adequately described in the preceding sections.

3.15.8 Effects Analysis and Summary for Cook's Desert-Parsley

Cook's desert parsley typically occurs in vernal pool complexes, but also occurs in seasonally wet habitats in some locations. Thus, Cook's desert parsley may be affected by some aquatic restoration projects, but is most likely to be affected by restorations techniques associated with vernal pools or wet prairies (mowing, herbicide use, burning, or grazing and plant propagation, wetlands restoration, etc). Effects from these proposed activities are described in the General Effects to Listed Plant Species (Section 3.29). No additional effects (direct or indirect) are anticipated based on the life history or habitat characteristics of Cook's desert parsley.

Over 4 years (2011 to 2014), neither PFW nor the Coastal program worked on projects that affected Cook's desert parsley, but wetland projects in Oregon averaged about 50 acres during that timeframe. The Service's Recovery Program funded up to 2 restoration projects per year that affected Cook's desert parsley between 2012 and 2014. We anticipate few, if any aquatic projects funded by the NOAA RC (which target anadromous salmonids) will occur in wetland habitats occupied by Cook's desert parsley. We also estimate an additional 1 restoration project implemented by other parties could be covered under this Opinion per year, as described in the Introduction in the section entitled *Action Area and Requirements for Coverage.*

Given this information, we anticipate up to 3 projects per year averaging 50 acres (150 acres annually) that will affect Cook's desert parsley. Given the limited number and average size of the potential restoration projects relative to number of population occurrences and suitable habitat acres, the numerous PDC and proposed conservation measures to minimize the number of plants adversely affected by the proposed action, and the anticipated long-term benefits from each project to native habitats and listed species in the long-term, we conclude the proposed restoration actions will not jeopardize the continued existence of Cook's desert parsley.

3.15.9 Effects to Critical Habitat for Vernal Pool Fairy Shrimp

Restoration activities most likely to affect the PCEs of fairy shrimp critical habitat include prairie restoration techniques used for vernal pool restoration (mowing, herbicide use, burning, or grazing and plant propagation) and wetland restoration (regrading, etc). Restoration in vernal pool complexes may reduce native plant density and alter soil and hydrologic conditions, resulting in short-term adverse effects to these PCEs. Equipment and vehicle entry into vernal pool habitat could introduce non-native invasive plants capable of displacing native plant communities in favor of a non-native plant community. This in turn, could negatively affect vernal pool hydrology and limit the inundation period and thus decrease the breeding cycle and reproduction at the affected site. Similarly, use of heavy equipment has the potential of causing soil disturbance and compaction that may negatively affect vernal pool hydrology, which could also negative affect vernal pools and the fairy shrimp that depend on them, especially if earth-moving / regrading is necessary

In the long-term, habitat manipulation, restoration, and enhancement activities will have beneficial effects on vernal pool complexses that support fairy shrimp, and improve PCEs of critical habitat for this species. Given the numerous PDCs and proposed conservation measures to minimize habitat impacts affected by the proposed action, and each project is intended to benefit native habitats, the long-term effects of the proposed activities are not likely to diminish the values of these critical habitats for the purpose for which it was designated. Thus, the proposed activities will not destroy or adversely modify the PCEs of critical habitats for fairy shrimp.

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3.16 Gentner's Fritillary (*Fritillaria gentneri*)

Genter's fritillary (fritillary) was federally listed as endangered on December 10, 1999 (USFWS 1999) without critical habitat designation. The species is also on the State of Oregon's State Endangered Plant list. A recovery plan for the species was published on July 21, 2003 (USFWS 2003). Fritillary occurs in Jackson and Josephine counties in Oregon and in northern Siskiyou County in California.

3.16.1 Population Trends and Distribution for Gentner's Fritillary

There are approximately 138 occurrences of fritillary. A high number of 1,955 flowering plants were observed on 50 BLM monitoring sites lands in 2004, but flower plant counts have been lower since then, even though seven new monitoring sites were added. The lowest years were 2006 and 2007 when less than 1,000 flowering plants were observed on the monitoring sites. In the last six years, flower fritillary counts have remained above 1,100. Eight occurrences contained 100 flowering plants or more in the last ten years, with surveyors recording a high of 602 flowering plants at the Pilot Rock Lower occurrence on the Cascade Siskiyou National Monument in 2013. The rest of the populations have fluctuated between 0 to 96 flowering plants (Siskiyou BioSurvey 2014). Flowering individuals are the most efficient to monitor because flowers are easily detected while leaves are less noticeable and cannot be positively identified to species. Available science has not established that a low number of flowering plants indicate an unhealthy population.

The Pickett Creek population has been the subject of a long-term demography study. In this population both flowering plants and vegetative leaves are documented. Flowering plant counts have steadily declined at this site over the last 13 years. In 2012, the lowest recorded numbers of flowering individuals were recorded (46 flowering individuals). However, the estimated total population size (both vegetative and flowering plants) based on density plots in the upper and below-road subpopulations has not consistently declined, but has fluctuated throughout the course of the study from a low of 6,715 in 2006 to a high of 17,684 in 2003 (Giles-Johnson et. al 2013).

For the last 14 years, the BLM has monitored fritillary flowers and leaves on 58 sites across all four recovery units and within 43 occurrences (Siskiyou Biosurvey LLC 2014). While results indicate that the number of flowering fritillary plants at most sites fluctuate annually, the overall flowering plant total indicates a seven-year increasing trend. With the discovery of over 40 new occurrences since the species was listed in 1999, the distribution of fritillary is more extensive than previously understood (S. Friedman, USFWS, *pers. comm.* 2015). Approximately 309 flowering plants have been discovered in the new occurrences, which approximate an increase of 15,450 m^2 or 3.8 acres. The most recent fritillary plant total across the range of the species is 2,907 flowering plants; up from 1,696 flowering plants at the time of 2003 recovery plan publication (USFWS 2003).

3.16.2 Life History and Ecology for Gentner's Fritillary

Fritillary is a perennial herb arising from a fleshy bulb producing numerous small rice-grained bulblets. The plant also produces several large scales surrounded by 10 to 150 small rice-grained bulblets per plant (USFWS 2003). Fritillary forms large maroon to bright reddish flowers with yellow mottles that are easily observed in the early spring. The flowers are solitary, or in bracted racemes, 1 to 7 (rarely more) on long slender pedicels. The 2.5 to 4.0 cm bell-shaped flower has segments that bend more or less outward, at times straight, but are not strongly recurved like the common scarlet fritillary (*Fritillaria recurva*).

Fritillary emerges from the ground in early February, flowers from mid-April to early June, and is dormant from mid-August to mid-January (USFWS 2003). Non-flowering fritillaries greatly outnumber flowering plants in natural populations, and are recognizable only by their single ovate to lanceolate basal leaf, indistinguishable from several other common related fritillaries. Due to poor and erratic seed production, bulblet production and disbursement are the principal means of Gentner's fritillary propagation.

Older research (Amsberry and Meinke 2002) documented erratic, extremely low seed production, and poor viability in the species (2.3% seed production), indicating that the plant largely reproduces asexually. However, inter-population fruit-set of *F. gentneri* x *F. gentneri* crosses was much higher, with 48.9% seed production and with good seed viability (Amsberry and Meinke 2007).

A population of fritillaries consists of plants at three different life stages: flowering plants, vegetative mature plants, and vegetative juvenile plants. Using data provided by Brock and Knapp (2000), each flowering fritillary located in a population represents an estimated 40 plants from all three life stages (USFWS 2003).

3.16.3 Habitat Characteristics for Gentner's Fritillary

Fritillary occurs in a variety of forested habitats including oak woodlands dominated by Oregon white oak (*Quercus garryana*), mixed hardwood forest dominated by California black oak (*Quercus kelloggii*), Oregon white oak, and madrone (*Arbutus menziesii*), and coniferous forests dominated by madrone and Douglas-fir (*Pseudotsuga menziesii*) (USFWS 2003). The 25 soil types that the plant has been known to occur on are Abegg, Beckman-Colestine complex, Brader-Debenger complex, Caris-offennbacher complex, Cornutt-Dubakelia complex, Dubakella-Pearsoll complex, Farva, Heppsie, Heppsie-McMullin complex, Holland, Langellain, Langellain-Brader complex, Manita, McNull-Medico complex, McMullin-Rockoutcrop complex, McNull, McNull-Medco complex, McNull-McMullin complex, Ruch, Tallowbox, Tatouche, Vannoy, Vannoy-Voorhies complex, Woodseye-rockoutcrop complex and Xerothents-Dumps complex (USFWS 2003). The soil types most commonly supporting the plant are Vannoy and Vannoy-Voorhies complex.

3.16.4 Threats/Reasons for Listing for Gentner's Fritillary

Habitat loss is the main threat to this species (USFWS 2003). Fritillary populations are often directly impacted by development in the form of housing construction, cemetery expansion, trail maintenance, road widening, landfill expansion, power line maintenance, water system construction, and agricultural conversions (USFWS 1999). These activities primarily occur on private lands. Between 1941 and the present, eight known occurrences have been extirpated due to developmental expansion (USFWS 2003).

The extent of use of *Fritillaria gentneri* by commercial and recreational activities is unknown; however, this native lily is quite attractive, and the genus *Fritillaria* is cultivated because of its colorful appearance. For example, flower picking and plant collection has been documented at the Jacksonville Woodlands (Pacific Crest Consulting 2010). Despite this, there is no evidence of widespread cultivation or population affects due to these activities (S. Friedman, USFWS, *pers. comm.* 2015).

Fritillaries appear to be a strongly preferred food choice by deer, which go to great lengths to eat flower stalks (USFWS 2003). Predation could conceivably reduce plant numbers and productivity. Many plant flowers are browsed before producing mature fruit. Many of the plants that were tagged for seed collection by Wayne Rolle, in 1988, had the capsules eaten by wildlife before the seed capsules matured (USFWS 1999). Since the species does not appear to produce viable seeds, floral and/or upper stem herbivory may yield little impact. Intensive grazing (including trampling) by livestock at some sites may pose a much greater threat than browsing by deer (USFWS 2003), though limited grazing could benefit the species by reducing competing vegetation and thus be used to maintain suitable habitat (S. Friedman, USFWS, *pers. comm.* 2015). Further studies are needed to increase our knowledge of livestock grazing compatibly with fritillary.

Fire exclusion has altered suitable habitat for the plant by permitting open oak woodland habitats to become more thickly wooded and less grassy (Siskiyou Biosurvey LLC 2014). This transition can result in partial to total exclusion of fritillary plants. At the same time, the increase of homes in the area makes prescribed burning difficult. This has reduced suitable habitat for the plant while a less-than-optimal habitat condition is achieved that is also susceptible to catastrophic fire.

The threat of extinction due to naturally occurring demographic and environmental events reduces the viability of the species as a whole. Because most plant sites occupy small areas, naturally occurring environmental events could also play a role in extirpation. Small clusters can disappear with one environmental event, such as erosion. Fritillary sites are small and isolated from each other due to habitat fragmentation. This isolation could inhibit re-colonization to other suitable areas and could result in a permanent loss of localized occurrences once they fall below a critical level.

3.16.5 Recovery Measures for Gentner's Fritillary

Much new information has been collected on the biology and life history of fritillary subsequent to the publication of the 2003 recovery plan. Cost share funding by Medford BLM, Institute for Applied Ecology, Oregon Departmenr of Agriculture, and the Service have enabled long term monitoring to continue on this species (S. Friedman, USFWS, *pers. comm.* 2015).

Most Fritillary populations occur on Federal lands and are protected from development (S. Friedman, USFWS, *pers. comm.* 2015). The Medford BLM manages the majority of known fritillary sites by performing annual monitoring, funding research to determine life history dynamics and funding recovery actions such as habitat restoration and population augmentation. All ground disturbing activities that are carried out or permitted on BLM lands are surveyed for Fritillary.

ODOT also manages two fritillary sites on highway right-of-ways and has designated Special Management Areas (SMA) at the two locations (S. Friedman, USFWS, *pers. comm.* 2015). Management under the SMAs calls for annual or biennial monitoring and suspension of spraying, ditching, disking, or mowing activities to conserve the populations. ODOT also surveys suitable habitat for fritillary for presence of new populations prior to ground disturbing activities.

The City of Jacksonville has developed a management plan to address restoration of a Fritillary population due to accidental construction of a road through the middle of a population and subsequent infestation of the noxious weed, *Centaurea solstitialis* (yellow starthistle). Currently the yellow starthistle is nearly under control and the population is carefully monitored (S. Friedman, USFWS, *pers. comm.* 2014).

Recovery group meetings were held to chart a course for downlisting the species from an endangered to threatened status in the next ten years (S. Friedman, USFWS, *pers. comm.* 2015). Some of the actions that will be undertaken will include signing a conservation agreement between BLM, the Service and ODA to manage Federal lands across most of the range of Gentner's fritillary and developing best management practices for managing habitat.

Beginning in 2003, 21,074 *Fritillaria gentneri* bulbs have been collected from 16 sites and propagated at an off-site nursery on the Oregon State University campus resulting in over 50,000 bulbs grown by propagation through 2012 (S. Friedman, USFWS, *pers. comm.* 2015). Since 2004, 31,060 bulbs have been planted at 22 sites within all 4 recovery units, 17 as augmentation of existing occurrences and 5 as reintroductions. The propagation efforts have yielded 7,038 non-flowering plants and 8 flowering plants, as of 2012, which is a 23% success rate. Although propagation and outplanting of bulbs is successful, it will likely take extensive bulb collection, propagation, and outplanting efforts to see recovery level populations met.

3.16.6 Conservation Measures for Gentner's Fritillary

All of the General Plant Conservation Measures (Section 3.13.1) apply for fritillary. In additional, livestock grazing will not be used to control or remove invasive and non-native vegetation at project sites occupied by Gentner's fritillary, unless approved by the local Service office.

3.16.7 Environmental Baseline for Gentner's Fritillary

The action area nearly encompasses the entire range of fritillary, except for a small portion of its range in northern California. Therefore, the environmental baseline for this species is adequately described in the preceding sections.

3.16.8 Effects Analysis and Summary for Gentner's Fritillary

Fritillary is a forested upland plant, and is therefore most likely to be affected by silviculture actions, such as thinning, typically done to benefit northern spotted owl habitats. Thinning thickly forested areas would benefit fritillary by allowing more light to the forest floor. Removal of trees or branches should avoid felling on to and crushing listed plant species. Overall, long-term benefits would be expected to fritillary by allowing more light to the forest floor. While there may be some localized, short-term loss to plant species, use of the General Plant Conservation Measures should limit impacts to any listed plants in the site boundary.

In some instances, fritillary could be affected by other proposed restoration techniques. Anticipated effects from such actions proposed are described in the General Effects to Listed Plant Species (Section 3.29). No additional effects (direct or indirect) are anticipated based on the life history or habitat characteristics of fritillary.

Over 4 years (2011 to 2014), none of the Service's funding programs worked on projects that affected Gentner's fritillary, but 15 PFW projects affecting northern spotted owls (and therefore presumably in forested areas and an appropriate surrogate for project size) averaged about 166 acres each during that timeframe. We anticipate few, if any aquatic projects funded by the NOAA RC (which target anadromous salmonids) will affect upland, forested habitats occupied by fritillary. We also estimate an additional 1 restoration project implemented by other parties could be covered under this Opinion per year, as described in the Introduction in the section entitled *Action Area and Requirements for Coverage.*

Given this information, we anticipate up to 5 projects per year averaging 166 acres each (or 830 acres annually) may affect fritillary. Given the limited number of projected projects that may affect fritillary relative to number of population occurrences throughout its range, the numerous PDC and proposed conservation measures to minimize the number of plants adversely affected by the proposed action, and the anticipated long-term benefits from each project to native habitats and listed species in the long-term, we conclude the proposed restoration actions will not jeopardize the continued existence of Gentner's fritillary.

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3.17 Golden Paintbrush (*Castilleja levisecta*)

Golden paintbrush was federally listed as threatened, without critical habitat, on June 11, 1997. This species is also on the state of Oregon's State Endangered Plant list. A recovery plan was published for the species on August 23, 2000 (USFWS 2000). Additional recovery guidelines are provided in the *Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington* (USFWS 2010). In Washington the WNHP has classified this species as endangered; this species is also on the state of Oregon's State Endangered Plant list (USFWS 2010). Golden paintbrush is currently known to occur in Oregon (Benton, Polk, and Multnomah counties), and in Washington (Island, San Juan, Thurston, and as of 2014, Clark counties) (T. Thomas, USFWS, *pers. comm.* 2015).

3.17.1 Populations Trends and Distribution for Golden Paintbrush

Historically, *Castilleja levisecta* has been reported from more than 30 sites in the Puget Trough of Washington and British Columbia, and as far south as Brownsville in the Willamette Valley of Oregon (Hitchcock *et al.*1959, Sheehan and Sprague 1984, Gamon 1995, Gamon *et al.*2001). Many populations have been extirpated as their habitats were converted for agricultural, residential, and commercial development. In Washington, the species occurs in the Puget Trough physiographic province, whereas in Oregon, the species occurs in the Willamette Valley physiographic province (Franklin and Dyrness 1988). As of 2014, there were 12 extant wild populations in Washington, totaling approximately 13,300 plants (T. Thomas, USFWS, *pers. comm.* 2015). In addition to the wild populations, 34 reintroductions were completed in Oregon and Washington.

In Oregon, *Castilleja levisecta* historically occurred in the grasslands and prairies of the Willamette Valley; the species has been extirpated from all of these sites as the habitat has been modified by agriculture (USFWS 2010). The last sighting of *Castilleja levisecta* in the wild in Oregon was during 1938 in Linn County; recent surveys have failed to re-locate wild populations of *Castilleja levisecta* in Oregon (Sheehan and Sprague 1984, Kaye 2009). In 2005, small populations of *Castilleja levisecta* were planted in a common garden study plots at William L. Finley and Baskett Butte National Wildlife Refuges in the Willamette Valley. The propagules primarily came from Washington state populations, with a smaller contribution of seed from Canada. These plants still persist at both refuges.

In summary, wild populations of golden paintbrush declined substantially in 2014, after maintaining relatively stable population rangewide from 2004 through 2013, at approximately 20,000 (+\- 2,000 flowering plants) (T. Thomas, USFWS, *pers. comm.* 2015). This recent decline is likely due to a lack of site management (primarily prescribed fire) at several of the wild populations, with two populations in particular declining more than 50 % since they were last reported. However, the combined rangewide population of both wild and introduced golden paintbrush is greater than 185,000 flowering plants, indicating that site management coupled with broadcast seeding can establish robust populations in relatively short time periods (about two years) (T. Thomas, USFWS, *pers. comm.* 2015). The distribution of plants rangewide and the number of plants in the majority of populations has increased due to outplanting seeds and plugs, and other on-the-ground conservation efforts.

Restoration actions are essential for the continued survival of golden paintbrush (T. Thomas, USFWS, *pers. comm*. 2015). Steps to increase population sizes and establish new populations within the historical range are necessary to ensure long term survival of golden paintbrush.

3.17.2 Life History and Ecology for Golden Paintbrush

Castilleja levisecta is a relatively short-lived perennial herb, with individual plants generally surviving 5 to 10 years (T. Thomas, USFWS, *pers. comm*. 2015). This species reproduces exclusively by seed; vegetative spread has never been reported. Plants may flower as early as April with the major flush of flowering plants forming in May; with most flowering completed by July. The fruit is a capsule, which matures in late summer, usually by August. The seed capsule generally dehisces by late summer, or early fall, distributing the abundant seed. Some capsules will persist into winter. By late summer the plants senesce, although some vegetative material may be present throughout the year, depending on the location. Like most paintbrushes (Heckard 1962), this species is a hemi-parasite – its roots penetrate the roots of neighboring plant species and derive nutrients, carbohydrates, and other secondary compounds from these hosts.

The breeding system of *Castilleja levisecta* has not been thoroughly documented. Evans *et al.*(1984) reported that a species of bumblebee, *Bombus californicus,* was observed visiting *Castilleja levisecta.* Pollinator exclusion experiments showed that fruits can be produced in the absence of pollinator visitation, but fruit set was almost five times greater in unbagged inflorescences compared to inflorescences bagged to prevent visits from pollinators (Wentworth 1994). More recently, formal pollinator monitoring was conducted in 2011 to document all pollinators that visit *C. levisecta*. Bombus species (bumblebees) were the most commonly observed pollinators (Bakker *et al.*2013); other types of pollinators included honey bees, solitary bees, flies, wasps, and a variety of butterflies.

Although seed dispersal has not been directly observed, the seeds are probably shaken from the seed capsules and fall a short distance from the parent plant. The seeds are minute, and light and could possibly be dispersed short distances by the wind; however, we observe little natural reproduction on sites that have not received management (T. Thomas, USFWS, *pers. comm*. 2015).

3.17.3 Habitat Characteristics for Golden Paintbrush

Castilleja levisecta occurs in upland prairies. Prairies may be generally flat in the glaciated portions of the species range; however, the species is also found on coastal bluffs in north Puget Sound, and on some grasslands characterized by mounded topography (T. Thomas, USFWS, *pers. comm*. 2015). The sites where *Castilleja levisecta* are found in the Willamette Valley, Oregon, are found on deeper, alluvial soils compared with the soil found at the Washington prairies within the species range. Low deciduous shrubs may be present as small to large thickets, although these shrub patches readily burn during prescribed fire events. With a fire return period of 2 to 5 years for prairies (Agee 1993, Hammond *et al.*2011), fire is thought to have historically played a key role in the maintenance of the upland prairie habitat occupied by this species by preventing the successional encroachment of woody shrubs and trees, and by creating bare soil areas to promote seed germination (T. Thomas, USFWS, *pers. comm.* 2015). In the absence of fire or other forms of management, most sites have been colonized by woody plants, primarily *Pseudotsuga menziesii,* and shrubs, including *Rosa nutkana* (wild rose), *Symphoricarpos albus* (snowberry) and *Cytisus scoparius,* an aggressive non-native, noxious weed.

The mainland population in Washington occurs in a gravelly, glacial outwash prairie (USFWS 2010). Most of the extant populations in Washington are on loamy sand or sandy loam soils derived from glacial origins. In the southern portion of its historic range in the Willamette Valley, populations occurred on clayey alluvial soils, in association with *Quercus garryana* (Oregon white oak) woodlands and savannah (Caplow 2004). Sites with a high abundance of native forbs and grasses have been determined to be the most suitable sites for reintroduction in Oregon (Lawrence and Kaye 2009), and likely this is the case throughout the species range.

3.17.4 Threats/Reasons for Listing for Golden Paintbrush

Threats to *Castilleja levisecta* include habitat modification due to fire suppression that permits successional changes to occur on prairies leading to invasion (encroachment) of grasslands by woody plants (invasive , nonnative shrubs and our native Douglas-fir (*Pseudotsuga menziesia*); development for commercial, residential, and agricultural use; low potential for expansion of *Castilleja levisecta* populations and their refugia because existing habitat is constricted; and herbivory (USFWS 1997).

Prairie destruction and degradation due to residential, commercial, or agricultural use is a threat at three wild populations that are still in private ownership (Arnett 2014). These populations have declined over time, and without intervention or some form of management, they are likely to become extirpated. Prior to listing the species as threatened in 1997 many populations were lost due to conversion of native prairie habitat to agricultural, residential, and commercial uses. Herbivory by rabbits, deer, and voles is also a problem at many sites where *Castilleja levisecta* occurs.

In the absence of active management, robust populations of *Castilleja levisecta* have rapidly declined to close to extirpation in less than a decade. These declines did not result from overt habitat destruction, but from the threats associated with low population numbers, in-breeding depression, fire-suppression and competition with non-native and invasive plant species (USFWS 2010). Competition from non-native, invasive noxious species such as *Hieracium pilosella* (mouse-ear hawkweed), *Cytisus scoparius* (Scot's broom) and *Leucanthemum vulgare* (ox-eye daisy), and other non-native plants may severely degrade golden paintbrush habitat (Wentworth 1998; Gamon 1995). Use of prescribed fires for prairie management may help to reverse the decline of golden paintbrush throughout its range (T. Thomas, USFWS, *pers. comm.* 2015).

3.17.5 Recovery Measures for Golden Paintbrush

Considerable research has been conducted on the population biology, genetics, fire ecology, propagation, host-plant relations, and restoration of *Castilleja levisecta* and the prairie ecosystem where the species resides (Dunwiddie *et al.*2001, Gamon *et al.*2001, Kaye 2001, Kaye and Lawrence 2003, Lawrence 2005; Godt *et al.*2005; Kaye and Blakely-Smith 2008; Lawrence and Kaye 2009; Bakker *et al.*2009, 2010, 2011, 2012, 2013; Delvin 2013). The results of these studies have been used to direct the management of the species at sites managed for upland prairies, and are critical to the future reintroduction and recovery of the species. A reintroduction plan has been prepared (Caplow 2004), as a recovery task recommended by the Golden Paintbrush Recovery Plan (USFWS 2000). Reintroduction into suitable historical habitat is the only method to recover the species into historical locations or suitable prairies of Oregon and southwestern Washington (T. Thomas, USFWS, *pers. comm.* 2015).

Recent research has considered the most appropriate seed sources and site characteristics for the reintroduction of *Castilleja levisecta* to the Willamette Valley (Lawrence 2005). The findings of this study are consistent with those recommended for other listed prairie species, in that the optimal sites for reintroduction were high quality prairies dominated by native perennial species with low abundance of non-native plant species. Furthermore, the study recommended against using genetic diversity, effective population size, or geographic distance in determining source material for reintroductions, instead suggesting that plant materials from Whidbey Island, Washington, had the greatest potential for successful reintroductions to the Willamette Valley (Lawrence 2005; Lawrence and Kaye 2009). Greenhouse trials and surveys of potential reintroduction sites in the Willamette Valley were completed (Lawrence 2005, Lawrence and Kaye 2009). In recent years, USFWS has instituted a method to determine the suitability of sites for golden paintbrush by planting small populations (100 plants) and assessing the success of the planting (T. Thomas, USFWS, *pers. comm.* 2015). At sites where survival was high, continued management has increased these populations through additional seeding or the planting of seedlings.

Federal, state, and county agencies, and nongovernmental organizations have been vital in the conservation of the ten remaining extant populations in Washington and two remaining populations in British Columbia, and the recently reintroduced populations throughout the species historical range (T. Thomas, USFWS, *pers. comm.* 2015). Whidbey Island Naval Air Station monitors and manages a relatively stable population on its land; however, this site has been modified by a nearby housing development that has created excess water accumulation on the site, which is not compatible with the conservation of *Castilleja levisecta*. In 1999, TNC acquired 147 acre parcel and worked with the National Park Service to purchase another 380 adjoining acres to preserve prairie habitats that benefit golden paintbrush (the Pratt Reserve). Large populations of golden paintbrush have been maintained and improved on lands managed by the Whidbey-Camano Land Trust at the Naas-Admiralty Inlet Natural Area Preserve on Whidbey Island. Also on Whidbey Island, the Pacific Rim Institute reintroduced *Castilleja levisecta* to their protected land and expanded this population through annual management of the site.

Since 2012, several reintroductions of *Castilleja levisecta* have occurred on National Park Service lands on San Juan Island, other conserved lands managed by the San Juan County Land Bank, and the San Juan Island Preservation Trust (T. Thomas, USFWS, *pers. comm.* 2015). In southern Vancouver Island, the Garry Oak Ecosystems Recovery Team is working to conserve over 100 endangered species, including golden paintbrush. The University of Washington's Botanical Garden, a participating institution of the Center for Plant Conservation, is actively involved in these efforts.

All extant sites with golden paintbrush are monitored annually. Recently reintroduced populations are also monitored annually, if funding is available; otherwise, some of the reintroduced populations may be surveyed only every two to three years (T. Thomas, USFWS, *pers. comm.* 2015). A large golden paintbrush population is monitored by golden paintbrush recovery technical team at the Pratt Preserve. Sites in British Columbia are in designated "Ecological Reserve" land. Entry is restricted and plant collection and resource destruction are not allowed (USFWS 2000).

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

3.17.6 Conservation Measures for Golden Paintbrush

All of the General Plant Conservation Measures (Section 3.13.1) apply for golden paintbrush. Additional species-specific measures include:

- Broadcast application of grass-specific herbicides may be used in on up to half of an area occupied by golden paintbrush between February 15 and April 15. If using a weed wiper to apply a grass-specific herbicide for a particular listed plant during the growing season, the herbicide will be applied to the upper grass stems of targeted non-native plants, thus avoiding the shorter listed plant species.
- All other broadcast applications will only occur after the plant has senensced (typically August 15 in Oregon and August 30 in Washington).

3.17.7 Environmental Baseline for Golden Paintbrush

The action area encompasses the entire range of golden paintbrush, and therefore the environmental baseline for this species and its critical habitat is adequately described in the preceding sections.

3.17.8 Effects Analysis and Summary for Golden Paintbrush

Golden paintbrush is an upland prairie species that may be affected by some aquatic restoration projects, but is most likely to be affected by techniques for prairie restoration (mowing, herbicide use, burning, grazing, and plant propagation). The general effects of aquatic and prairie restoration projects are described in General Effects to Listed Plants (Section 3.29), and these adequately describe the potential effects to golden paintbrush. No additional effects are anticipated for any of the proposed activities.

Over 4 years (2011 to 2014), PFW worked in 14 projects that restored 1,840 acres of habitat that affected golden paintbrush; the Coastal Program worked on 8 projects that affected 19 acres of golden paintbrush habitat during that time. The Service's Recovery Program funded an additional 20 restoration projects in Oregon that affected prairie habitats between 2012 and 2014; two of those projects affected golden paintbrush. In Washington, the Service's Recovery Program also funded 13 projects affecting prairie habitats between 2010 and 2012; six of those projects affected golden paintbrush. Restoration work conducted by the Willamette Valley Refuge Complex could occur on up to 572 acres of upland prairie/oak savannah habitat prairie (WVNWR CCP 2011, p. 4-2), and additional work on 200 acres at the Protection Island NWR. We anticipate few, if any aquatic projects funded by the NOAA RC (which target anadromous salmonids) will occur in prairie habitats occupied by golden paintbrush. We also estimate an additional 3 restoration projects implemented by other parties could be covered under this

Opinion per year, as described in the Introduction in the section entitled *Action Area and Requirements for Coverage.*

Given this information, we anticipate that up to 12 projects averaging of 85 acres (or 1,020 acres annually) affect golden paintbrush plus restoration work on up to 772 acres annually on refuge lands. Given the limited number and average size of the potential restoration projects relative to number of population occurrences and acres of occupied habitat, the numerous PDC and proposed conservation measures to minimize the number of plants adversely affected by the proposed action, and the anticipated long-term benefits from each project to native habitats and listed species in the long-term, we conclude the proposed restoration actions will not jeopardize the continued existence of golden paintbrush.

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3.18 Howell's Spectacular Thelypody (*Thelypodium howellii* ssp. *spectabilis*)

Howell's spectacular thelypody (thelypody) was federally listed on May 26, 1999 without critical habitat (USFWS 1999). A recovery plan was finalized for Howell's spectacular thelypody on June 3, 2002 (USFWS 2002). This species is on the state of Oregon's State Endangered Plant list (USFWS 2010). Howell's spectacular thelypody is currently known to occur in Oregon (Union and Baker counties).

3.18.1 Population Trends and Distribution for Thelypody

This taxon was thought to be extinct until rediscovered by Kagan in 1980 near North Powder (Kagan 1986a). The Recovery Plan identifies 11 different occurrences that are grouped into five separate "populations" The labeling of these geographically-clustered occurrences as "populations" is a loose application of the term, since we do not know the extent of genetic interchange among occurrences. The 2008 update of the Oregon Natural Heritage Information Center's (ORNHIC) database documents 15 Howell's thelypody occurrences (USFWS 2010). The known occurrences vary substantially in size and plant abundance. Some are small patches just several hundred square feet in size, while others extend over 10 to 20 acres.

One additional population has been established since the subspecies was listed. Staff from ODA's Native Plant Conservation Program translocated thelypody plants to three locations near Baldock Slough on a property that has a permanent conservation easement through the Wetland Reserve Program (Currin *et al.*2008).

All of the known thelypody occurrences are on private land and many are not accessible for monitoring. Since Federal listing in 1999, population monitoring efforts have focused on three sites where there are mechanisms in place that allow for thelypody monitoring: 1) the Haines Rodeo Grounds site, 2) the Miles Ranch Easement, and 3) the Baldock Slough introduction site (USFWS 2010).

At all of the monitored sites, the number of flowering plants tends to vary widely from year-to-year. The amount of early spring precipitation appears to be an important driver of annual abundance, with high precipitation levels correlated with increased plant abundance. The biennial habit of thelypody also appears to play a role, with spikes in abundance tending to occur every two years (J. Stephenson, USFWS, *pers. comm*., 2015). In one ½-acre plot at the Haines Rodeo Grounds that was intensively monitored from 2008 to 2010, thelypody abundance fluctuated from 3,011 plants in 2008 to 25,600 plants in 2009, and back down to 3,135 plants in 2010 (EcoWest Consulting 2011). As this is a protected site, no livestock grazing or other land use activities occur that might negatively affect plant development.

The inherent year-to-year variability in plant numbers make it difficult to assess long-term population trends, particularly since quantitative surveys are not conducted every year (J. . Stephenson, USFWS, *pers. comm*., 2015). During good years, the Haines Rodeo Grounds population is quite large (> 50,000 plants in 2009), however few plants were found during qualitative surveys in June 2014 leading to concerns that this population is declining. There is concern that the spread of invasive weeds, particularly cheatgrass, is outcompeting thelypody in this area.

There is less quantitative survey data for the Miles Ranch Easement, but it is also a large population in good years (> 35,000 plants in 2009). The Baldock Slough introduced population contained approximately 400 plants in 2009, distributed in 7 small areas. By 2013, plants were found at only 3 of the 7 areas, and a survey in June 2014 tallied only 20 plants in those 3 remaining areas (D. Trochlell, Natural Resource Conservation Service, *pers. comm.* 2014).

The other known thelypody locations are all located on private lands have either very limited or no access to the occupied sites (USFWS 2010). Where occurrences are visible from public roads, occasional presence/absence surveys have been done in June/early July (when flowering plants are highly visible) to document that the occurrence is still extant, while the less visible sites have not been observed in many years.

Much uncertainty remains given the inability to access and monitor the majority of populations on private lands that have no special management protections. However, the overall status of thelypody has improved since listing because additional populations have been found and 3 populations have some protections in place for thelypody. The protection of these sites and some modest progress in developing compatible livestock grazing management practices have moved these subspecies further away from the threat of extinction (USFWS 2010).

3.18.2 Life History and Ecology for Thelypody

Howell's spectacular thelypody is an herbaceous biennial that reaches approximately 60 cm (24 inches) tall, with branches arising from near the base of the stem. The basal leaves are approximately 5 cm (2 inches) long with wavy edges and are arranged in a rosette. Stem leaves are shorter, narrow, and have smooth edges. It is a root forming plant and is pollinated by insects. Flowers appear in loose spikes at the ends of the stems. Flowers have four purple petals approximately 1.9 cm (0.75 inches) in length, each of which is borne on a short stalk. Fruits are long, slender pods (Kagan 1986). The plant begins actively growing in April, flowers in May, fruits in June and goes dormant in August.

3.18.3 Habitat Characteristics for Thelypody

The thelypody occurs in wet alkaline meadows in valley bottoms, usually in and around woody shrubs that dominate the habitat on the knolls and along the edge of the wet meadow habitat between the knolls. Soils are pluvial-deposited alkaline clays mixed with recent alluvial silts, and are moderately well-drained (Kagan 1986). Associated species include *Sarcobatus vermiculatus* (greasewood), *Distichlis stricta* (alkali saltgrass), *Elymus cinereus* (giant wild rye), *Spartina gracilis* (alkali cordgrass), and *Poa juncifolia* (alkali bluegrass) (Kagan 1986). The thelypody may be dependent on periodic flooding since it appears to rapidly colonize areas adjacent to streams that have flooded (Kagan 1986). Abundance fluctuates widely from year to year in response to annual climate and soil moisture (USFWS 2010, p. 4).

Thelopody is readily consumed by cows. Thus, thelopody is typically only found under shrubs in areas that are intensively grazed during the growing season (USFWS 2010). In addition, this taxon does not compete well with encroaching weedy vegetation such as *Dipsacus fullonum* (teasel) (Davis and Youtie 1995).

3.18.4 Threats/Reasons for Listing for Thelypody

Howell's spectacular thelypody was listed as threatened in 1999 because of its very restricted range, the potential for further habitat destruction from agricultural and urban development, the prevalence of chronic habitat degradation from livestock grazing, invasive weeds, and alteration of wetland hydrology, and that only one of the known populations had any legal protections in place to facilitate long-term protection of the plant (USFWS 1999).

Today, threats to the taxon include 1) habitat loss due to urban and agricultural development; 2) habitat degradation due to livestock grazing and hydrological modification; 3) consumption by livestock; 4) use of herbicides or mowing during the growing season; and 5) competition with exotic species such as teasel (*Dipsacus fullonum*), bull thistle (*Cirsium vulgare*), Canada thistle (*C. canadensis*), and yellow sweet clover (*Melilotus officinalis*).

Most of the habitat for the thelypody has been modified or lost to urban and agricultural development. Habitat degradation at all remaining sites for this species is due to a combination of livestock grazing, agricultural conversion, hydrological modifications, and competition from non-native vegetation. These activities have resulted in the extirpation of thelypody from about half its former range in Baker, Union, and Malheur counties. Plants at the type locality in Malheur County are considered to be extirpated due to past agricultural development (Kagan 1986).

3.18.5 Recovery Measures for Thelypody

The thelypody recovery plan calls for the protection of five self-sustaining thelypody populations throughout its extant and historic range. Each of the five populations should have management plans providing for the plant's long-term protection and have stable or increasing trends for 10 years.

Currently, three populations of thelypody receive some level of protection from development and are managed for conservation (USFWS 2010). The Haines Rodeo Grounds is a purchased mitigation site specifically for thelypody conservation, and has a completed management plan for this species. The other two sites (the Miles Ranch Easement and the Baldock Slough introduction site) are easements managed for wetlands protection. While the Baldock slough will remain protected in the Wetland Reserve Program, it is not clear if the reintroduced population will become self-sustaining. In addition, there are also three small roadside populations managed by ODOT under a State Management Area.

In the past, there were two populations on private lands near North Powder that were managed via conservation easements: the BLM has managed a population for several years until about 2006, and the TNC managed another population for 15 years. At this time there are no agreements for the management of these two populations and their status is unknown.

3.18.6 Conservation Measures for Thelypody

All of the General Plant Conservation Measures (Section 3.13.1) apply for thelypody. In additional, livestock grazing will not be used to control or remove invasive and non-native vegetation at project sites occupied by Howell's spectacular thelypody, unless approved by the local Service office.

3.18.7 Environmental Baseline for Thelypody

The action area encompasses the entire range of Howell's spectacular thelypody, and therefore the environmental baseline for this species and its critical habitat is adequately described in the preceding sections.

3.18.8 Effects Analysis and Summary for Thelypody

Howell's spectacular thelypody occurs in wet meadow habitats, and therefore may be affected by some aquatic and wetland restoration projects. However, thelypody is most likely to be affected by techniques for prairie restoration (mowing, herbicide use, burning, and plant propagation). Grazing is prohibited for use in restoration in areas occupied by thelypody, and therefore grazing will have no effect on thelypody. The general effects of the other aquatic and prairie restoration projects are described in General Effects to Listed Plants (Section 3.29) and adequately describe the potential effects to thelypody. No additional effects are anticipated for any of the proposed activities based on the life history or characteristics of thelypody.

Over 4 years (2011 to 2014), PFW worked in 26 projects of habitat in Baker and Union counties in Oregon; however, none of these projects affected thelypody. The Coastal Program and Recovery Program did not work on any projects that directly affected thelypody during that time. We anticipate few, if any aquatic projects funded by the NOAA RC (which target anadromous salmonids) will occur in wet meadow habitats occupied by thelypody, though it is possible. We also estimate an additional 1 restoration project implemented by other parties could be covered under this Opinion per year, as described in the Introduction in the section entitled *Action Area and Requirements for Coverage.*

Given the few occurances and limited distribution of thelopdy, we anticipate that up to 2 projects averaging 5 acres (or 10 acres annually) will affect thelypody per year. Given the limited number and size of projected projects that may affect thelypody, the numerous PDC and proposed conservation measures to minimize the number of plants adversely affected by the proposed action, and the anticipated long-term benefits from each project to native habitats and listed species in the long-term, we conclude the proposed restoration actions will not jeopardize the continued existence of thelypody.

3.18.9 Literature Cited for Howell's Spectacular Thelypody

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Trochlell, Dave. 2014. Natural Resource Conservation Service, Corvallis, Oregon. Email correspondence to John Stephenson, USFWS, La Grande, Oregon. July 7, 2014. Subject: RE: Howell's Thelypody Site Visit, June 25, 2014.

3.19 Kincaid's Lupine (*Lupinus sulphureus* ssp. *kincaidii*)

Kincaid's lupine was listed as threatened, on January 25, 2000 (USFWS 2000). Critical habitat was designated on October 6, 2006 (USFWS 2006a). A recovery plan was finalized for this species on May 20, 2010 (USFWS 2010). 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 2010).

3.19.1 Critical Habitat for Kincaid's Lupine

The PCEs of critical habitat 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 PCEs, 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 2006a). Of those, 500 acres are designated on private lands, 78.1 on Federal lands, and 6 on State lands.

3.19.2 Population Trends and Distribution for 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 2010). 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 2010). 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 (USFWS, OFWO, 2014, unpublished data); 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 2010). 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).

3.19.3 Life History and Ecology for Kincaid's Lupine

Kincaid's lupine is a long-lived perennial species that can surviva 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 2010). 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 honey bees (*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.

3.19.4 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 2010). 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 (Joe Arnett, Washington Department of Natural Resources, *in litt* 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 2010). 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.

3.19.5 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 sulphureus* ssp. *kincaidii* populations are habitat loss, competition from non-native plants and elimination of historical disturbance regimes (Wilson *et al.*2003, USFWS 2010). 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 sulphureus* ssp. *kincaidii* (USFWS 2000). 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 sulphureus* 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 2000).

Habitat fragmentation and isolation of small populations may be causing inbreeding depression in *Lupinus sulphureus* ssp. *kincaidii*. The subspecies was likely wide-spread 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 sulphureus* 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 sulphureus* ssp. *kincaidii* (USFWS 2010). 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 sulphureus* ssp. *kincaidii* by shading out the plants (Wilson *et al.*2003). When *Lupinus sulphureus* ssp. *kincaidii* was listed, we estimated that 83% of upland prairie sites within its range were succeeding to forest (USFWS 2000).

3.19.6 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 2010). 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 2001a, 2001b, 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 2010). 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 2010)*: http://www.fws.gov/oregonfwo/Species/PrairieSpecies/Documents/PrairieSpeciesFinalRecoveryPlan.pdf.

3.19.7 Conservation Measures for Kincaid's Lupine

All of the General Plant Conservation Measures (Section 3.13.1) apply for Kincaid's lupine. Additional species-specific measures include:

- Broadcast application of grass-specific herbicides may be used in on up to half of an area occupied by Kincaid's lupine between February 15 and April 15. If using a weed wiper to apply a grass-specific herbicide for a particular listed plant during the growing season, the herbicide will be applied to the upper grass stems of targeted non-native plants, thus avoiding the shorter listed plant species.
- All other broadcast applications will only occur after August 15 when Kincaid's lupine is dormant. This plant is the primary host plant for Fender's blue butterflies (another listed species); see additional PDC, restrictions, and conservation measures that apply for Fender's blue butterfly.

3.19.8 Environmental Baseline for Kincaid's Lupine

The action area encompasses the entire range of Kincaid's lupine, and therefore the environmental baseline for this species and its critical habitat is adequately described in the preceding sections.

3.19.9 Effects Analysis and Summary for Kincaid's Lupine

Kincaid's lupine is an upland prairie species, which is most likely to be affected by techniques for prairie restoration (mowing, herbicide use, burning, grazing, and plant propagation), but could also be present in some wetland or aquatic restoration sites. The general effects of aquatic and prairie restoration projects are described in General Effects to Listed Plants (Section 3.29), and these adequately describe the potential effects to Kincaid's lupine. No additional effects (direct or indirect) are anticipated based on the life history or habitat characteristics of Kincaid's lupine.

Over 4 years (2011 to 2014), PFW worked on 37 projects over a total of 2,312 acres of upland or wetland habitats that affected Kincaid's lupine; the Coastal Program did not work on any projects that directly affected Kincaid's lupine during that time. The Service's Recovery Program funded an additional 33 restoration projects in Oregon (where the majority of Kincaid's lupine populations exist) that affected prairie habitats between 2012 and 2014; 9 projects affected Kincaid's lupine. The Service's Recovery Program funded an additional 9 restoration projects in Oregon (where the majority of Kincaid's lupine populations exist) between 2012 and 2014. Restoration work conducted by the Willamette Valley Refuge Complex could occur on up to 572 acres of upland prairie/oak savannah habitat prairie (WVNWR CCP 2011, p. 4-2). We anticipate few, if any aquatic projects funded by the NOAA RC (which target anadromous salmonids) will occur in prairie habitats occupied by Kincaid's lupine, but it is possible. We also estimate an additional 3 restoration projects implemented by other parties could be covered under this Opinion per year, as described in the Introduction in the section entitled *Action Area and Requirements for Coverage.*

Given this information, we anticipate that up to 18 restoration projects averaging 62 acres each (or 1,116 acres annually) that will affect Kincaid's lupine, plus restoration work on up to 572 acres annually on refuge lands. Given the numerous PDC and proposed conservation measures to minimize the number of plants adversely affected by the proposed action, and the anticipated long-term benefits from each project to native habitats and listed species in the long-term, we conclude the proposed restoration actions will not jeopardize the continued existence of Kincaid's lupine.

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3.20 Large-flowered Woolly Meadowfoam (*Limnanthes floccosa* ssp. *grandiflora*)

Large-flowered woolly meadowfoam (meadowfoam) was listed as federally endangered on December 7, 2002 (USFWS 2002) without designated critical habitat. A recovery plan was finalized in November 2012 (USFWS 2012). This species is also on the state of Oregon's State Endangered Plant list. Meadowfoam is only known to occur in Jackson County, Oregon.

3.20.1 Critical Habitat for Meadowfoam

Meadowfoam is endemic to the Middle Rogue River. Over much of its range, meadowfoam is restricted to the relatively wetter, inner fringe of vernal pools in the Rogue Valley plains. The PCEs for meadowfoam critical habitat include vernal pool habitat, the dominant native plant association of this habitat, and intact hydrology and soils that provides for adequate soil moisture (USFWS 2002). Critical habitat is designated for meadowfoam on 5,840 acres in Jackson County, Oregon. The majority of critical habitat for meadowfoam is designated on private lands (4,736 acres). A much lower proportion of the habitat occurs on municipal lands (268 acres), county lands (153 acres), state lands (612 acres), and Federal lands (71 acres) (USFWS 2010). All known populations of *L. pumila* ssp. *grandiflora* occur within designated critical habitat, and occupy 440 acres (USFWS 2012).

3.20.2 Population Trends and Distribution for Meadowfoam

Meadowfoam is endemic to the Middle Rogue River of Jackson County at elevations of 366 - 400 m (1,200 to 1,310 feet) within 1) a 20,510 acre landform within the Agate Desert, and 2) within the vicinity of Eagle Point and White City, Oregon. Meadowfoam is known from 23 extant and historical meadowfoam occurrences (OBIC 2011, Meyers 2008). The species has been historically documented from 7 occurrences in the north Rogue Valley and 14 occurrences in the south Rogue Valley in populations ranging from approximately under 100 to 100,000 (Oregon Natural Heritage Information Center 2008). Only 20 meadowfoam occurrences were observed in the last 5 years.

In the Agate Desert, the 18 extant occurrences are found on private, State, and federally owned lands (USFWS 2012). Across the species' range only 5 populations are monitored with any regularity. As of available information in 2012, populations appear to be stable at five the populations that receive regular monitoring.

Meadowfoam has no significant ecological, genetic, or geographic barriers separating its 21 historical and extant populations apart from development and road systems (USFWS 2012). The historical distribution of meadowfoam in the Rogue Valley occurs in nine areas. Fifteen populations of the plant occur in the central Agate Desert area, one population occurs near the Rogue Valley Airfield, and an additional five populations of meadowfoam occur in the Rogue River Valley areas north of Table Rock and have one population each. An additional population was recorded in Eagle Point vicinity in 1927, but the approximate site location has been developed and suitable vernal pool habitat is no longer present. All known populations of *L. pumila* ssp. *grandiflora* comprise approximately 440 acres), and are grouped into nine core areas that correspond to designated critical habitat units (USFWS 2012).

Meadowfoam numbers fluctuate annually depending on the seasonal precipitation and temperature, therefore the population status of the species will vary as well from year to year (USFWS 2012). In grazing allotments, sudden increases or declines in population density may be due to intensity, seasonality, and duration of grazing. In general, numbers of annual plants, such as meadowfoam may fluctuate more widely than those of perennial plants, such as Cook's desert parsley. For example, the year 2000 was a productive year for the meadowfoam due to the wet conditions; in 2001 (a dry year), population numbers declined in many areas. The number of plants recorded at selected vernal pools in the Agate Desert Preserve totaled 68,111 in 2000, and then declined in 2001 to 39,031. However, in 2002 the population increased to 63,752 plants, despite average rainfall figures were still below normal (Borgias 2004). Year-to-year changes of this magnitude may be within the normal range of variation for this annual plant. Generally, if the habitat is reasonably protected from degradation or fragmentation, pollinators are present, and the seed source protected, then the population should persist, with moderate annual fluctuations related to climatic conditions.

3.20.3 Life History and Ecology for Meadowfoam

Meadowfoam is a 3 to 15 cm (2 to 6 inches) tall herbaceous annual; with 1 to 5 cm (0.2 to 2 inches) leaves divided into 5 to 9 segments (USFWS 2002). The leaves, stems, and lower sepals are sparsely covered with short white, fuzzy hairs. The off-white petals have two rows of hairs near their base and are nearly even with the sepals, unlike the more common woolly meadowfoam, *Limnanthes floccosa ssp. floccosa*, which has hairless petals that exceed the sepals in length. The petals of meadowfoam are 0.75 to 0.9 cm (0.30 to 0.35 inches) and are slightly shorter than the sepals. Meadowfoam produces one to three flowers per flower stalk; each flower will produce a cluster of 1 to 5 hard nutlets by mid-May that will quickly drop in the drying mud. Over much of its range, meadowfoam is restricted to the relatively wetter, inner fringe of vernal pools in the Rogue Valley plains.

Meadowfoam typically begins flowering in March, reaches peak flowering in April, and may continue into May if conditions are suitable. Nutlets are produced in late April, and the plants begin to die back by mid-May or when the soil becomes dry (Borgias 2004). Nutlets of meadowfoam apparently are dispersed by water; they can remain afloat for up to three days (USFWS 2012). However, the nutlets of the plant are normally dispersed only short distances. Thus, meadowfoam nutlets would not be expected to disperse beyond their pool or swale of origin. Birds and livestock are potential sources of long-distance seed dispersal, but specific instances of dispersal have not been documented (Jain 1978).

3.20.4 Habitat Characteristics for Meadowfoam

Meadowfoam is endemic to vernal pool habitats within Jackson County, Oregon. The majority of the extant and historical sites for meadowfoam in the Rogue Valley occur on soil formations characterized by Agate-Winlo silty clay loam series (deep, poorly drained soils present in depressions in alluvial stream terraces) at elevations of 366 to 400 m (1,200 to 1,310 feet) (USFWS 2012). According to Arroyo (1973), the plant occurs generally near the wetter, inner edges of pools, as opposed to the drier outer fringes, which harbor the slightly more common *L. floccosa* ssp. *floccosa* (USFWS 2012). However, meadowfoam has been observed on the outside edges of vernal pools, sympatric with *L. floccosa* ssp. *floccosa*, and has even been observed in some areas on low upland mounds. The deeper basins are dominated by *Plagiobothrys stipitatus*, *Eryngium petiolatum*, *Navarretia leucocephala* ssp. *leucocephala*, and *Myosurus minimus*. *Alopecurus saccatus* (Pacific foxtail), and *Deschampsia danthonioides* are also common plant associates. The inner vernal pool edges occupied by meadowfoam often have up to 10 to 15% exposed soil, due partly to gopher or vole foraging activity.

3.20.5 Threats/ Reasons for Listing for Meadowfoam

Nearly 50% of *Limnanthes pumila* ssp. *grandiflora* sites have been severely altered (Meyers 2008). In 1999, a function and value assessment of vernal pool quality, abundance, and distribution determined that habitat with intact hydrology and only moderately altered vegetation accounted for just 3,600 acres or 17.6% of the original landform; approximately 2,104 acres of this contained well-distributed and abundant vernal pools (Oregon Natural Heritage Program 1999).

Specific threats to meadowfoam are fragmentation due to road construction, housing, industrial and commercial development, off-road vehicle damage, fill and contaminant dumping, invasion of non-native annual grasses and herbs, herbicide spraying, and poorly managed livestock grazing (USFWS 2012). Since 2002, a known meadowfoam population in the Agate Desert near Table Rocks Road was partially impacted due to disposal of contaminants (perhaps herbicide) that removed native vegetation from a 0.75 acre portion of vernal pools. The source of the spill was not determined. Recreational off-road vehicle activities have also impacted two meadowfoam populations in the White City area. Other development in Medford, occurring in 2006, resulted in the loss of habitat.

In addition there is a potential threat of predation by meadowfoam fly (*Scaptomyza apicalis*) larvae (USFWS 2012). The meadowfoam fly, which occurs in northern California and Southern Oregon, is the only insect pest of significance on species of meadowfoam. The larvae of the meadowfoam fly have been known to cause severe damage to both vegetative and reproductive tissue in *Limnanthes alba* and may be present on meadowfoam in the Agate Desert, though the fly has not been observed (USFWS 2012).

3.20.6 Recovery Measures for Meadowfoam

The Service published the Recovery Plan for Listed Species of the Rogue Valley Vernal Pool and Illinois Valley Wet Meadow Ecosystems (recovery plan) in 2012 (USFWS 2012). The recovery plan sets out specific goals, objectives and tasks to direct recovery efforts for meadowfoam, Cook's desert parsley and vernal pool fairy shrimp. These species are all listed under the ESA and associated with vernal pool complexes. Nine core areas were identified as focal areas for conservation.

The Service's Conservation Strategy in the Rogue Valley relies on conservation of vernal pool habitat to assist in the recovery of meadowfoam, Cook's desert parsley, and fairy shrimp. The strategy has a goal to conserve up to 2,000 acres of contiguous blocks of vernal pool complexes (USFWS 2011) to meet recovery criteria for the three species. This Conservation Strategy and its biological opinion (USFWS 2011), coupled with the recovery plan are anticipated to provide long-term conservation benefits to meadowfoam, Cook's desert parsley, and vernal pool fairy shrimp, and streamline projects with the principal purposes of protecting, preserving, restoring, enhancing, or maintaining the habitat and listed species attributes of the vernal pool complex.

Of the 5,840 acres of designated meadowfoam critical habitat on the Agate Desert, approximately 1,493 acres of habitat are protected through multiple conservation easements, public ownership, mitigation deed restrictions, and private land trusts such as TNC and Southern Oregon Land Trust. The Southern Oregon Land Conservancy has a conservation easement on 40 acres of vernal pool habitat occupied by meadowfoam. TNC manages three preserves in the Agate Desert area that total 346 acres, of which 252 acres are vernal pool habitat (USFWS 2012). Within these preserves and conservation easements are four populations of meadowfoam totaling 48 acres. At each of the sites the TNC performs annual monitoring and periodic restoration activities such as burning, mowing, and controlled grazing (Sam Friedman, USFWS, *pers. comm.* 2014).

In 2013, Wildlands, Inc. manages a 255 acre mitigation bank containing approximately 100 acres of vernal pool habitat. This bank is located adjacent to the Southern Oregon Land Conservancy conservation easement. Species and habitat surveys, wetland function and value assessments, and restoration efforts were conducted on these land parcels as part of efforts to conserve and protect critical habitat and the associated PCEs. At this time, there are approximately 5,000 meadowfoam plants (Running W Land & Cattle, LLC. 2014).

Large flowered woolly meadowfoam also occurs on two ODOT SMAs in the Agate Desert and at the Denman Wildlife Area, owned by the ODFW; these three areas are protected from development (Sam Friedman, USFWS, *pers. comm.* 2014).

Meadowfoam seed collected from several areas in the Agate Desert is currently stored at the Rae Selling Berry Botanical Garden (USFWS 2012). However, the plant is not yet a sponsored species and is not fully funded for germination trials or augmented seed collection (E. Guerrant, *pers. comm.*, 2012). In 2011, ODOT collected seed from a 0.4 acre highway expansion project build site to grow out meadowfoam within the ODOT vernal pool mitigation/conservation bank (USFWS 2013). Collected seed was planted these at the Herbert Stone Nursery, near Jacksonville, Oregon (Sam Friedman, USFWS, *pers. comm.* 2014). The resulting plants had high germination and grew to produce about 10 pounds of seed over two years. The seed has been sown into the ODOT bank area. Efforts to establish the population has been generally successful (Benton, ODOT, *pers. comm.* 2015).

3.20.7 Conservation Measures for Meadowfoam

All of the General Plant Conservation Measures (Section 3.13.1) apply for meadowfoam. In additional, livestock grazing will not be used to control or remove invasive and non-native vegetation at project sites occupied by large-flowered meadowfoam, unless approved by the local Service office. Also, this plant can be associated with vernal pool habitats, which can support Cook's desert parsley and vernal pool fairy shrimp (other listed species), and additional PDC, restrictions, and conservation measures may apply for vernal pool fairy shrimp.

3.20.8 Environmental Baseline for Meadowfoam

The action area encompasses the entire range of large-flowered woolly meadowfoam, and therefore the environmental baseline for this species and its critical habitat is adequately described in the preceding sections.

3.20.9 Effects Analysis and Summary for Meadowfoam

Large-flowered woolly meadowfoam is restricted to the relatively wetter, inner fringe of vernal pools in the Rogue Valley plains. Thus, meadowfoam is most likely to be affected by prairie restoration techniques used for vernal pool restoration (mowing, herbicide use, burning, or grazing and plant propagation) and wetland restoration (re-grading, etc). Effects from these proposed activities are described in the General Effects to Listed Plant Species (Section 3.29). No additional effects (direct or indirect) are anticipated based on the life history or habitat characteristics of meadowfoam.

Over 4 years (2011 to 2014), neither PFW nor the Coastal program worked on projects that affected meadowfoam, but Partners implemented 17 upland projects in Jackson County, Oregon, which averaged about 38 acres during that timeframe. The Service's Recovery Program funded 3 restoration projects that affected meadowfoam between 2012 and 2014. We anticipate few, if any aquatic projects funded by the NOAA RC (which target anadromous salmonids) will affect vernal pool habitats occupied by meadowfoam. We also estimate an additional 1 restoration project implemented by other parties could be covered under this Opinion per year, as described in the Introduction in the section entitled *Action Area and Requirements for Coverage.*

Given this information, we anticipate up to 4 projects averaging 38 acres (or 152 acres annually) that will affect meadowfoam. Given the limited number and average size of the potential restoration projects relative to number of population occurrences and acres of suitable and critical habitat, the numerous PDC and proposed conservation measures to minimize the number of plants adversely affected by the proposed action, and the anticipated long-term benefits from each project to native habitats and listed species in the long-term, we conclude the proposed restoration actions will not jeopardize the continued existence of meadowfoam.

3.20.10 Effects to Critical Habitat for Large-flowered Wooly Meadowfoam

As described earlierin the Opinion, the PCEs for meadowfoam are vernal pool habitats, the dominant native plant association of this habitat, and intact hydrology and soils that provides for adequate soil moisture.

Restoration activities most likely to affect the PCEs of meadowfoam critical habitat include prairie restoration techniques used for vernal pool restoration (mowing, herbicide use, burning, or grazing and plant propagation) and wetland restoration (regrading, etc). Restoration in vernal pool complexes may reduce native plant density and alter soil and hydrologic conditions, resulting in short-term adverse effects to these PCEs. However, extensive restoration projects involving regrading and other ground disturbing actions are likely to occur in areas that do not already contain highly functioning vernal pool or wetland complexes. Thus, the anticipated adverse effects are likely to be short-term in nature with likely long-term benefits to listed species, native habitats and vernal pool complexes.

In the long-term, habitat manipulation, restoration, and enhancement activities will have beneficial effects on habitat quality for meadowfoam, resulting in an increase in abundance of the PCEs of critical habitat for this species. Given the numerous PDCs and proposed conservation measures to minimize habitat impacts affected by the proposed action, and each project is intended to benefit native habitats, the long-term effects of the proposed activities are not likely to diminish the values of these critical habitats for the purpose for which it was designated. Thus, the proposed activities will not destroy or adversely modify the PCEs of critical habitats for meadowfoam.

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3.21 Nelson's Checkermallow (*Sidalcea nelsoniana*)

Nelson's checkermallow 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 2010). 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).

3.21.1 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 2010). 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.

3.21.2 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).

3.21.3 Habitat Characteristics for Nelson's Checkermallow

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. 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), honey bees (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*).

3.21.4 Threats/Reasons for Listing for Nelson's Checkermallow

As with several other rare prairie plants, 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).

There is a strong potential for interspecific hybridization among Nelson's checkermallow and other species of checkermallows in the region, although there are some ecological and genetic reproductive barriers to prevent it from occurring (Gisler 2003, 2004). Nelson's checkermallow flowers later in the year than sympatric populations of *Sidalcea malviflora* ssp. *virgata* (rose checkermallow), but allopatric populations sometimes overlap in flowering periods. The two species are sexually compatible, thus human-mediated movement of the plants could result in formation of hybrids. Nelson's checkermallow and *S. cusickii* (Cusick's checker-mallow) are also fully compatible, and they also share pollinators and flowering times, but their geographic ranges are parapatric, with nearest populations narrowly separated by less than 1.6 km (1 mile) at the south end of Finley National Wildlife Refuge (Gisler 2004). If these species come into contact through human-mediated dispersal, hybridization could easily occur.

Nelson's checkermallow is frequently found growing together with *S. campestris*, and they also share pollinators and flowering times, but they exhibit very low sexual compatibility (Gisler 2004). Reproductive barriers among the checker-mallows in the Willamette Valley likely evolved in response to selective pressure against hybridization (Gisler 2003, 2004); managers should be aware of the potential for hybridization as plants are moved around within the region.

3.21.5 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, 2001; 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 2010).

Nelson's checkermallow has a highly complex breeding system that facilitates both outcrossing and selfing (USFWS 2010). 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 2010). 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).

3.21.6 Threats/ Reasons for Listing for Nelson's Checkermallow

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). 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 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. 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 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.

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 2010). 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 2010)*: http://www.fws.gov/oregonfwo/Species/PrairieSpecies/Documents/PrairieSpeciesFinalRecoveryPlan.pdf.

3.21.7 Conservation Measures for Nelson's Checkermallow

All of the General Plant Conservation Measures (Section 3.13.1) apply for Nelson's checkermallow. Nelson's checkermallow does not senesis completely in the fall like many other prairies plant species, and additional protections include:

- Burning: at any site with a population of this species, no more than one half of the occupied habitat may be burned in any year.
- Herbicide use: protect Nelson's checkermallow plants from herbicide drift or overspray:
  - When treating target plants with triclopyr, glyphosate or 2,4-D amine, apply by hand (*e.g.*, with a backpack sprayer wand) when working near Nelson's checker-mallow to ensure protection of the listed plant.

- For all herbicide applications not excluded below, cover or otherwise protect (*e.g.*, by clipping leaves to remove exposed green tissue) individual Nelson's checker-mallow plants to ensure that no herbicide comes in contact with the plant. Means of coverage may include 5-gallon buckets, tree protection tubes or other suitable shielding or covering material. Immediately after herbicide treatment, remove coverings.
- When applying glyphosate with a weed wiper in areas with Nelson's checkermallow, no covering of individual Nelson's checker-mallow is necessary apply glyphosate at a height to target upper grass stems, and avoid shorter Nelson's checkermallow plants.
- No covering of Nelson's checkermallow is required if treating target plants with sethoxydim or clethodim.
- Broadcast application of grass-specific herbicides may be used in on up to half of an area occupied by Nelson's checkermallow between February 15 and April 15. If using a weed wiper to apply a grass-specific herbicide for a particular listed plant during the growing season, the herbicide will be applied to the upper grass stems of targeted non-native plants, thus avoiding the shorter listed plant species.
- All other broadcast applications will only occur after August 15.
- All other herbicides will only be applied from August 15 to October 31 when the species is dormant.

3.21.8 Environmental Baseline for Nelson's Checkermallow

The action area encompasses the entire range of Nelson's checkermallow, and therefore the environmental baseline for this species is adequately described in the preceding sections.

3.21.9 Effects Analysis and Summary for Nelson's Checkermallow

Nelson's checkermallow is typically found in wet prairies or along stream channels. Thus, this species may be affected by some aquatic restoration projects, as well as techniques for prairie restoration (mowing, herbicide use, burning, grazing, and plant propagation) and wetland restoration (re-grading, etc). The general effects of aquatic and prairie restoration projects are described in General Effects to Listed Plants (Section 3.29), and these adequately describe the potential effects to Nelson's checkermallow. No additional effects are anticipated for any of the proposed activities.

Over 4 years (2011 to 2014), PFW worked in 6 projects that restored 862 acres of wetland habitat in Oregon that affected Nelson's checkermallow; the Coastal Program did not work on any projects that affected Nelson's checkermallow during that time. The Service's Recovery Program funded an additional 33 restoration projects in Oregon (where the majority of Nelson's checkermallow populations exist) that affected prairie habitats between 2012 and 2014; 5 of those projects affected Nelson's checkermallow. One additional project in Washington for Nelson's checkermallow was funded between 2010 and 2012. Restoration work conducted by the Willamette Valley Refuge Complex could occur on up to 652 acres of wet prairie habitat. We anticipate few, if any aquatic projects funded by the NOAA RC (which target anadromous salmonids) will occur in wetland habitats occupied by Bradshaw's lomatium. We also estimate an additional 2 restoration projects implemented by other parties could be covered under this

Opinion per year, as described in the Introduction in the section entitled *Action Area and Requirements for Coverage.*

Given this information, we anticipate that up to 6 projects averaging of 140 acres (or 840 acres annually) will affect Nelson's checkermallow, plus restoration work on up to 2,459 acres annually on refuge lands. Given the limited number and average size of the potential restoration projects relative to number of population occurrences and acres of occupied habitat, the numerous PDC and proposed conservation measures to minimize the number of plants adversely affected by the proposed action, and the anticipated long-term benefits from each project to native habitats and listed species in the long-term, we conclude the proposed restoration actions will not jeopardize the continued existence of Nelson's checkermallow.

3.21.10 Literature Cited for Nelson's Checkermallow

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3.22 Rough Popcornflower (*Plagiobothrys hirtus*)

Rough popcornflower (popcornflower) was listed as federally endangered without critical habitat designation on February 24, 2000 (USFWS 2000). A recovery plan was published for the species on July 28, 2003 (USFWS 2003). Popcornflower is on the state of Oregon's State Endangered Plant list, and only occurs in Douglas County, Oregon.

3.22.1 Population Trends and Distribution for Popcornflower

At the time of its final listing (USFWS 2000), popcornflower was known from 17 naturally-occurring habitat patches and two successfully established populations. These habitat patches occurred in 8 extant Element Occurrences (or occurrences or EOs) at that time. A "habitat patch", "patch" or "sub-population" as described in the final listing rule, represents a patch. A "reserve" is a habitat patch that occurs on protected property and is not likely to be developed in the near future.

At present, 36 distinct patches, within 14 extant popcornflower occurrences, are distributed discontinuously from Yoncalla Creek, near Rice Hill, Oregon, south to the Sutherlin Creek, near Wilbur, in the Umpqua River watershed (Maddux and Meyers 2008, USFWS 2010). Of the 14 occurrences, five introduced populations have been established in the southern range of the population; two of these populations may exceed 5,000 plants in the next 5 years. Two naturally occurring populations have also been augmented with additional popcornflower. The average population size for 10 known occurrences as of 2014 was 8,480 plants; 8 estimates were in excess of 1,600 plants (K. Amsberry, Oregon Department of Agriculture, *pers. comm.* 2014). At present, six protected popcornflower reserves have approximately 5,000 plants or more.

TNC owns property with a popcornflower occurrence in Wilbur (the Popcorn Swale Preserve). This population has been declining for several years for unknown reasons, but believed to be attributed to invasive non-native and native plant invasion. In 2003, TNC counted 13,065 plants at the Popcorn Swale Preserve, but by June 2012 the number was down to about 1,000 plants and has continued to decline. Apart from the TNC population in Wilbur, most popcornflower populations are fairly abundant and stable throughout its range (Sam Friedman, USFWS, *pers. comm.* 2015).

3.22.2 Life History and Ecology for Popcornflower

Popcornflower can be a perennial, growing to 70 cm tall (27.5 inches), with dozens of flowering stems and hundreds of flowers, or can be a diminutive annual with only a few flowers (Amsberry and Meinke 2001). At Popcorn Swale Preserve, rough popcornflower generally reaches peak growth and flowering by mid-June. By July 1, many plants have dropped seed and are senescing. By July 15, rough popcornflower generally appears gray-brown and crispy although a rare flower or two may be found low to the ground in moister, shaded areas. Although most plants are dormant by mid-July, perhaps around 1% of individuals may still be green and actively growing and flowering.

Rough popcornflower, like most borages, can potentially produce four nutlets per flower. In most sites, copious numbers of mature seeds were observed from mid-June through early September, but plants in a few wetter habitats delayed seed maturation until the beginning of

August. The number of seeds produced by individual plants is largely controlled by the number of flowers produced, and correspondingly, large plants produce more flowers.

3.22.3 Habitat Characteristics for Popcornflower

Popcornflower is endemic to seasonal wetlands in the interior valley of the Umpqua River in southwestern Oregon between Yoncalla and Wilbur in Douglas County (USFWS 2000). The wetland plant community at rough popcornflower habitats may include red-root yampa, a Federal species of concern, great camas (*Camassia leichtlinii* var. *leichtlinii*), Douglas meadowfoam (*Limnanthes douglasii*), California oatgrass, one-sided sedge (*Carex unilateralis*), pointed rush (*Juncus oxymeris*), meadow barley (*Hordeum brachyantherum*), and Cusick's checkermallow (*Sidalcea cusickii*). Known occurrences for the plant are associated with North Umpqua drainage. Rough popcornflower is found in open seasonal wetlands at elevations ranging from 30 to 270 m (98 to 886 feet). Suitable habitat for rough popcornflower includes open vernally wet meadows, seasonally-ponding mud-flats, or Oregon ash-swale openings dominated by native wetland-associated herbs and graminoids in valley lowlands. Populations are known to occur on six different soil types (Conser silty clay loam, Bashaw silty clay loam, Brand silty clay loam, Nonpareil loam, Oakland silt loam, and Sibold fine sandy loam) but there is a positive correlation only for Conser silty clay loam (USFWS 2000). The taxon depends on seasonal flooding and/or fire to maintain open habitat and to limit competition with invasive native and non-native plant species (USFWS 2010).

3.22.4 Threats/Reasons for Listing for Popcornflower

Popcornflower is threatened by habitat loss or degradation and competition from native and non-native plant species. Most of the mapped historic occurrences of the species have been destroyed or deteriorated by development in the vicinity of the town of Sutherlin in the last twenty years. Habitat loss and degradation can be attributed to the following: destruction of wetlands due to drainage for agricultural uses; pools adjacent to altered land may also be affected due to the changes in hydrology (USFWS 2003); wetland destruction due to urban development (USFWS 2010); and invasive exotic weeds such as teasel (*Dipsacus fullonum*), knapweed (*Centaurea sp.*), Armenian blackberry (*Rubus armeniacus*), and pennyroyal (*Mentha pulegium*); native plants such as spreading rush (*Juncus patens*) and Oregon ash (*Fraxinus latifolia*) (USFWS 2010). Fire suppression resulting in encroaching native oaks and ash trees that shade popcornflower and reduced gene flow due to habitat fragmentation are considered to be other threat factors (USFWS 2010).

Cattle grazing was once considered to be a threat, due to loss of several populations in small livestock pastures (USFWS 2003), but from more recent observations, popcornflower is thought to be compatible with several different types of grazing practices (Friedman, USFWS, *pers. comm*. 2015. One of the largest documented populations occurs in a pasture grazed yearlong by both horse and cattle (USFWS 2010).

3.22.5 Recovery Measures for Popcornflower

Of the eleven populations of popcornflower currently protected from development, six meet recovery criteria (K. Amsberry, Oregon Department of Agriculture, *pers. comm.* 2014). One robust plant population is on land owned and managed by Douglas Soil and Water Conservation District. Two occur on ODOT right-of-ways, and two occur on land managed by TNC at the

Popcorn Swale Preserve. One population, estimated to have nearly 8,000 plants, occurs on the City of Sutherlin's Red Rock Park (USFWS 2009). Two populations were reintroduced on Roseburg BLM land prior to listing; two additional populations were reintroduced on ODOT land, and one was reintroduced on County land at the Orenco Ponds mitigation site in 2013.

Inventories for new and known populations of popcornflower were conducted throughout the species range in 2005 and 2014 by ODA (K. Amsberry, Oregon Department of Agriculture, *pers. comm.* 2014). Documentation of the distribution and abundance of popcornflower began in 1995 and has continued annually at most sites in most years; the exceptions are 2001 for BLM populations and 2008 to 2011 for TNC populations.

3.22.6 Conservation Measures for Popcornflower

All of the General Plant Conservation Measures (Section 3.13.1) apply for popcornflower. In addition, livestock grazing will not be used to control or remove invasive and non-native vegetation at project sites occupied by popcornflower, unless approved by the local Service office.

3.22.7 Environmental Baseline for Popcornflower

The action area encompasses the entire range of popcornflower, and therefore the environmental baseline for this species and its critical habitat is adequately described in the preceding sections.

3.22.8 Effects Analysis and Summary for Popcornflower

Popcornflower is endemic to seasonal wetlands. Thus, popcornflower may be affected by some aquatic restoration projects, but is most likely to be affected by restorations techniques associated with prairies (mowing, herbicide use, burning, or grazing and plant propagation) and wetland restoration (re-grading, etc). Effects from these proposed activities are described in the General Effects to Listed Plant Species (Section 3.29). No additional effects (direct or indirect) are anticipated based on the life history or habitat characteristics of popcornflower.

Over 4 years (2011 to 2014), neither PFW nor the Coastal program worked on projects that affected popcornflower, but PFW program completed 9 projects in Douglas County between 2011 and 2014. PFW wetland projects in Oregon during that time averaged about 50 acres. The Service's Recovery Program funded 1 restoration project that affected popcornflower between 2012 and 2014. We anticipate few, if any aquatic projects funded by the NOAA RC (which target anadromous salmonids) will occur in wetland habitats occupied by popcornflower, but it is possible individuals of popcornflower could be found in an aquatic restoration project site. We also estimate an additional 1 restoration project implemented by other parties could be covered under this Opinion per year, as described in the Introduction in the section entitled *Action Area and Requirements for Coverage.*

Given this information, we anticipate up to 4 projects per year averaging 50 acres each (or 200 acres annually) will affect popcornflower. Given the limited number and average size of the potential restoration projects relative to number of population occurrences and acres of suitable habitat, the numerous PDC and proposed conservation measures to minimize the number of plants adversely affected by the proposed action, and the anticipated long-term benefits from each project to native habitats and listed species in the long-term, we conclude the proposed restoration actions will not jeopardize the continued existence of popcornflower.

3.22.9 Literature Cited for Rough Popcornflower

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3.23 Spalding's Catchfly (*Silene spaldingii*)

Spalding's catchfly (catchfly) was listed as threatened in October 2001 (USFWS 2001). Designation of critical habitat was determined to be prudent; however, it will not be designated until available resources and priorities allow (USFWS 2001). The recovery plan was finalized on September 6, 2007 (USFWS 2007). Spalding's catchfly is on the Oregon's State Endangered Plant list, and classified as threatened in the states of Idaho and Washington. Spalding's catchfly is found in Idaho (Idaho, Latah, Lewis and Nez Perce counties), northeastern Oregon (Wallowa county), and Washington (Adams, Asotin, Lincoln, Spokane, and Whitman counties). It is also found in western Montana, and British Columbia, Canada, which are outside of the action area for this Opinion.

3.23.1 Population Trends and Distribution for Catchfly

When catchfly was initially listed in 2001, it was known from 58 populations if the element occurrence records within 1.6 km (1 mile) of one another are grouped together (USFWS 2007). There were 7 populations in Idaho, 6.5 in Montana, 9 in Oregon, 35 in Washington, and 0.5 in

British Columbia, Canada. Some 16,500 individual plants were estimated at the time of listing. As of 2007, there were 99 populations: 22 in Idaho, 10.33 in Montana, 17 in Oregon, 49 in Washington, and 0.66 in British Columbia, Canada (USFWS 2007). The number of individual plants in each population ranged from one to several thousand. Several new sites within the Canyon Grasslands have expanded our knowledge of the range of the species by 80.4 (50 miles) from those locations known in 2001.

New occurrences are likely a result of increased survey effort, not an increase in actual plant distribution or vigor. In 2007, the estimated number of plants was approximately 28,750 individuals in the United States. The ten largest populations are each made up of more than 500 plants. Approximately 78% of the total known individuals of catchfly are found within these few large populations. Of the 99 known populations, two-thirds (66 populations, or 67%) are small populations, each made up of fewer than 100 individuals (USFWS 2007). Much of the remaining habitat occupied by Spalding's catchfly is fragmented by roads, agricultural fields, and other developments. Additional plants and populations have been found throughout its range since 2007, but range-wide population numbers and trends have not been summarized to date (K. Colson, USFWS, *pers. comm.* 2015).

The 2007 Recovery Plant describes occupied habitat within five physiographic regions; 1) the Palouse Grasslands in west-central Idaho and southeastern Washington; 2) the Channeled Scablands in eastern Washington; 3) the Blue Mountain Basins in northeastern Oregon; 4) the Canyon Grasslands of the Snake River and its tributaries in Idaho, Oregon, and Washington; and 5) the Intermontane Valleys of northwestern Montana. These regions are distinctive from one another in climate, plant composition, historical fire frequencies, and soil characteristics. These differences are significant in that they may translate into differences in life histories, habitat trends, consequences of fire suppression, and types of weed control as they apply to conservation of catchfly.

The long-lived nature of Spalding's catchfly, in conjunction with sporadic and rare recruitment, delayed maturity, cryptic rosettes that may disappear before monitoring, prolonged dormancy, and difficulties identifying seedlings, make it challenging to measure changes in numbers of individuals of this species (USFWS 2007). For plants exhibiting prolonged dormancy, population trend monitoring needs to occur for 3 or more consecutive years every 5 to 20 years to adequately assess trends at a given site (USFWS 2007). Long-term demographic monitoring occurred at a number of sites, including two in eastern Washington, two in northwest Montana, and two in the canyon grasslands of the Snake and Salmon Rivers surrounding Craig Mountain, Idaho (USFWS 2007, Hill 2012, Lesica 2012, Hill *et al.*2014). Population trend data is also still collected at numerous sites in Washington and Oregon (K. Colson, USFWS, *pers. comm.* 2015). In 2012, guidelines for monitoring trend of catchfly populations in Key Conservation Areas were developed to encourage the development of consistent and statistically relevant monitoring methodologies across the range of the species.

Across the range of the species, the number of populations of Spalding's catchfly have increased since it was first listed. In Idaho, there are 34 populations; these populations vary from 1 to over 500 individuals (K. Colson, USFWS, *pers. comm.* 2015). In Montana, there are 15 populations, including the largest known population, which is over 16,000 plants (A. Pipp, Montana Natural

Heritiage Program, *pers. comm.* 2015). Many of these populations are relatively small, and only 2 populations exceed 500 plants.

In Oregon, there are approximately 21 populations; these populations vary from a few to over 40,000 individual plants documented on the Zumwalt preserve (Sausen, USFWS, *pers. comm*. 2015; Taylor *et al.*2012). On Federal lands in Oregon, this species occurs on the Wallowa-Whitman NF, BLM lands, and National Park Service Lands (Old Chief Joseph Gravesite and Cemetery). Of these 21 populations in Oregon, as of 2015, there are approximately 16 populations in the Blue Mountains Physiographic Region and approximately five populations in the Canyon Grasslands Physiographic Region.

In Washington, there are 53 populations composed of 563 site locations as of 2013; these populations vary from just a few individuals to several thousand plants (Arnett, 2014). On Federal lands in Washington this species occurs on the Umatilla NF. (Sausen, USFWS, *pers. comm*. 2015).

3.23.2 Life History and Ecology for Catchfly

Spalding's catchfly is a long-lived, herbaceous perennial plant, a plant that withers to the ground every fall and emerges again in spring (USFWS 2007). Spalding's catchfly is a member of the pink or carnation family, the Caryophyllaceae. It was first collected by Henry Spalding around 1846 near the Clearwater River in Idaho and later described by Sereno Watson in 1875, based on the Spalding material (USFWS 2007). The species has no other scientific synonyms nor has its taxonomy been questioned.

Plants range from 20 to 61 cm (8 to 24 inches) in height, occasionally up to 76 cm (30 inches) (USFWS 2007). There is generally one light-green stem per plant, but sometimes there may be multiple stems. Each stem bears four to seven pairs of leaves that are 5 to 8 cm (2 to 3 inches) in length, and has swollen nodes where the leaves are attached to the stem. All green portions of the plant (leaves, stems, calyx) are covered in dense sticky hairs that frequently trap dust and insects, hence the common name "catchfly." The plant has a persistent root crown atop a long taproot (1 m (3 feet)) in length. Typically, Spalding's catchfly blooms from mid-July through August, but it can bloom into September.

Three to 20 (up to 60) flowers are horizontally positioned near the top of the plant in a branched arrangement (inflorescence). Flowers are approximately 1 cm (0.5 inches) long; however, the majority of the flower petal is enclosed within a leaf like tube, the calyx, that resembles green material elsewhere on the plant and has 10 veins running from the flower mouth to the base of the flower. The visible portion of the five flower petals is small (2 mm [0.08 inch]), cream-colored, and extends only slightly beyond the calyx. Below the visible flower petals (blades) are four to six very small (0.5 mm [0.02 inch]) appendages, the same color as the blades. Seeds are small (2 mm [0.08 inch]), wrinkled, flattened, winged, and light brown when mature (USFWS 2007).

3.23.3 Habitat Characteristics for Catchfly

In general *Silene spaldingii* is found in open, mesic (moist) grassland communities or sagebrush-steppe communities (USFWS 2007). However, the species is occasionally found within open pine forests. The bunchgrass grasslands where *S. spaldingii* primarily occurs are characterized by either *Festuca idahoensis* (Idaho fescue) or *F. idahoensis* (Idaho fescue) with *Agropyron spicatum* = *Pseudoroegneria spicata* (bluebunch wheatgrass) except in Montana where the dominant bunchgrass is *F. scabrella* (rough fescue). The plant is found at elevations ranging from 365 to 1,615 m (1,200 to 5,300 feet), usually in deep, productive loess soils (fine, windblown soils). Plants are generally found in swales or on northwest to northeast facing slopes where soil moisture is relatively higher.

3.23.4 Threats/ Reasons for Listing for Catchfly

Spalding's catchfly continues to be impacted by habitat loss due to human development, habitat degradation associated with adverse grazing and trampling by domestic livestock and wildlife, and invasions of aggressive nonnative plants (USFWS 2007). In addition, a loss of genetic fitness (the loss of genetic variability and effects of inbreeding) is a problem for many small, fragmented populations where genetic exchange is limited. Other major impacts include changes in fire frequency and seasonality, off-road vehicle use, and herbicide spraying and drift. Additional details are available in the Recovery Plan for Spalding's catchfly (USFWS 2007).

3.23.5 Recovery Measures for Catchfly

The primary objectives of the Recovery Plan are to reduce or eliminate the threats to the species, and protect and maintain multiple reproducing, self-sustaining populations distributed across each of the five distinct physiographic regions where it resides sufficient to ensure the long-term persistence of the species (USFWS 2007). Briefly, the delisting targets include the establishment of 27 Key Conservation Areas, with at least 500 reproducing Spalding's catchfly individuals in each, and those populations showing stable or increasing trends; habitat supporting these populations should also have at least 80% of native vegetation cover.

Conservation efforts include inventory efforts, monitoring and demographic studies, invasive nonnative plant control (USFWS 2007), research, and out-planting efforts (K. Colson, USFWS, *pers. comm.* 2015). Inventories for *Silene spaldingii* are conducted on all lands managed by the Federal government and some private lands across its range where the plant currently resides or where there is suitable habitat. Many of these efforts are detailed in the Recovery Plan (USFWS 2007).

Draft consistent range-wide, long-term monitoring methods for Spalding's catchfly were developed and presented to technical team in 2012. A range-wide genetic analysis of this species is also currently being conducted in order to understand how genetic variation is distributed across the range of the species (K. Colson, USFWS, *pers. comm.* 2015). This information will help inform managers which populations should be protected in order to conserve genetic variation, as well as help determine whether the physiographic regions put forward in the recovery plan are optimal for attaining this goal. A final report is expected in 2016.

3.23.6 Conservation Measures for Catchfly

All of the General Plant Conservation Measures (Section 3.13.1) apply for catchfly. In addition, livestock grazing will not be used to control or remove invasive and non-native vegetation at project sites occupied by catchfly, unless approved by the local Service office.

3.23.7 Environmental Baseline for Catchfly

Within the three-state action area, the number of populations has increased since its listing in 2001: Idaho populations increased 7 to 22 populations); Oregon, 9 to 21 populations; and Washington, 28 to 53 populations, as described earlier in this document. This increase is largely due to increased surveys for this species. Many of the populations are fragmented and small, and may be declining or at risk. However, some larger populations exist throughout the action area.

3.23.8 Effects Analysis and Summary for Catchfly

Catchfly is typically found in grasslands, including wet areas, or sagebrush-steppe communities. Thus, catchfly is most likely to be affected by restorations techniques associated with prairies (mowing, herbicide use, burning, or grazing and plant propagation) and possibly wetland restoration (re-grading, etc). Effects from these proposed activities are described in the General Effects to Listed Plant Species (Section 3.29). No additional effects (direct or indirect) are anticipated based on the life history or habitat characteristics of popcornflower.

Over 4 years (2011 to 2014), PFW funded 7 projects over 280 acres that affected Spalding's catchfly. The Service's Recovery Program did not fund any projects that directly affected catchfly in Washington or Oregon, but did fund 6 projects within sagebrush-steppe habitats over a 3 year period. The Service's Recovery Program in Idaho funded 10 projects over between 2011 and 2014. We anticipate few, if any aquatic projects funded by the NOAA RC (which target anadromous salmonids) will occur in sagebrush-steppe habitats. We also estimate an additional 2 restoration projects implemented by other parties could be covered under this Opinion per year, as described in the Introduction in the section entitled *Action Area and Requirements for Coverage.*

Given this information, we anticipate up to 8 projects per year averaging 50 acres each (or 400 acres annually) will affect Spalding's catchfly. Given the limited number of potential restoration projects that may occur in any one year relative to number of population occurrences, the numerous PDC and proposed conservation measures to minimize the number of plants adversely affected by the proposed action, and the anticipated long-term benefits from each project to native habitats and listed species in the long-term, we conclude the proposed restoration actions will not exceed the effects described in this Opinion and will not jeopardize the continued existence of Spalding's catchfly.

3.23.9 Literature Cited for Spalding's Catchfly

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3.24 Ute Ladies'-Tresses (*Spiranthes diluvialis*)

Ute ladies'-tresses (ladies'-tresses) was federally listed as threatened in 1992 when it was only known from Colorado, Utah, and Nevada (USFWS 1992). Ladies'-tresses is now known to occur in Wyoming, Montana, Nebraska, Idaho, Utah, Colorado, Nevada, and Washington, and in British Columbia, Canada (NatureServe 2009). Within the three-state action area, this species is classified as endangered in Washington by the WNHP (Arnett 2014), and ranked "critically imperiled" and in Idaho (Miller 2010). The species is located in Okanogan and Chelan counties in Washington State. In Idaho, the species is located in Bannock, Bingham, Bonneville, Fremont, Jefferson, Madison, and Teton counties. Ladies'-tresses is also suspected to occur on the Okanogan-Wenatchee NF in Washington and the Wallowa-Whitman NF in Oregon.

3.24.1 Population Trends and Distribution for Ladies'-Tresses

In 1995, the total estimated population size of ladies'-tresses was 20,500 individuals. With multiple discoveries of the plant range-wide since 1995, population estimates have increased. The total population size of ladies'-tresses orchid was estimated to be 60,000 individuals range-wide (USFWS 2004). New occurrences have been documented in Nebraska, Wyoming, Washington, Idaho, Utah, and Colorado, substantially increasing the known range and estimated population size. Populations of flowering plants of this species are naturally variable depending on year to year and annual climate fluctuations that may alter the phenology of the ladies tresses, which can create conditions for mistimed surveys.

In Washington, two ladies'-tresses populations exist. One population was first reported in 1997, when 27 plants were documented in Okanogan County. This population expanded to approximately 200 plants as recently as 2000, but was not observed during monitoring efforts in 2007 through 2009, likely because it was in dormancy. In 2011, 15 plants were documented at the site (Arnett 2014).

The second population of ladies'-tresses in Washington is found in several clusters (6) along the western shores of the Columbia River at the Rocky River Reservoir, from rkm 809.5 to rkm 820.7 (river mile 503 to 510) (Arnett 2014). Although the plants are spread over miles of shoreline, this cluster of populations is considered a single element occurrence (EO) by the Washington Natural Heritage Program; it has been monitored annually since 2000, with a maximum number of 959 plants documented in 2007 (Arnett 2014). The collective populations found at Rocky Reach Reservoir have fluctuated from 439 to 816 plants between 2008 and 2013, with a reported total of 554 ladies'-tresses plants in 2013. Because of the difficulty in finding plants, and the species tendency of prolonged dormancy for multiple seasons (Camp and Gamon 2011), the population scattered along the Columbia River is considered to be stable (T. Thomas, USFWS, *pers. comm.,* 2015). Two new occurrences were discovered as recently as 2009; this increased distribution of the species provides greater security.

In Idaho, 24 populations of ladies'-tresses are present within the state (Miller 2010). These sites were assessed in 2009 and 2014, however summary information for the species is available only from 2009 (L. Kinter, IDFG, *pers. comm*., 2014). The 24 subpopulations represent to 8 element occurrences within Idaho. Four subpopulations are found on USFS lands, 16 on BLM lands, and four on private lands. The few subpopulations found private land or on Fort Hall reservation do not receive monitoring. From the 2009 census work, approximately 3,117 plants were counted at the Idaho subpopulations of ladies'-tresses.

3.24.2 Life History and Ecology for Ladies'-Tresses

Ladies'-tresses is a long-lived perennial, orchid that is endemic to moist soil habitat associated with floodplains, oxbows, stream and river terraces, subirrigated and spring-fed abandoned stream channels and valleys, lakeshores, and human-modified riparian and lacustrine habitat (Fertig *et al.*2005). This species reproduces by seed and possibly by asexual reproduction (Fertig *et al.*2005). The occasional presence of clustered plants is likely the result of asexual reproduction from a single root mass or broken root segment. Such clusters could also be from seed caches or germination of seed from an entire buried fruiting capsule.

The life cycle of ladies'-tresses consists of four primary life stages: seedling, subterranean dormant, above-ground vegetative, and reproductive. Across its range ladies'-tresses blooms from early July to late October and the fruits are produced in late August or September across most of the plant's range, with seeds shed shortly thereafter. As with other orchid species, ladies'-tresses seeds are microscopic, dust-like, and readily dispersed by wind or water. New vegetative shoots are produced in October and persist through the winter as small rosette. These resume growth in the spring and develop into short-stemmed, leafy, photosynthetic plants. Depending on site productivity and conditions, vegetative shoots may remain in this state all summer or develop inflorescences. Vegetative individuals die back in the winter to subterranean roots or persist as winter rosettes. Flowering typically occurs earlier in sites that have an open canopy and later in well-shaded sites. Bees are the primary pollinators of ladies'-tresses, particularly solitary bees in the genus *Anthophora*, bumblebees (genus *Bombus*), and occasionally non-native honeybees (*Apis mellifera*).

3.24.3 Habitat Characteristics for Ladies'-Tresses

When ladies'-tresses was listed in 1992 it was known primarily from moist meadows associated with perennial stream terraces, floodplains, and oxbows at elevations between 1310 to 2090 m (4300 to 6850 feet) (USFWS 1992). Surveys since 1992 have expanded the number of vegetation and hydrology types occupied by ladies'-tresses to include seasonally flooded river terraces, sub-irrigated or spring-fed abandoned stream channels and valleys, and lakeshores. Other populations have been discovered along irrigation canals, berms, levees, irrigated meadows, excavated gravel pits, roadside barrow pits, reservoirs, and other human-modified wetlands. New areas occupied by the species have also expanded the elevation range of the species from 220 to 558 m (720-1,830 feet) in Washington, to as high as 2,134 m (7,000 feet) in northern Utah.

3.24.4 Threats/ Reasons for Listing for Ladies'-Tresses

The orchid's pattern of distribution in small, scattered groups, restricted habitat, and low reproductive rate under natural conditions make it vulnerable to both natural and human-caused disturbances. In 1992, the US Fish and Wildlife Service identified habitat loss and modification (through urbanization, water development, and conversion of wetlands to agriculture), overcollection, competition from exotic weeds, and herbicides as the main current and potential threats to the long term survival of ladies'-tresses (USFWS 1992).

General threats present in 1992 continue to exist, but additional research and monitoring have shown that competition from invasive plants, vegetative succession, changes in hydrology (through flood control and dewatering), habitat disturbance associated with road construction, and impacts from recreation are now the most widespread potential threats (Fertig *et al.*2005). New research on management response and threats, however, indicate that *Spiranthes diluvialis* is far more adapted or resilient to human-influenced environments than was suspected in 1992 and relatively few populations are highly at risk (Fertig *et al.*2005).

3.24.5 Recovery Measures for Ladies'-Tresses

The Service developed a draft recovery plan for Ute ladies'-tresses (USFWS 1995), but this has not been finalized. This draft plan had three primary objectives for achieving recovery:

1. Obtaining information on life history, demographics, habitat requirements, and watershed processes that will allow specification of management and population goals and monitoring progress;
2. Managing watersheds to perpetuate or enhance viable populations of the orchid; and
3. Protecting and managing Ute ladies'-tresses populations in wet meadow, seep, and spring habitats.

Monitoring of species numbers, certain demographic parameters, and habitat characteristics has improved our understanding of population fluctuations, habitat preferences, and threats to habitat conditions. Research has continued on pollination biology, genetics, and root-associated fungi. Research and monitoring have been conducted on the relationship of stream flows, ground water levels, and stream channel form to surfaces on which the orchid occurs (USFWS 2004).

The draft recovery plan identified several action items needed to achieve these objectives. To date, progress has been made on elucidating the life history, demography, pollination biology, genetic structure, and habitat dynamics of ladies'-tresses (Fertig *et al.*2005). The known habitat of ladies'-tresses has broadened with the discovery of riverine populations in Utah, Idaho, and Washington, and there is a need to expand conservation targets in objective 3.

Less progress has been made on defining conservation units by watershed, developing watershed-based recovery goals, and informing the public about the merits of the watershed approach. Additionally, trend data and basic monitoring information are not available for nearly 75% of all known occurrences, making it difficult to identify management needs and develop conservation priorities. Active or partially active management actions involving monitoring, habitat manipulation, and other actions specifically intended to promote ladies'-tresses recovery have been initiated for 12 of 52 extant populations (23%). Eighteen extant populations (34.6%) are now under some form of protection through special management area designation, conservation easements, or management agreements with the USACE (Fertig *et al.*2005).

In Washington, the Rocky Reach Reservoir populations are primarily found on lands owned by the Bureau of Land Management, Chelan County PUD, Washington Department(s) of Fish and Wildlife, and Transportation (WDOT) (Arnett 2014). A single population in this reach occurs on private lands along the Columbia River, and a conservation easement has been acquired to allow weed control at this site. Annual monitoring for the Rock Reach Reservoir has occurred since 2000. The second element occurrence in Washington is located on private land in Okanogan County, at Wannacut Lake (T. Thomas, USFWS, *pers. comm.*, 2015). Monitoring at this location is somewhat intermittent, and no specific recovery actions are being implemented at this location because it is held in private ownership.

3.24.6 Conservation Measures for Ladies'-Tresses

All of the General Plant Conservation Measures (Section 3.13.1) apply for Ute ladies' tresses. There are no additional species-specific measures.

3.24.7 Environmental Baseline for Ladies'-Tresses

The action area includes Washington and Idaho, which only represents a portion of the range for ladies'-tresses. The baseline for these two states is described above for each state, and therefore the environmental baseline for this species is adequately described in the preceding sections.

3.24.8 Effects Analysis and Summary for Ladies'-Tresses

Ladies'-tresses is associated with wet meadows, seasonally flooded areas, and the edges of streams and lakes. Thus, this species may be affected by both aquatic/wetland restoration projects and techniques for prairie restoration (mowing, herbicide use, burning, grazing, and plant propagation). The general effects of aquatic and prairie restoration projects are described in General Effects to Listed Plants (Section 3.29), and these adequately describe the potential effects to ladies'-tresses. No additional effects are anticipated for any of the proposed activities.

Over 4 years (2011 to 2014), PFW worked on 2 projects in one year (2014) that restored 718 acres habitat that affected ladies'-tresses in Idaho; the Coastal Program did not work on any projects that directly affected ladies'-tresses. The Service's Recovery Programs in Washington has not funded any restoration projects affecting ladies'-tresses; the Recovery Program in Idaho funded up to 2 restoration projects for this species in any one year. We anticipate that some aquatic projects may also occur in habitats occupied by ladies'-tresses, but likely no more than one or two in any year. We also estimate an additional 2 restoration projects implemented by other parties could be covered under this Opinion per year, as described in the Introduction in the section entitled *Action Area and Requirements for Coverage.*

Given this information, we anticipate that up to 6 projects averaging of 360 acres each (or 2,160 acres annually) will affect ladies'-tresses. Given the limited number and average size of the potential restoration projects relative to number of population occurrences and acres of occupied habitat, the numerous PDC and proposed conservation measures to minimize the number of plants adversely affected by the proposed action, and the anticipated long-term benefits from each project to native habitats and listed species in the long-term, we conclude the proposed restoration actions will not jeopardize the continued existence of ladies'-tresses.

3.24.9 Literature Cited for Ute Ladies' Tresses

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3.25 Water Howellia (*Howellia aquatilis*)

Water howellia was listed as a threatened species in July 1994 (USFWS 1994). Critical habitat for this species was not considered prudent at the time of its listing. A draft Recovery Plan was published in 1996 (USFWS 1996). Water howellia is listed as classified as threatened in the states of Washington, Oregon, Idaho. Water howellia is known to occur in Idaho (Benewah, Clearwater, Idaho, Latah, Lewis and Nez Perce counties), Oregon (Clackamas county), and Washington (Clark, Pierce, Spokane, and Thurston counties). It is also known to occur in California and Montana.

3.25.1 Population Trends and Distribution for Water Howellia

Water howellia is endemic to the Pacific Northwest with historical occurrences identified in California, Oregon, Washington, Idaho, and Montana (Shelly and Moseley 1988, pp. 6, 9). Since listing, new occurrences have been documented in all five states, generally in areas known historically to support the species (USFWS 2013). Thus, locations of extant occurrences are generally representative of the areas where the species was thought to historically occur.

At the time of Federal listing (1994), 107 water howellia occurrences (defined as known populations) were known to occupy an estimated 200 acres across its range (USFWS 1994, p. 35861). In 2012, a minimum of 302 occurrences were documented; current, occupied acreage was unavailable (USFWS 2013). The majority of extant occurrences (91%) are within three meta-populations occupying three distinct, geographic areas: Montana's Swan Valley (Lake and Missoula Counties); Department of Defense property at Joint Base Lewis-McChord (JBLM), Pierce County in western Washington; and Turnbull National Wildlife Refuge, Spokane County in northeastern Washington. A meta-population is defined as a collection of interdependent populations affected by recurrent extinctions and linked by recolonizations (Murphy *et al.*1990, p. 47). As reported in 2013, the Status Review for this species, 244 of the 302 (80%) reported water howellia occurrences are on lands administered by the Federal government (USFWS 2013).

Trends for water howellia are difficult to determine (USFWS 2013). Substantial numbers of new occurrences have been discovered since listing; however, this may not necessarily indicate a positive population trend. Rather, this could indicate increased efficiency at finding new occurrences. A lack of consistent, standardized monitoring precludes the ability to document trends. Additionally, an occurrence is broadly defined as "a known population"; abundance of individual plants within occurrences is not accounted for. Further, annual counts of individual water howellia plants within occurrences fluctuate widely; due, in part, to environmental conditions of the preceding autumn, which affect seed germination rates.

Water howellia has been documented to be more widely distributed on the landscape than at the time of listing, including in areas where it was formerly considered extirpated (USFWS 2013). Federal listing and other regulatory mechanisms have provided protections from human-caused habitat destruction through management or conservation plans for the majority of occurrences (86% on Federal, state, and some private lands). Protection of 86% of known occurrences would conserve the current range-wide distribution of water howellia, including the three meta-populations. Given the reduction or elimination of threats present at the time of listing, increased redundancy range-wide, and increased habitat protections, water howellia is not in danger of extinction throughout all or a significant portion of its range (i.e., endangered) (USFWS 2013). Further, the Service concluded that water howellia does not meet the definition of an endangered or threatened species per the ESA and recommended the removal of water howellia from the Federal list of threatened and endangered species (USFWS 2013).

3.25.2 Life History and Ecology for Water Howellia

Water howellia is an annual, aquatic herb in the bellflower family (Campanulaceae) and a monotypic genus (USFWS 2013). The entire plant is smooth, possessing no hairs or projections. The stems are fragile, submerged and floating, reaching up to 100 cm (39 inches) in length. Stems branch several inches from the base, and each branch extends to the water surface. The numerous leaves are narrow and range from 25 to 50 mm (1 to 2 inches) long.

Water howellia produce two types of flowers; cleistogamous (closed) and chasmogamous (showy, open for pollination) (USFWS 2013). Small cleistogamous flowers are produced along the stem below the water surface and are, by nature, self-fertilizing. Chasmogamous flowers are produced on the water surface and commonly self-pollinate (Lesica *et al.*1988, p. 276; Shelly and Moseley 1988, pp. 5–6). The petals of the chasmogamous flowers are 2 to 3 mm (0.08 to 0.12 inches) long, 5 lobed, and distributed on one side of the flower. Fruit capsules from chasmogamous flowers are 10 to 20 mm (0.39 to 0.78 inches) long with elongate seeds 2 to 4 mm (0.08 to 0.15 inches) long (Hitchcock *et al.*1959, Shelly and Moseley 1988).

Seed germination occurs in the fall, only when ponds dry and seeds are exposed to air (Lesica 1990, pp. 5–7, 13; USFWS 2013). Water howellia seedlings overwinter in soil and resume growth in spring in northern climates (Mincemoyer 2005, p. 3). Spring growth in California and low elevation populations in western Washington typically commences in early April, in eastern Washington, Idaho, and Montana by early May. Range-wide, emergent (chasmogamous) flowers bloom soon after the stems reach the water surface and are typically present from May through July. Seed dispersal starts in June from submerged (cleistogamous) flowers and extends until late summer from emergent flowers (Shelly and Moseley 1988, p. 5).

3.25.3 Habitat Characteristics for Water Howellia

Water howellia typically inhabit small, vernal freshwater wetlands and ponds with an annual cycle of filling with water in spring and drying up in summer or autumn (USFWS 1996, p.14; 2013). These habitats can be glacial potholes or depressions (Shapley and Lesica 1997, p. 8; USDOD 2006, p. 3-3) or river oxbows (Lesica 1997) in Montana and western Washington, or riverine meander scars (Idaho NHP 2012, p. 1) in Idaho, glacial-flood remnant wetlands (Robison 2007, p. 8) in eastern Washington, but are all ephemeral to some degree (USFWS 2013). Depending on annual patterns of temperature and precipitation, the drying of the ponds may be complete or partial by autumn; these sites are usually shallow and less than 1 m (3 feet) in depth. Some ponds supporting water howellia are dependent on complex ground and surface water interactions. Snow melt runoff is important in maintaining suitable conditions in the spring, while localized groundwater flow mitigates water loss from evaporation and plant transpiration later in the summer (Reeves and Woessner 2004, pp. 7–9). Consolidated clay and organic sediments typically dominate composition of soils underlying ponds and wetlands occupied by water howellia (USFWS 1996, p.14).

Water howellia habitat is typically surrounded or nearly surrounded by forested vegetation (USFWS 2013). Broadleaf deciduous trees or shrubs are usually a component, with species composition varying with geographic location (Mincemoyer 2005, p. 7). This aspect of water howellia habitat may be important because of numerous observations reporting water howellia occupying shaded portions of ponds and wetlands (Isle 1997, p. 32; McCarten *et al.*1998, p. 4). It has been hypothesized that water howellia can photosynthesize at lower light levels than other wetland species (e.g., reed canarygrass [*Phalaris arundinacea*] [McCarten *et al* 1998, p. 4]), thus intact canopy cover surrounding water howellia habitat that provides shade to the water surface may provide a competitive advantage to water howellia. Forested vegetation surrounding water howellia habitat also contributes large woody debris to the water body; a feature thought to be important in water howellia persistence (Robison 2007, p. 17, 28).

3.25.4 Threats/Reasons for Listing for Water Howellia

Water howellia has narrow ecological requirements and subtle changes in its habitat could affect a population (USFWS 2013). Threats to the populations include loss of wetland habitat and habitat changes due to timber harvest and road building, livestock grazing, residential and agricultural development, alteration of the surface or subsurface hydrology, and competition from introduced plant species such as reed canary grass (*Phalaris arundinacea*) and purple loosestrife (*Lythrum salicaria*) (USFWS 1994).

Since the listing of water howellia, recovery actions in the form of increased survey effort has documented 195 additional occurrences, including the rediscovery of the species in Oregon and California where it was believed to be extirpated. It is unclear whether the increase in documented occurrences is due to increased distribution of water howellia, an increase in search efficiency, or some combination of these factors. Historical records and distribution data for water howellia are limited, thus precluding a meaningful interpretation of the relationship between historic and current water howellia distribution. Regardless, increased redundancy of the species across its known range is expected to be advantageous to the species' long-term persistence.

All three meta-populations of water howellia have reed canarygrass present; however, the invasion trend is static in all meta-populations (Montana, Turnbull NWR, and JBLM). In Idaho, reed canarygrass invasions have advanced and retracted since monitoring began, likely due to changing environmental and site-specific conditions. Efforts to reduce reed canarygrass in areas proximate to water howellia populations appear successful in California.

Habitat threats related to land management activities have largely been removed or minimized for approximately 86% of water howellia occurrences range-wide (USFWS 2013); this includes all lands occupied by water howellia that have active management or conservation plans that benefit water howellia. These plans have been implemented by Federal and State agencies and some private entities and have been effective at minimizing effects from forestry practices, road construction and maintenance, and grazing/trampling. Protections for the remainder of the known water howellia occurrences on private lands without a Federal nexus are limited. Habitats on these lands may still be affected by human-related development, altered hydrology, livestock grazing/trampling, and invasive species. Approximately 14% of water howellia occurrences are on private lands with no known conservation measures in place.

Many regulatory mechanisms are currently in place which provide protection to water howellia habitat and are expected to provide protection in the absence of ESA listing. Federal management plans (RMPs and CCPs) are in place providing protection to most water howellia occurrences within the three meta-populations. Other regulatory mechanisms mandate protections for occurrences on State and some private lands (conservation easements). Regulatory mechanisms for controlling invasive species are few; however, most management plans have procedures outlined to control invasive plants if monitoring data indicate the need.

Small, isolated populations are vulnerable to stochastic events. However, the current distribution of water howellia is favorable to the species' long-term persistence because of the intact nature of three large meta-populations and the spatial arrangement of other occurrences at different elevations and within varying climatic regimes. This mosaic distribution should improve the species ability to persist in the face of gradual or catastrophic changes in the environment.

3.25.5 Recovery Measures for Water Howellia

Monitoring since 1994 has revealed new occurrences (defined as known populations) of water howellia in all five states within the known historical range of the species (USFWS 2013). Some of the new occurrences have been discovered in Oregon and California, states where the species was once thought extirpated.

Several significant exchanges of land occupied by water howellia have occurred in Montana. The ownership changes (from private to Federal or State ownership) have resulted in more protective regulations for many water howellia occurrences within Montana. Formalized management plans have been in place for the following number of occurrences and years
a. 188 in Montana–since 1997, (16 years)
b. 37 in Spokane County, Washington–since 2007, (6 years)
c. 19 in Pierce County, Washington–since 2003, (10 years)
d. 4 in Clark County, Washington–since 2010, (3 years)
e. 7 in Mendocino County, California–since 1995, (18 years).

Monitoring indicates management plans have been effective at maintaining the minimum number of occurrences by reducing or eliminating anthropogenic threats associated with land management activities (e.g., timber harvest, road construction) and other threats (e.g., invasive species).

One occurrence located on private land in Latah County, Idaho is protected under a conservation agreement and a management plan is under development. New occurrences on private land in Idaho have been documented; Idaho Natural Heritage Program is actively engaging soil conservation districts and private landowners, and seeking collaborative partnerships (Idaho NHP 2012, p. 6) to conserve these occurrences and search for new ones.

3.25.6 Conservation Measures for Water Howellia

All of the General Plant Conservation Measures (Section 3.13.1) apply for water howellia. There are no additional species-specific measures.

3.25.7 Environmental Baseline for Water Howellia

The action area includes Oregon, Washington and Idaho, which only represents a portion of the range for howellia. In each of these states, the number of howellia populations has increased since listing (USFWS 2013). Idaho now supports 6 populations (an increase of 5 populations), Oregon supports one population (an increase of 1 population), and Washington supports 72 populations (an increase of 28 populations). The Service concluded that water howellia does not meet the definition of an endangered or threatened species per the ESA and recommended the removal of water howellia from the Federal list of threatened and endangered species across its range (USFWS 2013).

3.25.8 Effects Analysis and Summary for Water Howellia

Water howellia is an aquatic plant species that lives in ephemeral wetlands; thus, this plant could be affected by aquatic restoration projects. The general effects of aquatic and prairie restoration projects are described in General Effects to Listed Plants (Section 3.29), and these adequately describe the potential effects to howellia. No additional effects are anticipated for any of the proposed activities.

Over 4 years (2011 to 2014), the Service has not funded any restoration projects that affected water howellia through any of its funding sources. Also, because of the recommendation to remove this species from the ESA list, it is unlikely that limited restoration funds will target this species. However, it could be found within a wetland restoration project that targets multiple listed species. We would expect few, if any aquatic projects funded by the NOAA RC (which target anadromous salmonids) will occur in wetland habitats occupied by howellia. We also estimate an additional 1 restoration project implemented by other parties could be covered under this Opinion per year, as described in the Introduction in the section entitled *Action Area and Requirements for Coverage.*

Given this information, we anticipate that up to 1 project averaging of 50 acres per state each year (3 projects with 150 acres maximum annually) that will affect howellia. Given the limited number and average size of the potential restoration projects relative to number of population occurrences and acres of occupied habitat, the numerous PDC and proposed conservation measures to minimize the number of plants adversely affected by the proposed action, and the anticipated long-term benefits from each project to native habitats and listed species in the long-term, we conclude the proposed restoration actions will not jeopardize the continued existence of water howellia.

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3.26 Wenatchee Mountains Checker-Mallow (*Sidalcea oregana* var. *calva*)

The Wenatchee Mountains Checker-mallow was federally listed as endangered in 1999 (USFWS 1999). Critical habitat was designated in 2001 (USFWS 2001). In Washington, this species is classified by the WNHP as endangered. Wenatchee Mountains Checker-mallow is found in Chelan County, Washington.

3.26.1 Critical Habitat for Wenatchee Mountains Checker-Mallow

The area designated as critical habitat for the Wenatchee Mountains Checker-Mallow includes all of the lands that have the PCEs below 1,000 m (3,300 feet) within the Camas Creek watershed and in the small tributary within Pendleton Canyon before its confluence with Peshastin Creek. The PCEs for the species are surface water or saturated upper soil profiles; a wetland plant community dominated by native grasses and forbs, and generally free of woody shrubs and conifers that would produce shade and competition for Wenatchee mountain checkermallow; seeps and springs on fine textured soils (clay loams and silt loams), which contribute to the maintenance of hydrologic processes necessary to support meadows which remain moist into the early summer (USFWS 2001).

3.26.2 Population Trends and Distribution for Wenatchee Mountains Checker-Mallow

Although the species *Sidalcea oregana* (Oregon checker-mallow) occurs throughout the western United States, Wenatchee Mountain checkermallow is rare and known only to occur at five distinct sites (populations) in mid-elevation wetlands (~1,900 to 4,000 feet msl) and moist meadows of the Wenatchee Mountains in central Washington state (USFWS 2011). The Camas Meadows population contains over 75% of the global population of Wenatchee Mountain checkermallow, with the other populations ranging from 1 plant to approximately 2,500 plants at the Mountain Home population. The last time a complete census was taken at the Camas Meadows population more than 11,000 flowering plants were estimated in 2000. Since 2005 the WDNR has instituted surveys along transects which record the frequency of plants/m^2, thus providing a metric that will indicate trends without censusing the entire population. Because of the patchy distribution and large area covered by the Camas Meadows population it is difficult to census the entire population, and this method provides a snapshot of the condition and trend of the population. It is the opinion of the lead Natural Area Scientist for WDNR that the population is stable at this location.

The status of Wenatchee Mountain checkermallow has improved slightly in the years since publication and implementation of the recovery plan began in the spring of 2005, although all indications of improvement in the status of the species are mixed (USFWS 2011). Only one of the known populations with greater than 500 flowering plants (Camas Meadows) is stable, or improving and on a legally protected site (USFWS 2011). The population at Mountain Home, discovered to be much larger than previously thought, indicates that additional property with individual plants, groups, populations, perhaps large ones, may yet be detected. Conversely, the known small populations have not been noted to increase in size or vigor and remain at risk of extirpation.

3.26.3 Life History and Ecology for Wenatchee Mountains Checker-Mallow

Wenatchee Mountain checkermallow is a perennial plant with a stout taproot that branches at the root crown and gives rise to several stems that are 20 to 150 cm (8 to 59 inches) in length. Pink flowers begin to appear in middle June and peak in the middle to end of July. Fruits are ripe in August (USFWS 1999). The somewhat clumped distribution of mature Wenatchee Mountain checkermallow plants suggests that seed dispersal is restricted to the areas near mature plants, unless the seeds are moved by animals or transported by water (USFWS 2001). These plants are long-lived, and may show sign of diminished vigor when overtopped by woody vegetation. However, the species persists under these conditions and will respond positively to management actions that reduce or remove competing vegetation.

3.26.4 Habitat Characteristics for Wenatchee Mountains Checker-Mallow

Wenatchee Mountain checkermallow is endemic to moist areas at elevations ranging from 1,900 to 4,000 feet in Chelan County, Washington (USFWS 2011). Surface hydrology appears to determine the distribution of Wenatchee mountain checkermallow plants in the broader landscape. Wenatchee mountain checkermallow is most abundant in moist meadows that have surface water or saturated upper soil profiles during spring and early summer. Soils are typically clay-loam and silt-loams with low moisture permeability. It may also occur in open conifer stands dominated by ponderosa pine (*Pinus ponderosa*) and Douglas-fir (*Pseudotsuga menziesii*) and on the margins of shrub and hardwood thickets.

3.26.5 Threats/ Reasons for Listing for Wenatchee Mountains Checker-Mallow

At the time of listing, the primary threats to this species included alterations of hydrology, rural residential development and associated activities, competition from native and alien plants, recreation, fire suppression, and activities associated with fire suppression (USFWS 1999). According to the latest 5 year review (2011), the greatest challenges to survival for the species are: 1) small populations; 2) vulnerability of the species to competition from nonnative invasive plants and native woody plants; 3) landscape-level fire suppression; 4) the potential permanent loss of habitat due to human development; and 5) seed predation by weevils that directly impacts the reproductive capacity of the plant (USFWS 2011). The cumulative effect of these on-going threats to establishing plants in the wild is a challenge for this species, even on lands that are dedicated to conservation of this species.

3.26.6 Recovery Measures for Wenatchee Mountains Checker-Mallow

Since the development of the recovery plan (USFWS 2004), our understanding of the ecology and biology of the species has increased. Observations of the effects of prescribed fire on this species indicate that the species is fire-adapted. Based on observations after controlled burns, the resulting removal of the overstory and competing vegetation appears to benefit the species and stimulates germination and growth (USFWS 2011).

Restoration work by the WDNR in partnership with the Service within the Camas Meadows Natural Area Preserve has improved hydrology of the wetland habitat in the meadow. Temporary dikes made of straw were used to reduce erosion in the meadow caused by high-velocity spring runoff. This work restored several acres of wetted habitat, which resulted in numerous Wenatchee mountain checkermallow plants the next spring and created a higher diversity of native species (USFWS 2011). Grass, shrub, and tree removal (either due to fire or mechanical removal) has also increased the amount of suitable habitat and the number of Wenatchee mountain checkermallow plants. Tree and shrub removal at the Camas Meadows NAP, the USFS, and the Mountain Home sites has improved conditions for plant establishment leading to an increased population size.

Direct observations and the communication of the negative effect of fire suppression activities on Wenatchee mountain checkermallow habitat by the USFS and others may have reduced the risk of this threat (USFWS 2011). It is likely in that future prescribed fire plans will include habitat containing Wenatchee mountain checkermallow. Strategic thinning (removal of competing overstory conifers) or timber harvest coupled with prescribed fire may benefit Wenatchee mountain checkermallow. The objective of prescribed fire should be to decrease the distribution of competing shrub and tree encroachment, reverse plant succession due to the past history of fire suppression, which in turn will increase the amount of light, water and nutrients taken up by the plants. Any timber harvest operations in Wenatchee mountain checkermallow habitat should be carefully planned.

Reintroduction efforts for Wenatchee mountain checkermallow are in the initial stages, but much of the groundwork has been completed to move forward with a science-based, methodical approach to site selection and development (USFWS 2011). Reintroduction efforts will need to be well planned and implemented to be successful. Protection of and conservation actions at all extant populations of Wenatchee mountain checkermallow, combined with the establishment of four to six additional viable populations within its historical range, appear to provide the best opportunity to recover this species.

3.26.7 Conservation Measures for Wenatchee Mountains Checker-Mallow

All of the General Plant Conservation Measures (Section 3.13.1) apply for Wenatchee mountain checkermallow. There are no additional species-specific measures.

3.26.8 Environmental Baseline for Wenatchee Mountains Checker-Mallow

The action area encompasses the entire range of Wenatchee mountain checkermallow, and therefore the environmental baseline for this species and its critical habitat is adequately described in the preceding sections.

3.26.9 Effects Analysis and Summary for Wenatchee Mountains Checker-Mallow

Wenatchee mountain checkermallow is endemic to moist areas at elevations ranging from 1,900 to 4,000 feet in Chelan County, Washington that could be affected by some wetland or aquatic restoration projects, or prairie restoration. The general effects of aquatic and prairie restoration projects are described in General Effects to Listed Plants (Section 3.29), and these adequately describe the potential effects to Wenatchee mountain checkermallow. No additional effects are anticipated for any of the proposed activities.

Over 4 years (2011 to 2014), PFW worked on 1 project that restored 5 acres of wetland habitat in Oregon that affected Wenatchee mountain checkermallow; the Coastal Program and Recovery Programs did not work on any projects that directly affected Wenatchee mountain checkermallow during that time. We anticipate few, if any aquatic projects funded by the

NOAA RC (which target anadromous salmonids) will occur in habitats occupied by Wenatchee mountain checkermallow. We also estimate an additional 1 restoration project implemented by other parties could be covered under this Opinion per year, as described in the Introduction in the section entitled *Action Area and Requirements for Coverage.*

Given this information, we anticipate 2 projects averaging 5 acres each (or 10 acres annually) may affect Wenatchee mountain checkermallow. Given the limited range of this species, and the low number and average size of the potential restoration projects that could occur in a single year, the numerous PDC and proposed conservation measures to minimize the number of plants adversely affected by the proposed action, and the anticipated long-term benefits from each project to native habitats and listed species in the long-term, we conclude the proposed restoration actions will not jeopardize the continued existence of Wenatchee mountain checkermallow.

3.26.10 Effects to Wenatchee Mountain Checkermallow Critical Habitat

The PCEs for the Wenatchee mountain checkermallow are surface water or saturated upper soil profiles; a wetland plant community dominated by native grasses and forbs, and generally free of woody shrubs and conifers that would produce shade and competition for Wenatchee mountain checkermallow; seeps and springs on fine textured soils (clay loams and silt loams), which contribute to the maintenance of hydrologic processes necessary to support meadows which remain moist into the early summer.

Restoration activities most likely to affect the PCEs of this species include prairie restoration techniques used for wetland and wet prairie restoration (regrading, earth moving, mowing, herbicide use, burning, or grazing and plant propagation). Restoration in wetland may reduce native plant density and alter soil and hydrologic conditions, resulting in short-term adverse effects to these PCEs. However, extensive restoration projects involving regrading and other ground disturbing actions are likely to occur in areas that do not already contain highly functioning wetland complexes. Use of herbicides to reduce non-native plant species may temporarily reduce native grasses and forbs, but ultimately would reduce competition for Wenatchee mountain checkermallow and other native plants, and eliminate taller plants that would ultimately produce shade. Thus, the anticipated negative effects to PCEs for Wenatchee mountain checkermallow are likely to be short-term in nature with likely long-term benefits to listed species and native habitats from the restoration. In the long-term, habitat manipulation, restoration, and enhancement activities will have beneficial effects on habitat quality for Wenatchee mountain checkermallow, resulting in an increase in abundance of the PCEs of critical habitat. The long-term effects of the proposed activities are not likely to diminish the value of critical habitat for the purpose for which it was designated. Thus, the proposed activities will not destroy or adversely modify critical habitat of Wenatchee mountain checkermallow.

3.26.11 Literature Cited for Wenatchee Mountains Checker-Mallow

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Personal Communications for Wenatchee Mountains Checker-Mallow

Thomas, Ted. 2015. USFWS, Lacey, Washington. Email correspondence to Ann Gray, USFWS, Portland, Oregon. January 9, 2015. Subject: PROJECTS BA for *Castilleja levisecta* and *Sidalcea oregana* var. *calva*.

3.27 Western Lily (Lilium occidentale)

The western lily was listed as federally endangered on August 17, 1994 (USFWS 1994) and as state endangered in Oregon in 1989. Critical habitat was not designated. A recovery plan for western lily was published on March 31, 1998 (USFWS 1998) and a 5-year review for the species was prepared in 2009 (USFWS 2009). Western lily occurs in California (Del Norte and Humboldt counties) and Oregon (Coos and Curry counties).

3.27.1 Population Trends and Distribution for Western Lily

The western lily occurs within 6.4 km (4.0 miles) of the coast in southern Oregon and northern California, extending from approximately Coos Bay, Oregon to Humboldt Bay, California (USFWS 2009). A total of 23 principle populations exist in California and Oregon. Principle populations are discrete populations that have the potential to meet recovery criteria given aggressive restoration effort. Occupied habitat areas total about 16.2 ha (40 ac), ranging in size from less than 0.04 ha (0.1 ac) to more than 2.4 ha (6 ac) (USFWS 2009). Land ownerships in occupied areas include federal, state, city, and private.

Population monitoring surveys vary in frequency and type, confounding comparison among sites and across time (M. Vander Heyden, USFWS, *pers. comm*. 2014). Data from flowering censuses are more available, whereas intensive censuses that attempt to also locate vegetative (i.e., non-reproductive) and browsed plants are less common. Population size typically reflects the density of the surrounding vegetation, with the number of reproductive or total individuals declining when habitat conditions become overgrown as a result of competition for sunlight and water.

The data available indicates that population trends for western lily are downward since listing (USFWS 2009). Many of the 31 populations known at the time of listing were poorly described, variably estimated, and included incidences of isolated plants that did not constitute viable populations. Consequently, many of the occupied sites were not able to be relocated and other sites were determined extirpated. Despite the discovery of several relatively large sites since 1994, data indicate that overall the spatial distribution of the western lily has declined dramatically across its range. Of the 23 principle populations identified in the Five Year Review (USFWS 2009), only two exceeded 1,000 plants; both of these populations are in California.

3.27.2 Life History and Ecology for Western Lily

Western lily seedlings and small juvenile plants produce a single above-ground leaf, while multiple-leaved plants commonly reach a height of 0.9 to 1.5 m (3 to 5 feet). Leaves grow along the unbranched above-ground stem, ranging from 8.9 to 19 mm (0.35 to 0.75 inches) wide by 78 to 269 mm (3.1 to 10.6 inches) long, and are distributed singly or in whorls along the shoot (Schultz 1988).

The western lily can be distinguished from most other species of *Lilium* by its pendent red flowers, yellow to green centers, highly reflexed tepals, non-spreading stamens, and closely unbranched rhizomatous bulb. When viewed from their open end, the flowers give the appearance of a golden star because the yellow basal portion comes to a point toward the midline of each tepal. The primary distinguishing characteristic of this species is the presentation of the stamens and style that remain nearly straight.

The western lily reproduces primarily by seed, but asexual reproduction is possible from detached bulb scales growing into new plants. A bulb scale is formed in the fall, and the first true (epicotylar) leaf emerges the following spring. In cultivation, plants may take 4 to 5 years to flower for the first time and may live for 25 years or more (Kline 1984). Young flowering plants generally produce a single flower in each of the first few years after they begin to flower, and later produce progressively more flowers if they experience favorable environmental conditions. Non-flowering individuals may persist for many years under closed forest canopies (USFWS 2009). It is not clear whether these represent the remnants of populations that flowered in the past when conditions were different, or are the product of dispersal into conditions that allow juveniles to persist but not reproduce.

In nature, shoots typically emerge in March or April and continue to elongate until the flowers open. From May to July, green buds turn red for 3 to 5 days, open over a period of 1 to 2 days, and the nodding flowers last for 7 to 10 days. After the floral parts have fallen off, pedicels (flower stalks) become erect within a week and capsules enlarge to maturity over a period of 40 to 50 days. Seeds are primarily dispersed by wind and gravity, mostly within a 4 m (13 feet) radius. Each year the above ground portion of the plants die back and individuals overwinter underground as rhizomes or bulbs. Dead, above-ground shoots may persist for one or more years in protected sites before they collapse and decompose. From late September to February plants are usually dormant.

Hummingbirds are the primary pollinator of the lily, but some bees and other insects may also occasionally transfer pollen (Skinner 1988; Schultz 1989). Low fruit set in isolated plants or those concealed in dense vegetation may be a result of low visibility or access to hummingbirds (Schultz 1989).

Juvenile plants are often observed near flowering adult lilies. In suitable habitat, there are often more juvenile plants than adult flowering plants. At some sites, particularly those with more than 200 plants, Shultz (1989) found that the majority of plants were non-flowering, which he believed was probably an indication of stress.

Throughout the range of the lily, populations are often small and geographically isolated, rendering them subject to random genetic drift. They occur in areas with unique soil development and microclimates, and have observable differences in morphologic traits (Schultz 1989). These factors indicate a significant degree of genetic differentiation in the species across its range.

3.27.3 Habitat Characteristics for Western Lily

Western lily occurs in freshwater fens, bogs, coastal prairie and scrub, and the transition zones between these habitat types (USFWS 1998). Stunted, non-flowering plants can also occur within spruce forest. Sites are often near the ocean where fog is common, and evidence suggests fog drip may provide an important late season moisture source (Imper and Sawyer 1996). Populations occur from just above sea level to a maximum of 91.4 m (300 feet) in elevation, and from ocean-facing bluffs to nearly 6.4 km (4 mi) inland. The climate is characterized by cool, wet winters and warm, dry summers.

Western lily occurs on two types of poorly drained soils: decomposed peat or muck substrate, or soils that are poorly drained due to a shallow iron pan (e.g., Blacklock, Bandon, or Bullard series in Oregon), or a clay layer (e.g., Joeney series in Oregon, Hookton series in California). In all known occurrences, the soils are high quality native soils, exhibiting good structure and very low bulk density (Imper *et al.*1987; Imper and Sawyer 1994; USFWS 2009). Research at Table Bluff, Humboldt County, California in the 1990s correlated the local distribution of western lily with soils that were more acid, cooler, and that contained more organic material. Additionally, the soils were less dense and exhibited better structure compared to adjacent unoccupied soils. The western lily also prefers soils that retain moisture later into the growing season, and allow greater percolation of summer rainfall (USFWS 2009).

Historically, lily populations appear to have been maintained in early seral condition by occasional fires (at least at some sites in Oregon) and by moderate grazing (USFWS 2009). Both disturbances maintain open habitat conditions and cattle hooves may facilitate seed germination by grinding them into the soil (D. Imper, *pers. comm.*, 2014).

3.27.4 Threats/ Reasons for Listing for Western Lily

The primary threats to the lily are human modification and destruction of habitat. The lily is limited to coastal habitat which is currently undergoing intense development pressure. Lily habitat often occurs on level marine terraces that are desirable for coastal development because of gentle topography and close proximity to the ocean. From the 1940s to the present, development of cranberry farms, roads, and residential dwellings has eliminated suitable lily habitat including some populations between Bandon and Cape Blanco (Schultz 1989).

Cranberry bog development was described as the largest loss of suitable habitat in Oregon (USFWS 2009). As of 2005, in the Bandon area alone 1,600 acres comprised of soils in the Bandon/Bullard/Blacklock complex have been converted to cranberry bogs. These soils are preferred by cranberries for the same reason as western lilies, i.e., they perch water.

Grazing by vertebrates (elk, deer, voles, and domestic cattle) and invertebrates (beetle, moth, or butterfly larvae) has been documented for the lily and may suppress small populations (USFWS 2009). Clearing and draining along the Elk and Six Rivers for intensive livestock grazing have eliminated many of the once numerous populations there. Although cattle represent an obvious physical hazard to individual plants during the growth period, evidence suggests that the benefits of creating suitable habitat through controlled grazing during the dormant period outweigh the losses (USFWS 2009). High deer populations near developed areas also pose a threat as deer may remove a considerable fraction of flowers and fruit, thus seriously reducing reproductive output. Deer herbivory has occurred at nearly all sites, and was responsible for the elimination of nearly 100% of one population's annual seed production in California (Imper 2008).

Years of fire exclusion has led to changes in lily habitat structure and composition. Fire exclusion has altered suitable habitat for the lily by facilitating succession from open coastal prairie and wetland habitats to shrubs and trees (USFWS 2009). Opportunities to conduct prescribed burns are limited by an increasing human population living in rural areas. Furthermore, overgrowth of vegetation can render an area susceptible to catastrophic fire. For example, gorse (*Ulex europaeus*) is a highly fire prone and aggressive noxious species that occurs in coastal habitat within the range of the western lily. It forms dense monocultures that can quickly overrun lilies and other native species.

Because most lily sites are small, populations can disappear with one environmental event, such as erosion or changes in the site's hydrologic regime. Isolation due to habitat fragmentation could inhibit re-colonization to other suitable areas and could result in a permanent loss of localized occurrences once they fall below a critical level. Because many of the western lily populations continue to be small (i.e., less than 50 flowering plants) (USFWS 2009), the loss of genetic diversity due to inbreeding and/or genetic drift may also be a serious threat to some populations in the future.

Lastly, horticultural collection of lilies could adversely affect the species, especially along roads and trails where it is more observable and most vulnerable. Because the species occurs in small, isolated clusters, a collector could decimate an entire population in one gathering, extirpating the species from that area (USFWS 2009).

3.27.5 Recovery Measures for Western Lily

Efforts have been made to improve western lily habitat throughout its range (USFWS 2009). Actions primarily involve clearing or thinning of competing vegetation at occupied sites and in suitable habitat where lilies may be suppressed due to closed canopies. In Oregon, the majority of lily management actions occur at state park sites, most often in collaboration with the Service's Coastal Program (M. Vander Heyden, USFWS, *pers. comm*. 2014). In 2013 and 2014, several western lilies were documented in a previously unoccupied area following gorse clearing at Floras Lake State Park (S. Laier, Oregon Parks and Recreation Department, *pers. comm.* 2014). Gorse control and monitoring will continue at this site to further expand and release this population. Under a long-standing grazing lease, the Oregon Parks and Recreation Department (OPRD) is continuing to refine its management of cattle grazing at Cape Blanco State Park to benefit western lily habitat. Cross-fencing was erected in and around occupied habitat, and watering troughs were installed outside of suitable habitat to allow grazing within the occupied area during the dormant season. At Sunset Bay (i.e., Bastendorff Bog) and Harris Beach State Parks, piezometers provide data on ground water levels to better understand the relationship between the water table and lily populations. In addition to state park lands, other ownerships where management occurs include Oregon Department of Transportation (ODOT) right-of-way at Hauser Bog and in Brookings; the Coos Bay BLM at the New River Area of Critical Environmental Concern; and private lands where the Service has obtained landowner permission.

In January and November of 2013, the Oregon Department of Agriculture, under a Section 6 grant provided by the Service, planted a total of 2, 890 western lily bulbs at Hauser Bog (ODOT/private) and at the following four Oregon State Parks: Shore Acres, Floras Lake/Blacklock, Cape Blanco, and Harris Beach (two sites). These areas are considered prime locations for reintroduction/augmentation projects due to ongoing habitat restoration, existing suitable habitat, and habitat maintenance activities (ODA 2013).

Bulbs were propagated from seeds collected at each of the sites and grown out by the Natural Resource Conservation Service (NRCS) at its Plant Materials Center in Corvallis, Oregon. They were planted in small clusters or along 30 to 40 m (98.4 to 131.2 feet) transects and bulbs were individually marked with pin flags to monitor planting outcomes. Transects were placed at a range of elevations to determine how microsite variation may influence plant emergence. Bulbs will be monitored to determine their contribution to the wild population and will be protected from herbivory by installing deer fencing in 2015.

3.27.6 Conservation Measures for Western Lily

All of the General Plant Conservation Measures (Section 3.13.1) apply for Western Lily. There are no additional species-specific measures.

3.27.7 Environmental Baseline for Western Lily

Eleven of the 23 principle populations occur in Oregon. Since listing, limited survey data for the majority of these populations indicate that most are either in decline (e.g., Shore Acres State Park, Harris Beach State Park), or are stable (e.g., Bastendorff Bog, Floras Lake State Park). Based on recent population data, most populations in Oregon number fewer than 100 flowering plants (M. Vander Heyden, USFWS, *pers. comm*. 2014). Populations that appear to be increasing such as Hauser Bog and Morrison Road are most likely responding to repeated habitat maintenance and low browsing pressure from white-tailed deer (*Odocoileus hemionus*). In 2013, a new population was discovered at Coos Bay's South Slough (Indian Point). Rough population estimates placed the total population at over 1,000 plants, making it one of the largest in the state (M. Vander Heyden,USFWS, *pers. comm.* 2014). However, many of the observed plants were non-reproductive.

3.27.8 Effects Analysis and Summary for Western Lily

Western lily occurs in freshwater fens, bogs, coastal prairie and scrub, and the transition zones between these habitat types. While western lily may be affected by some wetland restoration projects, it is most likely to be affected by techniques such as those used for prairie restoration (mowing, herbicide use, burning, grazing, and plant propagation). The general effects of aquatic and prairie restoration projects are described in General Effects to Listed Plants (Section 3.29), and these adequately describe the potential effects to western lily. No additional effects are anticipated for any of the proposed activities.

Over 5 years (2010 to 2014), the Coastal Program worked on 2 projects that restored 5 acres of habitat in Oregon that affected western lily; the PFW and Recovery Programs did not work on any projects that directly affected western lily during that time. We anticipate few, if any, aquatic projects funded by the NOAA RC (which target anadromous salmonids) will occur in wetland habitats occupied by western lily. We also estimate an additional 1 restoration project implemented by other parties could be covered under this Opinion per year, as described in the Introduction in the section entitled *Action Area and Requirements for Coverage.*

Given this information, we anticipate that up to 3 projects averaging of 3 acres each (or 9 acres annually) will affect western lily. Given the limited number and average size of the potential restoration projects relative to number of population occurrences, the numerous PDC and proposed conservation measures to minimize the number of plants adversely affected by the proposed action, and the anticipated long-term benefits from each project to native habitats and listed species in the long-term, we conclude the proposed restoration actions will not jeopardize the continued existence of western lily.

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3.28 Willamette Valley Daisy (*Erigeron decumbens* var. *decumbens*)

The Willamette Valley daisy (Willamette daisy) was listed as endangered on January 25, 2000 (USFWS 2000). A recovery plan for the Willamette daisy was published on May 20, 2010 (USFWS 2010a). A critical habitat was designated for the species on October 6, 2006 (USFWS 2006). This species is known to exist in Benton, Clackamas, Lane, Linn, Marion, Polk, Washington, and Yamhill counties in Oregon. This species is also on the state of Oregon's State Endangered Plant list.

3.28.1 Critical Habitat for Willamette Daisy

Critical habitat was designated on October 6, 2006 (USFWS 2006). Critical habitat units for the Willamette daisy have been designated in Benton, Lane, Linn, Marion and Polk Counties, Oregon. The PCEs of critical habitat are the habitat components that provide 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.

Critical habitat is designated for Willamette daisy on 718 acres in Oregon's Willamette Valley (USFWS 2006). Of those, 381.5 acres are designated on private lands, 324.2 on Federal lands, 6 on State lands, and 6.3 on county/city property.

3.28.2 Population Trends and Distribution for Willamette Daisy

The Willamette daisy is endemic to the Willamette Valley of western Oregon. Herbarium specimens show a historical distribution of Willamette daisy throughout the Willamette Valley; frequent collections were made in the period between 1881 and 1934, yet no collections or observations were recorded from 1934 to 1980 (Clark *et al.*1993). The species was rediscovered in 1980 in Lane County, Oregon.

At the time of listing, 28 occurrences of Willamette daisy were recognized with a total of 286 acres of occupied habitat (USFWS 2000). In 2010, the total acreage considered to be occupied was 233 at 39 sites (USFWS 2010a). In 2010, Willamette daisy was believed to be extant at 37 sites that comprise 17 populations (USFWS 2010b). Of these, 3 populations had been augmented and Willamette daisy had been introduced to 5 new sites since the time of listing. Three of the extant populations are the direct result of recent introductions, and 5 natural populations have been discovered since the time of listing. Willamette daisy is believed to be extirpated or the status is unknown at 11 sites where it was previously documented. Of these sites, 8 were known at the time of listing, including 5 that represented individual populations and 3 that likely contributed to larger populations.

Current population estimates are based on available information from 2004 to 2010 (USFWS 2010b). For most sites, long-term data needed to detect population trends is not available. In some cases, documentation of the number of plants at a site is not available. Where sites are within 3 km (2 miles) of each other, they are generally considered to be subpopulations that comprise a larger population (i.e., metapopulation) based on pollinator travel distance (USFWS 2010a).

Of the 17 currently known populations, only 2 include protected sites that support relatively large subpopulations (i.e., with over 2,000 plants) known to have been stable for 8 years or more (USFWS 2010b). Trend data is not available for most sites, and many sites are not formally protected. Recovery criteria outlined for downlisting have not been met in any of the recovery zones. Almost all previously identified threats to the species still remain. Significant progress has been made to store genetic material, and efforts to collect and store seed will likely continue.

Population size may fluctuate substantially from year to year. Monitoring at the Oxbow West site, near Eugene, found 2,299 Willamette daisy plants in 1999, 2,912 plants in 2000, and only 1,079 plants in 2001 (Kaye and Brandt 2005). The population at Baskett Butte declined to 48% of the original measured population between 1993 and 1999 (Clark 2000; Clark *et al.*1995). Detecting trends in Willamette daisy populations is complicated by the biology and phenology of the species. For instance, Kagan and Yamamoto (1987) found it difficult to determine survival and mortality between years because of irregular emergence and sporadic flowering from year to year. They suggested that some plants probably lie dormant during some years, as indicated by the sudden appearance of large plants where they were not previously recorded, and the disappearance and later re-emergence of large plants within monitoring plots. In addition, Clark *et al.*(1993) stated that non-reproductive individuals can be very difficult to find and monitor due to their inconspicuous nature, and that the definition of individuals can be complicated when flowering clumps overlap.

3.28.3 Life History and Ecology for Willamette Daisy

The Willamette daisy is a taprooted perennial herb in the sunflower or daisy family (*Asteraceae*). It grows 1.5 to 6 cm (0.6 to 2.4 inches) tall, with erect to sometimes prostrate stems at the base. The basal leaves often wither prior to flowering and are mostly linear, 5 to 12 cm (2 to 5 inches) long and 3 to 4 mm (0.1 to 0.2 inches) wide. Flowering stems produce two to five heads, each of which is daisy-like, with pinkish to pale blue ray flowers and yellow disk flowers. The morphologically similar Eaton’s fleabane (*E. eatonii*) occurs east of the Cascade Mountains, while the sympatric species Hall’s aster (*Aster hallii*) flowers later in the summer. In its vegetative state, the Willamette daisy can be confused with Hall’s aster, but close examination reveals the reddish stems of Hall’s aster in contrast to the green stems of the Willamette daisy (Clark *et al.*1993).

The Willamette daisy typically flowers throughout June and July with pollination carried out by syphrid flies and solitary bees (Clark *et al.*1995). The daisy produces and subsequently disperses large quantities of wind-dispersed seed in July and August. The seeds of the daisy are achenes, like those of other Erigeron species, and have a number of small capillary bristles (the pappus) attached to the top, which allow them to be distributed by the wind. Due to the small size and number of these bristles, the seeds do not fly well in the wind, so seed distribution is quite restricted. The Willamette daisy is capable of spreading vegetatively through rhizomes over very short distances of less than 10 cm (4 inches) and is commonly found in large clumps scattered throughout a site (Clark *et al.*1993).

Willamette daisy responds positively to late spring and early summer rains. Studies conducted at the Willow Creek Preserve indicate that not all individuals of the Willamette daisy bloom every year, and that some individuals may remain dormant for an entire growing season (Kagan and Yamamoto 1987).

3.28.4 Habitat Characteristics for Willamette Daisy

The Willamette daisy is typically occurs where woody cover is nearly absent and where herbaceous vegetation is low in stature (Clark *et al.*1993; USFWS 2010a). It occurs in both wet prairie grasslands and drier upland prairie sites. The wet prairie grassland community, which was historically maintained by periodic flooding and fires, is characterized by the dominance of tufted-hairgrass, California oatgrass, and a number of Willamette Valley endemic forbs. It is a flat, open, seasonally wet prairie with bare soil between the pedestals created by the bunching Deschampsia cespitosa (Kagan and Yamamoto 1987). On drier upland prairie sites, associated species commonly include Symphotrichum hallii, Festuca idahoensis ssp. roemeri and Toxicodendron diversilobum (Meinke 1982, Clark *et al.*1993). Willamette daisy prefers heavier soils, and has been found on the following soil associations: Bashaw, Briedwell, Chehulpum, Dayton, Dixonville, Dupee, Hazelair, Marcola, Natroy, Nekia, Pengra, Philomath, Salkum, Saturn, Stayton, and Witzel.

3.28.5 Threats/ Reasons for Listing for Willamette Daisy

Like many native species endemic to Willamette Valley prairies, the Willamette daisy is threatened by habitat loss due to urban and agricultural development, secondary successional encroachment of habitat by trees and brush, competition with non-native weeds, and small population sizes (Kagan and Yamamoto 1987, Clark *et al.*1993). The Service (USFWS 2000) estimated that habitat loss is occurring at 80% of remaining 84 remnants of native prairies occupied by Willamette daisy and Kincaid's lupine. The Service (USFWS 2000) also stated that 24 of the 28 extant Willamette daisy populations occur on private lands and, "without further action, are expected to be lost in the near future."

Although populations occurring on private lands are the most vulnerable to threats of development (state and Federal plant protection laws do not apply to private lands), publicly owned populations are not immune to other important limitations to the species. For instance, Clark *et al.*(1993) identified four populations protected from development on public lands (Willow Creek, Basket Slough NWR, Bald Hill Park, and Fisher Butte Research Natural Area), but stated that even these appear to be threatened by the proliferation of non-native weeds and successional encroachment of brush and trees. Likewise, vulnerability arising from small population sizes and inbreeding depression may be a concern for the species, regardless of land ownership, especially among 17 of the 28 remaining sites that are smaller than 8 acres (USFWS 2000). Given the predominance of privately-owned populations, land ownership represents a serious obstacle to conservation and recovery of Willamette daisy.

3.28.6 Recovery Measures for Willamette Daisy

Some research has been conducted on the ecology and population biology of Willamette daisy, effective methods for habitat enhancement, and propagation and reintroduction techniques (Clark *et al.*1995, 1997; Wilson and Clark 1997; Kaye and Kuykendall 2001; Leininger 2001; Kaye *et al.*2003a, 2003b). The results of these studies have been used to direct the management of Willamette daisy populations at sites that are managed for native prairie values.

The efficacy of mowing and burning as tools to restore habitat for the Willamette daisy is under investigation. Preliminary findings indicate that the Willamette daisy responds negatively to both mowing and burning, although it is possible that positive effects will be detected in future (Thorpe and Kaye 2007).

Several studies have investigated the feasibility of growing the Willamette daisy in controlled environments for augmentation of wild populations. Cold stratification or seed-coat scarification is necessary for successful germination (Clark *et al.*1995, Kaye and Kuykendall 2001). Stem and rhizome cuttings have also been used successfully to establish plants in the greenhouse (Clark *et al.*1995, Wilson *et al.*2001). Attempts to establish the Willamette daisy at new sites has shown that transplanting cultivated plants is much more effective than sowing seeds directly (Kaye *et al.*2003b). It is likely that conservation of the Willamette daisy may require augmenting small populations with propagated individuals (Clark *et al.*1995). Seeds of this species have been banked at the Rae Selling Berry Seed Bank in Portland, Oregon (Portland State Environmental Science and Management 2015).

Habitat for the Willamette daisy occurs 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 Bureau of Land Management's West Eugene Wetlands, and TNC's Willow Creek Preserve. 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.fws.gov/oregonfwo/Species/PrairieSpecies/Documents/PrairieSpeciesFinalRecoveryPlan.pdf.

3.28.7 Conservation Measures for Willamette Daisy

All of the General Plant Conservation Measures (Section 3.13.1) apply for Willamette daisy. Additional species-specific measures include:

- Broadcast application of grass-specific herbicides may be used in on up to half of an area occupied by Willamette daisy between February 15 and April 15. If using a weed wiper to apply a grass-specific herbicide for a particular listed plant during the growing season, the herbicide will be applied to the upper grass stems of targeted non-native plants, thus avoiding the shorter listed plant species.
- All other broadcast applications will only occur after August 15 when Willamette daisy is dormant; spot and hand applications may occur any time of the year.

3.28.8 Environmental Baseline for Willamette Daisy

The action area encompasses the entire range of Willamette daisy, and therefore the environmental baseline for this species and its critical habitat is adequately described in the preceding sections.

3.28.9 Effects Analysis and Summary for Willamette Daisy

Willamette daisy is a wet prairie species that may be affected by some aquatic or wetland restoration projects, but is most likely to be affected by techniques for prairie restoration (mowing, herbicide use, burning, grazing, and plant propagation). The general effects of aquatic and prairie restoration projects are described in General Effects to Listed Plants (Section 3.29), and these adequately describe the potential effects to Willamette daisy. No additional effects are anticipated for any of the proposed activities.

Over 4 years (2011 to 2014), PFW worked in 14 projects that restored 874 acres of wetland habitat in Oregon that affected Willamette daisy; the Coastal Program did not work on any projects that directly affected Willamette daisy during that time. The Service's Recovery Program funded an additional 33 restoration projects in the Willamette Valley in Oregon that affected prairie habitats between 2012 and 2014; 8 of those projects affected Willamette daisy. Restoration work conducted by the Willamette Valley Refuge Complex could occur on up to 652 acres of wet prairie habitat (WVNWR 2011, p. 4-2). We anticipate few, if any aquatic projects funded by the NOAA RC (which target anadromous salmonids) will occur in wetland habitats occupied by Willamette daisy. We also estimate an additional 2 restoration projects implemented by other parties could be covered under this Opinion per year, as described in the Introduction in the section entitled *Action Area and Requirements for Coverage.*

Given this information, we anticipate that up to 9 projects averaging of 62 acres (or 558 acres annually) will affect Willamette daisy, plus restoration work on up to 652 acres annually on refuge lands. Given the limited number and average size of the potential restoration projects relative to number of population occurrences and acres of occupied habitat, the numerous PDC and proposed conservation measures to minimize the number of plants adversely affected by the proposed action, and the anticipated long-term benefits from each project to native habitats and listed species in the long-term, we conclude the proposed restoration actions will not jeopardize the continued existence of Willamette daisy.

3.28.10 Literature Cited for Willamette Valley Daisy

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3.29 General Effects and Conclusion for Listed Plant Species

All proposed restoration activities may negatively affect federally listed plant species (directly or indirectly) due the nature of the activity. The use of heavy equipment machinery and vehicles can crush plants or compact soil conditions such that plants are harmed or killed; similarly, the humans involved in the restoration actions or surveys may also inadvertently trample and crush plants or alter soils conditions such that plants are harmed or killed. Activities implemented near or within occupied habitats will have the greatest effects to these species. The General Plant Conservation Measures (Section 3.13.1), such as pre-project surveys to locate listed plants, designation of buffers around listed plants, and identification of appropriate access points for vehicles and staff, will minimize the potential for these negative effects. The anticipated long-term beneficial effects to listed species are expected to negate any short-term effects by improving habitat conditions for listed species.

Ground disturbing activities (*e.g.,* installation of structures and facilities, soil stabilization, grading, tilling, and habitat conversions, etc.) and the control or removal of invasive and non-native vegetation will have the most potential adverse effects to federally listed plant species. These activities can adversely affect all life stages of listed plants (*i.e.,* seeds, seedlings, and reproductive plants). Listed plant species can be trampled, broken, dug up, and killed; and soils compacted, displaced, or removed from the project site. Herbicides can harm or kill listed plants. However, the General Plant Conservations Measures (Section 3.13.1), and proposed PDC will minimize the potential for these negative effects. Long-term beneficial effects are expected by addressing threats to listed species, such as unrestricted livestock access, soil erosion, degraded ecosystem processes, and plant competition with non-native and invasive plant species.

Many of the listed plants addressed in this Opinion occur in wet areas, such as wet prairies, wetlands, or at the edges of stream and ponds. Thus, these plants may occur in or near sites where aquatic or wetland restoration projects occur. Many of these restoration projects are designed to improve natural conditions for rivers, streams or wetlands, which benefit the overall site characteristics for native and listed species. However, these actions may target benefits to listed fish, which may negatively impact listed plant individuals if they are present. The Plant Conservation Measures (Section 3.13.1)(such as surveys and buffers) will be applied and implemented as possible to minimize these impacts.

There may be circumstances in which listed plant individuals cannot be adequately buffered or avoided to meet the goals of the aquatic or wetland restoration action. Restoration actions may kill individual plants through regrading or other soil moving techniques, or alter the hydrology of the site such that the habitat will no longer support the listed plants. Although we anticipate this situation to be uncommon, these plants may have to be dug up and removed from the site in order to achieve the restoration goals. In these situations, use of the General Plant Conservations Measures (Section 3.13.1) will minimize the potential for these negative effects, including the development of a site-specific plan that minimizes the number of plants that will be harmed or killed. Further, listed plants often have very specific habitat requirements and are typically found at sites that are often undisturbed. As aquatic and wetland restoration projects generally occur in altered and disturbed areas, we anticipate few aquatic restoration projects will occur at sites that support listed plant species. Given 1) few aquatic restoration projects are likely to be sited at locations with listed plants and negatively affect individual listed plants, 2) the actual ground disturbance and subsequent effects are highly localized to the project site, and 3) any individual project site is typically small relative to the amount of occupied habitat by any one species; and 4) the number of populations of each listed plant are dispersed over a wide range (relative to aquatic restoration sites), we do not anticipate long-term negative effects to any listed plant populations from aquatic restoration projects.

3.29.1 Native Vegetation Restoration and Management

Native vegetation and restoration techniques are largely described in PDC 29 (Invasive Species and Non-native Plant Control) and PDC 51 (Native Vegetation Restoration and Management). PDC 29 includes the use of herbicides, which will be used for many restoration projects. PDC 51 includes mowing and other mechanical removal of vegetation, burning, and managed grazing, all of which primarily target restoration of native plants on prairie and savannah habitats, but may also be used other habitats to achieve restoration goals and objectives. All of these techniques may affect listed plants in the short-term, but often are necessary to create and maintain habitats that support listed plants, especially those that require prairie or open habitats. Specific PDC have been developed for each type of treatment and should significantly reduce risks to listed plants. Thus, the short-term loss is typically offset by long-term improvements in the treated populations.

3.29.1.1 Mowing and Mechanical Removal of Vegetation

Mowing and other mechanical removal techniques (hand tools, weed trimmers, *etc*.) are often used to reduce populations of non-native and invasive plant species (and thereby reduce competition), reduce thatch build-up and improve conditions for listed plant species. Species specific timing for mowing and appropriate mower deck height was included in the proposed action to minimize effects to listed plant species (Table 31). Buffer distances from listed plant individuals are described in the General Plant Conservation Measures (Section 3.13.1) for mowing and other techniques (such as sod rolling, tilling, etc.). Fall mowing in occupied habitats will have minimal adverse effects to many federally listed plant species since most plants will have senesced by this time. However, some plants do not completely senesce by the beginning of the fall mowing season (such as Nelson's checkermallow), and will be an exception. In these cases, we would expect some loss of above ground plant biomass. The level of effect will be based on the density of the species and size of the project site. Long-term benefits are expected within these listed plant populations because of the reduction in plant competition with non-native plant species.

Research on prairie management techniques has shown that mowing is an effective method for reducing non-native plants while providing beneficial effects to native prairie species, and maintaining early serial stage necessary to support prairie habitats. The General Plant Conservation Measures (Section 3.13.1), PDCs and timing windows and areal limitations developed for mowing treatments should significantly reduce associated risks. Long-term benefits are expected within these listed plant populations because of the reduction in plant competition with non-native plant species.

In certain situations, spring mowing may be necessary to achieve restoration goals. Spring mowing with tractor mowers or hand-held mowers may occur where necessary to control overwhelming weed infestations, except at sites where listed some butterflies occur. Some limitations may also occur with other listed animal species, if present. Spring mowing at sites with listed plants will maintain a buffer of 2 m (6 feet) from nearest listed plants, if this will meet the management objective. However, if needed to control serious infestations of weeds that reproduce mainly by seed (e.g., meadow knapweed), up to one half of the area occupied by the listed plant population at a site may be mowed in an effort to reduce seed set by non-native weeds. When possible, the mower deck will be set at a level high enough to avoid killing listed plants but low enough to remove weed flowers to minimize impacts to listed plants. Long-term benefits are expected within these listed plant populations because of the reduction in plant competition with non-native plant species.

3.29.1.2 Use of Herbicides

The use of herbicides poses significant risks to federally listed plant species. Available information on effects of each proposed herbicide on organisms contained in PDC 29 and 51 is summarized in the PROJECT BA's Appendix entitled *Detailed Effects and Risk Assessment for Herbicide Use*. Listed plants may be exposed to herbicides during their application through direct spraying, indirect (drift) spraying, surface runoff, sub-surface leaching, wind erosion, and the use of contaminated irrigation water. These conditions could result in harm or death of listed plants. However, PDC developed for herbicide applications, including limitations use and application techniques of specific herbicides, areal limitations for each treatment, appropriate timing windows and adequate shielding plants when necessary should significantly reduce these associated risks. These PDC address risks related to the types of herbicides to be used with a listed species, application methods, and their proximity of use near sites with listed plants. Therefore, the potential for listed plant species to come in contact with herbicides should be greatly reduced during their applications. Long-term benefits are expected with the appropriate use of herbicides because listed plants will have reduced competition with non-native plant species.

3.29.1.3 Prescribed Burns

Prescribed burns also have the potential to affect federally listed plant populations. Fires are used in restoration to maintain open prairies and reduce woody plant encroachment into these areas, both which help maintain suitable habitat for many listed prairie plants. Under the proposed action, burns are to be low intensity and conducted under cool field conditions. Prescribed burning under this restoration program will occur after listed plants have senesced for most species (Table 31). Fire is likely to kill seeds found at or near the surface of the soil; below ground structures of these perennial plants are not likely to be destroyed by burning but injury may occur to rhizomes close to the soil surface (USFWS 2008). Prescribed fire generally results in increased vigor of many listed plants (USFWS 2008). Fall burning has been effective in reducing the cover of invasive non-native plants for several species. Some plant species (such as Nelson's checkermallow) may not have completely senesced in the fall when prescribed burns are implemented (USFWS 2008). For this reason, no more than one half of the occupied habitat at any site may be burned for listed species that do not senensce. In these instances, some plants may die, but the restriction on burn area will preserve half of the population, which may serve as a recolonization source for the burned area.

There is always a chance that the fire intensity may be too hot and destroy plant seeds and underground root/support structures. Adverse effects have been observed in rare plant populations resulting from wildlife fires and prescribed burns (e.g. Pendergrass *et al.*1999).

These effects have included changes in seed production, population density, and plant growth and size several years after fire exposures. The severity of these effects has a direct relationship to the fuel densities within burned areas (*i.e.,* high fuel loads can result in longer sustained burns). The proposed PDC for prescribed burns should reduce fire intensity and limit these long-term negative effects, while achieving long-term benefits for listed plants and the habitats that support them.

3.29.1.4 Grazing as a Management Tool

In certain circumstances for some listed plant species, grazing may be an effective tool to improve habitat conditions for listed plants. Carefully controlled livestock grazing can be effective in the control of shrubby invasive vegetation and new invasive vegetation sprouts and the reduction of leaf litter buildup. Grazing at low to moderate levels during the dry season (after August 1) will have the least effect to listed plants, as most plants will have senesced. Livestock grazing will not be used at sites with known populations of the following species: Cook's desert parsley, Gentner's fritillary, Howell's spectacular thelypody, large-flowered meadowfoam, Nelson's checkermallow, rough popcornflower, and Spalding's catchfly, as stated in the proposed conservation measures for plants, unless approved by the local Service office. For other populations where limited grazing will be beneficial, proposed PDC will minimize negative effects of grazing, while providing long-term benefits for listed plants and the habitats that support them.

3.29.2 Plant Propagation and Enhancement

Plant propagation and enhancement activities are described in PDC 51 (Native Vegetation Restoration and Management). Plant populations may be augmented or introduced to increase the number and viability of listed plant populations throughout their historical range. Collection, storage, and transport of seeds or rhizomes from an existing listed population, and the subsequent cultivation and outplanting of listed plants can be used to accomplish augmentation or introduction. Collection, storage, transport, cultivation and outplanting methods will use the most up-to-date species-specific information and techniques for any proposed action, including the most appropriate limitation for collecting seeds or rhizomes from wild populations. Propagules may be also collected from listed plants cultivated at a greenhouse or nursery facility for further cultivation or outplanting.

An essential part of restoring populations of many rare species is the restoration of native prairie structure and function. In addition to collection of seed and rhizomes of listed plants, the seeds and plant parts of non-listed native species may be also collected and cultivated, and a variety of native forbs, including nectar species for listed butterflies, and grasses may be augmented or introduced as part of the prairie restoration efforts addressed in this Opinion.

3.29.2.1 Propagule collection, propagule storage, and cultivation of listed plants

The following activities are included in the proposed action: collect limited amounts of listed plant seed and/or rhizomes from existing populations; store and transport propagules for later cultivation or outplanting, and cultivate plants in nursery or greenhouse for later propagule collection and outplanting. Collecting seeds or rhizomes from an existing population may reduce the number of plants in future generations, and slow the expansion of that local population. Collection limits generally are defined separately for populations of different sizes and levels of vulnerability, as follows:

Roadside and populations < 50 individuals	Populations of 50-500 individuals	Populations > 500 individuals (60 m^2 for lupine)
50% seeds, 2% rhizome biomass	15% seeds, 2% rhizome biomass	25% seeds, 2% rhizome biomass

Propagule collections should target local populations of >500 individuals, when available. These limits should be further reduced if species-specific or site-specific information indicates lower limits are necessary to maintain the donor population levels. Because these collections are limited and based on the number of plants and site-specific information on the donor population, removal of seed or rhizomes should not substantially affect future recruitment to the donor population. Further, these seeds or rhizomes will be used to restore or augment other populations, and will increase the number of individuals or number of populations of these listed plants, and thereby benefit the species overall.

Cultivation of listed plants, either for reintroduction of a species to a site or augmentation of an existing listed plant population, and any associated activities (storage, transport, outplanting, etc.) may result in the loss of some of the cultivated plants. Not all seeds or rhizomes are expected to produce a healthy, cultivated plant; some cultivated plants may not survive to outplanting. However, use of the most up-to-date species-specific information and techniques for each listed plant species will minimize the loss of these cultivated plants, and we anticipate such losses to be low.

Augmentation to an existing listed population (either via seed, rhizomes, or outplanting cultivated plants) may negatively affect some individual plants already established at the site. Listed plants may be damaged via trampling, loss of roots via digging, or other similar activities necessary to complete the augmentation. However, augmentation is generally used when listed plants are sparse, and existing plants can likely be avoided. Use of the general PDC, the General Plant Conservation Measures (Section 3.13.1), and any applicable species specific conservation measures will minimize effects to existing populations and cultivated plants.

3.29.2.2 Outplanting Augmentation or Restoration Sites

An essential part of restoring populations of rare species is the restoration of native prairie structure and function. Seed and plant parts from many native prairie plants may be collected to create nursery stock for restoration projects, and a variety of native forbs, including nectar species for listed butterfly species, and grasses will be augmented or introduced as part of the prairie restoration efforts addressed in this Opinion. Seed collection, propagation and outplanting of these unlisted species are not restricted by the ESA, however, these activities could have some effects to listed species. Use of the general PDC, the General Plant Conservation Measures (Section 3.13.1) when listed plant species are present, and any applicable species-specific conservation measures will minimize effects to existing populations of listed species. If listed species occur at a site where collection of seeds or plant parts of non-listed plants is to take place, care will be taken to avoid trampling, damaging (above or below ground), or otherwise harming listed plants.

3.29.3 Summary – PDC 51

A serious long-term threat to many early seral plant species is the change in community structure due to plant succession. For example, 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 prairie sites that support listed plant species unless they are actively managed (e.g. Johannessen *et al.*1971; Kuykendall and Kaye 1993). Thus, restoration actions that re-set plant succession and mimic historical disturbance regimes that maintained early plant succession are necessary to create and maintain habitats that support listed plants and other native species they support.

All restoration techniques (mowing, herbicide use, burning, grazing, grading, etc.) may negatively affect individual popuations. However, PDCS etc will minimize the number of plants that will be harmed through appropriate timing of activities and limitations on the areal extent of a treatment on any one population. In the long term, these actions provide a long-term benefit to native and listed plants and their habitats. Thus, we determine the proposed techniques for native vegetation and management will not jeopardize the continued existence of any listed plant species.

Restoration work to collect listed plant seeds or rhizomes and reintroduce or augment listed plant species with cultivated plants may have some short-term, localized reduction in the number of plants at the donor site in future years. However, donor populations will be selected based on its ability to withstand these short-term losses. Further, these efforts are intended to increase the number of plants within existing populations that need assistance and increase the number of occurrences or populations of a listed plant throughout its range to thereby contribute to the recovery of the species. While there may be some localized, short-term loss, there are anticipated long-term benefits to the species overall. Thus, we determine the proposed plant propagation and enhancement will not jeopardize the continued existence of any listed plant species.

In summary, several of the restoration/recovery activities, especially ground disturbing activities and the control or removal of invasive and non-native vegetation, can result in short-term, adverse effects to federally listed plant species. However, these actions are often necessary to maintain habitats; without such actions, habitat may become unsuitable for the species over time. By implementing the PDC and General Plant Conservation Measures, as well as any species-specific conservation measures, there is a substantial reduction in the severity of the potential adverse effects to these species. Given the importance of these restoration actions to creating and maintaining habitats for these species, the projected annual number and size of projects relative to the amount of occupied habitat for any one species, the greatest risk to a listed plant species is at the individual level and not at the population level. Areal restrictions and timing windows for mowing and burning and herbicide use further minimize impacts to listed plant species. Individual plants may be injured or destroyed while implementing some activities, but populations should not be affected to a degree where they would be placed in significant harm: where continued survival, growth, and reproduction of that population would be impacted in the future. For these reasons, we determine that none of the proposed native vegetation restoration and management projects will jeopardize the continued existence of any listed plant species.

3.29.4 Silviculture Impacts

Few listed plant species are anticipated to occur in areas requiring silviculture treatments. The most likely species to occur in such forested areas is Gentner's fritillary and Western lily.

Restoration work associated with silviculture treatments could result in injury or death to individual plants via trampling or felled branches crushing the plants. Thinning thickly forested areas would benefit these species by allowing more light to the forest floor. If any listed plants were found in proposed silviculture treatment areas, the General Plant Conservation Measures (Section 3.13.1) would be implemented to minimize any effects from the restoration work. Removal of trees or branches should avoid felling on to and crushing listed plant species. Overall, long-term benefits to listed species would be expected from such actions, especially for listed birds (e.g. northern spotted owl and marbled murrelet), and may benefit listed plant species by allowing more light to the forest floor. While there may be some localized, short-term loss to plant species, use of the General Plant Conservation Measures should limit impacts to any listed plants in the site boundary. Thus, we determine the proposed silviculture actions to enhance forest habitats for listed species will not jeopardize the continued existence of any listed plant species.

3.29.5 Extent of Anticipated Effects and Coverage for Other Parties

Additional species-specific information and effects analysis is provided for each species in the sections below. The effects analysis for each species includes a projected annual number and average size of restoration projects that may affect that species, based on previous years' funding (Table 32). These numbers are based on 1) the Service's HABITS database for PFW and the Coastal Program for all 3 states from 2011 through 2014 (database accessed in December 2014); 2) Recovery funding as provided from local Idaho, Oregon Fish and Wildlife Office (2012 to 2014) and Western Washington Fish and Wildlife Office (2010 to 2012). Funding for restoration, recovery, and enhancement programs has been basically stagnant for at least five years, and there is no indication that funding will increase in the foreseeable future, and acres and miles of habitat treated are expected to remain the same or be reduced (USFWS 2015). For NWR lands, the Service also included acres on NWR lands that may be restored or maintained each year for listed species. The Service used existing habitat information available from the Willamette Valley NWR Complex (WVNWR 2011, Table 4-1) to estimate potential restoration for 5 listed plant species (Bradshaw's lomatium, golden paintbrush, Kincaid's lupine, Nelson's checkermallow, and Willamette daisy) (Table 32); however, we anticipate these acres will cover restoration on all NWR throughout the Action Area. For other species where information on NWR lands was not readily available, we assume the coverage already provided can be used on NWR lands.

When determining compliance in future years as projects are implemented under this Opinion, effects for each species will be averaged over three consecutive years (a rolling three-year average). Funding for a particular species will vary from year to year: one year may fund multiple projects for one species, while the following year funds none. This averaging allows some versatility in these restoration programs to prioritize and schedule restoration priorities.

Other parties and traditional Section 6 Grants to States conducting restoration projects may be covered under this Opinion, provided that party is able to meet all requirements of this Opinion (project review, PDC, conservation measures, reporting requirements, etc.) and review by the local Service office determines the proposed restoration action, in combination projects funded by the Action Agencies in the same year, will not exceed the effects described in this Opinion. While we do not have information to accurately estimate this number of restoration projects that would fall into this categoryinto the future, we identify a number a number of projects that could be covered in this manner for each species below, and include those projects in the overall effected acreage for each species.

3.29.6 Conclusion for Listed Plant Species

After reviewing the current status of Bradshaw's lomatium, Cook's desert-parsley, Gentner's fritillary, golden paintbrush, Howell's spectacular thelypody, Kincaid's lupine, large-flowered woolly meadowfoam, Nelson's checkermallow, rough popcornflower, Spalding's catchfly, Ute ladies'-tresses, water howellia, Wenatchee Mountains checker-mallow, Western lily, and Willamette daisy, the environmental baseline for the action area, the effects of the Action Agencies' proposed restoration programs, and the cumulative effects, it is the Service's Opinion that the activities implemented under the PROJECTS restoration program are not likely to jeopardize the continued existence of Bradshaw's lomatium, Cook's desert-parsley, Gentner's fritillary, golden paintbrush, Howell's spectacular thelypody, Kincaid's lupine, large-flowered woolly meadowfoam, Nelson's checkermallow, rough popcornflower, Spalding's catchfly, Ute ladies'-tresses, water howellia, Wenatchee Mountains checker-mallow, Western lily, and Willamette daisy, or result in the destruction or adverse modification of critical habitat that has been designated for bull trout, Warner suckers, Oregon silverspot butterfly, vernal pool fairy shrimp, Cook's desert parsley, large-flowered meadowfoam, and Wenatchee mountain checker-mallow.

These no jeopardy findings for Bradshaw's lomatium, Cook's desert-parsley, Gentner's fritillary, golden paintbrush, Howell's spectacular thelypody, Kincaid's lupine, large-flowered woolly meadowfoam, Nelson's checkermallow, rough popcornflower, Spalding's catchfly, Ute ladies'-tresses, water howellia, Wenatchee Mountains checker-mallow, Western lily, and Willamette daisy are supported by the following:

1. The proposed aquatic restoration actions may have adverse effects to some listed plant species; however, these restoration projects typically occur in disturbed areas that typically do not support habitat characteristics required by the above mentioned listed plants, and thus, few, if any aquatic restoration project sites are likely to contain listed plants in any given year. When this does occur, the proposed PDC and conservation measures will minimize the impacts to the the above mentioned listed plants.
2. Many of the proposed restoration actions (PDC 51) are often necessary to maintain native habitats that support the above mentioned listed plants; without such actions, these habitats may become unsuitable for the species over time due to succession. The proposed restoration actions are intended to maintain site conditions for listed plants and allow them to persist and thrive in the restored/maintained site. Significant long-term beneficial effects to the above mentioned listed plant species are anticipated from these activities.
3. When possible to achieve the restoration goals, the restoration activities will be implemented when listed plants have senesced, thereby minimizing effects to individual plants.
4. Proposed PDC, general plant conservation measures, and species-specific conservation measures will minimize adverse effects to listed plant species for activities that cannot avoid adverse effects. These include appropriate areal limitations and species-specific timing windows for certain actions. These measures substantially reduce the severity of adverse effects to listed plants, while allowing restoration activities to providing

significant long-term beneficial effects to habitats that support the above mentioned listed plants.

5. While some individual plants may be adversely affected by the proposed restoration projects, plant populations should not be affected to a degree where they would be placed in significant harm: where continued survival, growth, and reproduction of that population would be impacted in the future.

Table 32. Estimated number of acres (to be calculated on a 3-year rolling average) to be treated under this Opinion each year by plant species.

Plant Species	**Total annual affected acres**
Bradshaw's lomatium (*Lomatium bradshawii*)	1,120
Cook's desert parsley (*Lomatium cookii*)	150
Gentner's fritillary (*Fritillaria gentneri*)	830
Golden paintbrush (*Castilleja levisecta*)	1,792
Howell's spectacular thelypody (*Thelypodium howellii spectabilis*)	10
Kincaid's lupine (*Lupinus sulphureus ssp. kincaidii*)	1,412
Large-flowered woolly meadowfoam (*Limnanthes floccosa ssp. grandiflora*)	150
Nelson's checker-mallow (*Sidalcea nelsoniana*)	1,768
Rough popcornflower (*Plagiobothrys hirtus*)	200
Spalding's catchfly (*Silene spaldingii*)	400
Ute ladies'-tresses (*Spiranthes diluvialis*)	2,160
Water howellia (*Howellia aquatilis*)	150
Wenatchee mountains checkermallow (*Sidalcea oregana var. calva*)	10
Western lily (*Lilium occidentale*)	9
Willamette daisy (*Erigeron decumbens var. decumbens*)	1,210

3.29.7 Literature Cited for Introduction and General Effects to Listed Plant Species

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4 CUMULATIVE EFFECTS

"Cumulative effects" are 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 (50 CFR 402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

The contribution of non-federal activities to the current condition of ESA-listed species and designated critical habitats within the program-level action area was described in the Status of the Species and Critical Habitats and the Environmental Baseline sections above. Among those activities were agriculture, forest management, mining, road construction, urbanization, water development, and restoration. Those actions were driven by a combination of economic conditions that characterized traditional natural resource-based industries, general resource demands associated with settlement of local and regional population centers, and the efforts of social groups dedicated to the restoration and use of natural amenities, such as cultural inspiration and recreational experiences.

Resource-based industries caused many long-lasting environmental changes that impacted ESA-listed species and their critical habitats, such as 1) conversion of prairie habitats to urban and agriculturcal uses, 2) loss of natural disturbance regimes for both prairies and riverine habitats, 3) introcution of non-native species, and 4) state-wide loss or degradation of stream channel morphology, spawning substrates, instream roughness and cover, estuarine rearing habitats, wetlands, riparian areas, water quality (*e.g.*, temperature, sediment, dissolved oxygen, contaminants), fish passage, and habitat refugia. Those changes reduced the ability of populations of ESA-listed species to sustain themselves in the natural environment by altering native habitats or interfering with their behavior in ways that reduced their survival throughout their life cycle. The environmental changes also reduced the quality and function of critical habitat PCEs that are necessary for continued survival of these species. The declining level of resource-based industrial activity and rapidly rising industry standards for resource protection, however, are likely to reduce the intensity and severity of those impacts in the future.

The economic and environmental significance of natural resource-based economy is currently declining in absolute terms and relative to a newer economy based on mixed manufacturing and marketing with an emphasis on high technology (Brown 2011). Nonetheless, resource-based industries are likely to continue to have an influence on environmental conditions within the program-action area for the indefinite future. However, over time those industries have adopted management practices that avoid or reduce many of their most harmful impacts. Similarly, state and Federal standards are now more protective of environmental conditions, including those that support ESA-listed species.

While natural resource extraction within the Pacific Northwest may be declining, general resource demands are increasing with growth in the size and standard of living of the local and regional human population (Metro 2010; Metro 2011). Population growth is a good proxy for multiple, dispersed activities and provides the best estimate of general resource demands because as local human populations grow, so does the overall consumption of local and regional natural resources. Between 2010 and 2014, the combined population of Idaho, Oregon and Washington grew from 12.1 to 12.7 million, an increase of approximately 4.5%. Washington grew faster (5.0% increase), while Idaho and Oregon populations increased by 4.3 and 3.6%, respectively (U.S. Census Bureau 2015). By 2020, the population of Oregon and Washington is projected to grow to 13.5 million (Oregon Office of Economic Analysis 2011, Washington Office of Financial Management 2010, Idaho Division of Financial Management 2012). The Service assumes that future private, state, and Federal actions will continue within the action area, increasing as population rises.

The most common private activity likely to occur in the action areas addressed by this Opinion is unmanaged recreation. As human population growth continues, we anticipate recreational activities (including camping, hiking, horseback riding, off-road vehicle use, fishing, small-scale mining) will also increase. Expected impacts to ESA-listed species from this type of recreation include minor releases of suspended sediment, minor soil compaction, minor disturbance to riparian areas, potential introduction of non-native species, impacts to water quality, short-term barriers to fish movement, and minor changes to habitat structures. Streambanks, riparian vegetation, and reproductive behaviors can be disturbed wherever human use is concentrated.

When considered together, these cumulative effects are likely to have a continued negative effect on ESA-listed species, and some short-term negative effects on their habitats. Similarly, the condition of critical habitat PCEs will be slightly degraded by the cumulative effects.

5 INTEGRATION AND SYNTHESIS

The Integration and Synthesis section is the final step of the Service's assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we add the effects of the action (Section 3) and the cumulative effects (Section 4) to the status of the species (Section 3) and the environmental baseline (Sections 2.3 and 3) 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 the 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 (Section 3).

The many individual populations affected by the proposed program vary considerably in their biological status. The species addressed in this Opinion 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 baseline varies across the action area, but habitat will generally be degraded at sites selected for restoration actions, which makes them a candidate for project implementation.

The programmatic nature of the action precludes a precise analysis of each individual action that eventually will be funded or carried out under this Opinion, although each type of action will be carefully designed and constrained by comprehensive design criteria and conservation measures These criteria and measures will insure that the proposed activities will cause only short-term, localized, and relatively minor effects. Also, actions are likely to be widely distributed across any one species' range, so adverse effects will not be concentrated in time and space within the range of the affected species. Because all of these actions are inherently intended to advance conservation, in the long-term, these actions will contribute to a lessening of many of the factors limiting the recovery of these species. For aquatic habitats, those include factors related to fish passage, degraded floodplain connectivity, reduced aquatic habitat complexity, and riparian conditions, and improve the currently-degraded environmental baseline, particularly at the site scale. Similarly, for prairie habitats, these actions will contribute to maintaining and improving native prairie characteristics, such as reducing competition from non-native/invasive plants, restoring interrupted disturbance regimes, and maintaining early-seral habitats necessary to sustain prairie-dependent species.

A relatively small number of ESA-listed species will be affected by the adverse effects of any single action permitted under the proposed action. Because characteristics at the population 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 preceding chapters on each species, 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, succession of prairie habitat to forests, competition with non-native species, elevated water temperatures, excessive sediment, reduced access to spawning and rearing areas, reductions in aquatic habitat complexity, instream wood, and channel stability; degraded floodplain structure and function, and reduced flow. Cumulative effects within the action area described in Section 4 are likely to continue to have negative effects on ESA-listed species. Actions carried out under the proposed program will address and help to alleviate many of these limiting factors in the long run.

6 CONCLUSIONS

Previous chapters of this Opinion presented the current status of all the listed species likely to be adversely affected by this proposed action, the environmental baseline within the action area for each of these species, the direct and indirect effects of the proposed action on each of these species, and cumulative effects. As provided in the earlier chapters, it is Service's biological opinion that the proposed action is not likely to jeopardize the continued existence of bull trout, Lahontan cutthroat trout, Warner suckers, Northern spotted owls, marbled murrelets, streaked horned larks, Fender's blue butterfly, Oregon silverspot butterfly, Taylor's checkerspot butterfly, vernal pool fairy shrimp, Roy Prairie pocket gopher, Olympia pocket gopher, Tenino pocket gopher, Yelm pocket gopher, Bradshaw's lomatium, Cook's desert parsley, Gentner's fritillary, golden paintbrush, Howell's spectacular thelypody, Kincaid's lupine, large-flowered meadowfoam, Nelson's checkermallow, rough popcornflower, Spalding's catchfly, Ute ladies'-tresses, water howellia, Wenatchee mountain checker-mallow, Western lily, and Willamette daisy, or result in the destruction or adverse modification of critical habitat that has been designated for bull trout, Warner suckers, Oregon silverspot butterfly, vernal pool fairy shrimp, Cook's desert parsley, large-flowered meadowfoam, and Wenatchee mountain checker-mallow. Our conclusions are based on information provided in the sections above, and the body of literature and information referenced in this document.

7 INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulation pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. Harm is defined by the Service as an act which actually kills or injures wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavior patterns, including breeding, feeding, or sheltering (50 CFR 17.3). Harass is defined by the Service as an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering (50 CFR 17.3). Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by the Action Agencies so that they become binding conditions of any grant or permit issued to any party conducting restoration work under this Opinion, as appropriate, for the exemption in section 7(o)(2) to apply. The Action Agencies have a continuing duty to regulate the activity covered by this incidental take statement. If the Action Agencies 1) fail to assume and implement the terms and conditions or 2) fail to require partners provided coverage under this Opinion to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Action Agencies must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement [50 CFR 402.14(i)(3)]. Only incidental take that meets the terms and conditions of this incidental take statement will be exempt from the taking prohibition.

7.1 ESA-Listed Fish Species- Amount and Extent of Take

Work necessary to construct and maintain the restoration projects that will be authorized or carried out each year under this Opinion will take place adjacent to and within aquatic habitats that are reasonably certain to be occupied by individuals of one or more of the 26 ESA-listed species considered in this Opinion. As described below, each type of restoration action is likely to cause incidental take of one or more of those species. All life history stages of fish (other than eggs) are anticipated to be adversely affected.

Inwater work area isolation may require the capture and handling of all life history stages of ESA-listed fish for salvage purposes, which will result in take (kill, capture, injury). Isolation is necessary to minimize construction-related disturbance of streambank and channel areas caused by fish passage restoration; dam, tide/flood gate, and legacy structure removal; tide/flood gate replacement or retrofit; channel reconstruction/relocation; off- and side-channel habitat restoration; and the set-back or removal of existing berms, dikes, and levees. In-stream disturbance that cannot be avoided by work area isolation will lead to short-term increases in suspended sediment, temperature, dissolved oxygen demand, or other contaminants, and an overall decrease in habitat function that harms adult and juvenile fish by denying them normal use of the action area for reproduction, rearing, feeding, or migration. Exclusion from preferred habitat areas causes increased energy use and an increased likelihood of predation, competition and disease that is reasonably likely to result in some level of injury and perhaps death of some individual fish.

Similarly, adult, sub-adult and juvenile fish may be harmed by construction-related disturbance of upland, riparian and in-stream areas for actions related to large wood, boulder, and gravel placement; streambank restoration; reduction/relocation of recreation impacts; livestock fencing, stream crossings and off-channel livestock watering; piling, marine debris and other structure removal; shellfish bed/nearshore habitat restoration; in-channel nutrient enhancement; road and trail erosion control and decommissioning; invasive species and non-native plant control; juniper removal; restore native vegetation; native fish protection; wetland restoration; beaver habitat restoration; physical and biological surveys; and related in-stream work. The effects of those actions will include additional short-term reductions in water quality, as described above, and may also harm adult and juvenile fish as described above. Herbicide applications may result in herbicide drift or transportation into streams that will harm listed species by chemically impairing normal fish behavioral patterns related to feeding, rearing, and migration.

Projects that require two or more years of work to complete may cause adverse effects that last proportionally longer, and effects related to runoff from the project site may be exacerbated by winter precipitation. These adverse effects may continue intermittently for weeks, months, or years until riparian vegetation and floodplain vegetation are restored and a new topographic equilibrium is reached.

The Action Agencies will reinitiate consultation on the entirety of this consultation if they capture more fish or exceed mortality or injuries in any IRU or affected basin, as provided below (Table 33).

7.1.1 Capture of Fish During In-water Work Area Isolation

The Action Agencies anticipate completing an average of 126 aquatic (stream and river) restoration projects annually. The majority of these projects will be done within the Puget Sound/Olympic Peninsula coast, and associated tributaries (approximately 65%), with the remainder in the Columbia River, coast and associated tributaries (35%). The Service assumes that 60% of those projects (*i.e.*, 76 restoration projects per year) will require in-water work involving fish capture. The capture and handling of ESA-listed fish for salvage purposes will result in direct take (kill, capture, injury). However, the direct take resulting from salvage operations will minimize the incidental take of individual fish from stream diversion/dewatering activities.

7.1.1.1 Bull Trout

Given the great variability in project locations from year to year, the Service assumes that 76 projects per year on average will be implemented within the range of bull trout and require inwater work. For these projects, up to 404 individual bull trout (6 fish per project on average) may be captured and released per year. Of those 404 bull trout, we assume up to 5% of those fish (21 fish total per year) may be inadvertently killed or injured as a result of fish capture necessary to isolate in-water construction areas. Most of these fish are anticipated to be juveniles, but some number of sub-adults and adults will be captured. For utility of operation the Service will not separate actual take numbers between juveniles, sub-adults and adults, but will assume that most (at least 95%) of the capture would be juveniles. To account for variability in project funding between years, take will be calculated on a rolling three-year average. Based on previous years, we assume 35% of the restoration projects will occur in the Columbia River Basin, and 65% will occur in the Coastal/Puget Sound IRU. Take for each IRU is provided below. If more than 404 bull trout are captured, or more than 21 bull trout are harmed annually, as calculated by a three-year rolling average, or the amount or extent of take is exceed for either IRU (also calculated by a three-year rolling average), the Action Agencies must reinitiate consultation (Table 33).

7.1.1.2 Lahontan Cutthroat Trout

The Service assumes that one project will be done each year on average that could require the capture of fish within the range of Lahontan cutthroat trout. Because low flows exist within Lahontan cutthroat trout habitat during that part of the year when such projects would be implemented it is unlikely that very many fish would require salvage. Therefore, we assume that no more than five Lahontan cutthroat trout will be captured in any one restoration project (Table 33), as calculated on a three-year rolling average. This would equate to a total number of 15 Lahontan cutthroat trout over a consecutive three-year period. Mortality or injury is also expected to be low. Using a 5% injury/mortality rate (5% x 5 fish), the Service estimates that no more than one (rounded up to the whole fish) Lahontan cutthroat trout would suffer injury or mortality per year. If more than 5 Lahontan cutthroat trout are captured, or more than 1 Lahontan cutthroat trout are harmed, as calculated by a rolling three-year average, the Action Agencies must reinitiate consultation.

Table 33. Estimate of the amount of average capture, per year, for projects authorized or carried out under PROJECTS. Compliance with these take levels will be calculated on a rolling three-year average. "n" = the estimated number of projects per year that will require work area isolation.

Type of Take per Year	Bull Trout		Lahontan Cutthroat Trout	Warner Sucker
	Columbia River IRU n=28	Coastal Puget Sound IRU n=48	SE Oregon n=1	Warner Basin n= 2
fish captured	142	262	5	40
fish killed or injured (rounded up to whole number)	8	13	1	2

7.1.1.3 Warner Sucker

Warner suckers could be exposed to an average of two projects per year that would require capture. Based on past experience, approximately 20 Warner suckers could be captured during any project that requires de-watering. This equates to an average of 40 fish per year (Table 33). Using an injury/mortality rate of 5% the Service estimates that 2 suckers could be killed or injured annually. If more than 40 Warner suckers are captured, or more than 2 are injured or killed annually, as calculated on a three-year rolling average, the Action Agencies must reinitiate consultation.

7.1.2 Harm due to Habitat-Related Effects on ESA-Listed Fish Species

Take caused by the habitat-related effects of this action cannot be accurately quantified as a number of fish because the distribution and abundance of fish that occur within an project site are affected by habitat quality, competition, predation, and the interaction of processes that influence genetic, population, and environmental characteristics. These biotic and environmental processes interact in ways that may be random or directional, and may operate across far broader temporal and spatial scales than are affected by projects that will be completed under the proposed program. Thus, the distribution and abundance of fish within the program action area cannot be attributed entirely to habitat conditions, nor can the Service precisely predict the number of fish that are reasonably certain to be injured or killed if their habitat is modified or degraded by actions that will be completed under the proposed program. Additionally, there is no practical way to count the number of fish exposed to the adverse effects of the proposed action without causing additional stress and injury. In such circumstances, the Service uses the causal link established between the activity and the likely changes in habitat conditions affecting the listed species to describe the extent of take as a numerical level of habitat disturbance.

The Action Agencies must reinitiate consultation if they cover more stream miles, turbidity plume distance, or acres of vegetation treatments, as described below.

7.1.2.1 Suspended sediment and contaminants

For projects involving near- and in-water construction, the extent of take due to suspended sediment and contaminants is best identified as the maximum extent of the turbidity plume generated by construction activities. The distance that take (turbidity) will extend downstream will be proportional to the size of the stream. A turbidity flux will likely be measureable downstream from a nonpoint discharge a proportionately shorter distance in small streams than large streams.

The Action Agencies will complete and record the following water quality observations to ensure that any increase in suspended sediment is not exceeding this limit:

1. Take a turbidity sample using a turbidimeter, or a visual turbidity observation, every 4 hours when work is being completed, or more often as necessary to ensure that the in-water work area is not contributing visible sediment to water, at a relatively undisturbed area approximately 30.5 m (100 feet) upstream from the project area, or 91.4 m (300 feet) from the project area if subject to tidal or coastal scour. Record the observation, location, and time before monitoring at the downstream point.
2. Take a second visual observation, immediately after each upstream observation, approximately 15.2 m (50 feet) downstream from the project area in streams that are 9.2 m (30 feet) wide or less, 30.5 m (100 feet) from the project area for streams between 15.2 and 30.5 m (30 and 100 feet) wide, 61 m (200 feet) from the discharge point or nonpoint source for streams greater than 30.5 m (100 feet) wide, and 91.4 m (300 feet) from the discharge point or nonpoint source for areas subject to tidal or coastal scour. Record the downstream observation, location, and time.
3. Compare the upstream and downstream observations. If more turbidity or pollutants are observed downstream than upstream, the activity must be modified to reduce pollution. Continue to monitor every 4 hours until sediment releases cease to occur.
4. If the exceedance continues after the second monitoring interval (after 8 hours), the activity must stop until the turbidity or pollutant level returns to background.

The extent of take will be exceeded if the turbidity plume generated by construction activities is visible above background levels, about 10% increase in natural stream turbidity, downstream from the project area source as follows: A visible increase in suspended sediment (as estimated using turbidity measurements) 15.2 m (50 feet) from the project area in streams that are 9.14 m (30 feet) wide or less, 30.5 m (100 feet) from the discharge point or nonpoint source of runoff for streams between 9.1 and 30.5 m (30 and 100 feet) wide, 61 m (200 feet) from the discharge point or nonpoint source for streams greater than 30.5 m (100 feet) wide, or 91.4 m (300 feet) from the discharge point or nonpoint source for areas subject to tidal or coastal scour. If monitoring or inspections show that the pollution controls are ineffective, immediately mobilize work crews to repair, replace, or reinforce controls as necessary.

7.1.2.2 Construction-related disturbance of streambank and channel areas

The best available indicator for the extent of take due to construction-related disturbance of streambank and channel areas is the total length of stream reach that will be modified by construction each year. This total length of stream reach that will be modified by construction each year is proportional to the amounts of harm that each action is likely to cause through short-term degradation of water quality and physical habitat. The Action Agencies reported for 2010 to 2012 that nearly 14.5 km (9 linear-miles) of channel and stream banks were restored on 16 restoration projects, which is roughly 0.9 km (0.56 stream miles) per project. These 16 projects represented approximately one-fourth (25%) of the 63 total projects during that timeframe.

We estimate 32 stream bank- and channel-altering actions per year will be funded or carried out under the proposed restoration activities. Therefore, the extent of take for construction-related disturbance of streambank and channel areas is up to 29 linear km (32 projects x 0.9 km = 28.8 km) or 29,000 stream-meters per year across the action area, as calculated on three-year rolling average. In English units, this is equivalent to 18 linear miles (32 projects x 0.56 miles = 17.92 miles) (94,618 stream-feet).

7.1.2.3 Application of herbicides to control invasive and non-native plant species in riparian habitats.

Application of manual, mechanical or chemical plant controls will result in short-term reduction of vegetative cover, soil disturbance, and degradation of water quality, which will cause injury to fish in the form of sublethal adverse physiological effects. This is particularly true for herbicide applications in riparian areas or in ditches that may deliver herbicides to streams occupied by ESA-listed fish species. These sublethal effects, described in the effects analysis for this Opinion, will include increased respiration, reduced feeding success, and subtle behavioral changes that can result in predation. Based on the discussion provided above in the effects section, the extent of take due to the proposed invasive plant control is the proposed extent of treated areas, *i.e.*, less than, or equal to, 10% of the acres of riparian habitat within a 6^{th-}field HUC per year across the action area.

7.2 Marbled Murrelet - Amount and Extent of Take

Take of murrelets will occur from disruption related to the Action Agencies' project activities within the action area. In Oregon and Washington, we anticipate up to three nests may be harassed per year associated with 15 projects (including surveys). No more than three nests, or three chicks or eggs (one per nest) may be taken per year, as calculated on a three-year rolling average. This will result in the harassment (reduced fitness or greater risk of predation through disrupting normal behavioral patterns) of up to nine murrelets per consecutive three-year period in recovery zones 1, 2, 3, and 4 under this Opinion.

The Service will not refer the incidental take of any migratory bird for prosecution under the Migratory Bird Treaty Act of 1918, as amended (16 U.S.C. 703-711), if such take is in compliance with the terms and conditions (including amount and/or number) specified herein.

7.3 Northern Spotted Owl - Amount and Extent of Take

Take of spotted owls will occur from disruption related to the Action Agencies' project activities in Oregon and Washington in the action area. The Service anticipates that up to two spotted owl nests, or four owls, may be harassed per year associated with 8 projects, including surveys. No more than two nests, or four owls (two owls per nest), maybe taken in per year, as calculated on a three-year rolling average. This will result in a maximum harassment through injury (reduced fitness or greater risk of predation) of up to six nests (or 12 owls) per consecutive three-year period in Oregon and Washington.

The Service will not refer the incidental take of any migratory bird for prosecution under the Migratory Bird Treaty Act of 1918, as amended (16 U.S.C. 703-711), if such take is in compliance with the terms and conditions (including amount and/or number) specified herein.

7.4 Streaked Horned Lark- Amount and Extent of Take

The Service anticipates that the habitat restoration activities implemented under the PROJECTS program will result in the following forms of take of streaked horned larks:

- Virtually all streaked horned larks present on suitable habitat at restoration sites will be non-lethally harassed by the habitat restoration activities.
- A small but unquantifiable number of streaked horned larks will be harmed through the temporary loss of suitable habitat caused by the habitat restoration activities.
- A small but unquantifiable number of streaked horned larks will be harassed by surveys and monitoring before, during and after habitat restoration activities are implemented.
- A small number of streaked horned lark eggs and nestlings may die as a result of crushing or temporary abandonment by adults that are harassed due to habitat restoration activities. We estimate this number to be no more than 20% of nests at each restoration site; each nest may contain up to 3 to 5 eggs or nestlings.
- A small but unquantifiable number of streaked horned larks (all age classes) will be harmed by the immediate and delayed effects of chemical treatments for invasive plant control.

The take described above will be difficult to detect or quantify; the sublethal effects of harassment and harm may take years to manifest, and nests destroyed or individuals killed by habitat restoration activities may be missed, even with pre-project surveys. Instead the amount of take authorized by this Opinion will be tracked through the amount of habitat treated. We estimate that an average of 5,410 acres of potential lark habitat will be treated each year under the PROJECTS habitat restoration programs. The amount of take authorized by this Biological Opinion will have been exceeded if the amount of habitat treated at sites that may have streaked horned larks exceeds 5,410 acres, as calculated by a three-year rolling average.

The Service will not refer the incidental take of any migratory bird for prosecution under the Migratory Bird Treaty Act of 1918, as amended (16 U.S.C. 703-711), if such take is in compliance with the terms and conditions (including amount and/or number) specified herein.

7.5 ESA-Listed Butterflies

The Service anticipates that ESA-listed butterflies will be taken in the form of harm as a result of the proposed actions. All life stages (eggs, larvae, pupae, and adults) may be taken. Take will be in the form of sub-lethal and lethal losses to any or all of the life stages depending on the timing, intensity, and frequency of activities. However, the Service anticipates incidental take of butterfly individuals will be difficult to detect for the following reason(s):1) background levels of mortality are commonly high among invertebrate species, especially during early life stages, 2) assessments or verification of mortality are difficult because detection of individuals under field conditions is difficult, particularly during early life stages, and 3) the numbers affected may vary widely from year to year with fluctuating population levels, densities, and environmental conditions, and thus the amount of take will be dependent on population size and density at the time of the restoration action. Therefore, even though take is expected to occur, data are insufficient to enable the Service to estimate an exact number of individuals that will be taken for restoration actions. Instead, the level of take will be monitored and assessed by either the total quantity of, or proportion of, occupied or assumed occupied butterfly site that would be restored under the proposed action. This assumes the number of individuals likely to be killed is roughly proportional to the quantity of habitat exposed to the stressors that are reasonably certain to cause incidental take (prescribed fires, mowing, herbicide application, livestock grazing, and the foot traffic associated with all activities).

Timing and habitat limitations, as addressed under the proposed action, PDC and each butterfly conservation measures based on specific activities, will reduce the likelihood of take for the species. These activities will likely result in increasing ESA-listed butterfly populations and their associated host and nectar plant species in the restored areas. Species-specific information on take limitations are listed in the following sections.

7.6 Fender's Blue Butterfly- Amount and Extent of Take

The Service anticipates the following maximum annual incidental take of Fender's blue butterflies (all lifestages) associated with the proposed restoration activities on no more than 1,330 acres per year:

1. Mowing, use of manual and power tools, sod rolling, tilling, disking, use of shade cloth and solarization, propagation, augmentation and reintroduction, and surveys and monitoring may cause death or injury of a negligible percentage of larvae and eggs in the action area due to crushing during soil compaction by mowers and other vehicles, suction by mower, and trampling by foot traffic.

2. Chemical treatment activities have been designed to avoid harming butterflies and minimize exposure of larval Fender's blue butterflies to herbicides. At sites supporting 100 or more adult Fender's blue butterflies, the size of the area treated with herbicides will be no more than one half of the occupied habitat actively used by butterflies. At sites supporting fewer than 100 adult Fender's blue butterflies, the size of the area treated with herbicides will be no more than one third of the occupied habitat. We cannot calculate the number of larvae that will be killed or injured by incidental exposure to herbicide but given the targeted applications methods specified expect any death or injury to be less than 5% of larvae in the action area.

3. Prescribed burning may result in 100% mortality of larvae at all burned areas, which could be as much as one-third of each site within the action area based on the proposed areal limitations for burning within Fender's blue butterfly habitats.

4. Raking may result in the death or injury of a negligible percentage of larvae and eggs in the action area due to crushing or removal from habitat during removal of duff and litter layer.

7.7 Oregon Silverspot Butterfly- Amount and Extent of Take

The Service anticipates the following maximum annual incidental take of Oregon silverspot butterflies associated with the proposed restoration activities on no more than 12.5 acres per year:

1. Mowing, use of manual and power tools, sod rolling, tilling, disking, use of shade cloth and solarization, propagation, augmentation and reintroduction, and surveys and monitoring may cause death or injury of a negligible percentage of larvae and eggs in the project area due to crushing during soil compaction by mowers and other vehicles, suction by mower, and trampling by foot traffic.

2. Mowing will be allowed on up to 75% of an occupied area.

3. Raking will be allowed on one-third of an occupied area where there is more than 200 Oregon silverspot butterflies, and on one quarter of an occupied area where there is less than 200 Oregon silverspot butterflies.

4. Prescribed burning may result in 100% mortality of larvae at all burned areas. Burning will be allowed on one-third of an occupied area where there is more than 200 Oregon silverspot butterflies, and on one quarter of an occupied area where there is less than 200 Oregon silverspot butterflies.

5. Chemical treatment activities have been designed to avoid harming butterflies and minimize exposure of larval butterflies to herbicides. We cannot calculate the number of larvae that will be killed or injured by incidental exposure to herbicide but given the targeted applications methods specified expect any death or injury to be less than 5% of larvae in the action area. Herbicide applications may be used on 100% of an occupied area, provided seasonal timing restrictions and buffer distances are followed.

7.8 Taylor's Checkerspot Butterfly- Amount and Extent of Take

The Service anticipates the following maximum annual incidental take of Fender's blue butterflies (all lifestages) associated with the proposed restoration activities on no more than 1,330 acres per year:

1. Mowing, use of manual and power tools, tree/vegetation removal, native plantings, fencing, and foot traffic associated with all activities may cause death or injury of a negligible percentage of larvae and eggs in the action area due to crushing during soil compaction by mowers and other vehicles, suction by mower, and trampling by foot traffic.

2. Chemical treatment activities have been designed to avoid harming butterflies and minimize exposure of larval TCB to herbicides. We cannot calculate the number of larvae that will be killed or injured by incidental exposure to herbicide but given the targeted applications methods specified expect any death or injury to be less than 1% of

larvae in the action area. Herbicide applications may be used on 100% of an occupied area, provided seasonal timing restrictions and buffer distances are followed.

3. Prescribed burning may result in 100% mortality of larvae at all burned areas, which could be as much as one-third of each site within the action area based on the proposed areal limitations for burning within TCB habitats.

7.9 Vernal Pool Fairy Shrimp- Amount and Extent of Take

The Service anticipates that vernal pool fairy shrimp (fairy shrimp) will be taken in the form of harm, mortality, injury and harassment due to direct and indirect impacts of restoration activities in vernal pool complexes in Jackson County, Oregon. All life stages (cysts and adults) may be taken. Take will be in the form of sub-lethal and lethal losses to any or all of the life stages depending on the timing, intensity, and frequency of activities. However, the Service anticipates incidental take of fairy shrimp individuals will be difficult to detect for the following reason(s): 1) assessments or verification of mortality are difficult because detection of individuals under field conditions is difficult, and 2) the numbers affected may vary widely from year to year with fluctuating population levels, densities, and environmental conditions, and thus the amount of take will be dependent on population size and density at the time of the restoration action. Therefore, even though take is expected to occur, data are insufficient to enable the Service to estimate an exact number of individuals that will be taken for restoration actions. Instead, the level of take will be monitored and assessed by the total quantity of occupied vernal pool habitats that would be restored under the proposed actions (prescribed fires, mowing, herbicide application, livestock grazing, wetland and aquatic restoration actions, and the foot traffic associated with all activities).

The Service anticipates that all lifestages of fairy shrimp will be taken in 266 acres of habitat annually, as calculated on a rolling three-year average, due restoration activities in vernal pool complexes in Oregon. Timing and habitat limitations and other restrictions, as addressed under the proposed action, PDC and fairy shrimp conservation measures based on specific activities, will reduce the likelihood of take for the species. These activities will likely result in improving vernal pool complexes that support fairy shrimp populations in the restored areas.

7.10 Mazama Pocket Gopher (Four Subspecies)

The Service anticipates incidental take of Roy Prairie, Olympia, Tenino, or Yelm pocket gophers will be difficult to detect because Mazama pocket gophers are fossorial, and as such finding a dead or impaired specimen is unlikely. Instead, the level of take can be monitored and assessed by the quantity of Roy Prairie, Olympia, Tenino, and Yelm pocket gopher habitat within Nisqually soils that are mowed, harrowed, or raked because the number of individuals likely to be harmed or harassed is proportional to the amount of habitat exposed to the stressors that are reasonably certain to cause incidental take due to those actions.

7.10.1 Roy Prairie Pocket Gopher- Amount and Extent of Take

We anticipate incidental take of an unknown number of Roy Prairie pocket gophers associated with a maximum of approximately 8 acres each year (averaged over 5 years) of Roy Prairie pocket gopher habitat that will receive broadcast applications of glyphosate or Garlon (or similar-acting herbicides). This take is in the form of harm (death of individuals due to starvation as a result of loss of forage habitat) or harass (loss of fitness due to starvation as a result of loss of forage habitat).

We anticipate incidental take of a small number of Roy Prairie pocket gophers associated with an average of 10.4 acres of occupied habitat each year (averaged over 5 years) that may be directly impacted by restoration treatments (mowing, broadcast application of glyphosate or Garlon (or similar-acting herbicides) in areas with little or no residual native forb component, seeding with a harrow, and raking) under the proposed action. This take is in the form of harm (crushing or killing individuals that are trapped just below the surface when wheeled or tracked equipment traverses occupied habitat).

7.10.2 Olympia Pocket Gopher- Amount and Extent of Take

We anticipate incidental take of an unknown number of Olympia pocket gophers associated with a maximum of approximately 27 acres each year (averaged over 5 years) of Olympia pocket gopher habitat that will receive broadcast applications of glyphosate or Garlon (or similar-acting herbicides). This take is in the form of harm (death of individuals due to starvation as a result of loss of forage habitat) or harass (loss of fitness due to starvation as a result of loss of forage habitat).

We anticipate incidental take of a small number of Olympia pocket gophers associated with an average of 35.4 acres of occupied habitat each year (averaged over 5 years) that may be directly impacted by restoration treatments (mowing, broadcast application of glyphosate or Garlon (or similar-acting herbicides) in areas with little or no residual native forb component, seeding with a harrow, and raking) under the proposed action. This take is in the form of harm (crushing or killing individuals that are trapped just below the surface when wheeled or tracked equipment traverses occupied habitat).

7.10.3 Tenino Pocket Gopher- Amount and Extent of Take

We anticipate incidental take of an unknown number of Tenino pocket gophers associated with a maximum of approximately 16 acres each year (averaged over 5 years) of Tenino pocket gopher habitat that will receive broadcast applications of glyphosate or Garlon (or similar-acting herbicides) . This take is in the form of harm (death of individuals due to starvation as a result of loss of forage habitat) or harass (loss of fitness due to starvation as a result of loss of forage habitat).

We anticipate incidental take of a small number of Tenino pocket gophers associated with an average of 20.7 acres of occupied habitat each year (averaged over 5 years) that may be directly impacted by restoration treatments (mowing, broadcast application of glyphosate or Garlon (or similar-acting herbicides) in areas with little or no residual native forb component, seeding with a harrow, and raking) under the proposed action. This take is in the form of harm (crushing or killing individuals that are trapped just below the surface when wheeled or tracked equipment traverses occupied habitat).

7.10.4 Yelm Pocket Gopher- Amount and Extent of Take

We anticipate incidental take of an unknown number of Yelm pocket gophers associated with a maximum of approximately 21 acres each year (averaged over 5 years) of Yelm pocket gopher habitat that will receive broadcast applications of glyphosate or Garlon (or similar-acting herbicides). This take is in the form of harm (death of individuals due to starvation as a result of loss of forage habitat) or harass (loss of fitness due to starvation as a result of loss of forage habitat).

We anticipate incidental take of a small number of Yelm pocket gophers associated with an average of 28 acres of occupied habitat each year (averaged over 5 years) that may be directly impacted by restoration treatments (mowing, broadcast application of glyphosate or Garlon (or similar-acting herbicides) in areas with little or no residual native forb component, seeding with a harrow, and raking) under the proposed action. This take is in the form of harm (crushing or killing individuals that are trapped just below the surface when wheeled or tracked equipment traverses occupied habitat).

7.11 Effect of the Take

As provided in the earlier sections of this Opinion, the Service determined that the level of anticipated take is not likely to result in jeopardy to the bull trout, Lahontan cutthroat trout, Warner suckers, Northern spotted owls, marbled murrelets, streaked horned larks, Fender's blue butterfly, Oregon silverspot butterfly, Taylor's checkerspot butterfly, vernal pool fairy shrimp, Roy Prairie pocket gopher, Olympia pocket gopher, Tenino pocket gopher, or Yelm pocket gopher.

7.12 Reasonable and Prudent Measures

"Reasonable and prudent measures" are nondiscretionary measures to minimize the amount or extent of incidental take (50 CFR 402.02). The Service believes the following reasonable and prudent measures are necessary and appropriate to minimize the impact of incidental take of listed species from the proposed program.

The Action Agencies will:

1. Provide technical assistance to project cooperators, to the maximum extent practicable, when developing, designing, planning, implementing, and monitoring restoration/recovery projects.
2. Minimize incidental take due to authorizing or conducting restoration projects by ensuring that all such projects use the conservation measures described in this Opinion, as appropriate.
3. Ensure completion of a comprehensive monitoring and reporting program regarding all restoration projects conducted by the Action Agencies.
4. For all species of Mazama pocket gopher only (Roy Prairie, Olympia, Tenino, and Yelm pocket gophers), the Action Agencies will monitor and report incidental take caused by the proposed programs that fund or carry out upland restoration projects in the range of the Roy Prairie, Olympia, Tenino, and Yelm pocket gophers.

7.12.1 Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, the Action Agencies must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. The terms and conditions described below are non-discretionary, and the Action Agencies, or any other party affected by these terms and conditions must comply with them to implement the reasonable and prudent measures (50 CFR 402.14). The Action Agencies have a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this incidental take statement (50 CFR 402.14). If the following terms and conditions are not complied with, the protective coverage of section 7(o)(2) will lapse.

1. To implement reasonable and prudent measure #1 (conservation measures for restoration projects), the Action Agencies shall ensure that:
    a. Every action funded or carried out under this Opinion will be administered by the Action Agencies consistent with conservation measures 1 through 12.
    b. For each action involving construction, conservation measures 13 through 32, as appropriate, will be added as conditions of funding.
    c. For specific types of actions, the Action Agencies will apply criteria 33 through 53 as appropriate.
    d. Monitor the effects of each project during implementation to ensure compliance with PDC, conservation measures and other requirements addressed in the Opinion.
2. To implement reasonable and prudent measure #2 (minimize incidental take), the Action Agencies shall ensure that:
    a. Prior to submitting the restoration implementation form, the Action Agency project manager for each restoration action will ensure all appropriate PDC and species-specific conservation measures are incorporated in the project design.
    b. Prior to submitting the restoration implementation form, the Action Agency project manager for each restoration action will obtain the any necessary local Service office approvals.
    c. Use a tracking protocol to ensure the overall annual extent of incidental take (as calculated by rolling 3-year averages) of each listed species is not exceeded during the term of this Opinion and ensure that funded entities will not cumulatively exceed the extent of authorized take.

3. To implement reasonable and prudent measure #3 (monitoring and reporting), the Action Agencies shall ensure that:
    a. The following notifications and reports (Appendix B) are submitted to Service for each project to be completed under this Opinion. All notifications and reports are to be submitted electronically to the Service at PROJECTS@fws.gov.
        i. Project notification at least 30-days before start of construction (Part 1).
        ii. Project completion within 60-days of end of construction (Part 1 with Part 2 completed).
        iii. Fish salvage within 60-days of work area isolation with fish capture (Part 1 with Part 3 completed).

b. The Action Agencies will each submit a monitoring report to the Service by March 31 each year that describes the Action Agencies' efforts to carry out this Opinion. The report will include an assessment of overall program activity, a map showing the location and type of each action authorized and carried out under this Opinion, and any other data or analyses the Action Agencies deem necessary or helpful to assess habitat trends as a result of actions authorized under this Opinion.

c. The Action Agencies will each attend an annual coordination meeting with the Service by March 31 each year to discuss the annual monitoring report and any actions that will improve conservation under this Opinion, or make the program more efficient or more accountable.

d. Failure to provide timely reporting may constitute a modification of this Opinion that has an effect to listed species or critical habitat that was not considered in the Opinion and thus may require reinitiation of this consultation. Outside of the take authorized by this Opinion, permittees and grantees should be directed to notify the Service within three working days upon locating a dead, injured or sick endangered or threatened species specimen. Initial notification must be made to the nearest Service Law Enforcement Office. Notification must include the date, time, precise location of the injured animal or carcass, and any other pertinent information. Care should be taken in handling sick or injured specimens to preserve biological materials in the best possible state for later analysis of cause of death, if that occurs. In conjunction with the care of sick or injured endangered or threatened species or preservation of biological materials from a dead animal, the finder has the responsibility to ensure that evidence associated with the specimen is not unnecessarily disturbed. Contact the appropriate U.S. Fish and Wildlife Service Law Enforcement Office:

- Idaho: (208) 523-0855
- Oregon: (503) 682-6131
- Washington: (425) 883-8122

4. To implement reasonable and prudent measure #4 (monitoring and reporting for Mazama pocket gophers), the Action Agencies shall ensure that:

a. The Action Agencies must include the following special term and condition with all issued funds to ensure that the level of authorized incidental take is not exceeded: "[Funded entity] shall record the approximate yearly quantity of acres at each occupied site on Nisqually soils that received mowing, broadcast spraying, seeding with a harrow, or raking restoration treatments. Location of the site must be included, in order to determine which subspecies is/are affected. Include information on equipment used for each treatment type, and whether they made single passes or criss-cross passes with the equipment. Measurements of tire widths and wheel bases of equipment shall be kept. [Funded entity] shall provide these numbers to the Service by March 31 annually for the duration of the issued permit." Take will be calculated as total number of occupied acres that are treated with mowing, broadcast spraying, seeding with a harrow, or raking, multiplied by 26%. Example: 40 acres of habitat occupied by Olympia pocket gophers, seeded with a harrow, would be reported as 10.4 acres of Olympia pocket gopher habitat impacted, and counted against the allowable take limits.

b. "[Funded entity] shall record the approximate yearly quantity of acres at each occupied site that received broadcast spraying treatments with glyphosate or Garlon. Only record acres when there is little or no residual native forb component on the treated site(s). Location of the site must be included, in order to determine which subspecies is/are affected. [Funded entity] shall provide these numbers to the Service by March 31 annually for the duration of the issued permit." Take will be calculated as total number of degraded (as described above) occupied acres that are treated with broadcast spraying of glyphosate or Garlon, multiplied by 26%. Example: 40 acres of degraded habitat (as described above) occupied by Olympia pocket gophers, broadcast sprayed with glyphosate, would be reported as 8 acres of Olympia pocket gopher habitat impacted, and counted against the allowable take limits.

c. The Action Agencies must keep a record of the total take that has been funded or carried out by the proposed restoration programs in Roy Prairie, Olympia, Tenino, or Yelm pocket gopher-occupied habitat and include special terms and conditions as necessary to ensure that funded entities will not cumulatively exceed the extent of authorized take.

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize or eliminate the impact of incidental take that might otherwise result from the proposed action. If, during the course of the action, this level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided. The Action Agencies must immediately provide an explanation of the causes of the take, and review with the Service the need for possible modification of the reasonable and prudent measures.

7.12.2 Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA 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.

A. The Service recommends that the Action Agencies consider biological needs of lamprey species whenever they plan or conduct any instream or near-stream projects. An effort to follow all recommendations found in Best Management Practices to minimize adverse effect to Pacific Lamprey http://www.fws.gov/columbiariver/publications/BMP_Lamprey_2010.pdf will improve habitat conditions for all native fish, and may aid in the recovery of ESA-listed fish within the action area.

B. In order for the Service to be kept informed of actions that minimize or avoid adverse effects or that benefit listed species or their habitats, the Service that a copy of any relevant publications for conserving listed species and their habitats are sent to:

State Supervisor
USFWS- Oregon Fish and Wildlife Office
2600 SE 98th Avenue, Suite 100
Portland, Oregon 97266

C. In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations. Please provide notification in writing, or by email, to the following:

State Supervisor
USFWS- Oregon Fish and Wildlife Office
2600 SE 98th Avenue, Suite 100
Portland, Oregon 97266
Email: PROJECTS@fws.gov

D. For all 4 species of the Mazama pocket gopher, the Service recommends the Action Agencies or project applicant implement the following conservation recommendations:

(1) Conduct regular and repeated (every 5 to 10 years) reanalyses of cumulative effects that may negatively impact Mazama pocket gopher status.
(2) In order to reduce the likelihood of impacting Mazama pocket gophers, all burn plans for prescribed fires in gopher habitat will be reviewed and approved by Service.
(3) Prioritize prompt reestablishment of native prairie species, in order to prevent the invasion of undesirable species, while avoiding disturbing Mazama pocket gophers or limiting availability of gopher forage vegetation. This will require protecting, enhancing, and sustaining native seed bed nursery capabilities.
(4) Use Colvin Ranch's Grassland Reserve Program livestock grazing plans as guidance for best management practices of this proposed action.
(5) Evaluate the qualities of different soils as they are encountered during restoration, in terms of their susceptibility to compaction from use of wheeled or tracked equipment. Report your findings to the Service.
(6) Survey treated areas prior to restoration treatments to fully determine the extent of the area used by gophers. Use the most-recent, Service-approved mound survey techniques/methods/protocol that will yield this information. Post-treatment, survey the treated areas to determine if and/or how the areal extent of gopher use changes. Use hand-held GPS devices to aid in mapping use areas. Post-treatment surveys should occur within a week or two, and then a minimum of once per season, for a minimum of two years. This suggested survey design may change over time, based on new information.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects, or benefiting Mazama pocket gophers or their habitats, the Service requests notification of the implementation of any conservation recommendations. Please provide notification in writing, or by email, to the following:

Mr. Curtis Tanner
USFWS- Washington Fish and Wildlife Office
510 Desmond Drive SE, Suite 102
Lacey, Washington 98503
Email: curtis_tanner@fws.gov

7.13 Reinitiation of Consultation

This concludes formal consultation on the action(s) outlined in the (request/reinitiation request). As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: 1) the amount or extent of incidental take is exceeded; 2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this Opinion; 3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this Opinion; or 4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

If monitoring and reporting are not done in accordance with the description of the proposed action, the Action Agencies need to reinitiate formal consultation in accordance with the requirements of 402.16(c). Failure to adequately monitor and report constitutes a change in the proposed action that may facilitate effects to listed species or critical habitat that were not considered in the Opinion. To reinitiate consultation, contact the Oregon State Office of the Service and refer to the Reference Number 01EOFW00-2014-F-0222.

8 GENERAL LITERATURE CITED

Please note each species section has its own literature cited list.

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